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SC3 Series AC Servo driver

User Manual



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About this Manual

This manual provides information required to select SC3 series AC Servo Drives, and to design, perform trial operation of, tune, operate, and maintain the Servo Drives.

Read and understand this manual to ensure correct usage of the SC3 series AC Servo Drives.

Keep this manual in a safe place so that it can be referred to whenever necessary.

Using This Manual

◆ Technical Terms Used in This Manual

The following terms are used in this manual.

Term	Meaning
Servo driver	SC3 series AC servo driver
Servomotor	A generic term used for a MA6 series Rotary Servomotor
Servo Drive	The combination of a Servomotor and a Servo driver.
Servo System	A servo control system that includes the combination of a Servo Drive with a host controller and peripheral devices.
Servo ON	Supplying power to the motor
Servo OFF	Not supplying power to the motor.
Servo Lock	A state in which the motor is stopped and is in a position loop with a position reference of 0.
Main Circuit Cable	One of the cables that connect to the main circuit terminals, including the Main Circuit Power Supply Cable, Control Power Supply Cable, and Servomotor Main Circuit Cable.
DB	Dynamic Brake

◆ Visual Aids

The following aids are used to indicate certain types of information for easier reference.



Indicates precautions or restrictions that must be observed.
Also indicates alarm displays and other precautions that will not result in machine damage.



Indicates definitions of difficult terms or terms that have not been previously explained in this manual.

Safety Precautions

◆ Safety Information

To prevent personal injury and equipment damage in advance, the following signal words are used to indicate safety precautions in this document. The signal words are used to classify the hazards and the degree of damage or injury that may occur if a product is used incorrectly. Information marked as shown below is important for safety. Always read this information and heed the precautions that are provided.

⚠ DANGER

- Indicates precautions that, if not heeded, are likely to result in loss of life, serious injury, or fire.

⚠ WARNING

- Indicates precautions that, if not heeded, could result in loss of life, serious injury, or fire.

⚠ CAUTION

- Indicates precautions that, if not heeded, could result in relatively serious or minor injury, or in fire.

NOTICE

- Indicates precautions that, if not heeded, could result in property damage.

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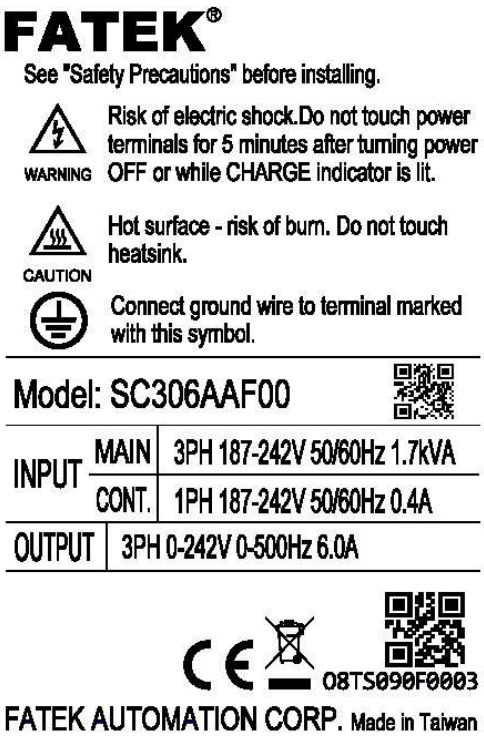
Chapter1. Basic Information on SC3

1.1 SC3 Series AC Servo driver

The SC3 series AC servo drivers are designed for applications that require frequent high-speed and high-precision positioning. The SC3 series AC servo drivers will make the most of machine performance in the shortest time possible, thus contributing to improving productivity.

1.2 Interpreting the Nameplate

The following basic information is provided on the nameplate.



1.3 Model Designations

1.3.1 Interpreting SC3 Series Model Numbers

■ 1-phase 220VAC / 3-phase 220VAC / 3-phase 380VAC

1	2	3	4	5	6
Series	Output Current	Rated Voltage	Motor	Control Type	# of Axes
SC3	06A	A	F	0	0

1	
Series	
Code	Specification
SC3	SC3 Series

2	
Continu Output Current	
Code	Specification
AC220V/380V	
03	3A
06	6.1A
08	8.5A
10	10A
12	12A
15	15A
16	16A
25	25A
28	28A

3	
Rated Voltage	
Code	Specification
A	AC220V
B	AC380C
C	--
D	AC380V+DC24V

4	
Motor Selection	
Code	Specification
A	50W
B	100W
C	200W
D	400W
E	750W
F	1KW
G	1.5KW
H	2KW
I	3KW
J	4KW
K	5KW
L	7.5KW

5	
Control Type	
Code	Specification
0	EtherCAT
1	Pulse

6	
# of Axes	
Code	Specification
0	1

Chapter2. Selecting a SC3 Servo Driver

2.1 Ratings and Specifications

2.1.1 Ratings

■ 1-phase 220VAC / 3-phase 220VAC

◆ SC3**03A**AD□□ / SC3**06A**AF□□ / SC3**08A**AG□□ / SC3**10A**AH□□

Model			03A	06A	08A	10A
Continuous Output Current [Amps]			3	6	8	10
Instan. Max. Output Current [Amps]			10	14	21	23
Main Circuit	Power Supply		1-phase / 3-phase AC 220V	3-phase AC 220V · -15% ~ +10%, 50 Hz / 60 Hz*1		
	Input Current [Amps]		1.9	3.9	5.4	6.3
Control Power Supply			1-phase AC 220V · -15% ~ +10%, 50 Hz / 60 Hz			
Power Supply Capacity [kVA]			1.3	1.7	2.4	2.8
Regenertative Resistor	Bulit-in Regenertative Resistor	Resistance [Ω]	-*2	40	40	40
		Capacity [W]	-	80	80	80
	Min. Allowable External Resistance [Ω]		30	15	12	12
Overvoltage Category			Ⅲ			

*1: If use 1-phase AC220V for power supply, the current output may not meet the spec.
*2: 03A servo driver have no bulit-in regenerative resistor.

■ 3-phase380VAC

◆ SC3**03A**DE□□ / SC3**06A**DH□□ / SC3**10A**DI□□ / SC3**15A**DK□□ / SC3**28A**BL□□

Model			03A	06	10A	15A	28A
Continuous Output Current [Amps]			3	6	10	15	28
Instan. Max. Output Current [Amps]			8.5	14	45	45	63
Main Circuit	Power Supply		3-phase AC 380V · -15% ~ +10%, 50 Hz / 60 Hz				
	Input Current [Amps]		3	5.9	9.7	15.5	24.8
Control Power Supply			DC 24V · -10% ~ +10%, 50W				1-phase AC 380V · -15% ~ +10%, 50 Hz / 60 Hz
Power Supply Capacity [kVA]			2.0	3.9	7.8	12.4	19.8
Regenertative Resistor	Bulit-in Regenertative Resistor	Resistance [Ω]	40	40	40	32	-*1
		Capacity [W]	80	80	40	150	-
	Min. Allowable External Resistance [Ω]		30	30	30	20	15
Overvoltage Category			Ⅲ				

*1: 28A servo driver have no bulit-in regenerative resistor.

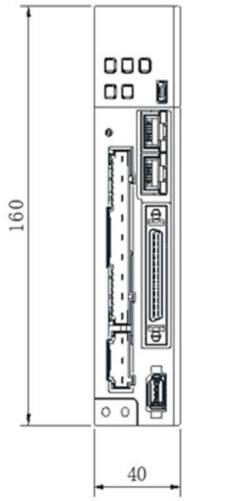
2.1.2 Specifications

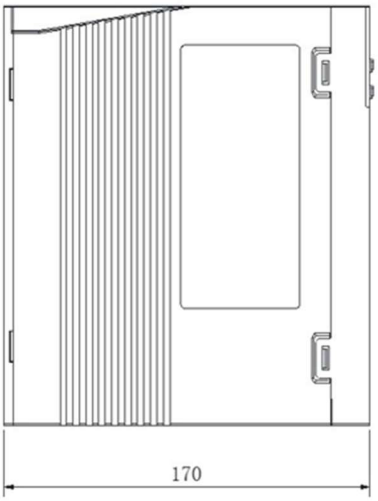
Item		Specification
Control Method		Position mode、JOG mode、speed mode...etc
Feedback		Serial encoder：17bits or 23bits (incremental encoder / absolute encoder)
Environment Conditions	Operation Temp.	0~+50℃
	Storage Temp.	-20~+85℃
	Environment Humidity	90% relative humidity max. (with no freezing or condensation)
	Storage Humidity	90% relative humidity max. (with no freezing or condensation)
	Vibration Resistance	4.9m/s^2
	Shock Resistance	19.6m/s^2
Mounting		Base-mounted
Performance	Speed Control Range	1:10000 (At the rated torque, the lower limit of the speed control range must not cause the Servomotor to stop.)
	Speed Response Freq.	3.1KHz
	Coefficient of Speed Flucuation	±0.01% of rated speed max. (for a load fluctuation of 0% to 100%)
		0% of rated speed max. (for a voltage fluctuation of ±10%)
		±0.1% of rated speed max. (for a temperature fluctuation of 25°C±25°C)
Speed Control	Reference Voltage	DC±10V
	Input Impedance	Approx. 20KΩ
	Circuit Time Constant	47us
Torque Control	Reference Voltage	DC±10V
	Input Impedance	Approx. 20KΩ
	Circuit Time Constant	47us
Digital Input	Number of points	8
	Input Signals That Can Be Allocated	Servo ON (/S-ON) *1、Proportional Control (/P-CON) *1、Forward Drive Prohibit (P-OT)、Reverse Drive Prohibit (N-OT)、Alarm Reset (/ALM-RST)、Forward External Torque Limit (/P-CL)、Reverse External Torque Limit (/N-CL)、Position Deviation Clear (/CLR)、Internal Setup Speed Switch...etc A Signal can be allocated and positive and negative logic can be changed.
Digital Output	Number of points	6
	Output Signals That Can Be Allocated	Servo Alarm (ALM)、Position Completion (/COIN)、Speed Coincidence Detection (/V-CMP)、Rotation Detection (/TGON)、Servo Ready (/S-RDY)、Torque Limit Detection (/CLT)、Brake (/BK)、Encoder Origin Output (PGC) A Signal can be allocated and positive and negative logic can be changed.
Encoder Divided Pulse Output		Phase A, phase B, phase Z: Line-driver output Number of divided output pulses: Any setting is allowed.
RS-485 *1 Communication	Protocal	MODBUS
	1:N Communications	Up to N=127 stations
	Axis Address Setting	Set with parameters
EtherCAT Communication	Protocal	CoE (CANOpen over EtherCAT)
	Control Mode	csp, pp, hm, csv, cst, pv, tq
	Homing Method	1-14, 17-30, 33, 34, 35, 37
	Synchronization Mode	DC, SM2, FreeRun
	Cycle Time	125us
Displays/Indicators		CHARGE indicator and five-digit seven-digit display
Regenerative Processing		Built-in (An external resistor must be connected to 220V_03A & 380V_28A)
Overtravel (OT) Prevention		Stopping with dynamic brake (DB), deceleration to a stop, or coasting to a stop for the P-OT (Forward Drive Prohibit) or N-OT (Reverse Drive Prohibit) signal
Protective Function		Overcurrent, overvoltage, low voltage, overload, regeneration error, etc.
Monitoring Functions		Speed, Current position, Reference pulse count (accumulated), Position deviation, Motor current, Operating status, Input/output signals
Utility Functions		Gain adjustment, alarm history, jogging, origin search, etc.
Intelligent Functions		Bulit-in Auto-tuning function
Applicable Load Inertia		Less than 5 times the motor inertia
Position	Feedforward Compensation	0 ~ 100% (Setup Unit1%)
	Reference Pulse Form	One of the following is selected: Pulse+Direction (P/R) pulse trains, CW+CCW (U/D) pulse trains, and two-phase pulse trains with 90 degree phase differential
	Input Form	Line driver or open-collector
	Max. Input Frequency	•Line Driver Pulse+Direction (P/R) pulse trains, CW+CCW (U/D) pulse trains: 500K pps two-phase pulse trains with 90-degree phase differential: 500K pps •Open-Collector P Pulse+Direction (P/R) pulse trains, CW+CCW (U/D) pulse trains: 200K pps two-phase pulse trains with 90-degree phase differential: 200K pps

*1: Only support **pulse type** model

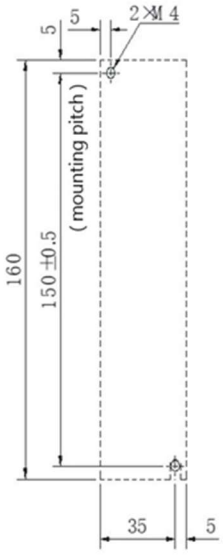
2.2 SC3 External Dimensions

- 220V: SC303AAD□□



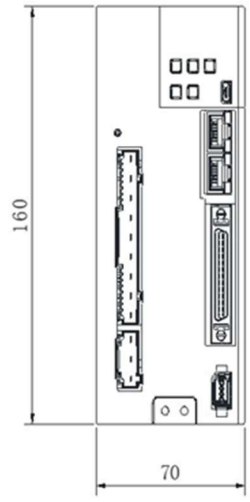


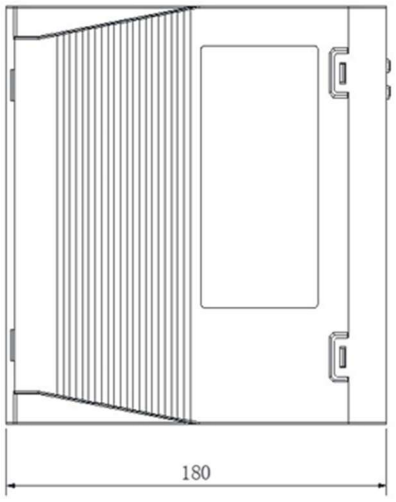
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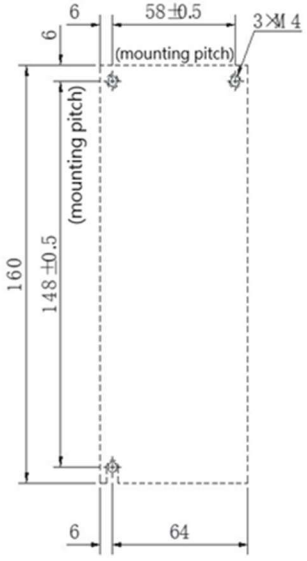
Mounting Hole Diagram

- 220V: SC306AAF□□
  380V: SC303ADE□□



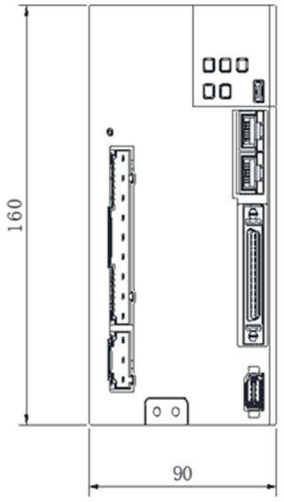


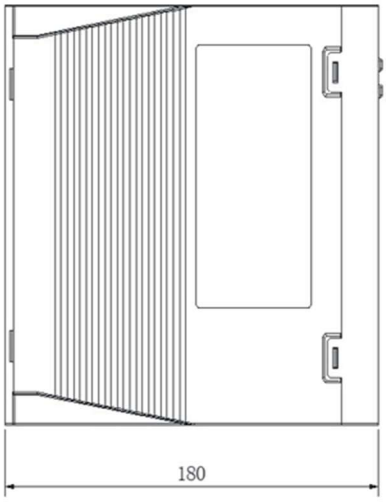
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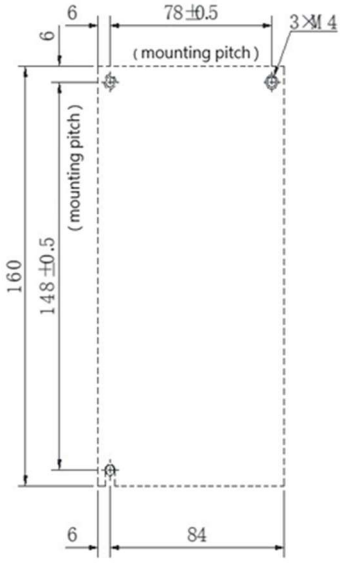
Mounting Hole Diagram

- 220V: SC308AAG□□ / SC310AAH□□
  380V: SC306ADH□□ / SC310ADI□□



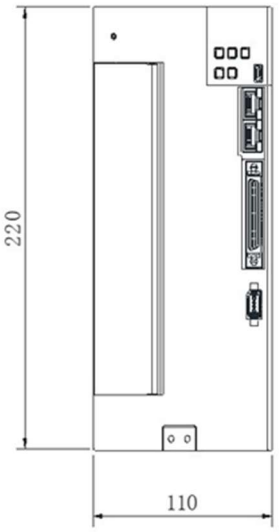


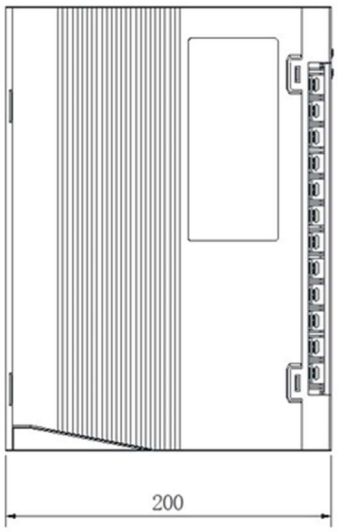
Unit : mm



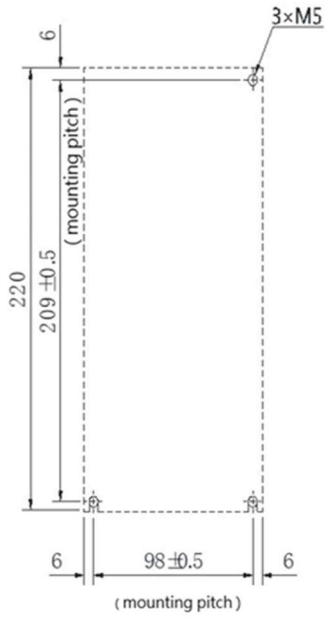
Mounting Hole Diagram

- 380V: SC315ADK□□



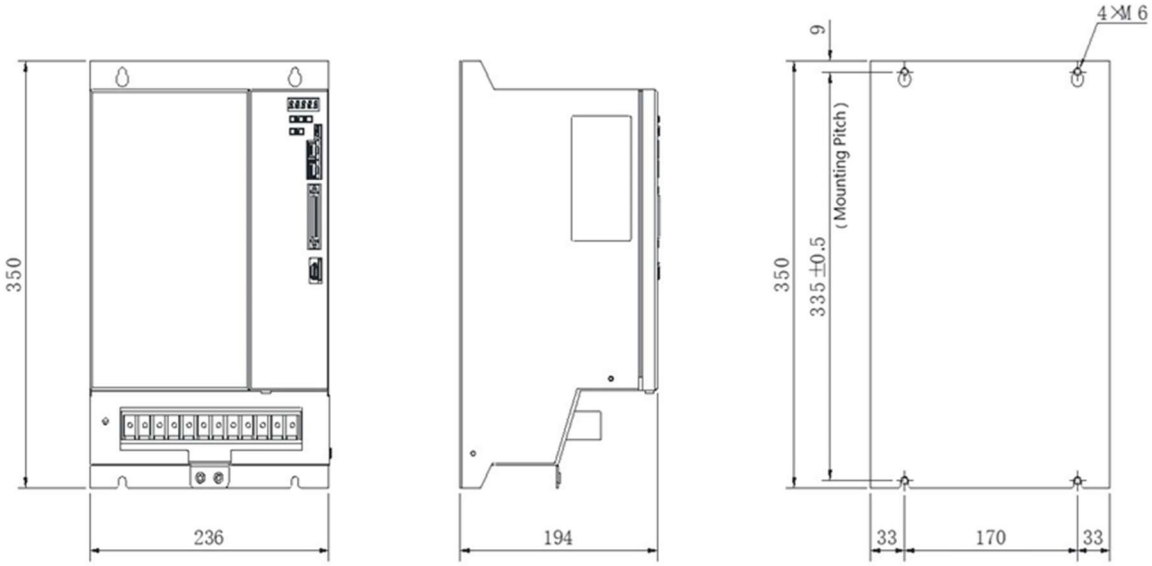


Unit : mm



Mounting Hole Diagram

- 380V: SC328ABL□□



Unit : mm

Mounting Hole Diagram

Chapter3. Installation of Servo driver

3.1 Installation Precautions

Refer to the following section for the ambient installation conditions.

■ Installation Near Sources of Heat

Implement measures to prevent temperature increases caused by radiant or convection heat from heat sources so that the ambient temperature of the servo driver meets the ambientconditions.

■ Installation Near Sources of Vibration

Install a vibration absorber on the mounting surface of the servo driver so that the servo driver will not be subjected to vibration.

■ Other Precautions

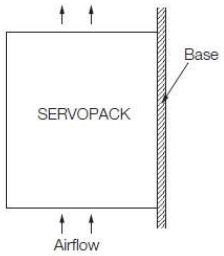
Do not install the servo driver in a location subject to high temperatures, high humidity, water drops, cutting oil, excessive dust, excessive dirt, excessive iron powder, corrosive gasses, or radioactivity.

3.2 Mounting Types and Orientation

The servo driver only support base-mounted and as shown in the following figure.

Also, mount the servo driver so that the front panel is facing toward the operator.

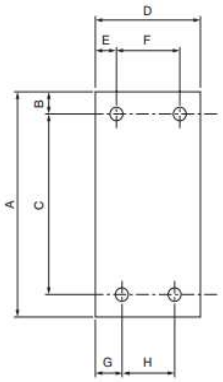
NOTE: Prepare two to four mounting holes for the servo driver and mount it securely in the mounting holes. (The number of mounting holes depends on the capacity of the servo driver.)



3.3 Mounting Hole Dimensions

Use mounting holes to securely mount the servo driver to the mounting surface.

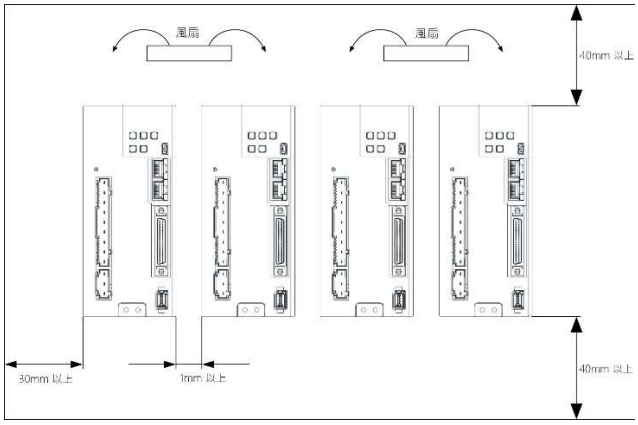
NOTE: To mount the servo driver, you will need to prepare a screwdriver that is longer than the depth of the servo driver.



3.4 Mounting Interval

Provide the following intervals between the servo drivers and spaces in a control panel.

Install cooling fans above the servo drivers so that hot spots do not occur.
Provide sufficient intervals and spaces as shown in the following figure to enable cooling by the fans and natural convection.



*: The distance of AC220V 03A/06A & AC380V 03A is 1mm.
The distance of others is 10mm.

Chapter4. Wiring and Connecting Servo driver

4.1 Precautions related to wiring

4.1.1 General Precautions

DANGER

- Do not change any wiring while power is being supplied.

There is a risk of electric shock or injury.

WARNING

- Wiring and inspections must be performed only by qualified engineers.

There is a risk of electric shock or product failure.

- Check all wiring and power supplies carefully.

Incorrect wiring or incorrect voltage application to the output circuits may cause short-circuit failures. If a short-circuit failure occurs as a result of any of these causes, the holding brake will not work. This could damage the machine or cause an accident that may result in death or injury.

- Connect the AC and DC power supplies to the specified servo driver terminals.
  - Connect an AC power supply to the L1, L2, and L3 terminals and the L1C and L2C terminals on the servo driver.
  - Connect a DC power supply to the B1/ and 2 terminals and the L1C and L2C terminals on the servo driver.
  - There is a risk of failure or fire.
- If you use a servo driver with the Dynamic Brake Hardware Option, connect an External Dynamic Brake Resistor that is suitable for the machine and equipment specifications to the specified terminals.

There is a risk of unexpected operation, machine damage, burning, or injury when an emergency stop is performed.

CAUTION

• Wait for at least five minutes after turning OFF the power supply and then make sure that the CHARGE indicator is not lit before starting wiring or inspection work. Do not touch the power supply terminals while the CHARGE lamp is lit because high voltage may still remain in the servo driver even after turning OFF the power supply.
There is a risk of electric shock.

• Observe the precautions and instructions for wiring and trial operation precisely as described in this document.
Failures caused by incorrect wiring or incorrect voltage application in the brake circuit may cause the servo driver to fail, damage the equipment, or cause an accident resulting in death or injury.

• Check the wiring to be sure it has been performed correctly.
Connectors and pin layouts are sometimes different for different models. Always confirm the pin layouts in technical documents for your model before operation.
There is a risk of failure or malfunction.

• Connect wires to power supply terminals and motor connection terminals securely with the specified methods and tightening torque.
Insufficient tightening may cause wires and terminal blocks to generate heat due to faulty contact, possibly resulting in fire.

• Use shielded twisted-pair cables or screened unshielded multi-twisted-pair cables for I/O Signal Cables and Encoder Cables.

• Observe the following precautions when wiring the servo driver’ s main circuit terminals.
  • Turn ON the power supply to the servo driver only after all wiring, including the main circuit terminals, has been completed.
  • If a connector is used for the main circuit terminals, remove the main circuit connector from the servo driver before you wire it.
  • Insert only one wire per insertion hole in the main circuit terminals.
  • When you insert a wire, make sure that the conductor wire (e.g., whiskers) does not come into contact with adjacent wires.

• Install molded-case circuit breakers and other safety measures to provide protection against short circuits in external wiring.
There is a risk of fire or failure.

NOTICE

• Whenever possible, use the Cables specified by Fatek.
If you use any other cables, confirm the rated current and application environment of your model and use the wiring materials specified by Fatek or equivalent materials.
• Securely tighten cable connector screws and lock mechanisms.
Insufficient tightening may result in cable connectors falling off during operation.
• Do not bundle power lines (e.g., the Main Circuit Cable) and low-current lines (e.g., the I/O Signal Cables or Encoder Cables) together or run them through the same duct. If you do not place power lines and low-current lines in separate ducts, separate them by at least 30 cm.
If the cables are too close to each other, malfunctions may occur due to noise affecting the low-current lines.
• Install a battery at either the host controller or on the Encoder Cable.
If you install batteries both at the host controller and on the Encoder Cable at the same time, you will create a loop circuit between the batteries, resulting in a risk of damage or burning.
• When connecting a battery, connect the polarity correctly.
There is a risk of battery rupture or encoder failure.

Important

• Use a molded-case circuit breaker or fuse to protect the main circuit. The servo driver connects directly to a commercial power supply; it is not isolated through a transformer or other device. Always use a molded-case circuit breaker or fuse to protect the servo system from accidents involving different power system voltages or other accidents.
• Install an earth leakage breaker. The servo driver does not have a built-in ground fault protective circuit. To configure a safer system, install a ground fault detector against overloads and short-circuiting, or install a ground fault detector combined with a molded-case circuit breaker.
• Do not turn the power supply ON and OFF more than necessary.
  • Do not use the servo driver for applications that require the power supply to turn ON and OFF frequently. Such applications will cause elements in the servo driver to deteriorate.
  • After you have started actual operation, allow at least one hour between turning the power supply ON and OFF (as a guideline).

To ensure safe, stable application of the servo system, observe the following precautions when wiring.
• Use the cables specified by Fatek. Design and arrange the system so that each cable is as short as possible.
• The signal cable conductors are as thin as 0.3 mm2. Do not subject them to excessive bending stress or tension.

4.1.2 Countermeasures against Noise

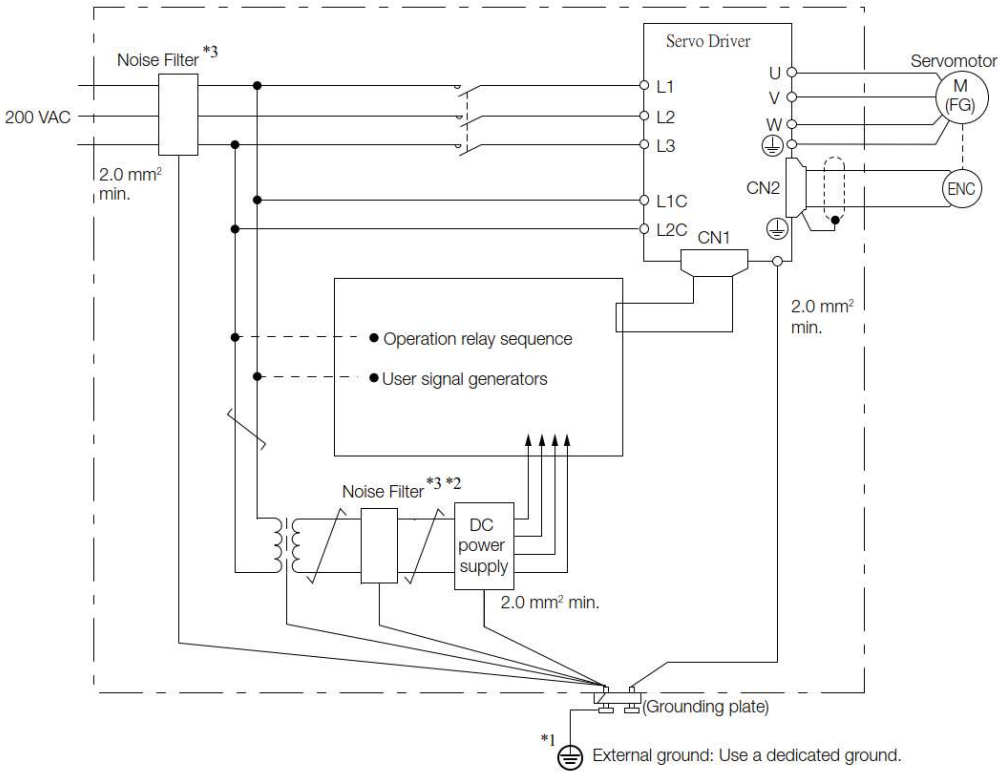
The servo driver is designed as an industrial device. It therefore provides no measures to prevent radio interference. The servo driver uses high-speed switching elements in the main circuit.
Therefore, peripheral devices may be affected by switching noise.
If the equipment is to be used near private houses or if radio interference is a problem, take countermeasures against noise. ◦

The servo driver uses microprocessors. Therefore, it may be affected by switching noise from peripheral devices.
To prevent the noise from the servo driver or the peripheral devices from causing malfunctions of any devices, take the following countermeasures against noise as required.

- Install the input reference device and Noise Filter as close to the servo driver as possible.
- Always install a Surge Absorber for relays, solenoids, and Magnetic Contactor coils.
- Do not place the following cables in the same duct or bundle them together. Also, separate the cables from each other by at least 30 cm.
  - Main Circuit Cables and I/O Signal Cables
  - Main Circuit Cables and Encoder Cables
- Do not share the power supply with an electric welder or electrical discharge machine. If the servo driver is placed near a high-frequency generator, install Noise Filters on the input side on the Main Circuit Power Supply Cable and Control Power Supply Cable even if the same power supply is not shared with the high-frequency generator. Refer to the following section for information on connecting Noise Filters.
- Implement suitable grounding measures. Refer to the following section for information on grounding measures.

Noise Filters

You must attach Noise Filters in appropriate places to protect the servo driver from the adverse effects of noise.
The following is an example of wiring for countermeasures against noise.



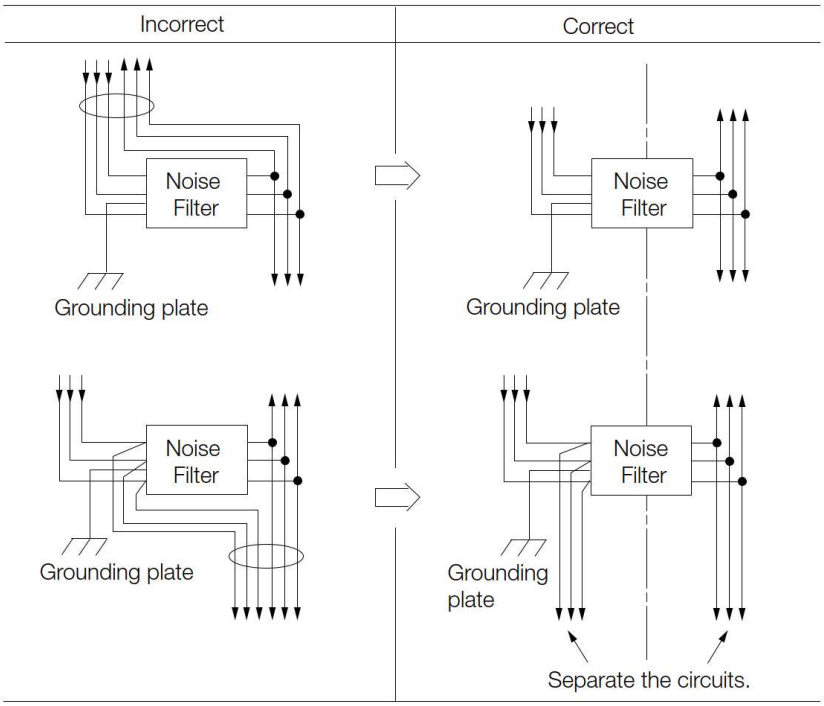
*1. For the ground wire, use a wire with a thickness of at least 2.0 mm2 (preferably, flat braided copper wire).

*2. Whenever possible, use twisted-pair wires to wire all connections marked with

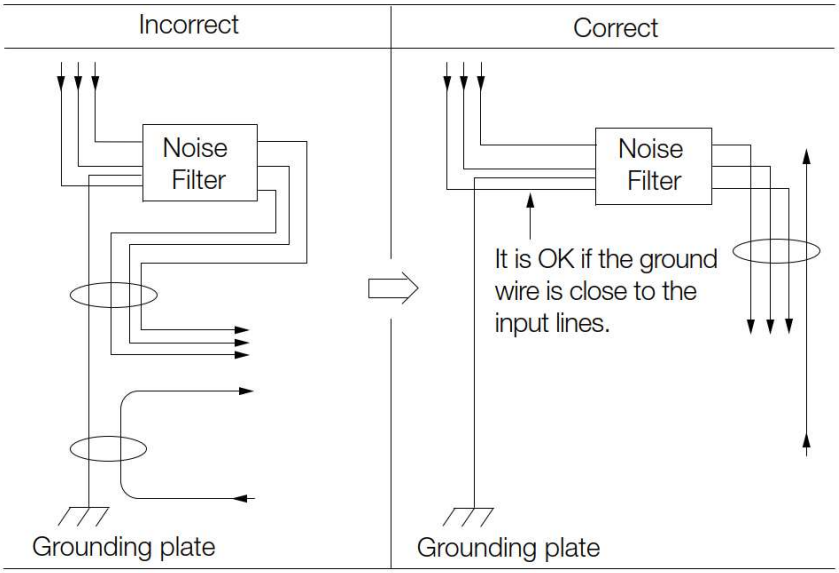
Noise Filter Wiring and Connection Precautions

Always observe the following precautions when wiring or connecting Noise Filters.

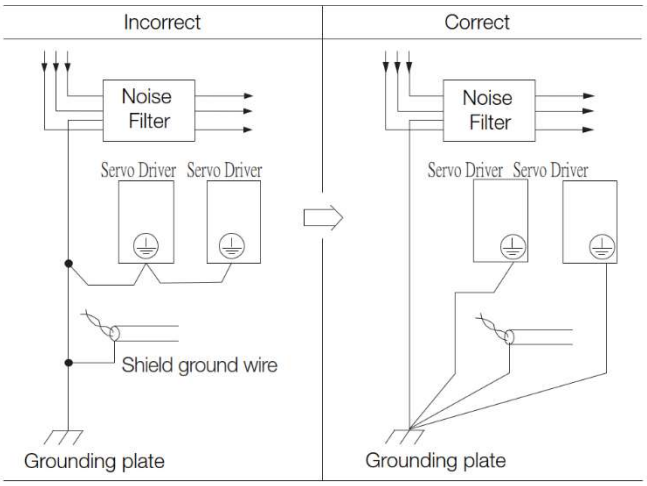
• Separate input lines from output lines. Do not place input lines and output lines in the same duct or bundle them together.



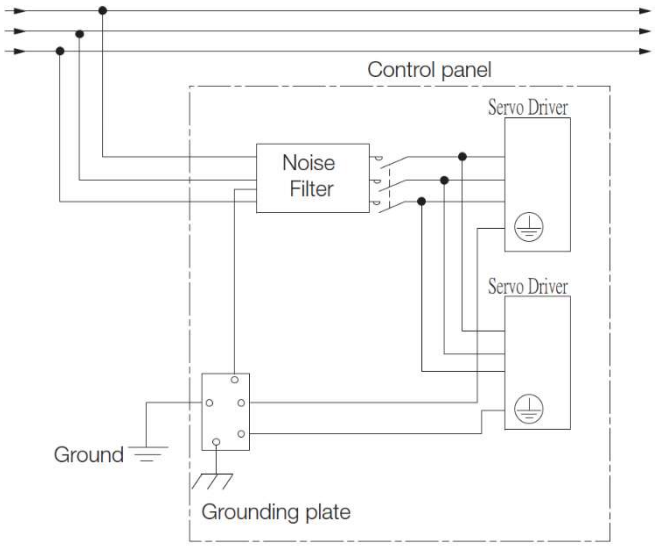
• Separate the Noise Filter ground wire from the output lines. Do not place the Noise Filter ground wire, output lines, and other signal lines in the same duct or bundle them together.



• Connect the Noise Filter ground wire directly to the grounding plate. Do not connect the Noise Filter ground wire to other ground wires.



•If a Noise Filter is located inside a control panel, first connect the Noise Filter ground wire and the ground wires from other devices inside the control panel to the grounding plate for the control panel, then ground the plate.



4.1.3 Grounding

Implement grounding measures as described in this section. Implementing suitable grounding measures will also help prevent malfunctions, which can be caused by noise.
Observe the following precautions when wiring the ground cable.

- Ground the servo driver to a resistance of 100 Ω or less.
- Be sure to ground at one point only.
- Ground the Servomotor directly if the Servomotor is insulated from the machine.

Motor Frame Ground or Motor Ground

If you ground the Servomotor through the machine, switching noise current can flow from the main circuit of the servo driver through the stray capacitance of the Servomotor.To prevent this, always connect the FG terminal of the Servomotor Main Circuit Cable connected to the Servomotor to the ground terminal on the servo driver. Also be sure to ground the ground terminal. Always connect the shield wire of the Encoder Cable connected to the Servomotor to the connector case (shell).

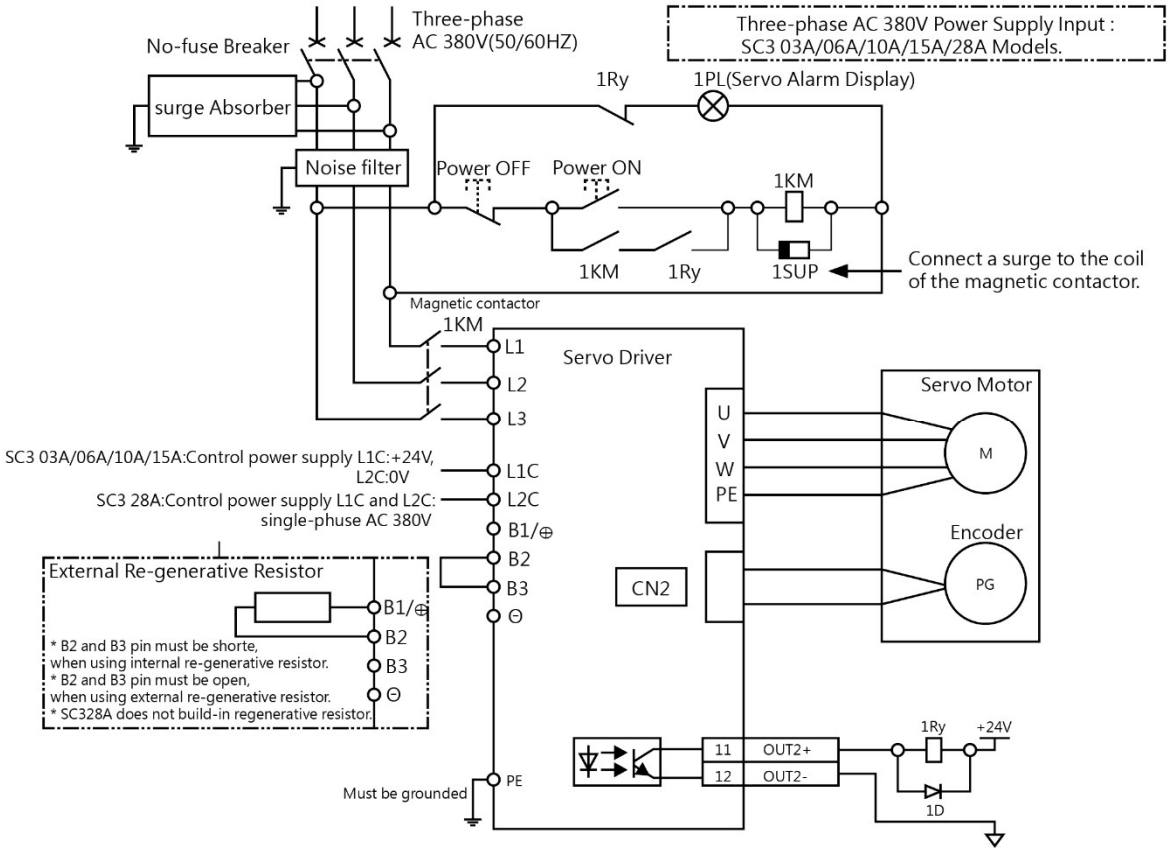
Ground both the Moving Coil and Magnetic Way of a Linear Servomotor

Noise on I/O Signal Cables

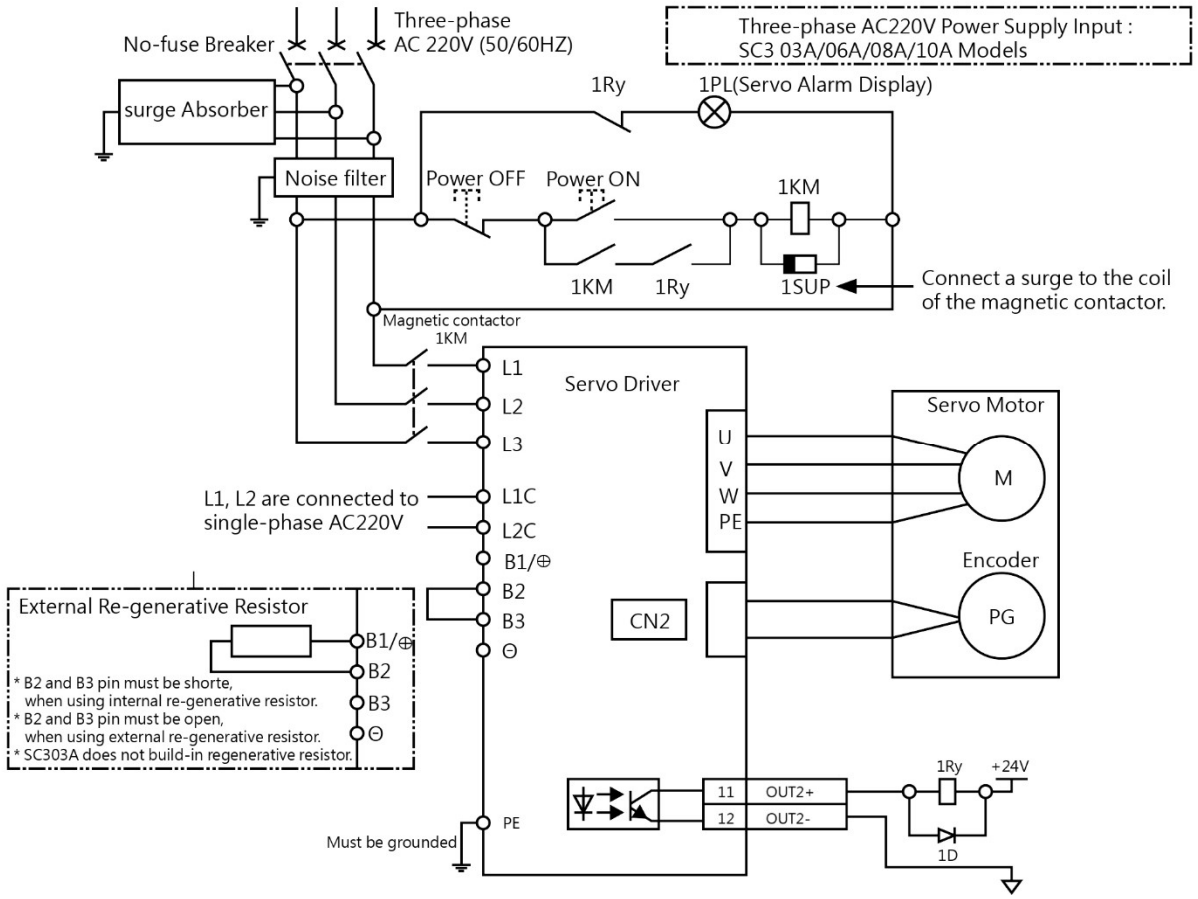
If noise enters the I/O Signal Cable, connect the shield of the I/O Signal Cable to the connector shell to ground it. If the Servomotor Main Circuit Cable is placed in a metal conduit, ground the conduit and its junction box. For all grounding, ground at one point only.

4.2 Basic Wiring Diagrams

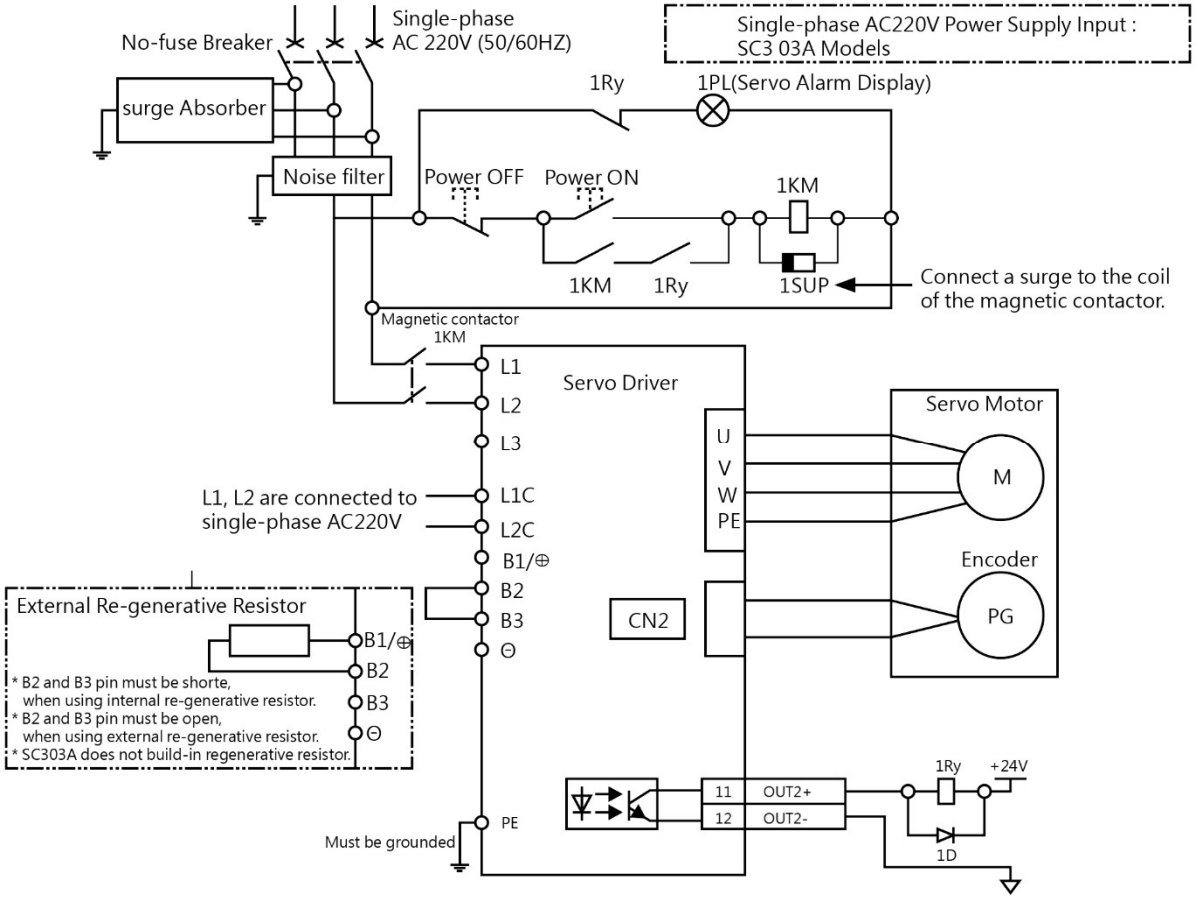
- Input 3-phase AC380V



•Input 3-phase AC220V



•Input 1-phase AC220V



4.3 Wiring the Power Supply to the servo driver

4.3.1 Terminal Symbols and Terminal Names

Use the main circuit connector on the servo driver to wire the main circuit power supply and control circuit power supply to the servo driver.

CAUTION
Wire all connections correctly according to the following table and specified reference information. There is a risk of servo driver failure or fire if incorrect wiring is performed.

The Servo driver have the following four types of main circuit power supply input specifica-tions.

■ 1-phase/3-phaseAC220V Power Supply Input

Terminal Symbols	Terminal Name	Specifications and Reference
L1、L2、L3	Main circuit power supply input terminals for AC power supply input	3-phaseAC 200V ~ 240V、-15% ~ +10%、50/60Hz 1-phaseAC 200V ~ 240V、-15% ~ +10%、50/60Hz
L1C、L2C	Control power supply terminals	1-phaseAC 200V ~ 240V、-15% ~ +10%、50/60Hz
B1/⊕、B2、B3	Regenerative Resistor terminals	If the regenerative capacity is insufficient, connect an External Regenerative Resistor between B1/ and B2. The External Regenerative Resistor is not included. Obtain it separately.
⊖	-	None. (Do not connect anything to this terminal.)

■ 3-phaseAC380V Power Supply input

Terminal Symbols	Terminal Name	Specifications and Reference
L1、L2、L3	Main circuit power supply input terminals for AC power supply input	3-phaseAC 380V ~ 420V、-15% ~ +10%、50/60Hz
L1C、L2C	Control power supply terminals	03/06/10/15A: DC 24V 、-10% ~ +10%、50W 28A: 1-phaseAC 380V ~ 420V、-15% ~ +10%、50/60Hz
B1/⊕、B2、B3	Regenerative Resistor terminals	03A/06A/10A/15A When the regenerative capacity is insufficient, remove the jumper wire between B2 and B3, and connect an external regenerative resistor between B1/⊕ and B2. Please purchase the external regenerative resistor separately.
		28A It does not have build-in re-generative resistor, thereforce short wire between B2 and B3 is not allowed, and connect an external regenerative resistor between B1/⊕ and B2. Please purchase the external regenerative resistor separately.
⊖	-	None. (Do not connect anything to this terminal.)

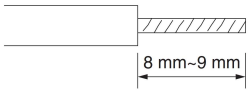
4.3.2 Wiring Procedure for Main Circuit Connector

- Required Items

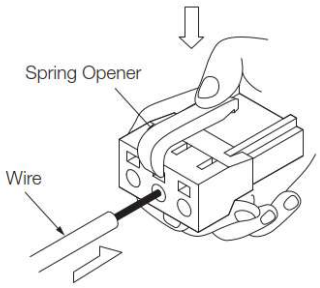
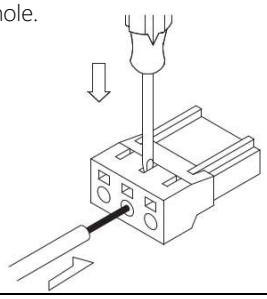
Required Item	Remarks
Spring Opener or Flatblade Screwdriver	• Spring Opener servo driver accessory • Flat-blade screwdriver Commercially available screwdriver with tip width of 3.0 mm to 3.5 mm

1. Remove the main circuit connector and motor connector from the servo driver.

2. Remove the sheath from the wire to connect.



3 · Open the wire insertion hole on the terminal connector with the tool. There are the following two ways to open the insertion hole. Use either method.

① Using a Spring Opener	② Using a Flat-blade Screwdriver
Open the insertion hole with the Spring Opener as shown in the figure. 	Firmly insert a flat-blade screwdriver into the screwdriver insertion hole to open the wire inser-tion hole. 

4. Insert the conductor into the wire insertion hole. Then, remove the Spring Opener or flat-blade screwdriver.

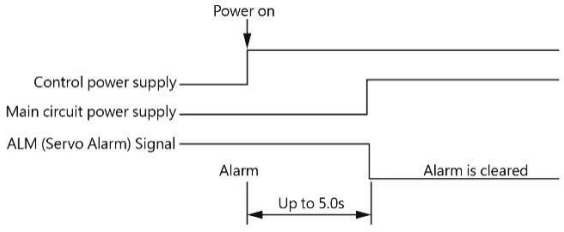
5. Make all other connections in the same way.

6. When you have completed wiring, attach the connectors to the servo driver.

4.3.3 Power ON Sequence

Consider the following points when you design the power ON sequence.

- The ALM (Servo Alarm) signal is output for up to five seconds when the control power supply is turned ON. Take this into consideration when you design the power ON sequence, and turn ON the main circuit power supply to the servo driver when the ALM signal is OFF (alarm cleared).



WARNING

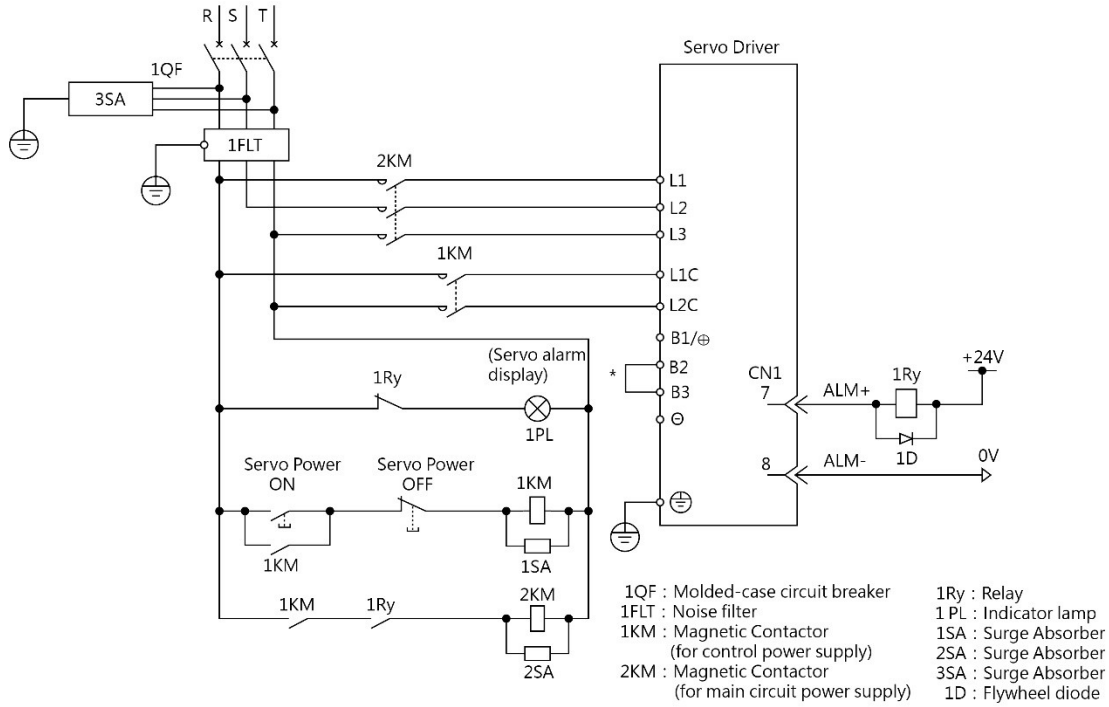
- Even after you turn OFF the power supply, a high residual voltage may still remain in the servo driver. To prevent electric shock, do not touch the power supply terminals after you turn OFF the power. When the voltage is discharged, the CHARGE indicator will turn OFF. Make sure the CHARGE indicator is OFF before you start wiring or inspection work.

Important

- Turn ON the control power supply before the main circuit power supply or turn ON the control power supply and the main circuit power supply at the same time.Turn OFF the main circuit power supply first, and then turn OFF the control power supply.

4.3.4 Power Supply Wiring Diagrams

•Wiring Example for Three-Phase Power Supply Input



*You do not have to connect B2 and B3 for the following models: 03A and 28A, Do not connect them.

* **AC380V 03A/06A/10A/15A** use DC +24V for control power supply

4.3.5 Wiring Regenerative Resistors

This section describes how to connect External Regenerative Resistors.

WARNING

- Be sure to wire Regenerative Resistors correctly. Do not connect B1/⊕ and B2.
  Doing so may result in fire or damage to the Regenerative Resistor or servo driver.

Connecting Regenerative Resistors

1. Remove the lead from between the B2 and B3 terminals on the servo driver.
2. Connect the External Regenerative Resistor between the B1/⊕ and B2 terminals.
3. Set Pn600 (Regenerative Resistor Capacity) and Pn603 (Regenerative Resistance).

NOTE: 03A and 28A does not have build-in re-generative resistor, thereforce short wire between B2 and B3 is not allowed, and connect an external regenerative resistor between B1/⊕ and B2.

4.4 Wiring Servomotors

4.4.1 Terminal Symbols and Terminal Names

The servo driver terminals or connectors that are required to connect the servo driver to a Servomotor are given below.

Terminal/Connector Symbols	Terminal/Connector Name
U · V · W	Servomotor terminals
⏚	Ground terminal
CN2	Encoder connector

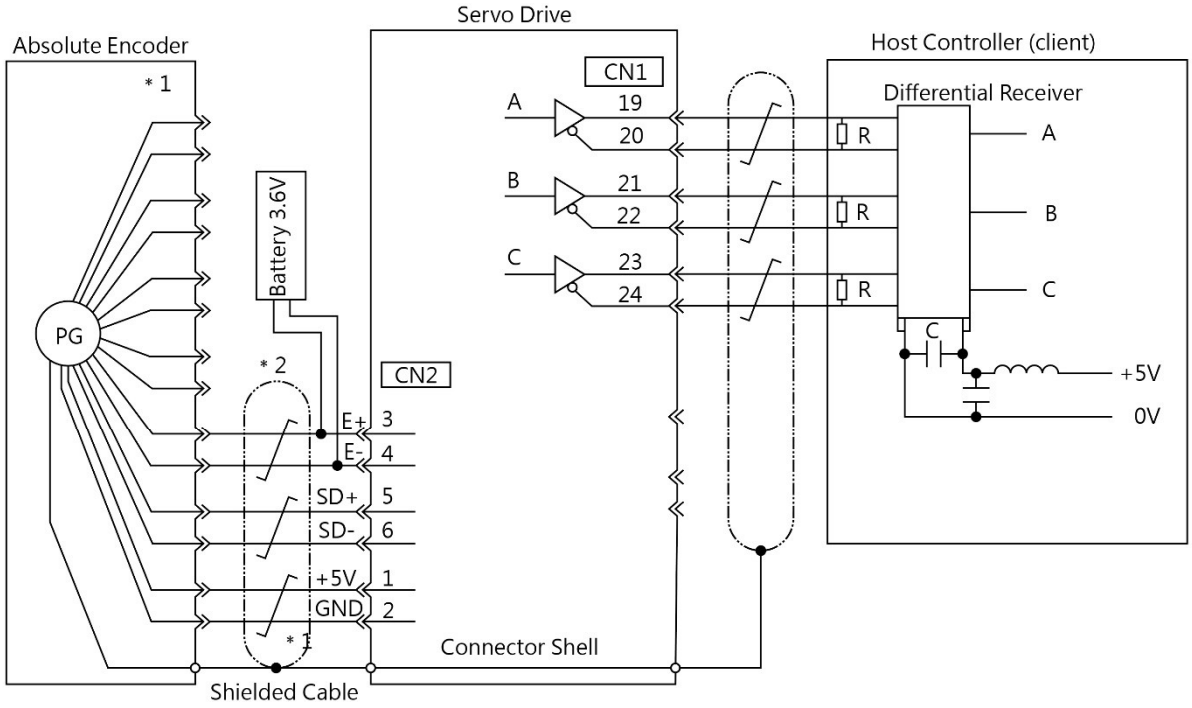
4.4.2 Pin Arrangement of Encoder Connector (CN2)

Pin No.	Signal	Function
1	PG5V	Encoder power supply +5 V
2	PG0V	Encoder power supply 0 V
3	E+*	Battery for absolute encoder (+)
4	E-*	Battery for absolute encoder (-)
5	SD+	Serial data (+)
6	SD-	Serial data (-)
Shell	Shield	—

*No wiring is required for an incremental encoder.

4.4.3 Wiring the servo driver to the Encoder

When Using an Absolute Encoder If you use an absolute encoder, use an Encoder Cable with a JUSP-BA01-E Battery Case or install a battery on the host controller.



* 1: The pin numbers of these connectors depend on the servo driver model.

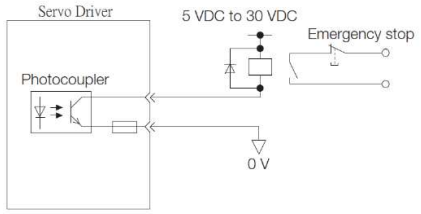
* 2: Represent a shielded twisted-pair cable.

• Wiring Example When Using an Encoder Cable with a Battery Case

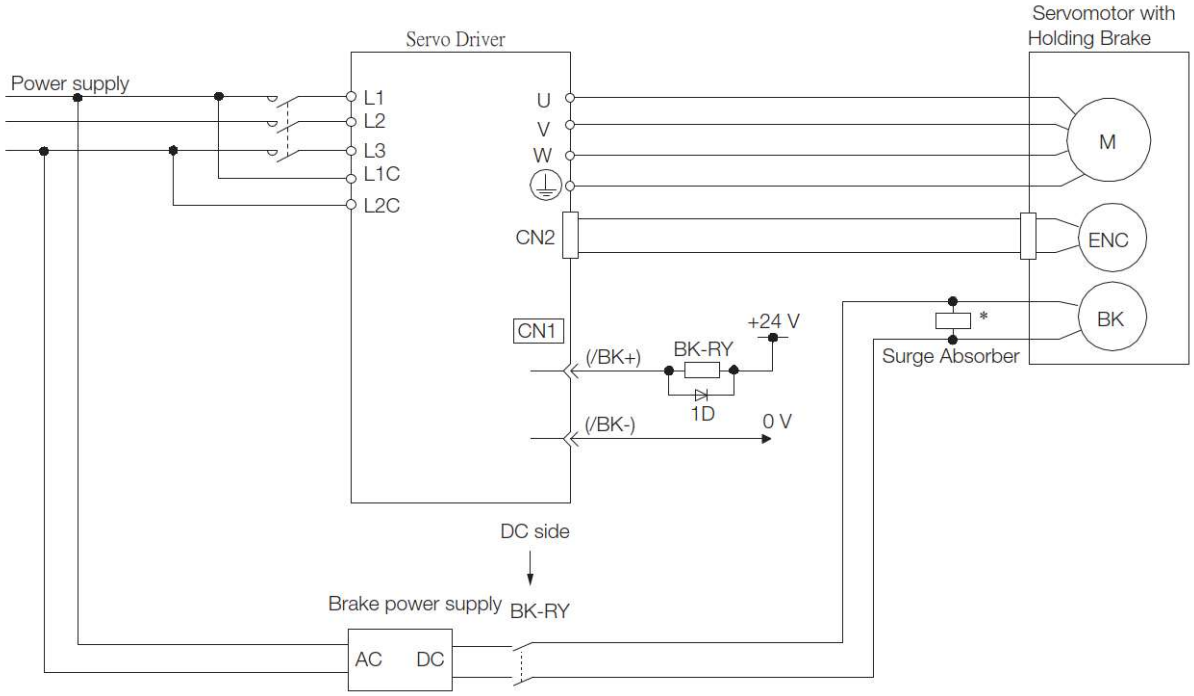
4.4.4 Wiring the servo driver to the Holding Brake

- If you use a Rotary Servomotor, select a Surge Absorber according to the brake current and brake power supply. Refer to the following manual for details.
- After the Surge Absorber is connected, check the brake operation delay time in your application.
  The Surge Absorber may affect the brake operation delay time.
  Configure the relay circuit to activate the holding brake for an emergency stop.

Relay Circuit Example



- The /BK (Brake) signal cannot be used with the default settings. You must allocate the output signal. Refer to the following section for details.
- If you use a 24-V brake, install a separate power supply for the 24-VDC power supply from other power supplies, such as the one for the I/O signals of the CN1 connector. If the power supply is shared, the I/O signals may malfunction.



BK-RY: Brake control relay

1D: Fly wheeling Diode

4.5 I/O Signal Connections

4.5.1 I/O Signal Connector (CN1) Names and Functions

EtherCAT Type (SC3 □□□□□ 00) :

Default settings are given in parentheses.

Pin No.	Name	Function	Pin No.	Name	Function
1	--		26	--	
2	--		27	--	
3	--	--	28	--	--
4	--		29	--	
5	--	--	30	--	--
6	--		31	--	
7	OUT0+	Output 0, Reallocatable (Default：ALM)	32	OUT3+	Output 3, Reallocatable (Factory reserved)
8	OUT0-		33	OUT3-	
9	OUT1+	Output 1, Reallocatable (Default：/BK)	34	OUT4+	Output 4, Reallocatable (Factory reserved)
10	OUT1-		35	OUT4-	
11	OUT2+	Output 2, Reallocatable (Factory reserved)	36	OUT5+	Output 5, Reallocatable (Factory reserved)
12	OUT2-		37	OUT5-	
13	DICOM	input signal common terminal	38	--	
14	IN0	Input 0, Reallocatable (Default：/P-OT)	39	IN4	Input 4, Reallocatable (Factory reserved)
15	IN1	Input 1, Reallocatable (Default：/N-OT)	40	IN5	Input 5, Reallocatable (Factory reserved)
16	IN2	Input 2, Reallocatable (Default：/DEC)	41	IN6	Input 6, Reallocatable (Factory reserved)
17	IN3	Input 3, Reallocatable (Factory reserved)	42	IN7	Input 7, Reallocatable (Factory reserved)
18	--		43	--	
19	PAO+	PG Divided Pulse Output, Phase A	44	--	--
20	PAO-		45	--	
21	PBO+	PG Divided Pulse Output, Phase B	46	--	--
22	PBO-		47	--	
23	PCO+	PG Divided Pulse Output, Phase Z	48	--	--
24	PCO-		49	--	
25	GND	Singal Ground	50	GND	Singal Ground

NOTE: 1、The terminal displays "--", please do not use。

2、Please connect the input and output signals to the connector by shielded cables.

Pulses Type (SC3 □□□□□ 10) :

Default settings are given in parentheses

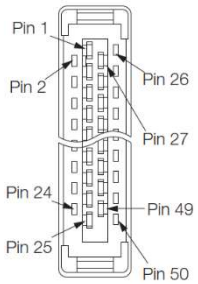
Pin NO.	Name	Function	Pin NO.	Name	Function
1	APULS+	Pulse Reference Input	26	--	--
2	APULS-		27	--	
3	BSIGN+	Sign of Reference Input (Line-Driver)	28	--	--
4	BSIGN-		29	--	
5	ANA0+	Speed Reference	30	ANA1+	Torque Refer-ence Input
6	ANA0-		31	ANA1-	
7	OUT0+	Output 0, Reallocatable (Default：ALM)	32	OUT3+	Output 3, Reallocatable (Factory reserved)
8	OUT0-		33	OUT3-	
9	OUT1+	Output 1, Reallocatable (Default：/COIN)	34	OUT4+	Output 4, Reallocatable (Factory reserved)
10	OUT1-		35	OUT4-	
11	OUT2+	Output 2, Reallocatable (Default：/BK)	36	OUT5+	Output 5, Reallocatable (Factory reserved)
12	OUT2-		37	OUT5-	
13	DICOM	input signal common terminal	38	--	
14	IN0	Input 0, Reallocatable (Default：/S-ON)	39	IN4	Input 4, Reallocatable (Factory reserved)
15	IN1	Input 1, Reallocatable (Default：/P-OT)	40	IN5	Input 5, Reallocatable (Factory reserved)
16	IN2	Input 2, Reallocatable (Default：/N-OT)	41	IN6	Input 6, Reallocatable (Factory reserved)
17	IN3	Input 3, Reallocatable (Default：/ALM-RST)	42	IN7	Input 7, Reallocatable (Factory reserved)
18	--		43	--	
19	PAO+	PG Divided Pulse Output, Phase A	44	--	--
20	PAO-		45	--	
21	PBO+	PG Divided Pulse Output, Phase B	46	--	--
22	PBO-		47	--	
23	PCO+	PG Divided Pulse Output, Phase Z	48	--	--
24	PCO-		49	--	
25	GND	Singal Ground	50	GND	Singal Ground

NOTE: 1、The terminal displays "--", please do not use。

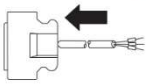
2、Please connect the input and output signals to the connector by shielded cables.

4.5.2 I/O Signal Connector (CN1) Pin Arrangement

EtherCAT Type (SC3 □□□□□ 00) :

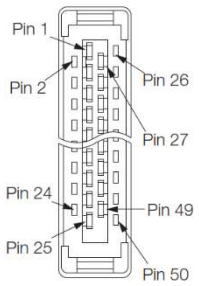


The above view is from the direc-tion of the follow-ing arrow without the connector shell attached.

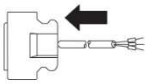


2	-	1	-			26	-
4	-	3	-	27	-	28	-
6	--	5	--	29	-	30	--
8	OUT0-	7	OUT0+	31	--	32	OUT3+
10	OUT1-	9	OUT1+	33	OUT3-	34	OUT4+
12	OUT2-	11	OUT2+	35	OUT4-	36	OUT5+
14	IN0	13	DICOM	37	OUT5-	38	-
16	IN2	15	IN1	39	IN4	40	IN5
18	-	17	IN3	41	IN6	42	IN7
20	PAO-	19	PAO+	43	-	44	-
22	PBO-	21	PBO+	45	-	46	-
24	PCO-	23	PCO+	47	-	48	-
		25	GND	49	-	50	GND

Pulses Type (SC3 □□□□□ 10) :



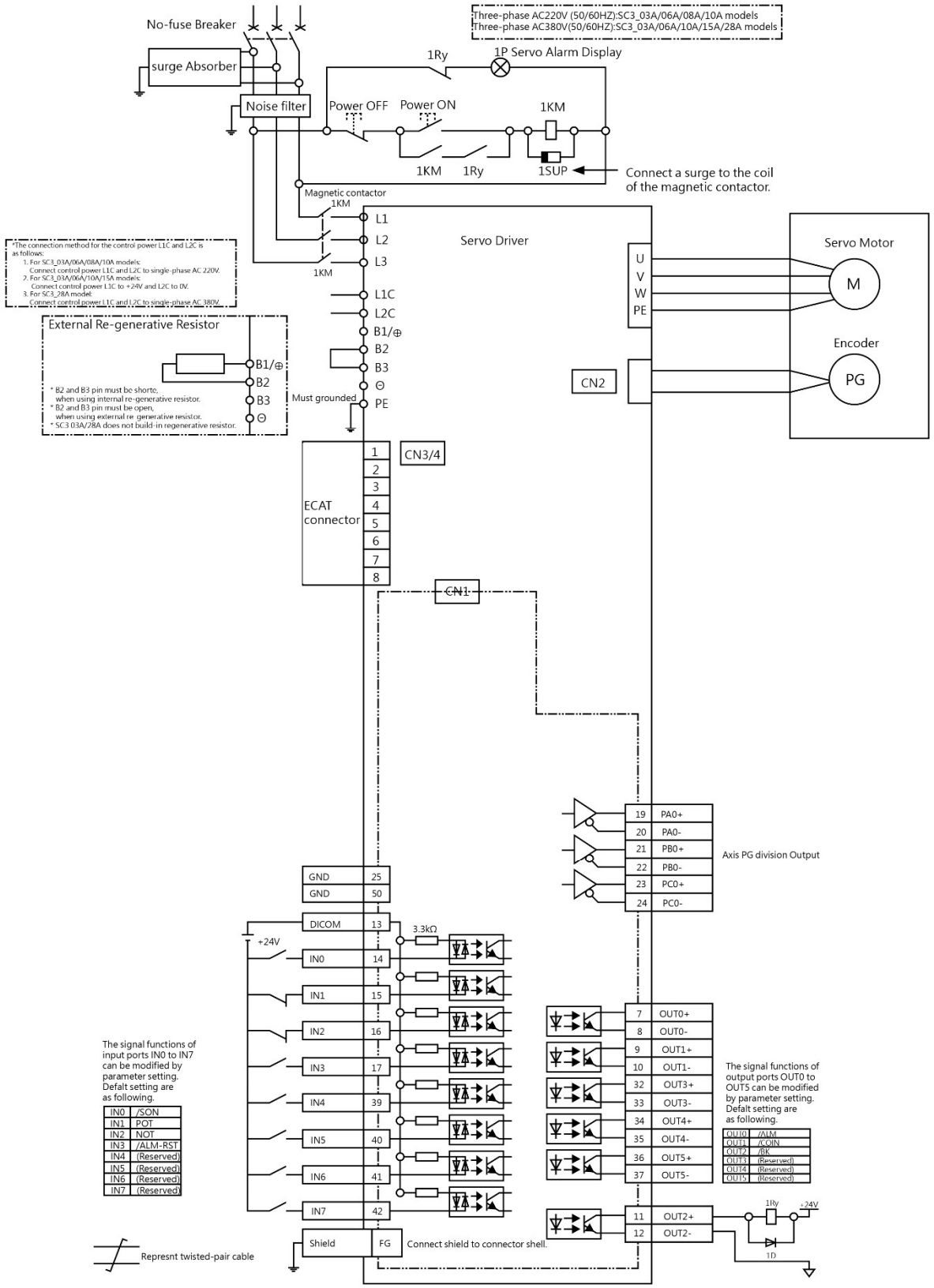
The above view is from the direction of the following arrow without the connector shell attached.



2	APULS-	1	APULS+	27	-	26	-
4	BSIGN-	3	BSIGN+	29	-	28	-
6	ANA0-	5	ANA0+	31	ANA1-	30	ANA1+
8	OUT0-	7	OUT0+	33	OUT3-	32	OUT3+
10	OUT1-	9	OUT1+	35	OUT4-	34	OUT4+
12	OUT2-	11	OUT2+	37	OUT5-	36	OUT5+
14	IN0	13	DICOM	39	IN4	38	-
16	IN2	15	IN1	41	IN6	40	IN5
18	-	17	IN3	43	-	42	IN7
20	PAO-	19	PAO+	45	-	44	-
22	PBO-	21	PBO+	47	-	46	-
24	PCO-	23	PCO+	49	-	48	-
		25	GND			50	GND

4.5.3 I/O Signal Wiring Examples

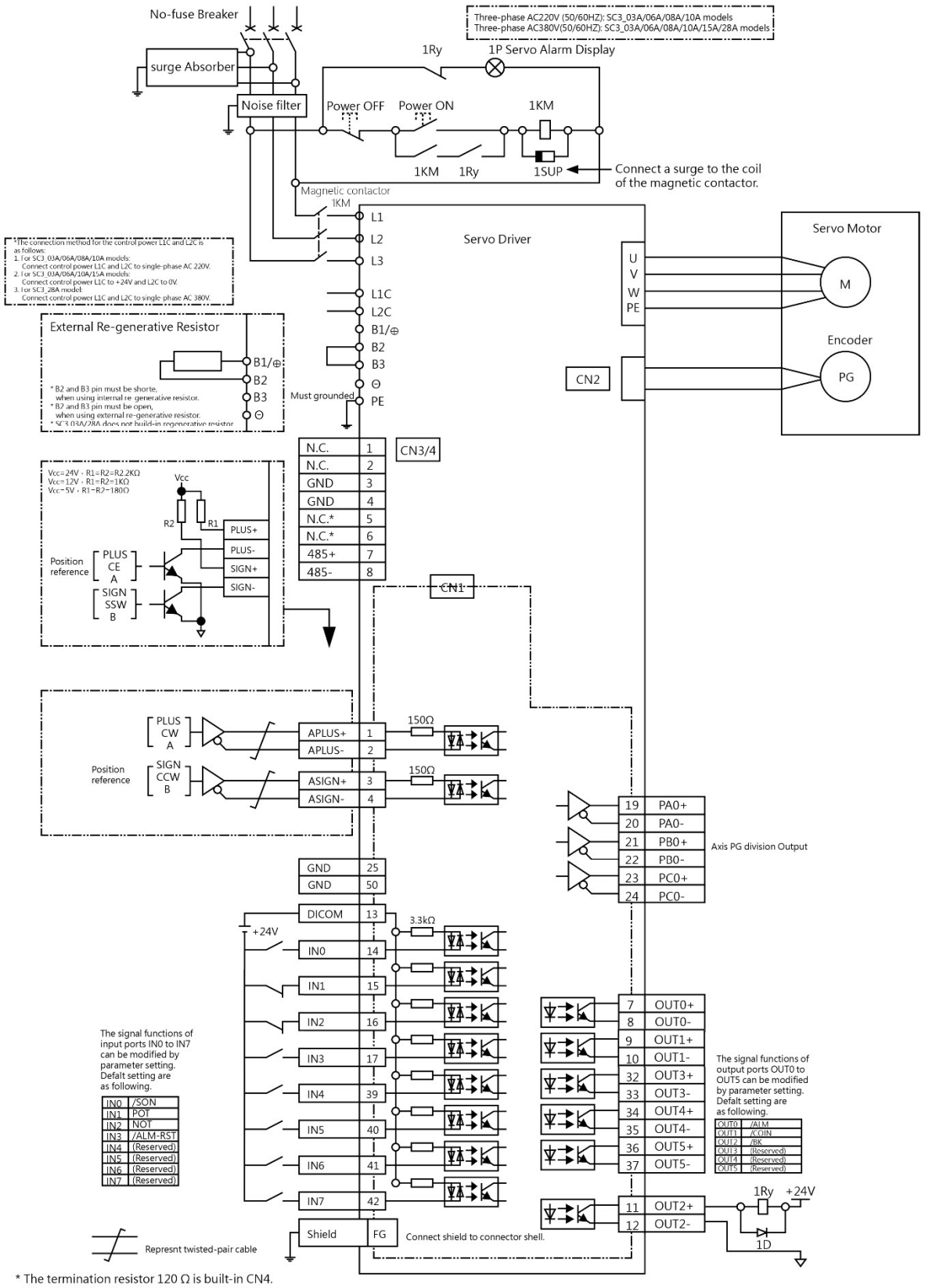
■ Communiaction Type：(SC3 □□□□□ 00)：Postioning Control Mode



IN0	/SON
IN1	POT
IN2	NOT
IN3	/ALM-RST
IN4	(Reserved)
IN5	(Reserved)
IN6	(Reserved)
IN7	(Reserved)

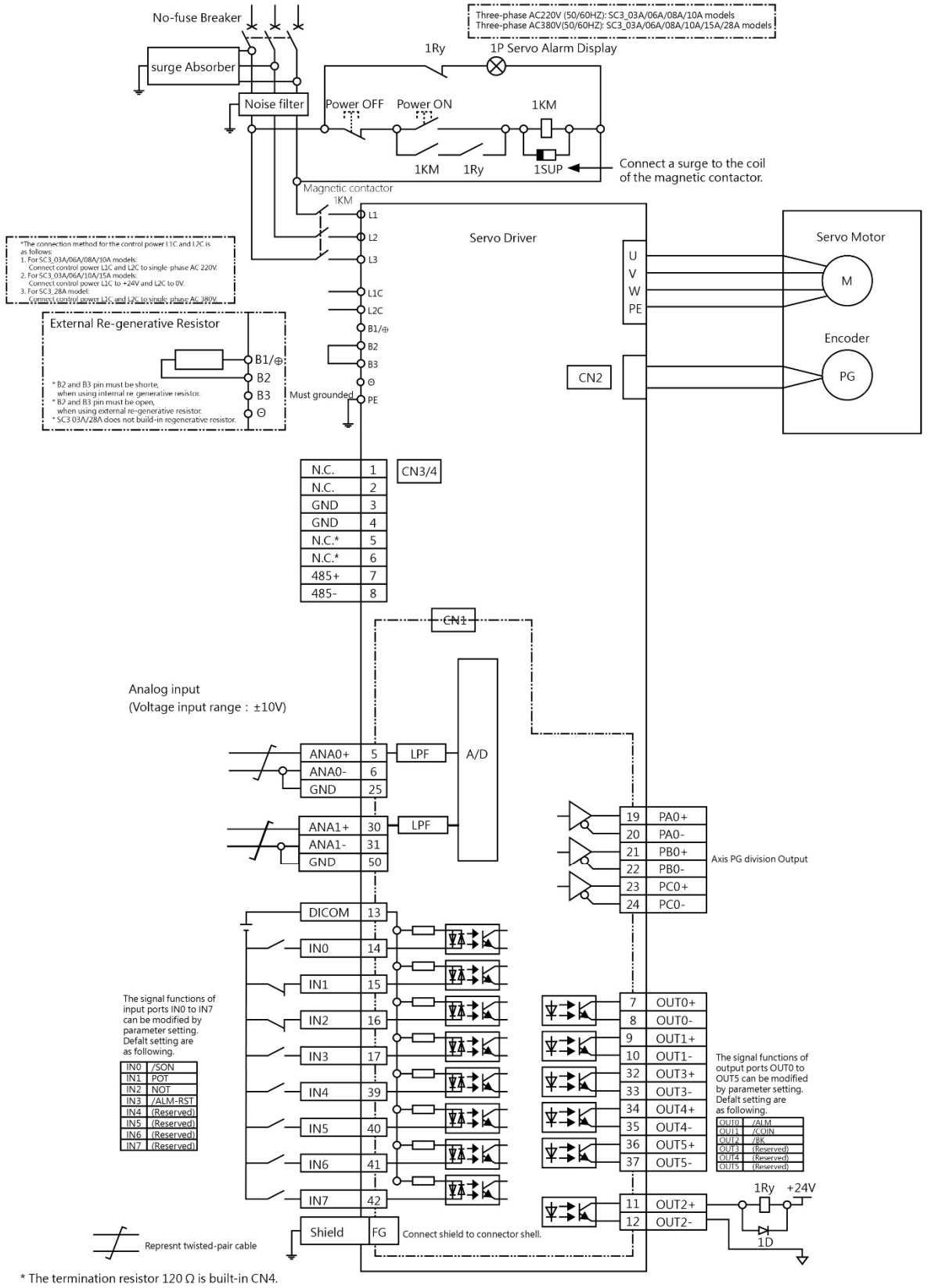
OUT0	/ALM
OUT1	/COIN
OUT2	/BK
OUT3	(Reserved)
OUT4	(Reserved)
OUT5	(Reserved)

■ Pulses Type (SC3 □ □ □ □ □ 10) : Postioning Control Mode



* The termination resistor 120 Ω is built-in CN4.

■ Pulses Type (SC3 □□□□□ 10) : Speed/Torque Contorl Mode

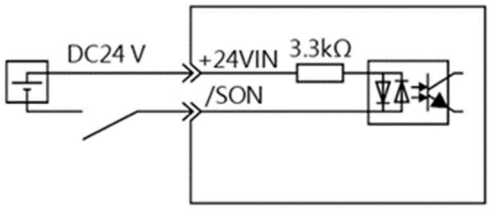
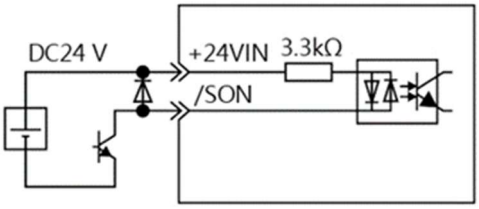


4.5.4 Sequence Input and Output Circuits

Sequence Input Circuits

◆ Photocoupler Input Circuits

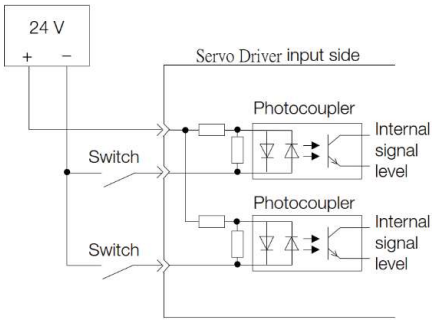
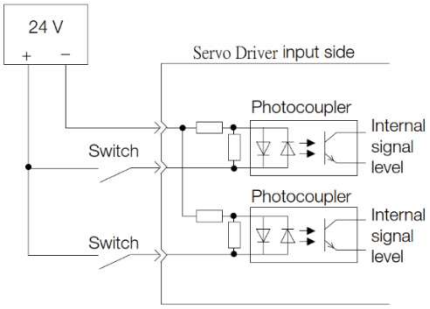
This section describes CN1 connector terminals CN1-IN0 ~ CN1-IN7. The circuits are connected through relay or openollector transistor circuits. If you connect through a relay, use a low-current relay. If you do not use a low-current relay, a faulty contact may result.

Examples for Relay Circuits	Examples for Open-Collector Circuits
	

NOTE: The 24-VDC external power supply capacity must be 50 mA minimum.

The servo driver input circuits use bidirectional photocouplers. Select either a sink circuit or source circuit according to the specifications required by the machine.

Please choose either the common collector configuration or the common emitter configuration based on the mechanical specifications. (伺 Servo Parameter Pn517~518)

Sink Circuits	Source Circuits
	

Input Signal Polarity		Input Signal Polarity	
Photocoupler	Internal Signal Leve	Photocoupler	Internal Signal Leve
ON	Low level	ON	High level
OFF	High level	OFF	Low level

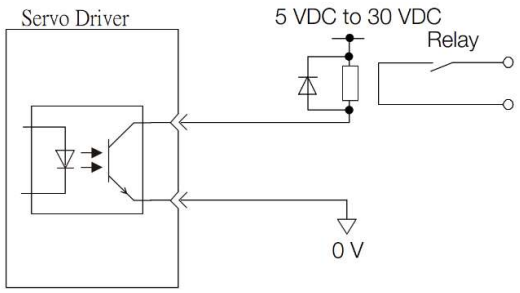
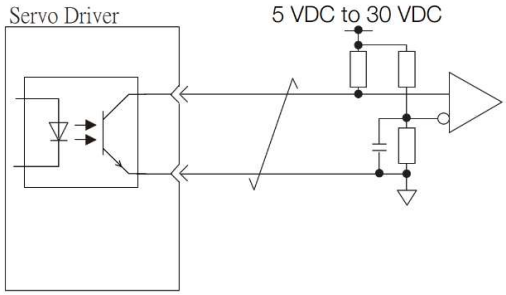
Sequence Output Circuit

Incorrect wiring or incorrect voltage application to the output circuits may cause short-circuit failures.

If a short-circuit failure occurs as a result of any of these causes, the holding brake will not work. This could damage the machine or cause an accident that may result in death or injury.

◆ Open-Collector Output Circuits

The Alarm Code (ALO1, ALO2, and ALO3) signals are output from open-collector transistor output circuits. Connect an open-collector output circuit to a photocoupler, relay, or line-receiver circuit.

Example for Relay Circuit	Example for Line-Receiver Circuit
	

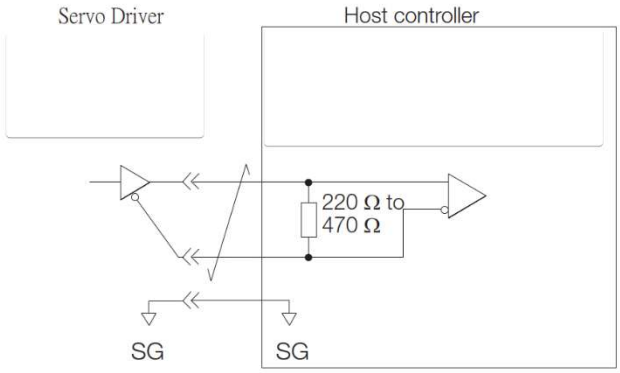
NOTE: The maximum allowable voltage and maximum allowable current for open-collector output circuits are as follows:

- Maximum allowable voltage: 30 VDC
- Maximum allowable current: 20 mA DC

◆ Line-Driver Output Circuits

This section describes CN1-19 ~ 24 (Phase-A, B, Z Signal)

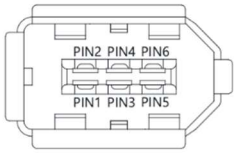
The serial data from the encoder is converted to two-phase (phases A and B) pulses. The resulting output signals (PAO, /PAO and PBO, /PBO), origin pulse signal (PCO and /PCO), and the absolute encoder position output signals (PSO and /PSO) are output with line-driver output circuits. Connect the line-driver output circuits to line-receiver circuits at the host controller.

Example for Line-Receiver Circuit


4.6 Encoder Connector Names

Pin No.	1	2	3	4	5	6
Name	5V	GND	E+	E-	SD+	SD-

NOTE:SD+、SD-are Pin of Data；E+、E-are Pin of Battery。

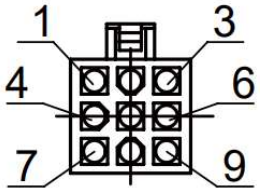


Encoder Cable Pins									
Num	1	2	3	4	5	6	7	8	9
Def	SD+	SD-	E+	-	-	5V	0V	E-	PE

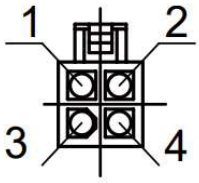
Power Cable Pins				
Num	1	2	3	4
Def	U	V	W	PE

Brake Cable Pins		
Num	1	2
Def	24V	0V

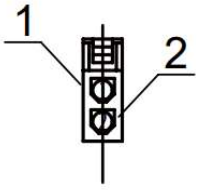
Encoder



Power



Brake

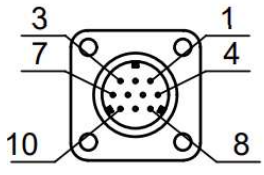


Encoder Cable Pins									
Num	1	2	3	4	5	6	7	8	9
Def	5V	0V	-	E+	SD+	SD-	-	E-	PE

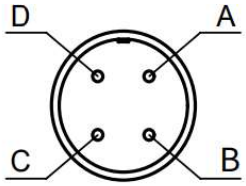
Power Cable Pins				
Num	A	B	C	D
Def	U	V	W	PE

Brake Cable Pins		
Num	1	2
Def	24V	0V

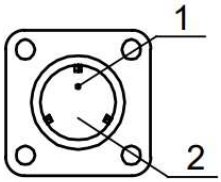
Encoder



Power



Brake



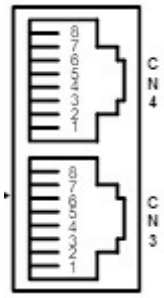
4.7 EtherCAT Connector Names

EtherCAT Type (SC3 □□□□□ 00) :

Pin Number		1	2	3	4	5	6	7	8
Name	CN3	TX_P_IN	TX_N_IN	RX_P_IN	--	--	RX_N_IN	--	--
	CN4	TX_P_OUT	TX_N_OUT	RX_P_OUT	--	--	RX_N_OUT	--	--

Pulses Type (SC3 □□□□□ 10) :

Pin Number		1	2	3	4	5	6	7	8
Name	CN3	--	--	GND	GND	--	--	RS485+	RS485-
	CN4	--	--	GND	GND	Build-in 120Ω		RS485+	RS485-



Chapter5. Basic Functions That Require Setting before Operation

5.1 Manipulating Parameters (Pn□□□)

This section describes the classifications, notation, and setting methods for the parameters given in this manual.

5.1.1 Parameter Classification

There are the following two types of servo driver parameters.

Classification	Meaning
Setup Parameters	Parameters for the basic settings that are required for operation.
Tuning Parameters	Parameters that are used to adjust servo performance.

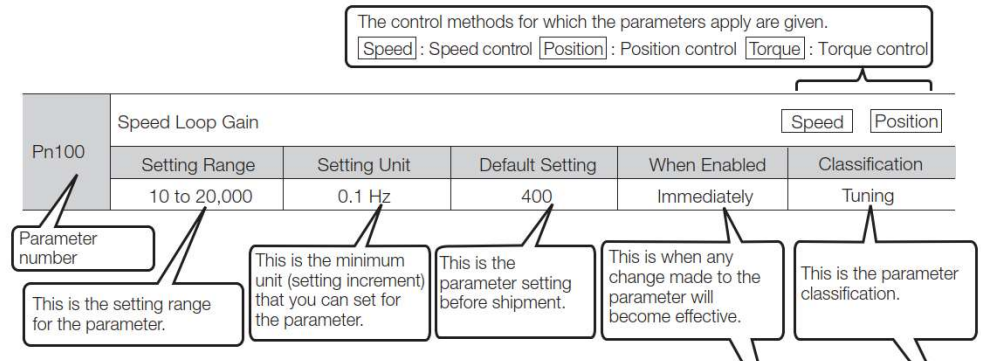
NOTE: When you edit parameters with a Panel Operator or Digital Operator, only setup parameters are displayed by default. To edit tuning parameters, set Pn00B to n. 1 (Display all parameters).

Parameter		Meaning	When Enabled	Classification
Pn00B	n.□□□0 [default setting]	Display only setup parameters.	After restart	Setup
	n.□□□1	Display all parameters.		

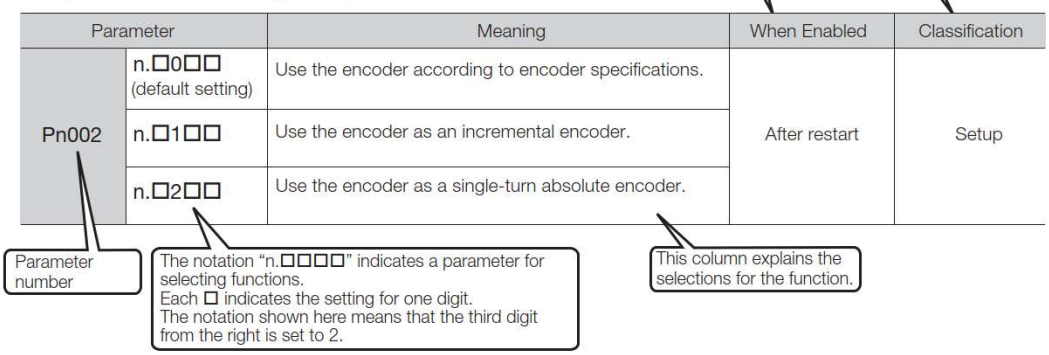
5.1.2 Notation for Parameters

There are two types of notations used for parameters that depend on whether the parameter requires a numeric setting (parameter for numeric setting) or requires the selection of a function (parameter for selecting a function).

- **Parameters for Numeric Settings**



- **Parameters for Selecting Functions**



5.1.3 Parameter Setting Methods

You can use the Protuner or the Panel Operator to set parameters.

5.1.4 Write Protection Setting for Parameters

You can prohibit writing parameters from the Panel Operator or the Digital Operator.
Even if you do, you will still be able to change parameter settings from the Protuner.

5.1.5 Initializing Parameter Settings

You can return the parameters to their default settings.

This function will not initialize the settings of the parameters that are adjusted for the FA00C, FA00D, FA00E, and FA00F utility functions.



To enable the new settings, turn the power supply to the servo driver OFF and ON again after you complete the operation.

Preparations

Always check the following before you initialize the parameter settings.
- The parameters must not be write prohibited.
- The servo must be OFF.

Applicable Tools
The following table lists the tools that you can use to initialize the parameter settings.

Too	FA No./Function Name	Reference
Panel Operator	FA005	ParameterSetup Initialize Parameters (FA005)
ProTuner	[Edit Parameters] - [Parameter Restore factory values]	

5.2 The EtherCAT of Communication Specification

The EtherCAT communication setting setup by Servo Parameter Pn013.

5.2.1 The Setting of EtherCAT Station Address

	EtherCAT Station Address			Speed Position Torque	
Pn013	Setup Range	Setup Unit	default setting	When Enabled	Classification
	0000～FFFF	--	1	After restart	Setup

5.3 Power Supply Type Settings for the Main Circuit and Control Circuit

A servo driver with a 220-VAC power supply input can be operated on either an AC power supply input or DC power supply input to the main and control circuits. If you select an AC power supply input, you can operate the servo driver on either a single-phase power supply input or a three-phase power supply input. This section describes the settings related to the power supplies.

5.3.1 AC Power Supply Input/DC Power Supply Input Setting

Set Pn001 = n. X (Main Circuit Power Supply AC/DC Input Selection) to specify whether to use an AC or DC power supply input for the main circuit power supply to the servo driver.

If the setting of Pn001 = n. X does not agree with the actual power supply input, an A.330 alarm (Main Circuit Power Supply Wiring Error) will occur.

Example: Examples of When an A.330 Alarm (Main Circuit Power Supply Wiring Error) Occurs

- A DC power supply is connected between the B1/ and 2 terminals, but an AC power supply input is specified (Pn001 = n. 0).
- An AC power supply is input to the L1, L2, and L3 terminals, but a DC power supply is specified (Pn001 = n. 1).

Parameter		Meaning	When Enabled	Classification
Pn001	n.□0□□ [default setting]	Use an AC power supply input.	After restart	Setup
	n.□1□□	Use a DC power supply input.		

WARNING

- Connect the AC or DC power supplies to the specified servo driver terminals.
  - Connect an AC power supply to the L1, L2, and L3 terminals and the L1C and L2C terminals on the servo driver.
  - Connect a DC power supply to the B1/ and 2 terminals and the L1C and L2C terminals on the servo driver.

  There is a risk of failure or fire.
- Always specify a DC power supply input (Pn001 = n. 1) before you input DC power for the main circuit power supply.

  If you input DC power without specifying a DC power supply input (i.e., without setting Pn001 to n. 1), the servo driver's internal elements may burn and may cause fire or damage to the equipment.
- With a DC power supply input, time is required to discharge electricity after the main power supply is turned OFF. A high residual voltage may remain in the servo driver after the power supply is turned OFF. Be careful not to get an electric shock.
- Install fuses on the power supply line if you use DC power.
- The Servomotor returns regenerative energy to the power supply. If you use a servo driver with a DC power supply input, regenerative energy is not processed. Process the regenera-tive energy at the power supply.

5.3.2 Single-phase AC Power Supply Input/Three-phase AC Power Supply Input Setting

If you use a single-phase, 220-VAC power supply input for the servo driver's main circuit power supply, set parameter Pn00B to n. 1 (Use a three-phase power supply input as a single-phase power supply input).

This restriction does not affect the SC3 03A model.

Parameter		Meaning	When Enabled	Classification
Pn00B	n.□0□□ [default setting]	Use a three-phase power supply input.	After restart	Setup
	n.□1□□	Use a three-phase power supply input as a single-phase power supply input.		

1. If you use a single-phase power supply input without specifying a single-phase AC power supply (Pn00B = n. 1), an A.F10 alarm (Power Supply Line Open Phase) will occur.
2. Not all Servo driver can be run on a single-phase AC power supply input. If you connect a single-phase AC power supply input to a servo driver that does not support single-phase power, an A.F10 alarm (Power Supply Line Open Phase) will occur.

3. If you use a single-phase 220AC power supply input, the torque-motor speed characteristic of the Servomotor will not be the same as for a three-phase AC power supply input. Decide whether to use a single-phase or three-phase AC power supply input after checking the characteristics given in the Servomotor manual or catalog.

5.4 Functions and Settings for the /S-ON (Servo ON) Signal

The /S-ON (Servo ON) signal is used to enable Servomotor operation.
This section describes the function of and settings for the /S-ON signal.

5.4.1 Function of the /S-ON (Servo ON) Signal

Type	Signal	Connector Pin No.	Signal Status	Function
Input	/S-ON	Must be allocated	ON (closed)	Power is supplied to the Servomotor to enable operation.
			OFF (open)	Power supply to the Servomotor is stopped and operation is disabled.

You can use Pn50A = n. X (/S-ON (Servo ON) Signal Allocation) to allocate the /S-ON signal to a different input signal terminal.



1. Always input the /S-ON signal before you input a speed, position, or torque reference to start the Servomotor. Never input the reference first and then use the /S-ON signal or turn ON the AC power supply to start the Servomotor. Doing so will degrade internal elements and may cause an accident.

2. Input the /S-ON signal while the Servomotor is stopped. You cannot turn ON the servo while the Servomotor is operating.

5.4.2 Setting to Keep the Servo ON and Supply Power to the Motor Continuously (For Pulses Type)

You can set Pn50A = n. X (/S-ON (Servo ON) Signal Allocation) to 9 (The signal is always active) to keep the servo ON and supply power to the motor continuously.

Parameter		Meaning	When Enabled	Classification
Pn50A	n.□□0□ [default setting]	he S-ON signal is active when CN1-40 input signal is ON (closed).	After restart	Setup
	n.□□9□	The signal is always active. (The /S-ON signal is always active.)		

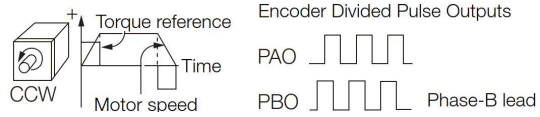
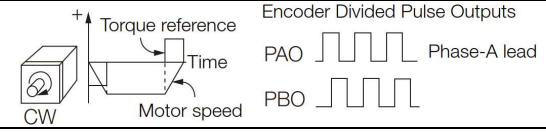
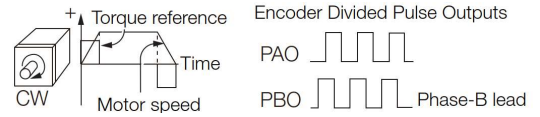
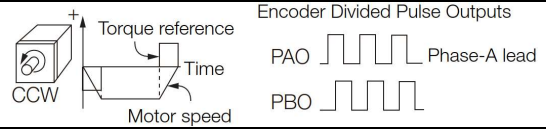


1. If you set this parameter to keep the servo ON continuously, power will be supplied to the motor as soon the main circuit power supply to the servo driver is turned ON. If there is already a speed, position, or torque reference input, the Servomotor or machine may perform unexpected operation. Always implement safety measures.

2. If a resettable alarm occurs and operation is disabled (power is not supplied to the motor), operation will be automatically enabled (power will be supplied to the motor) when the alarm is reset. If you set this parameter to keep the servo ON continuously, the Servomotor or machine may perform unexpected operation when an alarm is reset.

5.5 Motor Direction Setting

You can reverse the direction of Servomotor rotation by changing the setting of Pn000 = n. X (Rotation Direction Selection) without changing the polarity of the speed or position reference.
This causes the rotation direction of the Servomotor to change, but the polarity of the signals, such as encoder output pulses, output from the servo driver do not change. Set the appropriate direction for your system.
The default setting for forward rotation is counterclockwise (CCW) as viewed from the load end of the Servomotor.

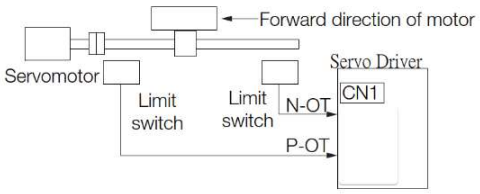
Parameter		Forward/Reverse Reference	Motor Direction and Encoder Divided Pulse Outputs	Applicable Overtravel Signal (OT)
Pn000	n. 0 Use CCW as the forward direction. (Default setting	Forward reference		P-OT (Forward Drive Prohibit) signal
		Reverse reference		N-OT (Reverse Drive Prohibit) signal
	n. 1 Use CW as the forward direction. (Reverse Rotation Mode)	Forward reference		P-OT (Forward Drive Prohibit) signal
		反 Reverse reference		N-OT (Reverse Drive Prohibit) signal

5.6 Overtravel and Related Settings

Overtravel is a function of the servo driver that forces the Servomotor to stop in response to a signal input from a limit switch that is activated when a moving part of the machine exceeds the safe range of movement.

The overtravel signals include the P-OT (Forward Drive Prohibit) and the N-OT (Reverse Drive Prohibit) signals.

You use the P-OT and N-OT signals to stop the machine by installing limit switches at the positions where you want to stop the machine that is operated by the Servomotor. A servo driver wiring example is provided below.



Using the overtravel function is not necessary for rotating applications such as rotary tables and conveyors. No wiring for overtravel input signals is required. This section describes the parameters settings related to overtravel.

CAUTION

- To prevent accidents that may result from contact faults or disconnections, use normally closed limit switches.
  Do not change the default settings of the polarity of the overtravel signals (P-OT and N-OT).
- If you use a Servomotor for a vertical axis, the /BK (Brake) signal will remain ON (i.e., the brake will be released) when overtravel occurs. This may result in the workpiece falling when overtravel occurs. To prevent the workpiece from falling, set Pn001 to n. 1 to place the Servomotor in a zero-clamped state when it stops.
- A base block state is entered after stopping for overtravel. This may cause the Servomotor to be pushed back by an external force on the load shaft. To prevent the Servomotor from being pushed back, set Pn001 to n. 1 to place the Servomotor in a zero-clamped state when it stops.

5.6.1 Overtravel Signals

The overtravel signals include the P-OT (Forward Drive Prohibit) and the N-OT (Reverse Drive Prohibit) signals.

Type	Signal	Connector Pin No.	Signal Status	Meaning
Input	P-OT	CN1-IN2	ON	Forward drive is enabled (actual operation).
			OFF	Forward drive is prohibited (forward overtravel).
	N-0T	CN1-IN3	ON	Reverse drive is enabled (actual operation).
			OFF	Reverse drive is prohibited (reverse overtravel).

You can operate the Servomotor in the opposite direction during overtravel by inputting a reference. ◦

5.6.2 Setting to Enable/Disable Overtravel

You can use Pn50A = n.X (P-OT (Forward Drive Prohibit) Signal Allocation) and Pn50B = n. X (N-OT (Reverse Drive Prohibit) Signal Allocation) to enable and disable the overtravel function.
You do not need to wire the overtravel input signals if you are not going to use the overtravel function.

Parameter		Meaning	When Enabled	Classification
Pn50A	n. 2□□□ [default setting]	The forward overtravel function is enabled and the P-OT (Forward Drive Prohibit) signal is input from CN1-CN0. (CN1-IN1 For Pulses Type)	After restart	Setup
	n. 8□□□	The forward overtravel function is disabled. Forward drive is always enabled.		
Pn50B	n.□□□3 [default setting	The reverse overtravel function is enabled and the N-OT (Reverse Drive Prohibit) signal is input from CN1-CN1. (CN1-IN2 For Pulses Type)	After restart	Setup
	n.□□□8	The reverse overtravel function is disabled. Reverse drive is always enabled.		

5.6.3 Motor Stopping Method for Overtravel

You can set the stopping method of the Servomotor when overtravel occurs in Pn001 = n. XX (Motor Stopping Method for Servo OFF and Group 1 Alarms and Overtravel Stopping Method).

Parameter		Motor Stopping Method*	Status after Stopping	When Enabled	Classification
Pn001	n.□□00 [default setting]	Dynamic brake	Coasting	After restart	Setup
	n.□□01				
	n.□□02	Coasting			
	n.□□1□	Deceleration according to setting of Pn406	Zero clamp		
	n.□□2□		Coasting		
	n.□□3□	Deceleration according to setting of Pn30A	Zero clamp		
	n.□□4□		Coasting		

* You cannot decelerate a Servomotor to a stop during torque control. For torque control, the Servomotor will be stopped with the dynamic braking or coast to a stop (according to the setting of Pn001 = n. X (Motor Stopping Method for Servo OFF and Group 1 Alarms)), and then the Servomotor will enter a coasting state.

Stopping the Servomotor by Setting Emergency Stop Torque

To stop the Servomotor by setting emergency stop torque, set Pn406 (Emergency Stop Torque).If Pn001 = n. X is set to 1 or 2, the Servomotor will be decelerated to a stop using the torque set in Pn406 as the maximum torque. The default setting is 800%. This setting is large enough to allow you to operate the Servomotor at the maximum torque. However, the maximum emergency stop torque that you can actually use is the maximum torque of the Servomotor.

	Emergency Stop Torque			Speed Position Torque	
Pn406	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0～800	1% *	800	Immediately	Setup

* Set a percentage of the motor rated torque.

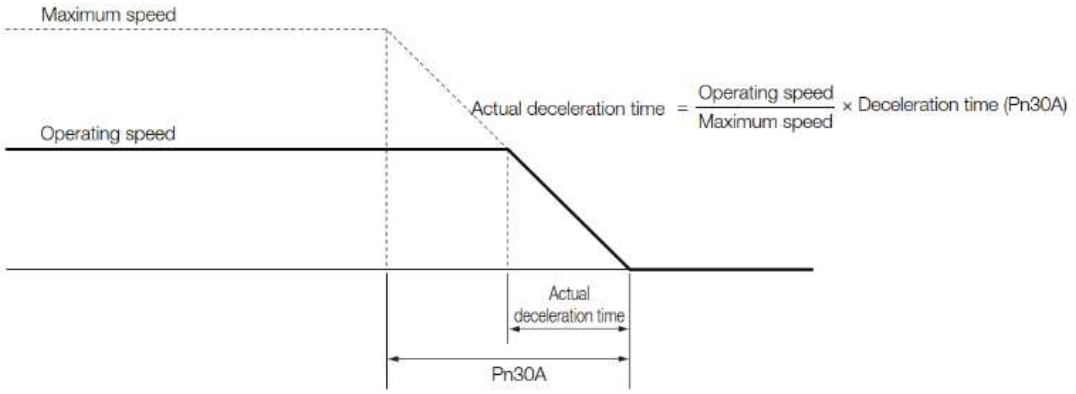
Stopping the Servomotor by Setting the Deceleration Time

To specify the Servomotor deceleration time and use it to stop the Servomotor, set Pn30A (Deceleration Time for Servo OFF and Forced Stops).

Pn30A	Deceleration Time for Servo OFF and Forced Stops			Speed Position Torque	
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0～10000	1ms	0	Immediately	Setup

If you set Pn30A to 0, the Servomotor will be stopped with a zero speed.

The deceleration time that you set in Pn30A is the time to decelerate the Servomotor from the maximum motor speed.



5.6.4 Overtravel Warnings

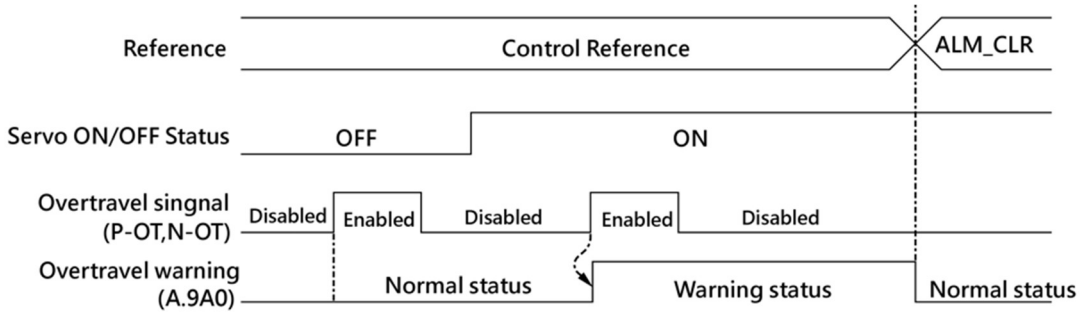
You can set the system to detect an A.9A0 warning (Overtravel) if overtravel occurs while the servo is ON. This allows the servo driver to notify the host controller with a warning even when the overtravel signal is input only momentarily. An alarm occurs only if overtravel occurs while the servo is ON. An overtravel warning will not be detected when the servo is OFF, even if overtravel occurs.

- The occurrence of an A.9A0 warning will not stop the motor or have any affect on host controller motion operations. The next step (e.g., the next motion or command) can be executed even if an overtravel warning exists.
  However, depending on the processing specifications and programming for warnings in the host controller, operation may be affected when an overtravel warning occurs (e.g., motion may stop or not stop). Confirm the specifications and programming in the host controller.
- When overtravel occurs, the servo driver will perform stop processing for overtravel. Therefore, when an A.9A0 warning occurs, the Servomotor may not reach the target position specified by the host controller. Check the feedback position to make sure that the axis is stopped at a safe position.

The following parameter is set for this function.

Parameter		Meaning	When Enabled	Classification
Pn00D	n.0□□□ [default setting]	Do not detect overtravel warnings.	restart	Setup
	n.1□□□	Detect overtravel warnings.		

A timing chart for warning detection is provided below.

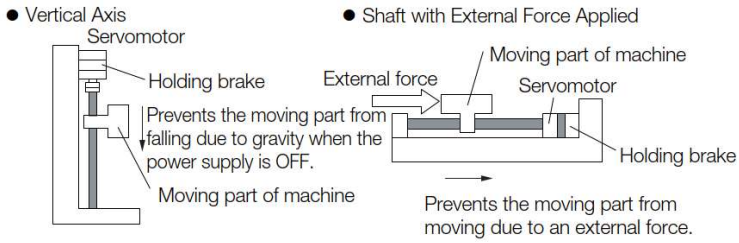


NOTE:
1. Warnings are detected for overtravel in the same direction as the reference.
2. Warnings are not detected for overtravel in the opposite direction from the reference. Example: A warning will not be output for a forward reference even if the N-OT signal turns ON.
3. A warning status can be detected in either the forward or reverse direction if there is no reference.
4. A warning status will not be detected when the servo is turned ON even if overtravel status exists.
5. A warning status is not related to Servo ON/Servo OFF or the overtravel signal status. It will be cleared by ALM_CLR.
6. When an overtravel warning status is triggered, it will not be triggered again until the it is cleared.
7. When the software limit is detected, An overtravel warning status will still be triggered.

5.7 Holding Brake

A holding brake is used to hold the position of the moving part of the machine when the servo driver is turned OFF so that moving part does not move due to gravity or an external force. You can use the brake that is built into a Servomotor with a Brake, or you can provide one on the machine.

The holding brake is used in the following cases.

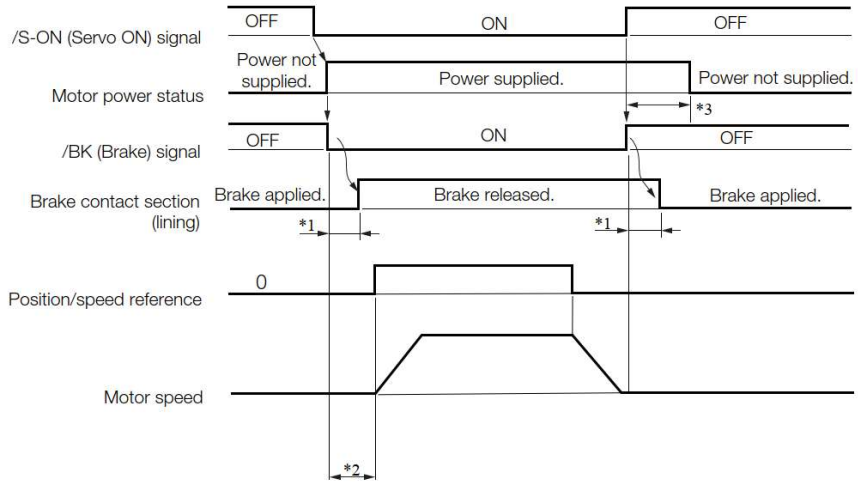


The brake built into a Servomotor with a Brake is a de-energization brake. It is used only to hold the Servomotor and cannot be used for braking. Use the holding brake only to hold a Servomotor that is already stopped.

5.7.1 Brake Operating Sequence

You must consider the brake release delay time and the brake operation delay time to determine the brake operation timing, as described below.

Brake Release Delay Time
The time from when the /BK (Brake) signal is turned ON until the brake is actually released.
Brake Operation Delay Time
The time from when the /BK (Brake) signal is turned OFF until the brake actually operates.



*1. Rotary Servomotors: The brake delay times for Servomotors with Holding Brakes are given in the following table. The operation delay times in the following table are examples for when the power supply is switched on the DC side. You must evaluate the actual brake delay times on the actual equipment before using the application.

*2. Before you output a reference from the host controller to the Servo Driver, wait for at least 50 ms plus the brake release delay time after you turn ON the /S-ON signal.

*3. Use the following parameters to set the timing of when the brake will operate and when the servo will be turned OFF.

• Rotary Servomotors: Pn506 (Brake Reference-Servo OFF Delay Time), Pn507 (Brake Reference Output Speed Level), and Pn508 (Servo OFF-Brake Command Waiting Time)

• Linear Servomotors: Pn506 (Brake Reference-Servo OFF Delay Time), Pn508 (Servo OFF-Brake Command Waiting Time), and Pn583 (Brake Reference Output Speed Level)

*4. After the SV_ON command is sent, wait for the brake release time plus an additional 50ms then output the command that sent by the upper device to the servo driver.

*5. Please use the following parameters to set up the brake action and servo OFF time:

Pn506(Brake command - Servo OFF delay time)，

Pn507(Brake command output speed value)，

Pn508(Servo OFF - Brake command wait time)

5.7.2 /BK (Brake) Signal

The following settings are for the output signal that controls the brake. The /BK (Brake) signal is not allocated by default. To use the brake, change the setting of Pn50F = n. X (/BK (Brake Output) Signal Allocation).
The /BK signal is turned OFF (to operate the brake) when the servo is turned OFF or when an alarm is detected. You can adjust the timing of brake operation (i.e., the timing of turning OFF the /BK signal) with the servo OFF delay time (Pn506).

Type	Singal	Connecter Pin No.	Singal Status	Meaning
Output	/BK	Must be allocated	ON (Closed)	Releases the brake
			OFF (Open)	Activates the brake

NOTE: The /BK signal will remain ON during overtravel. The brake will not be applied.

Allocating the /BK (Brake) Signal

To use the brake, you must allocate an output signal for the /BK signal.
Set the allocation for the /BK signal in Pn50F = n. X (/BK (Brake Output) Signal Allocation).

Parameter		Connecter Pin No.	meaning	When Enabled	Classification
Pn50F	n.□0□□	CN1-7,8	The /BK Signal is output from CN1-OUT0	After restart	setup
	n.□1□□	CN1-9,10	The /BK Signal is output from CN1-OUT1		
	n.□2□□ [default setting]	CN1-11,12	The /BK Signal is output from CN1-OUT2		

	n.□3□□	CN1-32,33	The /BK Signal is output from CN1-OUT3		
	n.□4□□	CN1-34,35	The /BK Signal is output from CN1-OUT4		
	n.□5□□	CN1-36,37	The /BK Signal is output from CN1-OUT5		
	n.□6□□	---	The /BK Signal is not used		

If you allocate more than one signal to the same output connector pin, a logical OR of the signals is output. Allocate the /BK signal to its own output connector pin, i.e., do not use the same output terminal for another signal.

For example, never allocate the /TGON (Rotation Detection) signal and /BK signal to the same output connector pin. If you did so, the /TGON signal would be turned ON by the falling speed on a vertical axis, and the brake would not operate.

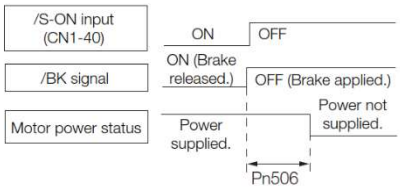
5.7.3 Output Timing of /BK (Brake) Signal When the Servomotor Is Stopped

When the Servomotor is stopped, the /BK signal turns OFF at the same time as the /S-ON signal turns OFF. Use the servo OFF delay time (Pn506) to change the timing to turn OFF power supply to the motor after the /S-ON signal turns OFF.

Pn506	Brake Reference-Servo OFF Delay Time			Speed Position Torque	
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0～50	1ms	0	Immediately	Setup

• When the Servomotor is used to control a vertical axis, the machine moving part may move slightly due to gravity or an external force. You can eliminate this slight motion by setting the servo OFF delay time (Pn506) so that power supply to the motor is stopped after the brake is applied.

• This parameter sets the timing of stopping power supply to the Servomotor while the Servomotor is stopped.



Power supply to the Servomotor will be stopped immediately when an alarm occurs, regardless of the setting of this parameter. The machine moving part may move due to gravity or an external force before the brake is applied.

5.7.4 Output Timing of /BK (Brake) Signal When the Servomotor Is Operating

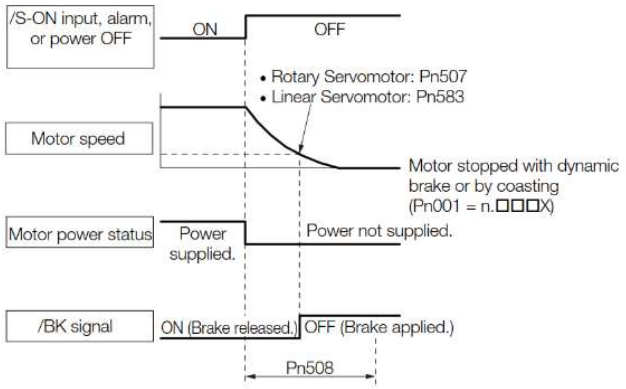
If an alarm occurs while the Servomotor is operating, the Servomotor will start stopping and the /BK signal will be turned OFF. You can adjust the timing of /BK signal output by setting the brake reference output speed level (Rotary Servomotors: Pn507, Linear Servomotors: Pn583) and the Servo OFF-Brake Command Waiting Time (Pn508).

NOTE: If zero-speed stopping is set as the stopping method for alarms, the setting of Pn506 (Brake Reference Servo OFF Delay Time) is used after the motor stops.

Pn507	Brake Reference Output Speed Level			Speed Position Torque	
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0～10000	1min^{-1} (RPM)	100	Immediately	Setup
Pn508	Servo OFF-Brake Command Waiting Time			Speed Position Torque	
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	10～100	10ms	50	Immediately	Setup

The brake operates when either of the following conditions is satisfied:

• When the Motor Speed Goes below the Level Set in Pn507 for a Rotary Servomotor or in Pn583 for a Linear



Servomotor after the Power Supply to the Motor Is Stopped

• When the Time Set In Pn508 Elapses after the Power Supply to the Motor Is Stopped

The Servomotor will be limited to its maximum speed even if the brake reference output speed level (Rotary Servomotor: Pn507, Linear Servomotor: Pn583) is higher than the maximum speed.

5.8 Motor Stopping Methods for Servo OFF and Alarms

You can use the following methods to stop the Servomotor when the servo is turned OFF or an alarm occurs. There are the following four stopping methods.

Motor Stopping Method	Meaning
Stopping by Applying the Dynamic Brake	The electric circuits are internally connected to stop the Servomotor quickly.
Coasting to a Stop	The motor stops naturally due to friction during operation.
Zero-speed Stopping	The speed reference is set to 0 to stop the Servomotor quickly.
Decelerating to a Stop	Emergency stop torque is used to decelerate the motor to a stop.

There are the following three conditions after stopping.

Status after Stopping	Meaning
Stopping by Applying the Dynamic Brake	The electric circuits are internally connected to hold the Servomotor.
Coasting	The servo driver does not control the Servomotor. (The machine will move in response to a force from the load.)
Zero Clamping	A position loop is created and the Servomotor remains stopped at a position reference of 0. (The current stop position is held.)

• The dynamic brake is used for emergency stops. The dynamic brake circuit will operate frequently if the power supply is turned ON and OFF or the servo is turned ON and OFF while areference input is applied to start and stop the Servomotor. This may result in deterioration of the internal elements in the servo driver. Use speed input references or position references to start and stop the Servomotor.

• If the Servomotor must be stopped by coasting rather than with the dynamic brake when the main circuit power supply or the control power supply is turned OFF before the servo is turned OFF, use a servo driver with the dynamic brake option.

• To minimize the coasting distance of the Servomotor to come to a stop when an alarm occurs, zero-speed stopping is the default method for alarms to which it is applicable. However, depending on the application, stopping with the dynamic brake may be more suitable than zero-speed stopping.

5.8.1 Stopping Method for Servo OFF

Set the stopping method for when the servo is turned OFF in Pn001 = n. X (Motor Stopping Method for Servo OFF and Group 1 Alarms).

Parameter		Servomotor Stopping Method	Status after Servomotor Stops	When Enabled	Classification
Pn001	n.□□□0 [default setting]	Dynamic brake*	Dynamic brake*	After restart	Setup
	n.□□□1		Coasting		
	n.□□□2	Coasting	Coasting		

NOTE: If Pn001 is set to n. 0 (Stop the motor by applying the dynamic brake) and the Servomotor is stopped or operates at a low speed, braking force may not be generated, just like it is not generated for coasting to a stop.

5.8.2 Servomotor Stopping Method for Alarms

There are two types of alarms, group 1 (Gr. 1) alarms and group 2 (Gr. 2) alarms. A different parameter is used to set the stopping method for alarms for each alarm type. Refer to the following section to see which alarms are in group 1 and which are in group 2.

Motor Stopping Method for Group 1 Alarms

When a group 1 alarm occurs, the Servomotor will stop according to the setting of Pn001 = n. X. The default setting is to stop by applying the dynamic brake.

Motor Stopping Method for Group 2 Alarms

When a group 2 alarm occurs, the Servomotor will stop according to the settings of the following three parameters. The default setting is for zero clamping.

- Pn001 = n. X (Motor Stopping Method for Servo OFF and Group 1 Alarms)
- Pn00A = n. X (Motor Stopping Method for Group 2 Alarms)
- Pn00B = n. X (Motor Stopping Method for Group 2 Alarms)

However, during torque control, the group 1 stopping method is always used. If you set Pn00B to n. 1 (Apply dynamic brake or coast Servomotor to a stop), you can use the same stopping method as group 1. If you are coordinating a number of Servomotors, you can use this stopping method to prevent machine damage that may result because of differences in the stopping method.

The following table shows the combinations of the parameter settings and the resulting stopping methods.

Parameter			ServomotorStopping Method	Status after Servomotor stops	When Enabled	Classification
Pn00B	Pn00A	Pn001				
n.□□0□ [default setting]	---	n.□□□0 [default setting]	Zero-speed stopping	Dynamic Brake	After restart	Setup
		n.□□□1		Coasting		
		n.□□□2				
n.□□1□		n.□□□0 [default setting]	Dynamic Brake	Dynamic Brake		
		n.□□□1		Coasting		
		n.□□□2	Coasting			
n.□□2□	n.□□□0 [default setting]	n.□□□0 [default setting]	Dynamic Brake	Dynamic Brake		
		n.□□□1		Coasting		
		n.□□□2	Coasting			
	n.□□□1	n.□□□0 [default setting]	Motor is decelerated using the torque set in Pn406 as the maximum torque.	Dynamic Brake		
		n.□□□1		Coasting		
		n.□□□2				
	n.□□□2	n.□□□0 [default setting]		Coasting		
		n.□□□1				
		n.□□□2				
	n.□□□3	n.□□□0 [default setting]	Motor is decelerated according to setting of Pn30A.	Dynamic Brake		
		n.□□□1		Coasting		
		n.□□□2				

	n.□□□4	n.□□□0 [default setting]		Coasting		
		n.□□□1				
		n.□□□2				

NOTE: 1. The setting of Pn00A is ignored if Pn00B is set to n. 0 or n. 1 .
2. The setting of Pn00A = n. X is enabled for position control and speed control. During torque control, the setting of Pn00A = n. X will be ignored and only the setting of Pn001 = n. X will be used.

5.9 Motor Overload Detection Level

The motor overload detection level is the threshold used to detect overload alarms and overload warnings when the Servomotor is subjected to a continuous load that exceeds the Servomotor ratings.

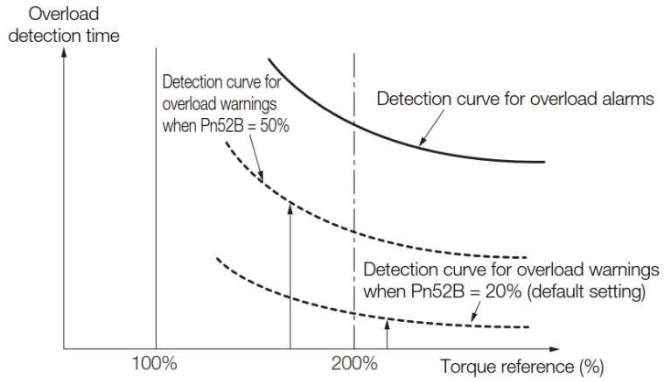
It is designed to prevent Servomotor overheating.

You can change the detection timing for A.910 warnings (Overload) and A.720 alarms (Continuous Overload). You cannot change the detection level for A.710 alarms (Instantaneous Overload).

5.9.1 Detection Timing for Overload Warnings (A.910)

With the default setting for overload warnings, an overload warning is detected in 20% of the time required to detect an overload alarm. You can change the time required to detect an overload warning by changing the setting of the overload warning level (Pn52B). You can increase safety by using overload warning detection as an overload protection function matched to the system.

The following graph shows an example of the detection of overload warnings when the overload warning level (Pn52B) is changed from 20% to 50%. An overload warning is detected in half of the time required to detect an overload alarm.



Pn52B	Overload Warning Level			Speed Position Torque	
	Setup Range	Setup Unit	default setting	When Enabled	Classification
	0～100	1%	20	immediately	Setup

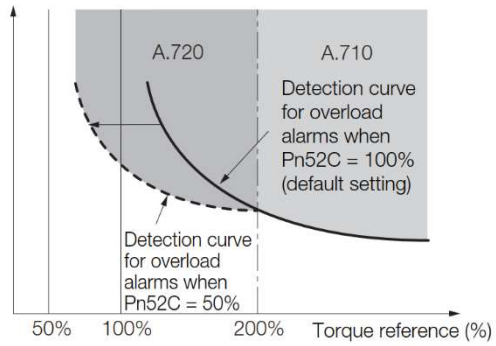
5.9.2 Detection Timing for Overload Alarms (A.720)

If Servomotor heat dissipation is insufficient (e.g., if the heat sink is too small), you can lower the overload alarm detection level to help prevent overheating.
To reduce the overload alarm detection level, change the setting of Pn52C (Base Current Derating at Motor Overload Detection)

Pn52C	Base Current Derating at Motor Overload Detection			Speed Position Torque	
	Setup Range	Setup Unit	default setting	When Enabled	Classification
	0～100	1%	100	After restart	Setup

An A.720 alarm (Continuous Overload) can be detected earlier to protect the Servomotor from overloading.

Overload detection time



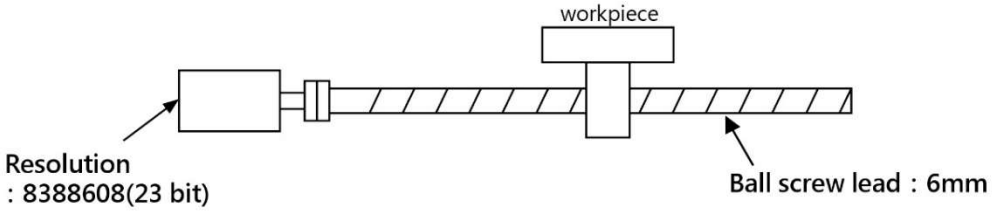
NOTE: The gray areas in the above graph show where A.710 and A.720 alarms occur.

5.10 Electronic Gear Settings

The minimum unit of the position data that is used to move a load is called the reference unit. The reference unit is used to give travel amounts, not in pulses, but rather in distances or other physical units (such as μm or °) that are easier to understand.

The electronic gear is used to convert the travel distances that are specified in reference units to pulses, which are required for actual movements.

With the electronic gear, one reference unit is equal to the workpiece travel distance per refer-ence pulse input to the servo driver. In other words, if you use the servo driver’ s electronic gear, pulses can be read as reference units.
NOTE: 1. If you set an electronic gear in the host controller, normally set the electronic gear ratio in the servo driver to 1:1. 2. If you enable reference pulse input multiplication switching, the reference unit is defined as the position data that is n times the reference pulses input from the host controller. (“n” is the reference pulse input multiplier.)



When the Electronic Gear Is Not Used

To move a workpiece 10mm:
①Calculate the number of revolutions.
The Servomotor will move 6 mm for earch revo-lution, so 10/6 revolutions are required to move 10mm.
②Calculate the required number of reference pulses.
One revolution is 8,388,608 pulses, therefore 10/6×8,388,608 = 13,981,013 pulses.
③Input 13,981,013 pulses as the reference.

Calculating the number of reference pulses for each reference is troublesome.

When the Electronic Gear Is Used

If you use reference units to move the workpiece when one reference unit is set to 1 μm, the travel distance is 1 μm per pulse.
To move the workpiece 10 mm (10,000 μm), 10,000÷1=10,000 pulses, so 10,000 pulses would be input.

Calculating the number of reference pulses for each reference is not necessary.

The difference between using and not using the electronic gear is shown below.

Electronic Gear Ratio Settings

Set the electronic gear ratio using Pn20E and Pn210.

Set the electronic gear ratio within the following range.
0.001 ≤ Electronic gear ratio (B/A) ≤ 64,000
If the electronic gear ratio is outside of this range, an A.040 alarm (Parameter Setting Error) will occur.

Pn20E	Electronic Gear Ratio (Numerator)				Position
	Setup Range	Setup Unit	default setting	When Enabled	Classification
	1 ~ 1073741824	1	1	After restart	Setup
Pn210	Electronic Gear Ratio (Denominator)			Speed	Position Torque
	Setup Range	Setup Unit	default setting	When Enabled	Classification
	1 ~ 1073741824	1	1	After restart	Setup

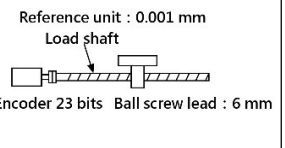
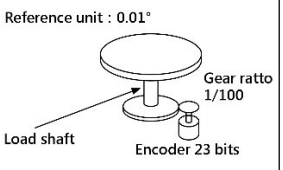
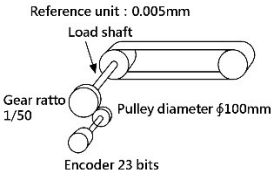
Calculating the Settings for the Electronic Gear Ratio

If the gear ratio between the Servomotor shaft and the load is given as n/m, where n is the number of load rotations for m Servomotor shaft rotations, the settings for the electronic gear ratio can be calculated as follows:

$$\text{Electronic gear ratio } \frac{B}{A} = \frac{Pn20E}{Pn210} = \frac{\text{Encoder resolution}}{\text{Travel distance per load shaft revolution (reference units)}} \times \frac{m}{n}$$

5.10.1 Electronic Gear Ratio Setting Examples

Setting examples are provided in this section.

Step	Description	Machine Configuration		
		Ball Screw	Rotary Table	Belt and Pulley
				
1	Machine Specifications	• Ball screw lead : 6mm • Gear ratio : 1/1	• Rotational angle per revolution : 360° • Gear ratio : 1/100	• Pulley dia : 100mm (Pulley circumference : 314mm) • Gear ratio : 1/50
2	Encoder Resolution	8388608(23 位)	8388608(23 位)	8388608(23 位)
3	Reference Unit	0.001 mm (1 μm)	0.01 mm (10 μm)	0.005 mm (5 μm)
4	Travel Distance per Load Shaft Revolution (Reference Units)	6 mm/0.001 mm = 6000	360°/0.01° = 36000	314 mm/0.005 mm = 62800
5	Electronic Gear Ratio	$\frac{B}{A} = \frac{8388608}{6000} \times \frac{1}{1}$	$\frac{B}{A} = \frac{8388608}{36000} \times \frac{100}{1}$	$\frac{B}{A} = \frac{8388608}{62800} \times \frac{50}{1}$
6	Parameter	Pn20E : 8388608	Pn20E : 838860800	Pn20E : 419430400
		Pn210 : 6000	Pn210 : 36000	Pn210 : 62800

5.11 Resetting the Absolute Encoder

In a system that uses an absolute encoder, the multiturn data must be reset at startup. An alarm related to the absolute encoder (A.810 or A.820) will occur when the absolute encoder must be reset, such as when the power supply is turned ON.

When you reset the absolute encoder, the multiturn data is reset and any alarms related to the absolute encoder are cleared.

Reset the absolute encoder in the following cases

- When an A.810 alarm (Encoder Backup Alarm) occurs
- When an A.820 alarm (Encoder Checksum Alarm) occurs
- When starting the system for the first time
- When you want to reset the multiturn data in the absolute encoder

• When the Servomotor has been replaced

CAUTION
• The multiturn data will be reset to a value between -2 and +2 rotations when the absolute encoder is reset. The reference position of the machine system will change. Adjust the reference position in the host controller to the position that results from resetting the absolute encoder. If the machine is started without adjusting the position in the host controller, unexpected operation may cause personal injury or damage to the machine.

NOTE: 1. The multiturn data will always be zero in the following cases. It is never necessary to reset the absolute encoder in these cases. An alarm related to the absolute encoder (A.810 or A.820) will not occur.
• When you use a single-turn absolute encoder
• When the encoder is set to be used as a single-turn absolute encoder (Pn002 = n. 2)
2. If a batteryless absolute encoder is used, an A.810 alarm (Encoder Backup Alarm) will occur the first time the power is turned ON. After you reset the absolute encoder, the A.810 alarm will no longer occur.

5.11.1 Precautions on Resetting

• You cannot use the /ALM-RST (Alarm Reset) signal from the servo driver to clear the A.810 alarm (Encoder Backup Alarm) or the A.820 alarm (Encoder Checksum Alarm). Always use the operation to reset the absolute encoder to clear these alarms.
• If an A.8 alarm (Internal Encoder Monitoring Alarm) occurs, turn OFF the power supply to reset the alarm.
Always check the following before you reset an absolute encoder.
• The parameters must not be write prohibited.
• The servo must be OFF.

5.11.2 Applicable Tools

The following table lists the tools that you can use to reset the absolute encoder

Tool	FA No./Function Name
Panel Operator	FA008
ProTuner	[Encoder Setting–Reset Absolute Encoder]

5.12 Setting the Regenerative Resistor Capacity

The regenerative resistor consumes regenerative energy that is generated by the Servomotor, e.g., when the Servomotor decelerates.

If an External Regenerative Resistor is connected, you must set Pn600 (Regenerative Resistor Capacity).

WARNING
• If you connect an External Regenerative Resistor, set Pn600 and Pn603 to suitable values. If a suitable value is not set, A.320 alarms (Regenerative Overload) will not be detected correctly, and the External Regenerative Resistor may be damaged or personal injury or fire may result. • When you select an External Regenerative Resistor, make sure that it has a suitable capacity. There is a risk of personal injury or fire.

Pn600	Regenerative Resistor Capacity			Speed Position Torque	
	Setup Range	Setup Unit	default setting	When Enabled	Classification
	0 ~ servo driver’s maximum applicable motor capacity	10W	0	immediately	Setup
Pn603	Regenerative Resistance			Speed Position Torque	
	Setup Range	Setup Unit	default setting	When Enabled	Classification
	0 ~ 65535	10mΩ	0	immediately	Setup

Set the regenerative resistor capacity to a value that is consistent with the allowable capacity of the External Regenerative Resistor. The setting depends on the cooling conditions of the External Regenerative Resistor.

• For self-cooling (natural convection cooling): Set the parameter to a maximum 20% of the capacity (W) of the actually installed regenerative resistor.

• For forced-air cooling: Set the parameter to a maximum 50% of the capacity (W) of the actually installed regenerative resistor.

For a self-cooling 100-W External Regenerative Resistor, set Pn600 to 2 (×10 W) (100 W × 20% = 20 W).

NOTE: 1. An A.320 alarm will be displayed if the setting is not suitable.

2. The default setting of 0 specifies that the servo driver’s built-in regenerative resistor



• When an External Regenerative Resistor is used at the normal rated load ratio, the resistor temperature increases to between 200°C and 300°C. Always apply derating. Consult the manufacturer for the resistor’s load characteristics.。

• For safety, use an External Regenerative Resistor with a thermoswitch.

Chapter6. Application Functions

6.1 I/O Signal Allocations

Functions are allocated to the pins on the I/O signal connector (CN1) in advance. You can change the allocations and the polarity for some of the connector pins. Function allocations and polarity settings are made with parameters.
This section describes the I/O signal allocations.

6.1.1 Input Signal Allocations

Changing Input Signal Allocations



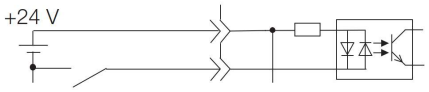
- If you change the default polarity settings for the /S-ON (Servo ON), P-OT (Forward Drive Pro-hibit), or N-OT (Reverse Drive Prohibit) signal, the main circuit power supply will not be turned OFF and the overtravel function will not operate if there are signal line disconnections or other problems. If you must change the polarity of one of these signals, verify operation and make sure that no safety problems will exist.
- If you allocate two or more signals to the same input circuit, a logical OR of the inputs will be used and all of the allocated signals will operate accordingly. This may result in unexpected operation

The input signals that you can allocate to the pins on the I/O signal connector (CN1) and the related parameters are given in the following table.(Taking EtherCAT type as an example)

Input Signal	Input Signal Name	Parameter
P-OT	Forward Drive Prohibit	Pn50A = n.X
N-OT	Reverse Drive Prohibit	Pn50B = n. X
/P-CL	Forward External Torque Limit	Pn50B = n. X
/N-CL	Reverse External Torque Limit	Pn50B = n.X
/DEX	Origin re-positioning deceleration switch input.	Pn511 = n. X
/EXT1	External capture input 1	Pn511 = n. X
/EXT2	External capture input 2	Pn511 = n. X
/EXT3	External capture input 3	Pn511 = n.X
FSTP	Forced Stop	Pn516 = n. X

◆Relationship between Parameter Settings, Allocated Pins, and Polarities

The following table shows the relationship between the input signal parameter settings, the pins on the I/O signal connector (CN1), and polarities.

Parameter Setting	Pin No.	Description
0	IN0(14)	 A reverse signal (a signal with "/" before the signal abbreviation, such as the /S-ON signal) is active when the contacts are ON (closed). A signal that does not have "/" before the signal abbreviation (such as the P-OT signal) is active when the contacts are OFF (open).
1	IN1(15)	
2	IN2(16)	
3	IN3(17)	
	IN4(39)	
5	IN5(40)	
6	IN6(41)	
7	IN7(42)	
8	-	The input signal is not allocated to a connector pin and it is always inactive. Set the parameter to 8 if the signal is not used.

9	-	The input signal is not allocated to a connector pin and it is always inactive. Set the parameter to 9 if the signal is not used.

Example of Changing Input Signal Allocations

The following example shows reversing the P-OT (Forward Drive Prohibit) signal allocated to CN1-IN1 and the /P-CL (External Torque Limit) signal allocated to CN1-IN3.

Pn50A = n.1□□□ Pn511 = n.□□□3 Before change
↓ ↓
Pn50A = n.3□□□ Pn511 = n.□□□1 After change

Confirming the Allocation Status of Input Signals

You can confirm the allocation status of input signals with the I/O Signal Allocations Window of the Protuner. Refer to the following section for details.
8.3.2 I/O Signals Status Monitor Monitor

6.1.2 Output Signal Allocations

You can allocate the desired output signals on the I/O signal connector (CN1). You set the allocations in the following parameters: Pn50E, Pn50F and Pn510.

Changing Output Signal Allocations



- The signals that are not detected are considered to be OFF. For example, the /COIN (Positioning Completion) signal is considered to be OFF during speed control.
- Reversing the polarity of the /BK (Brake) signal, i.e., changing it to positive logic, will prevent the holding brake from operating if its signal line is disconnected. If you must change the polarity of this signal, verify operation and make sure that no safety problems will exist.
- If you allocate more than one signal to the same output circuit, a logical OR of the signals will be output.

Example of Changing Output Signal Allocations

After disabling the positioning completion output (/COIN) signal assigned to CN1-OUT3, an example of assigning the Servo Ready Output (/S-RDY) signal is shown below.

Pn50E = n.0□□3
↓
Pn50E = n.3□□0

Confirming the Allocation Status of Output Signals

You can confirm the allocation status of output signals with the I/O Signal Allocations Window of the Protuner. Refer to the following section for details.
8.3.2 I/O Signals Status Monitor Monitor

6.1.3 ALM (Servo Alarm) Signal

This signal is output when the servo driver detects an error.



Configure an external circuit so that this alarm output turns OFF the main circuit power supply to the servo driver whenever an error occurs.

Type	Signal	Connector Pin No.	Signal Status	Meaning
Output	ALM	Must be allocated	ON (closed)	Normal servo driver status
			OFF (opern)	servo driver alarm

6.1.4 /WARN (Warning) Signal

Both alarms and warnings are generated by the servo driver. Alarms indicate errors in the servo driver for which operation must be stopped immediately. Warnings indicate situations that may results in alarms but for which stopping operation is not yet necessary.
The /WARN (Warning) signal indicates that a condition exists that may result in an alarm.

Type	Signal	Connector Pin No.	Signal Status	Meaning
Output	/WARN	Must be allocated	ON (CLOSED)	Warning
			OFF (OPEN)	Normal status

NOTE: You must allocate the /WARN signal to use it. Use Pn50F = n.X (/WARN (Warning Output) Signal Allocation) to allocate the signal to a connector pin. Refer to the following section for details.

6.1.5 /TGON (Rotation Detection) Signal

The /TGON signal indicates that the Servomotor is operating.
This signal is output when the shaft of the Servomotor rotates at the setting of Pn502. or faster.

Type	Signal	Connector Pin No.	Signal Status	Meaning
輸出	/TGON	Must be allocated	ON(CLOSED)	The Servomotor is operating at the setting of Pn502 or faster.
			OFF (OPEN)	The Servomotor operating at a speed that is slower than the setting of Pn502.

Setting the Rotation Detection Level

Use the following parameter to set the speed detection level at which to output the /TGON signal.

	Rotation Detection Level			Speed Position Torque	
Pn502	Setup Range	Setup Unit	default setting	When Enabled	Classification
	0 ~ 10000	1min^{-1} (RPM)	20	immediately	Setup

6.1.6 /S-RDY (Servo Ready) Signal

The /S-RDY (Servo Ready) signal turns ON when the servo driver is ready to accept the /S-ON (Servo ON) input signal.

The /S-RDY signal is turned ON under the following conditions.

- Main circuit power supply is ON.
- There is no hard wire base block state.
- There are no alarms.
- If an absolute encoder is used, the SEN (Absolute Data Request) signal is ON (high level).
- If a Servomotor without a polarity sensor is used, polarity detection has been completed. *
- If an absolute encoder is used, the servo driver must be ready to accept the /S-ON (Servo ON) signal and, if the SEN signal is ON (high level), the output of the position data from the absolute encoder to the host controller must have been completed.

* Do not include this condition if the /S-ON (Servo ON) signal is input for the first time after the control power supply was turned ON. In that case, when the first /S-ON signal is input, polarity detection is started immediately and the /S-RDY signal turns ON at the completion of polarity detection.

Type	Signal	Connector Pin No.	Signal Status	Meaning
Output	/S-RDY	Must be allocated	ON(CLOSED)	Ready to receive the /S-ON (Servo ON) signal.
			OFF (OPEN)	Not ready to receive the /S-ON (Servo ON) signal.

NOTE: 1. Use Pn50E = n.X (/S-RDY (Servo Ready) Signal Allocation) to allocate the /S-RDY signal to another connector pin. Refer to the following section for details.

*1: STO is an optional function

6.1.7 /V-CMP (Speed Coincidence Detection) Signal

The /V-CMP (Speed Coincidence Output) signal is output when the Servomotor speed is the same as the reference speed. This signal is used, for example, to interlock the servo driver and the host controller. You can use this output signal only during speed control.

The /V-CMP signal is described in the following table.

Type	Signal	Connector Pin No.	Signal Status	Meaning
Output	/V-CMP	Must be allocated	ON (CLOSED)	The speed coincides.
			OFF (OPEN)	The speed does not coincide.

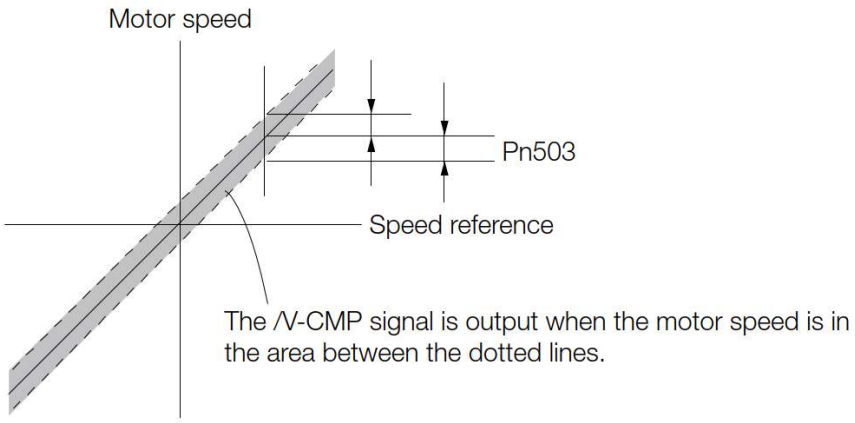
NOTE: You can use Pn50E = n. X (/V-CMP (Speed Coincidence Detection Output) Signal Allocation) to allocate the /V-CMP signal to different output connector pins.

You can set the speed detection width for the /V-CMP signal in Pn503.

Pn503	Speed Coincidence Detection Signal Output Width			Speed	
	SetupRange	Setup Unit	default setting	When Enabled	Classification
	0 ~ 100	1min^{-1} (RPM)	10	immediately	Setup

The signal is output when the difference between the reference speed and motor speed is equal or less than the setting.

NOTE: If Pn503 is set to 100 and the speed reference is 2,000 min-1, the signal would be output when the motor speed is between 1,900 min-1 and 2,100 min-1.



6.1.8 /COIN (Positioning Completion) Signal

The /COIN (Positioning Completion) signal indicates that Servomotor positioning has been completed during position control.

The /COIN signal is output when the difference between the reference position output by the host controller and the current position of the Servomotor (i.e., the position deviation as given by the value of the deviation counter) is equal to or less than the setting of the positioning completed width (Pn522).

Use this signal to check the completion of positioning from the host controller.

Type	Signal	Connector Pin No.	Signal Status	Meaning
Output	/COIN	Must be allocated	ON (CLOSED)	Positioning has been completed.
			OFF (OPEN)	Positioning has not been completed.

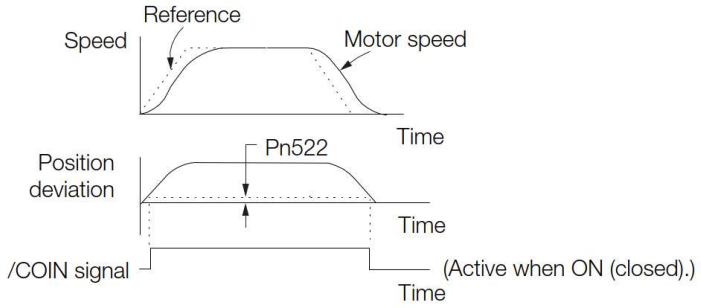
NOTE: Use Pn50E = n. X (/COIN (Positioning Completion Output) Signal Allocation) to allocate the /COIN signal to other
connector pins. Refer to the following section for details.

Setting the Positioning Completed Width

The /COIN signal is output when the difference between the reference position and the current position (i.e., the position deviation as given by the value of the deviation counter) is equal to or less than the setting of the positioning completed width (Pn522).

	Positioning Completed Width				Position
Pn522	Setup Range	Setup Unit	default setting	When Enabled	Classification
	0 ~ 1073741824	1 reference unit	10	immediately	Setup

• The setting of the positioning completed width has no effect on final positioning accuracy.



NOTE: If the parameter is set to a value that is too large, the /COIN signal may be output when the position deviation is low during a low-speed operation. If that occurs, reduce the setting until the signal is no longer output.

Setting the Output Timing of the /COIN (Positioning Completion Output) Signal

You can add a reference input condition to the output conditions for the /COIN signal to change the signal output timing.

If the position deviation is always low and a narrow positioning completed width is used, change the setting of Pn207 = n.X (/COIN (Positioning Completion Output) Signal Output Timing) to change output timing for the /COIN signal. ◦

Parameter		Name	Description	When Enabled	Classification
Pn207	n.0□□□ [default setting]	Output Timing of the /COIN (Positioning Completion Output) Signal	Output the /COIN signal when the absolute value of the position deviation is the same or less than the setting of Pn522 (Positioning Completed Width).	After restart	Setup
	n.1□□□		Output the /COIN signal when the absolute value of the position deviation is the same or less than the setting of Pn522 (Positioning Completed Width) and the reference after the position reference filter is 0.		
	n.2□□□		Output the /COIN signal when the absolute value of the position deviation is the same or less than the setting of Pn522 (Positioning Completed Width) and the reference input is 0.		

6.1.9 /NEAR (Near) Signal

The /NEAR (Near) signal indicates when positioning completion is being approached.

The host controller receives the NEAR signal before it receives the /COIN (Positioning Completion) signal, it can start preparations for the operating sequence to use after positioning has been completed. This allows you to reduce the time required for operation when positioning is completed.

The NEAR signal is generally used in combination with the /COIN signal.

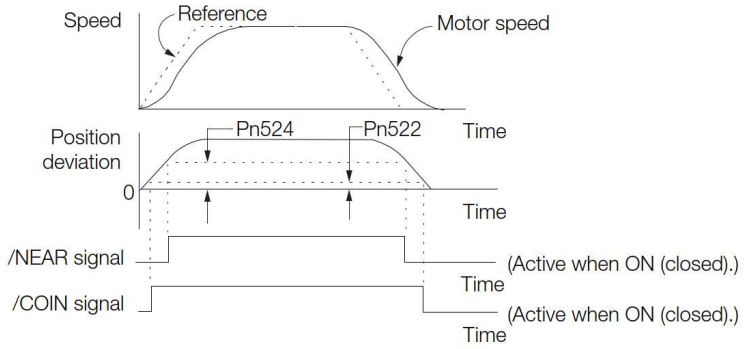
Type	Signal	Connector Pin No.	Signal Status	Meaning
Output	/NEAR	Must be allocated	ON (CLOSED)	The Servomotor has reached a point near to positioning completion.
			OFF (OPEN)	The Servomotor has not reached a point near to positioning completion.

NOTE: You must allocate the /NEAR signal to use it. Use Pn510 = n. X (/NEAR (Near) Signal Allocation) to allocate the signal to a connector pin. Refer to the following section for details.

/NEAR (Near) Signal Setting

You set the condition for outputting the /NEAR (Near) signal (i.e., the near signal width) in Pn524 (Near Signal Width). The /NEAR signal is output when the difference between the reference position and the current position (i.e., the position deviation as given by the value of the deviation counter) is equal to or less than the setting of the near signal width (Pn524).

	Near Signal Width				Position
Pn524	Setup Range	Setup Unit	default setting	When Enabled	Classification
	0 ~ 1073741824	1 reference unit	1073741824	immediately	Setup



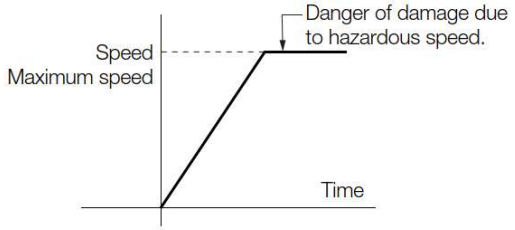
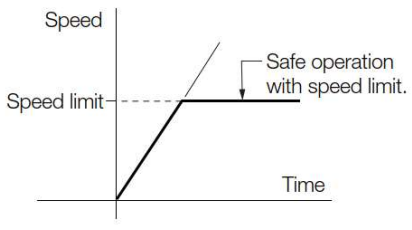
NOTE: Normally, set Pn524 to a value that is larger than the setting of Pn522 (Positioning Completed Width).

6.1.10 Speed Limit during Torque Control

You can limit the speed of the Servomotor to protect the machine.

When you use a Servomotor for torque control, the Servomotor is controlled to output the specified torque, but the motor speed is not controlled. Therefore, if a reference torque is input that is larger than the machine torque, the speed of the Servomotor may increase greatly. If that may occur, use this function to limit the speed.

NOTE: The actual limit of Servomotor speed depends on the load conditions on the Servomotor.

With No Speed Limit	With a Speed Limit
	

/VLT (Speed Limit Detection) Signal

The signal that is output when the motor speed is being limited by the speed limit is described in the following table.

Type	Signal	Connector Pin No.	Signal Status	Meaning
Output	/VLT	Must be allocated	ON(CLOSED)	The Servomotor speed is being limited.
			OFF (OPEN)	The Servomotor speed is not being limited.

NOTE: You must allocate the /VLT signal to use it. Use Pn50F = n. X (/VLT (Speed Limit Detection) Signal Allocation) to allocate the signal to a connector pin. Refer to the following section for details.

Selecting the Speed Limit

You set the speed limit to use in Pn002 = n. X (Torque Control Option). If you set Pn.002 to n. 1 (Use V-REF as an external speed limit input), the smaller of the external speed limit and the internal speed limit will be used.

Parameter		Meaning	When Enabled	Classification
Pn002	n.□□0□	System reserved Parameter (Don't Setup)	After restart	Setup
	n.□□1□ [default setting]	Use V-REF as an external speed limit input signal and limit the speed with the V-REF input voltage and the setting of Pn300. (Use external speed limiting.)		

◆ Internal Speed Limiting

If you select internal speed limiting for the torque control option (Pn002 = n. 0), set the speed limit for the motor in Pn407 (Speed Limit during Torque Control) or Pn480 (Speed Limit during Force Control). ◦

Also set Pn408 = n. X (Speed Limit Selection) to specify using the maximum motor speed or the overspeed alarm detection speed as the speed limit. Select the overspeed alarm detection speed to limit the speed to the equivalent of the maximum motor speed.

Parameter		Meaning	When Enabled	Classification
Pn408	n.□□0□ [default setting]	Use the smaller of the maximum motor speed and the setting of Pn407 or Pn480 as the speed limit.	After restart	Setup
	n.□□1□	Use the smaller of the overspeed alarm detection speed and the setting of Pn407 or Pn480 as the speed limit.		

NOTE: If you are using a Rotary Servomotor, set Pn407 (Speed Limit during Torque Control).

	Speed Limit during Torque Control				Torque
Pn407	Setup Range	Setup Unit	default setting	When Enabled	Classification
	0 ~ 10000	1min^{-1} (RPM)	10000	immediately	Setup

NOTE: If the parameter setting exceeds the maximum speed of the Servomotor, the Servomotor's maximum speed or the overspeed alarm detection speed will be used.

◆ External Speed Limiting

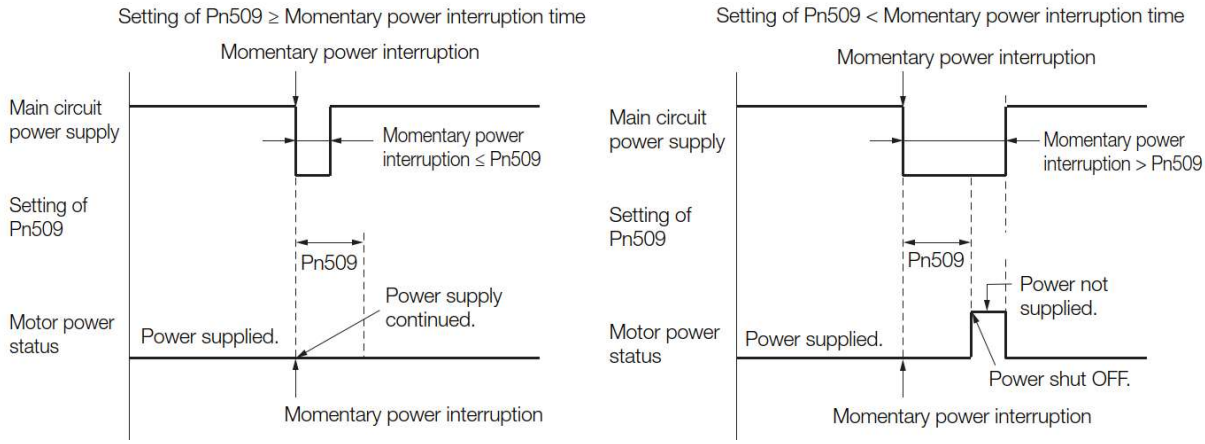
If you select external speed limiting for the torque control option (Pn002 = n. X), set the V-REF (Speed Reference Input) signal.

6.2 Operation for Momentary Power Interruptions

Even if the main power supply to the Servo Driver is interrupted momentarily, power supply to the motor (servo ON status) will be maintained for the time set in Pn509 (Momentary Power Interruption Hold Time).

	Momentary Power Interruption Hold Time			Speed	Position	Torque
Pn509	Setup Range	Setup Unit	default setting	When Enabled	Classification	
	20 ~ 50000	1 ms	20	immediately	Setup	

If the momentary power interruption time is equal to or less than the setting of Pn509, power supply to the motor will be continued. If it is longer than the setting, power supply to the motor will be stopped. Power will be supplied to the motor again when the main circuit power supply recovers.



NOTE: 1. If the momentary power interruption time exceeds the setting of Pn509, the /S-RDY (Servo Ready) signal will turn OFF.

2. If uninterruptible power supplies are used for the control power supply and main circuit power supply, the Servo Driver can withstand a power interruption that lasts longer than 50,000 ms.
3. The holding time of the Servo Driver control power supply is approximately 100 ms. If control operations become impossible during a momentary power interruption of the control power supply, the setting of Pn509 will be ignored and the same operation will be performed as for when the power supply is turned OFF normally.



The holding time of the main circuit power supply depends on the output from the Servo Driver. If the load on the Servomotor is large and an A.410 alarm (Undervoltage) occurs, the setting of Pn509 will be ignored.

6.3 SEMI F47 Function

The SEMI F47 function detects an A.971 warning (Undervoltage) and limits the output current if the DC main circuit power supply voltage to the Servo Driver drops to a specified value or lower because the power was momentarily interrupted, or the main circuit power supply voltage was temporarily reduced.

This function complies with the SEMI F47 standards for semiconductor manufacturing equipment.

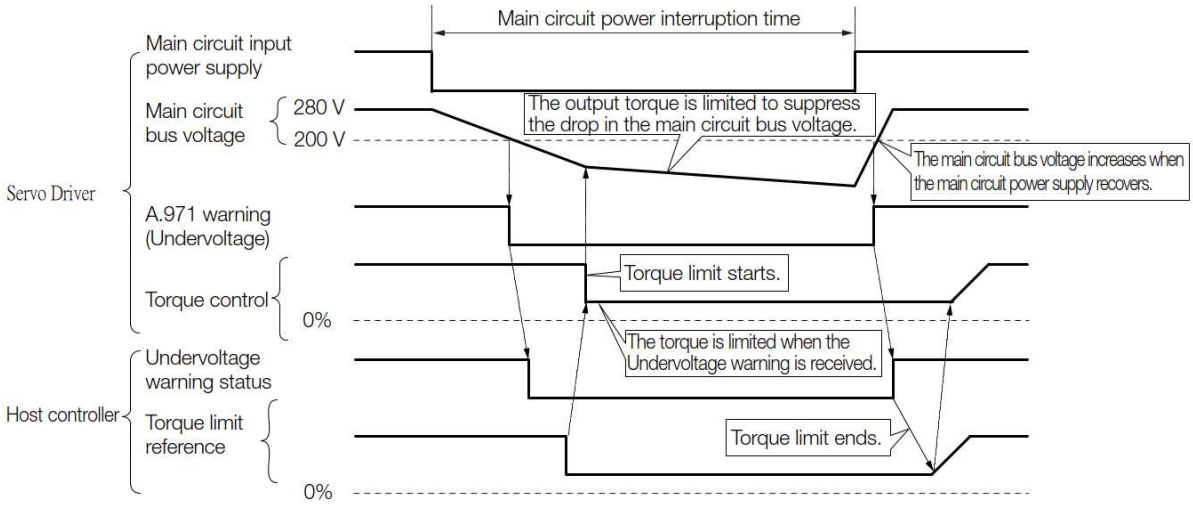
You can combine this function with the momentary power interruption hold time (Pn509) to allow the Servomotor to continue operating without stopping for an alarm or without recovery work even if the power supply voltage drops.

Execution Sequence

This function can be executed either with the host controller or with the Servo Driver. Use Pn008 = n. X (Function Selection for Undervoltage) to specify whether the function is executed by the host controller or by the Servo Driver.

◆Execution with the Host Controller (Pn008 = n. 1)

The host controller limits the torque in response to an A.971 warning (Undervoltage).
The host controller removes the torque limit after the Undervoltage warning is cleared.



◆Execution with the Servo Driver (Pn008 = n. 2)

The torque is limited in the Servo Driver in response to an Undervoltage warning.
The Servo Driver controls the torque limit for the set time after the Undervoltage warning is cleared.

The Setting of Undervoltage WARNING(A.971)

Parameter		Meaning	When Enabled	Classification
Pn008	n.□□0□ [default setting]	Do not detect undervoltage.	After restart	Setup
	n.□□1□	Detect undervoltage warning and limit torque at host controller.		
	n.□□2□	Detect undervoltage warning and limit torque with Pn424 and Pn425 (i.e., only in Servo Driver).		

◆Related Parameters

The following parameters are related to the SEMI F47 function.

Pn424	Torque Limit at Main Circuit Voltage Drop			Speed Position Torque	
	Setup Range	Setup Unit	default setting	When Enabled	Classification
	10 ~ 100	1% *	50	immediately	Setup
Pn425	Release Time for Torque Limit at Main Circuit oltage Drop			Speed Position Torque	
	Setup Range	Setup Unit	default setting	When Enabled	Classification
	10 ~ 1000	1 ms	100	immediately	Setup
Pn509	Momentary Power Interruption Hold Time			Speed Position Torque	
	Setup Range	Setup Unit	default setting	When Enabled	Classification
	20 ~ 50000	1 ms	20	immediately	Setup

* Set a percentage of the motor rated torque.

NOTE: If you will use the SEMI F47 function, set the time to 1,000 ms.

- This function handles momentary power interruptions for the voltage and time ranges stipulated in SEMI F47. An uninterruptible power supply (UPS) is required as a backup for momentary power interruptions that exceed these voltage and time ranges.
- Set the host controller or Servo Driver torque limit so that a torque reference that exceeds the specified acceleration torque will not be output when the power supply for the main circuit is restored.
- For a vertical axis, do not limit the torque to a value that is lower than the holding torque.
- This function limits torque within the range of the Servo Driver’ s capability for power interruptions. It is not intended for use under all load and operating conditions. Set the parameters while monitoring operation on the actual machine.

• You can set the momentary power interruption hold time to increase the amount of time from when the power supply is turned OFF until power supply to the motor is stopped. To stop the power supply to the motor immediately, use the /S-ON (Servo ON) signal.

6.4 Setting the Motor Maximum Speed

You can set the maximum speed of the Servomotor with the following parameter.

Pn316	Maximum Motor Speed			Speed Position Torque	
	Setup Range	Setup Unit	default setting	When Enabled	Classification
	0 ~ 65535	1min^{-1} (RPM)	10000	After restart	Setup

You can achieve the following by lowering the maximum speed of the Servomotor.
• If the Servomotor speed exceeds the setting, an A.510 alarms (Overspeed) will occur.
Changing the setting of the parameter is effective in the following cases.
• To protect the machine by stopping machine operation with an alarm when the set speed is reached or exceeded
• To limit the speed so that the load is driven beyond the allowable moment of inertia Refer to relevant manual from the following list for the relationship between the speed and the allowable moment of inertia.時

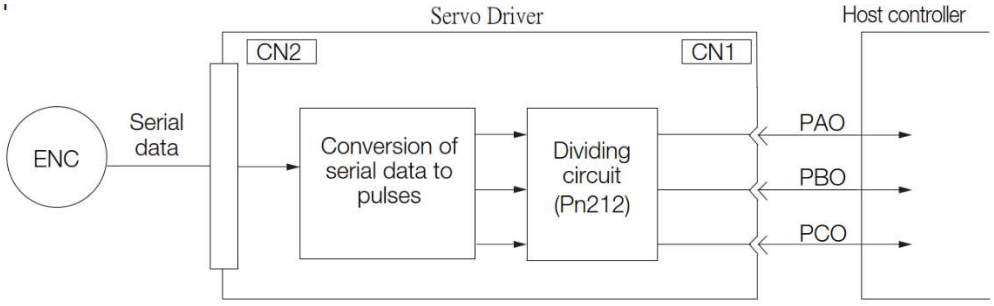
6.5 Encoder Divided Pulse Output

The encoder divided pulse output is a signal that is output from the encoder and processed inside the servo driver. It is then output externally in the form of two-phase pulse signals (phases A and B) with a 90° phase differential. At the host controller, it is used as the position feedback.

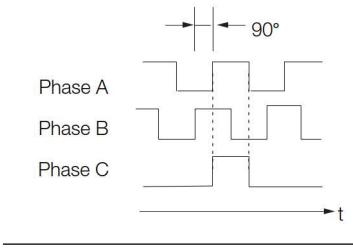
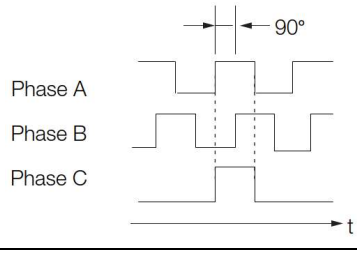
The following table describes the signals and output phase forms.

6.5.1 Encoder Divided Pulse Output Signals

Type	Signal	Connector Pin No.	Name	Remarks
Output	PAO+	CN1-19	Encoder Divided Pulse Output, Phase A	This encoder divided pulse output pins output the number of pulses per Servomotor resolution that is set in Pn212 (Number of Encoder Output Pulses). The phase difference between phase A and phase B is an electric angle of 90°.
	PAO-	CN1-20		
	PBO+	CN1-21	Encoder Divided Pulse Output, Phase B	
	PBO-	CN1-22		
	PCO+	CN1-23	Encoder Divided Pulse Output, Phase Z	These pins output one pulse every Servomotor rotation.
	PCO-	CN1-24		



Output Phase Forms

Forward rotation or movement (phase B leads by 90°)	Reverse rotation or movement (phase A leads by 90°)
	

NOTE: The pulse width of the origin within one encoder rotation depends on the setting of number of encoder output pulses (Pn212) or the encoder output resolution (Pn281). It is the same as the width of phase A.
Even for reverse operation (Pn000 = n. 1), the output phase form is the same as shown above.

If you use the servo driver' s phase-C pulse output for an origin return, rotate the Servomotor two or more rotations before you start an origin return. If the Servomotor cannot be rotated two or more times, perform an origin return operation at a motor speed of 600 min-1 or lower. If the motor speed is higher than 600 min-1, the phase-C pulse may not be output correctly.

6.5.2 Setting for the Encoder Divided Pulse Output

This section describes the setting for the encoder divided pulse output for a Rotary Servomotor or Linear Servomotor.

If you will use a Rotary Servomotor, set the number of encoder output pulses (Pn212)

	Number of Encoder Output Pulses			Speed Position Torque	
Pn212	Setup Range	Setup Unit	default setting	When Enabled	Classification
	16 ~ 1073741824	1 pitch/Rev	2500	After restart	Setup

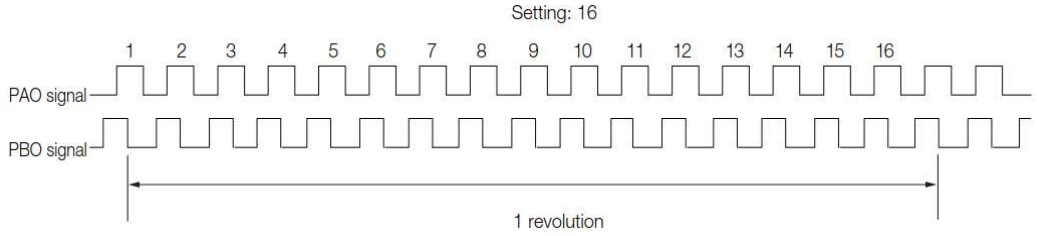
The number of pulses from the encoder per rotation are processed inside the servo driver, divided by the setting of Pn212, and then output.

Set the number of encoder divided output pulses according to the system specifications of the machine or host controller.

The setting of the number of encoder output pulses is limited by the resolution of the encoder.

NOTE: 1. The setting range of the number of encoder output pulses (Pn212) depends on the resolution of the Servomotor encoder. An A.041 alarm (Encoder Output Pulse Setting Error) will occur if the above setting conditions are not met.
Correct setting example: Pn212 can be set to 25,000 [P/Rev].Incorrect setting example: Pn212 cannot be set to 25,001 (P/Rev) because the setting increment in the above table is not used.
2. The upper limit of the pulse frequency is approximately 1.6 Mpps. The Servomotor speed will be limited if the setting of the number of encoder output pulses is too high.
An A.511 alarm (Encoder Output Pulse Overspeed) will occur if the upper limit of the motor speed is exceeded.

Output example: An output example is given below for the PAO (Encoder Pulse Output Phase A) signal and the PBO (Encoder Pulse Output Phase B) signal when Pn212 is set to 16 (16 pulses output per revolution).



6.6 The Software Limit Function

The software limits is that, when the mechanical movement exceeds the software limit values without using limit signals (P-OT, N-OT), it performs a forced stop just like over-traveling.

When using software limits, the following setup is required: ◦
• Enable the software limit function
• Set the software limit values.

6.6.1 The Validity/Invalidity of The Software Limit Function

The validity/invalidity of the software limit function is set through Pn801=n. X (software limit function). The software limit function is effective in the following cases (when the mechanical coordinate system origin is confirmed). In other situations, even if the software limit range is exceeded, the software limit function will not activate:

• After completing the ZRET command
• After executing the POS_SET command with REFE = 1
• After completing the sensor ON (SENS_ON) command when using an absolute encoder.

Parameter		Meaning	When Enabled	Classification
Pn801	n.□□□0	Enable the software limit of both positive and negative direction.	immediately	Setup
	n.□□□1	Disable the software limit of positive direction.		
	n.□□□2	Disable the software limit of negative direction.		
	n.□□□3 [default setting]	Disable the software limit of both positive and negative direction. ◦		

6.6.2 Setup of Software Limit Value

Set up the software limit values for the positive and negative directions.
According to the setup direction, ensuring that "negative direction software limit value < positive direction software limit value.

	positive direction software limit value				Position
Pn804	Setup Range	Setup Unit	default setting	When Enabled	Classification
	-1073741823 ~ 1073741823	1 Unit	1073741823	immediately	Setup
	negative direction software limit value				Position
Pn806	Setup Range	Setup Unit	default setting	When Enabled	Classification
	-1073741823 ~ 1073741824	1 Unit	-1073741823	immediately	Setup

6.6.3 The software Limit Check

When sending commands such as POSING or INTERPOLATE to move to the target position, the software limit check is performed. If the target position exceeds the software limit values, the system will decelerate and stop at the position set in the software limits.

Parameter		Meaning	When Enabled	Classification
Pn801	n.□0□□ [default setting]	With software limit check	immediately	Setup
	n.□□□1	Without software limit check		

6.7 Selecting Torque Limits

You can limit the torque that is output by the servomotor.

There are four different ways to limit the torque. These are described in the following table.

Limit Method	Outline	Control Method	備註
Internal Torque Limits	The torque is always limited with the setting of a parameter.	Speed control Position control Torque control	
External TorqueLimits	The torque is limited with an input signal from the host computer.		
Torque Limuts Based on TLIM*	Torque limits can be configured through the TLIM command.	Speed control Position control	
Torque Limits Based on The P_CL & N_CL of Output signals (SVCMD_ID)*	Torque limits can be configured through the P_CL & N_CL command.		

NOTE: Even if the setup value exceeds the maximum torque of the servo motor being used, the actual torque will be limited to within the maximum torque of the servo motor.

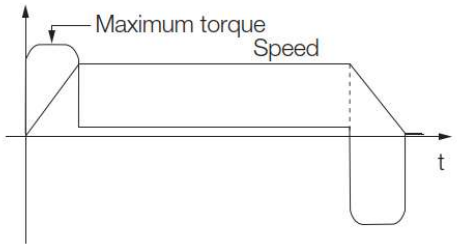
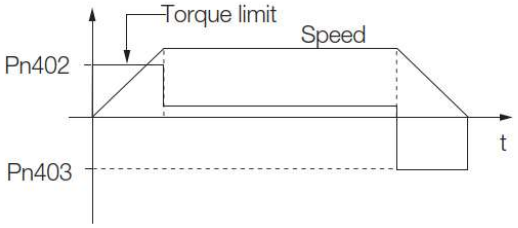
6.7.1 Internal Torque Limits

f you use internal torque limits, the maximum output torque will always be limited to the specified forward torque limit (Pn402) and reverse torque limit (Pn403).

Pn402	Forward Torque Limit			Speed Position Torque	
	Setup Range	Setup Unit	default setting	When Enabled	Classification
	0 ~ 800	1%*	800	immediately	Setup
Pn403	Reverse Torque Limit			Speed Position Torque	
	Setup Range	Setup Unit	default setting	When Enabled	Classification
	0 ~ 800	1%*	800	immediately	Setup

* Set a percentage of the rated motor torque.

NOTE: If the setting of Pn402 or Pn403 is too low, the torque may be insufficient for acceleration or deceleration of the Servomotor.

Without Internal Torque Limits (Output to the maximum torque is possible.)	With Internal Torque Limits
	

6.7.2 External Torque Limits

You can limit the torque only when required by the operating conditions of the machine by turning a signal ON and OFF. You can use this for applications such as stopping on physical contact, or holding a workpiece with a robot.

External Torque Limit Reference Signals

The /P-CL (Forward External Torque Limit) and /N-CL (Reverse External Torque Limit) signals are used as the external torque limit reference signals. The /P-CL signal is used for the forward torque limit and the /N-CL signal is used for the reverse torque limit.

Type	Signal	Connector Pin No.	Signal Status	Meaning
Input	/P-CL	Must be allocated	ON(CLOSED)	Applies the forward external torque limit. The torque is limited to the smaller of the settings of Pn402 and Pn404.
			OFF (OPEN)	Cancels the forward external torque limit. The torque is limited to the setting of Pn402.
Input	/N-CL	Must be allocated	ON(CLOSED)	Applies the reverse external torque limit. The torque is limited to the smaller of the settings of Pn403 and Pn405.
			OFF (OPEN)	Cancels the reverse external torque limit. The torque is limited to the setting of Pn403.

NOTE: You can use the following parameters to allocate the /P-CL and /N-CL signals to other terminals.

- Pn50B = n. X (/P-CL (Forward External Torque Limit Input) Signal Allocation)
- Pn50B = n.X (/N-CL (Reverse External Torque Limit Input) Signal Allocation)

Setting the Torque Limits

The parameters that are related to setting the torque limits are given below.

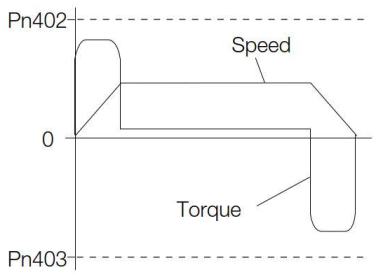
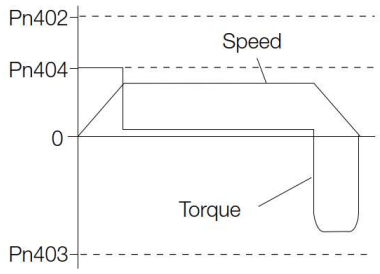
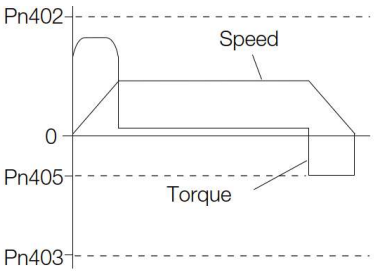
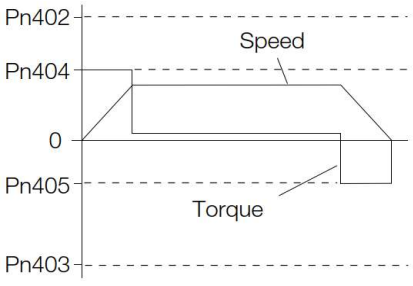
If the setting of Pn402 (Forward Torque Limit), Pn403 (Reverse Torque Limit), Pn404 (Forward External Torque Limit), or Pn405 (Reverse External Torque Limit) is too low, the torque may be insufficient for acceleration or deceleration of the Servomotor.

Pn402	Forward Torque Limit			Speed Position Torque	
	Setup Range	Setup Unit	default setting	When Enabled	Classification
	0 ~ 800	1%*	800	immediately	Setup
Pn403	Reverse Torque Limit			Speed Position Torque	
	Setup Range	Setup Unit	default setting	When Enabled	Classification
	0 ~ 800	1%*	800	immediately	Setup
Pn404	Forward External Torque Limit			Speed Position Torque	
	Setup Range	Setup Unit	default setting	When Enabled	Classification
	0 ~ 800	1%*	100	immediately	Setup
Pn405	Reverse External Torque Limit			Speed Position Torque	
	Setup Range	Setup Unit	default setting	When Enabled	Classification
	0 ~ 800	1%*	100	immediately	Setup

* Set a percentage of the rated motor torque.

Changes in the Output Torque for External Torque Limits

The following table shows the changes in the output torque when the internal torque limit is set to 800%.
In this example, the Servomotor direction is set to Pn000 = n. 0 (Use CCW as the forward direction).

Singal		/P-CL	
	Status	OFF	ON
/N-CL	OFF		
	ON		

6.7.3 /CLT (Torque Limit Detection) Signal

This section describes the /CLT signal, which indicates the status of limiting the motor output torque.

Type	Signal	Connector Pin No.	Signal Status	Meaning
Input	/CLT	Must be allocated	ON(CLOSED)	The motor output torque is being limited.
			OFF (OPEN)	The motor output torque is not being limited.

NOTE: You must allocate the /CLT signal to use it. Use Pn50F = n. X (/CLT (Torque Limit Detection Output) Signal Allocation) to allocate the signal to a connector pin. Refer to the following section for details.

6.8 Absolute Encoders

The absolute encoder records the current position of the stop position even when the power supply is OFF.
With a system that uses an absolute encoder, the host controller can monitor the current position.
Therefore, it is not necessary to perform an origin return operation when the power supply to the system is turned ON.
There are four types of encoders for Rotary Servomotors. The usage of the encoder is specified in Pn002 = n. X .
•Parameter Settings When Using an Incremental Encoder

Parameter		Meaning	When Enabled	Classification
Pn002	n.□0□□ [default setting]	Use the encoder as an incremental encoder. A battery is not required.	After restart	Setup
	n.□1□□	Use the encoder as an incremental encoder. A battery is not required.		
	n.□2□□	Use the encoder as a single-turn absolute encoder. A battery is not required.		

• Parameter Settings When Using a Single-Turn Absolute Encoder

Parameter		Meaning	When Enabled	Classification
Pn002	n.□0□□ [default setting]	Use the encoder as a single-turn absolute encoder. A battery is not required.	After restart	Setup
	n.□1□□	Use the encoder as an incremental encoder. A battery is not required.		
	n.□2□□	Use the encoder as a single-turn absolute encoder. A battery is not required.		

• Parameter Settings When Using a Batteryless Multiturn Absolute Encoder

Parameter		Meaning	When Enabled	Classification
Pn002	n.□0□□ [default setting]	Use the encoder as a multiturn absolute encoder. A battery is required.	After restart	Setup
	n.□1□□	Use the encoder as an incremental encoder. A battery is not required.		
	n.□2□□	Use the encoder as a single-turn absolute encoder. A battery is not required.		

NOTICE

• Install a battery at either the host controller or on the Encoder Cable.
If you install batteries both at the host controller and on the Encoder Cable at the same time, you will create a loop circuit between the batteries, resulting in a risk of damage or burning.

6.9 Forcing the Motor to Stop

You can force the Servomotor to stop for a signal from the host controller or an external device.

To force the motor to stop, you must allocate the FSTP (Forced Stop Input) signal in Pn516 =n. X. You can specify one of the following stopping methods: dynamic brake (DB), coasting to a stop, or decelerating to a stop.

NOTE: Forcing the motor to stop is not designed to comply with any safety standard. In this respect, it is different from the hard wire base block (HWBB).

NOTE: When a forced stop is performed, the panel display will display FST and the Digital Operator will display FSTP.

6.9.1 FSTP (Forced Stop Input) Signal

Type	Signal	Connector Pin No.	Signal Status	Meaning
Input	FSTP	Must be allocated	ON(CLOSED)	Drive is enabled (normal operation).
			OFF (OPEN)	The motor is stopped.

NOTE: You must allocate the FSTP signal to use it. Use Pn516 = n. X (FSTP (Forced Stop Input) Signal Allocation) to allocate the FSTP signal to a connector pin. Refer to the following section for details.

6.9.2 Stopping Method Selection for Forced Stops

Use Pn00A = n. X (Stopping Method for Forced Stops) to set the stopping method for forced stops.

Parameter		Meaning	When Enabled	Classification
Pn00A	n.□□0□	Apply the dynamic brake or coast the motor to a stop (use the stopping method set in Pn001 = n. X).	After restart	Setup
	n.□□1□ [default setting]	Decelerate the motor to a stop using the torque set in Pn406 as the maximum torque. Use the setting of Pn001 = n. X for the status after stopping.		
	n.□□2□	Decelerate the motor to a stop using the torque set in Pn406 as the maximum torque and then let the motor coast.		
	n.□□3□	Decelerate the motor to a stop using the deceleration time set in Pn30A. Use the setting of Pn001 = n. X for the status after stopping.		
	n.□□4□	Decelerate the motor to a stop using the deceleration time set in Pn30A and then let the motor coast.		

NOTE: You cannot decelerate a Servomotor to a stop during torque control. For torque control, the Servomotor will be stopped with the dynamic braking or coast to a stop according to the setting of Pn001 = n. X (Motor Stopping Method for Servo OFF and Group 1 Alarms).

Stopping the Servomotor by Setting Emergency Stop Torque (Pn406)

To stop the Servomotor by setting emergency stop torque, set Pn406 (Emergency Stop Torque).

If Pn00A = n. X is set to 1 or 2, the Servomotor will be decelerated to a stop using the torque set in Pn406 as the maximum torque.

The default setting is 800%. This setting is large enough to allow you to operate the Servomotor at the maximum torque. However, the maximum emergency stop torque that you can actually use is the maximum torque of the Servomotor.

Pn406	Emergency Stop Torque			Speed / Position / Torque	
	Setup Range	Setup Unit	default setting	When Enabled	Classification
	0 ~ 800	1%*	800	immediately	Setup

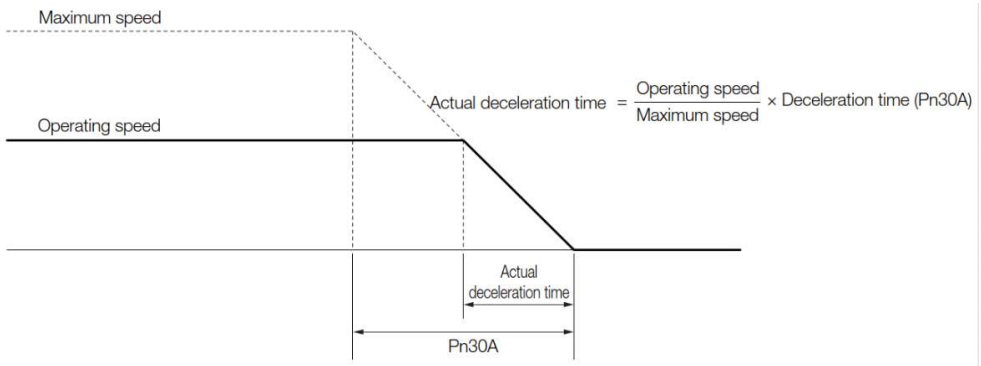
* 相對於馬達額定 Torque 的百分比。

Stopping the Servomotor by Setting the Deceleration Time for Servo OFF and Forced Stops (Pn30A)

To specify the Servomotor deceleration time and use it to stop the Servomotor, set Pn30A (Deceleration Time for Servo OFF and Forced Stops).

Pn30A	Deceleration Time for Servo OFF and Forced Stops			Speed / Position	
	Setup Range	Setup Unit	default setting	When Enabled	Classification
	0 ~ 10000	1 ms	0	immediately	Setup

If you set Pn30A to 0, the Servomotor will be stopped with a zero speed.



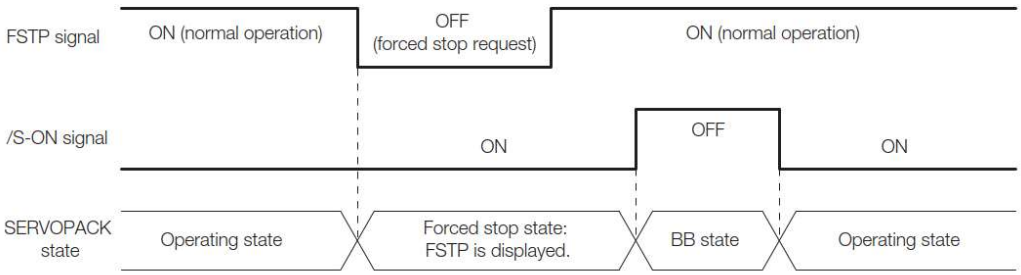
The deceleration time that you set in Pn30A is the time to decelerate the Servomotor from the maximum motor speed.

6.9.3 Resetting Method for Forced Stops

This section describes the reset methods that can be used after stopping operation for an FSTP (Forced Stop Input) signal.

If the FSTP (Forced Stop Input) signal is OFF and the /S-ON (Servo ON Input) signal is input, the forced stop state will be maintained even after the FSTP signal is turned ON.

Turn OFF the /S-ON signal to place the servo driver in the base block (BB) state and then turn ON the /S-ON signal again.



Chapter7.Trial Operation and Actual Operation

This chapter provides information on the flow and procedures for trial operation and convenient functions to use during trial operation.

7.1 Flow of Trial Operation

7.1.1 Flow of Trial Operation for Rotary Servomotors

The procedure for trial operation is given below.

Step	Meaning
1	Installation Install the Servomotor and servo driver according to the installation conditions. First, operation is checked with no load. Do not connect the Servomotor to the machine.
2	Wiring and Connections Wire and connect the servo driver. First, Servomotor operation is checked without a load. Do not connect the CN1 connector on the servo driver.
3	Confirmations before Trial Operation
4	Power ON
5	Resetting the Absolute Encoder This step is necessary only for a Servomotor with an Absolute Encoder.

7.2 Inspections and Confirmations before Trial Operation

To ensure safe and correct trial operation, check the following items before you start trial operation.

- Make sure that the servo driver and Servomotor are installed, wired, and connected correctly.
- Make sure that the correct power supply voltage is supplied to the servo driver.
- Make sure that there are no loose parts in the Servomotor mounting.
- If you are using a Servomotor with an Oil Seal, make sure that the oil seal is not damaged.

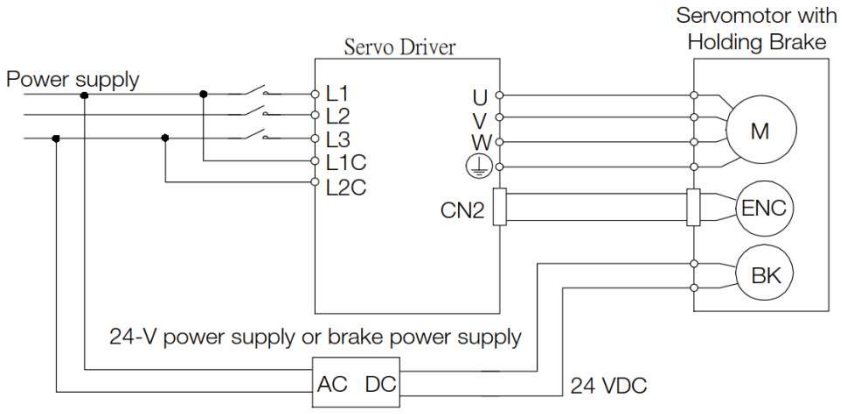
Also make sure that oil has been applied.

- If you are performing trial operation on a Servomotor that has been stored for a long period of time, make sure that all Servomotor inspection and maintenance procedures have been completed.

Refer to the manual for your Servomotor for Servomotor maintenance and inspection information.

- If you are using a Servomotor with a Holding Brake, make sure that the brake is released in advance. To release the brake, you must apply the specified voltage of 24 VDC to the brake.

A circuit example for trial operation is provided below.



7.3 Trial Operation for the Servomotor without a Load

You use jogging for trial operation of the Servomotor without a load.
Jogging is used to check the operation of the Servomotor without connecting the servo driver to the host controller. The Servomotor is moved at the preset jogging speed.

CAUTION
• During jogging, the overtravel function is disabled. Consider the range of motion of your machine when you jog the Servomotor.

7.3.1 Preparations

Always check the following before you execute jogging.

- The parameters must not be write prohibited.
- The main circuit power supply must be ON.
- There must be no alarms.
- There must be no hard wire base block (HWBB).
- The servo must be OFF.
- The jogging speed must be set considering the operating range of the machine.

The jogging speed is set with the following parameters.

*1: STO is an optional function.

Rotary Servomotors

Pn304	Jogging Speed			Speed Position Torque	
	Setup Range	Setup Unit	default setting	When Enabled	Classification
	0 ~ 10000	1 min^{-1} (RPM)	500	immediately	Setup
Pn305	Soft Start Acceleration Time			Speed	
	Setup Range	Setup Unit	default setting	When Enabled	Classification
	0 ~ 10000	1 ms	0	immediately	Setup
Pn306	Soft Start Deceleration Time			Speed	
	Setup Range	Setup Unit	default setting	When Enabled	Classification
	0 ~ 10000	1 ms	0	immediately	Setup

7.3.2 Applicable Tools

The following table lists the tools that you can use to perform jogging

Tool	FA No./Function Name
Panel Operator	FA002
ProTuner	Operation - Jog

Chapter8. Panel Displays and Panel Operator Procedures

8.1 Panel Operator

8.1.1 Panel Operator Key Names and Functions

The Panel Operator consists of a panel display and Panel Operator keys.
You can use the Panel Operator to set parameters, display status, execute utility functions, and monitor servo driver operation.
The Panel Operator key names and functions are given below.

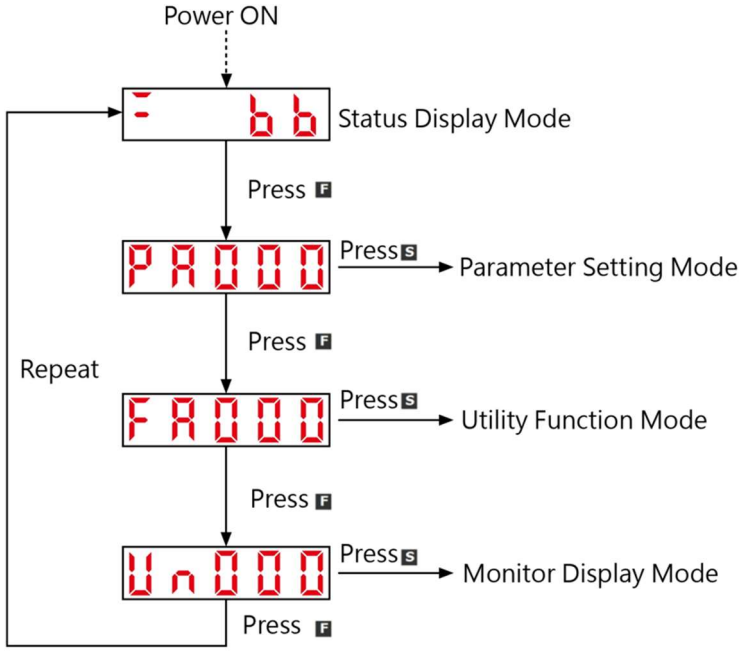


Key No.	Key Name	Function
	Function Key	Changes the display. Status Display, Assistance Tool、Parameter Setup, Monitering.
	Setting Key	Pressing this key displays the setup and setup values of each parameter, enters the parameter setup state, and clears error alarm.
	UP Key	Increases the setting. In the assistance tool mode, the JOG operation acts as a forward start key
	Down Key	Decreases the setting. In the assistance tool mode, the JOG operation acts as a reverse start key
	Shift Key	Moves to the next digit on the left when a digit is flashing.

8.1.2 Changing Modes

Press the F Key to change between the modes as shown below.

Refer to the reference pages for the operating procedures in each function mode.



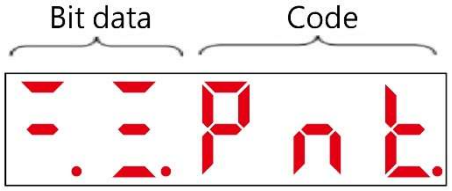
NOTE: You can change the setting of Pn52F (Monitor Display at Startup) to display the Monitor Display Mode instead of the Status Display Mode after the power supply is turned ON.Set Pn52F to the Un number of the monitor display to display after the power supply is turned ON.

	Monitor Display at Startup			Speed	Position	Torque
Pn52F	Setup Range	Setup Unit	default setting	When Enabled	Classification	
	0000 ~ 0FFF	-	0FFF	immediately	Setup	

If 0FFF is set (default setting), the servo driver will enter the Status Display Mode after the power supply is turned ON.

8.1.3 Status Displays

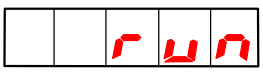
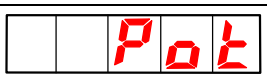
The status is displayed as described below.

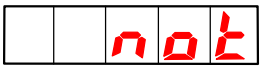
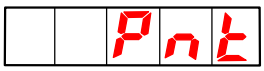
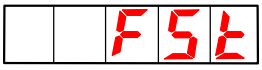
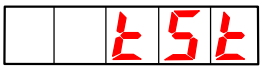
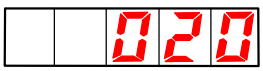


■ Interpreting Bit Data

Display	Meaning
	Control Power ON Display Lit while the servo driver control power is ON. Not lit if the servo driver control power is OFF.
	Main Power ON Display Lit while the servo driver Main power is ON. Not lit if the servo driver Main power is OFF.
	Base Block Display Lit if the servo is OFF. Not lit while the servo is ON.
	During Speed Control: /V-CMP (Speed Coincidence Detection) Signal Display Lit if the difference between the Servomotor speed and the reference speed is the same as or less than the setting of Pn503 or Pn582. (The default setting is 10 min-1 or 10 mm/s.) Always lit during torque control. Additional Information If there is noise in the reference voltage during speed control, the horizontal segment (-) on the top of the leftmost digit on the Panel Operator display may flash. Refer to the following section and implement countermeasures against noise. During Position Control: /COIN (Positioning Completion) Signal Display Lit if the deviation between the position reference and actual motor position is equal to or less than the setting of Pn522. (The default setting is 7 reference units.) Not lit it the deviation exceeds the setting.
	/TGON (Rotation Detection) Signal Display Lit if the Servomotor speed is higher than the setting of Pn502 or Pn581 and not lit if the speed is lower than the setting. (The default setting is 20 min-1 or 20 mm/s.)
	During Speed Control: Speed Reference Input Display Lit if the current input reference is larger than the setting of Pn502 or Pn581 and not lit if the reference is smaller than the setting. (The default setting is 20 min-1 or 20 mm/s.) During Position Control: Reference Pulse Input Display Lit while reference pulses are being input. Not lit if reference pulses are not being input.
	"During Torque Control: Torque Reference Input Display Lit if the current input torque reference is larger than the specified value (10% of the rated torque) and not lit if the reference is smaller than the specified value. During Position Control: Clear Signal Input Display Lit while the clear signal is being input. Not lit if the clear signal is not being input.
	EtherCAT (Input) Connert Display The Status.of CN3
	EtherECAT (Output) Connert Display The Status.of CN4

■ Interpreting Codes

Display	Meaning
	Base Block Active Indicates that the servo is OFF.
	Operation in Progress Indicates that the servo is ON.
	Forward Drive Prohibited Indicates that the P-OT (Forward Drive Prohibit) signal is open.

Display	Meaning
	Reverse Drive Prohibited Indicates that the N-OT (Reverse Drive Prohibit) signal is open.
	Forward Drive Prohibited and Reverse Drive Prohibited Indicates that the P-OT (Forward Drive Prohibit) signal is open, and the N-OT (Reverse Drive Prohibit) signal is open.
	Forced Stop Status Indicates that the FSTP (Force Stop Input) signal forced the Servomotor to stop.
	Test without Motor in Progress Indicates that the test without a motor is in progress.
	Alarm Status Flashes the alarm number.

8.2 Parameter (Pn) Operations on the Panel Operator

The Panel Operator displays numbers beginning with "Pn."

NOTE: The SC3 servo driver currently supports only single-axis motors, so PA represents the parameters for the first axis. If dual-axis motors are supported in the future, PB will represent the parameters for the second axis.

This section describes the procedures for setting the parameters that are used in this manual.

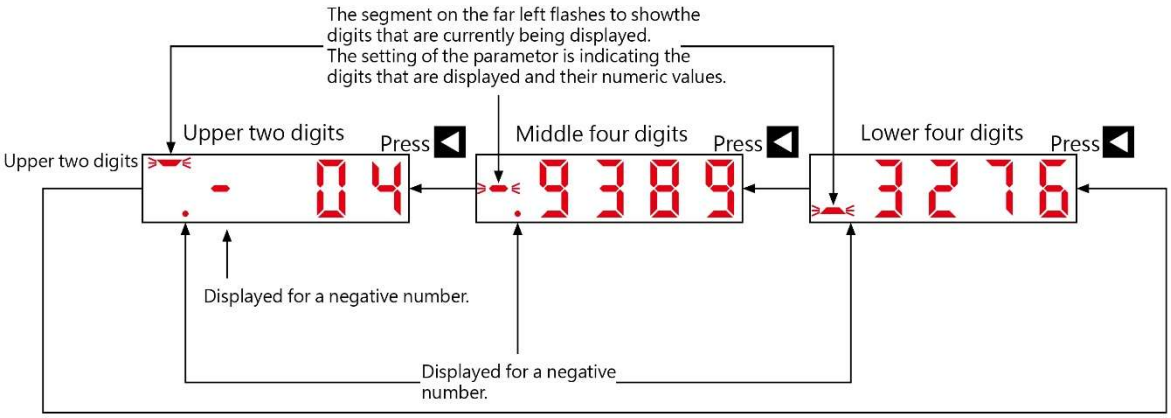
8.2.1 "Setting Parameters That Require Numeric Settings

The following procedure shows how to change the setting of Pn100 (Speed Loop Gain) from 40.0 to 100.0 as an example of a parameter that requires a numeric setting.

Step	Panel Display after Operation	Keys	Operation
1		F	Press the F Key to enter Parameter Setting Mode. If Pn100 is not displayed.
2		▲ ▼	press the UP Key or DOWN Key to display Pn100.
3		S	Press the S Key for.The current setting of Pn100 will be displayed.。
4		◀	ress the Shift Key to move the digit that is flashing to "4". (You can change the value of the digit that is flashing.)
5		▲	Press the UP Key six times to change the setting to 100.0.
6		F	Press the F Key. The display will flash. The setting has now been changed from 40.0 to 100.0.
7		S	Press the S Key for approximately one second to return the display to Pn100.

- Parameters with Settings of More Than Five Digits

The Panel Operator displays five digits. Settings of more than five digits are displayed as shown in the following figure.



8.2.2 "Setting Parameters That Require Selection of Functions

For parameters that require selection of functions, you can select the individual digits of the numbers displayed on the Panel Operator to set the functions assigned to them.

The following example shows how to change the setting of Pn000 = n. X (Control Method Selection) in Pn000 (Basic Function Selections 0) from speed control to position control.

Step	Panel Display after Operation	Keys	Operation
1	PA000	F	Press the F Key to enter Parameter Setting Mode. If Pn000 is not displayed, press the UP Key or DOWN Key to display Pn000.
3	n.0000	S	Press the S Key. for approximately one second. The current setting of Pn000 will be displayed.
4	n.0000	◀	Press the S Key. to move the digit that is flashing. (You can change the value of the digit that is flashing.)
5	n.0010	▲	Press the UP Key once to change the display to n.0010. (This changes the control method from speed control to position control.)
6	n.0010	F	Press the F Key. The display will flash. The control method has now been changed from speed control to position control.
7	PA000	S	Press the S Key. for approximately one second. Pn000 is displayed again.

8.3 Monitor Display (Un) Operations on the Panel Operator

You can monitor the status of the reference values and I/O signals that are set in the servo driver and the internal status of the servo driver with monitor displays. The Panel Operator displays numbers beginning with "Un."

NOTE: The SC3 servo driver currently supports only single-axis motors, so UA represents the parameters for the first axis. If dual-axis motors are supported in the future, UB will represent the parameters for the second axis.

Display Example for Motor Speed



This section describes the basic operations for monitor displays and how to interpret some special monitor displays.

■ List of Monitor Display

Monitor Number	Meaning	Unit
Un000	Motor Speed	1r/min
Un001	Speed Refence	1r/min
Un002	Torque Refence	1%
Un003	Rotation Angle 1	encoder pulse
Un004	Rotation Angle 2	deg
Un005	Input Signal Monitor	
Un006	Output Signal Monitor	
Un007	Input Speed Command	1r/min
Un008	Position Deviatoin	command
Un009	Cumulative Load Rate	1%
Un00A	Re-generative Load Rate	1%
Un00B	DB Resistor Power Consumption	1%
Un00C	Input Command Counter	command
Un00D	Feedback Pulse Counter	encoder pulse
Un013	Feedback Pulse Counter	command
Un020	Rated Speed of Motor	1r/min
Un021	MAX. Speed of Motor	1r/min
Un040	The Number of Rotation of Absulte Encoder	r
Un041	The Position of One Rotation of Absulte Encoder	encoder pulse
Un140	Bus Voltage	1V

8.3.1 Basic Monitor Display Operations

The procedure for Un000 (Motor Speed) is described here as an example.

Step	Panel Display after Operation	Keys	Operation
1		F	Press the F Key to enter Monitor Display Mode.
2		S	Press the S Key.The contents of the monitor display for the specified Un number will appear.
3		▲ ▼	--
3		S	Press the S Key for approximately one second. The display shown for step 1 will appear again.

8.3.2 Input Signal Monitor (Un005/ Un006)

You can use Un005/Un006 to display the status of allocated signals on the LED segments of the Panel Operator.

◆ Interpreting the Display

LED Segments



- If the input signal that corresponds to the LED number is OFF, the top LED segment will be lit.
- If the input signal that corresponds to the LED number is ON, the bottom LED segment will be lit.

The allocations are given in the following table.

Monitor Number	LED number	Input Pin Number
Un005	0	IN0 (CN1-14)
	1	IN1 (CN1-15)
	2	IN2 (CN1-16)
	3	IN3 (CN1-17)
	4	IN4 (CN1-39)
	5	IN5 (CN1-40)
	6	IN6 (CN1-41)
	7	IN7 (CN1-42)
Un006	0	OUT0 (CN1-7 · -8)
	1	OUT1 (CN1-9 · -10)
	2	OUT2 (CN1-11 · -12)
	3	OUT3 (CN1-32 · -33)
	4	OUT4 (CN1-34 · -35)
	5	OUT5 (CN1-36 · -37)

8.4 Utility Function (FA) Operations on the Panel Operator

Utility functions are used to set up and tune the servo driver.
The Panel Operator displays numbers beginning with "FA."

NOTE: The SC3 servo driver currently supports only single-axis motors, so FA represents the parameters for the first axis. If dual-axis motors are supported in the future, FB will represent the parameters for the second axis.

Display Example: Origin Search



The operating procedures from the Panel Operator are described here. Refer to the descriptions of individual utility functions for preparations and related parameters.

■ List of Assistance Tool

Utility Function Number	Function
FA000	Display Alarm History
FA002	Jog
FA003	Origin Search
FA004	Jog Program
FA005	Initialize Parameters
FA006	Clear Alarm History
FA008	Reset Absolute Encoder
FA009	Autotune Analog (Speed/Torque) Reference Offset
FA00A	Manually Adjust Speed Reference Offset
FA00B	Manually Adjust Torque Reference Offset
FA00E	Autotune Motor Current Detection Signal Offset
FA010	Write Prohibition Setting
FA011	Display Servomotor Model
FA012	Display Software Version
FA203	One-Parameter Tuning
FA206	Easy FFT

FA208	Load Inertia Detection

8.4.1 Display Alarm History (FA000)

Refer to the following section for information on this utility function other than the procedure.

Step	Panel Display after Operation	Keys	Operation
1		F	Press the F Key to enter Utility Function Mode.
2		S	Press the S Key.The most recent alarm will be displayed.
3		▲ ▼	Press the DOWN Key to display the next older alarm. Press the UP Key to display the next newer alarm. The higher the far-left segment is, the older the alarm is.
4		S	Press the S Key again to return the display to FA000.

8.4.2 JOG (FA002)

Refer to the following section for information on this utility function other than the procedure.

Step	Panel Display after Operation	Keys	Operation
1		F	Press the F Key to enter Utility Function Mode.
2		▲ ▼	Press the UP Key or DOWN Key to display FA02.
Step	**Panel Display after Operation**	**Keys**	**Operation**
3		S	Press the S Key. The display shown at the left will appear.
4		F	Press the F Key to turn ON the servo.
5		▲ ▼	The Servomotor will operate at the speed set in Pn304 or Pn383 while the UP Key (for forward operation) or DOWN Key (for reverse operation) is pressed.
6		F	Press the F Key to turn OFF the servo.
7		S	Press the S Key again to return the display to FA002.

8.4.3 Origin Search (FA003)

Refer to the following section for information on this utility function other than the procedure.

Step	Panel Display after Operation	Keys	Operation
1		F	Press the F Key to enter Utility Function Mode.
2		▲ ▼	Press the UP Key or DOWN Key to display FA003.
3		S	Press the S Key The display shown at the left will appear.
4		F	Press the F Key to turn ON the servo. Additional Information
5		▲ ▼	Press the UP Key to operate the Servomotor in the forward direction. Press the DOWN Key to operate the Servomotor in the reverse direction.

6		F	When the Servomotor origin search has been completed, the display will flash. At this time, the Servomotor is servo-locked at the origin within one rotation of the encoder.
7		S	Press the S Key again to return the display to FA003.

8.4.4 Jog Program (FA004)

Refer to the following section for information on this utility function other than the procedure.

Step	Panel Display after Operation	Keys	Operation
1		F	Press the F Key to enter Utility Function Mode.
2		▲ ▼	Press the UP Key or DOWN Key to display FA004.
3		S	Press the S Key. The display shown at the left will appear.
4		F	Press the F Key to turn ON the servo.
5		▲ ▼	Press the UP Key or DOWN Key according to the initial movement direction of the operation pattern. The operation will start after the preset waiting time.
6		-	When program jogging has been completed, End will flash on the display, and then the display shown on the left will appear again. Press the S Key again to return the step 2.

8.4.5 Initialize Parameters (FA005)

Refer to the following section for information on this utility function other than the procedure.

Step	Panel Display after Operation	Keys	Operation
1		F	Press the F Key to enter Utility Function Mode.
2		▲ ▼	Press the UP Key or DOWN Key to display FA005.
3		S	Press the S Key. The display shown at the left will appear.
4		F	Press the F Key to initialize the parameters. When the initialization has been completed, donE will flash on the display, and then the display shown on the left will appear again.

8.4.6 Clear Alarm History (FA006)

Refer to the following section for information on this utility function other than the procedure.

Step	Panel Display after Operation	Keys	Operation
1		F	Press the F Key to enter Utility Function Mode.
2		▲ ▼	Press the UP Key or DOWN Key to display FA006.
3		S	Press the S Key. The display shown at the left will appear.
4		F	Press the F Key to clear the alarm history. When deleting the alarms has been completed, donE will flash on the display, and then the display shown on the left will appear again.
5		S	Press the S Key again to return the display to FA006.

8.4.7 Reset Absolute Encoder (FA008)

Refer to the following section for information on this utility function other than the procedure.

Step	Panel Display after Operation	Keys	Operation
1		F	Press the F Key to enter Utility Function Mode.
2		▲ ▼	Press the UP Key or DOWN Key to display FA008.
3		S	Press the S Key. PGCL1 will be displayed.
4		▲	Continue pressing the UP Key until PGCL5 is displayed.
5		F	Press the F Key. The absolute encoder will be initialized. When initialization has been completed, donE will flash on the display for approximately one second.
6		-	After displaying donE, the display will return to the PGCL5 display.
7		S	Press the S Key again to return the display to FA008.

8.4.8 Autotune Motor Current Detection Signal Offset (FA00E)

Refer to the following section for information on this utility function other than the procedure.

Step	Panel Display after Operation	Keys	Operation
1		F	Press the F Key to enter Utility Function Mode.
2		▲ ▼	Press the UP Key or DOWN Key to display FA00E.
3		S	Press the S Key. The display shown at the left will appear.
4		F	Press the F Key to perform automatic offset-signal adjustment. When the adjustment has been completed, donE will flash on the display, and then the display shown on the left will appear again.
5		S	Press the S Key again to return the display to FA00E.

8.4.9 Write Prohibition Setting (FA010)

Refer to the following section for information on this utility function other than the procedure.

Step	Panel Display after Operation	Keys	Operation
1		F	Press the F Key to enter Utility Function Mode.
2		▲ ▼	Press the UP Key or DOWN Key to display FA010
3		S	Press the S Key. The display shown at the left will appear.
4		▲ ▼	Press the UP Key or DOWN Key and set one of the following. P.0000: Write permitted (default setting) P.0001: Write prohibited
5		F	Press the F Key to enter the value. When the setting has been completed, donE will flash on the display, and then the display shown on the left will appear again.

8.4.10 Display Servomotor Model (FA011)

Refer to the following section for information on this utility function other than the procedure.

Step	Panel Display after Operation	Keys	Operation
1		F	Press the F Key to enter Utility Function Mode.
2		▲ ▼	Press the UP Key or DOWN Key to display FA011
3		S	Press the S Key to display the Servomotor voltage and model codes.
4		F	Press the F Key. The Servomotor Parameter 1 will be displayed.
5		F	Press the F Key. The Servomotor Parameter 2 will be displayed.
6		F	Press the F Key. The Servomotor Parameter 3 will be displayed.
7		F	Press the F Key. The Servomotor Parameter 4 will be displayed.
8		F	Press the F Key. The Servomotor Parameter 5 will be displayed.
9		F	Press the F Key. The Servomotor capacity will be displayed.
10		F	Press the F Key. The Encoder Resolution will be displayed.
11		S	Press the S Key again to return the display to FA011.

8.4.11 Display Software Version (FA012)

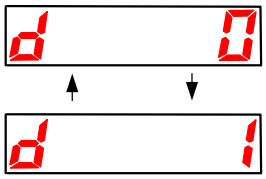
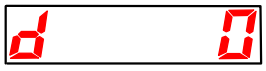
Refer to the following section for information on this utility function other than the procedure.

Step	Panel Display after Operation	Keys	Operation
1		F	Press the F Key to enter Utility Function Mode.
2		▲ ▼	Press the UP Key or DOWN Key to display FA012
3		S	Press the S Key. The software version of the servo driver will be displayed.

4		F	Press the F Key. The FPGA version will be displayed.
5		S	Press the S Key again to return the display to FA012.

8.4.12 One-Parameter Tuning (FA203)

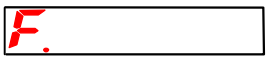
Refer to the following section for information on this utility function other than the procedure.

Step	Panel Display after Operation	Keys	Operation
1		F	Press the F Key to enter Utility Function Mode.
2		▲ ▼	Press the UP Key or DOWN Key to display FA20
3		S	Press the S Key. The display shown at the left will appear.
4		▲ ▼	Press the UP Key or DOWN Key to enter Tuning Mode. Tuning Mode (Strength of Tuning Setting) 0: Performs tuning giving priority to stability. 1: Performs tuning giving priority to response. NOTE: The rigidity type is always 2.
5		-	If the servo is OFF (i.e., if power is not supplied to the Servomotor), input the /S-ON (Servo ON) from the host controller. If the servo is ON, go to step 6.
6		◀	Press the S Key. The one-parameter gain will be displayed as shown on the left.
7		▲ ▼	Press the UP Key or DOWN Key to change the oneparameter gain value and change the actual servo gains (Pn100, Pn101, Pn102, and Pn401) at the same time. You end this tuning function when you decide that the response is satisfactory.
8		F	Press the F Key to save the four calculated gains to the parameters. When tuning has been completed, donE will flash on the display, and then the display shown on the left will appear again. NOTE: To end operation without saving the calculated gains, go to step 9.
9		S	Press the S Key again to return the display to FA203.

8.4.13 EasyFFT (FA206)

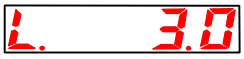
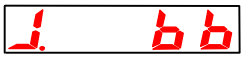
Refer to the following section for information on this utility function other than the procedure.

Step	Panel Display after Operation	Keys	Operation
1		F	Press the F Key to enter Utility Function Mode.
2		▲ ▼	Press the UP Key or DOWN Key to display FA206
3		S	Press the S Key. The display shown on the left will appear and the Panel Operator will enter Reference Amplitude Setting Mode.
4		▲ ▼	Press the UP Key or DOWN Key to set the reference amplitude. Reference amplitude setting range: 1 to 800 NOTE: 1. If you are setting Easy FFT for the first time, do not change the reference amplitude setting, but rather start from the default value of 15. Although

			increasing the reference amplitude will increase the detection accuracy, the vibration and noise in the machine will increase momentarily. Increase the reference amplitude a little at a time and observe the results. 2. The set reference amplitude will be stored in Pn456.
5		S	Press the S Key. The ready to operate status will be entered.
6		F	Press the F Key to turn ON the servo. Additional Information Press the F Key again to turn OFF the servo. Return to step 5.
7		▲ ▼	While the servo is ON, press the UP Key (forward) or the DOWN Key (reverse). The Servomotor will automatically perform round-trip operation, moving in forward and reverse several times for 1/4th of a rotation for a Rotary Servomotor and 10 mm or less for a Linear Servomotor. The Servomotor performs this operation for approximately 2 seconds. During this operation, the display shown on the left will flash. NOTE: 1. Press the F Key to cancel the operation. Return to step 5. 2. The Servomotor will move slightly. Also at the same time, the Servomotor will emit noise. To ensure safety, do not approach or enter the range of machine motion.
		--	If detection is completed normally, E_FFt will stop flashing and the detected resonance frequency will be displayed. If detection fails, F---- will be displayed. To check the results, go to step 9. To monitor the resonance frequency without setting the detection result, press the S Key to return to step 2. ● IMPORTANT If the operation ended normally but it took two seconds or longer, the detection accuracy may not be sufficient. Increase the reference amplitude to a value higher than 15 to increase the detection accuracy. Although increasing the reference amplitude will increase the detection accuracy, the vibration and noise in the machine will increase momentarily. Increase the reference amplitude a little at a time and observe the results.
9		F	Press the F Key. The optimum notch filter for the detected resonance frequency will automatically be set. If the notch filter is set correctly, donE will flash on the display, and then the display shown on the left will appear. If the 1st notch filter frequency is already set (Pn408 = n. 1), the 2nd notch filter frequency will be automatically set (Pn40C). Press the F Key to return to step 5. NOTE: 1. If both the 1st and 2nd notch filter frequencies are already set (Pn408 = n. 1 1), no more notch filter frequencies can be set. 2. If the frequency detected by this function is not to be used, set Pn408 to n. 0 (Disable notch filter).
10		S	Press the S Key again to return the display to FA206.

8.4.17 Load Inertia Detection (FA208)

Refer to the following section for information on this utility function other than the procedure.

Step	Panel Display after Operation	Keys	Operation
1		F	Press the F Key to enter Utility Function Mode.
2		▲ ▼	Press the UP Key or DOWN Key to display FA208
3		S	Press the S key to display the content as shown in the left image, entering the movement distance settings of load inertia detection.
4		▲ ▼	Press the UP or DOWN key to set the movement distance
5		S	Press the S Key. The ready to operate status will be entered.
6		S	Press the F Key to turn ON the servo. Additional Information Press the F Key again to turn OFF the servo. Return to step 5.
7		▲ ▼	In the servo ON state, pressing the UP (forward) or DOWN (reverse) key will cause the servo motor to repeatedly rotate forward and backward within the setup movement distance a few times. The execution time is approximately 8 seconds. During the operation, the display shown in the left image will flash.
8		--	After the detection process concludes successfully, the flashing will stop, and the detected load inertia percentage will be displayed. If the detection fails, "J.----" will be shown.
9		S	Press the S Key again to return the display to FA208.

Chapter9. Maintenance

9.1 Inspections and Part Replacement

This section describes inspections and part replacement for SERVO DRIVER.

9.1.1 Inspections

Perform the inspections given in the following table at least once every year for the servo driver.
Daily inspections are not required.

Item	Frequency	Inspection	Correction
Exterior	At least once a year	Check for dust, dirt, and oil on the surfaces.	Clean with compressed air or a cloth.
Loose Screws		Check for loose terminal block and connector screws and for other loose parts.	Tighten any loose screws or other loose parts.

9.1.2 Replacing the Battery

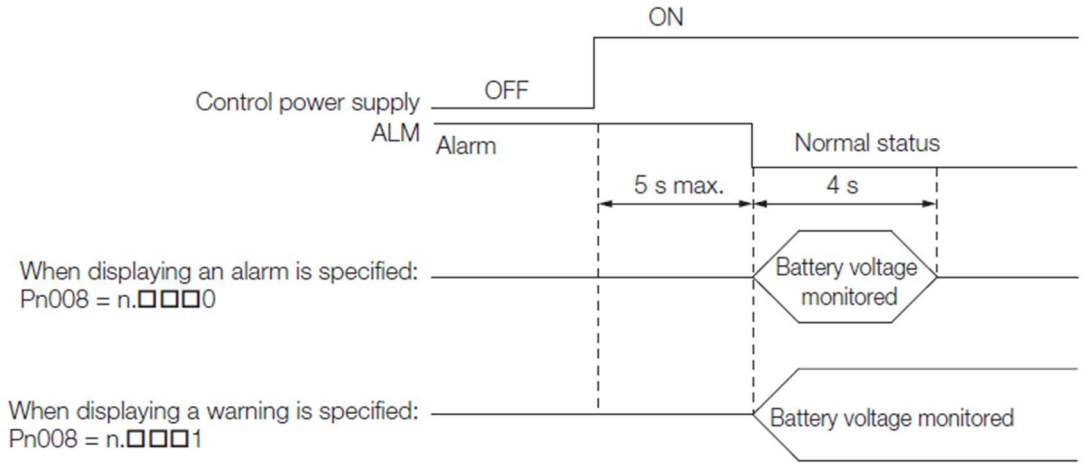
If the battery voltage drops to approximately 3V or less, an A.830 alarm (Encoder Battery Alarm) or an A.930 warning (Absolute Encoder Battery Error) will be displayed.

Battery Alarm/Warning Selection

Whether to display an alarm or a warning is determined by the setting of Pn008 = n. X (Low Battery Voltage Alarm/Warning Selection)..

Parameter		Function	When Enabled	Classification
Pn008	n.□□□0 [default setting]	Output alarm for low battery voltage (A.830).	After restart	Setup
	n.□□□1	Output warning for low battery voltage (A.930).		

• Pn008=n.□□□0
•The ALM (Servo Alarm) signal is output for up to five seconds when the control power supply is turned ON, and then the battery voltage is monitored for four seconds.
No alarm will be displayed even if the battery voltage drops below the specified value after these four seconds.
• Pn008=n.□□□1
•The ALM (Servo Alarm) signal is output for up to five seconds when the control power supply is turned ON, and then the battery voltage is monitored continuously.

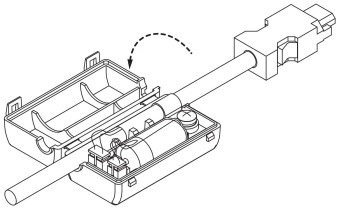


◆When Using an Encoder Cable with a Battery Case

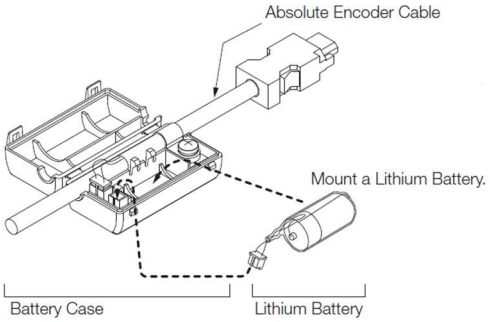
1.Turn ON only the control power supply to the servo driver.

> If you remove the Battery or disconnect the Encoder Cable while the control power supply to the servo driver is OFF, the absolute encoder data will be lost.

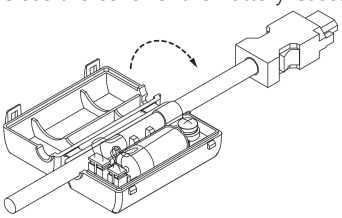
2.Open the cover of the Battery Case



3.Remove the old Battery and mount a new Battery.



4.Close the cover of the Battery Case.



5.Turn OFF the power supply to the servo driver to clear the A.830 alarm (Encoder Battery Alarm).

6.Turn ON the power supply to the servo driver.

7.Make sure that the alarm has been cleared and that the servo driver operates normally.

9.2 Alarm Displays

If an error occurs in the servo driver, an alarm number will be displayed on the panel display.

Example: If an A.020 alarm occurs,

"020" will flash on the display :



9.2.1 List of Alarms

The list of alarms gives the alarm name, alarm meaning, alarm stopping method, alarm reset possibility, and alarm code output in order of the alarm numbers.

Alarm Reset Possibility

Yes: You can use an alarm reset to clear the alarm. However, this assumes that the cause of the alarm has been removed.

No: You cannot clear the alarm.

List of Alarms

Alarm Number	Alarm Name	Alarm Meaning	Servomotor Stopping Method	Alarm Reset Possible
A.020	Parameter Checksum Error	There is an error in the parameter data in the servo driver.	Gr.1	No
A.021	Parameter Format Error	There is an error in the parameter data format in the servo driver.	Gr.1	No
A.022	System Checksum Error	There is an error in the parameter data in the servo driver.	Gr.1	No
A.030	Main Circuit Detector Error	There is an error in the detection data for the main circuit.	Gr.1	Yes
A.040	Parameter Setting Error	A parameter setting is outside of the setting range.	Gr.1	No
A.042	Parameter Combination Error	The combination of some parameters exceeds the setting range.	Gr.1	No
A.050	Combination Error	The capacities of the servo driver and Servomotor do not match.	Gr.1	Yes
A.051	Unsupported Device Alarm	An unsupported device was connected.	Gr.1	No
A.0b0	Invalid Servo ON Command Alarm	The /S-ON (Servo ON) signal was input from the host controller after a utility function that turns ON the Servomotor was executed.	Gr.1	Yes
A.100	Overcurrent Detected	An overcurrent flowed through the power transistor or the heat sink overheated.	Gr.1	No
A.101	Motor Overcurrent Detected	The current to the motor exceeded the allowable current	Gr.1	No
A.300	Regeneration Error	There is an error related to regeneration.	Gr.1	Yes
A.320	Regenerative Overload	A regenerative overload occurred.	Gr.2	Yes
A.330	Main Circuit Power Supply Wiring Error	• The AC power supply input setting or DC power supply input setting is not correct. • The power supply wiring is not correct.	Gr.1	Yes
A.400	Overvoltage	The main circuit DC voltage is too high.	Gr.1	Yes
A.410	Undervoltage	The main circuit DC voltage is too low.	Gr.2	Yes
A.510	Overspeed	The motor exceeded the maximum speed.	Gr.1	Yes
A.520	Vibration Alarm	Abnormal oscillation was detected in the motor speed.	Gr.1	Yes
A.521	Autotuning Alarm	Vibration was detected during autotuning for the tuning-less function.	Gr.1	Yes
A.600	Incorrect ESM requires exception protection	Received a state conversion request that cannot be converted from the current state.	Gr.1	Yes
A.601	Undefined ESM requires exception protection	Undefined state transition request received.	Gr.1	Yes
A.602	Boot state requires exception protection	Received Bootstrap status conversion request.	Gr.1	Yes
A.603	PLL incomplete exception protection	After 1 second of synchronization processing, the bit combination of communication and servo still cannot be completed.	Gr.1	Yes
A.604	PDO watchdog exception protection	When SP or OP, bit10 of ESC register 0200h does not turn ON within the specified time.	Gr.1	Yes
A.605	ESC hardware initialization error	ESC hardware initialization error.	Gr.1	Yes
A.606	PLL abnormal protection	The ESM status is under SP or OP, and the communication and servo bits do not match.	Gr.1	Yes
A.607	Synchronous signal abnormality protection	After the synchronization process is completed, the SYNC0 or IRQ interrupt processing times out.	Gr.1	Yes
A.610	Synchronization cycle setting abnormality protection	Unsupported synchronization period (SYNC0) is set.	Gr.1	Yes
A.611	Email settings abnormality protection	The SM0/1 setting of the mailbox is incorrect.	Gr.1	Yes
A.614	PDO watchdog setting abnormal protection	PDO watchdog setting error.	Gr.1	Yes
A.615	DC setting abnormality protection	DC setting error.	Gr.1	Yes
A.616	SM event mode setting abnormality protection	Unsupported SM event is set.	Gr.1	Yes
A.617	SM2/3 setting abnormality protection	SM2/3 is set to an incorrect value.	Gr.1	Yes
A.650	TxPDO allocation exception protection	The data size mapped by TxPDO exceeds 32 bytes.	Gr.1	Yes
A.651	RxPDO allocation exception protection	RxPDO mapped data size exceeds 32 bytes.	Gr.1	Yes
A.652	Lost link exception protection	After ESM leaves the Init state, Port0 or 1 appears in the lost link state.	Gr.1	Yes
A.710	Instantaneous Overload	The Servomotor was operating for several seconds to several tens of seconds under a torque that largely exceeded the rating.	Gr.2	Yes

A.720	Continuous Overload	The Servomotor was operating continuously under a torque that exceeded the rating.	Gr.1	Yes
A.730/1	Dynamic Brake Overload	When the dynamic brake was applied, the rotational or linear kinetic energy exceeded the capacity of the dynamic brake resistor.	Gr.1	Yes
A.740	Inrush Current Limiting Resistor Overload	The main circuit power supply was frequently turned ON and OFF.	Gr.1	Yes
A.810	Encoder Backup Alarm	The power supplies to the encoder all failed and the position data was lost.	Gr.1	No
A.820	Encoder Checksum Alarm	There is an error in the checksum results for encoder memory.	Gr.1	No
A.830	Encoder Battery Alarm	The battery voltage was lower than the specified level after the control power supply was turned ON.	Gr.1	Yes
A.840	Encoder Data Alarm	There is an internal data error in the encoder.	Gr.1	No
A.850	Encoder Overspeed	The encoder was operating at high speed when the power was turned ON.	Gr.1	No
A.C10	Servomotor Out of Control	The Servomotor ran out of control.	Gr.1	Yes
A.C20	Phase Detection Error	The detection of the phase is not correct.	Gr.1	No
A.C22	Phase Information Disagreement	The phase information does not match.	Gr.1	No
A.C90	Encoder Communications Error	Communications between the encoder and servo driver is not possible.	Gr.1	No
A.C91	Encoder Communications Position Data Acceleration Rate Error	An error occurred in calculating the position data of the encoder.	Gr.1	No
A.C92	Encoder Communications Timer Error	An error occurred in the communications timer between the encoder and servo driver.	Gr.1	No
A.CA0	Encoder Parameter Error	The parameters in the encoder are corrupted.	Gr.1	No
A.Cb0	Encoder Echoback Error	The contents of communications with the encoder are incorrect.	Gr.1	No
A.d00	Position Deviation Overflow	The setting of Pn520 (Position Deviation Overflow Alarm Level) was exceeded by the position deviation while the servo was ON.	Gr.1	Yes
A.d01	Position Deviation Overflow Alarm at Servo ON	The servo was turned ON after the position deviation exceeded the setting of Pn526 (Position Deviation Overflow Alarm Level at Servo ON) while the servo was OFF.	Gr.1	Yes
A.d02	Position Deviation Overflow Alarm for Speed Limit at Servo ON	If position deviation remains in the deviation counter, the setting of Pn529 or Pn584 (Speed Limit Level at Servo ON) limits the speed when the servo is turned ON. This alarm occurs if reference pulses are input and the setting of Pn520 (Position Deviation Overflow Alarm Level) is exceeded before the limit is cleared. ◦	Gr.2	Yes
A.d10	Motor-Load Position Deviation Overflow	There was too much position deviation between the motor and load during fully-closed loop control.	Gr.2	Yes
A.d30	Position Data Overflow	The position feedback data exceeded ±1,879,048,192.	Gr.1	No
A.F10	Power Supply Line Open Phase	The voltage was low for more than one second for phase R, S, or T when the main power supply was ON.	Gr.2	Yes

* These alarms are not stored in the alarm history. They are only displayed on the panel display ◦

9.2.2 Troubleshooting Alarms

The causes of and corrections for the alarms are given in the following table. Contact your Fatek representative if you cannot solve a problem with the correction given in the table.

Alarm Number: Alarm Name	Possible Cause	Confirmation	Correction
A.020 : Parameter Checksum Error (There is an error in the parameter data in the servo driver.)	The power supply voltage suddenly dropped.	Measure the power supply voltage.	Set the power supply voltage within the specified range, and initialize the parameter settings.
	The power supply was shut OFF while writing parameter settings.	Check the timing of shutting OFF the power supply.	Initialize the parameter settings and then set the parameters again.
	The number of times that parameters were written exceeded the limit.	Check to see if the parameters were frequently changed from the host controller.	The servo driver may be faulty. Replace the servo driver. Reconsider the method for writing the parameters
	A malfunction was caused by noise from the AC power supply, ground, static electricity, or other source.	Turn the power supply to the servo driver OFF and ON again. If the alarm still occurs, noise may be the cause.	Implement countermeasures against noise.

	Gas, water drops, or cutting oil entered the servo driver and caused failure of the internal components.	Check the installation conditions.	The servo driver may be faulty. Replace the servo driver.
	A failure occurred in the servo driver.	The servo driver may be faulty. Replace the servo driver.	The servo driver may be faulty. Replace the servo driver.
A.021 : Parameter Format Error (There is an error in the parameter data format in the servo driver.)	The software version of the servo driver that caused the alarm is older than the software version of the parameters specified to write.	Read the product information to see if the software versions are the same. If they are different, it could be the cause of the alarm.	Write the parameters from another servo driver with the same model and the same software version, and then turn the power OFF and ON again.
	A failure occurred in the servo driver.	-	The servo driver may be faulty. Replace the servo driver.
A.022 : System Checksum Error (There is an error in the parameter data in the servo driver.)	The power supply voltage suddenly dropped.	Measure the power supply voltage.	The servo driver may be faulty. Replace the servo driver.
	The power supply was shut OFF while setting a utility function.	Check the timing of shutting OFF the power supply.	The servo driver may be faulty. Replace the servo driver.
	A failure occurred in the servo driver.	Turn the power supply to the servo driver OFF and ON again. If the alarm still occurs, the servo driver may have failed.	The servo driver may be faulty. Replace the servo driver.
A.030 : Main Circuit Detector Error	A failure occurred in the servo driver.	-	The servo driver may be faulty. Replace the servo driver
A.040 : Parameter Setting Error (A parameter setting is outside of the setting range.)	The servo driver and Servomotor capacities do not match each other.	Check the combination of the servo driver and Servomotor capacities.	Select a proper combination of servo driver and Servomotor capacities.
	A failure occurred in the servo driver.	-	The servo driver may be faulty. Replace the servo driver.
	A parameter setting is outside of the setting range.	Check the setting ranges of the parameters that have been changed.	Set the parameters to values within the setting ranges.
	The electronic gear ratio is outside of the setting range.	Check the electronic gear ratio. The ratio must be within the following range: 0.001 < (Pn20E/Pn210) < 64,000.	Set the electronic gear ratio in the following range: 0.001 < (Pn20E/ Pn210) < 64,000.
A.042 : Parameter Combination Error	The speed of program jogging went below the setting range when the electronic gear ratio (Pn20E/ Pn210) or the Servomotor was changed.	Check to see if the detection conditions*1 are satisfied.	Decrease the setting of the electronic gear ratio (Pn20E/Pn210).
	The speed of program jogging went below the setting range when Pn533(Program Jogging Movement Speed) was changed.	Check to see if the detection conditions*1 are satisfied.	Increase the setting of Pn533.
	The movement speed of advanced autotuning went below the setting range when the electronic gear ratio (Pn20E/ Pn210) or the Servomotor was changed.	Check to see if the detection conditions*2 are satisfied.	Decrease the setting of the electronic gear ratio (Pn20E/Pn210).
A.050 : Combination Error (The capacities of	The servo driver and Servomotor capacities do not match each other.	Confirm that the following condition is met: 1/4 ≤ (Servomotor	Select a proper combination of the servo driver and Servomotor capacities.

the servo driver and Servomotor do not match.)		capacity/servo driver capacity) ≤ 4	
	A failure occurred in the servo driver.	-	The servo driver may be faulty. Replace the servo driver.
A.051 : Unsupported Device Alarm	The motor parameter file was not written to the linear encoder. (This applies only when not using a Serial Converter Unit.)	Check to see if the motor parameter file was written to the linear encoder.	Write the motor parameter file to the linear encoder.
A.0b0 : Invalid Servo ON Command Alarm	The /S-ON (Servo ON) signal was input from the host controller after a utility function that turns ON the Servomotor was executed.	-	Turn the power supply to the servo driver OFF and ON again. Or, execute a software reset.
A.100 : Overcurrent Detected (An overcurrent flowed through the power transistor or the heat sink overheated.)	The Main Circuit Cable is not wired correctly or there is faulty contact.	Check the wiring.	Correct the wiring.
	There is a short-circuit or ground fault in a Main Circuit Cable.	Check for short-circuits across Servomotor phases U, V, and W, or between the ground and Servomotor phases U, V, and W.	The cable may be shortcircuited. Replace the cable.
	There is a short-circuit or ground fault inside the Servomotor.	Check for short-circuits across Servomotor phases U, V, and W, or between the ground and Servomotor phases U, V, or W.	The Servomotor may be faulty. Replace the Servomotor.
	The regenerative resistor is not wired correctly or there is faulty contact.	Check the wiring.	Correct the wiring.
	The dynamic brake (DB, emergency stop executed from the servo driver) was frequently activated, or a DB overload alarm occurred.	Check the power consumed by the DB resistor to see how frequently the DB is being used. Or, check the alarm display to see if a DB overload alarm (A.730 or A.731) has occurred.	Change the servo driver model, operating methods, or the mechanisms so that the dynamic brake does not need to be used so frequently.
	The regenerative processing capacity was exceeded.	Tab Page to see how frequently the regenerative resistor is being used.	Recheck the operating conditions and load.
	The servo driver regenerative resistance is too small.	Tab Page to see how frequently the regenerative resistor is being used.	Change the regenerative resistance to a value larger than the servo driver minimum allowable resistance.
	A heavy load was applied while the Servomotor was stopped or running at a low speed	Check to see if the operating conditions exceed Servo Drive specifications.	Reduce the load applied to the Servomotor. Or, increase the operating speed.
	A malfunction was caused by noise.	Improve the noise environment, e.g. by improving the wiring or installation conditions, and check to see if the alarm still occurs.	Implement countermeasures against noise, such as correct wiring of the FG. Use an FG wire size equivalent to the servo drivers main circuit wire size.
	A failure occurred in the servo driver.	-	Turn the power supply to the servo driver OFF and ON again. If the alarm still occurs, the servo driver may be faulty. Replace the servo driver.

A.101 : Motor Overcurrent Detected (The current to the motor exceeded the allowable current.)	The Main Circuit Cable is not wired correctly or there is faulty contact.	Check the wiring.	Correct the wiring.
	There is a short-circuit or ground fault in a Main Circuit Cable.	Check for short-circuits across cable phases U, V, and W, or between the ground and cable phases U, V, and W.	The cable may be shortcircuited. Replace the cable.
	There is a short-circuit or ground fault inside the Servomotor.	Check for short-circuits across Servomotor phases U, V, and W, or between the ground and Servomotor phases U, V, or W.	The Servomotor may be faulty. Replace the Servomotor.
	There is a short-circuit or ground fault inside the servo driver.	Check for short-circuits across the Servomotor connection terminals U, V, and W on the servo driver, or between the ground and terminals U, V, or W.	The servo driver may be faulty. Replace the servo driver.
	A heavy load was applied while the Servomotor was stopped or running at a low speed.	Check to see if the operating conditions exceed Servo Drive specifications.	Reduce the load applied to the Servomotor. Or, increase the operating speed.
	A malfunction was caused by noise.	Improve the noise environment, e.g. by improving the wiring or installation conditions, and check to see if the alarm still occurs.	Implement countermeasures against noise, such as correct wiring of the FG. Use an FG wire size equivalent to the servo driver's main circuit wire size.
	A failure occurred in the servo driver.	-	Turn the power supply to the servo driver OFF and ON again. If the alarm still occurs, the servo driver may be faulty. Replace the servo driver.
A.300 : Re-generation Fault	The regenerative resistor capacity (Pn600) is set to a value other than "0", and the regenerative resistor is not installed.	Check to see if an External Regenerative Resistor is connected and check the setting of Pn600.	Connect an external regenerative resistor, or set Pn600 (regenerative resistor capacity) to 0 when the regenerative resistor is not needed.
	No external regeneration resistor	Check to see if an External Regenerative Resistor or a Regenerative Resistor Unit is connected and check the setting of Pn600.	After connecting the external regeneration resistor, set the appropriate value for Pn600.
	The jumper wire of the regenerative resistor connection terminals B2-B3 is disconnected.	Check to see if the jumper is connected between power supply terminals B2 and B3.	Correctly connect a jumper.
	The External Regenerative Resistor or Regenerative Resistor Unit is not wired correctly, or was removed or disconnected	Check the wiring of the External Regenerative Resistor or Regenerative Resistor Unit.	Correct the wiring of the External Regenerative Resistor or Regenerative Resistor Unit.
	A failure occurred in the servo driver.	-	While the main circuit power supply is OFF, turn the control power supply to the servo driver OFF and ON again. If the alarm still occurs, the servo driver may be faulty. Replace the servo driver.
A.320 : Regenerative Overload	The power supply voltage exceeded the specified range.	Measure the power supply voltage.	Set the power supply voltage within the specified range.

	The external regenerative resistance value or regenerative resistor capacity is too small, or there has been a continuous regeneration state.	Reconfirm operating conditions and capacity	Change the regenerative resistor value and regenerative resistor capacity, and adjust the operating conditions again.
	Continuously bear negative load and be in continuous regeneration state	Check the load applied to the running servo motor.	Reconsider the system including the servo, machine, and operating conditions.
	The setting of Pn600 (Regenerative Resistor Capacity) is smaller than the capacity of the External Regenerative Resistor.	Check to see if a Regenerative Resistor is connected and check the setting of Pn600.	Correct the setting of Pn600.
	The setting of Pn603 (Regenerative Resistance) is smaller than the capacity of the External Regenerative Resistor.	Check to see if a Regenerative Resistor is connected and check the setting of Pn603.	Correct the setting of Pn603.
	The external regenerative resistance is too high	Check the regenerative resistance.	Change the regenerative resistance to a correct value or use an External Regenerative Resistor of an appropriate capacity.
	A failure occurred in the servo driver.	-	The servo driver may be faulty. Replace the servo driver.
A.330 : Main Circuit Power Supply Wiring Error (Detected when the main circuit power supply is turned ON.)	The regenerative resistor was disconnected when the servo driver power supply voltage was high.	Measure the resistance of the regenerative resistor using a measuring instrument.	If you are using the regenerative resistor built into the servo driver, replace the servo driver. If you are using an External Regenerative Resistor, replace the External Regenerative Resistor.
	DC power was supplied when an AC power supply input was specified in the settings	Check the power supply to see if it is a DC power supply.	Correct the power supply setting to match the actual power supply.
	AC power was supplied when a DC power supply input was specified in the settings.	Check the power supply to see if it is an AC power supply.	Correct the power supply setting to match the actual power supply.
	The regenerative resistor capacity (Pn600) is set to a value other than "0" and the regenerative resistor is not installed.	Check to see if an External Regenerative Resistor is connected and check the setting of Pn600.	Connect an External Regenerative Resistor, or if an External Regenerative Resistor is not required, set Pn600 to 0.
	A failure occurred in the servo driver.	-	The servo driver may be faulty. Replace the servo driver.
A.400 : Overvoltage (Detected in the main circuit power supply section of the servo driver.)	The power supply voltage exceeded the specified range.	Measure the power supply voltage.	Set the AC/DC power supply voltage within the specified range.
	The power supply is not stable or was influenced by a lightning surge.	Measure the power supply voltage.	Improve the power supply conditions, install a surge absorber, and then turn the power supply OFF and ON again. If the alarm still occurs, the servo driver may be faulty. Replace the servo driver.
	The voltage for AC power supply was too high during acceleration or deceleration.	Check the power supply voltage and the speed and torque during operation.	Set the AC power supply voltage within the specified range.
	The external regenerative resistance is too high for the operating conditions.	Check the operating conditions and the regenerative resistance.	Confirm that the moment of inertia ratio or mass ratio is within the allowable range。
	The moment of inertia ratio or mass ratio exceeded the allowable value.	Check to see if the moment of inertia ratio or mass ratio is within the allowable range.	Increase the deceleration time, or reduce the load.
	A failure occurred in	-	While the main circuit

	the servo driver.		power supply is OFF, turn the control power supply to the servo driver OFF and ON again. If the alarm still occurs, the servo driver may be faulty. Replace the servo driver.
A.410 : Undervoltage (Detected in the main circuit power supply section of the servo driver.)	The power supply voltage went below the specified range.	Measure the power supply voltage.	Set the power supply voltage within the specified range.
	The power supply voltage dropped during operation.	Measure the power supply voltage.	Increase the power supply capacity.
	A momentary power interruption occurred.	Measure the power supply voltage.	If you have changed the setting of Pn509 (Momentary Power Interruption Hold Time), decrease the setting.
	The servo driver fuse is blown out.	-	The servo driver may be faulty. Replace the servo driver.
	A failure occurred in the servo driver.	-	The servo driver may be faulty. Replace the servo driver.
A.510 : Overspeed (The motor exceeded the maximum speed.)	The order of phases U, V, and W in the motor wiring is not correct.	Check the wiring of the Servomotor.	Make sure that the Servomotor is correctly wired.
	A reference value that exceeded the overspeed detection level was input.	Check the input reference.	Reduce the reference value. Or, adjust the gain.
	The motor exceeded the maximum speed.	Check the waveform of the motor speed.	Reduce the speed reference input gain and adjust the servo gain. Or, reconsider the operating conditions.
	A failure occurred in the servo driver.	-	The servo driver may be faulty. Replace the servo driver.
A.520 : Vibration Alarm	Abnormal oscillation was detected in the motor speed.	Check for abnormal motor noise, and check the speed and torque waveforms during operation.	Reduce the motor speed. Or, reduce the setting of Pn100 (Speed Loop Gain).
	The setting of Pn103 (Moment of Inertia Ratio) is greater than the actual moment of inertia or was greatly changed.	Check the moment of inertia ratio or mass ratio.	Set Pn103 (Moment of Inertia Ratio) to an appropriate value.
	The vibration detection level (Pn312 or Pn384) is not suitable.	Check that the vibration detection level (Pn312 or Pn384) is suitable.	Set a suitable vibration detection level (Pn312 or Pn384).
A.521 : Autotuning Alarm (Vibration was detected while executing the custom tuning, Easy FFT, or the tuning-less function.)	The Servomotor vibrated considerably while performing the tuning-less function.	Check the waveform of the motor speed.	Reduce the load so that the moment of inertia ratio is within the allowable value. Or increase the load level or reduce the rigidity level in the tuningless level settings.
	The Servomotor vibrated considerably while performing custom tuning or Easy FFT.	Check the waveform of the motor speed.	Check the operating procedure of corresponding function and implement corrections.
A.710 : Instantaneous Overload A.720 : Continuous Overload	The wiring is not correct or there is a faulty connection in the motor or encoder wiring.	Check the wiring.	Make sure that the Servomotor and encoder are correctly wired.
	Operation was performed that exceeded the overload protection characteristics.	Check the motor overload characteristics and Run command.	Reconsider the load and operating conditions. Or, increase the motor capacity.
	An excessive load was applied during operation	Check the operation reference and motor	Correct the mechanical problem.

	because the Servomotor was not driven due to mechanical problems.	speed.	
	A failure occurred in the servo driver.	-	The servo driver may be faulty. Replace the servo driver.
A.730 : A.731 : Dynamic Brake Overload (An excessive power consumption by the dynamic brake was detected.)	The Servomotor was rotated by an external force.	Check the operation status.	Implement measures to ensure that the motor will not be rotated by an external force.
	When the Servomotor was stopped with the dynamic brake, the rotational or linear kinetic energy exceeded the capacity of the dynamic brake resistor.	Check the power consumed by the DB resistor to see how frequently the DB is being used.	Reconsider the following: • Reduce the Servomotor command speed. • Decrease the moment of inertia ratio or mass ratio. • Reduce the frequency of stopping with the dynamic brake.
	A failure occurred in the servo driver.	-	The servo driver may be faulty. Replace the servo driver.
A.740 : Inrush Current Limiting Resistor Overload (The main circuit power supply was frequently turned ON and OFF.)	The allowable frequency of the inrush current limiting resistor was exceeded when the main circuit power supply was turned ON and OFF.	-	Reduce the frequency of turning the main circuit power supply ON and OFF.
	A failure occurred in the servo driver.	-	The servo driver may be faulty. Replace the servo driver.
A.810 : Encoder Backup Alarm (Detected at the encoder, but only when an absolute encoder is used.)	Encoder type Pn002:n.□X□□ is not set	Confirm power supply and parameter settings.	Incremental type: □1□□
	The power to the absolute encoder was turned ON for the first time.	Check to see if the power supply was turned ON for the first time.	Set up the encoder.
	The Encoder Cable was disconnected and then connected again.	Check to see if the power supply was turned ON for the first time.	Check the encoder connection and set up the encoder.
	Power is not being supplied both from the control power supply (+5 V) from the servo driver and from the battery power supply.	Check the encoder connector battery and the connector status.	Replace the battery or implement similar measures to supply power to the encoder, and set up the encoder.
	A failure occurred in the absolute encoder.	-	If the alarm still occurs after setting up the encoder again, replace the Servomotor.
	A failure occurred in the servo driver.	-	The servo driver may be faulty. Replace the servo driver.
A.820 : Encoder Checksum Alarm (Detected at the encoder.)	A failure occurred in the encoder.	-	When Using an Absolute Encoder Set up the encoder again. If the alarm still occurs, the Servomotor may be faulty. Replace the Servomotor. When Using a Singleturn Absolute Encoder or Incremental Encoder • The Servomotor may be faulty. Replace the Servomotor. • The linear encoder may be faulty. Replace the linear encoder.
	A failure occurred in the servo driver.	-	The servo driver may be faulty. Replace the servo driver.
A.830 : Encoder Battery Alarm (The absolute encoder battery voltage was lower than the specified level.)	The battery connection is faulty or a battery is not connected.	Check the battery connection.	Correct the battery connection.
	The battery voltage is lower than the specified value (2.7 V).	Measure the battery voltage.	Replace the battery.
	A failure occurred in the servo driver.	-	The servo driver may be faulty. Replace the servo driver.
A.840 : Encoder Data	The encoder malfunctioned.	-	Turn the power supply to the servo driver OFF and

Alarm (Detected at the encoder.)			ON again. If the alarm still occurs, the Servomotor or linear encoder may be faulty. Replace the Servomotor or linear encoder.
	The encoder malfunctioned due to noise.	-	Correct the wiring around the encoder by separating the Encoder Cable from the Servomotor Main Circuit Cable or by grounding the encoder.
A.850 : Encoder Overspeed (Detected at the encoder when the control power supply is turned ON.)	Rotary Servomotor: The Servomotor speed was 200 min-1 or higher when the control power supply was turned ON.	Check the motor speed when the power supply is turned ON.	Reduce the Servomotor speed to a value less than 200 min-1, and turn ON the control power supply.
	A failure occurred in the encoder.	-	Turn the power supply to the servo driver OFF and ON again. If the alarm still occurs, the Servomotor or linear encoder may be faulty. Replace the Servomotor or linear encoder.
	A failure occurred in the servo driver.	-	Turn the power supply to the servo driver OFF and ON again. If the alarm still occurs, the servo driver may be faulty. Replace the servo driver.
A.C10 : Servomotor Out of Control (Detected when the servo is turned ON.)	The order of phases U, V, and W in the motor wiring is not correct.	Check the Servomotor wiring.	Make sure that the Servomotor is correctly wired.
	A failure occurred in the encoder.	-	If the motor wiring is correct and the alarm still occurs after turning the power supply OFF and ON again, the Servomotor or linear encoder may be faulty. Replace the Servomotor or linear encoder.
	A failure occurred in the servo driver.	-	Turn the power supply to the servo driver OFF and ON again. If the alarm still occurs, the servo driver may be faulty. Replace the servo driver.
A.C20 : Phase Detection Error	The linear encoder signal level is too low.	Check the voltage of the linear encoder.	Fine-tune the mounting of the scale head. Or, replace the linear encoder.
	The count-up direction of the linear encoder does not match the forward direction of the Moving Coil in the motor.	Check the setting of Pn080 = n. X (Motor Phase Sequence Selection). Check the installation orientation for the linear encoder and Moving Coil.	Change the setting of Pn080 = n. X . Correctly reinstall the linear encoder or Moving Coil.
	The polarity sensor signal is being affected by noise.	-	Correct the FG wiring. Implement countermeasures against noise for the polarity sensor wiring.
A.C21 : Polarity Sensor Error	Linear encoder pitch (Pn282) setting value is wrong	Confirm the linear encoder pitch (Pn282).	Confirm the linear encoder specifications and set the values correctly.
	The polarity sensor is protruding from the Magnetic Way of the motor.	Check the polarity sensor.	Correctly reinstall the Moving Coil or Magnetic Way of the motor.
	The polarity sensor is not wired correctly.	Check the wiring of the polarity sensor.	Correct the wiring of the polarity sensor
	The polarity sensor failed.	-	Replace the polarity sensor.
A.C22 : Phase Information Disagreement	The servo driver phase information is different from the linear encoder phase information.	-	Perform polarity detection.

A.C50 : Polarity Detection Failure	The parameter settings are not correct.	Check the linear encoder specifications and feedback signal status.	The settings of Pn282 (Linear Encoder Scale Pitch) and Pn080 = n. X (Motor Phase Sequence Selection) may not match the installation. Set the parameters to correct values.
	There is noise on the scale signal.	Check to make sure that the frame grounds of the Serial Converter Unit and Servomotor are connected to the FG terminal on the servo driver and that the FG terminal on the servo driver is connected to the frame ground on the power supply. And, confirm that the shield is properly processed on the Linear Encoder Cable. Check to see if the detection reference is repeatedly output in one direction.	Implement appropriate countermeasures against noise for the Linear Encoder Cable.
	An external force was applied to the Moving Coil of the motor.	-	The polarity cannot be properly detected if the detection reference is 0 and the speed feedback is not 0 because of an external force, such as cable tension, applied to the Moving Coil. Implement measures to reduce the external force so that the speed feedback goes to 0. If the external force cannot be reduced, increase the setting of Pn481 (Polarity Detection Speed Loop Gain).
	The linear encoder resolution is too low.	Check the linear encoder scale pitch to see if it is within 100 μm.	If the linear encoder scale pitch is 100 μm or higher, the servo driver cannot detect the correct speed feedback. Use a linear encoder scale pitch with higher resolution. (We recommend a pitch of 40 μm or less.) Or, increase the setting of Pn485 (Polarity Detection Reference Speed). However, increasing the setting of Pn485 will increase the Servomotor movement range that is required for polarity detection.
A.C51 : Overtravel Detected during Polarity Detection	The overtravel signal was detected during polarity detection.	Check the overtravel position.	Wire the overtravel signals. Execute polarity detection at a position where an overtravel signal would not be detected.
A.C52 : Polarity Detection Not Completed	The servo was turned ON under the following circumstances. • Before polarity detection was completed • Before /P-DET was input	-	Input the /P-DET signal.
A.C53 : Out of Range of Motion for Polarity Detection	The travel distance exceeded the setting of Pn48E (Polarity Detection Range) in the middle of detection.	-	Increase the setting of Pn48E (Polarity Detection Range). Or, increase the setting of Pn481 (Polarity Detection Speed Loop Gain).
A.C54 : Polarity Detection Failure 2	An external force was applied to the Servomotor.	-	Increase the setting of Pn495 (Polarity Detection Confirmation Force Reference). Increase the setting of Pn498 (Polarity Detection

			Allowable Error Range). Increasing the allowable error will also increase the motor temperature.
A.C80 : Encoder Clear Error or Multiturn Limit Setting Error	A failure occurred in the encoder.	-	Turn the power supply to the servo driver OFF and ON again. If the alarm still occurs, the Servomotor or linear encoder may be faulty. Replace the Servomotor or linear encoder.
	A failure occurred in the servo driver.	-	Turn the power supply to the servo driver OFF and ON again. If the alarm still occurs, the servo driver may be faulty. Replace the servo driver.
A.C90 : Encoder Communications Error	There is a faulty contact in the connector or the connector is not wired correctly for the encoder.	Check the condition of the encoder connector.	Reconnect the encoder connector and check the encoder wiring.
	There is a cable disconnection or shortcircuit in the encoder. Or, the cable impedance is outside the specified values.	Check the condition of the Encoder Cable.	Use the Encoder Cable within the specified specifications.
	One of the following has occurred: corrosion caused by improper temperature, humidity, or gas, a short-circuit caused by entry of water drops or cutting oil, or faulty contact in connector caused by vibration.	Check the operating environment.	Improve the operating environment, and replace the cable. If the alarm still occurs, replace the servo driver.
	A malfunction was caused by noise.	-	Correct the wiring around the encoder by separating the Encoder Cable from the Servomotor Main Circuit Cable or by grounding the encoder.
	A failure occurred in the servo driver.	-	Connect the Servomotor to another servo driver, and turn ON the control power supply. If no alarm occurs, the servo driver may be faulty. Replace the servo driver.
A.C91 : Encoder Communications Position Data Acceleration Rate Error	Noise entered on the signal lines because the Encoder Cable is bent or the sheath is damaged.	Check the condition of the Encoder Cable and connectors.	Check the Encoder Cable to see if it is installed correctly.
	The Encoder Cable is bundled with a highcurrent line or installed near a highcurrent line.	Check the installation condition of the Encoder Cable.	Confirm that there is no surge voltage on the Encoder Cable.
	There is variation in the FG potential because of the influence of machines on the Servomotor side, such as a welder.	Check the installation condition of the Encoder Cable.	Properly ground the machine to separate it from the FG of the encoder.
A.C92 : Encoder Communications Timer Error	Noise entered on the signal line from the encoder.	-	Implement countermeasures against noise for the encoder wiring.
	Excessive vibration or shock was applied to the encoder.	Check the operating conditions.	Reduce machine vibration. Correctly install the Servomotor or linear encoder.

	A failure occurred in the encoder.	-	Turn the power supply to the servo driver OFF and ON again. If the alarm still occurs, the Servomotor or linear encoder may be faulty. Replace the Servomotor or linear encoder.
	A failure occurred in the servo driver.	-	
A.CA0 : Encoder Parameter Error	A failure occurred in the encoder.	-	Turn the power supply to the servo driver OFF and ON again. If the alarm still occurs, the Servomotor or linear encoder may be faulty. Replace the Servomotor or linear encoder.
A.Cb0 : Encoder Echoback Error	The encoder is wired incorrectly or there is faulty contact.	Check the wiring of the encoder.	Make sure that the encoder is correctly wired.
	The specifications of the Encoder Cable are not correct and noise entered on it.	-	Use a shielded twistedpair wire cable or a screened twisted-pair cable with conductors of at least 0.12 mm^2.
	The Encoder Cable is too long and noise entered on it.	-	• Rotary Servomotors: The Encoder Cable wiring distance must be 50 m max. • Linear Servomotors: The Encoder Cable wiring distance must be 20 m max.
	There is variation in the FG potential because of the influence of machines on the Servomotor side, such as a welder.	Check the condition of the Encoder Cable and connectors.	Properly ground the machine to separate it from the FG of the encoder.
	Excessive vibration or shock was applied to the encoder.	Check the operating conditions.	Reduce machine vibration. Correctly install the Servomotor or linear encoder.
	A failure occurred in the encoder.	-	Turn the power supply to the servo driver OFF and ON again. If the alarm still occurs, the Servomotor or linear encoder may be faulty. Replace the Servomotor or linear encoder.
	A failure occurred in the servo driver.	-	Turn the power supply to the servo driver OFF and ON again. If the alarm still occurs, the servo driver may be faulty. Replace the servo driver.
A.d00 : Position Deviation Overflow (The setting of Pn520 (Position Deviation Overflow Alarm Level) was exceeded by the position deviation while the servo was ON.)	The Servomotor U, V, and W wiring is not correct.	Check the wiring of the Servomotor’ s Main Circuit Cables.	Make sure that there are no faulty contacts in the wiring for the Servomotor and encoder.
	The acceleration of the position reference is too high.	Reduce the reference acceleration and try operating the servo driver.	Reduce the "position command" speed or command acceleration, or adjust the electronic gear ratio.
	The setting of Pn520 (Position Deviation Overflow Alarm Level) is too low for the operating conditions.	Check Pn520 (Position Deviation Overflow Alarm Level) to see if it is set to an appropriate value.	Optimize the setting of Pn520.
	A failure occurred in the servo driver.	-	Turn the power supply to the servo driver OFF and ON again. If the alarm still occurs, the servo driver may be faulty. Replace the servo driver.
A.d01 : Position Deviation Overflow Alarm at Servo ON	The servo was turned ON after the position deviation exceeded the setting of Pn526 (Position Deviation	Check the position deviation while the servo is OFF.	Set the position deviation to be cleared while the servo is OFF. Optimize the setting of Pn526 (Position Deviation

	Overflow Alarm Level at Servo ON) while the servo was OFF.		Overflow Alarm Level at Servo ON).
A.d02 : Position Deviation Overflow Alarm for Speed Limit at Servo ON	When the servo is turned on in the position deviation accumulation state, the speed limit is implemented by the speed limit value (Pn529) when the servo is turned on. In this state, the "position command" is input and exceeds the set value of the excessive position deviation error alarm value (Pn520).	-	Set the correct excessive position deviation error alarm value (Pn520). Or set the speed limit value (Pn529) when the servo is on to the correct value.
A.d10 : Motor-Load Position Deviation Overflow	The motor direction and external encoder installation orientation are backward.	Check the motor direction and the external encoder installation orientation.	Install the external encoder in the opposite direction, or change the setting of Pn002 = n.X (External Encoder Usage) to reverse the direction.
	There is an error in the connection between the load (e.g., stage) and external encoder coupling.	Check the coupling of the external encoder.	Check the mechanical coupling.
FA.d30 Position Data Overflow	The position data exceeded ±1,879,048,192.	Check the input reference pulse counter.	Reconsider the operating specifications.
A.F10 : Power Supply Line Open Phase (The voltage was low for more than one second for phase R, S, or T when the main power supply was ON.)	A single-phase power supply was input without specifying a single-phase AC power supply input (Pn00B = n. 1).	Check the power supply and the parameter setting.	Set the correct power input and parameters. (Pn00B=n.1)
	The three-phase power supply wiring is not correct.	Check the power supply wiring.	Make sure that the power supply is correctly wired.
	The three-phase power supply is unbalanced.	Measure the voltage for each phase of the three-phase power supply.	Balance the power supply by changing phases.
	A failure occurred in the servo driver.	-	Turn the power supply to the servo driver OFF and ON again. If the alarm still occurs, the servo driver may be faulty. Replace the servo driver.
	Poor wiring or bad connections in the motor wiring	Confirm the wiring.	Check if there is any problem with the motor wiring.

*1. Detection Conditions

Rotary Servomotor

If either of the following conditions is detected, an alarm will occur.

- Pn533[min^{-1}(RPM)]$\times \frac{Encoder\ resolution}{6\times10^5} \leq \frac{Pn20E}{Pn210}$
- Maximum motor speed [min^{-1}(RPM)]$\times \frac{\text{Encoder resolution}}{\text{Approx.}3.66\times10^{12}} \leq \frac{Pn20E}{Pn210}$

*2. Detection Conditions

- Rotary Servomotor

If either of the following conditions is detected, an alarm will occur.

- Rated motor speed [min^{-1}(RPM)]$\times \frac{1}{3}\times \frac{\text{Encoder resolution}}{6\times10^5} \leq \frac{Pn20E}{Pn210}$
- Maximum motor speed [min^{-1}(RPM)]$\times \frac{\text{Encoder resolution}}{\text{Approx.}3.66\times10^{12}} \geq \frac{Pn20E}{Pn210}$

9.2.3 Resetting Alarms

If there is an ALM (Servo Alarm) signal, use one of the following methods to reset the alarm after eliminating the cause of the alarm.

The /ALM-RST (Alarm Reset) signal will not always reset encoder-related alarms. If you cannot reset an alarm with the /ALM-RST signal, turn OFF the control power supply to reset it.



Be sure to eliminate the cause of an alarm before you reset the alarm.
If you reset the alarm and continue operation without eliminating the cause of the alarm, it may result in damage to the equipment or fire.

- Reset based on false alarm, warning clear (ALM_CLR) signal
- Based on the panel operation buttons, press the S button to reset

9.2.4 Displaying the Alarm History

The alarm history displays up to the last ten alarms that have occurred in the servo driver.

9.2.5 Clearing the Alarm History

You can clear the alarm history that is recorded in the servo driver.

The alarm history is not cleared when alarms are reset or when the servo driver main circuit power is turned OFF.

You must perform the following procedure.

Tool	Distribute
Panel Operator	Fn006
ProTuner	[Alarm display]--- [Alarm History]--- [Clear]

9.3 Warning Displays

If a warning occurs in the servo driver, a warning number will be displayed on the panel display.

Warnings are displayed to warn you before an alarm occurs.

This section provides a list of warnings and the causes of and corrections for warnings.

9.3.1 List of Warnings

The list of warnings gives the warning name, warning meaning.

Warning Number	Warning Name	Meaning	Alarm Reset Possible
A.900	Position Deviation Overflow	The position deviation exceeded the percentage set with the following formula: (Pn520 × Pn51E/100)	YES
A.901	Position Deviation Overflow Alarm at Servo ON	The position deviation when the servo was turned ON exceeded the percentage set with the following formula: (Pn526 × Pn528/100)	YES
A.910	Overload	This warning occurs before an overload alarm (A.710 or A.720) occurs. If the warning is ignored and operation is continued, an alarm may occur.	YES
A.911	Vibration	Abnormal vibration was detected during motor operation. The detection level is the same as A.520. Set whether to output an alarm or a warning by setting Pn310 (Vibration Detection Selection).	YES
A.920	Regenerative Overload	This warning occurs before an A.320 alarm (Regenerative Overload) occurs. If the warning is ignored and operation is continued, an alarm may occur.	YES
A.921	Dynamic Brake Overload	This warning occurs before an A.731 alarm (Dynamic Brake Overload) occurs. If the warning is	YES

		ignored and operation is continued, an alarm may occur.	
A.930	Absolute Encoder Battery Error	This warning occurs when the voltage of absolute encoder’ s battery is low.	YES
A.941	Change of Parameters Requires Restart	Parameters have been changed that require the power supply to be turned OFF and ON again.	YES
A.94A	Data setting warning 1 (parameter number)	The parameter number of the data setting warning 1 (parameter number) command is incorrect.	automatic reset*
A.94B	Data setting warning 2 (out of data range)	A value outside the range is set in the command data.	automatic reset*
A.94C	Data setting warning 3 (calculation error)	A calculation error was detected.	automatic reset*
A.94D	Data setting warning 4 (parameter size)	A data size discrepancy was detected.	automatic reset*
A.94E	Data setting warning 5 (capture exception)	A capture mode exception was detected.	YES
A.95A	Command warning 1 (outside command conditions)	The instruction was given when the conditions for the instruction were insufficient.	automatic reset*
A.95B	Command warning 2 (unsupported command)	Unsupported command entered.	automatic reset*
A.95D	Command warning 4 (command interference)	Interference of instructions (mainly refers to interference of capture instructions).	automatic reset*
A.95E	Command warning 5 (subcommands cannot be used)	The subcommand conflicts with the main command.	automatic reset*
Warning Number	Warning Name	Meaning	Alarm Reset Possible
A.95F	Command warning 6 (undefined command)	Undefined command entered.	automatic reset*
A.971	Undervoltage	This warning occurs before an A.410 alarm (Undervoltage) occurs. If the warning is ignored and operation is continued, an alarm may occur.	YES
A.97A	Command warning 7 (layer exception)	An instruction that cannot be executed is specified in the current layer.	automatic reset*
A.97b	Out-of-data range data clamp element	Fixed by setting the minimum value and maximum value outside the range of the command data.	automatic reset*
A.9A0	Overtravel	Overtravel was detected while the servo was ON.	YES

NOTE:1. A warning code is not output unless you set Pn001 to n.1 (Output both alarm codes and warning codes).

2.Use Pn008 = n. X (Warning Detection Selection) to control warning detection.

However, the following warnings are not affected by the setting of Pn008 = n. X and other parameter settings are required in addition to Pn008 = n. X .

Warning	Parameters That Must Be Set to Select Warning Detection
A.911	Pn310 = n. X (Vibration Detection Selection)
A.923	- (Not affected by the setting of Pn008 = n. X .)
A.930	Pn008 = n. X (Low Battery Voltage Alarm/Warning Selection)
A.942	Pn423=n. X (Speed Ripple Compensation Information Disagreement Warning Detection Selection)
A.94A ~ A.960 A.97A ~ A.97b	Pn800=n. X (Warning Check Mask)
A.971	Pn008 = n. X (Function Selection for Undervoltage) (Not affected by the setting of Pn008 = n. X .)
A.9A0	Pn00D = n.X (Overtravel Warning Detection Selection) (Not affected by the setting of Pn008 = n. X .)
A.9b0	Pn00F = n. X (Preventative Maintenance Warning Selection)

9.3.2 Troubleshooting Warnings

The causes of and corrections for the warnings are given in the following table.
Contact your Fatek representative if you cannot solve a problem with the correction given in the table.

Warning Number: Warning Name	Possible Cause	Confirmation	Correction
A.900 : Position Deviation Overflow	The Servomotor U, V, and W wiring is not correct.	Check the wiring of the Servomotor’ s Main Circuit Cables.	Make sure that there are no faulty connections in the wiring for the Servomotor and encoder.
	A servo driver gain is too low.	Check the servo driver gains.	Increase the servo gain, e.g., by using autotuning without a host reference.
	The acceleration of the position reference is too high.	Reduce the reference acceleration and try operating the servo driver.	Reduce the "position command" acceleration. Or, select the "Position Command" filter to smooth the "Position Command" acceleration.
	The excessive position deviation alarm level (Pn520) is too low for the operating conditions.	Check excessive position deviation alarm level (Pn520) to see if it is set to an appropriate value.	Optimize the settings of Pn520
	A failure occurred in the servo driver.	-	Turn the power supply to the servo driver OFF and ON again. If the alarm still occurs, the servo driver may be faulty. Replace the servo driver.
A.901 : Position Deviation Overflow Alarm at Servo ON	The position deviation when the servo was turned ON exceeded the percentage set with the following formula: (Pn526 × Pn528/ 100)	-	Optimize the setting of Pn528 (Position Deviation Overflow Warning Level at Servo ON).
A.910 : Overload (warning before an A.710 or A.720 alarm occurs	The wiring is not correct or there is a faulty connection in the motor or encoder wiring.	Check the wiring.	Make sure that the Servomotor and encoder are correctly wired.
	Operation was performed that exceeded the overload protection characteristics	Check the motor overload characteristics and Run command.	Reconsider the load and operating conditions. Or, increase the motor capacity.
	An excessive load was applied during operation because the Servomotor was not driven because of mechanical problems.	Check the operation reference and motor speed.	Remove the mechanical problem.
	The overload warning level (Pn52B) is not suitable.	Check that the overload warning level (Pn52B) is suitable.	Set a suitable overload warning level (Pn52B).
	A failure occurred in the servo driver.	-	The servo driver may be faulty. Replace the servo driver.
A.911 : Vibration	Abnormal vibration was detected during motor operation.	Check for abnormal motor noise, and check the speed and torque waveforms during operation.	Reduce the motor speed. Or, reduce the servo gain with custom tuning.
	The setting of Pn103 (Moment of Inertia Ratio) is greater than the actual moment of inertia or was greatly changed.	Check the moment of inertia ratio or mass ratio.	Set Pn103 (Moment of Inertia Ratio) to an appropriate value.
	The vibration detection level (Pn312 or Pn384) is not suitable.	Check that the vibration detection level (Pn312 or Pn384) is suitable.	Set a suitable vibration detection level (Pn312 or Pn384).
A.920 : Regenerative Overload (warning before	The power supply voltage exceeded the specified range.	Measure the power supply voltage.	Set the power supply voltage within the specified range.

an A.320 alarm occurs)	There is insufficient external regenerative resistance, regenerative resistor capacity, or servo driver capacity, or there has been a continuous regeneration state.	Check the operating conditions.	Change the regenerative resistance value, regenerative resistance capacity .
	There was a continuous regeneration state because a negative load was continuously applied.	Check the load applied to the Servomotor during operation.	Reconsider the system including the servo, machine, and operating conditions.
A.921 : Dynamic Brake Overload (warning before an A.731 alarm occurs)	The Servomotor was rotated by an external force.	Check the operation status.	Implement measures to ensure that the motor will not be rotated by an external force.
	When the Servomotor was stopped with the dynamic brake, the rotational or linear kinetic energy exceeded the capacity of the dynamic brake resistor.	Check the power consumed by the DB resistor to see how frequently the DB is being used.	Reconsider the following: • Reduce the Servomotor command speed. • Decrease the moment of inertia or mass. • Reduce the frequency of stopping with the dynamic brake.
	A failure occurred in the servo driver.	-	The servo driver may be faulty. Replace the servo driver.
A.930 : Absolute Encoder Battery Error (The absolute encoder battery voltage was lower than the specified level.) (Detected only when an absolute encoder is connected.)	The battery connection is faulty or a battery is not connected.	Check the battery connection.	Correct the battery connection.
	The battery voltage is lower than the specified value (2.7 V).	Measure the battery voltage.	Replace the battery.
	A failure occurred in the servo driver.	-	The servo driver may be faulty. Replace the servo driver.
A.971 : Undervoltage	Servo drive AC power supply voltage is too low.	Measure the power supply voltage.	Adjust the power supply voltage to the normal range.
	The power supply voltage dropped during operation.	Measure the power supply voltage.	Increase the power supply capacity.
	A momentary power interruption occurred.	Measure the power supply voltage.	If you have changed the setting of Pn509 (Momentary Power Interruption Hold Time), decrease the setting.
	The servo driver fuse is blown out.	-	Replace the servo driver and connect a reactor
	A failure occurred in the servo driver.	-	The servo driver may be faulty. Replace the servo driver.
A.97A : Instruction Warning 7	An unexecutable instruction was received in the current layer	-	Send the command after the sending conditions are met.
A.97b : Out of data range.	A value outside the range is set in the command data.		Set a value within the setting range in the command data.
A.9A0 : Overtravel (Overtravel status was detected.)	Overtravel was detected while the servo was ON.	Check the status of the overtravel signals on the input signal monitor.	Even if an overtravel signal is not shown by the input signal monitor, momentary overtravel may have been detected. Take the following precautions. • Do not specify movements that would cause overtravel from the host

			controller. • Check the wiring of the overtravel signals. • Implement countermeasures against noise.

9.4 Monitoring of communication data when error alarms and warnings

The command data when an error alarm or warning (for example: data setting warning (A.94□), command warning (A.95□)) occurs can be monitored through the following parameters. The following is the data when an error alarm or warning occurs under normal conditions.

CMD data when error alarm or warning occurs: Pn890 ~ Pn8A6

RSP data when error alarm or warning occurs: Pn8A8 ~ Pn8BE

Command byte order	The location where the command data is saved when an error alarm or warning occurs	
	CMD	RSP
0	Pn890 = n.□□□□□□XX	Pn8A8 = n.□□□□□□XX
1	Pn890 = n.□□□□XX□□	Pn8A8 = n.□□□□XX□□
2	Pn890 = n.□□XX□□□□	Pn8A8 = n.□□XX□□□□
3	Pn890 = n.XX□□□□□□	Pn8A8 = n.XX□□□□□□
4 ~ 7	Pn892	Pn8AA
8 ~ 11	Pn894	Pn8AC
12 ~ 15	Pn896	Pn8AE
16 ~ 19	Pn898	Pn8B0
20 ~ 23	Pn89A	Pn8B2
24 ~ 27	Pn89C	Pn8B4
28 ~ 31	Pn89E	Pn8B6
32 ~ 35	Pn8A0	Pn8B8
36 ~ 39	Pn8A2	Pn8BA
40 ~ 43	Pn8A4	Pn8BC
44 ~ 47	Pn8A6	Pn8BE

NOTE: The data is arranged in little endian storage order and expressed in hexadecimal.

9.5 Troubleshooting Based on the Operation and Conditions of the Servomotor

This section provides troubleshooting based on the operation and conditions of the Servomotor, including causes and corrections.

When checking and handling the items in the thick line box in the table below, be sure to cut off the power supply of the servo system.

Problem	Possible Cause	Confirmation	Correction
Servomotor Does Not Start	The control power supply is not turned ON.	Measure the voltage between control power supply terminals.	Turn OFF the power supply to the servo system. Correct the wiring so that the control power supply is turned ON.
	The main circuit power supply is not turned ON.	Measure the voltage between the main circuit power input terminals.	Turn OFF the power supply to the servo system. Correct the wiring so that the main circuit power supply is turned ON.
	The I/O signal connector (CN1) pins are not wired correctly or are disconnected.	Turn OFF the power supply to the servo system. Check the wiring condition of the I/O signal connector (CN1) pins.	Correct the wiring of the I/O signal connector (CN1) pins.
	The wiring for the Servomotor Main Circuit Cables or Encoder Cable is disconnected.	Check the wiring conditions.	Turn OFF the power supply to the servo system. Wire the cable correctly.
	There is an overload on the Servomotor.	Operate the Servomotor with no load and check the load status.	Turn OFF the power supply to the servo system. Reduce the load or replace the Servo Motor with a Servo Motor with a larger capacity.
	The type of encoder that is being used does not agree with the setting of Pn002 = n. X (Encoder Usage).	Check the type of the encoder that is being used and the setting of Pn002 = n. X .	Set Pn002 = n. X according to the type of the encoder that is being used.

	There is a mistake in the input signal allocations (Pn50A, Pn50B, Pn511, Pn516).	Confirm the setting values of input signals (Pn50A, Pn50B, Pn511, Pn516).	Correctly allocate input signals (Pn50A, Pn50B, Pn511, Pn516).
	No servo ON(SV-ON) command	Confirm the instructions from the host device.	Input the servo ON (SV_ON) command from the host device.
	There is no sensor ON (SENS_ON) command	Confirm the instructions from the host device.	Send instructions to the servo drive in the correct sequence.
	The P-OT (Forward Drive Prohibit) or N-OT (Reverse Drive Prohibit) signal is still OFF.	Check the P-OT and NOT signals.	Turn ON the P-OT and N-OT signals.
	The FSTP (Forced Stop Input) signal is still OFF.	Check the FSTP signal.	• Turn ON the FSTP signal. • If you will not use the function to force the motor to stop, set Pn516 = n. X (FSTP (Forced Stop Input) Signal Allocation) to disable the signal.
	A failure occurred in the servo driver.	-	The servo driver may be faulty. Replace the servo driver.
The servo motor runs momentarily and then stops.	Servo motor wiring error	Confirm the wiring.	Correct wiring.
	Wiring error of encoder or serial conversion unit	Confirm the wiring.	Correct wiring.
Servo motor operation is unstable	There is a faulty connection in the Servomotor wiring.	The connector connections for the power line (U, V, and W phases) and the encoder or Serial Converter Unit may be unstable. Turn OFF the power supply to the servo system. Check the wiring.	Tighten any loose terminals or connectors and correct the wiring.
Problem	Possible Cause	Confirmation	Correction
Servomotor Moves without a Reference Input	A failure occurred in the servo driver.	Check that the directions match.	Replace servo drive.
Dynamic Brake Does Not Operate	The setting of Pn001 = n. X (Motor Stopping Method for Servo OFF and Group 1 Alarms) is not suitable.	Check the setting of Pn001 = n. X.	Set Pn001 = n. X correctly.
	The dynamic brake resistor is disconnected.	Check the moment of inertia, motor speed, and dynamic brake frequency of use. If the moment of inertia, motor speed, or dynamic brake frequency of use is excessive, the dynamic brake resistance may be disconnected.	Turn OFF the power supply to the servo system. Replace the servo driver. To prevent disconnection, reduce the load.
	There was a failure in the dynamic brake drive circuit.	-	There is a defective component in the dynamic brake circuit. Turn OFF the power supply to the servo system. Replace the servo driver.
Abnormal Noise from Servomotor	The Servomotor vibrated considerably while performing the tuning -less function with the default settings.	Check the waveform of the motor speed.	Reduce the load so that the moment of inertia ratio or mass ratio is within the allowable value, or increase the load level or reduce the rigidity level in the tuning-less level settings.
	The machine mounting is not secure.	Turn OFF the power supply to the servo system. Check to see if there are any loose mounting screws.	Tighten the mounting screws.
	The machine mounting is not secure.	Check whether the coupling is eccentric.	Align the core of the coupling.
	The bearings are defective.	Turn OFF the power supply to the servo system. Check for noise and vibration around the bearings.	Replace the Servomotor.
	There is a vibration source at the driven machine.	Turn OFF the power supply to the servo system. Check for any foreign matter, damage, or deformation in the machine' s moving parts.	Consult with the machine manufacturer.
	Noise interference occurred because of incorrect I/O signal cable specifications.	Turn OFF the power supply to the servo system. Check the I/O signal cables to see if they satisfy	Use cables that satisfy the specifications.

		specifications. Use shielded twisted-pair cables or screened twisted-pair cables with conductors of at least 0.12 mm2 (stranded wire).	
	Noise interference occurred because an I/O signal cable is too long.	Turn OFF the power supply to the servo system. Check the lengths of the I/O signal cables.	The I/O signal cables must be no longer than 3 m.
	Noise interference occurred because of incorrect Encoder Cable specifications.	Turn OFF the power supply to the servo system. Check the Encoder Cable to see if it satisfies specifications. Use shielded twisted-pair cables or screened twisted-pair cables with conductors of at least 0.12 mm2 (stranded wire).	Use cables that satisfy the specifications.
	Noise interference occurred because the Encoder Cable is too long.	Turn OFF the power supply to the servo system. Check the length of the Encoder Cable.	Rotary Servomotors: The Encoder Cable length must be 50 m max.
	Noise interference occurred because the Encoder Cable is damaged.	Turn OFF the power supply to the servo system. Check the Encoder Cable to see if it is pinched or the sheath is damaged.	Replace the Encoder Cable and correct the cable installation environment.
	The Encoder Cable was subjected to excessive noise interference.	Turn OFF the power supply to the servo system. Check to see if the Encoder Cable is bundled with a high-current line or installed near a high-current line.	Correct the cable layout so that no surge is applied by high-current lines.
	There is variation in the FG potential because of the influence of machines on the Servomotor side, such as a welder.	Turn OFF the power supply to the servo system. Check to see if the machines are correctly grounded.	Properly ground the machines to separate them from the FG of the encoder.
	There is a servo driver pulse counting error due to noise.	Check to see if there is noise interference on the signal line from the encoder.	Turn OFF the power supply to the servo system. Implement countermeasures against noise for the encoder wiring.
	The encoder was subjected to excessive vibration or shock.	Turn OFF the power supply to the servo system. Check to see if vibration from the machine occurred. Check the Servomotor installation (mounting surface precision, securing state, and alignment). Check the linear encoder installation (mounting surface precision and securing method).	Reduce machine vibration. Improve the mounting state of the Servomotor or linear encoder.
	A failure occurred in the encoder.	-	Turn OFF the power supply to the servo system. Replace the Servomotor.
	A failure occurred in the Serial Converter Unit.	-	Turn OFF the power supply to the servo system. Replace the Serial Converter Unit.
Servomotor Vibrates at Frequency of Approx. 200 to 400 Hz.	The servo gains are not balanced.	Check to see if the servo gains have been correctly tuned.	Perform autotuning without a host reference.
	The setting of Pn100 (Speed Loop Gain) is too high.	Check the setting of Pn100. The default setting is Kv = 40.0 Hz.	Set Pn100 to an appropriate value.

	The setting of Pn102 (Position Loop Gain) is too high.	Check the setting of Pn102. The default setting is Kp = 40.0/s.	Set Pn102 to an appropriate value.
	The setting of Pn101 (Speed Loop Integral Time Constant) is not appropriate.	Check the setting of Pn101. The default setting is Ti = 20.0 ms.	Set Pn101 to an appropriate value.
	The setting of Pn103 (Moment of Inertia Ratio or Mass Ratio) is not appropriate.	Check the setting of Pn103.	Set Pn103 to an appropriate value.
Large Motor Speed Overshoot on Starting and Stopping	The servo gains are not balanced.	Check to see if the servo gains have been correctly tuned.	Perform autotuning without a host reference.
	The setting of Pn100 (Speed Loop Gain) is too high.	Check the setting of Pn100. The default setting is Kv = 40.0 Hz.	Set Pn100 to an appropriate value.
	The setting of Pn102 (Position Loop Gain) is too high.	Check the setting of Pn102. The default setting is Kp = 40.0/s.	Set Pn102 to an appropriate value.
	The setting of Pn101 (Speed Loop Integral Time Constant) is not appropriate.	Check the setting of Pn101. The default setting is Ti = 20.0 ms.	Set Pn101 to an appropriate value.
	The setting of Pn103 (Moment of Inertia Ratio or Mass Ratio) is not appropriate.	Check the setting of Pn103.	Set Pn103 to an appropriate value.
	The torque reference is saturated.	Check the waveform of the torque reference.	Use the mode switch.
	The force limits (Pn483 and Pn484) are set to the default values.	The default values of the force limits are Pn483 = 30% and Pn484 = 30%.	Set Pn483 and Pn484 to appropriate values.

Problem	Possible Cause	Confirmation	Correction
Absolute Encoder Position Deviation Error (The position that was saved in the host controller when the power was turned OFF is different from the position when the power was next turned ON.)	Noise interference occurred because of incorrect Encoder Cable specifications.	Turn OFF the power supply to the servo system. Check the Encoder Cable to see if it satisfies specifications. Use shielded twisted-pair cables or screened twisted-pair cables with conductors of at least 0.12 mm2 (stranded wire).	Use cables that satisfy the specifications.
	Noise interference occurred because the Encoder Cable is too long.	Turn OFF the power supply to the servo system. Check the length of the Encoder Cable.	Rotary Servomotors: The Encoder Cable length must be 50 m max.
	Noise interference occurred because the Encoder Cable is damaged.	Turn OFF the power supply to the servo system. Check the Encoder Cable to see if it is pinched or the sheath is damaged.	Replace the Encoder Cable and correct the cable installation environment.
	The Encoder Cable was subject to excessive noise interference.	Turn OFF the power supply to the servo system. Check to see if the Encoder Cable is bundled with a high-current line or installed near a high-current line.	Correct the cable layout so that no surge is applied by high-current lines.
	There is variation in the FG potential because of the influence of machines on the Servomotor side, such as a welder.	Turn OFF the power supply to the servo system. Check to see if the machines are correctly grounded.	Properly ground the machines to separate them from the FG of the encoder.
	There is a servo driver pulse counting error due to noise.	Turn OFF the power supply to the servo system. Check to see if there is noise interference on the I/O signal line from the encoder or Serial Converter Unit.	Implement countermeasures against noise for the encoder or Serial Converter Unit wiring.

	The encoder was subjected to excessive vibration or shock.	Turn OFF the power supply to the servo system. Check to see if vibration from the machine occurred. Check the Servomotor installation (mounting surface precision, securing state, and alignment). Check the linear encoder installation (mounting surface precision and securing method).	Reduce machine vibration. Improve the mounting state of the Servomotor or linear encoder.
	A failure occurred in the encoder.	-	Turn OFF the power supply to the servo system. Replace the Servomotor or linear encoder.
	A failure occurred in the servo driver.	-	The servo driver may be faulty. Replace the servo driver.
	Host Controller Multiturn Data or Absolute Encoder Position Data Reading Error	Check the error detection section of the host controller.	Correct the error detection section of the host controller.
		Check to see if the host controller is executing data parity checks.	Perform parity checks for the multiturn data or absolute encoder position data.
		Check for noise interference in the cable between the servo driver and the host controller.	Implement countermeasures against noise and then perform parity checks again for the multiturn data or absolute encoder position data.
Overtravel Occurred (OT)	The P-OT/N-OT (Forward Drive Prohibit or Reverse Drive Prohibit) signal was input.	Check the external power supply (+24 V) voltage for the input signals.	Correct the external power supply (+24 V) voltage for the input signals.
		Check the operating condition of the overtravel limit switches.	Make sure that the overtravel limit switches operate correctly.
		Check the wiring of the overtravel limit switches.	Correct the wiring of the overtravel limit switches.
		Check the settings of the overtravel input signal allocations (Pn50A/Pn50B).	Set the parameters to correct values.
	The P-OT/N-OT (Forward Drive Prohibit or Reverse Drive Prohibit) signal malfunctioned.	Check for fluctuation in the external power supply (+24 V) voltage for the input signals.	Eliminate fluctuation from the external power supply (+24 V) voltage for the input signals.
		Check to see if the operation of the overtravel limit switches is unstable.	Stabilize the operating condition of the overtravel limit switches.
		Check the wiring of the overtravel limit switches (e.g., check for cable damage and loose screws).	Correct the wiring of the overtravel limit switches.
	There is a mistake in the allocation of the P-OT or N-OT (Forward Drive Prohibit or Reverse Drive Prohibit) signal in Pn50A = n.X or Pn50B = n. X.	Check to see if the P-OT signal is allocated in Pn50A = n.X .	If another signal is allocated in Pn50A =n.X , allocate the P-OT signal instead.
		Check to see if the N-OT signal is allocated in Pn50B = n. X.	If another signal is allocated in Pn50B =n. X, allocate the N-OT signal instead.
	The selection of the Servomotor stopping method is not correct.	Check the servo OFF stopping method set in Pn001 = n. X or Pn001 = n. X .	Select a Servomotor stopping method other than coasting to a stop.
		Check the torque control stopping method set in Pn001 = n. X orPn001 = n. X .	Select a Servomotor stopping method other than coasting to a stop.

Improper Stop Position for Overtravel (OT) Signal	The limit switch position and dog length are not appropriate.	-	Install the limit switch at the appropriate position.
	The overtravel limit switch position is too close for the coasting distance.	-	Install the overtravel limit switch at the appropriate position.

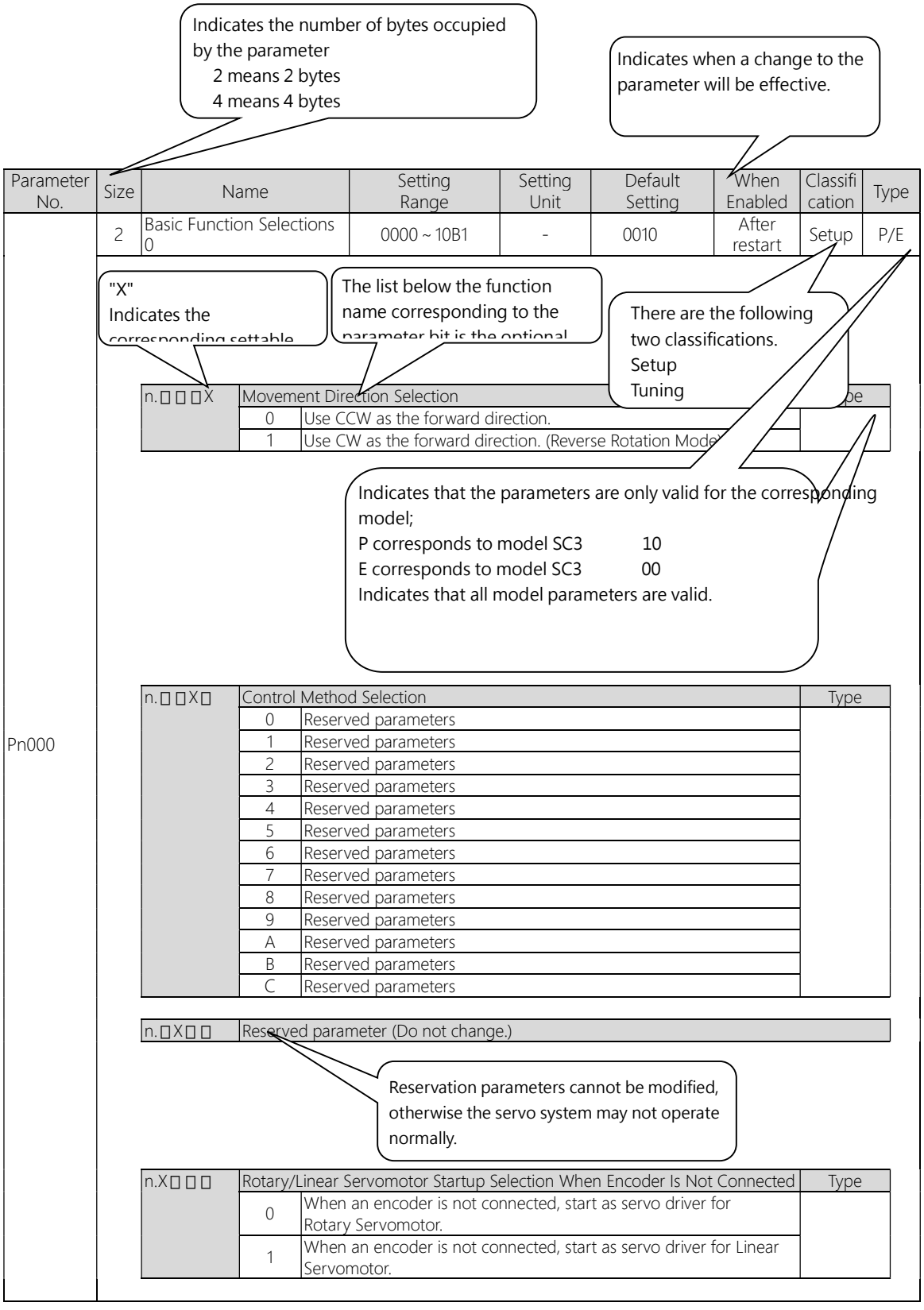
Problem	Possible Cause	Confirmation	Correction
Position Deviation (without Alarm)	Noise interference occurred because of incorrect Encoder Cable specifications.	Check the Encoder Cable to see if it satisfies specifications. Use shielded twisted-pair cables or screened twisted-pair cables with conductors of at least 0.12 mm2 (stranded wire).	Use cables that satisfy the specifications.
	Noise interference occurred because the Encoder Cable is too long.	Turn OFF the power supply to the servo system. Check the length of the Encoder Cable.	Rotary Servomotors: The Encoder Cable length must be 50 m max.
	Noise interference occurred because the Encoder Cable is damaged.	Turn OFF the power supply to the servo system. Check the Encoder Cable to see if it is pinched or the sheath is damaged.	Replace the Encoder Cable and correct the cable installation environment.
	The Encoder Cable was subjected to excessive noise interference.	Turn OFF the power supply to the servo system. Check to see if the Encoder Cable is bundled with a high-current line or installed near a high-current line.	Correct the cable layout so that no surge is applied by high-current lines.
	There is variation in the FG potential because of the influence of machines on the Servomotor side, such as a welder.	Turn OFF the power supply to the servo system. Check to see if the machines are correctly grounded.	Properly ground the machines to separate them from the FG of the encoder.
	There is a servo driver pulse counting error due to noise.	Turn OFF the power supply to the servo system. Check to see if there is noise interference on the I/O signal line from the encoder or Serial Converter Unit.	Implement countermeasures against noise for the encoder wiring or Serial Converter Unit wiring.
	The encoder was subjected to excessive vibration or shock.	Turn OFF the power supply to the servo system. Check to see if vibration from the machine occurred. Check the Servomotor installation (mounting surface precision, securing state, and alignment). Check the linear encoder installation (mounting surface precision and securing method).	Reduce machine vibration. Improve the mounting state of the Servomotor or linear encoder.
	The coupling between the machine and Servomotor is not suitable.	Turn OFF the power supply to the servo system. Check to see if position offset occurs at the coupling between machine and Servomotor.	Correctly secure the coupling between the machine and Servomotor.
	Noise interference occurred because of incorrect I/O signal cable specifications.	Turn OFF the power supply to the servo system. Check the I/O signal cables to see if they satisfy specifications. Use shielded twisted-pair cables or screened	Use cables that satisfy the specifications.

		twisted-pair cables with conductors of at least 0.12 mm2 (stranded wire).	
	Noise interference occurred because an I/O signal cable is too long.	Turn OFF the power supply to the servo system. Check the lengths of the I/O signal cables.	The I/O signal cables must be no longer than 3 m.
	An encoder fault occurred. (The pulse count does not change.)	-	Turn OFF the power supply to the servo system. Replace the Servomotor or linear encoder.
	A failure occurred in the servo driver.	-	The servo driver may be faulty. Replace the servo driver.
Servomotor Overheated	The surrounding air temperature is too high.	Measure the surrounding air temperature around the Servomotor.	Reduce the surrounding air temperature to 40°C or less.
	The surface of the Servomotor is dirty.	Turn OFF the power supply to the servo system. Visually check the surface for dirt.	Clean dirt, dust, and oil from the surface.
	There is an overload on the Servomotor.	Check the load status with a monitor.	If the Servomotor is overloaded, reduce the load or replace the Servo Drive with a servo driver and Servomotor with larger capacities.

Chapter10. Parameter Lists

10.1 List of Parameters

10.1.1 Interpreting the Parameter Lists



Parameter No.	Size	Name	Setting Range	Setting Unit	Default Setting	When Enabled	Classification	Type
Pn000	2	Basic Function Selections 0	0000 ~ 10B1	-	0010	After restart	Setup	P/E

n.□□□X	Movement Direction Selection		pe
	0	Use CCW as the forward direction.	
	1	Use CW as the forward direction. (Reverse Rotation Mode)	

n.□□X□	Control Method Selection		Type
	0	Reserved parameters	
	1	Reserved parameters	
	2	Reserved parameters	
	3	Reserved parameters	
	4	Reserved parameters	
	5	Reserved parameters	
	6	Reserved parameters	
	7	Reserved parameters	
	8	Reserved parameters	
	9	Reserved parameters	
	A	Reserved parameters	
	B	Reserved parameters	
	C	Reserved parameters	

n.□X□□	Reserved parameter (Do not change.)

n.X□□□	Rotary/Linear Servomotor Startup Selection When Encoder Is Not Connected		Type
	0	When an encoder is not connected, start as servo driver for Rotary Servomotor.	
	1	When an encoder is not connected, start as servo driver for Linear Servomotor.	

10.1.2 List of Parameters

The following table lists the parameters.

NOTE: Do not change the following parameters from their default settings.

- Reserved parameters
- Parameters not given in this manual

Parameter No.	Size	Name	Setting Range	Setting Unit	Default Setting	When Enabled	Classification	Type
Pn000	2	Basic Function Selections 0	0000 ~ 10B1	-	0000	After restart	Setup	-

n.□□□X	Movement Direction Selection		Type
	0	Use CCW as the forward direction.	
	1	Use CW as the forward direction. (Reverse Rotation Mode)	

n.□□X□	Control Method Selection		Type
	0	Speed control with analog references	P
	1	Position control with pulse train references	
	2	Torque control with analog references	
	3	Internal set speed control with contact commands	
	4	Switching between internal set speed control with contact references and speed control with analog references	
	5	Switching between internal set speed control with contact references and position control with pulse train references	
	6	Switching between internal set speed control with contact references and torque control with analog references	
	7	Switching between position control with pulse train references and speed control with analog references	
	8	Switching between position control with pulse train references and torque control with analog references	
	9	Switching between torque control with analog references and speed control with analog references	
	A	Switching between speed control with analog references and speed control with zero clamping	
	B	Switching between position control with pulse train references and position control with reference pulse inhibition	
	C	Position control of program operation (point control)	
	D	Reserved parameter (Do not change.)	
	E	Reserved parameter (Do not change.)	
	F	Customized CAN control	

n.□X□□	Reserved parameter (Do not change.)

n.X□□□	Rotary/Linear Servomotor Startup Selection When Encoder Is Not Connected		Type
	0	When an encoder is not connected, start as servo driver for Rotary Servomotor.	
	1	When an encoder is not connected, start as servo driver for Linear Servomotor.	

Parameter No.	Size	Name	Setting Range	Setting Unit	Default Setting	When Enabled	Classification	Type
Pn001	2	Application Function Selections 1	0000 ~ 1142	-	0000	After restart	Setup	-

n.□□□X	Motor Stopping Method for Servo OFF and Group 1 Alarms		Type
	0	Stop the motor by applying the dynamic brake.	
	1	Stop the motor by the applying dynamic brake and then release the dynamic brake	
	2	Coast the motor to a stop without the dynamic brake.	

n.□□X□	Overtravel Stopping Method		Type
	0	Apply the dynamic brake or coast the motor to a stop (use the stopping method set in Pn001 = n. X).	
	1	Decelerate the motor to a stop using the torque set in Pn406 as the maximum torque and then servo-lock the motor.	
	2	Decelerate the motor to a stop using the torque set in Pn406 as the maximum torque and then let the motor coast.	
	3	Decelerate the motor to a stop using the deceleration time set in Pn30A and then servo-lock the motor.	
	4	Decelerate the motor to a stop using the deceleration time set in Pn30A and then let the motor coast.	

n.□X□□	Main Circuit Power Supply AC/DC Input Selection		Type
	0	Input AC power as the main circuit power supply using the L1, L2, and L3 terminals (do not use shared converter).	
	1	Input DC power between B1/⊕,⊖ as the main circuit power supply (use an external converter or universal converter).	

n.X□□□	Motor Stopping Method for Servo OFF		Type
	0	Apply the dynamic brake or coast the motor to a stop (use the stopping method set in Pn001 = n. X).	P
	1	Decelerate the motor to a stop using the torque set in Pn406 as the maximum torque(use the stopping method set in Pn001 = n. X).	
	2	Decelerate the motor to a stop using the deceleration time set in Pn30A(use the stopping method set in Pn001 = n. X).	

Parameter No.	Size	Name	Setting Range	Setting Unit	Default Setting	When Enabled	Classification	Type
Pn002	2	Application Function Selections 2	0000 ~ 4213	-	0000	After restart	Setup	P
					0011			E

n.□□□X	Speed/Position Control Option (T-REF Input Allocation)		Type
	0	Do not use T-REF.	P
	1	Use T-REF as an external torque limit input. (In EtherCAT mode, enable torque limit)	P (E)
	2	Use T-REF as a torque feedback input.	P
	3	Use T-REF as an external torque limit input when /P-CL or /N-CL is ON.	P

n.□□X□	Torque Control Option (V-REF Input Allocation)		Type
	0	Do not use V-REF.	P
	1	Use V-REF as an external speed limit input. (In EtherCAT mode, enable torque limit)	P (E)

n.□X□□	Encoder Usage		Type
	0	Use the encoder according to encoder specifications.	
	1	Use the encoder as an incremental encoder.	
	2	Use the encoder as a single-turn absolute encoder.	

n.X□□□	External Encoder Usage		Type
	0	Do not use an external encoder	
	1	The external encoder moves in the forward direction for CCW motor rotation.	
	2	Reserved setting (Do not use.)	
	3	The external encoder moves in the reverse direction for CCW motor rotation.	
	4	Reserved setting (Do not use.)	

Parameter No.	Size	Name	Setting Range	Setting Unit	Default Setting	When Enabled	Classification	Type
Pn008	2	Application Function Selections 8	0000 ~ 7121	-	4000	After restart	Setup	

n.□□□X	Low Battery Voltage Alarm/Warning Selection		Type
	0	Output alarm (A.830) for low battery voltage.	
	1	Output warning (A.930) for low battery voltage.	

n.□□X□	Function Selection for Undervoltage		Type
	0	Do not detect undervoltage.	
	1	Detect undervoltage warning and limit torque at host controller.	
	2	Detect undervoltage warning and limit torque with Pn424 and Pn425.	

n.□X□□	Warning Detection Selection		Type
	0	Detect warnings.	
	1	Do not detect warnings except for A.971.	

n.X□□□	Reserved parameter (Do not change.)

Pn009	2	Application Function Selections 9	0000 ~ 0121	-	0010	After restart	Tuning	-

n.□□X□	Current Control Mode Selection	Type
	0 Use current control mode 0.	
	1 Use current control mode 1.	
	2 Use current control mode 2.	

n.□X□□	Speed feedback filter Selection	Type
	0 Disable speed feedback average filtering.	
	1 Speed feedback 2 times average filtering	
	2 Speed feedback 4 times average filtering	
	3 Speed feedback 8 times average filtering	
	4 Speed feedback 16 times average filtering	

n.X□□□	Reserved parameter (Do not change.)	Type

Parameter No.	Size	Name	Setting Range	Setting Unit	Default Setting	When Enabled	Classification	Type
Pn00A	2	Application Function Selections A	0000 ~ 0044	-	0001	After restart	Setup	-

n.□□□X	Motor Stopping Method for Group 2 Alarms	Type
	0 Apply the dynamic brake or coast the motor to a stop (use the stopping method set in Pn001 = n. X).	-
	1 Decelerate the motor to a stop using the torque set in Pn406 as the maximum torque. Use the setting of Pn001 = n. X for the status after stopping.	
	2 Decelerate the motor to a stop using the torque set in Pn406 as the maximum torque and then let the motor coast.	
	3 Decelerate the motor to a stop using the deceleration time set in Pn30A. Use the setting of Pn001 = n. X for the status after stopping.	
	4 Decelerate the motor to a stop using the deceleration time set in Pn30A and then let the motor coast.	

n.□□X□	Stopping Method for Forced Stops	Type
	0 Apply the dynamic brake or coast the motor to a stop (use the stopping method set in Pn001 = n. X).	-
	1 Decelerate the motor to a stop using the torque set in Pn406 as the maximum torque. Use the setting of Pn001 = n. X for the status after stopping.	
	2 Decelerate the motor to a stop using the torque set in Pn406 as the maximum torque and then let the motor coast.	
	3 Decelerate the motor to a stop using the deceleration time set in Pn30A. Use the setting of Pn001 = n. X for the status after stopping.	
	4 Decelerate the motor to a stop using the deceleration time set in Pn30A and then let the motor coast.	

n.□X□□	Reserved parameter (Do not change.)

n.X□□□	Reserved parameter (Do not change.)

Pn00B	2	Application Function Selections B	0000 ~ 1121	-	0000	After restart	Setup	-

n.□□□X	Operator Parameter Display Selection	Type
	0 Display only setup parameters.	-
	1 Display all parameters.	

n.□□X□	Motor Stopping Method for Group 2 Alarms	Type
	0 Stop the motor by setting the speed reference to 0.	-
	1 Apply the dynamic brake or coast the motor to a stop (use the stopping method set in Pn001 = n. X).	
	2 Set the stopping method with Pn00A = n. X.	

n.□X□□	Power Input Selection for Three-phase servo driver	Type
	0 Use a three-phase power supply input.	-

			1	Use a three-phase power supply input as a single-phase power supply input.					
		n.X□□□	Reserved parameter (Do not change.)						
Pn00D	2	Application Function Selections D		0000 ~ 1001	-	0000	After restart	Setup	-
		n.□□□X	Reserved parameter (Do not change.)						
		n.□□X□	Reserved parameter (Do not change.)						
		n.□X□□	Reserved parameter (Do not change.)						
		n.X□□□	Overtravel Warning Detection Selection						
			0	Do not detect overtravel warnings.					
			1	Detect overtravel warnings.					
Pn00F	2	Application Function Selections F		0000 ~ 2011	-	0000	After restart	Setup	-
		n.□□□X	Preventative Maintenance Warning Selection						
			0	Do not detect preventative maintenance warnings.					
			1	Detect preventative maintenance warnings.					
		n.□□X□	Reserved parameter (Do not change.)						
		n.□X□□	Reserved parameter (Do not change.)						
		n.X□□□	Reserved parameter (Do not change.)						

Parameter No.	Size	Name	Setting Range	Setting Unit	Default Setting	When Enabled	Classification	Type
Pn010	2	Axis Address Selection (USB)	1 ~ 127	-	1	After restart	Setup	-
Pn011	2	UART/CAN Communication parameter selection switch	0000 ~ 1643	-	0401	After restart	Setup	P
		n.□□□X	Selecting UART serial communication rate					Type
			0	9600 bps				
			1	19200 bps				
			2	38400 bps				-
			3	57600 bps				
			4	115200 bps				
		n.□□X□	Selecting UART serial comminication parity check and stop bit					Type
			0	No Parity ，1 Stop Bit				
			1	Even Parity ，1 Stop Bit				-
			2	Odd Parity ，1 Stop Bit				
		n.□X□□	Reserved parameter (Do not change.)					Type
		n.X□□□	Reserved parameter (Do not change.)					Type
Pn013	2	EtherCAT station number selection (for ECAT communication)	0000～FFFF	-	0001	After restart	Setup	E

Parameter No.	Size	Name	Setting Range	Setting Unit	Default Setting	When Enabled	Classification	Type
Pn080	2	Application Function Selections 80	0000 ~ 1111	-	0000	After restart	Setup	E

n.□□□X	Polarity Sensor Selection	Type
	0 Use polarity sensor.	-
	1 Do not use polarity sensor.	

n.□□X□	Motor Phase Sequence Selection	Type
	0 Set a phase-A lead as a phase sequence of U, V, and W.	-
	1 Set a phase-B lead as a phase sequence of U, V, and W.	

n.□X□□	Reserved parameter (Do not change.)

n.X□□□	Reserved parameter (Do not change.)

Parameter No.	Size	Name	Setting Range	Setting Unit	Default Setting	When Enabled	Classification	Type
Pn100	2	Speed Loop Gain	10 ~ 20000	0.1 Hz	400	Immediately	Tuning	
Pn101	2	Speed Loop Integral Time Constant	15 ~ 51200	0.01 ms	2000	Immediately	Tuning	
Pn102	2	Position Loop Gain	10 ~ 20000	0.1/s	400	Immediately	Tuning	
Pn103	2	Moment of Inertia Ratio	0 ~ 20000	1%	100	Immediately	Tuning	
Pn104	2	Second Speed Loop Gain	10 ~ 20000	0.1 Hz	400	Immediately	Tuning	
Pn105	2	Second Speed Loop Integral Time Constant	15 ~ 51200	0.01 ms	2000	Immediately	Tuning	
Pn106	2	Second Position Loop Gain	10 ~ 20000	0.1/s	400	Immediately	Tuning	
Pn109	2	Feedforward	0 ~ 100	1%	0	Immediately	Tuning	
Pn10A	2	Feedforward Filter Time Constant	0 ~ 6400	0.01 ms	0	Immediately	Tuning	
Pn10B	2	Gain Application Selections	0000 ~ 5334	-	0000	-	Setup	-

n.□□□X	Mode Switching Selection	When Enabled	Type
	0 Use the internal torque reference as the condition(level setting: Pn10C).	Immediately	-
	1 Use the speed reference as the condition (level setting:Pn10D).		
	1 Use the speed reference as the condition (level setting:Pn181).		
	2 Use the acceleration reference as the condition (level setting: Pn10E).		
	2 Use the acceleration reference as the condition (level setting: Pn182).		
	3 Use the position deviation as the condition (level setting: Pn10F).		
	4 Do not use mode switching.		

n.□□X□	Speed Loop Control Method	When Enabled	Type
	0 PI Control	After restart	-
	1 I-P Control		
	2 ~ 3 Reserved settings (Do not use.)		

n.□X□□	Reserved Parameter (Do not change.)

n.X□□□	Speed observer switch Selection	When Enabled	Type
	0 Speed observer off	Immediately	-
	1 Speed observer on		

Parameter No.	Size	Name	Setting Range	Setting Unit	Default Setting	When Enabled	Classification	Type
Pn10C	2	Mode Switching Level for Torque Reference	0 ~ 800	1%	200	Immediately	Tuning	
Pn10D	2	Mode Switching Level for Speed Reference	0 ~ 10000	1 min^{-1} (RPM)	0	Immediately	Tuning	
Pn10E	2	Mode Switching Level for Acceleration	0 ~ 30000	1min^{-1} (RPM)/S	0	Immediately	Tuning	

Pn10F	2	Mode Switching Level for Position Deviation	0 ~ 10000	1 reference unit	0	Immediately	Tuning	
Pn11F	2	Position Integral Time Constant	0 ~ 50000	0.1 ms	0	Immediately	Tuning	
Pn121	2	Friction Compensation Gain	10 ~ 1000	1%	100	Immediately	Tuning	
Pn122	2	Second Friction Compensation Gain	10 ~ 1000	1%	100	Immediately	Tuning	
Pn123	2	Friction Compensation Coefficient	0 ~ 100	1%	0	Immediately	Tuning	
Pn124	2	Friction Compensation Frequency Correction	-10000 ~ 10000	0.1 Hz	0	Immediately	Tuning	
Pn125	2	Friction Compensation Gain Correction	1 ~ 1000	1%	100	Immediately	Tuning	
Pn131	2	Gain Switching Time 1	0 ~ 65535	1 ms	0	Immediately	Tuning	
Pn132	2	Gain Switching Time 2	0 ~ 65535	1 ms	0	Immediately	Tuning	
Pn135	2	Gain Switching Waiting Time 1	0 ~ 65535	1 ms	0	Immediately	Tuning	
Pn136	2	Gain Switching Waiting Time 2	0 ~ 65535	1 ms	0	Immediately	Tuning	
Pn139	2	Automatic Gain Switching Selections 1	0000 ~ 0052	-	0000	Immediately	Tuning	

n.□□□X	Gain Switching Selection
0	Use manual gain switching. The gain is switched manually with the /G-SEL (Gain Selection) signal.
1	Reserved setting (Do not use.)
2	Use automatic gain switching pattern 1. The gain settings 1 switch automatically to 2 when switching condition A is satisfied. The gain settings 2 switch automatically to 1 when switching condition A is not satisfied.

n.□□X□	Gain Switching Condition A
0	/COIN (Positioning Completion Output) signal turns ON.
1	/COIN (Positioning Completion Output) signal turns OFF.
2	/NEAR (Near Output) signal turns ON.
3	/NEAR (Near Output) signal turns OFF.
4	Position reference filter output is 0 and reference pulse input is OFF.
5	Position reference pulse input is ON.

n.□X□□	Reserved parameter (Do not change.)

n.X□□□	Reserved parameter (Do not change.)

Pn13D	2	Current Gain Level	100 ~ 2000	1%	2000	Immediately	Tuning	
Pn140	2	Model Following Control-Related Selections	0000 ~ 1121	-	0100	Immediately	Tuning	-

n.□□□X	Model Following Control Selection	Type
0	Do not use model following control.	-
1	Use model following control.	

n.□□X□	Vibration Suppression Selection	Type
0	Do not perform vibration suppression.	-
1	Perform vibration suppression for a specific frequency.	
2	Perform vibration suppression for two specific frequencies.	

n.□X□□	Vibration Suppression Adjustment Selection	Type
0	Do not adjust vibration suppression automatically during execution of autotuning without a host reference, autotuning with a host reference, and custom tuning.	-
1	Adjust vibration suppression automatically during execution of autotuning without a host reference, autotuning with a host reference, and custom tuning.	

n.X□□□	Speed Feedforward (VFF)/Torque Feedforward Selection	Type
0	Do not use model following control and speed/torque feedforward together.	-

			1	Use model following control and speed/torque feedforward together.					
Pn141	2	Model Following Control Gain		10 ~ 20000	0.1/s	500	Immediately	Tuning	
Pn142	2	Model Following Control Gain Correction		500 ~ 2000	0.1%	1000	Immediately	Tuning	
Pn143	2	Model Following Control Bias in the Forward Direction		0 ~ 10000	0.1%	1000	Immediately	Tuning	
Pn144	2	Model Following Control Bias in the Reverse Direction		0 ~ 10000	0.1%	1000	Immediately	Tuning	
Pn145	2	Vibration Suppression 1 Frequency A		10 ~ 2500	0.1 Hz	500	Immediately	Tuning	
Pn146	2	Vibration Suppression 1 Frequency B		10 ~ 2500	0.1 Hz	700	Immediately	Tuning	
Pn147	2	Model Following Control Speed Feedforward Compensation		0 ~ 10000	0.1%	1000	Immediately	Tuning	
Pn148	2	Second Model Following Control Gain		10 ~ 20000	0.1/s	500	Immediately	Tuning	
Pn149	2	Second Model Following Control Gain Correction		500 ~ 2000	0.1%	1000	Immediately	Tuning	
Pn14A	2	Vibration Suppression 2 Frequency		10 ~ 2000	0.1 Hz	800	Immediately	Tuning	
Pn14B	2	Vibration Suppression 2 Correction		10 ~ 1000	1%	100	Immediately	Tuning	
Pn14F	2	Control-Related Selections		0000 ~ 0021	-	0021	After restart	Tuning	-
		n.□□□X	Model Following Control Type Selection					Type	
			0	Use model following control type 1.				-	
			1	Use model following control type 2.					
		n.□□X□	Tuning-less Type Selection					Type	
			0	Use tuning-less type 1.				-	
			1	Use tuning-less type 2.					
			2	Use tuning-less type 3.					
		n.□X□□	Reserved parameter (Do not change.)						
		n.X□□□	Reserved parameter (Do not change.)						
Pn160	2	Anti-Resonance Control-Related Selections		0000 ~ 0011		0010	Immediately	Tuning	
		n.□□□X	Anti-Resonance Control Selection					Type	
			0	Do not use anti-resonance control.				-	
			1	Use anti-resonance control.					
		n.□□X□	Anti-Resonance Control Adjustment Selection					Type	
			0	Do not adjust anti-resonance control automatically during execution of autotuning without a host reference, autotuning with a host reference, and custom tuning.				-	
			1	Adjust anti-resonance control automatically during execution of autotuning without a host reference, autotuning with a host reference, and custom tuning.					
		n.□X□□	Reserved parameter (Do not change.)						
		n.X□□□	Reserved parameter (Do not change.)						
Pn161	2	Anti-Resonance Frequency		10 ~ 20000	0.1 Hz	1000	Immediately	Tuning	
Pn162	2	Anti-Resonance Gain Correction		1 ~ 1000	1%	100	Immediately	Tuning	
Pn163	2	Anti-Resonance Damping Gain		0 ~ 300	1%	0	Immediately	Tuning	
Pn164	2	Anti-Resonance Filter Time Constant 1 Correction		-1000 ~ 1000	0.01 ms	0	Immediately	Tuning	

Pn165	2	Anti-Resonance Filter Time Constant 2 Correction	-1000 ~ 1000	0.01 ms	0	Immediately	Tuning
Pn166	2	Anti-Resonance Damping Gain 2	0 ~ 1000	1%	0	Immediately	Tuning
Pn170	2	Tuning-less Function-Related Selections	0000 ~ 2711	-	1400	-	Setup

n.□□□X	Tuning-less Selection	When Enabled
	0 Disable tuning-less function.	After restart
	1 Enable tuning-less function.	

n.□□X□	Speed Control Method	When Enabled
	0 Use for speed control.	After restart
	1 Use for speed control and use host controller for position control.	

n.□X□□	Rigidity Level	When Enabled
	0 ~ 7 Set the rigidity level.	Immediately

n.X□□□	Tuning-less Load Level	When Enabled
	0 ~ 2 Set the load level for the tuning-less function.	Immediately

Pn181	2	Mode Switching Level for Speed Reference	0 ~ 10000	1 mm/s	0	Immediately	Tuning	-
Pn182	2	Mode Switching Level for Acceleration	0 ~ 30000	1 mm/s 2	0	Immediately	Tuning	-

Parameter No.	Size	Name	Setting Range	Setting Unit	Default Setting	When Enabled	Classification	Type
Pn200	2	Position Control Reference Form Selections	0000 ~ F236	-	0000	After restart	Setup	P

n.□□□X	Reference Pulse Form
	0 Sign and pulse train, positive logic.
	1 CW and CCW pulse trains, positive logic
	2 Two-phase pulse trains with 90° phase differential (phase A and phase B) ×1,positive logic
	3 Two-phase pulse trains with 90° phase differential (phase A and phase B) ×2,positive logic
	4 Two-phase pulse trains with 90° phase differential (phase A and phase B) ×4,positive logic
	5 Sign and pulse train, negative logic.
	6 CW and CCW pulse trains, negative logic
	7 Two-phase pulse trains with 90° phase differential (phase A and phase B) ×1,Negative logic.
	8 Two-phase pulse trains with 90° phase differential (phase A and phase B) ×2,Negative logic.
	9 Two-phase pulse trains with 90° phase differential (phase A and phase B) ×4,Negative logic.

n.□□X□	Clear Signal Form
	0 Clear position deviation when the signal is at high level.
	1 Clear position deviation on the rising edge of the signal.
	2 Clear position deviation when the signal is at low level.
	3 Clear position deviation on the falling edge of the signal.

n.□X□□	Clear Operation
	0 Clear position deviation at a base block (at servo OFF or when alarm occurs).
	1 Do not clear position error (cleared only with CLR (Clear Position Deviation) signal).
	2 Clear position deviation when an alarm occurs.

n.X□□□	Filter Selection
	0 Use the reference input filter for a line-driver signal.
	0 ~ F Use the reference input filter for an open-collector signal.

Pn207	2	Position Control Function Selections	0000 ~ 2210	-	0010	After restart	Setup	-

n.□□□X	Encoder output direction setting	
	0	Set a Phase A leads
	1	Set a Phase B leads

n.□□X□	Position Control Option	
	0	Do not use V-REF.
	1	Use V-REF as a speed feedback input.

n.□X□□	Reserved parameter (Do not change.)

n.X□□□	/COIN (Positioning Completion Output) Signal Output Timing	
	0	Output when the absolute value of the position deviation is the same or less than the setting of Pn522 (Positioning Completed Width).
	1	Output when the absolute value of the position error is the same or less than the setting of Pn522 (Positioning Completed Width) and the reference after the position reference filter is 0.
	2	Output when the absolute value of the position error is the same or less than the setting of Pn522 (Positioning Completed Width) and the reference input is 0.

Pn20A	4	Number of External Encoder Scale Pitches	4 ~ 16777216	1 scale pitch/revolution	32768	Tuning		-
Pn20E	4	Electronic Gear Ratio (Numerator)	1 ~ 1073741824	1	1(EtherCAT) 32 (pulse)	After restart	Setup	-
Pn210	4	Electronic Gear Ratio (Denominator)	1 ~ 1073741824	1	1	After restart	Setup	-
Pn212	4	Encoder AB phase pulse number	16 ~ 1073741824	1(pitch)/Rev	2500	After restart	Setup	-
Pn216	2	Position Reference Acceleration/Deceleration Time Constant	0 ~ 65535	0.1ms	0	Immediately after the motor stops	Setup	-
Pn217	2	Average Position Reference Movement Time	0 ~ 10000	0.1ms	0	Immediately after the motor stops	Setup	-
Pn218	2	Reference Pulse Input Multiplier	1 ~ 100	1 倍	1	Immediately	Setup	-
Pn22A	2	Fully-closed Control Selections	0000 ~ 11FF	-	0000	After restart		--

n.□□□X	Biss Encoder single turn bits (17+Hex0)	
	0~9	17~26 bits
	A~F	27~32 bits

n.□□X□	BissEncoder multi-turn bit number (10+Hex1)/ linear scale =0	
	0	0 bit
	1~9	11~l9 bits
	A ~ F	20~25 bits

n.□X□□	External encoder type selection	
	0	BiSS interface
	1	EnDat interface

n. X□□□	Fully-closed Control Speed Feedback Selection	
	0	Use motor encoder speed.
	1	Use external encoder speed.

Pn230	2	Position control extended function switch	0000 ~ 0001	-	0000	After restart	Setup	-

n.□□□X	Backlash compensation direction	
	0	compensate forward references.
	1	compensate reverse references.

n.X X X□	Reserved parameter (Do not change.)

Pn231	4	Backlash compensation	-500000 ~ 500000	0.1 references units	0	Immediately	Setup	-

Pn233	2	Backlash compensation time constant	0 ~ 65535	0.01 ms	0	Immediately	Setup	-
Pn281	2	Encoder Output Resolution	1 ~ 4096	1 edge/ pitch	20	After restart	Setup	-
Pn282	2	Linear Encoder Scale Pitch	0 ~ 6553600	0.01 μm	0	After restart	Setup	-
Pn300	2	Speed Reference Input Gain	150 ~ 3000	0.01V/Rated motor speed	600	Immediately	Setup	-
Pn301	2	Internal Set Speed 1	0 ~ 10000	Rotary : 1min^{-1} (RPM)	100	Immediately	Setup	-
Pn302	2	Internal Set Speed 2	0 ~ 10000	Rotary : 1min^{-1} (RPM)	200	Immediately	Setup	-
Pn303	2	Internal Set Speed 3	0 ~ 10000	Rotary : 1min^{-1} (RPM)	300	Immediately	Setup	-
Pn304	2	Jogging Speed	0 ~ 10000	1min^{-1} (RPM)	500	Immediately	Setup	-
Pn305	2	Soft Start Acceleration Time	0 ~ 10000	1 ms	0	Immediately	Setup	-
Pn306	2	Soft Start Deceleration Time	0 ~ 10000	1 ms	0	Immediately	Setup	-
Pn308	2	Speed Feedback Filter Time Constant	0 ~ 65535	0.01 ms	0	Immediately	Setup	-
Pn30A	2	Deceleration Time for Servo OFF and Forced Stops	0 ~ 10000	1 ms	0	Immediately	Setup	-
Pn30C	2	Speed Feedforward Average Movement Time	0 ~ 5100	0.1 ms	0	Immediately	Setup	-
Pn310	2	Vibration Detection Selections	0000 ~ 0002	-	0000	Immediately	Setup	--
Pn311	2	Vibration Detection Sensitivity	50 ~ 500	1%	100	Immediately	Tuning	-
Pn312	2	Vibration Detection Level	0 ~ 5000	1min^{-1} (RPM)	50	Immediately	Tuning	-
Pn316	2	Maximum Motor Speed	0 ~ 65535	1min^{-1} (RPM)	10000	After restart	Setup	-
Pn324	2	Moment of Inertia Calculation Starting Level	0 ~ 20000	1%	300	Immediately	Setup	-
Pn380	2	Internal Set Speed 1	0 ~ 10000	1 mm/s	10	Immediately	Setup	-
Pn381	2	Internal Set Speed 2	0 ~ 10000	1 mm/s	20	Immediately	設定	-
Pn382	2	Internal Set Speed 3	0 ~ 10000	1 mm/s	30	Immediately	Setup	-
Pn383	2	Jogging Speed	0 ~ 10000	1 mm/s	50	Immediately	Setup	-
Pn384	2	Vibration Detection Level	0 ~ 5000	1 mm/s	10	Immediately	Tuning	-
Pn385	2	Maximum Motor Speed	0 ~ 100	100 mm/s	50	After restart	Setup	-
Pn400	2	Torque Reference Input Gain	10 ~ 100	0.1 V/rated torque	30	Immediately	Setup	-
Pn401	2	First Stage First Torque Reference Filter Time Constant	0 ~ 65535	0.01 ms	100	Immediately	Tuning	-
Pn402	2	Forward Torque Limit	0 ~ 800	1% *1	800	Immediately	Setup	-
Pn403	2	Reverse Torque Limit	0 ~ 800	1% *1	800	Immediately	Setup	-
Pn404	2	Forward External Torque Limit	0 ~ 800	1% *1	100	Immediately	Setup	-
Pn405	2	Reverse External Torque Limit	0 ~ 800	1% *1	100	Immediately	Setup	-

Pn310

n.□□□X	Vibration Detection Selection	
	0	Do not detect vibration.
	1	Output a warning (A.911) if vibration is detected.
	2	Output an alarm (A.520) if vibration is detected.
n.□□X□	Reserved parameter (Do not change.)	
n.□X□□	Reserved parameter (Do not change.)	
n.X□□□	Reserved parameter (Do not change.)	

Pn406	2	Emergency Stop Torque	0 ~ 800	1% *1	800	Immediately	Setup	-
Pn407	2	Speed Limit during Torque Control	0 ~ 10000	1min^{-1} (RPM)	10000	Immediately	Setup	-
Pn408	2	Torque-Related Function Selections	0000 ~ 1111	-	0000	-	Setup	--

n.□□□X	Notch Filter Selection 1	When Enabled
	0 Disable first stage notch filter.	Immediately
	1 Enable first stage notch filter.	

n.□□X□	Speed Limit Selection	When Enabled
	0 Use the smaller of the maximum motor speed and the setting of Pn407 as the speed limit.	After restart
	1 Use the smaller of the overspeed alarm detection speed and the setting of Pn407 as the speed limit.	

n.□X□□	Notch Filter Selection 2	When Enabled
	0 Disable second stage notch filter.	Immediately
	1 Enable second stage notch filter.	

n.X□□□	Friction Compensation Function Selection	When Enabled
	0 Disable friction compensation.	Immediately
	1 Enable friction compensation.	

Parameter No.	Size	Name	Setting Range	Setting Unit	Default Setting	When Enabled	Classification	Type
Pn409	2	First Stage Notch Filter Frequency	50 ~ 5000	1 Hz	5000	Immediately	Tuning	
Pn40A	2	First Stage Notch Filter Q Value	50 ~ 1000	0.01	70	Immediately	Tuning	
Pn40B	2	First Stage Notch Filter Depth	0 ~ 1000	0.001	0	Immediately	Tuning	
Pn40C	2	Second Stage Notch Filter Frequency	50 ~ 5000	1 Hz	5000	Immediately	Tuning	
Pn40D	2	Second Stage Notch Filter Q Value	50 ~ 1000	0.01	70	Immediately	Tuning	
Pn40E	2	Second Stage Notch Filter Depth	0 ~ 1000	0.001	0	Immediately	Tuning	
Pn40F	2	Second Stage Second Torque Reference Filter Frequency	100 ~ 5000	1 Hz	5000	Immediately	Tuning	
Pn410	2	Second Stage Second Torque Reference Filter Q Value	50 ~ 100	0.01	50	Immediately	Tuning	
Pn412	2	First Stage Second Torque Reference Filter Time Constant	0 ~ 65535	0.01 ms	100	Immediately	Tuning	
Pn415	2	T-REF Filter Time Constant	0 ~ 65535	0.01 ms	0	Immediately	Setup	
Pn416	2	Torque-Related Function Selections 2	0000 ~ 1111	-	0000	Immediately	Setup	

n.□□□X	Notch Filter Selection 3
	0 Disable third stage notch filter.
	1 Enable third stage notch filter.

n.□□X□	Notch Filter Selection 4
	0 Disable fourth stage notch filter.
	1 Enable fourth stage notch filter.

n.□X□□	Notch Filter Selection 5
	0 Disable fifth stage notch filter.
	1 Enable fifth stage notch filter.

n.X□□□	Reserved parameter (Do not change.)

Pn417	2	Third Stage Notch Filter Frequency	50 ~ 5000	1 Hz	5000	Immediately	Tuning	
Pn418	2	Third Stage Notch Filter Q Value	50 ~ 1000	0.01	70	Immediately	Tuning	
Pn419	2	Third Stage Notch Filter Depth	0 ~ 1000	0.001	0	Immediately	Tuning	
Pn41A	2	Fourth Stage Notch Filter Frequency	50 ~ 5000	1 Hz	5000	Immediately	Tuning	
Pn41B	2	Fourth Stage Notch Filter Q Value	50 ~ 1000	0.01	70	Immediately	Tuning	
Pn41C	2	Fourth Stage Notch Filter Depth	0 ~ 1000	0.001	0	Immediately	Tuning	
Pn41D	2	Fifth Stage Notch Filter Frequency	50 ~ 5000	1 Hz	5000	Immediately	Tuning	
Pn41E	2	Fifth Stage Notch Filter Q Value	50 ~ 1000	0.01	70	Immediately	Tuning	
Pn41F	2	Fifth Stage Notch Filter Depth	0 ~ 1000	0.001	0	Immediately	Tuning	
Pn423	2	Speed Ripple Compensation Selections	0000 ~ 1111	-	0000	-	Setup	

n.□□□X	Speed Ripple Compensation Function Selection		When Enabled
	0	Disable speed ripple compensation.	Immediately
	1	Enable speed ripple compensation.	

n.□□X□	Speed Ripple Compensation Information Disagreement Warning Detection Selection		When Enabled
	0	Detect A.942 alarms.	After restart
	1	Do not detect A.942 alarms.	

n.□X□□	Speed Ripple Compensation Enable Condition Selection		When Enabled
	0	Speed reference	After restart
	1	Motor speed	

n.X□□□	Reserved parameter (Do not change.)

Pn424	2	Torque Limit at Main Circuit Voltage Drop	0 ~ 100	1% *1	50	Immediately	Setup	
Pn425	2	Release Time for Torque Limit at Main Circuit Voltage Drop	0 ~ 1000	1 ms	100	Immediately	Setup	
Pn426	2	Torque Feedforward Average Movement Time	0 ~ 5100	0.1 ms	0	Immediately	Setup	
Pn427	2	Speed Ripple Compensation Enable Speed	0 ~ 10000	1min^{-1} (RPM)	0	Immediately	Tuning	
Pn456	2	Sweep Torque Reference Amplitude	0 ~ 800	1%	15	Immediately	Tuning	
Pn460	2	Notch Filter Adjustment Selections 1	0000 ~ 0101	-	0101	Immediately	Tuning	

n.□□□X	Notch Filter Adjustment Selection 1	
	0	Do not adjust the first stage notch filter automatically during execution of autotuning without a host reference, autotuning with a host reference, and custom tuning.
	1	Adjust the first stage notch filter automatically during execution of autotuning without a host reference, autotuning with a host reference, and custom tuning.

n.□□X□	Reserved parameter (Do not change.)

n.□X□□	Notch Filter Adjustment Selection 2	
	0	Do not adjust the second stage notch filter automatically when the tuning-less function is enabled or during execution of autotuning without a host reference, autotuning with a host reference, and custom tuning.
	1	Adjust the second stage notch filter automatically when the tuning-less function is enabled or during execution of autotuning without a host reference, autotuning with a host reference, and custom tuning.

n.X□□□	Reserved parameter (Do not change.)

Pn480	2	Speed Limit during Force Contro	0 ~ 10000	1mm/s	10000	Immediately	Setup	
Pn481	2	Polarity Detection Speed Loop Gain	10 ~ 20000	0.1Hz	400	Immediately	Tuning	
Pn482	2	Polarity Detection Speed Loop Integral Time Constant	15 ~ 51200	0.01ms	3000	Immediately	Setup	
Pn483	2	Forward Force Limit	0 ~ 800	1%	30	Immediately	Setup	
Pn484	2	Reverse Force Limit	0 ~ 800	1%	30	Immediately	Tuning	
Pn485	2	Polarity Detection Reference Speed	0 ~ 100	1mm/s	20	Immediately	Tuning	
Pn486	2	Polarity Detection Reference Acceleration/ Deceleration Time	0 ~ 100	1ms	25	Immediately	Tuning	
Pn487	2	Polarity Detection Constant Speed Time	0 ~ 300	1ms	0	Immediately	Tuning	
Pn488	2	Polarity Detection Reference Waiting Time	50 ~ 500	1ms	100	Immediately	Tuning	
Pn48E	2	Polarity Detection Range	1 ~ 65535	1mm	10	Immediately	Tuning	
Pn490	2	Polarity Detection Load Level	0 ~ 20000	1%	100	Immediately	Tuning	
Pn495	2	Polarity Detection Confirmation Force Reference	0 ~ 200	1%	100	Immediately	Tuning	
Pn498	2	Polarity Detection Allowable Error Range	0 ~ 30	1deg	10	Immediately	Tuning	
Pn501	2	Zero Clamping Level	0 ~ 10000	1min^{-1} (RPM)	10	Immediately	Setup	
Pn502	2	Rotation Detection Level	1 ~ 10000	1min^{-1} (RPM)	20	Immediately	Setup	
Pn503	2	Speed Coincidence Detection Signal Output Width	0 ~ 100	1min^{-1} (RPM)	10	Immediately	Setup	
Pn506	2	Brake Reference-Servo OFF Delay Time	0 ~ 50	10 ms	0	Immediately	Setup	
Pn507	2	Brake Reference Output Speed Level	0 ~ 10000	1min^{-1} (RPM)	100	Immediately	Setup	
Pn508	2	Servo OFF-Brake Command Waiting Time	10 ~ 100	10 ms	50	Immediately	Setup	
Pn509	2	Momentary Power Interruption Hold Time	20 ~ 50000	10 ms	20	Immediately	Setup	

Parameter No.	Size	Name	Setting Range	Setting Unit	Default Setting	When Enabled	Classification	Type
Pn50A	2	Input Signal Selections 1	0000 ~ 9991	-	0 0	After restart	Setup	P E

n.□□□X		Reserved parameter (Do not change.)	Type
	1	Reserved parameter (Do not change.)	E/P

n.□□X□		Reserved parameter (Do not change.)	Type
	8	Reserved parameter (Do not change.)	E

n.□□X□		S/-ON(Servo on) signal Allcation	Type
	0	Active when CN1-IN0 input signal is ON (closed).	P
	1	Active when CN1-IN1 input signal is ON (closed).	
	2	Active when CN1-IN2 input signal is ON (closed).	
	3	Active when CN1-IN3 input signal is ON (closed).	
	4	Active when CN1-IN4 input signal is ON (closed).	
	5	Active when CN1-IN5 input signal is ON (closed).	
	6	Active when CN1-IN6 input signal is ON (closed).	
	7	Active when CN1-IN7 input signal is ON (closed).	
	8	The signal is always inactive.	
	9	The signal is always active.	

n.□X□□		Reserved parameter (Do not change.)	Type
	8	Reserved parameter (Do not change.)	

n.□X□□	/P-CON(Proportional Control signal Allcation		Type
	0	Active when CN1-IN0 input signal is ON (closed).	P
	1	Active when CN1-IN1 input signal is ON (closed).	
	2	Active when CN1-IN2 input signal is ON (closed).	
	3	Active when CN1-IN3 input signal is ON (closed).	
	4	Active when CN1-IN4 input signal is ON (closed).	
	5	Active when CN1-IN5 input signal is ON (closed).	
	6	Active when CN1-IN6 input signal is ON (closed).	
	7	Active when CN1-IN7 input signal is ON (closed).	
	8	The signal is always inactive.	
	9	The signal is always active.	

n.X□□□	P-OT (Forward Drive Prohibit) Signal Allocation		Type
	0	Enable forward drive when CN1-IN0 input signal is ON (closed).	E/P
	1	Enable forward drive when CN1-IN1 input signal is ON (closed).	
	2	Enable forward drive when CN1-IN2 input signal is ON (closed).	
	3	Enable forward drive when CN1-IN3 input signal is ON (closed).	
	4	Enable forward drive when CN1-IN4 input signal is ON (closed).	
	5	Enable forward drive when CN1-IN5 input signal is ON (closed).	
	6	Enable forward drive when CN1-IN6 input signal is ON (closed).	
	7	Enable forward drive when CN1-IN7 input signal is ON (closed).	
	8	Set the signal to always enable forward drive.	
	9	Set the signal to always prohibit forward drive.	

Pn50B	2	Input Signal Selections 2	0000 ~ 9999	-	0 0	After restart	Setup	P E

n.□□□X	N-OT (Reverse Drive Prohibit) Signal Allocation		Type
	0	Enable reverse drive when CN1-IN0 input signal is ON (closed).	E/P
	1	Enable reverse drive when CN1-IN1 input signal is ON (closed).	
	2	Enable reverse drive when CN1-IN2 input signal is ON (closed).	
	3	Enable reverse drive when CN1-IN3 input signal is ON (closed).	
	4	Enable reverse drive when CN1-IN4 input signal is ON (closed).	
	5	Enable reverse drive when CN1-IN5 input signal is ON (closed).	
	6	Enable reverse drive when CN1-IN6 input signal is ON (closed).	
	7	Enable reverse drive when CN1-IN7 input signal is ON (closed).	
	8	Set the signal to always enable forward drive.	
	9	Set the signal to always prohibit forward drive.	

n.□□X□	Reserved parameter (Do not change.)		Type
	8	Reserved parameter (Do not change.)	E

n.□□X□	/ALM-RST(Alram Reset) signal Allcation		Type
	0	Active on signal edge when CN1-IN0 input signal changes form OFF(open) to ON(closed).	P
	1	Active on signal edge when CN1-IN1 input signal changes form OFF(open) to ON(closed).	
	2	Active on signal edge when CN1-IN2 input signal changes form OFF(open) to ON(closed).	
	3	Active on signal edge when CN1-IN3 input signal changes form OFF(open) to ON(closed).	
	4	Active on signal edge when CN1-IN4 input signal changes form OFF(open) to ON(closed).	
	5	Active on signal edge when CN1-IN5 input signal changes form OFF(open) to ON(closed).	
	6	Active on signal edge when CN1-IN6 input signal changes form OFF(open) to ON(closed).	
	7	Active on signal edge when CN1-IN7 input signal changes form OFF(open) to ON(closed).	
	8	The signal is always inactive.	
	9	The signal is always active.	

n.□X□□	/P-CL (Forward External Torque Limit Input) Signal Allocation		Type
	0	Active when CN1-IN0 input signal is ON (closed).	E/P
	1	Active when CN1-IN1 input signal is ON (closed).	
	2	Active when CN1-IN2 input signal is ON (closed).	
	3	Active when CN1-IN3 input signal is ON (closed).	
	4	Active when CN1-IN4 input signal is ON (closed).	
	5	Active when CN1-IN5 input signal is ON (closed).	
	6	Active when CN1-IN6 input signal is ON (closed).	

7	Active when CN1-IN7 input signal is ON (closed).	
8	The signal is always inactive.	
9	The signal is always active.	

n.X□□□	/N-CL (Reverse External Torque Limit Input) Signal Allocation	Type
0 ~ 9	The allocations are the same as the /P-CL (Servo ON) signal allocations.	

Parameter No.	Size	Name	Setting Range	Setting Unit	Default Setting	When Enabled	Classification	Type
Pn50C	2	Input Signal Selections 3	0000 ~ 9999	-	8888	After restart	Setup	P

n.□□□X	/SPD-D (Motor Direction) Signal Allocation	Type
0	Active when CN1-IN0 input signal is ON (closed).	P
1	Active when CN1-IN1 input signal is ON (closed).	
2	Active when CN1-IN2 input signal is ON (closed).	
3	Active when CN1-IN3 input signal is ON (closed).	
4	Active when CN1-IN4 input signal is ON (closed).	
5	Active when CN1-IN5 input signal is ON (closed).	
6	Active when CN1-IN6 input signal is ON (closed).	
7	Active when CN1-IN7 input signal is ON (closed).	
8	The signal is always inactive.	
9	The signal is always active.	

n.□□X□	/SPD-A (Internal Set Speed Selection Input) Signal Allocation	Type
0 ~ 9	The allocations are the same as the /SPD-D (Motor Direction) signal allocations.	P

n.□X□□	/SPD-B (Internal Set Speed Selection Input) Signal Allocation	Type
0 ~ 9	The allocations are the same as the /SPD-D (Motor Direction) signal allocations.	P

n.X□□□	/C-SEL (Control Selection Input) Signal Allocation	Type
0 ~ 9	The allocations are the same as the /SPD-D (Motor Direction) signal allocations.	P

Pn50D	2	Input Signal Selections 4	0000 ~ 0999	-	0888	After restart	Setup	P

n.□□□X	/ZCLAMP (Zero Clamping Input) Signal Allocation	Type
0	Active when CN1-IN0 input signal is ON (closed).	P
1	Active when CN1-IN1 input signal is ON (closed).	
2	Active when CN1-IN2 input signal is ON (closed).	
3	Active when CN1-IN3 input signal is ON (closed).	
4	Active when CN1-IN4 input signal is ON (closed).	
5	Active when CN1-IN5 input signal is ON (closed).	
6	Active when CN1-IN6 input signal is ON (closed).	
7	Active when CN1-IN7 input signal is ON (closed).	
8	The signal is always inactive.	
9	The signal is always active.	

n.□□X□	/INHIBIT (Reference Pulse Inhibit Input) Signal Allocation	Type
0 ~ 9	The allocations are the same as the /ZCLAMP (Zero Clamping Input) signal allocations.	P

n.□X□□	/G-SEL (Gain Selection Input) Signal Allocation	Type
0 ~ 9	The allocations are the same as the /ZCLAMP (Zero Clamping Input) signal allocations.	P

n.X□□□	/P-DET (Polarity Detection Input) Signal Allocation	Type
0 ~ 9	The allocations are the same as the /ZCLAMP (Zero Clamping Input) signal allocations.	P

Parameter No.	Size	Name	Setting Range	Setting Unit	Default Setting	When Enabled	Classification	Type
Pn50E	2	Output Signal Selections 1	0000 ~ 6666	-	0	After restart	Setup	-

n.□□□X	/COIN (Positioning Completion Output) Signal Allocation		Type
	0	Output the signal from the CN1-OUT0(7、8) output terminal.	
	1	Output the signal from the CN1-OUT1(9、10) output terminal.	
	2	Output the signal from the CN1-OUT2(11、12) output terminal.	
	3	Output the signal from the CN1-OUT3(32、33) output terminal.	
	4	Output the signal from the CN1-OUT4(34、35) output terminal.	
	5	Output the signal from the CN1-OUT5(36、37) output terminal.	
	6	Disabled (the above signal output is not used).	

n.□□X□	/V-CMP (Speed Coincidence Detection Output) Signal Allocation		Type
	0 ~ 6	The allocations are the same as the /COIN (Positioning Completion) signal allocations.	

n.□X□□	/TGON (Rotation Detection Output) Signal Allocation		Type
	0 ~ 6	The allocations are the same as the /COIN (Positioning Completion) signal allocations.	

n.X□□□	/S-RDY (Servo Ready) Signal Allocation		Type
	0 ~ 6	The allocations are the same as the /COIN (Positioning Completion) signal allocations.	

Parameter No.	Size	Name	Setting Range	Setting Unit	Default Setting	When Enabled	Classification	Type
Pn50F	2	Output Signal Selections 2	0000 ~ 6666	-	0	After restart	Setup	-

n.□□□X	/CLT (Torque Limit Detection Output) Signal Allocation		Type
	0	Output the signal from the CN1-OUT0(7、8) output terminal.	
	1	Output the signal from the CN1-OUT1(9、10) output terminal.	
	2	Output the signal from the CN1-OUT2(11、12) output terminal.	
	3	Output the signal from the CN1-OUT3(32、33) output terminal.	
	4	Output the signal from the CN1-OUT4(34、35) output terminal.	
	5	Output the signal from the CN1-OUT5(36、37) output terminal.	
	6	Disabled (the above signal output is not used).	

n.□□X□	/VLT (Speed Limit Detection) Signal Allocation		Type
	0 ~ 6	The allocations are the same as the /CLT (Torque Limit Detection Output) signal allocations.	

n.□X□□	/BK (Brake Output) Signal Allocation		Type
	0 ~ 6	The allocations are the same as the /CLT (Torque Limit Detection Output) signal allocations.	

n.X□□□	/WARN (Warning Output) Signal Allocation		Type
	0 ~ 6	The allocations are the same as the /CLT (Torque Limit Detection Output) signal allocations.	

Parameter No.	Size	Name	Setting Range	Setting Unit	Default Setting	When Enabled	Classification	Type
Pn510	2	Output Signal Selections 3	0000 ~ 6666	-	0	After restart	Setup	-

n.□□□X	/NEAR (Near Output) Signal Allocation		Type
	0	Output the signal from the CN1-OUT0(7、8) output terminal.	
	1	Output the signal from the CN1-OUT1(9、10) output terminal.	
	2	Output the signal from the CN1-OUT2(11、12) output terminal.	
	3	Output the signal from the CN1-OUT3(32、33) output terminal.	
	4	Output the signal from the CN1-OUT4(34、35) output terminal.	
	5	Output the signal from the CN1-OUT5(36、37) output terminal.	
	6	Disabled (the above signal output is not used).	

n.□□X□	Encoder C pulse output (/PGC) Signal Allocation	
	0 ~ 6	The allocations are the same as the /NEAR (Near Output) signal allocations.

n.□X□□	/PSELA (Reference Pulse Input Multiplication Switching Output) Signal Allocation		Type
	0 ~ 6	The allocations are the same as the /NEAR (Near Output) signal allocations.	P

n.X□□□	error alram output (ALM) Signal Allocation		
	0 ~ 6	The allocations are the same as the /NEAR (Near Output) signal allocations.	

Parameter No.	Size	Name	Setting Range	Setting Unit	Default Setting	When Enabled	Classification	Type
Pn511	2	Input Signal Selections 5	0000 ~ 9999	-	0 0	After restart	Setup	P E

n.□□□X	Origin reset deceleration switch input (/DEC) Signal Allocation		Type
	0	Active when CN1-IN0 input signal is ON (closed).	
	1	Active when CN1-IN1 input signal is ON (closed).	
	2	Active when CN1-IN2 input signal is ON (closed).	
	3	Active when CN1-IN3 input signal is ON (closed).	
	4	Active when CN1-IN4 input signal is ON (closed).	
	5	Active when CN1-IN5 input signal is ON (closed).	
	6	Active when CN1-IN6 input signal is ON (closed).	
	7	Active when CN1-IN7 input signal is ON (closed).	
	8	The signal is always inactive.	
	9	The signal is always active.	

n.□□X□	External capture input 1 (/EXT1) Signal Allocation		Type
	0 ~ 4	The signal is always inactive.	E
	5	Active when CN1-IN5 input signal is ON (closed).	
	6	Active when CN1-IN6 input signal is ON (closed).	
	7	Active when CN1-IN7 input signal is ON (closed).	
	8 ~ C	The signal is always inactive.	
	D	Active when CN1-IN5 input signal is ON (closed).	E
	E	Active when CN1-IN6 input signal is ON (closed).	
	F	Active when CN1-IN7 input signal is ON (closed).	

n.□X□□	External capture input 2 (/EXT2) Signal Allocation		
	0 ~ F	The allocations are the same as the /EXT1 (External capture input 1) signal allocations.	E

n.X□□□	External capture input 3 (/EXT3) Signal Allocation		
	0 ~ F	The allocations are the same as the /EXT1 (External capture input 1) signal allocations.	E

Parameter No.	Size	Name	Setting Range	Setting Unit	Default Setting	When Enabled	Classification	Type
Pn512	2	Output Signal Inverse Settings 0	0000 ~ 1111	-	0000	After restart	Setup	-

n.□□□X	Output Signal Inversion for CN1-OUT0(7, 8) Terminals	
	0	The signal is not inverted.
	1	The signal is inverted.

n.□□X□	Output Signal Inversion for CN1-OUT0(9, 10) Terminals	
	0	The signal is not inverted.
	1	The signal is inverted.

n.□X□□	Output Signal Inversion for CN1-OUT0(11, 12) Terminals	
	0	The signal is not inverted.
	1	The signal is inverted.

n.X□□□	Output Signal Inversion for CN1-OUT0(32, 33) Terminals	
	0	The signal is not inverted.
	1	The signal is inverted.

Parameter No.	Size	Name	Setting Range	Setting Unit	Default Setting	When Enabled	Classification	Type
Pn513	2	Output Signal Inverse Settings 1	0000 ~ 0011	-	0000	After restart	Setup	-

n.□□□X	Output Signal Inversion for CN1-OUT0(34, 35) Terminals	
	0	The signal is not inverted.
	1	The signal is inverted.

n.□□X□	Output Signal Inversion for CN1-OUT0(36, 37) Terminals	
	0	The signal is not inverted.
	1	The signal is inverted.

n.□X□□	Reserved parameter (Do not change.)
n.X□□□	Reserved parameter (Do not change.)

Parameter No.	Size	Name	Setting Range	Setting Unit	Default Setting	When Enabled	Classificatinon	Type
Pn515	2	Input Signal Selections 5	0000 ~ 9999	-	8888	After restart	Setup	P

n.□□□X	SEN (Absolute Data Request Input) Signal Allocation		Type
	0	Active when CN1-IN0 input signal is ON (closed).	P
	1	Active when CN1-IN1 input signal is ON (closed).	
	2	Active when CN1-IN2 input signal is ON (closed).	
	3	Active when CN1-IN3 input signal is ON (closed).	
	4	Active when CN1-IN4 input signal is ON (closed).	
	5	Active when CN1-IN5 input signal is ON (closed).	
	6	Active when CN1-IN6 input signal is ON (closed).	
	7	Active when CN1-IN7 input signal is ON (closed).	
	8	The signal is always inactive.	
	9	The signal is always active.	

n.□□X□	/PSEL (Reference Pulse Input Multiplication Switching Input) Signal Allocation		Type
	0	Active when CN1-IN0 input signal is ON (closed).	P
	1	Active when CN1-IN1 input signal is ON (closed).	
	2	Active when CN1-IN2 input signal is ON (closed).	
	3	Active when CN1-IN3 input signal is ON (closed).	
	4	Active when CN1-IN4 input signal is ON (closed).	
	5	Active when CN1-IN5 input signal is ON (closed).	
	6	Active when CN1-IN6 input signal is ON (closed).	
	7	Active when CN1-IN7 input signal is ON (closed).	
	8	The signal is always inactive.	
	9	The signal is always active.	

n.□X□□	Reserved parameter (Do not change.)

n.X□□□	Pulse input command signal Allocation		Type
	0	Use Reference Pulse Input 0.	P
	1	Use Reference Pulse Input 1.	
	2~9	Use Reference Pulse Input 0.	

Parameter No.	Size	Name	Setting Range	Setting Unit	Default Setting	When Enabled	Classification	Type
Pn516	2	Input Signal Selections 6	0000 ~ 9999	-	1088	After restart	Setup	P
					8888			E

n.□□□X	FSTP (Forced Stop Input) Signal Allocation		Type
	0	Enable drive when CN1-IN0 input signal is ON (closed).	E (P)
	1	Enable drive when CN1-IN1 input signal is ON (closed)	
	2	Enable drive when CN1-IN2 input signal is ON (closed)	
	3	Enable drive when CN1-IN3 input signal is ON (closed)	
	4	Enable drive when CN1-IN4 input signal is ON (closed)	
	5	Enable drive when CN1-IN5 input signal is ON (closed)	
	6	Enable drive when CN1-IN6 input signal is ON (closed)	
	7	Enable drive when CN1-IN7 input signal is ON (closed)	
	8	Set the signal to always prohibit drive (always force the motor to stop).	
	9	Set the signal to always enable drive (always disable forcing the motor to stop).	
	A	Enable drive when CN1-IN0 input signal is OFF (open).	E
	B	Enable drive when CN1-IN1 input signal is OFF (open).	
	C	Enable drive when CN1-IN2 input signal is OFF (open).	
	D	Enable drive when CN1-IN3 input signal is OFF (open).	
	E	Enable drive when CN1-IN4 input signal is OFF (open).	
	F	Enable drive when CN1-IN5 input signal is OFF (open).	

n.□□X□	Position deviation clear (CLR) Signal Allocation		Type
	0	Active when CN1-IN0 input signal is ON (closed).	P
	1	Active when CN1-IN1 input signal is ON (closed).	

	2	Active when CN1-IN2 input signal is ON (closed).	
	3	Active when CN1-IN3 input signal is ON (closed).	
	4	Active when CN1-IN4 input signal is ON (closed).	
	5	Active when CN1-IN5 input signal is ON (closed).	
	6	Active when CN1-IN6 input signal is ON (closed).	
	7	Active when CN1-IN7 input signal is ON (closed).	
	8	The signal is always inactive.	
	9	The signal is always active.	

n.□X□□	Analog quantity "speed command" (VREF) Signal Allocation	Type
	0 Use the input signal of ANA0	P
	1 Use the input signal of ANA1	
	2 ~ 9 The signal is always inactive.	

n.X□□□	Analog quantity "torque command" (TREF) Signal Allocation	Type
	0 Use the input signal of ANA0	P
	1 Use the input signal of ANA1	
	2 ~ 9 The signal is always inactive.	

Parameter No.	Size	Name	Setting Range	Setting Unit	Default Setting	When Enabled	Classification	Type
Pn517	2	Input Signal Inverse Settings 1	0000 ~ 1111	-	0000	After restart	Setup	-

n.□□□X	Input Signal Inversion for CN1-IN0 Terminals
	0 The signal is not inverted.
	1 The signal is inverted.

n.□□X□	Input Signal Inversion for CN1-IN1 Terminals
	0 The signal is not inverted.
	1 The signal is inverted.

n.□X□□	Input Signal Inversion for CN1-IN2 Terminals
	0 The signal is not inverted.
	1 The signal is inverted.

n.X□□□	Input Signal Inversion for CN1-IN3 Terminals
	0 The signal is not inverted.
	1 The signal is inverted.

Parameter No.	Size	Name	Setting Range	Setting Unit	Default Setting	When Enabled	Classification	Type
Pn518	2	Input Signal Inverse Settings 2	0000 ~ 1111	-	0000	After restart	Setup	-

n.□□□X	Input Signal Inversion for CN1-IN4 Terminals
	0 The signal is not inverted.
	1 The signal is inverted.

n.□□X□	Input Signal Inversion for CN1-IN5 Terminals
	0 The signal is not inverted.
	1 The signal is inverted.

n.□X□□	Input Signal Inversion for CN1-IN6 Terminals
	0 The signal is not inverted.
	1 The signal is inverted.

n.X□□□	Input Signal Inversion for CN1-IN7 Terminals
	0 The signal is not inverted.
	1 The signal is inverted.

Parameter No.	Size	Name	Setting Range	Setting Unit	Default Setting	When Enabled	Classification	Type
Pn51B	4	Motor-Load Position Deviation Overflow Detection Level	0 ~ 1073741824	1 reference unit	1000	Immediately	Setup	
Pn51E	2	Position Deviation Overflow Warning Level	10 ~ 100	1%	100	Immediately	Setup	
Pn520	4	Position Deviation Overflow Alarm Level	1 ~ 1073741823	1 reference unit	5242880	Immediately	Setup	
Pn522	4	Positioning Completed Width	0 ~ 1073741824	1 reference unit	7	Immediately	Setup	
Pn524	4	Near Signal Width	1 ~ 1073741824	1 reference unit	1073741824	Immediately	Setup	

Pn526	4	Position Deviation Overflow Alarm Level at Servo ON	1 ~ 1073741823	1 reference unit	5242880	Immediately	Setup	
Pn528	2	Position Deviation Overflow Warning Level at Servo ON	10 ~ 100	1%	100	Immediately	Setup	
Pn529	2	Speed Limit Level at Servo ON	0 ~ 10000	1min^{-1} (RPM)	10000	Immediately	Setup	
Pn52A	2	Multiplier per Fullyclosed Rotation	0 ~ 100	1%	20	Immediately	Tuning	
Pn52B	2	Overload Warning Level	1 ~ 100	1%	20	Immediately	Setup	
Pn52C	2	Base Current Derating at Motor Overload Detection	10 ~ 100	1%	100	After restart	Setup	
Pn52F	2	Monitor Display at Startup	0000 ~ 0FFF	-	0FFF	Immediately	Setup	
Pn530	2	Program Jogging-Related Selections	0000 ~ 0005	-	0000	Immediately	Setup	

n.□□□X	Program Jogging Operation Pattern
	0 (Waiting time in Pn535 → Forward by travel distance in Pn531) × Number of movements in Pn536
	1 (Waiting time in Pn535 → Reverse by travel distance in Pn531) × Number of movements in Pn536
	2 (Waiting time in Pn535 → Forward by travel distance in Pn531) × Number of movements in Pn536 (Waiting time in Pn535 → Reverse by travel distance in Pn531) × Number of movements in Pn536
	3 (Waiting time in Pn535 → Reverse by travel distance in Pn531) × Number of movements in Pn536 (Waiting time in Pn535 → Forward by travel distance in Pn531) × Number of movements in Pn536
	4 (Waiting time in Pn535 → Forward by travel distance in Pn531 → Waiting time in Pn535 → Reverse by travel distance in Pn531) × Number of movements in Pn536
	5 (Waiting time in Pn535 → Reverse by travel distance in Pn531 → Waiting time in Pn535 → Forward by travel distance in Pn531) × Number of movements in Pn536

n.□□X□	Reserved parameter (Do not change.)
n.□X□□	Reserved parameter (Do not change.)
n.X□□□	Reserved parameter (Do not change.)

Pn531	4	Program Jogging Travel Distance	0 ~ 1073741824	1 reference unit	32768	Immediately	Setup	
Pn533	2	Program Jogging Movement Speed	1 ~ 10000	1min^{-1} (RPM)	500	Immediately	Setup	
Pn534	2	Program Jogging Acceleration/ Deceleration Time	2 ~ 10000	1 ms	100	Immediately	Setup	
Pn535	2	Program Jogging Waiting Time	0 ~ 10000	1 ms	100	Immediately	Setup	
Pn536	2	Program Jogging Number of Movements	0 ~ 1000		1	Immediately	Setup	

Parameter No.	Size	Name	Setting Range	Setting Unit	Default Setting	When Enabled	Classification	Type
Pn560	2	Residual Vibration Detection Width	1 ~ 3000	0.1%	400	Immediately	Setup	
Pn561	2	Overshoot Detection Level	0 ~ 100	1%	100	Immediately	Setup	
Pn581	2	Zero Speed Level	1 ~ 10000	1 mm/s	20	Immediately	Setup	
Pn582	2	Speed Coincidence Detection Signal Output Width	1 ~ 100	1 mm/s	10	Immediately	Setup	
Pn583	2	Brake Reference Output	1 ~ 10000	1 mm/s	10	Immediately	Setup	

		Speed Level						
Pn584	2	Speed Limit Level at Servo ON	1 ~ 10000	1 mm/s	10000	Immediately	Setup	
Pn585	2	Program Jogging Movement Speed	1 ~ 10000	1 mm/s	50	Immediately	Setup	
Pn586	2	Motor Running Cooling Ratio	1 ~ 100	1 %/Max.speed	0	Immediately	Setup	
Pn600	2	Regenerative Resistor Capacity*2	Depends on Type *3	10W	0	Immediately	Setup	
Pn601	2	Dynamic Brake Resistor Allowable Energy Consumption	0 ~ 65535	10J	0	After restart	Setup	
Pn603	2	Regenerative Resistance	0 ~ 65535	10 mΩ	0	Immediately	Setup	
Pn604	2	Dynamic Brake Resistance	0 ~ 65535	10 mΩ	0	After restart	Setup	

Parameter No.	Size	Name	Setting Range	Setting Unit	Default Setting	When Enabled	Classification	Type
Pn610	2	Forward rotation side software limit value	-1073741823 ~ 1073741823	1 reference unit	0	After restart	Setup	P
Pn612	2	Reverse side software limit value	-1073741823 ~ 1073741823	1 reference unit	0	After restart	Setup	P
Pn614	2	Absolute encoder origin position offset	-1073741823 ~ 1073741823	1 reference unit	0	After restart	Setup	P
Pn630	2	Program table mode selection	0000 ~ 01F3	-	0000	After restart	Setup	P

n.□□□X	Program step mode coordinate setting and movement method
	0 Set coordinates in a straight line.
	1 Set coordinates in rotation type. Set the movement method in the shortest path.
	2 Set coordinates in rotation type. Always set the movement method to Forward.
	3 Set coordinates in rotation type. Set the movement method all the way to Reverse.

n.□□X□	Automatically assign program steps (valid under rotation coordinates)
	0 Turn off automatic assignment of steps.
	1 Automatically assign 2 program steps.
	2 Automatically assign 3 program steps.
	3 Automatically assign 4 program steps.
	4 Automatically assign 5 program steps.
	5 Automatically assign 6 program steps.
	6 Automatically assign 7 program steps.
	7 Automatically assign 8 program steps.
	8 Automatically assign 9 program steps.
	9 Automatically assign 10 program steps.
	A Automatically assign 11 program steps.
	B Automatically assign 12 program steps.
	C Automatically assign 13 program steps.
	D Automatically assign 14 program steps.
	E Automatically assign 15 program steps.
	F Automatically assign 16 program steps.

n.□X□□	Reserved parameter (Do not change.)

n.X□□□	Reserved parameter (Do not change.)

Pn631	2	Linear acceleration parameters	1 ~ 65535	10000 reference unit/S^2	100	After restart	Setup	P
Pn632	2	Linear deceleration parameters	1 ~ 65535	10000 reference unit/S^2	100	After restart	Setup	P
Pn633	2	Return to origin mode selection	0000 ~ 000F	-	000H	After restart	Setup	P

		n.□□□X	Return to origin mode selection					
			0	Set current position to origin				
			1	After looking for the rising edge of NOT in the negative direction, look for index in the positive direction.				
			2	After looking for the rising edge of POT in the forward direction, then look for index in the reverse direction.				
			3	After looking for the rising edge of DEC in the forward direction, then look for index in the reverse direction.				
			4	After looking for the rising edge of DEC in the positive direction, look for index in the positive direction.				
			5	After looking for the falling edge of DEC in the negative direction, look for index in the positive direction.				
			6	After looking for the rising edge of DEC in the negative direction, look for index in the negative direction.				
			7	After looking for the rising edge of DEC in the positive direction, look for index in the negative direction, and reverse when encountering Pot.				
			8	After looking for the rising edge of DEC in the positive direction, look for index in the positive direction, and reverse when encountering Pot.				
			9	After looking for the falling edge of DEC in the forward direction, then look for index in the reverse direction, and reverse when encountering Pot.				
			A	After looking for the falling edge of DEC in the positive direction, look for index in the positive direction, and reverse when encountering Pot.				
			B	After searching for the rising edge of DEC in the negative direction, search for index in the positive direction, and reverse when Not				
			C	After looking for the rising edge of DEC in the negative direction, look for index in the negative direction, and reverse when Not				
			D	After looking for the falling edge of DEC in the negative direction, look for index in the positive direction, and reverse when Not				
			E	After looking for the falling edge of DEC in the negative direction, look for index in the negative direction, and reverse when Not				
			F	reserve				
		n.□□X□	Reserved parameter (Do not change.)					
		n.□X□□	Reserved parameter (Do not change.)					
		n.X□□□	Reserved parameter (Do not change.)					
Pn634	2	Find reference switching speed	1 ~ 65535	-	200	After restart	Setup	P
Pn635	2	Leave reference switching speed	1 ~ 65535	-	100	After restart	Setup	P
Pn636	2	ZONE signal range	1 ~ 65535	-	100	After restart	Setup	P
Pn640	2	Input signal selection 7	0 ~ 9999	-	8888	After restart	Setup	P
		n.□□□X	Distribution of program start input (/PGM-START) signal					
			0	Active when CN1-IN0 input signal is ON (closed).				
			1	Active when CN1-IN1 input signal is ON (closed).				
			2	Active when CN1-IN2 input signal is ON (closed).				
			3	Active when CN1-IN3 input signal is ON (closed).				
			4	Active when CN1-IN4 input signal is ON (closed).				
			5	Active when CN1-IN5 input signal is ON (closed).				
			6	Active when CN1-IN6 input signal is ON (closed).				
			7	Active when CN1-IN7 input signal is ON (closed).				
			8	The signal is always inactive.				
			9	The signal is always active.				
		n.□□X□	Distribution of program step change input (/PGM-STEP) signal					
			0 ~ 9	The allocations are the same as the /PGM-START (Distribution of program start input signal) signal allocations.				
		n.□X□□	Reserved parameter (Do not change.)					
		n.X□□□	Distribution of return-to-origin start input (/Home-START) signal					
			0 ~ 9	The allocations are the same as the /PGM-START (Distribution of program start input signal) signal allocations.				

Pn641	2	Input Signal Selections 8	0 ~ 9999	-	8888	After restart	Setup	P

n.□□□X	
Program step selects the assignment of the input 0 (/SELO) signal	
0	Active when CN1-IN0 input signal is ON (closed).
1	Active when CN1-IN1 input signal is ON (closed).
2	Active when CN1-IN2 input signal is ON (closed).
3	Active when CN1-IN3 input signal is ON (closed).
4	Active when CN1-IN4 input signal is ON (closed).
5	Active when CN1-IN5 input signal is ON (closed).
6	Active when CN1-IN6 input signal is ON (closed).
7	Active when CN1-IN7 input signal is ON (closed).
8	The signal is always inactive.
9	The signal is always active.

n.□□X□	
Distribution of program start input 1 (/SEL1) signal	
0 ~ 9	The allocations are the same as the /SELO (Program step selects the assignment of the input 0) signal allocations.

n.□X□□	
Distribution of program start input 2 (/SEL2) signal	
0 ~ 9	The allocations are the same as the /SELO (Program step selects the assignment of the input 0) signal allocations.

n.X□□□	
Distribution of program start input 3 (/SEL3) signal	
0 ~ 9	The allocations are the same as the /SELO (Program step selects the assignment of the input 0) signal allocations.

Pn642	2	Output Signal Selections 8	0 ~ 6666	-	6666	After restart	Setup	P

n.□□□X	
Distribution of current location zone output 0 (/ZONEO) signal	
0	The output terminals of CN1-OUT0(7,8) output the above signals.
1	The output terminals of CN1-OUT0(9,10) output the above signals.
2	The output terminals of CN1-OUT0(11,12) output the above signals.
3	The output terminals of CN1-OUT0(32,33) output the above signals.
4	The output terminals of CN1-OUT0(34,35) output the above signals.
5	The output terminals of CN1-OUT0(36) output the above signals.
6	Invalid (the above signal output is not used).

n.□□X□	
Distribution of current location zone output 1 (/ZONE1) signal	
0 ~ 6	The allocations are the same as the /ZONEO (Distribution of current location zone output 0 signal) signal allocations.

n.□X□□	
Distribution of current location zone output 2 (/ZONE1) signal	
0 ~ 6	The allocations are the same as the /ZONEO (Distribution of current location zone output 0 signal) signal allocations.

n.X□□□	
Distribution of current location zone output 3 (/ZONE1) signal	
0 ~ 6	The allocations are the same as the /ZONEO (Distribution of current location zone output 0 signal) signal allocations.

Pn700	2	Pgm step 0 mode selection	0000 ~ 0001	-	0001	After restart	Setup	P

n.□□□X	
Relative/absolute position selection	
0	absolute position
1	relative position

n.X X X□	
Reserved parameter (Do not change.)	

Pn701	2	Pgm step 0 target position	-1073747823 ~ 1073741823	1 reference unit	0	After restart	Setup	P
Pn703	2	Pgm step 0 positioning speed	0 ~ 65535	100 reference unit/s	100	After restart	Setup	P
Pn704	2	Pgm step 0 end condition	0000 ~ 0005	-	0000	After restart	Setup	P

n.□□□X	
Step condition	
0	The step ends when the /COIN (positioning completion output) signal turns ON (closed).
1	The step Ends when the /NEAR signal width is entered.
2	The step ends when position reference distribution is completed (DEN).

		3	Execution waits for milliseconds after the /COIN (positioning completion output) signal turns ON (closed)					
		4	Execution waits for milliseconds after the /NEAR (NEAR Output) signal turns ON (closed)					
		5	Execution waits for milliseconds after position reference distribution is completed (DEN).					
		n.X X X□	Reserved parameter (Do not change.)					
Pn705	2	Pgm step 0 Wait time	1 ~ 65535	1ms	0	After restart	Setup	P
Pn706	2	Pgm step 0 Number of loops	1 ~ 65535	-	1	After restart	Setup	P
Pn707	2	Pgm step 0 Next program step	-1 ~ 15	-	-1	After restart	Setup	P
Pn708	2	Pgm step 1 mode selection	0000 ~ 0001	-	0001	After restart	Setup	P
		n.□□□X	Relative/absolute position selection					
			0	absolute position				
			1	relative position				
		n.X X X□	Reserved parameter (Do not change.)					
Pn709	2	Pgm step 1 target position	-1073747823 ~ 1073741823	1 reference unit	0	After restart	Setup	P
Pn70B	2	Pgm step 1 positioning speed	0 ~ 65535	100 reference unit/s	100	After restart	Setup	P
Pn70C	2	Pgm step 1 end condition	0000 ~ 0005	-	0000	After restart	Setup	P
		n.□□□X	Step condition					
			0	The step ends when the /COIN (positioning completion output) signal turns ON (closed).				
			1	The step Ends when the /NEAR signal width is entered.				
			2	The step ends when position reference distribution is completed (DEN).				
			3	Execution waits for milliseconds after the /COIN (positioning completion output) signal turns ON (closed)				
			4	Execution waits for milliseconds after the /NEAR (NEAR Output) signal turns ON (closed)				
			5	Execution waits for milliseconds after position reference distribution is completed (DEN).				
		n.X X X□	Reserved parameter (Do not change.)					
Pn70D	2	Pgm step 1 Wait time	1 ~ 65535	1ms	0	After restart	Setup	P
Pn70E	2	Pgm step 1 Number of loops	1 ~ 65535	-	1	After restart	Setup	P
Pn70F	2	Pgm step 1 Next program step	-1 ~ 15	-	-1	After restart	Setup	P
Pn710	2	Pgm step 2 mode selection	0000 ~ 0001	-	0001	After restart	Setup	P
		n.□□□X	Relative/absolute position selection					
			0	absolute position				
			1	relative position				
		n.X X X□	Reserved parameter (Do not change.)					
Pn711	2	Pgm step 2 target position	-1073747823 ~ 1073741823	1 reference unit	0	After restart	Setup	P
Pn713	2	Pgm step 2 positioning speed	0 ~ 65535	100 reference unit/s	100	After restart	Setup	P
Pn714	2	Pgm step 2 end condition	0000 ~ 0005	-	0000	After restart	Setup	P
		n.□□□X	Step condition					
			0	The step ends when the /COIN (positioning completion output) signal turns ON (closed).				
			1	The step Ends when the /NEAR signal width is entered.				
			2	The step ends when position reference distribution is completed (DEN).				

		3	Execution waits for milliseconds after the /COIN (positioning completion output) signal turns ON (closed)					
		4	Execution waits for milliseconds after the /NEAR (NEAR Output) signal turns ON (closed)					
		5	Execution waits for milliseconds after position reference distribution is completed (DEN).					
		n.X X X□	Reserved parameter (Do not change.)					
Pn715	2	Pgm step 2 Wait time	1 ~ 65535	1ms	0	After restart	Setup	P
Pn716	2	Pgm step 2 Number of loops	1 ~ 65535	-	1	After restart	Setup	P
Pn717	2	Pgm step 2 Next program step	-1 ~ 15	-	-1	After restart	Setup	P
Pn718	2	Pgm step 3 mode selection	0000 ~ 0001	-	0001	After restart	Setup	P
		n.□□□X	Relative/absolute position selection					
			0	absolute position				
			1	relative position				
		n.X X X□	Reserved parameter (Do not change.)					
Pn719	2	Pgm step 3 target position	-1073747823 ~ 1073741823	1 reference unit	0	After restart	Setup	P
Pn71B	2	Pgm step 3 positioning speed	0 ~ 65535	100 reference unit/s	100	After restart	Setup	P
Pn71C	2	Pgm step 3 end condition	0000 ~ 0005	-	0000	After restart	Setup	P
		n.□□□X	Step condition					
			0	The step ends when the /COIN (positioning completion output) signal turns ON (closed).				
			1	The step Ends when the /NEAR signal width is entered.				
			2	The step ends when position reference distribution is completed (DEN).				
			3	Execution waits for milliseconds after the /COIN (positioning completion output) signal turns ON (closed)				
			4	Execution waits for milliseconds after the /NEAR (NEAR Output) signal turns ON (closed)				
			5	Execution waits for milliseconds after position reference distribution is completed (DEN).				
		n.X X X□	Reserved parameter (Do not change.)					
Pn71D	2	Pgm step 3 Wait time	1 ~ 65535	1ms	0	After restart	Setup	P
Pn71E	2	Pgm step 3 Number of loops	1 ~ 65535	-	1	After restart	Setup	P
Pn71F	2	Pgm step 3 Next program step	-1 ~ 15	-	-1	After restart	Setup	P
Pn720	2	Pgm step 4 mode selection	0000 ~ 0001	-	0001	After restart	Setup	P
		n.□□□X	Relative/absolute position selection					
			0	absolute position				
			1	relative position				
		n.X X X□	Reserved parameter (Do not change.)					
Pn721	2	Pgm step 4 target position	-1073747823 ~ 1073741823	1 reference unit	0	After restart	Setup	P
Pn723	2	Pgm step 4 positioning speed	0 ~ 65535	100 reference unit/s	100	After restart	Setup	P
Pn724	2	Pgm step 4 end condition	0000 ~ 0005	-	0000	After restart	Setup	P
		n.□□□X	Step condition					
			0	The step ends when the /COIN (positioning completion output) signal turns ON (closed).				
			1	The step Ends when the /NEAR signal width is entered.				
			2	The step ends when position reference distribution is completed (DEN).				

		3	Execution waits for milliseconds after the /COIN (positioning completion output) signal turns ON (closed)					
		4	Execution waits for milliseconds after the /NEAR (NEAR Output) signal turns ON (closed)					
		5	Execution waits for milliseconds after position reference distribution is completed (DEN).					
		n.X X X□	Reserved parameter (Do not change.)					
Pn725	2	Pgm step 4 Wait time	1 ~ 65535	1ms	0	After restart	Setup	P
Pn726	2	Pgm step 4 Number of loops	1 ~ 65535	-	1	After restart	Setup	P
Pn727	2	Pgm step 4 Next program step	-1 ~ 15	-	-1	After restart	Setup	P
Pn728	2	Pgm step 5 mode selection	0000 ~ 0001	-	0001	After restart	Setup	P
		n.□□□X	Relative/absolute position selection					
			0	absolute position				
			1	relative position				
		n.X X X□	Reserved parameter (Do not change.)					
Pn729	2	Pgm step 5 target position	-1073747823 ~ 1073741823	1 reference unit	0	After restart	Setup	P
Pn72B	2	Pgm step 5 positioning speed	0 ~ 65535	100 reference unit/s	100	After restart	Setup	P
Pn72C	2	Pgm step 5 end condition	0000 ~ 0005	-	0000	After restart	Setup	P
		n.□□□X	Step condition					
			0	The step ends when the /COIN (positioning completion output) signal turns ON (closed).				
			1	The step Ends when the /NEAR signal width is entered.				
			2	The step ends when position reference distribution is completed (DEN).				
			3	Execution waits for milliseconds after the /COIN (positioning completion output) signal turns ON (closed)				
			4	Execution waits for milliseconds after the /NEAR (NEAR Output) signal turns ON (closed)				
			5	Execution waits for milliseconds after position reference distribution is completed (DEN).				
		n.X X X□	Reserved parameter (Do not change.)					
Pn72D	2	Pgm step 5 Wait time	1 ~ 65535	1ms	0	After restart	Setup	P
Pn72E	2	Pgm step 5 Number of loops	1 ~ 65535	-	1	After restart	Setup	P
Pn72F	2	Pgm step 5 Next program step	-1 ~ 15	-	-1	After restart	Setup	P
Pn730	2	Pgm step 6 mode selection	0000 ~ 0001	-	0001	After restart	Setup	P
		n.□□□X	Relative/absolute position selection					
			0	absolute position				
			1	relative position				
		n.X X X□	Reserved parameter (Do not change.)					
Pn731	2	Pgm step 6 target position	-1073747823 ~ 1073741823	1 reference unit	0	After restart	Setup	P
Pn733	2	Pgm step 6 positioning speed	0 ~ 65535	100 reference unit/s	100	After restart	Setup	P
Pn734	2	Pgm step 6 end condition	0000 ~ 0005	-	0000	After restart	Setup	P
		n.□□□X	Step condition					
			0	The step ends when the /COIN (positioning completion output) signal turns ON (closed).				
			1	The step Ends when the /NEAR signal width is entered.				
			2	The step ends when position reference distribution is completed (DEN).				

		3	Execution waits for milliseconds after the /COIN (positioning completion output) signal turns ON (closed)					
		4	Execution waits for milliseconds after the /NEAR (NEAR Output) signal turns ON (closed)					
		5	Execution waits for milliseconds after position reference distribution is completed (DEN).					
		n.X X X□	Reserved parameter (Do not change.)					
Pn735	2	Pgm step 6 Wait time	1 ~ 65535	1ms	0	After restart	Setup	P
Pn736	2	Pgm step 6 Number of loops	1 ~ 65535	-	1	After restart	Setup	P
Pn737	2	Pgm step 6 Next program step	-1 ~ 15	-	-1	After restart	Setup	P
Pn738	2	Pgm step 7 mode selection	0000 ~ 0001	-	0001	After restart	Setup	P
		n.□□□X	Relative/absolute position selection					
			0	absolute position				
			1	relative position				
		n.X X X□	Reserved parameter (Do not change.)					
Pn739	2	Pgm step 7 target position	-1073747823 ~ 1073741823	1 reference unit	0	After restart	Setup	P
Pn73B	2	Pgm step 7 positioning speed	0 ~ 65535	100 reference unit/s	100	After restart	Setup	P
Pn73C	2	Pgm step 7 end condition	0000 ~ 0005	-	0000	After restart	Setup	P
		n.□□□X	Step condition					
			0	The step ends when the /COIN (positioning completion output) signal turns ON (closed).				
			1	The step Ends when the /NEAR signal width is entered.				
			2	The step ends when position reference distribution is completed (DEN).				
			3	Execution waits for milliseconds after the /COIN (positioning completion output) signal turns ON (closed)				
			4	Execution waits for milliseconds after the /NEAR (NEAR Output) signal turns ON (closed)				
			5	Execution waits for milliseconds after position reference distribution is completed (DEN).				
		n.X X X□	Reserved parameter (Do not change.)					
Pn73D	2	Pgm step 7 Wait time	1 ~ 65535	1ms	0	After restart	Setup	P
Pn73E	2	Pgm step 7 Number of loops	1 ~ 65535	-	1	After restart	Setup	P
Pn73F	2	Pgm step 7 Next program step	-1 ~ 15	-	-1	After restart	Setup	P
Pn740	2	Pgm step 8 mode selection	0000 ~ 0001	-	0001	After restart	Setup	P
		n.□□□X	Relative/absolute position selection					
			0	absolute position				
			1	relative position				
		n.X X X□	Reserved parameter (Do not change.)					
Pn741	2	Pgm step 8 target position	-1073747823 ~ 1073741823	1 reference unit	0	After restart	Setup	P
Pn743	2	Pgm step 8 positioning speed	0 ~ 65535	100 reference unit/s	100	After restart	Setup	P
Pn744	2	Pgm step 8 end condition	0000 ~ 0005	-	0000	After restart	Setup	P
		n.□□□X	Step condition					
			0	The step ends when the /COIN (positioning completion output) signal turns ON (closed).				
			1	The step Ends when the /NEAR signal width is entered.				
			2	The step ends when position reference distribution is completed (DEN).				

			3	Execution waits for milliseconds after the /COIN (positioning completion output) signal turns ON (closed)				
			4	Execution waits for milliseconds after the /NEAR (NEAR Output) signal turns ON (closed)				
			5	Execution waits for milliseconds after position reference distribution is completed (DEN).				
		n.X X X□	Reserved parameter (Do not change.)					
Pn745	2	Pgm step 8 Wait time	1 ~ 65535	1ms	0	After restart	Setup	P
Pn746	2	Pgm step 8 Number of loops	1 ~ 65535	-	1	After restart	Setup	P
Pn747	2	Pgm step 8 Next program step	-1 ~ 15	-	-1	After restart	Setup	P
Pn748	2	Pgm step 9 mode selection	0000 ~ 0001	-	0001	After restart	Setup	P
		n.□□□X	Relative/absolute position selection					
			0	absolute position				
			1	relative position				
		n.X X X□	Reserved parameter (Do not change.)					
Pn749	2	Pgm step 9 target position	-1073747823 ~ 1073741823	1 reference unit	0	After restart	Setup	P
Pn74B	2	Pgm step 9 positioning speed	0 ~ 65535	100 reference unit/s	100	After restart	Setup	P
Pn74C	2	Pgm step 9 end condition	0000 ~ 0005	-	0000	After restart	Setup	P
		n.□□□X	Step condition					
			0	The step ends when the /COIN (positioning completion output) signal turns ON (closed).				
			1	The step Ends when the /NEAR signal width is entered.				
			2	The step ends when position reference distribution is completed (DEN).				
			3	Execution waits for milliseconds after the /COIN (positioning completion output) signal turns ON (closed)				
			4	Execution waits for milliseconds after the /NEAR (NEAR Output) signal turns ON (closed)				
			5	Execution waits for milliseconds after position reference distribution is completed (DEN).				
		n.X X X□	Reserved parameter (Do not change.)					
Pn74D	2	Pgm step 9 Wait time	1 ~ 65535	1ms	0	After restart	Setup	P
Pn74E	2	Pgm step 9 Number of loops	1 ~ 65535	-	1	After restart	Setup	P
Pn74F	2	Pgm step 9 Next program step	-1 ~ 15	-	-1	After restart	Setup	P
Pn750	2	Pgm step 10 mode selection	0000 ~ 0001	-	0001	After restart	Setup	P
		n.□□□X	Relative/absolute position selection					
			0	absolute position				
			1	relative position				
		n.X X X□	Reserved parameter (Do not change.)					
Pn751	2	Pgm step 10 target position	-1073747823 ~ 1073741823	1 reference unit	0	After restart	Setup	P
Pn753	2	Pgm step 10 positioning speed	0 ~ 65535	100 reference unit/s	100	After restart	Setup	P
Pn754	2	Pgm step 10 end condition	0000 ~ 0005	-	0000	After restart	Setup	P
		n.□□□X	Step condition					
			0	The step ends when the /COIN (positioning completion output) signal turns ON (closed).				
			1	The step Ends when the /NEAR signal width is entered.				
			2	The step ends when position reference distribution is completed (DEN).				

		3	Execution waits for milliseconds after the /COIN (positioning completion output) signal turns ON (closed)					
		4	Execution waits for milliseconds after the /NEAR (NEAR Output) signal turns ON (closed)					
		5	Execution waits for milliseconds after position reference distribution is completed (DEN).					
		n.X X X□	Reserved parameter (Do not change.)					
Pn755	2	Pgm step 10 Wait time	1 ~ 65535	1ms	0	After restart	Setup	P
Pn756	2	Pgm step 10 Number of loops	1 ~ 65535	-	1	After restart	Setup	P
Pn757	2	Pgm step 10 Next program step	-1 ~ 15	-	-1	After restart	Setup	P
Pn758	2	Pgm step 11 mode selection	0000 ~ 0001	-	0001	After restart	Setup	P
		n.□□□X	Relative/absolute position selection					
			0	absolute position				
			1	relative position				
		n.X X X□	Reserved parameter (Do not change.)					
Pn759	2	Pgm step 11 target position	-1073747823 ~ 1073741823	1 reference unit	0	After restart	Setup	P
Pn75B	2	Pgm step 11 positioning speed	0 ~ 65535	100 reference unit/s	100	After restart	Setup	P
Pn75C	2	Pgm step 11 end condition	0000 ~ 0005	-	0000	After restart	Setup	P
		n.□□□X	Step condition					
			0	The step ends when the /COIN (positioning completion output) signal turns ON (closed).				
			1	The step Ends when the /NEAR signal width is entered.				
			2	The step ends when position reference distribution is completed (DEN).				
			3	Execution waits for milliseconds after the /COIN (positioning completion output) signal turns ON (closed)				
			4	Execution waits for milliseconds after the /NEAR (NEAR Output) signal turns ON (closed)				
			5	Execution waits for milliseconds after position reference distribution is completed (DEN).				
		n.X X X□	Reserved parameter (Do not change.)					
Pn75D	2	Pgm step 11 Wait time	1 ~ 65535	1ms	0	After restart	Setup	P
Pn75E	2	Pgm step 11 Number of loops	1 ~ 65535	-	1	After restart	Setup	P
Pn75F	2	Pgm step 11 Next program step	-1 ~ 15	-	-1	After restart	Setup	P
Pn760	2	Pgm step 12 mode selection	0000 ~ 0001	-	0001	After restart	Setup	P
		n.□□□X	Relative/absolute position selection					
			0	absolute position				
			1	relative position				
		n.X X X□	Reserved parameter (Do not change.)					
Pn761	2	Pgm step 12 target position	-1073747823 ~ 1073741823	1 reference unit	0	After restart	Setup	P
Pn763	2	Pgm step 12 positioning speed	0 ~ 65535	100 reference unit/s	100	After restart	Setup	P
Pn764	2	Pgm step 12 end condition	0000 ~ 0005	-	0000	After restart	Setup	P
		n.□□□X	Step condition					
			0	The step ends when the /COIN (positioning completion output) signal turns ON (closed).				
			1	The step Ends when the /NEAR signal width is entered.				
			2	The step ends when position reference distribution is completed (DEN).				

		3	Execution waits for milliseconds after the /COIN (positioning completion output) signal turns ON (closed)					
		4	Execution waits for milliseconds after the /NEAR (NEAR Output) signal turns ON (closed)					
		5	Execution waits for milliseconds after position reference distribution is completed (DEN).					
		n.X X X□	Reserved parameter (Do not change.)					
Pn765	2	Pgm step 12 Wait time	1 ~ 65535	1ms	0	After restart	Setup	P
Pn766	2	Pgm step 12 Number of loops	1 ~ 65535	-	1	After restart	Setup	P
Pn767	2	Pgm step 12 Next program step	-1 ~ 15	-	-1	After restart	Setup	P
Pn768	2	Pgm step 13 mode selection	0000 ~ 0001	-	0001	After restart	Setup	P
	n.□□□X	Relative/absolute position selection						
		0	absolute position					
		1	relative position					
	n.X X X□	Reserved parameter (Do not change.)						
Pn769	2	Pgm step 13 target position	-1073747823 ~ 1073741823	1 reference unit	0	After restart	Setup	P
Pn76B	2	Pgm step 13 positioning speed	0 ~ 65535	100 reference unit/s	100	After restart	Setup	P
Pn76C	2	Pgm step 13 end condition	0000 ~ 0005	-	0000	After restart	Setup	P
	n.□□□X	Step condition						
		0	The step ends when the /COIN (positioning completion output) signal turns ON (closed).					
		1	The step Ends when the /NEAR signal width is entered.					
		2	The step ends when position reference distribution is completed (DEN).					
		3	Execution waits for milliseconds after the /COIN (positioning completion output) signal turns ON (closed)					
		4	Execution waits for milliseconds after the /NEAR (NEAR Output) signal turns ON (closed)					
		5	Execution waits for milliseconds after position reference distribution is completed (DEN).					
	n.X X X□	Reserved parameter (Do not change.)						
Pn76D	2	Pgm step 13 Wait time	1 ~ 65535	1ms	0	After restart	Setup	P
Pn76E	2	Pgm step 13 Number of loops	1 ~ 65535	-	1	After restart	Setup	P
Pn76F	2	Pgm step 13 Next program step	-1 ~ 15	-	-1	After restart	Setup	P
Pn770	2	Pgm step 14 mode selection	0000 ~ 0001	-	0001	After restart	Setup	P
	n.□□□X	Relative/absolute position selection						
		0	absolute position					
		1	relative position					
	n.X X X□	Reserved parameter (Do not change.)						
Pn771	2	Pgm step 14 target position	-1073747823 ~ 1073741823	1 reference unit	0	After restart	Setup	P
Pn773	2	Pgm step 14 positioning speed	0 ~ 65535	100 reference unit/s	100	After restart	Setup	P
Pn774	2	Pgm step 14 end condition	0000 ~ 0005	-	0000	After restart	Setup	P
	n.□□□X	Step condition						
		0	The step ends when the /COIN (positioning completion output) signal turns ON (closed).					
		1	The step Ends when the /NEAR signal width is entered.					
		2	The step ends when position reference distribution is completed (DEN).					

			3	Execution waits for milliseconds after the /COIN (positioning completion output) signal turns ON (closed)				
			4	Execution waits for milliseconds after the /NEAR (NEAR Output) signal turns ON (closed)				
			5	Execution waits for milliseconds after position reference distribution is completed (DEN).				
		n.X X X□	Reserved parameter (Do not change.)					
Pn775	2	Pgm step 14 Wait time	1 ~ 65535	1ms	0	After restart	Setup	P
Pn776	2	Pgm step 14 Number of loops	1 ~ 65535	-	1	After restart	Setup	P
Pn777	2	Pgm step 14 Next program step	-1 ~ 15	-	-1	After restart	Setup	P
Pn778	2	Pgm step 15 mode selection	0000 ~ 0001	-	0001	After restart	Setup	P
		n.□□□X	Relative/absolute position selection					
			0	absolute position				
			1	relative position				
		n.X X X□	Reserved parameter (Do not change.)					
Pn779	2	Pgm step 15 target position	-1073747823 ~ 1073741823	1 reference unit	0	After restart	Setup	P
Pn77B	2	Pgm step 15 positioning speed	0 ~ 65535	100 reference unit/s	100	After restart	Setup	P
Pn77C	2	Pgm step 15 end condition	0000 ~ 0005	-	0000	After restart	Setup	P
		n.□□□X	Step condition					
			0	The step ends when the /COIN (positioning completion output) signal turns ON (closed).				
			1	The step Ends when the /NEAR signal width is entered.				
			2	The step ends when position reference distribution is completed (DEN).				
			3	Execution waits for milliseconds after the /COIN (positioning completion output) signal turns ON (closed)				
			4	Execution waits for milliseconds after the /NEAR (NEAR Output) signal turns ON (closed)				
			5	Execution waits for milliseconds after position reference distribution is completed (DEN).				
		n.X X X□	Reserved parameter (Do not change.)					
Pn77D	2	Pgm step 15 Wait time	1 ~ 65535	1ms	0	After restart	Setup	P
Pn77E	2	Pgm step 15 Number of loops	1 ~ 65535	-	1	After restart	Setup	P
Pn77F	2	Pgm step 15 Next program step	-1 ~ 15	-	-1	After restart	Setup	P

*1. Percentage relative to motor rated torque.

*2. Normally set to "0". When an external regenerative resistor is used, set the capacity value (W) of the regenerative resistor.

*3. The upper limit value is the maximum output capacity (W) of the applicable servo drive.

*4. Effective after SENS_ON.

*5. Changing during operation will affect the command output, so please make changes while the command is stopped (DEN=1).

*6. The value is updated only when the instruction is stopped (DEN=1).

Chapter11. Tuning Software (ProTuner)

Using the host computer software (ProTuner), the following functions can be realized online:

- Parameter management: parameter setting and adjustment
- Status monitoring: Monitor the working status and related data of the servo system
- Use tracking: Use tracking for servo power, instructions, output current and other related data
- Auxiliary debugging: realize online auxiliary debugging of servo functions using the host computer

11.1 ProTuner Connect and login



1. Install the ProTuner debugging software on the PC

2. Connect the PC to the MiniUSB interface on the servo drive panel operator through a USB cable Connection, the communication interface is shown in the picture on the right.

3. After the communication line is correctly connected, execute the ProTuner debugging software on the PC (as shown in the picture).
When the [User Login] window is displayed, click the [Search] button (Figure 1).
4. After the [Connect] window is displayed, select the searched drive address 1 or address 2, and then click the [Connect] button (Figure 2).
5. After the connection is successful, the [System Monitoring] shortcut window (Figure 3) and [ProTuner] debugging window (Figure 4) will be displayed. ◦

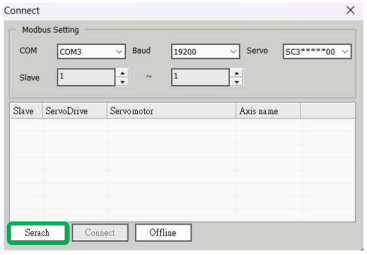


Figure 1

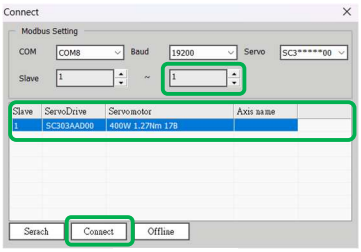


Figure 2

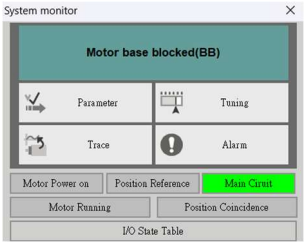


Figure 3

At this time, the ProTuner debugging software is successfully connected.

- In the [ProTuner] debugging window, you can selectively monitor various statuses of the servo in each window.
- In the menu bar of the [ProTuner] debugging window, you can click the debugging shortcut button to enter the debugging interface. ◦

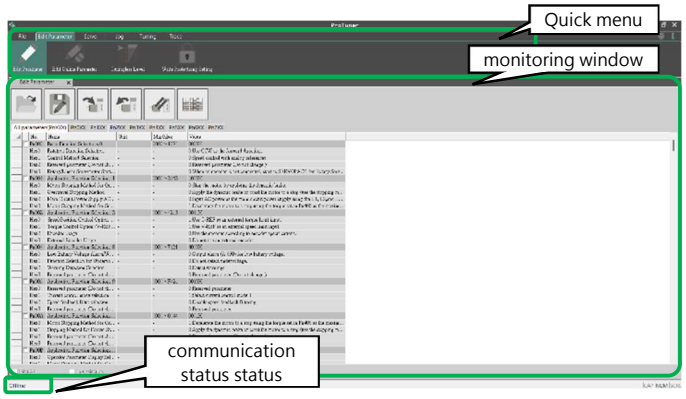


Figure 4

11.2 Automatic Adjustment (No Upper-Level Commands)

Automatic Adjustment (No Upper-Level Commands) refers to the functionality where the servo unit operates autonomously (reciprocating motion in both forward and reverse) without receiving commands from upper-level devices, and adjusts itself during operation based on mechanical characteristics.
The automatic adjustment items are as follows:

- Moment of inertia ratio
- Gain adjustment (speed loop gain, position loop gain)
- Filter adjustments (torque command filter, notch filter)
- Friction compensation
- Anti-resonance control
- Vibration suppression

Automatic Adjustment (No Upper-Level Commands) adjustment is explained.

- Automatic Adjustment (No Upper-Level Commands) Adjust based on the set speed loop gain (Pn100). If vibration occurs at the beginning of adjustment, correct adjustment will not be possible. Please reduce the speed loop gain (Pn100) until the vibration no longer occurs and then make adjustments.
- Automatic Adjustment (No Upper-Level Commands) cannot be executed while the adjustment-free function is enabled (Pn170= n.□□□1 [Default Setting]). Please disable the adjustment-free function (Pn170 = n.□□□0) before making adjustments。
- After executing Automatic Adjustment (No Upper-Level Commands), change the load status or transmission mechanism of the machine, and set the "estimated moment of inertia" again. When executing Automatic Adjustment (No Upper-Level Commands), please refer to the following setting parameters. If automatic adjustment is performed in a state other than the following (without upper bit command), it may cause mechanical vibration and damage to the machine。

  Pn140 = n.□□□0 (Not using model tracking control)
  Pn160 = n.□□□0 (Not using anti-resonance control)
  Pn408 = n.00□0 (Not using friction compensation, first-stage and second-stage notch filters)

  NOTE: When using a digital operator, if the above parameters are not displayed, please select the setting to display all parameters (Pn00B = n.□□□1) and then power cycle the device.

■Things to confirm before execution

Before executing Automatic Adjustment (No Upper-Level Commands), please ensure the following settings are confirmed:

- Main Circuit Power supply must be ON。
- There must be no over-travel.
- The system must be in the servo OFF state.
- Torque control must not be active.
- The gain switch must be set to manual gain switching (Pn139 = n.□□□0).
- The first gain must be selected.
- No error alarms or warnings should be present.
- STO must be in the OFF state *1.
- The write protection setting for parameters must not be set to "Write Prohibited."
- The adjustment-free function must be disabled (Pn170 = n.□□□0), or if the adjustment-free function is enabled (Pn170 = n.□□□1), it must be set to "Estimated Moment of Inertia."
- When executing in speed control mode, the mode selection must be set to 1.

*1: STO is an optional feature.

■Operation steps

1、Confirm that the moment of inertia ratio has been set correctly (Pn103).

2、Connect the servo drive, and in the ProTuner [System Diagnostics] window, click the [Tuning] button in the workspace (see Figure 5).

Alternatively, click the tuning shortcut button from the context menu in the [ProTuner] debugging window ()。

3、In the [Tuning] window, click the [Execute] button (see Figure 6).

4、 Enter the [Tuning Axis] window (see Figure 7).

- Select the [Automatic Adjustment] group.
- Choose [No Reference Input].
- Click the [Automatic Adjustment] button.

5、 Enter the [Automatic Adjustment Setting Conditions] window (see Figure 8) and set the following:

- [Switch Load Inertia (Load Quality) Estimation] field
- [Mode Selection] field
- [Mechanism Selection] field
- [Distance] field
- [Adjustment Parameters] field

Then click【Next】

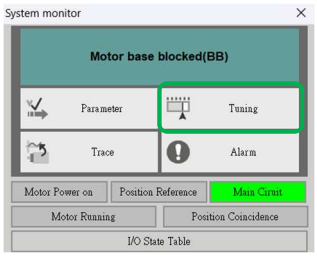


Figure 5

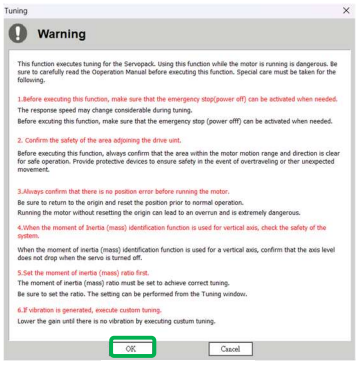


Figure 6

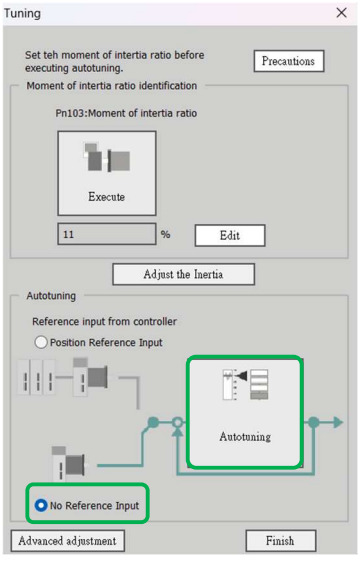
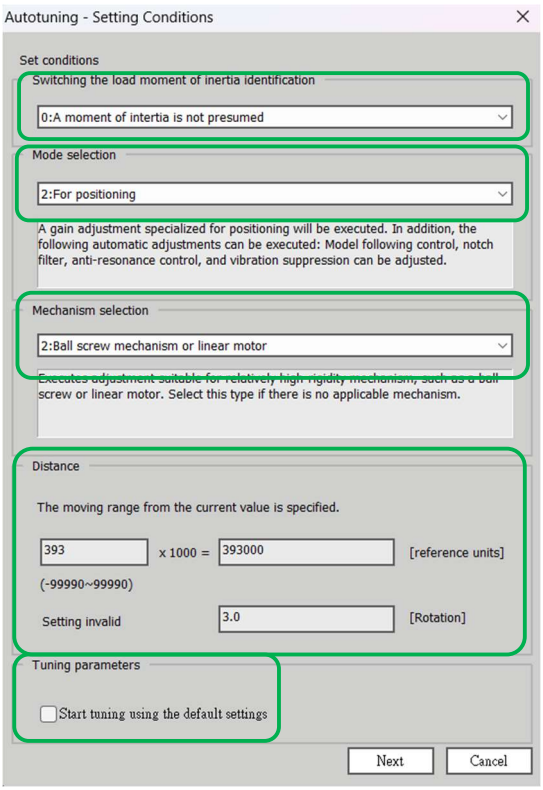


Figure 7



- Select to switch load moment of inertia (load mass) estimation
  0 : Do not estimate moving inertia [Factory Setting]
  1 : Estimate moving inertia

- Mode Selection

Mode Selection	illustrate
1 : standard	Make standard gain adjustments. In addition to gain adjustment, notch filter and low-frequency resonance suppression (Anti-resonance) are also automatically adjusted.
2 : Location	Make positioning-specific adjustments. In addition to gain adjustment, model tracking control, notch filter, low-frequency resonance suppression (Anti-resonance) and vibration suppression are also automatically adjusted.
3 : Location (Be careful not to overshoot)	Perform positioning-specific adjustments (adjustments that focus on not overshooting). In addition to gain adjustment, notch filter, low-frequency resonance suppression (Anti-resonance) and vibration suppression are also automatically adjusted.

- Institutional selection

Institutional selection	illustrate
1 : Belt drive mechanism	Make adjustments suitable for low-rigidity mechanisms such as belt mechanisms.
2 : Ball screw mechanism or linear servo mechanism	Make adjustments suitable for highly rigid mechanisms such as ball screw mechanisms or linear servo motors. Please select this type if there is no corresponding organization.
3 : rigid body mechanism	Make adjustments suitable for highly rigid mechanisms such as rigid body systems.

- distance

Set the moving distance.
Movement range: -99990000 ~ +99990000 [reference unit]
Minimum setting scale of moving distance: 1000 [reference unit]
Initial setting value:
Rotary servo motor approximately 3 turns
Direct drive servo motor approximately 0.3 turns
Linear servo motor about 90mm
Please set it to a value higher than the following value. In addition, to ensure adjustment accuracy, it is recommended to set the movement distance around the initial setting value. ◦
Rotary servo motor 0.5 turn
Direct drive servo motor 0.05 turn
Linear servo motor 5mm

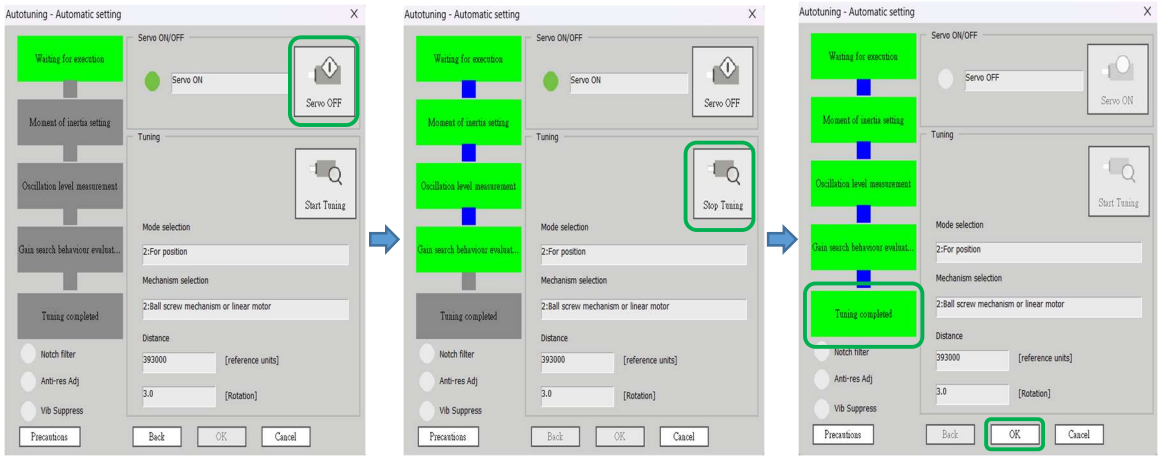
- Adjust parameters

Specify the tuning parameters to use.
If the [Start adjustment with preset values] check box is checked, adjustment will be performed after the adjustment parameters are restored to the factory condition.

6、Enter the [Auto Adjustment] window

Click the [Servo On] button ()，to energize the servo motor.

Next, click the [Start Adjustment] button ()，the servo motor rotates and the adjustment is performed.



Automatically detects vibration generated during adjustment and makes optimal settings for the generated vibration. After the setting is completed, the executed function box will light up.

7、After the adjustment is completed, click the [Finish] button to return to the [Tuning Axis] window. At this point, the operation of Automatic Adjustment (No Upper-Level Commands) is completed.

Common Error Alarms

1. Error alarm when powering on for the first time [A.810] Encoder backup error alarm:

Pn002【Application Function Selections 2】:□1□□

n.□X□□	Encoder Usage	
	0	Use the encoder according to encoder specifications.
	1	Use the encoder as an incremental encoder.
	2	Use the encoder as a single-turn absolute encoder.

2.Error alarm when powering on for the first time [A.F10] The power line is missing a phase (in the Main Circuit PowerON state, one of the L1, L2, and L3 phases has a low voltage state that lasts for more than 1 second)

Pn00b【Application Function Selections B】:□1□□

n.□X□□	Power Input Selection for Three-phase SERVOPACK	
	0	Use a three-phase power supply input.
	1	Use a three-phase power supply input as a single-phase power supply input.

Common parameters【X set parameter position】

1. Motor Direction Change

Pn000【Basic Function Selections 0】: 0000【Factory settings】

n.□□□X	Movement Direction Selection	
	0	Use CCW as the forward direction.。
	1	Use CW as the forward direction. (Reverse Rotation Mode)

2. Rigid setting (Pn100, Pn101, Pn102) and Inertia setting (Pn103)

Parameter No.	Size	Name	Setting Range	Setting Unit	出廠設定
Pn100	2	Speed Loop Gain	10 ~ 20000	0.1 Hz	400
Pn101	2	Speed Loop Integral Time Constant	15 ~ 51200	0.01 ms	2000
Pn102	2	Position Loop Gain	10 ~ 20000	0.1/s	400
Pn103	2	Moment of Inertia Ratio	0 ~ 20000	1%	100

3. Control filter selection

Pn200【Position Control Reference Form Selections】: 0000【Factory settings】

n.X□□□	Filter Selection	
	0	Use the reference input filter for a line-driver signal. (1 Mpps max.)
	1	Use the reference input filter for an open-collector signal. (200 page 6-31 kpps max.)
	2	Use reference input filter 2 for a line-driver signal. (1 to 4 Mpps)

4. Electronic gear ratio setting

Pn20E【Electronic Gear Ratio(Numerator)】:131072【17 Bit encoder】; 8388608【23 Bit encoder】

Pn210【Electronic Gear Ratio(Denominator)】:1000

5. Operation settings

Pn50A【Input Signal Selections 1】:

8881【"Forward rotation side can be driven"; enable: power on enable】

0881【"Forward rotation side can be driven"; enable : Enable forward drive when CN1-IN0 input signal is ON (closed).】

Pn50B【Input Signal Selections 2】: 8889【 "Set the signal to always prohibit forward drive." 】

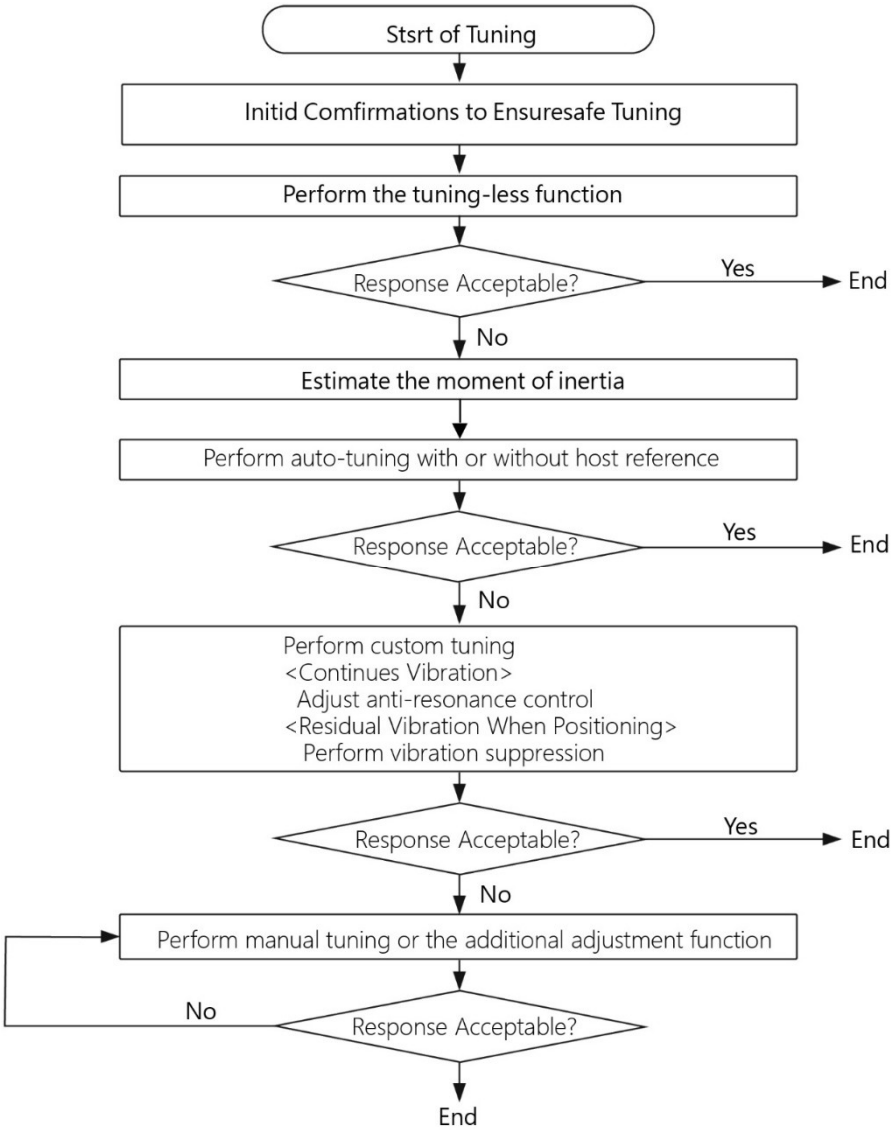
Chapter12. Tuning

12.1 Overview and Flow of Tuning

Tuning is performed to optimize response by adjusting the servo gains in the servo driver.

The servo gains are set using a combination of parameters, such as parameters for the speed loop gain, position loop gain, filters, friction compensation, and moment of inertia ratio. These parameters influence each other, so you must consider the balance between them.

The servo gains are set to stable settings by default. Use the various tuning functions to increase the response even further for the conditions of your machine.
The basic tuning procedure is shown in the following flowchart. Make suitable adjustments considering the conditions and operating requirements of your machine.



12.1.1 Tuning Functions

The following table provides an overview of the tuning functions.

Tuning Function	Outline	Applicable Control Methods	Reference
Tuning-less Function	This automatic adjustment function is designed to enable stable operation without servo tuning. This function can be used to obtain a stable response regardless of the type of machine or changes in the load. You can use it with the default settings.	Speed control or position control	Page 12-10
Moment of Inertia Estimation	The moment of inertia ratio is calculated by operat-ing the Servomotor a few times. The moment of inertia ratio that is calculated here is used in other tuning functions.	Speed control, position control, or torque control	Page 12-13
Autotuning without Host Reference	The following parameters are automatically adjusted in the internal references in the servo driver during automatic operation. •Gains (e.g., position loop gain and speed loop gain) •Filters (torque reference filter and notch filters) •Friction compensation •Anti-resonance control •Vibration suppression	Speed control or position control	Page 12-20
Autotuning with Host Reference	The following parameters are automatically adjusted with the position reference input from the host controller while the machine is in operation. You can use this function for fine-tuning after you perform autotuning without a host reference. •Gains (e.g., position loop gain and speed loop gain) •Filters (torque reference filter and notch filters) •Friction compensation •Anti-resonance control •Vibration suppression	Position control	Page 12-29
Custom Tuning	The following parameters are adjusted with the position reference or speed reference input from the host controller while the machine is in operation. •Gains (e.g., position loop gain and speed loop gain) •Filters (torque reference filter and notch filters) •Friction compensation •Anti-resonance control	Speed control or position control	Page 12-36
Anti-resonance Control Adjustment	This function effectively suppresses continuous vibration.	Speed control or position control	Page 12-44
Vibration Suppression	This function effectively suppresses residual vibra-tion if it occurs when positioning.	Position control	Page 12-47
Additional Adjustment Function	This function combines autotuning with custom tuning. You can use it to improve adjustment results.	Depends on the functions that you use.	Page 12-51
Manual Tuning	You can manually adjust the servo gains to adjust the response.	Speed control, position control, or torque control	Page 12-58

12.1.2 Diagnostic Tool

You can use the following tools to measure the frequency characteristics of the machine and set notch filters.

Diagnostic Tool	Outline	Applicable Control Methods	Reference
Easy FFT	The machine is subjected to vibration to detect resonance frequencies. The measurement results are displayed only as numeric data.	Speed control, position control, or torque control	Page 12-74

12.2 Monitoring Methods

You can use the data tracing function of the ProTuner or the analog monitor signals of the servo driver for monitoring. If you perform custom tuning or manual tuning, always use the above functions to monitor the machine operating status and servo driver signal waveform while you adjust the servo gains.

Check the adjustment results with the following response waveforms.

- Position Control

Item	Unit	
	Rotary Servomotor	Linear Servomotor
Torque reference	%	
Feedback speed	min^{-1}	mm/s
Position reference speed	min^{-1}	mm/s
Position deviation	Reference units	

- Speed Control

Item	Unit	
	Rotary Servomotor	Linear Servomotor
Torque reference	%	
Feedback speed	min^{-1}	mm/s
Reference speed	min^{-1}	mm/s

- Torque Control

Item	Unit	
	Rotary Servomotor	Linear Servomotor
Torque reference	%	
Feedback speed	min^{-1}	mm/s

12.3 Precautions to Ensure Safe Tuning

⚠ CAUTION

Observe the following precautions when you perform tuning.

- Do not touch the rotating parts of the motor when the servo is ON.
- Before starting the Servomotor, make sure that an emergency stop can be performed at any time.
- Make sure that trial operation has been successfully performed without any problems.
- Provide an appropriate stopping device on the machine to ensure safety.

Perform the following settings in a way that is suitable for tuning.

12.3.1 Overtravel Settings

Overtravel settings are made to force the Servomotor to stop for a signal input from a limit switch when a moving part of the machine exceeds the safe movement range.

12.3.2 Torque Limit Settings

You can limit the torque that is output by the Servomotor based on calculations of the torque required for machine operation. You can use torque limits to reduce the amount of shock applied to the machine when problems occur, such as collisions or interference. If the torque limit is lower than the torque that is required for operation, overshooting or vibration may occur.

12.3.3 Setting the Position Deviation Overflow Alarm Level

The position deviation overflow alarm is a protective function that is enabled when the servo driver is used in position control.

If the alarm level is set to a suitable value, the servo driver will detect excessive position deviation and will stop the Servomotor if the Servomotor operation does not agree with the refer

ence.

The position deviation is the difference between the position reference value and the actual position.

You can calculate the position deviation from the position loop gain (Pn102) and the motor speed with the following formula.

- Rotary Servomotors

$$\text{Position deviation [reference units]} = \frac{\text{Motor speed [min}^{-1}\text{]}}{60} \times \frac{\text{Encoder resolution}^{*1}}{\text{Pn102 [0.1/s]/10}^{*2,\,*3}} \times \frac{\text{Pn210}}{\text{Pn20E}}$$

- Linear Servomotors

$$\text{Position deviation [reference units]} = \frac{\text{Motor speed [mm/s]}}{\text{Pn102 [0.1/s]/10}^{*2,\,*3}} \times \frac{\text{Resolution}}{\text{Linear encoder pitch [μm]/1,000}} \times \frac{\text{Pn210}}{\text{Pn20E}}$$

Position Deviation Overflow Alarm Level (Pn520) [setting unit: reference units]

- Rotary Servomotors

$$Pn520 > \frac{\text{Maximum motor speed [min}^{-1}\text{]}}{60} \times \frac{\text{Encoder resolution}^{*1}}{\text{Pn102 [0.1/s]}/10^{*2,*3}} \times \frac{Pn210}{Pn20E} \times \underline{(1.2 \text{ to } 2)^{*4}}$$

*1. Refer to the following section for details.

*2. When model following control (Pn140 = n. 1) is enabled, use the setting of Pn141 (Model Following Control Gain) instead of the setting of Pn102 (Position Loop Gain).

*3. To check the setting of Pn102 on the Digital Operator, change the parameter display setting to display all parameters (Pn00B = n. 1).

*4. The underlined coefficient "× (1.2 to 2)" adds a margin to prevent an A.d00 alarm (Position Deviation Overflow) from occurring too frequently.

If you set a value that satisfies the formula, an A.d00 alarm (Position Deviation Overflow) should not occur during normal operation. If the Servomotor operation does not agree with the reference, position deviation will occur, an error will be detected , and the Servomotor will stop.

The following calculation example uses a Rotary Servomotor with a maximum motor speed of 6,000 and an encoder resolution of 16,777,216 (24 bits). Pn102 is set to 400.

$$Pn520 = \frac{6{,}000}{60} \times \frac{16{,}777{,}216}{400/10} \times \frac{1}{16} \times 2$$

$$= 2{,}621{,}440 \times 2$$

$$= 5{,}242{,}880 \text{ (default setting of Pn520)}$$

If the acceleration/deceleration rate required for the position reference exceeds the tracking capacity of the Servomotor, the tracking delay will increase and the position deviation will no longer satisfy the above formulas. If this occurs, lower the acceleration/deceleration rate so that the Servomotor can follow the position reference or increase the position deviation over-flow alarm level.

Related Parameters

Pn520	Position Deviation Overflow Alarm Level			Position	
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	1 ~ 1073741823	1 reference unit	5242880	Immediately	Setup

Related Alarms

Alarm Number	Alarm Name	Alarm Meaning
A.d00	Position Deviation Overflow	This alarm is displayed when the position deviation exceeds the set-ting of Pn520 (Position Deviation Overflow Alarm Level).

12.3.4 Vibration Detection Level Setting

You can set the vibration detection level (Pn312) to more accurately detect A.520 alarms (Vibration Alarm) and A.911 warnings (Vibration) when vibration is detected during machine operation.

Set the initial vibration detection level to an appropriate value. Refer to the following section for details.

12.3.5 Setting the Position Deviation Overflow Alarm Level at Servo ON

If the servo is turned ON when there is a large position deviation, the Servomotor will attempt to return to the original position to bring the position deviation to 0, which may create a hazardous situation. To prevent this, you can set a position deviation overflow alarm level at servo ON to restrict operation.

The related parameters and alarms are given in the following tables.

Related Parameters

Pn526	Position Deviation Overflow Alarm Level at Servo ON			Position	
	Setting Range	Setting Range	Default Setting	When Enabled	Classification
	1 ~ 1073741823	1 reference unit	5242880	Immediately	Setup

Pn528	Position Deviation Overflow Warning Level at Servo ON			Position	
	Setting Range	Setting Range	Default Setting	When Enabled	Classification
	10 ~ 100	1%	100	Immediately	Setup

Pn529	Speed Limit Level at Servo ON			Position	
	Setting Range	Setting Range	Default Setting	When Enabled	Classification
	0 ~ 10000	$1min^{-1}$	10000	Immediately	Setup

Related Alarms

Alarm Number	Alarm Name	Alarm Meaning
A.d01	Position Deviation Overflow Alarm at Servo ON	This alarm occurs if the servo is turned ON after the position deviation exceeded the setting of Pn526 (Position Deviation Overflow Alarm Level at Servo ON) while the servo was OFF.
A.d02	Position Deviation Overflow Alarm for Speed Limit at Servo ON	If position deviation remains in the deviation counter, the setting of Pn529 or Pn584 (Speed Limit Level at Servo ON) will limit the speed when the servo is turned ON. This alarm occurs if reference pulses are input and the setting of Pn520 (Position Deviation Overflow Alarm Level) is exceeded.

Refer to the following section for information on troubleshooting alarms.

12.4 Tuning-less Function

The tuning-less function performs autotuning to obtain a stable response regardless of the type of machine or changes in the load. Autotuning is started when the servo is turned ON.

⚠ CAUTION

- The tuning-less function is disabled during torque control.
- The Servomotor may momentarily emit a sound the first time the servo is turned ON after the Servomotor is connected to the machine. This sound is caused by setting the automatic notch filter. It does not indicate a problem. The sound will not be emitted from the next time the servo is turned ON.
- The Servomotor may vibrate if it exceeds the allowable load moment of inertia.
  If that occurs, set the tuning-less load level to 2 (Pn170 = n.2) or reduce the tuningless rigidity level (Pn170 = n. X).
- To ensure safety, make sure that you can perform an emergency stop at any time when you execute the tuning-less function.

12.4.1 Application Restrictions

The following application restrictions apply to the tuning-less function.

Function	Executable *	Remarks
Vibration Detection Level Initialization	O	-
Moment of Inertia Estimation	×	Disable the tuning-less function (Pn170 = n. 0) before you execute moment of inertia estimation.
Autotuning without Host Reference	×	Disable the tuning-less function (Pn170 = n. 0) before you execute autotuning without a host reference.
Autotuning with Host Reference	×	-
Custom Tuning	×	-
Anti-Resonance Control Adjustment	×	-
Vibration Suppression	×	-
EasyFFT	O	The tuning-less function is disabled while you execute Easy FFT and then it is enabled when Easy FFT has been completed.

*0: Yes ×: No

12.4.2 Operating Procedure

The tuning-less function is enabled in the default settings. No specific procedure is required. You can use the following parameter to enable or disable the tuning-less function.

Parameter		Meaning	When Enabled	Classification
Pn170	n.□□□0	Disable tuning-less function.	After restart	Setup
	n.□□□1 [default setting]	Enable tuning-less function.		
	n.□□0□ [default setting]	Use for speed control.		
	n.□□1□	Use for speed control and use host controller for position control.		

When you enable the tuning-less function, you can select the tuning-less type. Normally, set Pn14F to n. 2 (Use tuning-less type 3) (default setting).
If compatibility with previous models is required, set Pn14F to n. 0 (Use tuning-less type 1) or n. 1 (Use tuning-less type 2).

Parameter		Meaning	When Enabled	Classification
Pn14F	n.□□0□	Use tuning-less type 1.	After restart	Tuning
	n.□□1□ [default setting]	Use tuning-less type 2. (The noise level is improved more than with tuning-less type 1.)		

Tuning-less Level Settings

If vibration or other problems occur, change the tuning-less levels. To change the tuning-less levels, use the Protuner.

◆ Preparations

Always check the following before you set the tuning-less levels.

- The tuning-less function must be enabled (Pn170 = n. 1).

◆ Procedure

Use the following procedure to set the tuning-less levels.

In addition to the following procedure, you can also set the parameters directly. Refer to Related Parameters, below, for the parameters to set.

1. Select from the menu bar on the Protuner main screen [Setup] - [Response Level Setting]。
Setting [Response Level Setting] in the Menu Dialog Box.

2. Click the [▲] or [▼] Button to adjust the tuning-less level setting. Increase the tuning-less level setting to increase the response. Decrease the tuning-less level setting to suppress vibration. The default response level setting is 4.

Tuning-less Level	Description
"7"	Responselevel:High
"6"	
"5"	
"4" [default setting]	
"3"	
"2"	
"1"	Response level: Low

3. Click the Completed Button.
The adjustment results will be saved in the servo driver.

◆ Related Parameters

■ Tuning-less Rigidity Level

Parameter		Description	When Enabled	Classification
Pn170	n.□0□□	Tuning-less rigidity level 0 (low rigidity)	Immediately	Setup
	n.□1□□	Tuning-less rigidity level 1		
	n.□2□□	Tuning-less rigidity level 2		
	n.□3□□	Tuning-less rigidity level 3		
	n.□4□□ [default setting]	Tuning-less rigidity level 4		
	n.□5□□	Tuning-less rigidity level 5		
	n.□6□□	Tuning-less rigidity level 6		
	n.□7□□	Tuning-less rigidity level 7 (high rigidity)		

■ Tuning-less Load Level

Parameter		Description	When Enabled	Classification
Pn170	n.0□□□	Tuning-less load level 0	Immediately	Setup
	n.1□□□ [default setting]	Tuning-less load level 1		
	n.2□□□	Tuning-less load level 2		

12.4.3 Troubleshooting Alarms

An A.521 alarm (Autotuning Alarm) will occur if a resonant sound occurs or if excessive vibration occurs during position control. If an alarm occurs, implement the following measures.

- Resonant Sound
  Decrease the setting of Pn170 = n.X or the setting of Pn170 = n. X .
- Excessive Vibration during Position Control
  Increase the setting of Pn170 = n.X or decrease the setting of Pn170 = n. X .

12.4.4 Parameters Disabled by Tuning-less Function

Item	Parameter Name	Parameter Number
Gain-Related Parameters	Speed Loop Gain Second Speed Loop Gain	Pn100 Pn104
	Speed Loop Integral Time Constant Second Speed Loop Integral Time Constant	Pn101 Pn105
	Position Loop Gain Second Position Loop Gain	Pn102 Pn106
	Moment of Inertia Ratio	Pn103
Advanced Control-Related arameters	Anti-Resonance Control Selection	Pn160= n.□□□X

The tuning-less function is disabled during torque control, Easy FFT, and mechanical analysis for a vertical axis. The gain-related parameters in the above table are enabled for torque control, Easy FFT, and mechanical analysis. Of these, Pn100, Pn103, and Pn104 are enabled for torque control.

12.4.5 Automatically Adjusted Function Setting

You can also automatically adjust notch filters.

Normally, set Pn460 to n. 1 (Adjust automatically) (default setting). Vibration is automatically detected and a notch filter is set. Set Pn460 to n. 0 (Do not adjust automatically) only if you do not change the setting of the notch filter before you execute the tuning-less function.

Parameter		Meaning	When Enabled	Classification
Pn460	n.□0□□	Do not adjust the second stage notch filter automatically when the tuning-less function is enabled or during execution of autotuning without a host reference, autotuning with a host reference, and custom tuning.	Immediately	Tuning
	n.□1□□ [default setting]	Adjust the second stage notch filter automati cally when the tuning-less function is enabled or during execution of autotuning without a host reference, autotuning with a host reference, and custom tuning.		

12.4.6 Related Parameters

The following parameters are automatically adjusted when you execute the tuning-less function.

Do not manually change the settings of these parameters after you have enabled the tuning-less function.

Parameter	Name
Pn401	First Stage First Torque Reference Filter Time Constant
Pn40C	Second Stage Notch Filter Frequency
Pn40D	Second Stage Notch Filter Q Value

12.5 Estimating the Moment of Inertia

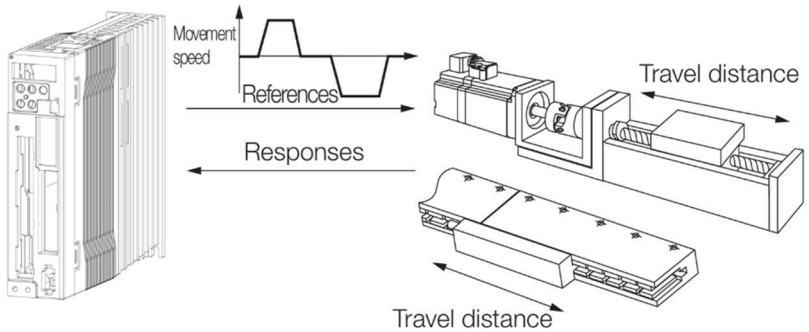
This section describes how the moment of inertia is calculated.
The moment of inertia ratio that is calculated here is used in other tuning functions. You can also estimate the moment of inertia during autotuning without a host reference. Refer to the following section for the procedure.

12.5.1 Outline

The moment of inertia during operation is automatically calculated by the servo driver for round-trip forward and reverse) operation. A reference from the host controller is not used.
The moment of inertia ratio (i.e., the ratio of the load moment of inertia to the motor moment of inertia) is a basic parameter for adjusting gains. It must be set as accurately as possible. Although the load moment of inertia can be calculated from the weight and structure of the mechanisms, doing so is very troublesome and calculating it accurately can be very difficult with the complex mechanical structures that are used these days. With moment of inertia estimation, you can get an accurate load moment of inertia simply by operating the Servomotor in the actual system in forward and reverse a few times.

The Servomotor is operated with the following specifications.

- Maximum speed: ±1,000 min-1 (can be changed)
- Acceleration rate: ±20,000 min-1/s (can be changed)
- Travel distance: ±2.5 rotations max. (can be changed)



NOTE: Execute moment of inertia estimation after jogging to a position that ensures a suitable range of motion.

12.5.2 Restrictions

The following restrictions apply to estimating the moment of inertia.

Systems for which Execution Cannot Be Performed

- When the machine system can move only in one direction
- When the range of motion is 0.5 rotations or less

Systems for Which Adjustments Cannot Be Made Accurately

- When a suitable range of motion is not possible
- When the moment of inertia changes within the set operating range
- When the machine has high dynamic friction
- When the rigidity of the machine is low and vibration occurs when positioning is performed
- When the position integration function is used
- When proportional control is used

NOTE:If you specify calculating the moment of inertia, an error will occur if the /P-CON (Proportional Control) signal changes to specify the proportional action during moment of inertia estimation

- When mode switching is used

NOTE:If you specify moment of inertia estimation, mode switching will be disabled and PI control will be used while the moment of inertia is being calculated. Mode switching will be enabled after moment of inertia estimation has been completed.

- When speed feedforward or torque feedforward is input

Preparations

Always check the following before you execute moment of inertia estimation.

- The main circuit power supply must be ON.
- There must be no overtravel.
- The servo must be OFF.
- The control method must not be set to torque control.
- The gain selection switch must be set to manual gain selection (Pn139 = n. 0).
- The first gains must be selected.
- There must be no alarms or warnings.
- There must be no hard wire base block (HWBB).
- The parameters must not be write prohibited.
- The tuning-less function must be disabled (Pn170 = n. 0).

12.5.3 Applicable Tools

The following table lists the tools that you can use to estimate the moment of inertia.

Tool	Fn No./Function Name	Operating Procedure Reference
Panel Operator	You cannot estimate the moment of inertia from the Panel Operator.	
Protuner	[Tuning] - [Tuning]	Operating Procedure

12.5.4 Operating Procedure

Use the following procedure to estimate the moment of inertia ratio.

⚠WARNING

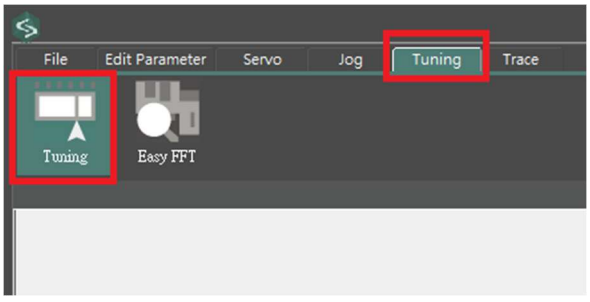
- Estimating the moment of inertia requires operating the Servomotor and therefore presents hazards. Observe the following precautions.
  - Confirm safety around moving parts.
    This function involves automatic operation with vibration. Make sure that you can perform an emergency stop (to turn OFF the power supply) at any time. There will be movement in both directions within the set range of movement. Check the range of movement and the directions and implement protective controls for safety, such as the overtravel functions. ◦

⚠CAUTION

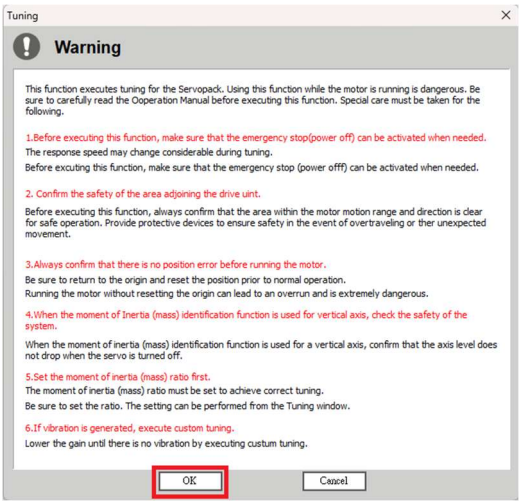
- Be aware of the following points if you cancel the moment of inertia estimation while the Servomotor is operating.
  - If you cancel operation with the Servo OFF Button, the Servomotor will stop according to setting of the Servo OFF stopping method (Pn001 = n. X).
  - If you cancel operation with the Cancel Button, the Servomotor will decelerate to a stop and then enter a zero-clamped state.

1. Select Tuning in the Menu Dialog Box.

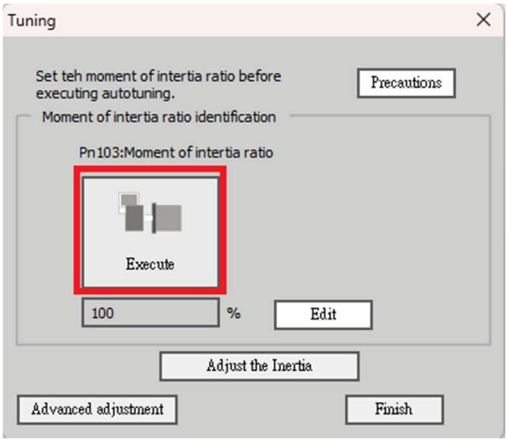
The Tuning Dialog Box will be displayed.



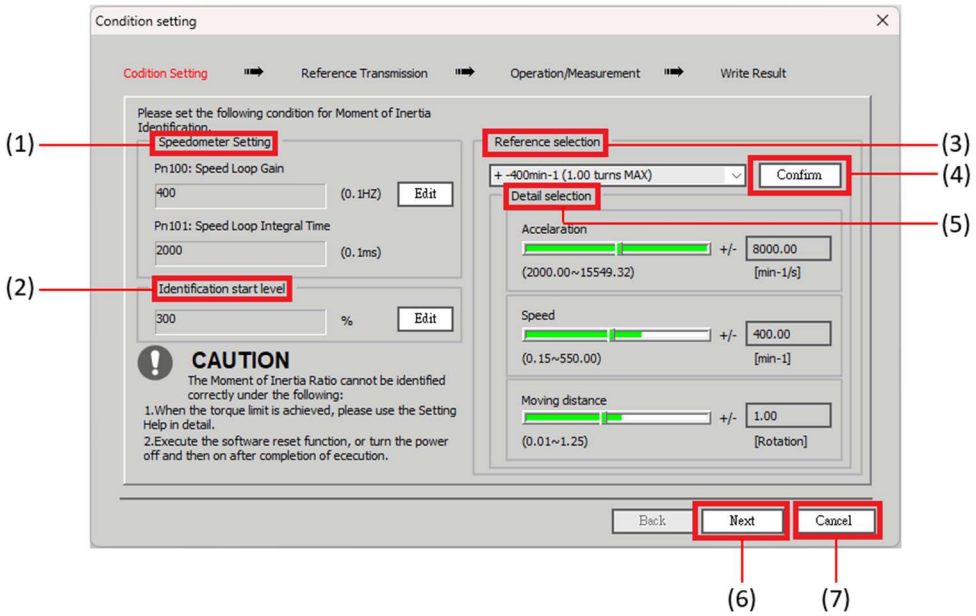
2. Click the OK Button.



3. Click the Execute Button.



4. Set the conditions as required.



(1) [Speed Loop Setting]

Make the speed loop settings in this area.
If the speed loop response is too bad, it will not be possible to measure the moment of inertia ratio accurately.
The values for the speed loop response that are required for moment of inertia estimation are set for the default settings.
It is normally not necessary to change these settings. If the default speed loop gain is too high for the machine (i.e., if vibration occurs), lower the setting. It is not necessary to increase the setting any farther.

(2) [Identification Start Level]

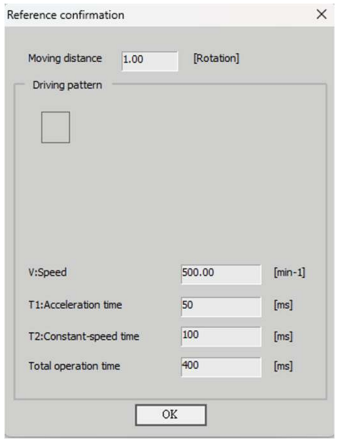
This is the setting of the moment of inertia calculation starting level.
If the load is large or the machine has low rigidity, the torque limit may be applied, caus-ing moment of inertia estimation to fail.
If that occurs, estimation may be possible if you double the setting of the start level.

(3) [Reference Selection]

Either select the reference pattern for estimation processing from the box, or set the val-ues in the Detailed Setting Group. Generally speaking, the larger the maximum acceler-ation rate is, the more accurate the moment of inertia estimation will be.
Set the maximum acceleration range within the possible range of movement considering the gear ratio, e.g., the pulley diameters or ball screw pitch.

(4) [Confirm]

Click this button to display the Reference Confirmation Dialog Box.



(5) [Detailed Setting]

You can change the settings by moving the bars or directly inputting the settings to cre-ate the required reference pattern.

(6) [Next]

(7) [Cancel]

Click this button to return to the Tuning Dialog Box.

⚠ CAUTION

- The travel distance is the distance for one operation in the forward or reverse direction. During multiple operations, the operation starting position may move in one direction or the other. Confirm the possible operating range for each measurement or operation.
- Depending on the parameter settings and the moment of inertia of the machine, overshooting and undershooting may occur and may cause the maximum speed setting to be exceeded temporarily. Allow sufficient leeway in the settings.

NOTE: Estimating the moment of inertia ratio cannot be performed correctly if the torque limit is activated. Adjust the limits or reduce the acceleration rate in the reference selection so that the torque limit is not activated. ◦

5. Click the Next Button.
The Reference Transmission Dialog Box will be displayed.

6. Click the Start Button



(1) [Start]
The reference conditions will be transferred to the servo driver. A progress bar will show the progress of the transfer.

(2) [Cancel]
The Cancel Button is enabled only while data is being transferred to the servo driver. You cannot use it after the transfer has been completed.

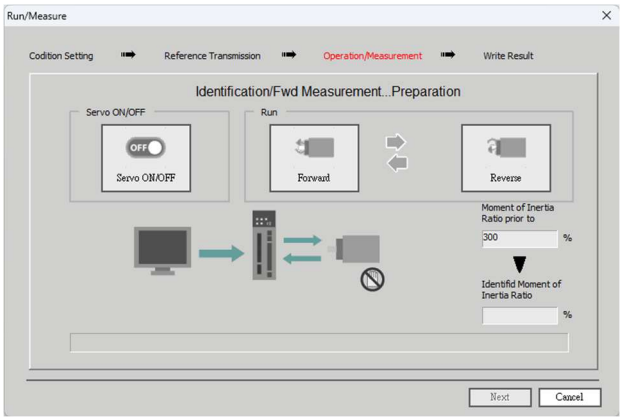
(3) [Back]
This button returns you to the Condition Setting Dialog Box. It is disabled while data is being transferred.

(4) [Next]
This button is enabled only when the data has been transferred correctly. You cannot use it if an error occurs or if you cancel the transfer before it is completed. Click the Next Button to display the Operation/Measurement Dialog Box. ◦

(5) [Cancel]
This button cancels processing and returns you to the Tuning Dialog Box.

7. Click the Next Button.
The Operation/Measurement Dialog Box will be displayed.

8. Click the Servo On Button.



9. Click the Forward Button.
The Servomotor shaft will rotate in the forward direction and the measurement will start.

10. Click the Reverse Button.

The Servomotor shaft will rotate in the reverse direction and the measurement will start. After the measurement and data transfer have been completed, the Forward Button will be displayed in color.

11. Repeat steps 8 to 9 until the Next Button is enabled.

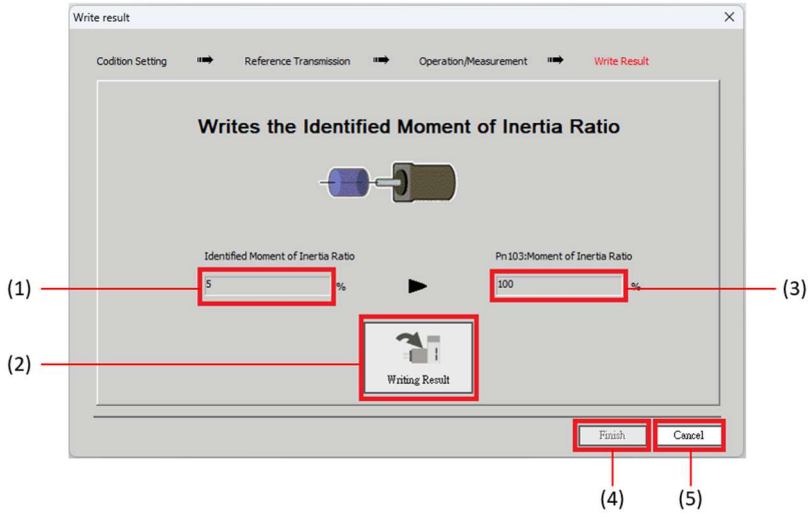
Measurements are performed from 2 to 7 times and then verified. The number of measurements is displayed in upper left corner of the dialog box.

12. When the measurements have been completed, click the Servo On Button to turn OFFthe servo.

13. Click the Next Button.

The Write Results Dialog Box will be displayed.

14. Click the Writing Results Button.



(1)[Identified Moment of Inertia Ratio]

The moment of inertia ratio that was found with operation and measurements is dis-played here.

(2) [Writing Results]

If you click this button, Pn103 (Moment of Inertia Ratio) in the servo driver is set to the value that is displayed for the identified moment of inertia ratio.

(3) [Pn103: Moment of Inertia Ratio Box]

The value that is set for the parameter is displayed here.

After you click the Writing Results Button, the value that was found with operation andmeasurements will be displayed as the new setting. ◦

(4)[Finish]

(5) [Cancel]

This button will return you to the Tuning Dialog Box.

15. Confirm that the Identified Moment of Inertia Ratio Box and the Pn103: Moment of Inertia Ratio Box show the same value and then click the Finish Button.

16. Click the Execute Button.



If the setting of the moment of inertia ratio (Pn103) was changed, the new value will be saved and the Tuning Dialog Box will be displayed again. ◦

12.6 Autotuning without Host Reference

This section describes autotuning without a host reference.

- Autotuning without a host reference performs adjustments based on the setting of the speed loop gain (Pn100). Therefore, precise adjustments cannot be made if there is vibration when adjustments are started. Make adjustments after lowering the speed loop gain (Pn100) until vibration is eliminated.
- You cannot execute autotuning without a host reference if the tuning-less function is enabled (Pn170 = n. 1 (default setting)). Disable the tuning-less function (Pn170 = n. 0) before you execute autotuning without a host reference.
- If you change the machine load conditions or drive system after you execute autotuning without a host reference and then you execute autotuning without a host reference with moment of inertia estimation specified, use the following parameter settings. If you execute autotuning without a host reference for any other conditions, the machine may vibrate and may be dam-aged.

  Pn140 = n. 0 (Do not use model following control.)

  Pn160 = n. 0 (Do not use anti-resonance control.)

  Pn408 = n.00 0 (Disable friction compensation, first stage notch filter, and second stage notch filter.)

  NOTE: If you are using the Digital Operator and the above parameters are not displayed, change the parameter display setting to display all parameters (Pn00B = n. 1) and then turn the power supply OFF and ON again.

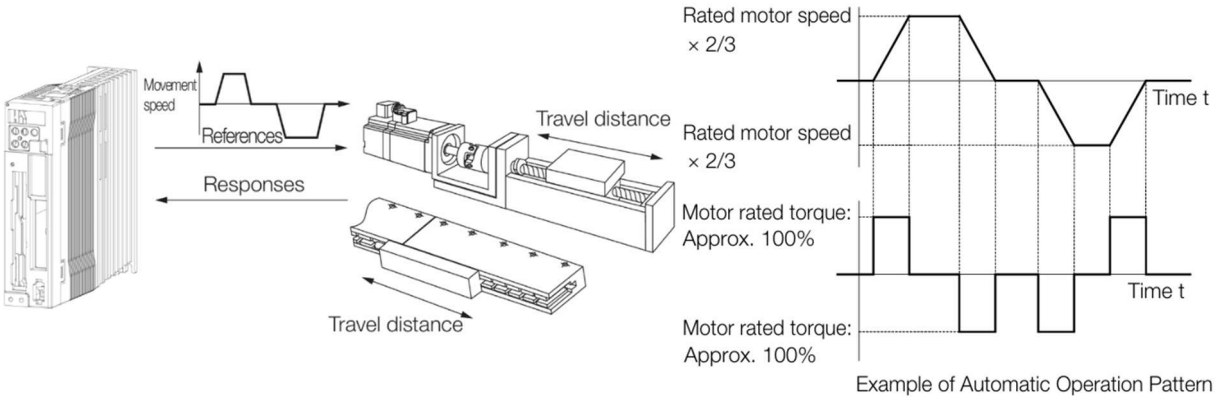
12.6.1 Outline

The following items are adjusted automatically.

- Moment of inertia ratio
- Gains (e.g., speed loop gain and position loop gain)
- Filters (torque reference filter and notch filters)
- Friction compensation
- Anti-resonance control
- Vibration suppression (only for mode 2 or 3)

The Servomotor is operated with the following specifications.

Maximum speed	Rated motor speed × 2/3	
Acceleration Torque	Rated motor torque: Approx. 100% NOTE: The acceleration torque depends on the setting of the moment of inertia ratio (Pn103), and the influences of machine friction and external disturbance. ◦	
Travel Distance	Rotary Servomotors	You can set the desired travel distance. The default setting is for a value equivalent to 3 Servomotor shaft rotations.
	Direct Drive Servomotors	You can set the desired travel distance. The default setting is for a value equivalent to 0.3 rotations.



Example of Automatic Operation Pattern

NOTE: Execute autotuning without a host reference after jogging to a position that ensures a suitable range of motion. ◦

⚠ WARNING

- Autotuning without a host reference requires operating the Servomotor and therefore presents hazards. Observe the following precaution.
  - Confirm safety around moving parts.
    This function involves automatic operation with vibration. Make sure that you can perform an emergency stop (to turn OFF the power supply) at any time. There will be movement in both directions within the set range of movement. Check the range of movement and the directions and implement protective controls for safety, such as the overtravel functions.

12.6.2 Restrictions

The following restrictions apply to autotuning without a host reference.

Systems for Which Execution Cannot Be Performed

- When the machine system can move only in one direction
- When the range of motion is 0.5 rotations or less

Systems for Which Adjustments Cannot Be Made Accurately

- When a suitable range of motion is not possible
- When the moment of inertia changes within the set operating range
- When the machine has high friction
- When the rigidity of the machine is low and vibration occurs when positioning is performed
- When the position integration function is used
- When proportional control is used

  NOTE: If you specify calculating the moment of inertia, an error will occur if the /P-CON (Proportional Control) signal changes to specify the proportional action during moment of inertia estimation.
- When mode switching is used

  NOTE:If you specify moment of inertia estimation, mode switching will be disabled and PI control will be used while the moment of inertia is being calculated. Mode switching will be enabled after moment of inertia estimation has been completed. ◦
- When speed feedforward or torque feedforward is input
- When the positioning completed width (Pn522) is too narrow

Preparations

Always check the following before you execute autotuning without a host reference.

- The main circuit power supply must be ON.
- There must be no overtravel.
- The servo must be OFF
- The control method must not be set to torque control.
- The gain selection switch must be set to manual gain selection (Pn139 = n. 0).
- The first gains must be selected.
- There must be no alarms or warnings.
- There must be no hard wire base block (HWBB).
- The parameters must not be write prohibited.”
- The tuning-less function must be disabled (Pn170 = n. 0), or the tuning-less function must be enabled (Pn170 = n. 1) (default setting) and moment of inertia estimation must be specified. ”
- If you execute autotuning without a host reference during speed control, set the mode to 1.

  NOTE: If you start autotuning without a host reference while the servo driver is in speed control for mode 2 or 3, the servo driver will change to position control automatically to perform autotuning without a host reference. The servo driver will return to speed control after autotuning has been completed. ◦

Reference pulse input multiplication switching is disabled during autotuning without a host reference.

12.6.3 Applicable Tools

Tool	Fn No./Function Name	Operating Procedure Reference
Panel Operator	-	You cannot perform autotuning without a host reference from the Panel Operator.
Digital Operator	Fn201	Operator Operating Manual
Protuner	[Tuning] - [Tuning]	Operating Procedure

12.6.4 Operating Procedure

Use the following procedure to perform autotuning without a host reference.

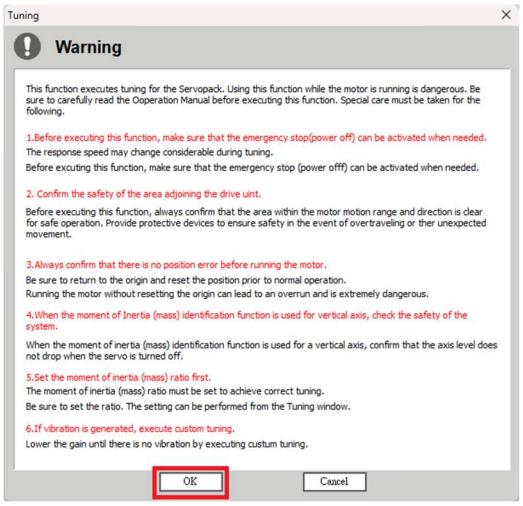
⚠ CAUTION

- If you specify not estimating the moment of inertia, set the moment of inertia ratio (Pn103) correctly. If the setting greatly differs from the actual moment of inertia ratio, normal control of the machine may not be possible, and vibration may result. ◦
- If you are using a SC3 If you are using a · set the mode selection to 1. If 2 or 3 is selected for the mode, correct phase control may not be possible.

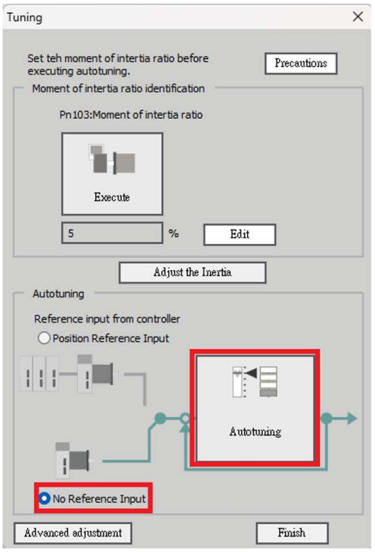
1. Confirm that the moment of inertia ratio (Pn103) is set correctly.

2. Select Tuning in the Menu Dialog Box.
The Tuning Dialog Box will be displayed.
Click the Cancel Button to cancel tuning.

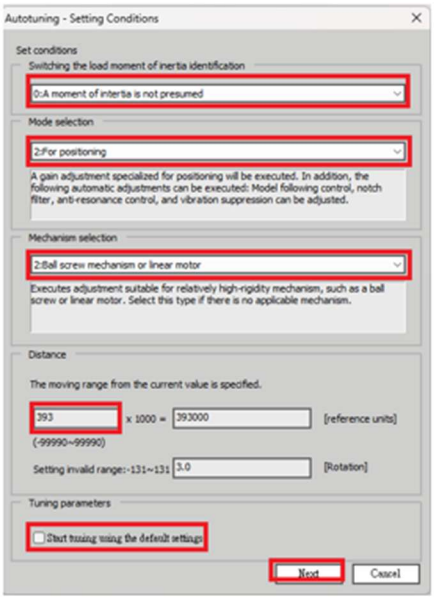
3. Click the OK Button.



4. Select the No Reference Input Option in the Autotuning Area and then click the Auto-tuning Button.。



5. Set the conditions in the Switching the load moment of inertia (load mass) identifica-tion Box, the Mode selection Box,the Mechanism selection Box, and the Distance Box, and then click the Next Button.



- **Distance** Box
  Set the travel distance.
  Movement range: -99,990,000 to +99,990,000 [reference units]
  Minimum setting increment for travel distance: 1,000 [reference units]
  Negative values are for reverse operation and positive values are for forward operation from the current position.
  Default settings:
  Rotary Servomotors: Approx. 3 rotations
  Direct Drive Servomotors: Approx. 0.3 rotations
  Linear Servomotors: Approx 90 mm
  Set the distance to the following values or higher. To ensure tuning precision, we recommend that you use approximately the default distance setting.
  Rotary Servomotors: 0.5 rotations
  Direct Drive Servomotors: 0.05 rotations
  Linear Servomotors: 5 mm

- **Switching the load moment of inertia (load mass) identification** Box
  Specify whether to estimate the moment of inertia.
  0: A moment of inertia is presumed. (default setting)
  1: A moment of inertia is not presumed.

- **Mode selection** Box
  Set the mode.

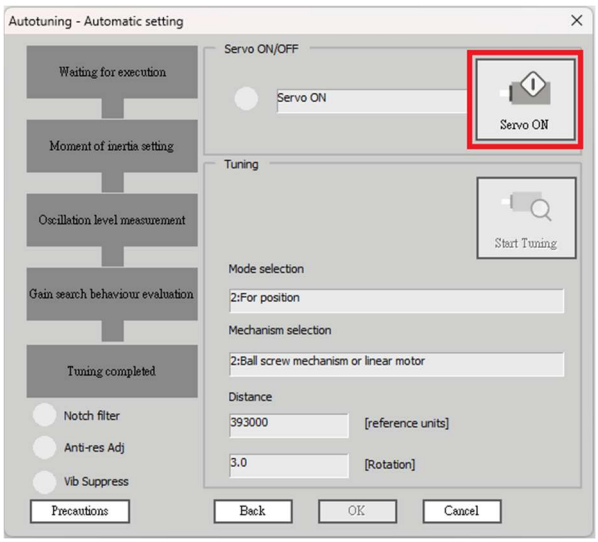
Mode Selection	Description
1: Standard	Standard gain adjustment is performed. In addition to gain adjustment, notch filters and anti-resonance control are automatically adjusted.
2: For positioning	Tuning is performed for positioning applications. In addition to gain adjustment, model following control, notch filters, anti-resonance control, and vibration suppression are automatically adjusted.
3: For positioning especially to prevent overshooting	Tuning is performed for positioning applications with emphasis on eliminating overshooting. In addition to gain adjustment, notch filters, anti-resonance control, and vibration suppression are automatically adjusted.

- **Mechanism selection** Box
  Select the type according to the machine element to drive.
  If there is noise or if the gain does not increase, better results may be obtained by changing the rigidity type.
  Select the type according to the following guidelines.

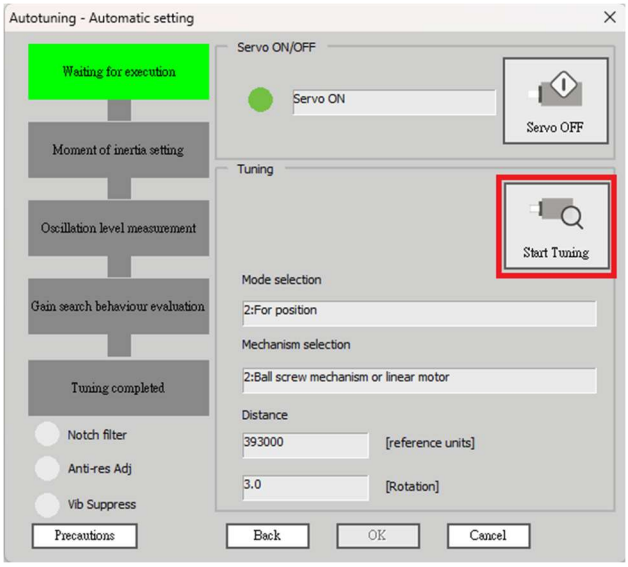
Mechanism Selection	Description
1: Belt mechanism	Tuning is performed for a mechanism with relatively low rigidity, e.g., a belt.
2: Ball screw mechanism or linear motor	Tuning is performed for a mechanism with relatively high rigidity, e.g., a ball screw or Linear Servomotor. Use this setting if there is no other appropriate setting.
3: Rigid model	Tuning is performed for a mechanism with high rigidity, e.g., a rigid body system.

- **Tuning parameters** Box
  Specify the parameters to use for tuning.
  If you select the **Start tuning using the default settings** Check Box, the tuning parameters will be returned to the default settings before tuning is started.

6. Click the Servo ON Button.



7. Click the Start tuning Button.



The Servomotor will start operating and tuning will be executed.
When the settings have been completed, the indicators for the functions that were used will light at the lower left of the dialog box.

8. When tuning has been completed, click the Finish Button.
The results of tuning will be set in the parameters and you will return to the Tuning Dialog Box.

This concludes the procedure to perform autotuning without a host reference.

12.6.5 Troubleshooting Problems in Autotuning without a Host Reference

The following tables give the causes of and corrections for problems that may occur in autotuning without a host reference.

Autotuning without a Host Reference Was Not Performed

Possible Cause	Corrective Action
Main circuit power supply is OFF.	Turn ON the main circuit power supply.
An alarm or warning occurred.	Remove the cause of the alarm or warning.
Overtraveling occurred.	Remove the cause of overtraveling.
The second gains were selected with the gain selection.	Disable automatic gain switching.
The HWBB was activated.	Release the HWBB.
The setting of the travel distance is too small.	Set the travel distance again in step 6 of the procedure.
The settings for the tuning-less function are not correct.	• Disable the tuning-less function (Pn170 = n. 0). • Enable the tuning-less function (Pn170 = n. 1) and specify moment of inertia estimation.

When an Error Occurs during Execution of Autotuning without a Host Reference

Error	Possible Cause	Corrective Action
The gain adjustments were not successfully completed.	Machine vibration occurs or the positioning completion signal is not stable when the Servomotor stops.	• Increase the setting of the positioning completed width (Pn522). • Change the mode from 2 to 3. • If machine vibration occurs, suppress the vibration with the anti-resonance control adjustment and the vibration suppression function.
An error occurred during calculation of the moment of inertia.	Refer to the following section for troubleshooting information. When an Error Occurs during Calculation of Moment of Inertia	
Positioning was not completed within approximately 10 seconds after position adjustment was completed.	The positioning completed width is too narrow or proportional control is being used.	• Increase the setting of the positioning completed width (Pn522). • Turn OFF the /P-CON (Proportional Control) signal.

When an Error Occurs during Calculation of Moment of Inertia

Possible Cause	Corrective Action
The servo driver started calculating the moment of inertia but the calculation was not completed.	• Increase the setting of the speed loop gain (Pn100). • Increase the stroke (travel distance).
The moment of inertia fluctuated greatly and did not converge within 10 tries.	Set Pn103 (Moment of Inertia Ratio) from the machine specifications and specify not estimating the moment of inertia.
Low-frequency vibration was detected.	Double the setting of moment of inertia calculation starting level (Pn324).
The torque limit was reached.	• If you are using the torque limit, increase the torque limit. • Double the setting of moment of inertia calculation starting level (Pn324).
The speed control section changed to proportional control during calculation of the moment of inertia, e.g., the /P-CON (Proportional Control) signal was input.	Use PI control when calculating the moment of inertia.

Adjustment Results Are Not Satisfactory for Position Control

You may be able to improve the adjustment results by changing the settings of the positioning completed width (Pn522) and the electronic gear ratio (Pn20E/Pn210).

- Pn561 = 100% (default setting)
- This will allow tuning with overshooting that is equivalent to the positioning completed width.
- Pn561 = 0%

  This will allow tuning to be performed without overshooting within the positioning completed width.

Pn561	Overshoot Detection Level			Speed	Position	Torque
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification	
	0 ~ 100	1%	100	Classification	Setup	

12.6.6 Automatically Adjusted Function Settings

You can specify whether to automatically adjust the following functions during autotuning.

◆ Automatic Notch Filters

Normally, set Pn460 to n. 1 (Adjust automatically) (default setting).

Vibration will be detected during autotuning without a host reference and a notch filter will be adjusted.

Set Pn460 to n. 0 (Do not adjust automatically) only if you do not change the setting of the notch filter before you execute this function.

Parameter		Function	When Enabled	Classification
Pn460	n.□□□0	Do not adjust the first stage notch filter auto matically during execution of autotuning with out a host reference, autotuning with a host reference, and custom tuning.	Immediately	Tuning
	n.□□□1 [default setting]	Adjust the first stage notch filter automatically during execution of autotuning without a host reference, autotuning with a host reference, and custom tuning.		
	n.□0□□	Do not adjust the second stage notch filter automatically when the tuning-less function is enabled or during execution of autotuning without a host reference, autotuning with a host reference, and custom tuning.		
	n.□1□□ [default setting]	Adjust the second stage notch filter automatically when the tuning-less function is enabled or during execution of autotuning without a host reference, autotuning with a host reference, and custom tuning.		

◆ Anti-Resonance Control Adjustment

This function reduces low vibration frequencies, for which the notch filters cannot be used.
Normally, set Pn160 to n. 1 (Adjust automatically) (default setting).
Vibration will be detected during autotuning without a host reference and anti-resonance control will be automatically adjusted.◦

Parameter		Function	When Enabled	Classification
Pn160	n.□□0□	Do not adjust anti-resonance control automatically during execution of autotuning without a host reference, autotuning with a host reference, and custom tuning.	Immediately	Tuning
	n.□□1□ [default setting]	Adjust anti-resonance control automatically during execution of autotuning without a host reference, autotuning with a host reference, and custom tuning.		

◆ Vibration Suppression

You can use vibration suppression to suppress transitional vibration at a low frequency from 1 Hz to 100 Hz, which is generated mainly when the machine vibrates during positioning.

Normally, set Pn140 to n. 1 (Adjust automatically) (default setting). Vibration will be detected during autotuning without a host reference and vibration suppression control will be automatically set.

Set Pn140 = n. 0 (Do not adjust automatically) only if you do not change the settings for vibration suppression before you execute autotuning without a host reference.

NOTE: Autotuning without a host reference uses model following control. Therefore, it can be executed only if the mode is set to 2 or 3.◦

Parameter		Function	When Enabled	Classification
Pn140	n.□0□□	Do not adjust vibration suppression automatically during execution of autotuning without a host reference, autotuning with a host reference, and custom tuning.	Immediately	Tuning
	n.□1□□ [default setting]	Adjust vibration suppression automatically during execution of autotuning without a host reference, autotuning with a host reference, and custom tuning.		

◆ Friction Compensation

Friction compensation compensates for changes in the following conditions.

- Changes in the viscous resistance of the lubricant, such as grease, on the sliding parts of the machine
- Changes in the friction resistance resulting from variations in the machine assembly
- Changes in the friction resistance due to aging

The conditions for applying friction compensation depend on the mode selection.

Mode Selection Settings	Friction Compensation
1 : Standard	Based on the setting of Pn408 = n.X (Friction Compensation Function Selection)*
2 : For position control	Adjusted with friction compensation.
3 : For position control (emphasis on overshooting)	

Parameter		Function	When Enabled	Classification
Pn408	n.0□□□ [default setting]	Disable friction compensation.	Immediately	Setup
	n.1□□□	Enable friction compensation.		

* Refer to the following section for details.

◆ Feedforward

If Pn140 is set to n.0 (Do not use model following control and speed/torque feedforward together (default setting)) and tuning is performed with the mode selection set to 2 or 3, feedforward (Pn109), the speed feedforward input (V-REF), and the torque feedforward input (TREF) will be disabled.
To use the speed feedforward input (V-REF), the torque feedforward input (T-REF), and model following control from the host controller in the system, set Pn140 to n.1 (Use model following control and speed/torque feedforward together).

Parameter		Function	When Enabled	Classification
Pn140	n.0□□□ [default setting]	Do not use model following control and speed/torque feedforward together.	Immediately	Setup
	n.1□□□	Use model following control and speed/torque feedforward together.		

Refer to the following section for information on the torque feedforward input (T-REF) and the speed feedforward input (V-REF).



When model following control is used with the feedforward function, it is used to make optimum feedforward settings in the ServoDriver. Therefore, model following control is not normally used together with either the speed feedforward input (V-REF) or torque feedforward input (T-REF) from the host controller. However, model following control can be used with the speed feedforward input (V-REF) or torque feedforward input (T-REF) if required. An unsuitable feedforward input may result in overshooting. ◦

12.6.7 Related Parameters

The following parameters are automatically adjusted or used as reference when you execute autotuning without a host reference.

Do not change the settings while autotuning without a host reference is being executed.

Parameter	Name	Automatic Changes
Pn100	Speed Loop Gain	Yes
Pn101	Speed Loop Integral Time Constant	Yes
Pn102	Position Loop Gain	Yes
Pn103	Moment of Inertia Ratio	Yes
Pn121	Friction Compensation Gain	Yes
Pn123	Friction Compensation Coefficient	Yes
Pn124	Friction Compensation Frequency Correction	No
Pn125	Friction Compensation Gain Correction	Yes
Pn401	First Stage First Torque Reference Filter Time Constant	Yes
Pn408	Torque-Related Function Selections	Yes
Pn409	First Stage Notch Filter Frequency	Yes
Pn40A	First Stage Notch Filter Q Value	Yes
Pn40C	Second Stage Notch Filter Frequency	Yes
Pn40D	Second Stage Notch Filter Q Value	Yes
Pn140	Model Following Control-Related Selections	Yes
Pn141	Model Following Control Gain	Yes
Pn142	Model Following Control Gain Correction	Yes
Pn143	Model Following Control Bias in the Forward Direction	Yes
Pn144	Model Following Control Bias in the Reverse Direction	Yes
Pn145	Vibration Suppression 1 Frequency A	Yes
Pn146	Vibration Suppression 1 Frequency B	Yes
Pn147	Model Following Control Speed Feedforward Compensation	Yes
Pn160	Anti-Resonance Control-Related Selections	Yes
Pn161	Anti-Resonance Frequency	Yes
Pn163	Anti-Resonance Damping Gain	Yes
Pn531	Program Jogging Travel Distance	No
Pn533	Program Jogging Movement Speed for Rotary Servomotor	No
Pn585	Program Jogging Movement Speed for Linear Servomotor	No
Pn534	Program Jogging Acceleration/Deceleration Time	No
Pn535	Program Jogging Waiting Time	No
Pn536	Program Jogging Number of Movements	No

Yes: The parameter is automatically set.

No: The parameter is not automatically set, but the setting is read during execution.

12.7 Autotuning with a Host Reference

This section describes autotuning with a host reference.

Autotuning with a host reference makes adjustments based on the set speed loop gain (Pn100). Therefore, precise adjustments cannot be made if there is vibration when adjustments are started. Make adjustments after lowering the speed loop gain (Pn100) until vibration is eliminated. ◦

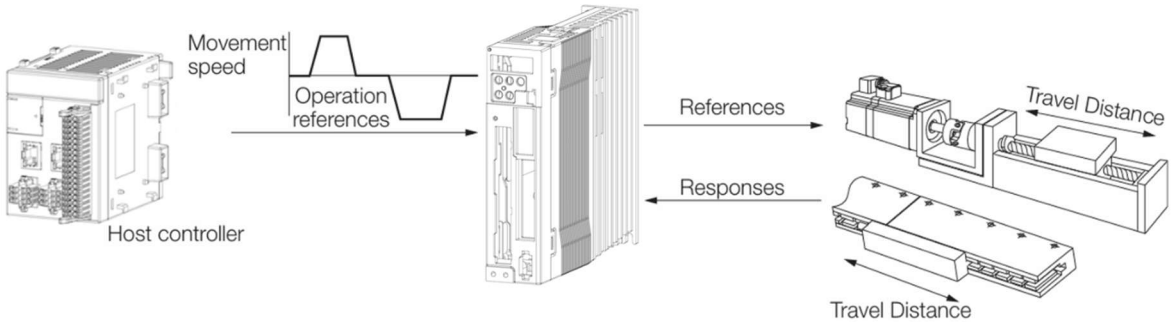
12.7.1 Outline

Autotuning with a host reference automatically makes optimum adjustments for operation references from the host controller. ◦

The following items are adjusted automatically.

- Gains (e.g., speed loop gain and position loop gain)
- Filters (torque reference filter and notch filters)
- Friction compensation
- Anti-resonance control
- Vibration suppression

Refer to the following section for details on the parameters that are adjusted.



CAUTION

- Because autotuning with a host reference adjusts the SERVOPACK during automatic operation, vibration or overshooting may occur. To ensure safety, make sure that you can perform an emergency stop at any time. ◦

12.7.2 Restrictions

Systems for Which Adjustments Cannot Be Made Accurately

Adjustments will not be made correctly for autotuning with a host reference in the following cases.

Use custom tuning.

- When the travel distance for the reference from the host controller is equal to or lower than the setting of the positioning completed width (Pn522)
- Rotary Servomotors: When the movement speed for the reference from the host controller is equal to or lower than the setting of the rotation detection level (Pn502)
- Linear Servomotors: When the movement speed for the reference from the host controller is equal to or lower than the setting of the zero speed level (Pn581)
- When the time required to stop is 10 ms or less
- When the rigidity of the machine is low and vibration occurs when positioning is performed
- When the position integration function is used
- When proportional control is used
- When mode switching is used
- When the positioning completed width (Pn522) is too narrow

Preparations

Always check the following before you execute autotuning with a host reference.

- The servo must be in ready status.
- There must be no overtravel. ◦
- The servo must be OFF.
- Position control must be selected if power is supplied to the motor (i.e., when the servo is ON).
- The gain selection switch must be set to manual gain selection (Pn139 = n. 0).
- The first gains must be selected.
- There must be no warnings.
- The tuning-less function must be disabled (Pn170 = n. 0).
- The parameters must not be write prohibited.

12.7.3 Applicable Tools

The following table lists the tools that you can use to perform autotuning with a host reference.

Tool	Fn No./Function Name	Operating Procedure Reference
Panel Operator	-	You cannot perform autotuning without a host reference from the Panel Operator.
Digital Operator	Fn202	Digital Operator Operating Manual
Protuner	[Tuning] - [Tuning]	Operating Procedure

12.7.4 Operating Procedure

Use the following procedure to perform autotuning with a host reference.

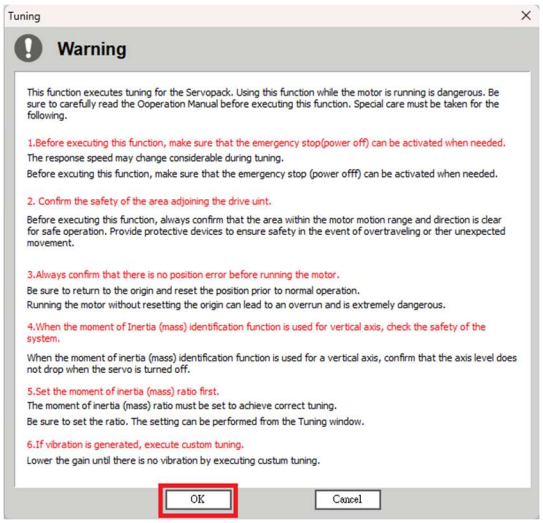
⚠ CAUTION

- If you are using an MP3000-Series Controller for phase control, set the mode selection to 1. If 2 or 3 is selected for the mode, correct phase control may not be possible.

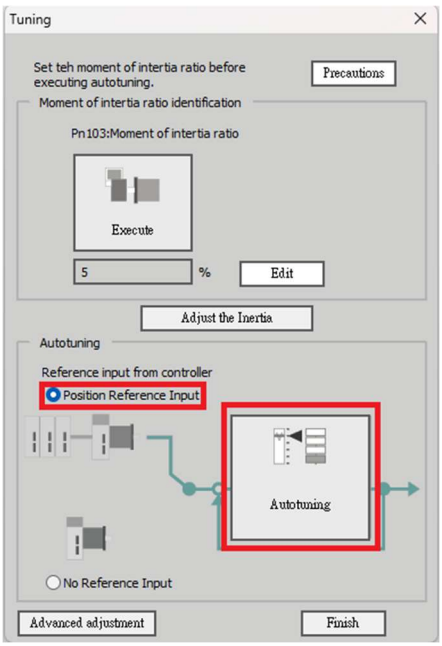
1. Confirm that the moment of inertia ratio (Pn103) is set correctly.

2. Select Tuning in the Menu Dialog Bot
The Tuning Dialog Box will be displayed.
Click the Cancel Button to cancel tuning.

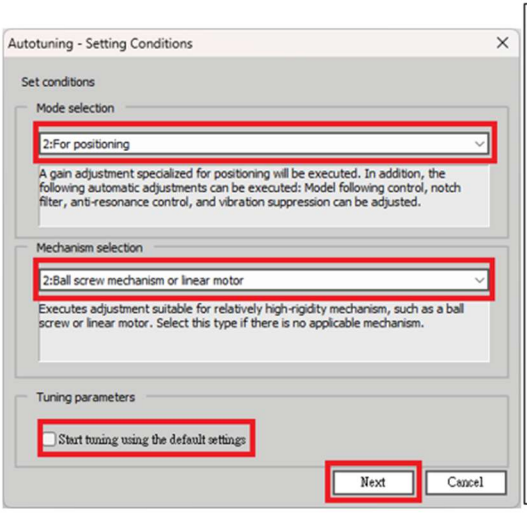
3. Click the OK Button.



4. Select the Position reference input Option in the Autotuning Area and then click the Autotuning Button.



Set the conditions in the Mode selection Box and the Mechanism selection Box, and then click the Next Button.
If you select the Start tuning using the default settings Check Box in the Tuning parameters Area, the tuning parameters will be returned to the default settings before tuning is started.



- **Mode selection** Box
  Set the mode.

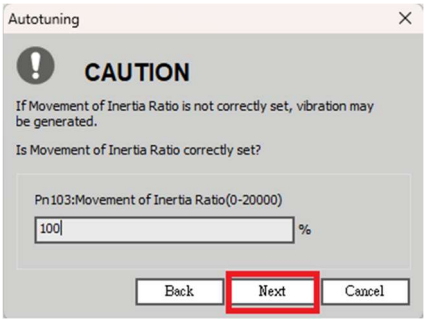
Mode Selection	Description
1: Standard	Standard gain adjustment is performed. In addition to gain adjustment, notch filters and anti-resonance control are automatically adjusted.
2: For positioning	Tuning is performed for positioning applications. In addition to gain adjustment, model following control, notch filters, anti-resonance control, and vibration suppression are automatically adjusted.
3: For positioning especially to prevent overshooting	Tuning is performed for positioning applications with emphasis on eliminating overshooting. In addition to gain adjustment, notch filters, anti-resonance control, and vibration suppression are automatically adjusted.

- **Tuning parameters** Box
  Specify the parameters to use for tuning. If you select the **Start tuning using the default settings** Check Box, the tuning parameters will be returned to the default settings before tuning is started.

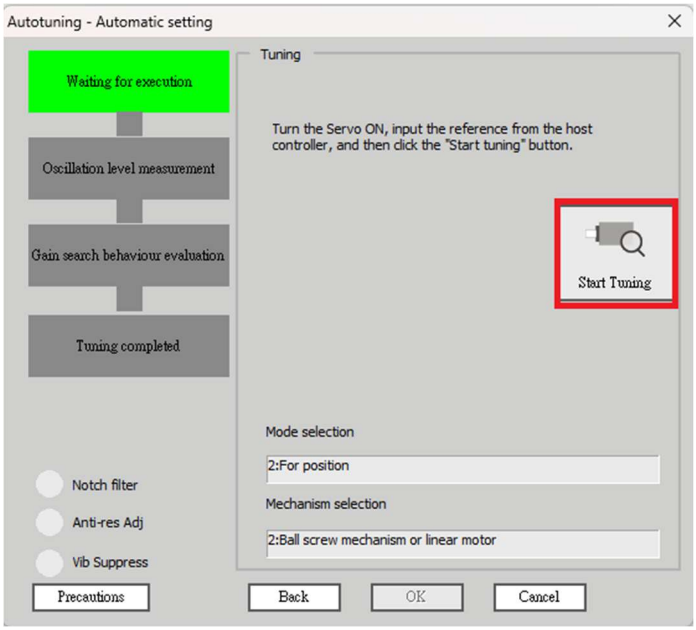
- **Mechanism selection** Box
  Select the type according to the machine element to drive.
  If there is noise or if the gain does not increase, better results may be obtained by changing the rigidity type. Select the type according to the following guidelines.

Mechanism Selection	Description
1: Belt mechanism	Tuning is performed for a mechanism with relatively low rigidity, e.g., a belt.
2: Ball screw mechanism or linear motor	Tuning is performed for a mechanism with relatively high rigidity, e.g., a ball screw or Linear Servomotor. Use this setting if there is no other appropriate setting.
3: Rigid model	Tuning is performed for a mechanism with high rigidity, e.g., a rigid body system.

5. Input the correct moment of inertia ratio and click the Next Button.



6. First confirm safety around moving parts. Then turn ON the servo, enter a reference from the host controller , and click the Start tuning Button.



Tuning will be executed.

Vibration that occurs during tuning will be detected automatically and suitable settings will be made for that vibration. When the settings have been completed, the indicators for the functions that were used will light at the lower left of the dialog box. ◦

7. When tuning has been completed, click the Finish Button.

The results of tuning will be set in the parameters and you will return to the Tuning Dialog Box.

This concludes the procedure to perform autotuning with a host reference.

12.7.5 Troubleshooting Problems in Autotuning with a Host Reference

The following tables give the causes of and corrections for problems that may occur in autotuning with a host reference.

◆ Autotuning with a Host Reference Was Not Performed

Possible Cause	Corrective Action
Main circuit power supply is OFF.	Turn ON the main circuit power supply.
An alarm or warning occurred.	Remove the cause of the alarm or warning.
Overtraveling occurred.	Remove the cause of overtraveling.
The second gains were selected with the gain selection.	Disable automatic gain switching.
The HWBB was activated.	Release the HWBB.

◆ Troubleshooting Errors

Error	Possible Cause	Corrective Action
The gain adjustments were not successfully completed.	Machine vibration occurs or positioning completion is not stable when the Servomotor stops.	• Increase the setting of the positioning completed width (Pn522). • Change the mode from 2 to 3. • If machine vibration occurs, suppress the vibration with the anti-resonance control adjustment and the vibration suppression function.
Positioning was not completed within approximately 10 seconds after position adjustment was completed.	The positioning completed width is too narrow or proportional control is being used.	• Increase the setting of the positioning completed width (Pn522). • Turn OFF the /P-CON (Proportional Control) signal.

◆ Adjustment Results Are Not Satisfactory for Position Control

You may be able to improve the adjustment results by changing the settings of the positioning completed width (Pn522) and the electronic gear ratio (Pn20E/Pn210).
If satisfactory results are still not possible, adjust the overshoot detection level (Pn561). That may improve the adjustment results.

- Pn561 = 100% [default setting]

This will allow tuning with overshooting that is equivalent to the positioning completed width.

- Pn561 = 0%

This will allow tuning to be performed without overshooting within the positioning completed width, but the positioning completed width may be extended.

Pn561	Overshoot Detection Level			Speed	Position	Torque
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification	
	0 ~ 100	1%	100	Immediately	Setup	

12.7.6 Automatically Adjusted Function Settings

These function settings are the same as for autotuning without a host reference. Refer to the following section.

12.6.6 Automatically Adjusted Function Settings

12.7.7 Related Parameters

The following parameters are automatically adjusted or used as reference when you execute autotuning with a host reference.
Do not change the settings while autotuning with a host reference is being executed.

Parameter	Name	Automatic Changes
Pn100	Speed Loop Gain	Yes
Pn101	Speed Loop Integral Time Constant	Yes
Pn102	Position Loop Gain	Yes
Pn103	Moment of Inertia Ratio	No
Pn121	Friction Compensation Gain	Yes
Pn123	Friction Compensation Coefficient	Yes
Pn124	Friction Compensation Frequency Correction	No
Pn125	Friction Compensation Gain Correction	Yes
Pn401	First Stage First Torque Reference Filter Time Constant	Yes
Pn408	Torque-Related Function Selections	Yes
Pn409	First Stage Notch Filter Frequency	Yes
Pn40A	First Stage Notch Filter Q Value	Yes
Pn40C	Second Stage Notch Filter Frequency	Yes
Pn40D	Second Stage Notch Filter Q Value	Yes
Pn140	Model Following Control-Related Selections	Yes
Pn141	Model Following Control Gain	Yes
Pn142	Model Following Control Gain Correction	Yes
Pn143	Model Following Control Bias in the Forward Direction	Yes
Pn144	Model Following Control Bias in the Reverse Direction	Yes
Pn145	Vibration Suppression 1 Frequency A	Yes
Pn146	Vibration Suppression 1 Frequency B	Yes
Pn147	Model Following Control Speed Feedforward Compensation	Yes
Pn160	Anti-Resonance Control-Related Selections	Yes
Pn161	Anti-Resonance Frequency	Yes
Pn163	Anti-Resonance Damping Gain	Yes

Yes: The parameter is automatically set.

No: The parameter is not automatically set, but the setting is read during execution.

12.8 Custom Tuning

This section describes custom tuning.

12.8.1 Outline

You can use custom tuning to manually adjust the servo during operation using a speed or position reference input from the host controller. You can use it to fine-tune adjustments that were made with autotuning.

The following items are adjusted automatically.

- Gains (e.g., speed loop gain and position loop gain)
- Filters (torque reference filter and notch filters)
- Friction compensation
- Anti-resonance control

Refer to the following section for details on the parameters that are adjusted.

There are two adjustment methods that you can use for custom tuning.

◆ **Tuning Mode 0 (Setting Servo Gains Giving Priority to Stability) or 1 (Setting Servo Gains Giving Priority to Good Response)**

These modes allow you to set stable control conditions for multiple servo gains by manipulating only one tuning level. Automatic setting of notch filters and anti-resonance control is provided if vibration is detected. Manual anti-resonance control adjustment is also possible during custom tuning. ◦

◆ **Tuning Mode 2 (Setting Servo Gains Giving Priority to Position Control Applications) or 3 (Setting Servo Gains Giving Priority to Preventing Overshooting in Position Control Applications)**

Two tuning levels are manipulated to reduce positioning time even further and set multiple servo gains.
Model following control is used to reduce the positioning time.
If vibration is detected, notch filters and anti-resonance control are automatically adjusted, and friction compensation is automatically set. Manual anti-resonance control adjustment and vibration suppression are also possible during custom tuning.

⚠ CAUTION

- **Vibration or overshooting may occur during custom tuning. To ensure safety, make sure that you can perform an emergency stop at any time.**

12.8.2 Preparations

Always check the following before you execute custom tuning.

- The tuning-less function must be disabled (Pn170 = n. 0).
- If speed control is used, tuning mode 0 or 1 must be set.
- The parameters must not be write prohibited.

12.8.3 Applicable Tools

The following table lists the tools that you can use to perform custom tuning.

Tool	Fn No./Function Name	Operating Procedure Reference
Panel Operator	-	You cannot perform custom tuning from the Panel Operator.
Digital Operator	Fn203	Digital Operator Operating Manual
Protuner	[Tuning] - [Tuning]	Operating Procedure

12.8.4 Operating Procedure

Use the following procedure to perform custom tuning.

⚠ WARNING

- Before you execute custom tuning, check the information provided in the ProTuner operating manual.

  Observe the following precautions.

  Make sure that you can perform an emergency stop at any time.

  When custom tuning is started, several parameters will be overwritten with the recommended settings, which may greatly affect the response before and after execution. Make sure that you can perform an emergency stop at any time.

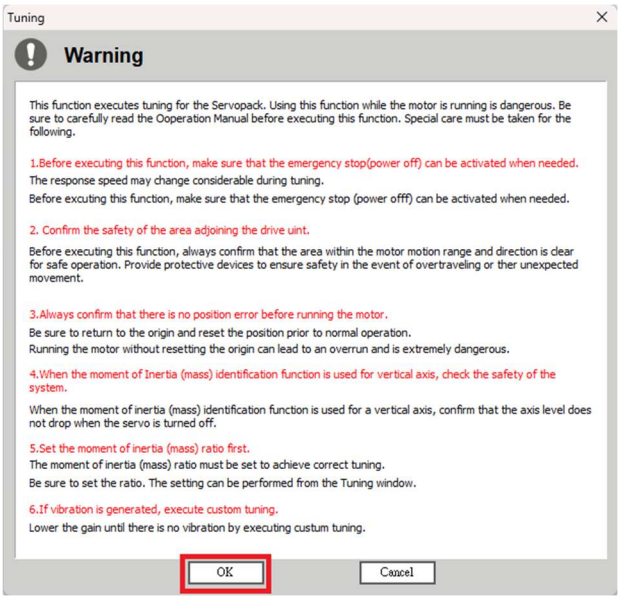
  Set the moment of inertia correctly before you execute custom tuning. If the setting greatly differs from the actual moment of inertia, vibration may occur.

  If you change the feedforward level, the new setting will not be used immediately. It will be used after positioning is completed. ◦

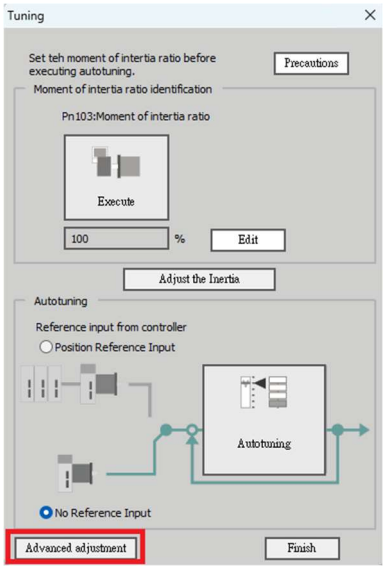
⚠ CAUTION

- If you are using an MP3000-series Controller for phase control, set the tuning mode to 0 or 1. If 2 or 3 is selected for the tuning mode, correct phase control may not be possible.

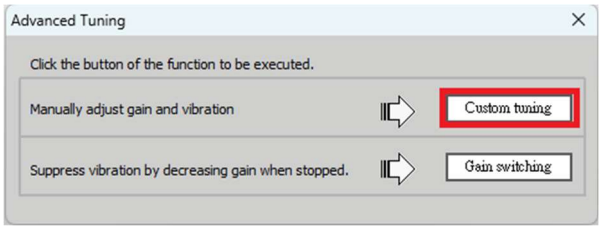
1. Confirm that the moment of inertia ratio (Pn103) is set correctly.
2. Select Tuning in the Menu Dialog Box.
   The Tuning Dialog Box will be displayed.
   Click the Cancel Button to cancel tuning.
3. Click the OK Button.



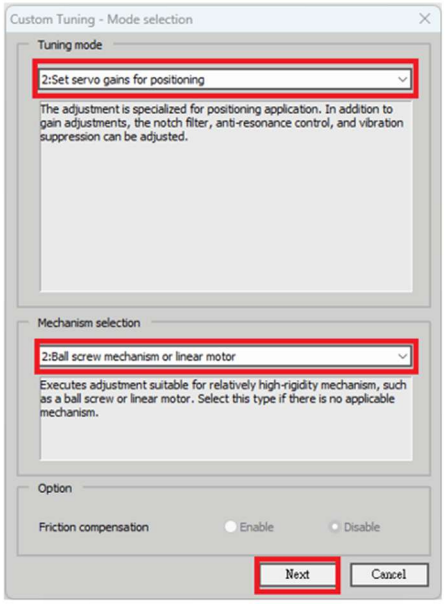
4. Click the Advanced adjustment Button.



5. Click the Custom tuning Button.



6. Set the Tuning mode Box and Mechanism selection Box, and then click the Next Button.



Tuning mode Box

Mode Selection	Description
0: Set servo gains with priority given to stability.	This setting gives priority to stability and preventing overshooting. In addition to gain adjustment, notch filters and anti-resonance control (except during torque control) are automatically adjusted.
1: Set servo gains with priority given to response.	Overshooting may occur because priority is given to response. In addition to gain adjustment, notch filters and anti-resonance control (except during torque control) are automatically adjusted.
2: Set servo gains for positioning application.	Tuning is performed for positioning applications. In addition to gain adjustment, notch filters, anti-resonance control, and vibration suppression are adjusted.
3: Set servo gains especially to prevent overshooting during positioning application.	Tuning is performed for positioning applications with emphasis on eliminating overshooting. In addition to gain adjustment, notch filters, anti-resonance control, and vibration suppression are adjusted.

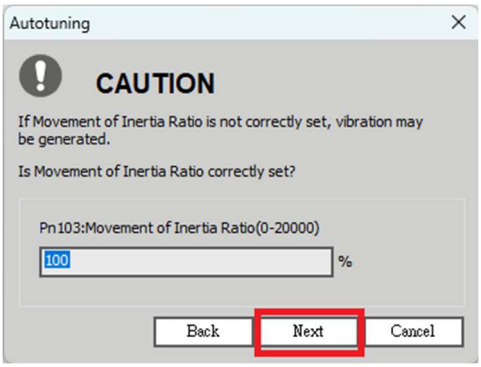
- **Mechanism Selection** Box

Select the type according to the machine element to drive.
If there is noise or if the gain does not increase, better results may be obtained by changing the rigidity type. Select the type according to the following guidelines.

Mechanism Selection	Description
1: Belt mechanism	Tuning is performed for a mechanism with relatively low rigidity, e.g., a belt.
2: Ball screw mechanism or Linear motor	Tuning is performed for a mechanism with relatively high rigidity, e.g., a ball screw or Linear Servomotor. Use this setting if there is no other appropriate setting.
3: Rigid body system	Tuning is performed for a mechanism with high rigidity, e.g., a rigid body system.

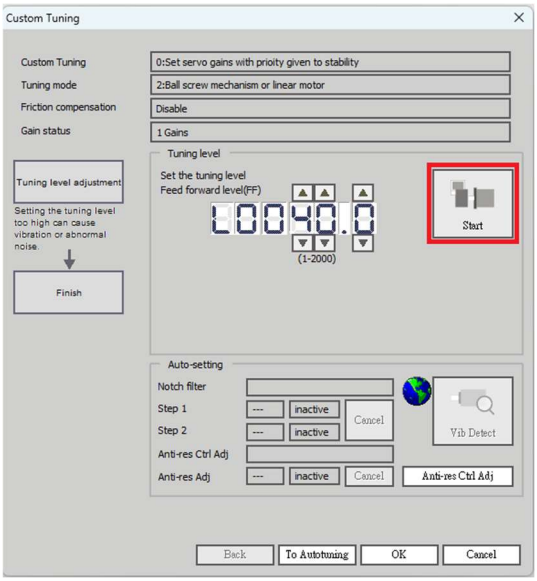
NOTE: The tuning modes that you can select depend on the servo driver setting.

7. If the moment of inertia ratio is not set correctly, correct the setting and then click the Next Button.

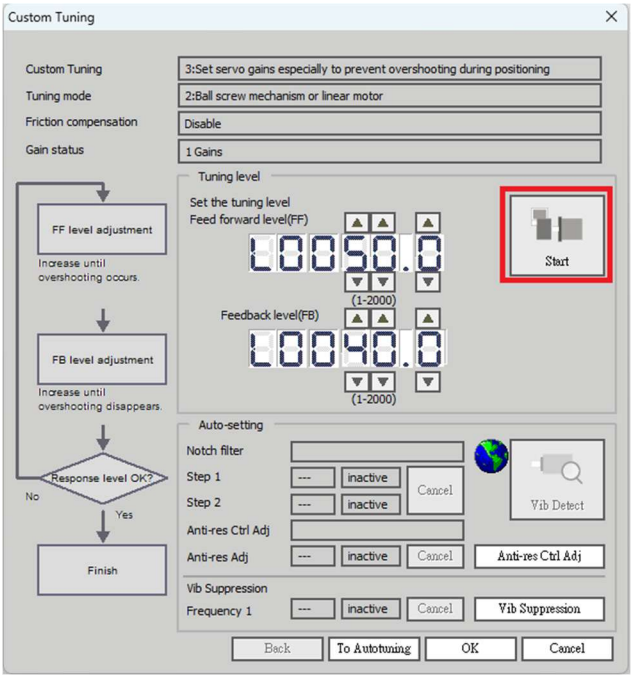


8. Turn ON the servo, enter a reference from the host controller, and then click the Start tuning Button.

< Tuning Mode 0 or 1 >



< Tuning Mode 2 or 3 >



9. Use the [▲] and [▼] Buttons to change the tuning level.

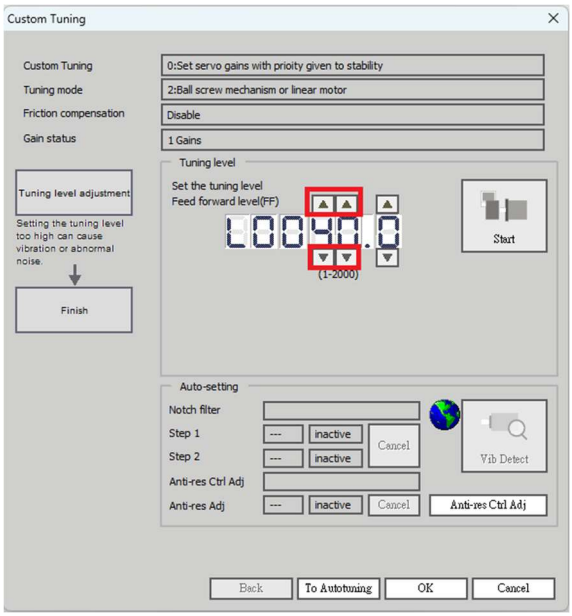
Click the Back Button during tuning to restore the setting to its original value. The tuning level will return to the value from before when custom tuning was started.

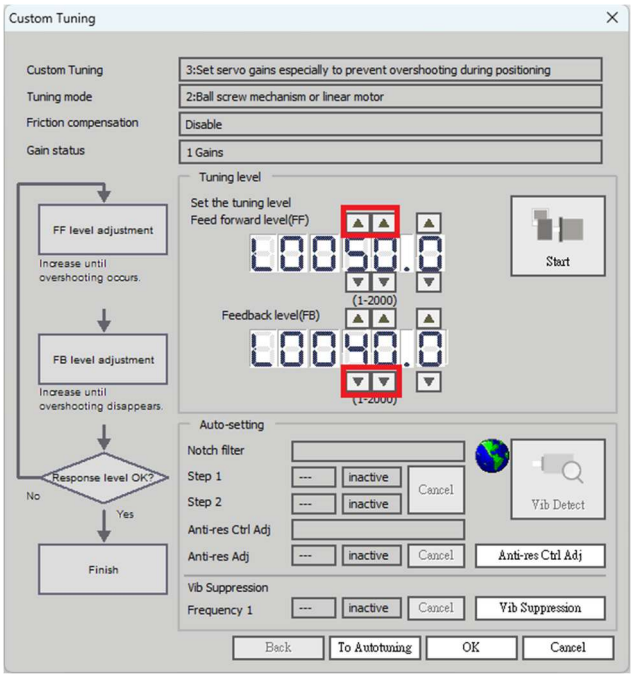
< Tuning Mode 0 or 1 >

Increase the tuning level until overshooting occurs. ◦

< Tuning Mode 2 or 3 >

Increase the feedforward level until overshooting occurs and then increase the feedback level until overshooting is eliminated. Repeat these changes to make the adjustment. ◦



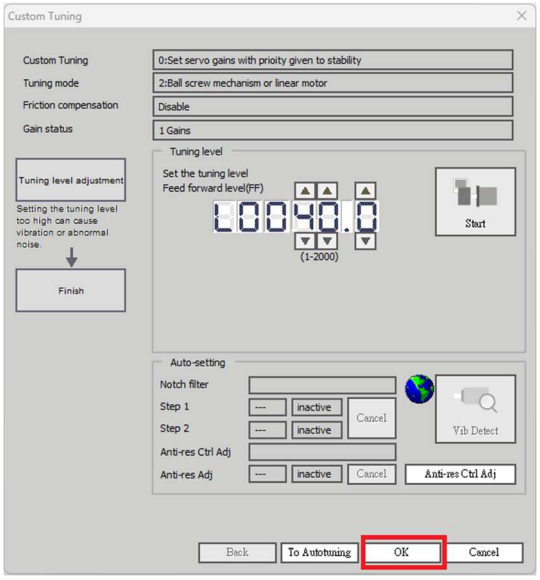


NOTE: The new feedforward level will not be used until the positioning completed signal is output.

10. You can set the functions to suppress vibration (notch filters, automatic anti-resonance control setting, anti-resonance control adjustment, and autotuning with a host reference) as required.

11. When tuning has been completed, click the OK Button.

The values that were changed will be saved in the servo driver and you will return to the Tuning Dialog Box.



This concludes the procedure to set up custom tuning.

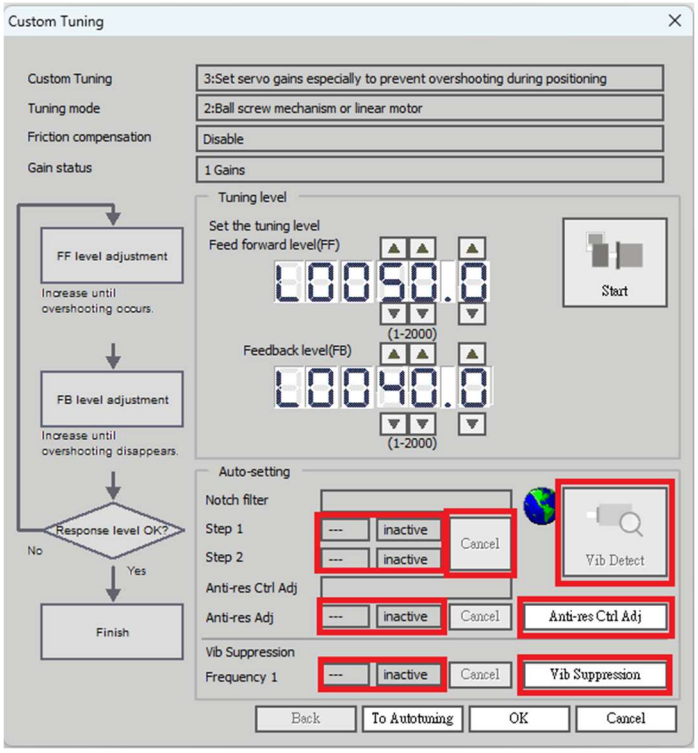
Vibration Suppression Functions

◆ Notch Filters and Automatic Anti-resonance Control Setting

If the vibration frequency that occurs when you increase the servo gains is at 1,000 Hz or higher, notch filters are effective to suppress vibration. If the vibration is between 100 Hz and 1,000 Hz, anti-resonance control is effective.

◆ Automatic Setting

To set vibration suppression automatically, use the parameters to enable notch filters and automatic anti-resonance control setting. The notch filter frequency (stage 1 or 2) or anti-resonance control frequency that is effective for the vibration that was detected during tuning will be automatically set.



Auto-setting Cancel Buttons

The automatically set notch filter frequencies or the anti-resonance control frequencies may not always suppress vibration. Click the Cancel Button to reset the notch filter frequencies or the anti-resonance control frequencies to the values from just before these frequencies were set automatically. When they are reset, vibration detection will start again.

Vib Detect Button

While the notch filter or automatic anti-resonance control setting function is enabled, you can click the Vib Detect Button to manually detect vibration. When you click the Vib Detect Button, the servo driver will detect vibration at that time, and set the notch filter frequency (stage 1 or 2) or anti-resonance control frequency that is effective for the detected vibration. You can also perform manual vibration detection even when the servo driver does not detect vibration.

Anti-res Ctrl Adj Button

You can use the Anti-res Ctrl Adj Button to execute the anti-resonance control adjust ment if fine-tuning is required. Refer to the following section.

Vib Suppress Button

Click the Vib Suppress Button to suppress low and transient vibration (oscillation) of approximately 1 Hz to 100 Hz that occurs during positioning. Refer to the following section.

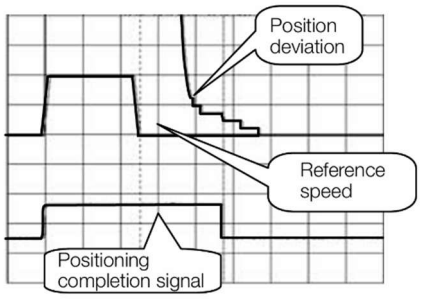
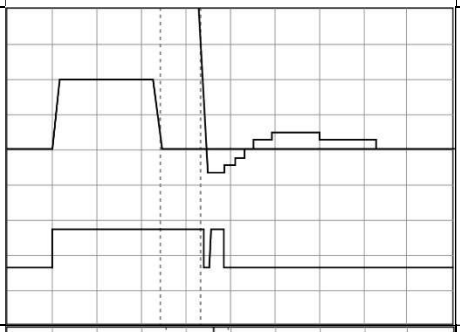
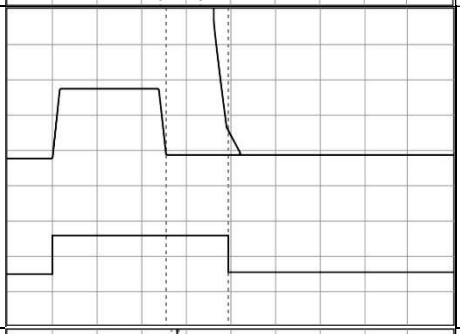
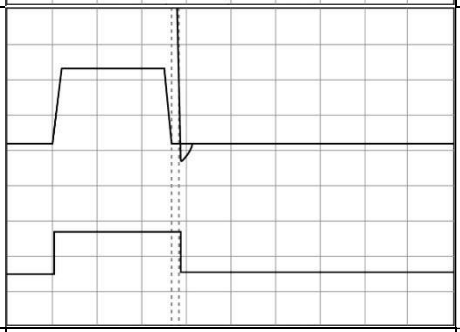
◆ Autotuning with a Host Reference

You can perform autotuning with a host reference. Refer to the following section for details.

12.8.5 Automatically Adjusted Function Settings

You cannot use vibration suppression functions at the same time. Other automatic function settings are the same as for autotuning without a host reference. Refer to the following section.

12.8.6 Tuning Example for Tuning Mode 2 or 3

Step	Measurement Display Examples	Operation
1		The positioning time is measured after the moment of inertia ratio (Pn103) is set correctly. Tuning is completed if the specifications are met. The tuning results are saved in the servo driver.
2		The positioning time will be reduced if the feedforward level is increased. Tuning is completed if the specifications are met. The tuning results are saved in the servo driver. If overshooting occurs before the specifications are met, proceed to step 3.
3		Overshooting will be reduced if the feedback level is increased. If the overshooting is eliminated, proceed to step 4.
4		The graph shows overshooting that occurred when the feedforward level was increased even more after step 3. In this state, overshooting occurs, but the positioning settling time is shorter. Tuning is completed if the specifications are met. The tuning results are saved in the servo driver. If overshooting occurs before the specifications are met, repeat steps 3 and 4. If vibration occurs before the overshooting is eliminated, the vibration is suppressed with the notch filters and anti-resonance control.
5	-	The tuning results are saved in the servo driver.

12.8.7 Related Parameters

The following parameters are automatically adjusted or used as reference when you execute custom tuning.
Do not change the settings while custom tuning is being executed. ◦

Parameter	Name	Automatic Changes
Pn100	Speed Loop Gain	Yes
Pn101	Speed Loop Integral Time Constant	Yes
Pn102	Position Loop Gain	Yes
Pn103	Moment of Inertia Ratio	No
Pn121	Friction Compensation Gain	Yes
Pn123	Friction Compensation Coefficient	Yes
Pn124	Friction Compensation Frequency Correction	No
Pn125	Friction Compensation Gain Correction	Yes
Pn401	First Stage First Torque Reference Filter Time Constant	Yes
Pn408	Torque-Related Function Selections	Yes
Pn409	First Stage Notch Filter Frequency	Yes
Pn40A	First Stage Notch Filter Q Value	Yes
Pn40C	Second Stage Notch Filter Frequency	Yes
Pn40D	Second Stage Notch Filter Q Value	Yes
Pn140	Model Following Control-Related Selections	Yes
Pn141	Model Following Control Gain	Yes
Pn142	Model Following Control Gain Correction	Yes
Pn143	Model Following Control Bias in the Forward Direction	Yes
Pn144	Model Following Control Bias in the Reverse Direction	Yes
Pn145	Vibration Suppression 1 Frequency A	No
Pn146	Vibration Suppression 1 Frequency B	No
Pn147	Model Following Control Speed Feedforward Compensation	Yes
Pn160	Anti-Resonance Control-Related Selections	Yes
Pn161	Anti-Resonance Frequency	Yes
Pn163	Anti-Resonance Damping Gain	Yes

Yes: The parameter is automatically set.

No: The parameter is not automatically set, but the setting is read during execution.

12.9 Anti-Resonance Control Adjustment

This section describes anti-resonance control.

12.9.1 Outline

Anti-resonance control increases the effectiveness of vibration suppression after custom tuning.
Anti-resonance control is effective for suppression of continuous vibration frequencies from 100 to 1,000 Hz that occur when the control gain is increased. Vibration can be eliminated by setting vibration frequencies through automatic detection or by manually setting them to adjust the damping gain. Input an operation reference and execute this anti-resonance control adjust ment when there is vibration.

Anti-resonance control is automatically set by autotuning without a host reference or autotuning with a host reference. Use anti-resonance control adjustment only if fine-tuning is required or readjustment is required as a result of a failure to detect vibration.

Perform custom tuning if required to increase the response after performing anti-resonance control adjustment. If the control gain is increased, e.g., when custom tuning is performed, vibration may occur again. If that occurs, perform anti-resonance control adjustment again to fine-tune the parameters.

⚠ CAUTION

- Related parameters will be set automatically when anti-resonance control adjustment is executed. This may greatly affect the response before and after execution. Make sure that you can perform an emergency stop at any time.
- Before you execute anti-resonance control adjustment, set the correct moment of inertia ratio (Pn103). If the setting greatly differs from the actual moment of inertia ratio, normal control of the machine may not be possible, and vibration may occur.



- Anti-resonance control adjustment detects vibration frequencies between 100 Hz and 1,000 Hz. If the vibration frequency is not within this range, use custom tuning with tuning mode 2 selected to automatically set a notch filter or use vibration suppression.
- Vibration reduction can be made more effective by increasing the anti-resonance damping gain (Pn163), but the vibration may become larger if the damping gain is too high. Increase the damping gain by approximately 0% to 200% in 10% increments while checking the effect on vibration. If vibration reduction is still insufficient at a gain of 200%, cancel the setting, and lower the control gain by using a different method, such as custom tuning.

12.9.2 Preparations

Always check the following before you execute anti-resonance control adjustment.

- The tuning-less function must be disabled (Pn170 = n. 0).
- The control method must not be set to torque control.
- The parameters must not be write prohibited.

12.9.3 Applicable Tools

The following table lists the tools that you can use to perform anti-resonance control adjustment.

Tool	Fn No./Function Name	Operating Procedure Reference
Panel Operator	You cannot execute anti-resonance control adjustment from the Panel Operator.	
Digital Operator	Fn204	Digital Operator Operating Manual
Protuner	[Tuning] - [Tuning]	Operating Procedure

12.9.4 Operating Procedure

To execute anti-resonance control adjustment, an operation reference is input, and the adjust ment is executed while vibration is occurring.

- To automatically detect the vibration frequency
- To manually set the vibration frequency

Use the following procedure to perform anti-resonance control.

⚠ CAUTION

- **Before you execute anti-resonance control adjustment, check the information provided in the Protuner operating manual.**
  Observe the following precautions.

  Make sure that you can perform an emergency stop at any time. Parameters will be set automatically when anti-resonance control adjustment is executed. This may greatly affect the response before and after execution. Make sure that you can perform an emergency stop (to turn OFF the power supply) at any time.

  Set the moment of inertia correctly before you execute anti-resonance control adjustment. If the setting greatly differs from the actual moment of inertia, effective vibration reduction may not be possible.

  If you have already performed anti-resonance control adjustment and then you change the frequency, the current anti-resonance control effect may be lost. Caution is particularly required when automatically detecting the vibration frequency. ◦

  If effective vibration reduction is not achieved even after you execute anti-resonance control adjustment, cancel the function and lower the control gain by using a different method, such as custom tuning.Perform custom tuning separately if required to increase the response after performing anti-resonance control adjustment.

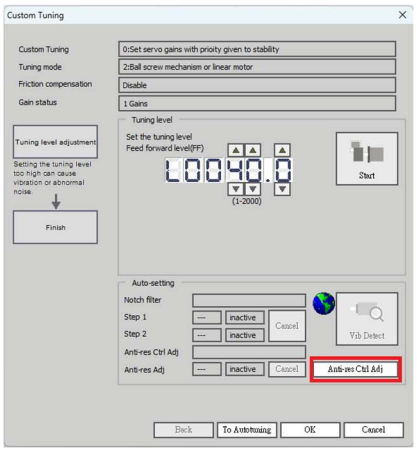
  If the servo gain is increased, e.g., when custom tuning is performed, vibration may occur again.

  If that occurs, perform anti-resonance control adjustment again to fine-tune the parameters.

1. Perform steps 1 to 8 of the procedure for custom tuning. Refer to the following section for details. ◦

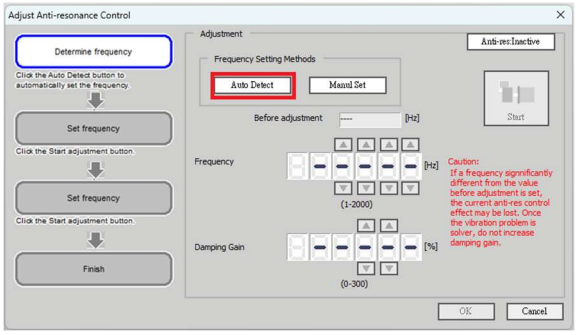
2. Click the Anti-res Ctrl Adj Button.

The rest of the procedure depends on whether you know the vibration frequency.

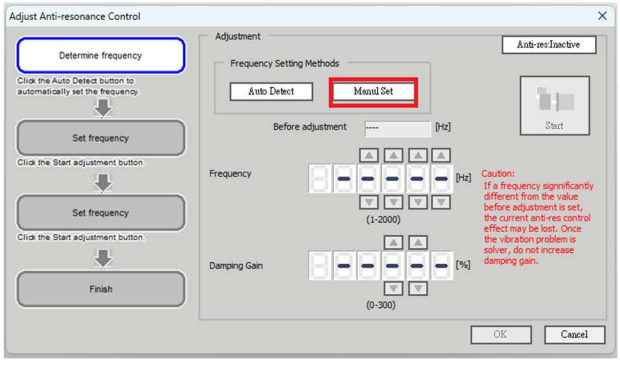


3. If you do not know the vibration frequency, click the Auto Detect Button. If you know the vibration frequency, click the Manual Set Button.

To Automatically Detect the Vibration Frequency
The frequency will be set.



To Manually Set the Vibration Frequency

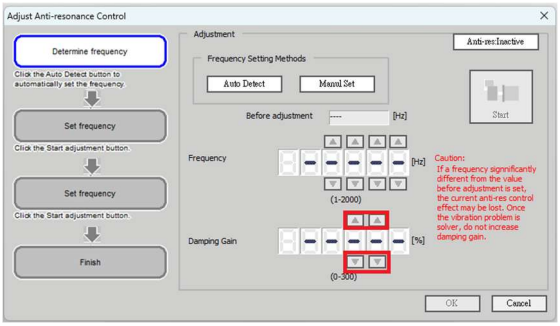


4. Click the Start adjustment Button.

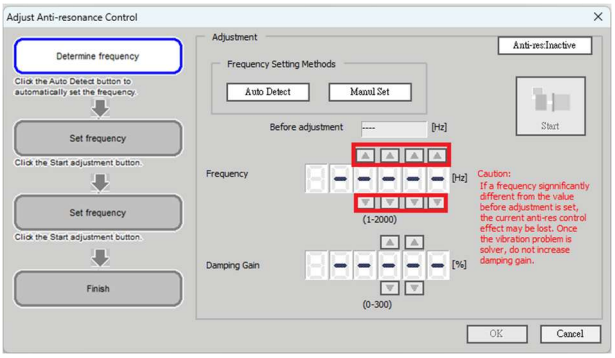
5. Use the [▲] and [▼] Buttons in the Adjustment Area to change the settings.

Click the Reset Button during tuning to restore the setting to its original value. The tuning level will return to the value from before when custom tuning was started.

To Automatically Detect the Vibration Frequency
Change the setting of the damping gain.

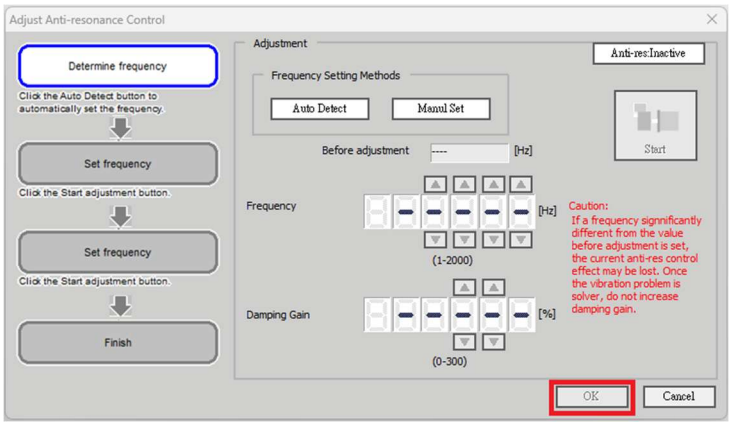


To Manually Set the Vibration Frequency
Change the settings of the frequency and damping gain.



6. When the adjustment has been completed, click the OK Button.

The values that were changed will be saved in the servo driver and you will return to the Tuning Dialog Box.



This concludes the procedure to set up anti-resonance control.

12.9.5 Related Parameters

The following parameters are automatically adjusted or used as reference when you execute anti-resonance control adjustment.
Do not change the settings while anti-resonance control adjustment is being executed.

Parameter	Name	Automatic Changes
Pn160	Anti-Resonance Control-Related Selections	Yes
Pn161	Anti-Resonance Frequency	Yes
Pn162	Anti-Resonance Gain Correction	No
Pn163	Anti-Resonance Damping Gain	Yes
Pn164	Anti-Resonance Filter Time Constant 1 Correction	No
Pn165	Anti-Resonance Filter Time Constant 2 Correction	No

Yes: The parameter is automatically set.

No: The parameter is not automatically set, but the setting is read during execution.

12.10 Vibration Suppression

This section describes vibration suppression.

12.10.1 Outline

You can use vibration suppression to suppress transient vibration at a low frequency from 1 Hz to 100 Hz, which is generated mainly when the machine vibrates during positioning. This is effective for vibration frequencies for which notch filters and anti-resonance control adjustment are not effective.

Vibration suppression is automatically set by autotuning without a host reference or autotuning with a host reference. Use vibration suppression only if fine-tuning is required or readjustment is required as a result of a failure to detect vibration.
To execute vibration suppression, input an operation reference and execute the function when there is vibration.

Perform custom tuning if required to increase the response after performing vibration suppression.

⚠ CAUTION

- Related parameters will be set automatically when vibration suppression is executed. This may greatly affect the response before and after execution. Make sure that you can perform an emergency stop at any time.
- Before you execute vibration suppression, set the correct moment of inertia ratio (Pn103) with autotuning without a host reference or another method. If the setting greatly differs from the actual moment of inertia ratio, normal control of the machine may not be possible, and vibration may occur.



- Vibration suppression detects vibration frequencies between 1 Hz and 100 Hz.
- Frequency detection will not be performed if there is no vibration in the position deviation or if the vibration frequency is outside the range of detectable frequencies. If that is a problem, use a device such as a displacement meter or vibration sensor to measure the vibration frequency.
- If an automatically detected vibration frequency is not suppressed, the actual frequency and the detected frequency may be different. Fine-tune the detected frequency if necessary.

Items That Influence Performance

If continuous vibration occurs while the Servomotor is stopping, vibration suppression cannot be used to suppress the vibration effectively. In this case, use anti-resonance control adjustment or custom tuning.

Detection of Vibration Frequencies

Frequency detection may not be possible if vibration does not appear in the position deviation or the vibration that results from the position deviation is too small. You can adjust the detection sensitivity by changing the setting of the residual vibration detection width (Pn560), which is set as a percentage of the positioning completed width (Pn522). Perform the detection of vibration frequencies again after adjusting the setting of Pn560.

Pn560	Residual Vibration Detection Width			Position	
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	1 ~ 3000	0.1%	400	Immediately	Setup

NOTE: As a guideline, change the setting 10% at a time. If the setting of this parameter is lowered, the detection sensitivity will be increased. Vibration may not be detected accurately if the setting is too small.

NOTE:The vibration frequencies that are automatically detected may vary somewhat with each positioning operation. Perform positioning several times and make adjustments while checking the effect of vibration suppression.

12.10.2 Preparations

Always check the following before you execute vibration suppression.

- Position control must be used.
- The tuning-less function must be disabled (Pn170 = n. 0).
- The parameters must not be write prohibited."

12.10.3 Applicable Tools

The following table lists the tools that you can use to perform vibration suppression.

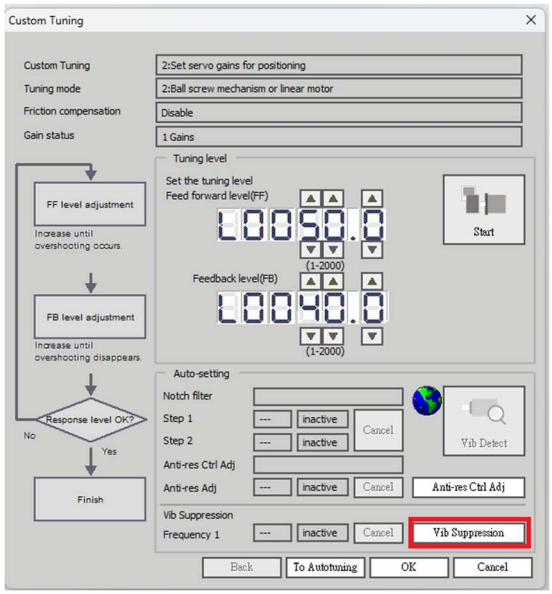
Tool	Fn No./Function Name	Operating Procedure Reference
Panel Operator	You cannot execute vibration suppression from the Panel Operator.	
Digital Operator	Fn205	Digital Operator Operating Manual
Protuner	[Tuning] - [Tuning]	Operating Procedure

12.10.4 Operating Procedure

Use the following procedure to perform vibration suppression.

1. Perform steps 1 to 8 of the procedure for custom tuning. Refer to the following section for details.

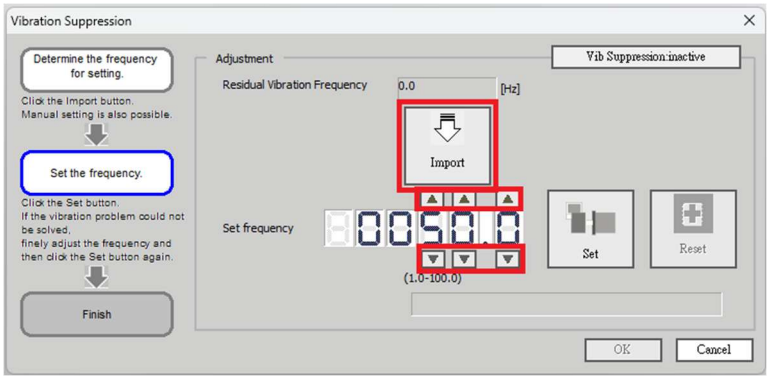
2. Click the Vib Suppress Button.



3. Click the Import Button or click [▲] and [▼] Button to manually adjust the set frequency.
When you click the Import Button, the residual vibration frequency in the Servomotor is read as the set frequency. (The frequency can be read only when the residual vibration frequency is between 1.0 and 100.0.)

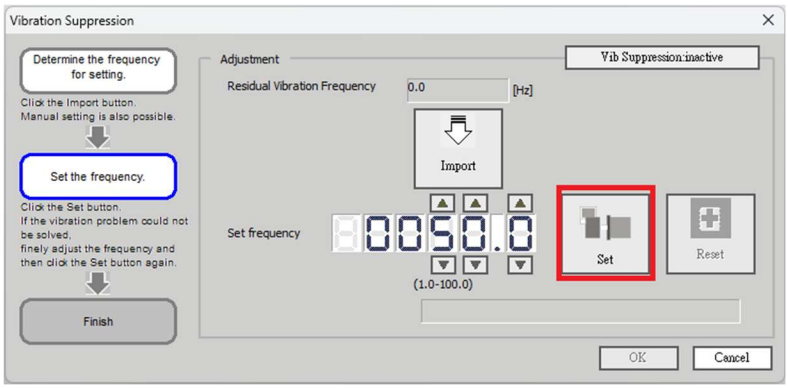


Frequency detection will not be performed if there is no vibration or if the vibration frequency is outside the range of detectable frequencies. If a vibration frequency is not detected, provide a means of measuring the vibration frequency.

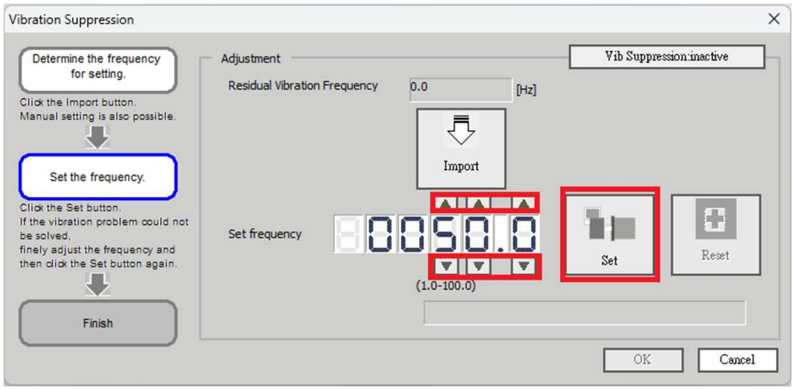


4. Click the Set Button.

> No settings related to vibration suppression are changed during operation. If the Servomotor does not stop within approximately 10 seconds after changing the setting, an update timeout will occur. The setting will be automatically returned to the previous value.



If the vibration is not eliminated, use the [▲] and [▼] Buttons for the set frequency to fine-tune the value and click the Set Button again.



Click the Reset Button during adjustment to restore the setting to its original value. The status from before when adjustment was started will be restored.

5. When the vibration has been eliminated, click the Finish Button.
The updated value will be saved in the servo driver.

> Vibration suppression will be enabled in step 5. The Servomotor response, however, will change when the Servomotor comes to a stop with no reference input. ◦

This concludes the procedure to set up vibration suppression.

12.10.5 Setting Combined Functions

You can also use the feedforward function when you execute vibration suppression.

In the default settings, feedforward (Pn109), the speed feedforward input (V-REF), and the torque feedforward input (T-REF) are disabled.

To use the speed feedforward input (V-REF), the torque feedforward input (T-REF), and model following control from the host controller in the system, set Pn140 to n.1 (Use model following control and speed/torque feedforward together).

Parameter		Function	When Enabled	Classification
Pn140	n.0□□□ [default setting]	Do not use model following control and speed/torque feedforward together.	Immediately	Tuning
	n.1□□□	Use model following control and speed/ torque feedforward together.		

Refer to the following section for information on the torque feedforward input (T-REF) and the speed feedforward input (V-REF).



- When model following control is used with the feedforward function, it is used to make optimum feedforward settings in the ServoDriver. Therefore, model following control is not normally used together with either the speed feedforward input (V-REF) or torque feedforward input (T-REF) from the host controller. However, model following control can be used with the speed feedforward input (V-REF) or torque feedforward input (T-REF) if required. An unsuitable feedforward input may result in overshooting. ◦

12.10.6 Related Parameters

The following parameters are automatically adjusted or used as reference when you execute vibration suppression.

Do not change the settings while vibration suppression is being executed.

Parameter	Name	Automatic Changes
Pn140	Model Following Control-Related Selections	Yes
Pn141	Model Following Control Gain	Yes
Pn142	Model Following Control Correction	No
Pn143	Model Following Control Bias in the Forward Direction	No
Pn144	Model Following Control Bias in the Reverse Direction	No
Pn145	Vibration Suppression 1 Frequency A	Yes
Pn146	Vibration Suppression 1 Frequency B	Yes
Pn147	Model Following Control Speed Feedforward Compensation	No
Pn14A	Vibration Suppression 2 Frequency	No
Pn14B	Vibration Suppression 2 Correction	No

Yes: The parameter is automatically set.

No: The parameter is not automatically set, but the setting is read during execution. ◦

12.11 Additional Adjustment Functions

This section describes the functions that you can use to make adjustments after you perform autotuning without a host reference, autotuning with a host reference, and custom tuning.

Function	Applicable Control Methods
Gain Switching	Position control, speed control, or torque control*
Friction Compensation	Position control or speed control
Current Control Mode Selection	Position control, speed control, or torque control
Current Gain Level Setting	Position control or speed control
Speed Detection Method Selection	Position control, speed control, or torque control
Proportional Control	Position control or speed control

* Automatic gain switching is enabled only for position control.

12.11.1 Gain Switching

Two gain switching functions are available, manual selection and automatic switching. The manual switching function uses an external input signal to select the gains, and the automatic.

switching function changes the gains automatically. You can use gain switching to shorten the positioning time by increasing the gains during positioning and suppressing vibration by decreasing the gains while stopping.

Parameter		Function	When Enabled	Classification
Pn139	n.□□□0 [default setting]	Use manual gain switching.	Immediately	Tuning
	n.□□□2	Use automatic gain switching pattern 1.		

NOTE: Pn139 = n. 1 is a reserved setting. Do not use this setting.

Gain Switching Combinations

Selected Gains	Speed Loop Gain	Speed Loop Integral Time Constant	Position Loop Gain	Torque Reference Filter	Model Following Control Gain	Model Following Control Correction	Friction Compensation Gain
Gain Settings 1	Speed Loop Gain (Pn100)	Speed Loop Integral Time Constant (Pn101)	Position Loop Gain (Pn102)	First Stage First Torque Reference Filter Time Constant (Pn401)	Model Following Control Gain* (Pn141)	Model Following Control Correction* (Pn142)	Friction Compensation Gain (Pn121)
Gain Settings 2	Second Speed Loop Gain (Pn104)	Second Speed Loop Integral Time Constant (Pn105)	Second Position Loop Gain (Pn106)	First Stage Second Torque Reference Filter Time Constant (Pn412)	Second Model Following Control Gain* (Pn148)	Second Model Following Control Gain Correction* (Pn149)	Second Friction Compensation Gain(Pn122)

* Gain switching for the model following control gain and the model following control gain correction is applicable only to manual gain switching. To enable gain switching with these parameters, a gain switching input signal must be used and the following con ditions must be met. If the conditions are not met, these parameters will not be changed even if the other param eters in the above table are changed.
  - There must be no reference.
  - The motor must be stopped.

Manual Gain Switching

With manual gain switching, you use the /G-SEL (Gain Selection) signal to change between gain settings 1 and gain settings 2.

Type	Signal	Connector Pin No.	Setting	Meaning
Input	/G-SEL	Must be allocated.	OFF	Changes the gain settings to gain settings 1.
			ON	Changes the gain settings to gain settings 2.

Automatic Gain Switching

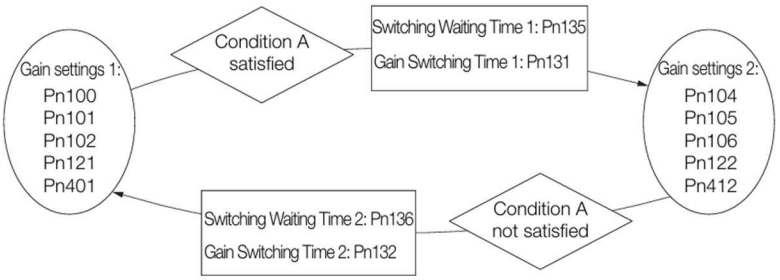
Automatic gain switching is enabled only for position control. The switching conditions are specified by using the following settings.

Parameter		Switching Condition	Selected Gains	Switching Waiting Time	Switching Time
Pn139	n.□□□2	Condition A satisfied	Gain settings 1 to gain settings 2	Gain Switching Waiting Time 1 Pn135	Gain Switching Time 1 Pn131
		Condition A not satisfied	Gain settings 2 to gain settings 1	Gain Switching Waiting Time 2 Pn136	Gain Switching Time 2 Pn132

Select one of the following settings for switching condition A.

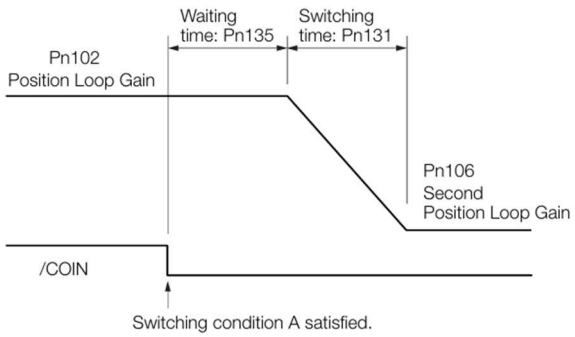
Parameter		Position Control Gain Switching Condition A	For Control Methods Other Than Position Control (No Switching)	When Enabled	Classification
Pn139	n.□□0□ [default setting]	/COIN (Positioning Completion) signal ON	Gain settings 1 used.	Immediately	Tuning
	n.□□1□	/COIN (Positioning Completion) signal OFF	Gain settings 2 used.		
	n.□□2□	/NEAR (Near) signal ON	Gain settings 1 used.		
	n.□□3□	/NEAR (Near) signal OFF	Gain settings 2 used.		
	n.□□4□	Position reference filter output is 0 and reference pulse input is OFF.	Gain settings 1 used.		
	n.□□5□	Position reference pulse input is ON.	Gain settings 2 used.		

Automatic Switching Pattern 1 (Pn139 = n. 2)



◆ Relationship between the Waiting Times and Switching Times for Gain Switching

In this example, an ON /COIN (Positioning Completion) signal is set as condition A for automatic gain switching. The position loop gain is changed from the value in Pn102 (Position Loop Gain) to the value in Pn106 (Second Position Loop Gain). When the /COIN signal turns ON, the switching operation begins after the waiting time (Pn135). The switching operation changes the position loop gain linearly from the gain set in Pn102 to the gain set in Pn106 over the switching time (Pn131).



NOTE: You can use gain switching for either PI control or I-P control (Pn10B = n. 0 or 1).

Related Parameters

Pn100	Speed Loop Gain			Speed	Position
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	10 ~ 20000	0.1Hz	400	Immediately	Tuning
Pn101	Speed Loop Integral Time Constant			Speed	Position
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	15 ~ 51200	0.01ms	2000	Immediately	Tuning
Pn102	Position Loop Gain				Position
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	10 ~ 20000	0.1/s	400	Immediately	Tuning
Pn401	First Stage First Torque Reference Filter Time Constant			Speed	Position Torque
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 ~ 65535	0.01ms	100	Immediately	Tuning
Pn141	Model Following Control Gain				Position
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	10 ~ 20000	0.1/s	500	Immediately	Tuning
Pn142	Model Following Control Gain Correction				Position
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	500 ~ 2000	0.1%	1000	Immediately	Tuning
Pn121	Friction Compensation Gain			Speed	Position
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	10 ~ 1000	1%	100	Immediately	Tuning
Pn104	Second Speed Loop Gain			Speed	Position
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	10 ~ 20000	0.1Hz	400	Immediately	Tuning
Pn105	Second Speed Loop Integral Time Constant			Speed	Position
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	15 ~ 51200	0.01ms	2000	Immediately	Tuning
Pn106	Second Position Loop Gain				Position
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	10 ~ 20000	0.1/s	400	Immediately	Tuning
Pn412	First Stage Second Torque Reference Filter Time Constant			Speed	Position Torque
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 ~ 65535	0.01ms	100	Immediately	Tuning
Pn148	Second Model Following Control Gain				Position
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	10 ~ 20000	0.1/s	500	Immediately	Tuning
Pn149	Second Model Following Control Gain Correction				Position
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	500 ~ 2000	0.1%	1000	Immediately	Tuning
Pn122	Second Friction Compensation Gain			Speed	Position
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	10 ~ 1000	1%	100	Immediately	Tuning

Parameters Related to Automatic Gain Switching

Pn131	Gain Switching Time 1				Position
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 ~ 65535	1ms	0	Immediately	Tuning
Pn132	Gain Switching Time 2				Position
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 ~ 65535	1ms	0	Immediately	Tuning

Pn135	Gain Switching Waiting Time 1			Position	
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 ~ 65535	1ms	0	Immediately	Tuning
Pn136	Gain Switching Waiting Time 2			Position	
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 ~ 65535	1ms	0	Immediately	Tuning

Related Monitoring

- Protuner

  You can monitor gain switching with the status monitor or with tracing.

- Analog Monitors

Parameter	Analog Monitor	Monitor Name	Output Value	Description
Pn006 Pn007	n.□□0B	Active Gain Monitor	1V	Gain settings 1 are enabled.
			2V	Gain settings 2 are enabled.

12.11.2 Friction Compensation

Friction compensation is used to compensate for viscous friction fluctuations and regular load fluctuations.

You can automatically adjust friction compensation with autotuning without a host reference, autotuning with a host reference, or custom tuning, or you can manually adjust it with the following procedure. ◦

Required Parameter Settings

The following parameter settings are required to use friction compensation.

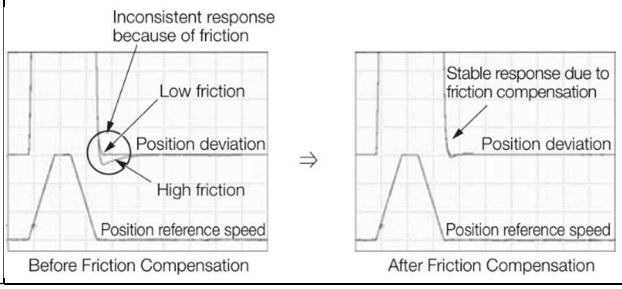
Parameter		Function	When Enabled	Classification
Pn408	n.0□□□ [default setting]	Disable friction compensation.	Immediately	Setup
	n.1□□□	Enable friction compensation.		

Pn121	Friction Compensation Gain			Speed / Position	
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	10 ~ 1000	1%	100	Immediately	Tuning
Pn122	Second Friction Compensation Gain			Speed / Position	
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	10 ~ 1000	1%	100	Immediately	Tuning
Pn123	Friction Compensation Coefficient			Speed / Position	
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 ~ 100	1%	0	Immediately	Tuning
Pn124	Friction Compensation Frequency Correction			Speed / Position	
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	-10000 ~ 10000	0.1Hz	0	Immediately	Tuning
Pn125	Friction Compensation Gain Correction			Speed / Position	
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	1 ~ 1000	1%	100	Immediately	Tuning

Operating Procedure for Friction Compensation

⚠ CAUTION

- Before you execute friction compensation, set the moment of inertia ratio (Pn103) as accurately as possible. If the setting greatly differs from the actual moment of inertia, vibration may occur.

Step	Operation
1	Set the following parameters related to friction compensation to their default settings. Friction compensation gain (Pn121): 100 Second friction compensation gain (Pn122): 100 Friction compensation coefficient (Pn123): 0 Friction compensation frequency correction (Pn124): 0 Friction compensation gain correction (Pn125): 100 NOTE:Always use the default settings for the friction compensation frequency correction (Pn124) and friction compensation gain correction (Pn125).
2	Gradually increase the friction compensation coefficient (Pn123) to check the effect of friction compensation. NOTE:Usually, set the friction compensation coefficient (Pn123) to 95% or less. If the effect is insufficient, increase the friction compensation gain (Pn121) by 10% increments until vibration stops. Effect of Adjusted Parameters Pn121: Friction Compensation Gain and Pn122: Second Friction Compensation Gain These parameters set the response to external disturbances. The higher the setting is, the better the response will be. If the machine has a resonance frequency, however, vibration may occur if the setting is too high. Pn123: Friction Compensation Coefficient This parameter sets the effect of friction compensation. The higher the setting is, the more effective friction compensation will be. If the setting is too high, however, vibration will occur more easily. Usually, set the value to 95% or less.
3	Effect of Adjustments The following graphs show the response with and without adjustment.  Before Friction Compensation ⇒ After Friction Compensation

12.11.3 Current Gain Level Setting

You can set the current gain level to reduce noise by adjusting the parameter for current control inside the servo driver according to the speed loop gain (Pn100). The noise level can be reduced by decreasing the current gain level (Pn13D) from its default setting of 2,000% (disabled). However, if the setting is decreased, the level of noise will be lowered, but the response characteristic of the servo driver will also be reduced. Adjust the current gain level within the range that maintains the servo driver response characteristic. This function is always disabled during torque control (Pn000 = n. 2).

Pn13D	Current Gain Level			Speed	Position
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	100 ~ 2000	1%	2000	Immediately	Tuning

If the current gain level is changed, the response characteristic of the speed loop will also change. Servo tuning must therefore be performed again.

12.11.4 Speed Detection Method Selection

You can use the speed detection method selection to ensure smooth Servomotor speed changes during operation.
To ensure smooth motor speed changes during operation, set Pn009 to n. 1 (Use speed detection 2).

With a Linear Servomotor, you can reduce the noise level of the running motor when the linear encoder scale pitch is large. ◦

Parameter		Meaning	When Enabled	Classification
Pn009	n.□0□□ [default setting]	Use speed detection 1.	After restart	Tuning
	n.□1□□	Use speed detection 2.		



If the speed detection method is changed, the response characteristic of the speed loop will also change. Servo tuning must therefore be performed again.

12.11.5 Speed Feedback Filter

You can set a first order lag filter for the speed feedback in the speed loop. This ensures smooth changes in the feedback speed to reduce vibration. If a large value is set, it will increase the delay and make response slower.

	Speed Feedback Filter Time Constant			Speed	Position	
Pn308	Setting Range	Setting Unit	Default Setting	When Enabled		Classification
	0 ~ 65535 (0.00 ~ 655.35ms)	0.01ms	0 (0.00ms)	Immediately		Setup

12.11.6 Proportional Control (P Control)

You can input the /P-CON (Proportional Control) signal from the host controller to select P control.

The speed control section uses proportional-integral control (PI control) if the reference remains at zero during speed control. The integral effect may cause the Servomotor to move. To prevent that, you can change from PI control to P control.

P control is set using Pn000 = n. X and the /P-CON signal.

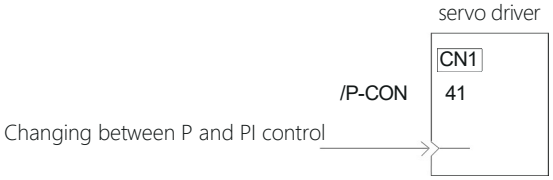
However, if Pn000 is set to n. A (Switching between speed control with analog references and speed control with zero clamping), a position loop will be formed. Therefore, there is no need to use this function.
P control is used while the /P-CON signal is ON.

/P-CON (Proportional Control) Signal

The /P-CON signal is used to switch between P control and PI control.

Type	Signal	Connector Pin No.	Setting	Meaning
Input	/P-CON	CN1-41 [default setting]	ON (closed)	Changes to P control
			OFF (open)	Changes to PI control

When Using the Default Input Signal Allocations



NOTE:This example uses the default input signal allocations.

Control Methods and P Control Input Signals

Changing to P control is enabled when the control method is set to speed control or position control.

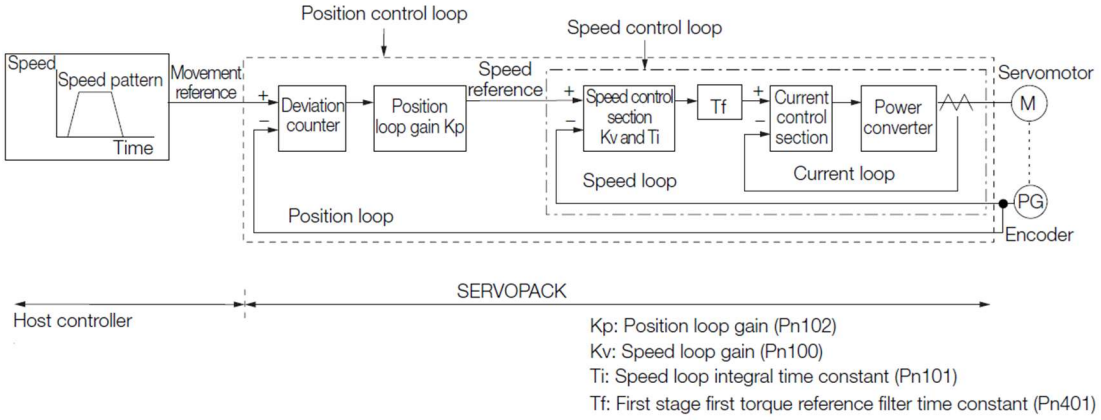
Parameter	Control Method Selection	Description	Changing to P Control
Pn000	n.□□0□ [default setting]	Speed control with analog references	You can change to P control with the default setting (CN141 = /P-CON). You can also allocate the /P-CON signal to another connector pin.
	n.□□1□	Position control with pulse train references	
	n.□□2□	Torque control with analog references	You cannot change to P control.
	n.□□3□	Internal set speed control with contact commands	You must allocate the /P-CON signal to CN1-40 to CN1-46.
	n.□□4□	Switching between internal set speed control with contact commands and speed control with analog references	
	n.□□5□	Switching between internal set speed control with contact commands and position control with pulse train references	
	n.□□6□	Switching between internal set speed control with contact commands and torque control with analog references	
	n.□□7□	Switching between position control with pulse train references and speed control with analog references	
	n.□□8□	Switching between position control with pulse train references and torque control with analog references	
	n.□□9□	Switching between torque control with analog references and speed control with analog references	
	n.□□A□	Switching between speed control with analog references and speed control with zero clamping	
	n.□□B□	Switching between position control with pulse train references and position control with reference pulse inhibition	

NOTE: Refer to the following section for information on changing the control method.

12.12 Manual Tuning

This section describes manual tuning.

12.12.1 Tuning the Servo Gains



In order to manually tune the servo gains, you must understand the configuration and characteristic of the servo driver and adjust the servo gains individually. In most cases, if you greatly change any one parameter, you must adjust the other parameters again. To check the response characteristic, you must prepare a measuring instrument to monitor the output waveforms from the analog monitor.

The Servo Driver has three feedback systems (the position loop, speed loop, and current loop), and the response characteristic must be increased more with the inner loops. If this relationship is not maintained, the response characteristic will suffer and vibration will occur more easily.

A sufficient response characteristic is ensured for the current loop. There is never a need for it to be adjusted by the user.

Outline

You can use manual tuning to set the servo gains in the servo driver to increase the response characteristic of the servo driver. For example, you can reduce the positioning time for position control.

Use manual tuning in the following cases.

- When tuning with autotuning without a host reference or autotuning with a host reference does not achieve the
- desired results
- When you want to increase the servo gains higher than the gains that resulted from autotuning without a host
- reference or autotuning with a host reference
- When you want to determine the servo gains and moment of inertia ratio yourself

You start manual tuning either from the default parameter settings or from the gain settings that resulted from autotuning without a host reference or autotuning with a host reference.

Applicable Tools

You can monitor the servo gains with the Protuner or with the analog monitor.

Precautions

Vibration may occur while you are tuning the servo gains. We recommend that you enable vibration alarms (Pn310 = n. 2) to detect vibration. Refer to the following section for information on vibration detection.

Tuning Procedure Example (for Position Control or Speed Control)

Step	Description
1	Adjust the first stage first torque reference filter time constant (Pn401) so that vibration does not occur.
2	Increase the Speed loop gain (Pn100) and reduce the speed loop integral time constant (Pn101) as far as possible within the range that does not cause machine vibration.
3	Repeat steps 1 and 2 and return the settings about 10% to 20% from the values that you set.
4	For position control, increase the position loop gain (Pn102) within the range that does not cause vibration.

NOTE: If you greatly change any one servo gain parameter, you must adjust the other parameters again. Do not increase the setting of just one parameter. As a guideline, adjust the settings of the servo gains by approximately 5% each. As a rule, change the servo parameters in the following order. ◦

- To Increase the Response Speed

1. Reduce the torque reference filter time constant.
2. Increase the speed loop gain.
3. Decrease the speed loop integral time constant.
4. Increase the position loop gain.

- To Reduce Response Speed and to Stop Vibration and Overshooting

1. Reduce the position loop gain.
2. Increase the speed loop integral time constant.
3. Decrease the speed loop gain.
4. Increase the torque filter time constant.

Adjusted Servo Gains

You can set the following gains to adjust the response characteristic of the Servo Driver.

- Pn100 : Speed Loop Gain
- Pn101 : Speed Loop Integral Time Constant
- Pn102 : Position Loop Gain
- Pn401 : First Stage First Torque Reference Filter Time Constant

◆ Position Loop Gain

The position loop gain determines the response characteristic of the position loop in the Servo Driver. If you can increase the setting of the position loop gain, the response characteristic will improve and the positioning time will be shortened. However, you normally cannot increase the position loop gain higher than the inherit vibration frequency of the machine system. Therefore, to increase the setting of the position loop gain, you must increase the rigidity of the machine to increase the inherit vibration frequency of the machine.

Pn102	Position Loop Gain			Position	
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	10 ~ 20000	0.1/s	400	Immediately	Tuning

NOTE:For machines for which a high position loop gain (Pn102) cannot be set, overflow alarms can occur during high-speed operation. If that is the case, you can increase the setting of the following parameter to increase the level for alarm detection.

Use the following condition as a guideline for determining the setting.

$$Pn520 \geqq \frac{\text{Maximum feed speed [reference units/s]}}{Pn102 \div 10\ (1/s)} \times 2.0$$

If you use a position reference filter, transient deviation will increase due to the filter time constant. When you make the setting, consider deviation accumulation that may result from the filter. ◦

Pn520	Position Deviation Overflow Alarm Level			Position	
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	1 ~ 1073741823	1 reference unit	5242880	Immediately	Setup

◆ Speed Loop Gain

This parameter determines the response characteristic of the speed loop. If the response characteristic of the speed loop is low, it becomes a delay factor for the position loop located outside of the speed loop. This will result in overshooting and vibration in the speed reference.

Therefore, setting the speed loop gain as high as possible within the range that will not cause the machine system to vibrate will produce a stable servo system with a good response characteristic.

Pn100	Speed Loop Gain			Speed	Position	Torque
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification	
	10 ~ 20000	0.1Hz	400	Immediately	Tuning	

$$\text{Setting of Pn103} = \frac{\text{Load moment of inertia at motor shaft } (J_L)}{\text{Servomotor moment of inertia } (L_M)} \times 100(\%)$$

The default setting of Pn103 (Moment of Inertia Ratio) is 100. Before you tune the servo, calculate the moment of inertia ratio with the above formula and set Pn103 to the calculation result.

Pn103	Moment of Inertia Ratio			Speed	Position	Torque
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification	
	0 ~ 20000	1%	100	Immediately	Tuning	

◆ Speed Loop Integral Time Constant

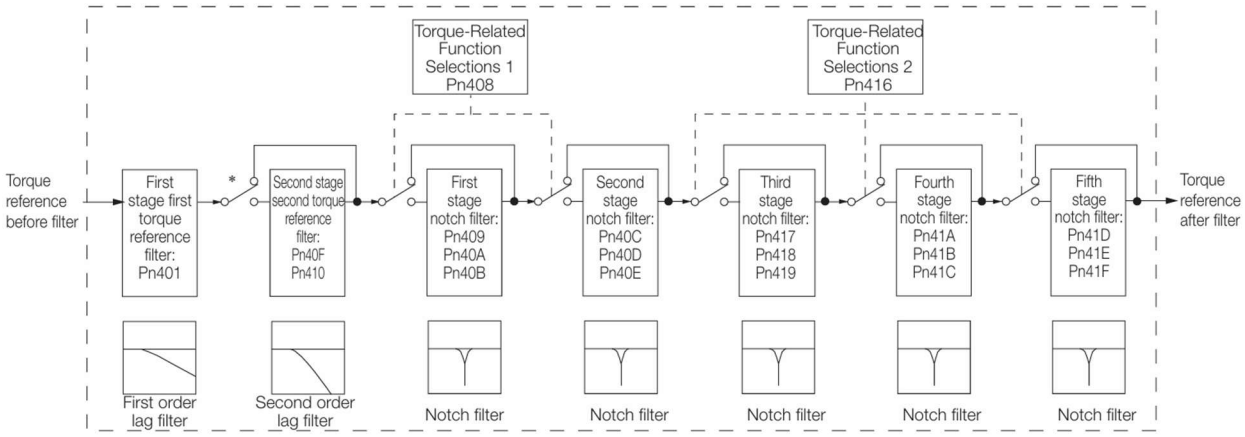
To enable response to even small inputs, the speed loop has an integral element. The integral element becomes a delay factor in the servo system. If the time constant is set too high, overshooting will occur, positioning settling time will increase, and the response characteristic will suffer.

Pn101	Speed Loop Integral Time Constant			Speed	Position	
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification	
	15 ~ 51200	0.01ms	2000	Immediately	Tuning	

◆ Torque Reference Filter

As shown in the following diagram, the torque reference filter contains a first order lag filter and notch filters arranged in series, and each filter operates independently.

The notch filters can be enabled and disabled with Pn408 = n. X X and Pn416 = n. XXX.



* The second stage second torque reference filter is disabled when Pn40F is set to 5,000 (default setting) and it is enabled when Pn40F is set to a value lower than 5,000.

Torque Reference Filter

If you suspect that machine vibration is being caused by the Servo Drive, try adjusting the torque reference filter time constant. This may stop the vibration. The lower the value, the better the control response characteristic will be, but there may be a limit depending on the machine conditions.

Pn401	First Stage First Torque Reference Filter Time Constant			Speed	Position	Torque
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification	
	0 ~ 65535	0.01ms	100	Immediately	Tuning	
Pn40F	Second Stage Second Torque Reference Filter Frequency			Speed	Position	Torque
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification	
	100 ~ 5000	1Hz	5000*	Immediately	Tuning	

Pn410	Second Stage Second Torque Reference Filter Q Value			Speed	Position	Torque
	Setting Range	Setting Unit	Default Setting	When Enabled		Classification
	50 ~ 100	0.01	50	Immediately		Tuning

* The filter is disabled if you set the parameter to 5,000.

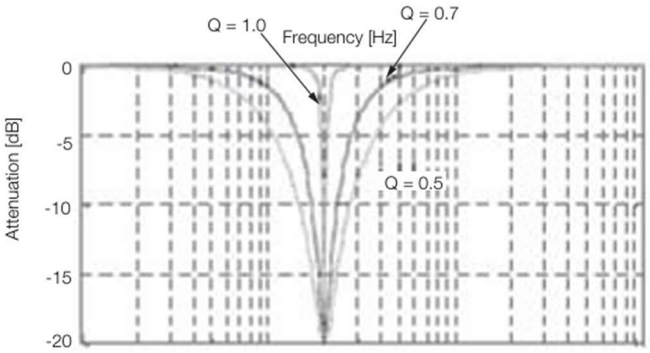
Notch Filters

The notch filter can eliminate specific frequency elements generated by the vibration of sources such as resonance of the shaft of a ball screw.
The notch filter puts a notch in the gain curve at the specific vibration frequency (called the notch frequency). The frequency components near the notch frequency can be reduced or removed with a notch filter.
Notch filters are set with three parameters for the notch filter frequency, notch filter Q value, and notch filter depth. This section describes the notch filter Q value and notch filter depth.

Notch filter Q Value

The setting of the notch filter Q value determines the width of the frequencies that are filtered for the notch filter frequency. The width of the notch changes with the notch filter Q value. The larger the notch filter Q value is, the steeper the notch is and the narrower the width of frequencies that are filtered is.

The notch filter frequency characteristics for different notch filter Q values are shown below.

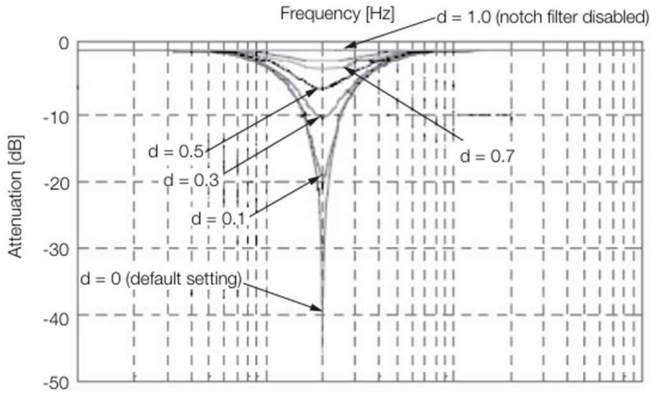


Notch Filter Depth

The setting of the notch filter depth determines the depth of the frequencies that are filtered for the notch filter frequency. The depth of the notch changes with the notch filter depth. The smaller the notch filter depth is, the deeper the notch is, increasing the effect of vibration suppression. However, if the value is too small, vibration can actually increase.

The notch filter is disabled if the notch filter depth, d, is set to 1.0 (i.e., if Pn419 is set to 1,000).

The notch filter frequency characteristics for different notch filter depths are shown below.



You can enable or disable the notch filter with Pn408 and Pn416.

Parameter		Meaning	When Enabled	Classification
Pn408	n.□□□0 [default setting]	Disable first stage notch filter.	Immediately	Setup
	n.□□□1	Enable first stage notch filter.		
	n.□0□□ [default setting]	Disable second stage notch filter.		
	n.□1□□	Enable second stage notch filter.		
Pn41F	n.□□□0 [default setting]	Disable third stage notch filter.		
	n.□□□1	Enable third stage notch filter.		
	n.□□0□ [default setting]	Disable fourth stage notch filter.		
	n.□□1□	Enable fourth stage notch filter.		
	n.□0□□ [default setting]	Disable fifth stage notch filter.		
	n.□1□□	Enable fifth stage notch filter.		

Set the machine vibration frequencies in the notch filter parameters.

Pn409	First Stage Notch Filter Frequency			Speed	Position Torque
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	50 ~ 5000	1Hz	5000	Immediately	Tuning
Pn40A	First Stage Notch Filter Q Value			Speed	Position Torque
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	50 ~ 1000	0.01	70	Immediately	Tuning
Pn40B	First Stage Notch Filter Depth			Speed	Position Torque
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 ~ 1000	0.001	0	Immediately	Tuning
Pn40C	Second Stage Notch Filter Frequency			Speed	Position Torque
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	50 ~ 5000	1Hz	5000	Immediately	Tuning
Pn40D	Second Stage Notch Filter Q Value			Speed	Position Torque
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	50 ~ 1000	0.01	70	Immediately	Tuning
Pn40E	Second Stage Notch Filter Depth			Speed	Position Torque
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 ~ 1000	0.001	0	Immediately	Tuning
Pn417	Third Stage Notch Filter Frequency			Speed	Position Torque
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	50 ~ 5000	1Hz	5000	Immediately	Tuning
Pn418	Third Stage Notch Filter Q Value			Speed	Position Torque
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	50 ~ 1000	0.01	70	Immediately	Tuning
Pn419	Third Stage Notch Filter Depth			Speed	Position Torque
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 ~ 1000	0.001	0	Immediately	Tuning
Pn41A	Fourth Stage Notch Filter Frequency			Speed	Position Torque
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	50 ~ 5000	1Hz	5000	Immediately	Tuning
Pn41B	Fourth Stage Notch Filter Q Value			Speed	Position Torque
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	50 ~ 1000	0.01	70	Immediately	Tuning
Pn41C	Fourth Stage Notch Filter Depth			Speed	Position Torque
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 ~ 1000	0.001	0	Immediately	Tuning

Pn41D	Fifth Stage Notch Filter Frequency			Speed	Position / Torque
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	50 ~ 5000	1Hz	5000	Immediately	Tuning
Pn41E	Fifth Stage Notch Filter Q Value			Speed	Position / Torque
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	50 ~ 1000	0.01	70	Immediately	Tuning
Pn41F	Fifth Stage Notch Filter Depth			Speed	Position / Torque
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 ~ 1000	0.001	0	Immediately	Tuning

- Do not set notch filter frequencies (Pn409, Pn40C, Pn417, Pn41A, and Pn41D) that are close to the speed loop's response frequency. Set a frequency that is at least four times the speed loop gain (Pn100). (However, Pn103 (Moment of Inertia Ratio) must be set correctly. If the setting is not correct, vibration may occur and the machine may be damaged.
- Change the notch filter frequencies (Pn409, Pn40C, Pn417, Pn41A, and Pn41D) only while the Servomotor is stopped. Vibration may occur if a notch filter frequency is changed during operation.

Guidelines for Manually Tuning Servo Gains

When you manually adjust the parameters, make sure that you completely understand the information in the product manual and use the following conditional expressions as guidelines. The appropriate values of the parameter settings are influenced by the machine specifications, so they cannot be determined universally. When you adjust the parameters, actually operate the machine and use the Protuner or analog monitor to monitor operating conditions. Even if the status is stable while the Servomotor is stopped, an unstable condition may occur when an operation reference is input. Therefore, input operation references and adjust the servo gains as you operate the Servomotor.

Stable gain: Settings that provide a good balance between parameters.
However, if the load moment of inertia is large and the machine system contains elements prone to vibration, you must sometimes use a setting that is somewhat higher to prevent the machine from vibrating. ◦

Critical gain: Settings for which the parameters affect each other ◦
Depending on the machine conditions, overshooting and vibration may occur and operation may not be stable. If the critical gain condition expressions are not met, operation will become more unstable, and there is a risk of abnormal motor shaft vibration and round-trip operation with a large amplitude. Always stay within the critical gain conditions.

If you use the torque reference filter, second torque reference filter, and notch filters together, the interference between the filters and the speed loop gain will be superimposed. Allow leeway in the adjustments. ◦

The following adjusted value guidelines require that the setting of Pn103 (Moment of Inertia Ratio) is correctly set for the actual machine.

◆ When Pn10B = n. 0 (PI Control)

Guidelines are given below for gain settings 1.

The same guidelines apply to gain settings 2 (Pn104, Pn105, Pn106, and Pn412). ◦

- Speed Loop Gain (Pn100 [Hz]) and Position Loop Gain (Pn102 [/s])
  Stable gain: Pn102 [/s] ≤ 2π × Pn100/4 [Hz]
  Critical gain: Pn102 [/s] < 2π × Pn100 [Hz]

- Speed Loop Gain (Pn100 [Hz]) and Speed Loop Integral Time Constant (Pn101 [ms])
  Stable gain: Pn101 [ms] ≥ 4,000/(2π × Pn100 [Hz])
  Critical gain: Pn101 [ms] > 1,000/(2π × Pn100 [Hz])

- Speed Loop Gain (Pn100 [Hz]) and First Stage First Torque Reference Filter Time Constant (Pn401 [ms])
  Stable gain: Pn401 [ms] ≤ 1,000/(2π × Pn100 [Hz] × 4)
  Critical gain: Pn401 [ms] < 1,000/(2π × Pn100 [Hz] × 1)

- Speed Loop Gain (Pn100 [Hz]) and Second Stage Second Torque Reference Filter Frequency (Pn40F [Hz])
  Critical gain: Pn40F [Hz] > 4 × Pn100 [Hz]
  NOTE: Set the Second Stage Second Torque Reference Filter Q Value (Pn410) to 0.70.

- Speed Loop Gain (Pn100 [Hz]) and First Stage Notch Filter Frequency (Pn409 [Hz]) (or Second Stage Notch Filter Frequency (Pn40C [Hz]))
  Critical gain: Pn409 [Hz] > 4 × Pn100 [Hz]

- Speed Loop Gain (Pn100 [Hz]) and Speed Feedback Filter Time Constant (Pn308 [ms])
  Stable gain: Pn308 [ms] ≤ 1,000/(2π × Pn100 [Hz] × 4)
  Critical gain: Pn308 [ms] < 1,000/(2π × Pn100 [Hz] × 1)

◆ When Pn10B = n. 1 (I-P Control)

Guidelines are given below for gain settings 1.

The same guidelines apply to gain settings 2 (Pn104, Pn105, Pn106, and Pn412).

For I-P control, the relationships between the speed loop integral time constant, speed loop gain, and position loop gain are different from the relationships for PI control. The relationship between other servo gains is the same as for PI control.

- Speed Loop Gain (Pn100 [Hz]) and Speed Loop Integral Time Constant (Pn101 [ms])
  Stable gain: Pn100 [Hz] ≥ 320/Pn101 [ms]

- Position Loop Gain (Pn102 [/s]) and Speed Loop Integral Time Constant (Pn101 [ms])
  Stable gain: Pn102 [/s] ≤ 320/Pn101 [ms]

NOTE: Selecting the Speed Loop Control Method (PI Control or I-P Control)Usually, I-P control is effective for high-speed positioning and high-speed, high-precision processing applications. With I-P control, you can use a lower position loop gain than for PI control to reduce the positioning time and reduce arc radius reduction. However, if you can use mode switching to change to proportional control to achieve the desired application, then using PI control would be the normal choice.

◆ Decimal Points in Parameter Settings

For the SC3 servo drivers, decimal places are given for the settings of parameters on the Digital Operator, Panel Operator, and in the manual. For example with Pn100 (Speed Loop Gain), Pn100 = 40.0 is used to indicate a setting of 40.0 Hz. In the following adjusted value guidelines, the decimal places are also given.

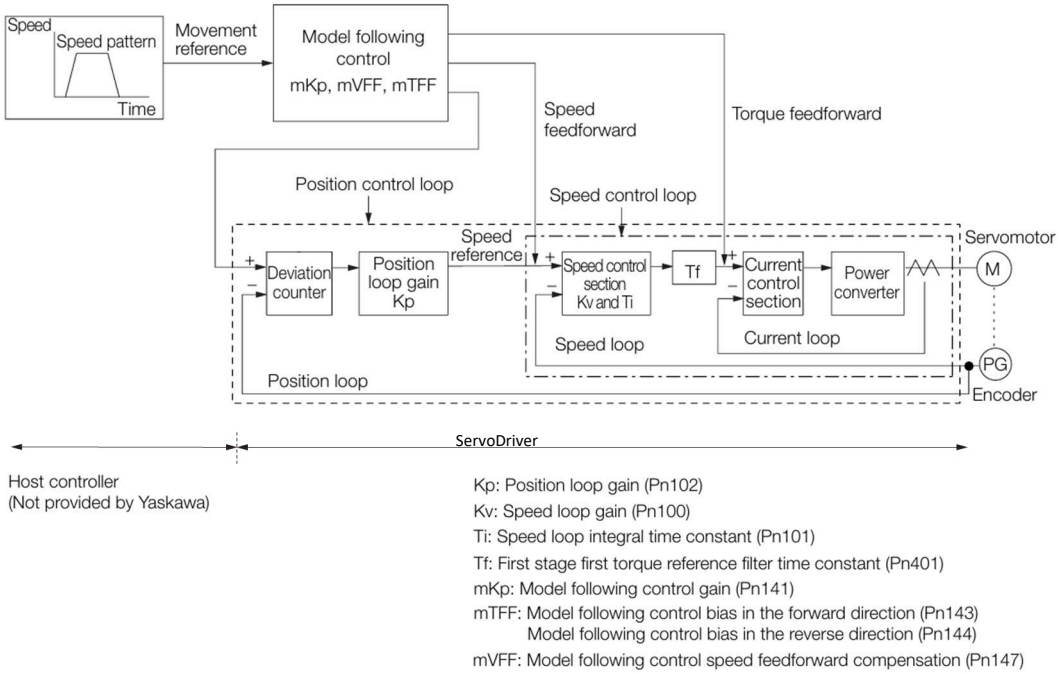
- Speed Loop Gain (Pn100 [Hz]) and Speed Loop Integral Time Constant (Pn101 [ms])
  Stable gain: Pn101 [ms] ≥ 4,000/(2π × Pn100 [Hz]), therefore If Pn100 = 40.0 [Hz], then Pn101 = 4,000/(2π × 40.0) ≈ 15.92 [ms].)

Model Following Control

You can use model following control to improve response characteristic and shorten positioning time. You can use model following control only with position control. Normally, the parameters that are used for model following control are automatically set along with the servo gains by executing autotuning or custom tuning. However, you must adjust them manually in the following cases.

- When the tuning results for autotuning or custom tuning are not acceptable
- When you want to increase the response characteristic higher than that achieved by the tuning results for autotuning or custom tuning
- When you want to determine the servo gains and model following control parameters yourself

The block diagram for model following control is provided below.



◆ Manual Tuning Procedure

Use the following tuning procedure for using model following control.

Step	Description
1	Friction compensation must also be used. Set the friction compensation parameters. Refer to the following section for the setting procedure.
2	Adjust the servo gains. Refer to the following section for an example procedure. NOTE: 1. Set the moment of inertia ratio (Pn103) as accurately as possible. 2. Refer to the guidelines for manually tuning the servo gains and set a stable gain for the position loop gain (Pn102).
3	Increase the model following control gain (Pn141) as much as possible within the range in which overshooting and vibration do not occur.
4	If overshooting occurs or if the response is different for forward and reverse operation, fine-tune model following control with the following settings: model following control bias in the forward direction (Pn143), model following control bias in the reverse direction (Pn144), and model following control speed feedforward compensation (Pn147).

◆ Related Parameters

Next we will describe the following parameters that are used for model following control.

- Pn140 (Model Following Control-Related Selections)
- Pn141 (Model Following Control Gain)
- Pn143 (Model Following Control Bias in the Forward Direction)
- Pn144 (Model Following Control Bias in the Reverse Direction)
- Pn147 (Model Following Control Speed Feedforward Compensation)

Model Following Control-Related Selections

Set Pn140 = n. X to specify whether to use model following control.
If you use model following control with vibration suppression, set Pn140 to n. 1 or Pn140 = n. 2 . When you also perform vibration suppression, adjust vibration suppression with custom tuning in advance.

NOTE: If you use vibration suppression (Pn140 = n. 1 or Pn140 = n. 2), always set Pn140 to n. 1 (Use model following control).

Parameter		Function	When Enabled	Classification
Pn140	n.□□□0 [default setting]	Do not use model following control.	Immediately	Tuning
	n.□□□1	Use model following control.		
	n.□□0□ [default setting]	Do not perform vibration suppression.		
	n.□□1□	Perform vibration suppression for a specific frequency.		
	n.□□2□	Perform vibration suppression for two specific frequencies.		

Model Following Control Gain

The model following control gain determines the response characteristic of the servo system. If you increase the setting of the model following control gain, the response characteristic will improve and the positioning time will be shortened. The response characteristic of the servo system is determined by this parameter, and not by Pn102 (Position Loop Gain).

Pn141	Model Following Control Gain			Position	
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	10 ~ 20000	0.1/s	500	Immediately	Tuning

NOTE: For machines for which a high model following control gain cannot be set, the size of the position deviation in model following control will be determined by the setting of the model following control gain. For a machine with low rigidity, in which a high model following control gain cannot be set, position deviation overflow alarms may occur during high-speed operation. If that is the case, you can increase the setting of the following parameter to increase the level for alarm detection.
Use the following conditional expression for reference in determining the setting.

$$\text{Pn 520} \geq \frac{\text{Maximum feed speed [reference units/s]}}{\text{Pn 141/10 [1/s]}} \times 2.0$$

Pn520	Position Deviation Overflow Alarm Level			Position	
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	1 ~ 1073741823	1 reference unit	5242880	Immediately	Tuning

Model Following Control Bias in the Forward Direction and Model Following Control Bias in the Reverse Direction

If the response is different for forward and reverse operation, use the following parameters for fine-tuning.

If you decrease the settings, the response characteristic will be lowered but overshooting will be less likely to occur.

Pn143	Model Following Control Bias in the Forward Direction			Position	
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 ~ 10000	0.1%	1000	Immediately	Tuning
Pn144	Model Following Control Bias in the Reverse Direction			Position	
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 ~ 10000	0.1%	1000	Immediately	Tuning

Model Following Control Speed Feedforward Compensation

If overshooting occurs even after you adjust the model following control gain, model following control bias in the forward direction, and model following control bias in the reverse direction, you may be able to improve performance by setting the following parameter.

If you decrease the settings, the response characteristic will be lowered but overshooting will be less likely to occur.

Pn147	Model Following Control Speed Feedforward Compensation			Position	
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 ~ 10000	0.1%	1000	Immediately	Tuning

Model Following Control Type Selection

When you enable model following control, you can select the model following control type. Normally, set Pn14F to n. 1 (Use model following control type 2) (default setting). If compatibility with previous models is required, set Pn14F to n. 0 (Use model following control type 1).

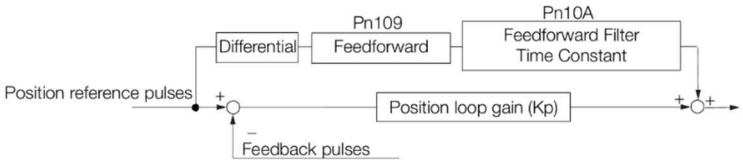
Parameter		Meaning	When Enabled	Classification
Pn14F	n.□□□0	Use model following control type 1.	After restart	Tuning
	n.□□□0 [default setting]	Use model following control type 2.		

12.12.2 Compatible Adjustment Functions

The compatible adjustment functions are used together with manual tuning. You can use these functions to improve adjustment results. These functions allow you to use the same functions as for SC3-Series servo drivers to adjust SC3-Series servo drivers. ◦

Feedforward

The feedforward function applies feedforward compensation to position control to shorten the positioning time.



Pn109	Feedforward			Position	
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 ~ 100	1%	0	Immediately	Tuning
Pn10A	Feedforward Filter Time Constant			Position	
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 ~ 6400	0.01ms	0	Immediately	Tuning

NOTE: If you set the feedforward value too high, the machine may vibrate. As a guideline, use a setting of 80% or less. ◦

Torque Feedforward and Speed Feedforward

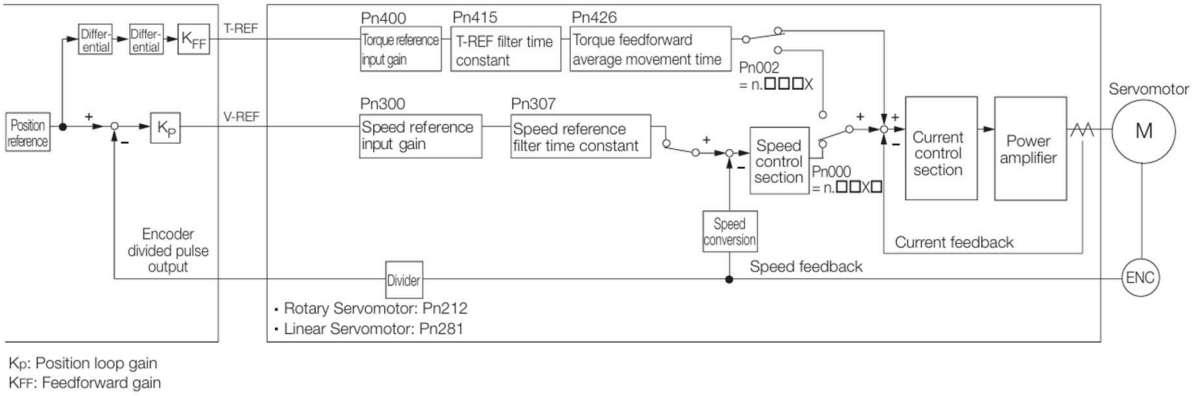
You can use the torque feedforward and speed feedforward functions to help shorten the positioning time. The reference is created from the differential of the position reference at the host controller.

Torque feedforward: This is effective for speed control or position control. It is sent from the host controller along with the speed reference. Connect the speed reference from the host controller to the V-REF (CN1-5 and CN1-6) signal and the torque feedforward reference from the host controller to the T-REF (CN1- 9 and CN1-10) signal.

Speed feedforward: This is effective only for position control. It is sent to the servo driver from the host controller along with the position reference. Connect the position reference from the host controller to the PULS and SIGN (CN1-7,CN1 -8, CN1-11, and CN1-12) signals and the speed feedforward reference from the host controller to the V-REF (CN1-5 and CN1-6) signal.

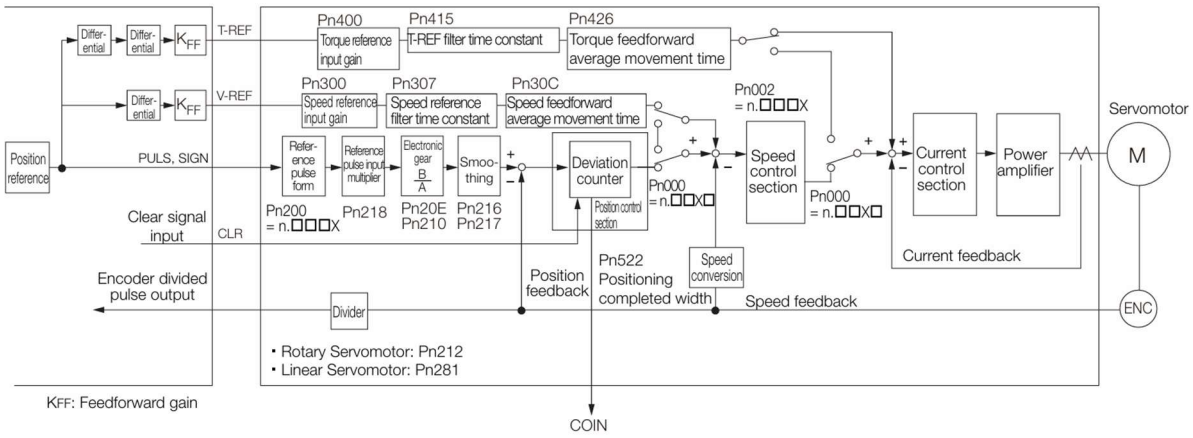
◆ Examples of Connections to Host Controllers

When servo driver Performs Speed Control



K_P: Position loop gain
K_{FF}: Feedforward gain

When servo driver Performs Position Contro



K_{FF}: Feedforward gain

■ Related Parameters

Torque feedforward is allocated to T-REF (Pn002 = n. X) and it is set using the torque reference input gain (Pn400) and T-REF filter time constant (Pn415).

The default setting of Pn400 is 30. Therefore, if the torque feedforward value is ±3 V, then the torque is limited to ±100% of the rated torque.

Parameter		Meaning	When Enabled	Classification
Pn002	n.□□□0 [default setting]	Do not use T-REF.	After restart	Setup
	n.□□□1	Use T-REF as an external torque limit input.		
	n.□□□2	Use T-REF as a torque feedback input.		
	n.□□□3	Use T-REF as an external torque limit input when /P-CL or /N-CL is active.		

Pn400	Torque Reference Input Gain			Speed Position Torque	
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	10 ~ 100	0.1 V/rated torque	30	Immediately	Setup
Pn415	T-REF Filter Time Constant			Speed Position Torque	
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 ~ 65535	0.01ms	0	Immediately	Setup

Pn426	Torque feedforward average movement time				
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 ~ 5100	0.1ms	0	Immediately	Setup

NOTE:1.Overshooting will occur if you set the torque feedforward too high. Set the optimum value while monitoring the response.
2.You cannot use the torque feedforward function together with torque limiting with an analog voltage reference.

■ Speed Feedforward

You set the speed feedforward function with the position control option (Pn207 = n. X) and the speed reference input gain (Pn300).
The default setting of Pn300 is 600. Therefore, if the speed feedforward value is ±6 V, then it will indicate the rated speed.

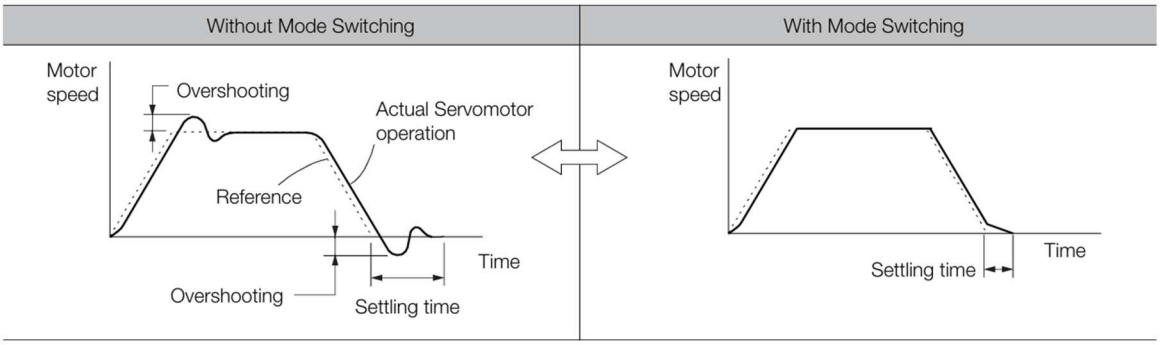
Parameter		Meaning	When Enabled	Classification
Pn207	n.□□0□ [default setting]	Do not use V-REF.	After restart	Setup
	n.□□1□	Use V-REF as a speed feedback input.		

Pn300	Speed Reference Input Gain			Speed	Position	Torque
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification	
	150 ~ 3000	0.01 V/Rated motor speed	600	Immediately	Setup	
Pn307	Speed Reference Filter Time Constant					
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification	
	0 ~ 65535	0.01ms	40	Immediately	Setup	
Pn30C	Speed Feedforward Average Movement Time					
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification	
	0 ~ 5100	0.1ms	0	Immediately	Setup	

NOTE: Overshooting will occur if you set the feedforward too high. Set the optimum value while monitoring the response.

Mode Switching (Changing between Proportional and PI Control)

You can use mode switching to automatically change between proportional control and PI control. Overshooting caused by acceleration and deceleration can be suppressed and the settling time can be reduced by setting the switching condition and switching levels.



◆ Related Parameters

Select the switching condition for mode switching with Pn10B = n. X.

Parameter		Mode Switching Selection	Parameter That Sets the Level		When Enabled	Classification
			Rotary Servomotor	Linear Servomotor		
Pn10B	n.□□□0 [default setting]	Use the internal torque reference as the condition.	Pn10C		Immediately	Setup
	n.□□□1	Use the speed reference as the condition.	Pn10D	Pn181		
	n.□□□2	Use the acceleration reference as the condition.	Pn10E	Pn182		
	n.□□□3	Use the position deviation as the condition.	Pn10F			
	n.□□□4	Do not use mode switching.	-			

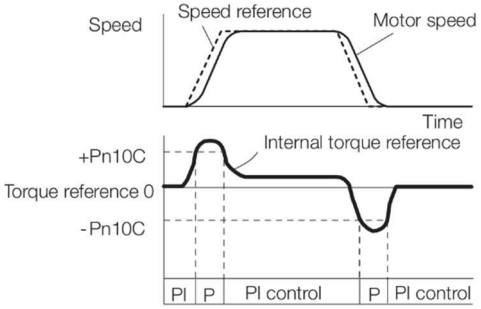
■ Parameters That Set the Switching Levels

• Rotary Servomotors

Pn10C	Mode Switching Level for Torque Reference			Speed	Position
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 ~ 800	1%	200	Immediately	Tuning
Pn10D	Mode Switching Level for Speed Reference			Speed	Position
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 ~ 10000	$1min^{-1}$	0	Immediately	Tuning
Pn10E	Mode Switching Level for Acceleration			Speed	Position
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 ~ 30000	$1min^{-1}/s$	0	Immediately	Tuning
Pn10F	Mode Switching Level for Position Deviation				Position
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 ~ 10000	1 reference unit	0	Immediately	Tuning

■ Using the Internal Torque Reference as the Mode Switching Condition (Default Setting)

When the Internal torque reference equals or exceeds the torque set for the mode switching level for torque reference (Pn10C), the speed loop is changed to P control. The default setting for the torque reference level is 200%.

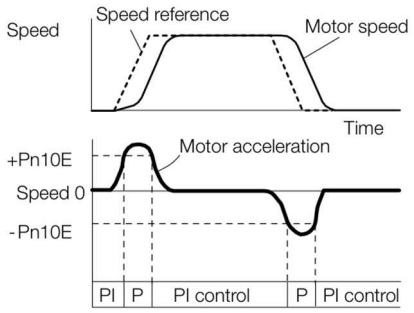


■ Using the Speed Reference as the Mode Switching Condition

- Rotary Servomotors
  When the speed reference equals or exceeds the speed set for the mode switching level for a speed reference (Pn10D), the speed loop is changed to P control.

■ Using the Acceleration as the Mode Switching Condition

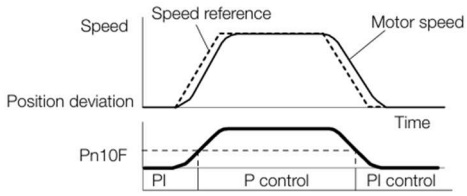
- Rotary Servomotors
  When the speed reference equals or exceeds the acceleration rate set for the mode switching level for acceleration (Pn10E), the speed loop is changed to P control.



◆ Using the Position Deviation as the Mode Switching Condition

When the position deviation equals or exceeds the value set for the mode switching level for position deviation (Pn10F), the speed loop is changed to P control. This setting is enabled only for position control.

Position Integral



The position integral is the integral function of the position loop. It is used for the electronic cams and electronic shafts when using the servo driver with a Yaskawa MP3000-Series Machine Controller.

Pn11F	Position Integral Time Constant			Position	
	Setting Range	Setting Unit Position	Default Setting	When Enabled	Classification
	0 ~ 50000	0.1ms	0	Immediately	Tuning

12.13 Diagnostic Tools

12.13.1 Easy FFT

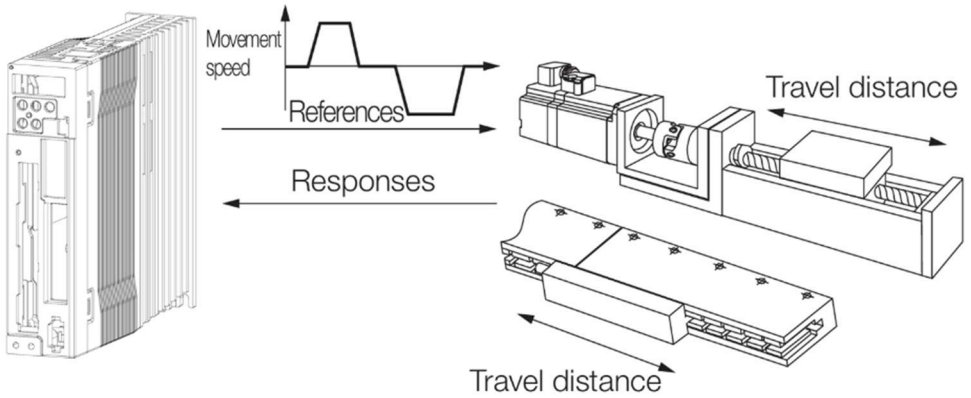
The machine is made to vibrate and a resonance frequency is detected from the generated vibration to set notch filters according to the detected resonance frequencies. This is used to eliminate high-frequency vibration and noise.
During execution of Easy FFT, a frequency waveform reference is sent from the servo driver to the Servomotor to automatically cause the shaft to rotate multiple times within 1/4th of a rotation, thus causing the machine to vibrate.
Execute Easy FFT after the servo is turned OFF if operation of the servo driver results in highfrequency noise and vibration

⚠WARNING

- Never touch the Servomotor or machine during execution of Easy FFT. Doing so may result in injury.

⚠CAUTION

Use Easy FFT when the servo gain is low, such as in the initial stage of servo tuning. If you execute Easy FFT after you increase the gain, the machine may vibrate depending on the machine characteristics or gain balance.



Easy FFT is built into the servo driver for compatibility with previous products. Normally use autotuning without a host reference for tuning.

Preparations

Always check the following before you execute Easy FFT.

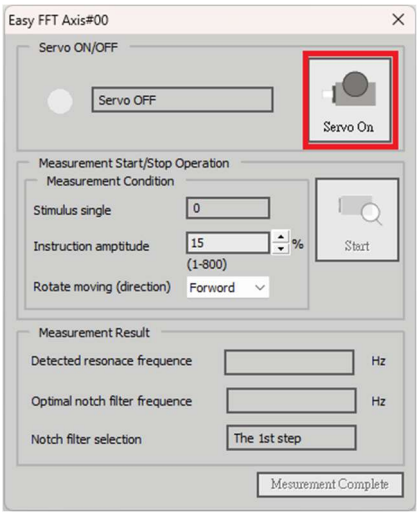
- The parameters must not be write prohibited.
- The main circuit power supply must be ON.
- There must be no alarms.
- The servo must be OFF.
- There must be no overtravel.
- An external reference must not be input.

Operating Procedure

Use the following procedure

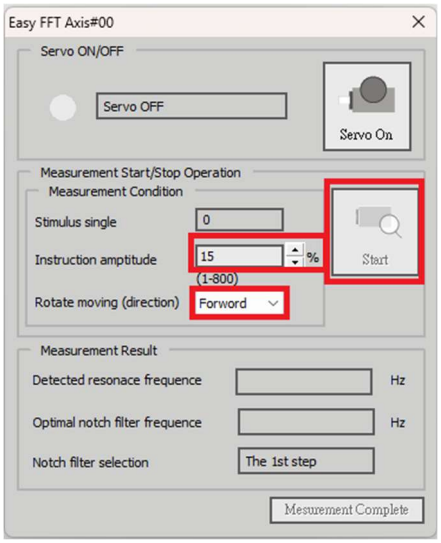
1. Click the ServoDrive Button in the workspace of the Main Window of the Protuner.
Select Easy FFT in the Menu Dialog Box.
The Easy FFT Dialog Box will be displayed.
Click the Cancel Button to cancel Easy FFT. You will return to the main window

2. Click the Servo ON Button.



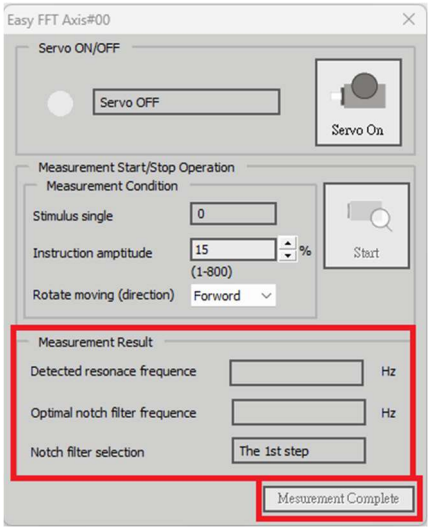
3. Select the instruction (reference) amplitude and the rotation direction in the Measurement condition Area, and then click the Start Button.

The Servomotor shaft will rotate and measurements will start.

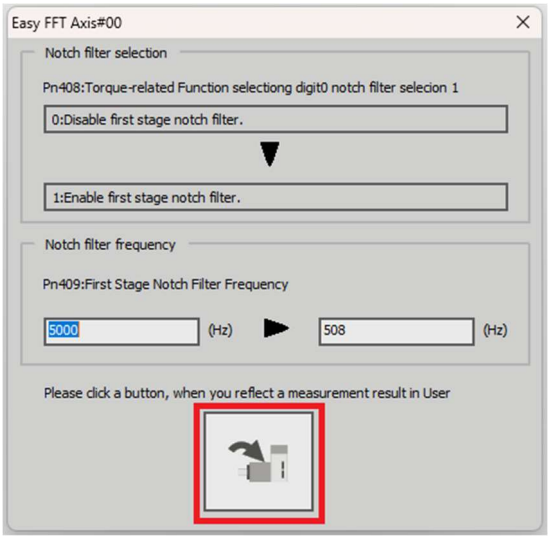


When measurements have been completed, the measurement results will be displayed.

4. Check the results in the Measurement result Area and then click the Measurement complete Button.



5. Click the Result Writing Button if you want to set the measurement results in the parameters.



This concludes the procedure to set up

Related Parameters

The following parameters are automatically adjusted or used as reference when you execute Easy FFT.

Do not change the settings of these parameters during execution of Easy FFT.

Parameter	Name	Automatic Changes
Pn408	Torque-Related Function Selections	Yes
Pn409	First Stage Notch Filter Frequency	Yes
Pn40A	First Stage Notch Filter Q Value	No
Pn40C	Second Stage Notch Filter Frequency	Yes
Pn40D	Second Stage Notch Filter Q Value	No
Pn456	Sweep Torque Reference Amplitude	No

Yes: The parameter is automatically set.

No: The parameter is not automatically set, but the setting is read during execution.

12.14 Modbus

Address	Name	Unit	Read/Write	Length	Comment
0x0000-0x07FF	Paramaters	--	RW	Reference Manual	Auto back up to ERROM and saved when power off
0x1000-0x17FF	Paramaters	--	RW	Reference Manual	Not back up to ERROM and not saved when power off
0xC060	Motor SN		RO	16	
0xE000	Motor Speed	rpm	RO	16	Un000
0xE001	Speed Reference	rpm	RO	16	Un001
0xE002	Torque Reference	1%	RO	16	Un002
0xE005	Rotational Angle 2	deg	RO	16	Un004
0xE006	Input Signal Monitor	--	RO	16	Un005
0xE007	Output Signal Monitor	--	RO	16	Un006
0xE008	Input Reference Pulse Speed	rpm	RO	16	Un007
0xE009	Position Deviation	Reference Units	RO	32	Un008
0xE00B	Accumulated Load Ratio	1%	RO	16	Un009
0xE00C	Regenerative Load Ratio	1%	RO	16	Un00A
0xE00D	Dynamic Brake Resistor Power Consumption	1%	RO	16	Un00B
0xE00E	Input Reference Pulse Counter	Reference Units	RO	32	Un00C
0xE010	Feedback Pulse Counter	Pulse	RO	32	Un00D
0xE012	Fully-closed Loop Feedback Pulse Counter	Pulse	RO	32	Un00E
0xE01B	Feedback Pulse Counter	Reference Units	RO	32	Un013
0xE040	Absolute Encoder Multiturn Data	Turn	RO	16	Un040
0xE041	Position within One Rotation of Absolute Encoder	Pulse	RO	32	Un041
0xEC00	Absolute Position	Reference Units	RO	32	Un070
0xE110	Servo Inteneral Status	--	RO	32	
	bit0 Main Circuit bit1 Encoder (PGRDY) bit2 Motor Power (Request) bit3 Dynamic Brake (DB) bit4 Rotation (Movement) Direction bit5 Mode Switch bit6 Speed Reference bit7 Torque Reference bit8 Position Reference bit9 Position Reference Direction bit10 Reserve bit11 Return To The Zero Position Completed		bit16 Motor Power Status bit17 Reserve bit18 Overcurrent bit19 Origin Not Passed bit21 Polarity Detection bit22 Polarity Detection Completed bit23 Reserve bit26 Clear Signal (CLR)		

	bit12 AC Power ON bit13 CHARGE OK bit14 Regenerative Transistor bit15 Regenerative Error Detection				
0xE120	Servo Inteneral Inputs Status	--	RO	32	
	Bit0 S-ON Bit1 P/PI Switch Bit2 P-OT Bit3 N-OT Bit4 ALM_RESET Bit5 PCL Bit6 NCL Bit7 SENSOR ON Bit8 CLR Bit9 Reserve Bit10 Reserve Bit11 Reserve Bit12 Reserve Bit13 Reserve Bit14 Gain Selection 0 Bit15 Gain Selection 2		Bit16 PDET Bit17 FSTP Bit18-Dec Bit19 EXT0 Bit20 EXT1 Bit21 EXT2		
0xE130	Servo Inteneral Output Status	--	RO	32	
	Bit0 ALARM Bit1 COIN Bit2 V-CMP Bit3 TGON Bit4 S-RDY Bit5 CLT Bit6 VLT Bit7 BK Bit8 WARN Bit9 NEAR				
0xE140	DC-Link Voltage	1V	RO	16	Un140
0xE50A	Current Alarm State	--	RO	16	
0xE517	Servo Software Version	--	RO	32	
0xE51B	Servo Status	--	RO	16	
	1:Alarm 3:POT NOT 4:POT 5:NOT 6:bb 7:run 8:RUN Polarity Detection A:Fstp				
0xE51C	Servo Control Mode	--	RO	16	
	0:Speed 1:Position 2:Torque				

0x2700	Communication input Supported by V20F and above	--	RW	32	
	bit0 PGM-START bit1 HOME-START bit2 PGM-STEP bit3 PGM-SEL0 bit4 PGM-SEL1 bit5 PGM-SEL2 bit6 PGM-SEL3 bit7 Reserve bit8 Reserve bit9 Reserve bit10 Reserve bit11 PDET bit12 SON bit13 ALM_RESET bit14 Dec bit15 Reserve bit16 P-OTReserve bit17 N-OTReserve bit18 PCL bit19 NCL bit20 CLR bit21 PCON bit22 ZCLAMP bit23 INHIBIT bit24 PSEL bit25 SPD bit26 SPA bit27 SPB bit28 CSEL bit29 GSEL bit30 SEN bit31 FstpReserve				

When using Modbud RTU to control the servo (in internal program table position control mode), Pn000 needs to be set to 00C0 (control mode setting C is position control running with internal program).
Internal program operation related parameters:
Pn640:
Hex0 (PGM-START): 0~7 are controlled by CN1 IO input, 8 is fixed as invalid, can be controlled by external communication, 9 is fixed as valid, ignore external communication and CN1 IO control
Hex1 (PGM-STEP): 0~7 are controlled by CN1 IO input, 8 is fixed as invalid, can be controlled by external communication, 9 is fixed as valid, ignore external communication and CN1 IO control
Pn641:
Hex0 (Program step 0 / SEL0 signal): 0~7 are controlled by CN1 IO input, 8 is fixed as invalid, can be controlled by external communication, 9 is fixed as valid, ignore external communication and CN1 IO control
Hex1 (Program step 1 / SEL1 signal): 0~7 are controlled by CN1 IO input, 8 is fixed as invalid, can be controlled by external communication, 9 is fixed as valid, ignore external communication and CN1 IO
Hex2 (Program step 2 / SEL2 signal): 0~7 are controlled by CN1 IO input control, 8 is fixed as invalid, can be controlled by external communication, 9 is fixed as valid, ignore external communication and CN1 IO
Hex3 (Program step 2 / SEL3 signal): 0~7 are controlled by CN1 IO input, 8 is fixed as invalid, can be controlled by external communication, 9 is fixed as valid, ignore external communication and CN1 IO
Control bit 0x2700 Communication input description:
1. The entire register must be written once with a single 32-bit integer.
2. Please fill in 0 for unused or reserved bits.
Example:
Communication control servo SON sets Bit 12 to 1 (0=Servo off 1= Servo on)
0x2700=0000 0000 0000 0000 0000 0001 0000 0000 0000(0x1000)
Communication command
01 10 27 00 00 02 04 00 00 10 00 41 9E

Set the position and speed of program step 0
0x0800=1 (=0 absolute position =1 relative position) 0x0801-0x0802 Target position (command unit)
0x0801=C350 Set the target position low bit to 50000 pulses
0x0802=0000 Set the target position high bit to 0
0x0803=01F4 Set the running speed to 300 rpm (speed unit 100 pulses/s, 500*100*60/10000=300 rpm)
Communication command
01 10 08 00 00 04 08 00 01 C3 50 00 00 01 F4 68 DA
Communication selection execution program step 0
Servo SON must be issued first
0x2700=0000 0000 0000 0000 0000 0001 0000 0000 0000(0x1000)
Communication command

01 10 27 00 00 02 04 00 00 10 00 41 9E
Select execution of program step 0 bit0=1 bit2=1 bit3=1
0x2700=0000 0000 0000 0000 0001 0000 0000 1101(0x0001000D)
Communication command
01 10 27 00 00 02 04 00 00 00 0D 8D 9B
After the program step is completed, if you need to execute other program steps or repeat the execution, you must set bit2=0 and only keep the SON state
0x2700=0x 0000 0000 0000 0000 0000 0001 0000 0000 0000(0x1000)
Communication command
01 10 27 00 00 02 04 00 00 10 00 41 9E
Repeat execution and issue again
Select execution program step 0 bit0=1 bit2=1 bit3=1
0x2700=0000 0000 0000 0000 0001 0000 0000 1101(0x0001000D)
Communication command
01 10 27 00 00 02 04 00 00 00 0D 8D 9B
Select other steps, such as step 3
bit0=1 bit2=1 bit3=1 bit4=1(bit3~ bit6 are combined into 1 word to indicate the step number)
0x2700=0000 0000 0000 0000 0001 0000 0001 1101(0x0001011D)
Communication command
01 10 27 00 00 02 04 00 00 00 1D 8C 57

(Note) The action mode of PGM-START(bit0) is that when the signal is written to 0, it will stop immediately. If it is written to 1 again, PGM-STEP(bit2) needs to be re-triggered (the writing action is from 0->1)

Internally set speed switching input (SPD, SPA, SPB) signal operation related parameters:
Pn000: 3
Pn301~Pn303: Set the operation speed
After the setting is completed, the communication can be written to bit25 (SPD), bit26 (SPA), bit27 (SPB)

Chapter13. Regenerative Resistor

13.1 The selection and calculation method for regenerative resistors.

When the direction of the motor's torque and speed is opposite, the power generated from the load side will be transmitted back to the drive, and the regenerative resistors is needed to dissipate the rally power to avoid drive failure.

1. Find the inertia and speed of the servo Motor according to the table below

Voltage	Motor Wattage	Rated speed (rev/min)	motor inertia (×10-4 Kg*m2)
AC 220V	100W(brakeless)	3000	0.067
	100W(braked)	3000	0.067
	200W(brakeless)	3000	0.26
	200W(braked)	3000	0.28
	400W(brakeless)	3000	0.49
	400W(braked)	3000	0.51
	750W(brakeless)	3000	1.51
	750W(braked)	3000	1.71
	1KW(brakeless)	2000	13.88
	1KW(braked)	2000	15.78
	1.5KW(brakeless)	2000	18.57
	1.5KW(braked)	2000	20.24
	2KW(brakeless)	2000	23.69
	2KW(braked)	2000	25.36
AC 380V	400W(brakeless)	3000	0.49
	400W(braked)	3000	0.51
	750W(brakeless)	3000	1.51
	750W(braked)	3000	1.71
	1KW(brakeless)	1500	16.04
	1KW(braked)	1500	17.71
	2KW(brakeless)	2000	23.69
	2KW(braked)	2000	25.36
	2.9KW(brakeless)	1500	56.8
	2.9KW(braked)	1500	65.3
	4KW(brakeless)	2000	56.8
	4KW(braked)	2000	65.3
	5.5KW(brakeless)	2000	78.2
	5.5KW(braked)	2000	86
	7.5KW(brakeless)	1500	130
	7.5KW(braked)	1500	140
	13KW(brakeless)	1500	272.8
	15KW(brakeless)	1500	248

2. Calculate the rotational energy(E_S) generated during servo operation using the formula.

$E_S = J \times (n_M)^2/182$ (Joules)

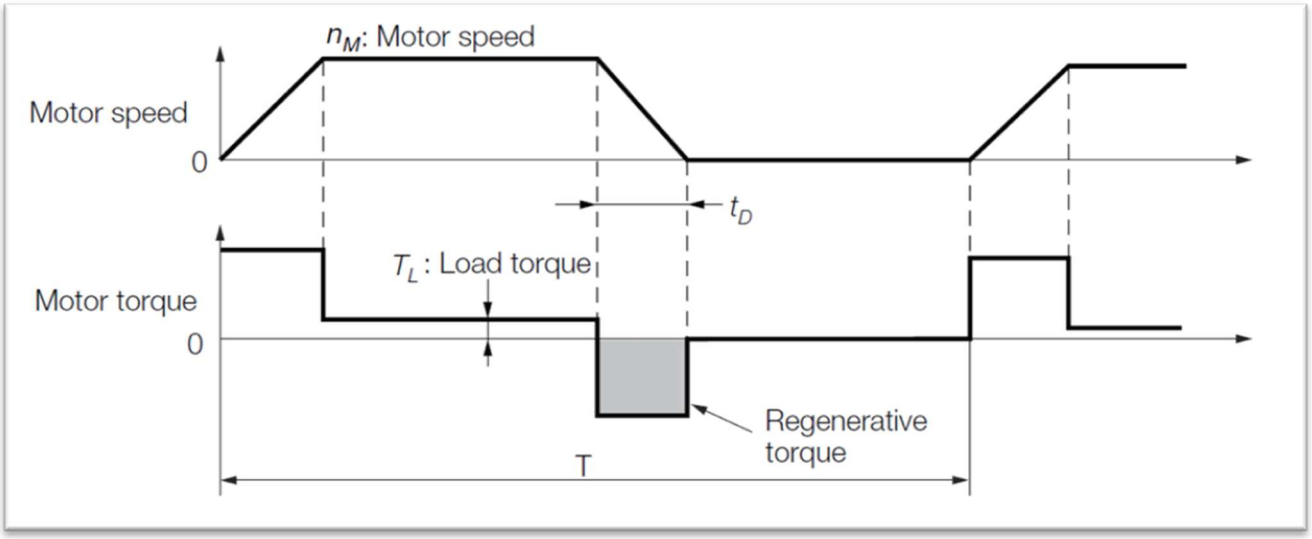
$J = J_M + J_L$

J_M : Servo motor moment of inertia (kg·m2)

J_L : Load moment of inertia at motor shaft (kg·m2)

n_M : Servo motor operating motor speed (min^{-1})

3. Calculation Procedure for Regenerative Resistor Capacity



$W_K = E_S/(0.2 \times T)$

Note: 1. The 0.2 in the equation for calculating W_K is the value when the regenerative resistor's utilized load ratio is 20%.

W_K : Required regenerative resistor capacity (W)

E_S : rotational energy

T : Servomotor repeat operation cycle (s)

If the value of W_K does not exceed the capacity of the built-in regenerative resistor of the ServoDrive, an External Regenerative Resistor is not required. For details on the built-in regenerative resisters, refer to the ServoDrive specifications. If the value of W_K exceeds the capacity of the built-in regenerative resistor, install an External Regenerative Resistor with a capacity equal to the value for W calculated above

Chapter14. Return to Homing Mode Instructions

14.1 Overview of Homing Mode Functionality.

The Homing Mode is used during machine startup or reset to accurately position the axis at the home reference point, ensuring correct baseline for subsequent operations. This mode combines sensor signals and encoder Z-phase signals to achieve safe and precise positioning.

14.2 Description of Homing Mode Parameters and Signal Switches.

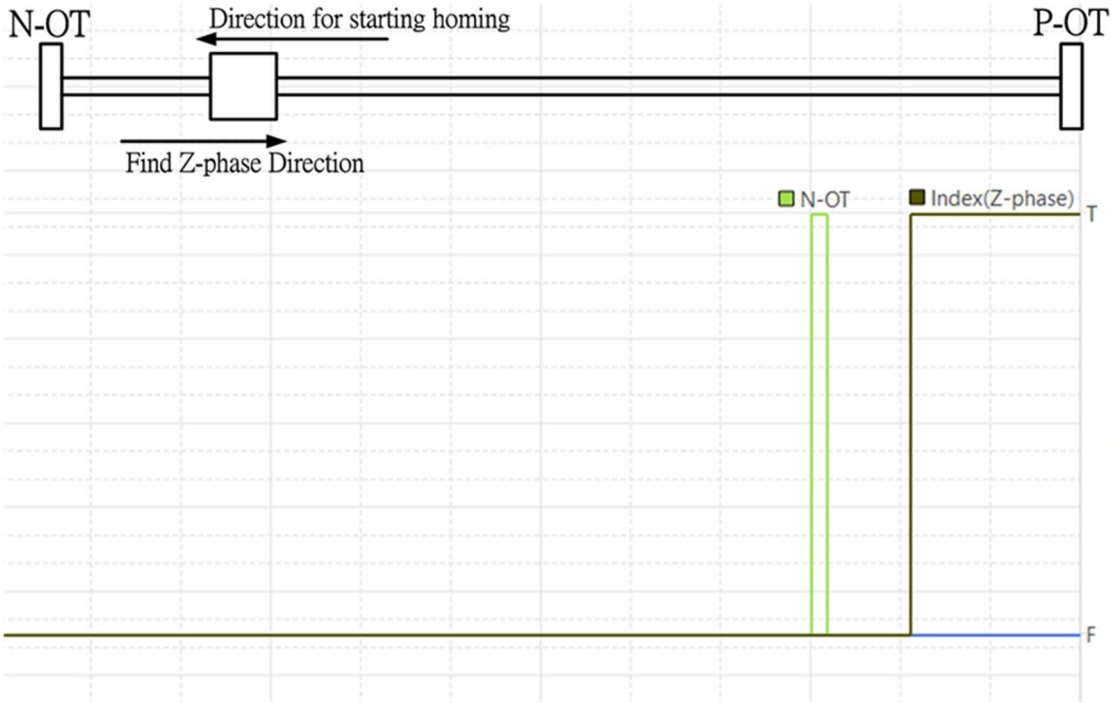
1. Original Point Signal Finding (DEC) The servo moves slowly in the specified direction (positive or negative), detecting the rising or falling edge of the original point sensor signal. The default is a normally closed switch.
2. Encoder Z-Phase Signal Finding Depending on the mode setting, it moves in the positive or negative direction. Upon detecting the Z-phase signal, it immediately stops and sets the origin.
3. Limit Protection Reverse and Overtravel If a limit sensor (P-OT or N-OT) trigger is detected during movement, it stops or automatically reverses according to the mode setting, continuing to search for the Z-phase signal. The default is a normally closed switch.

Related Parameters

Parameter	Name
Pn633	Home method
Pn634	Speed during search for switch
Pn635	Speed during search for zero

14.3 Description of Home method

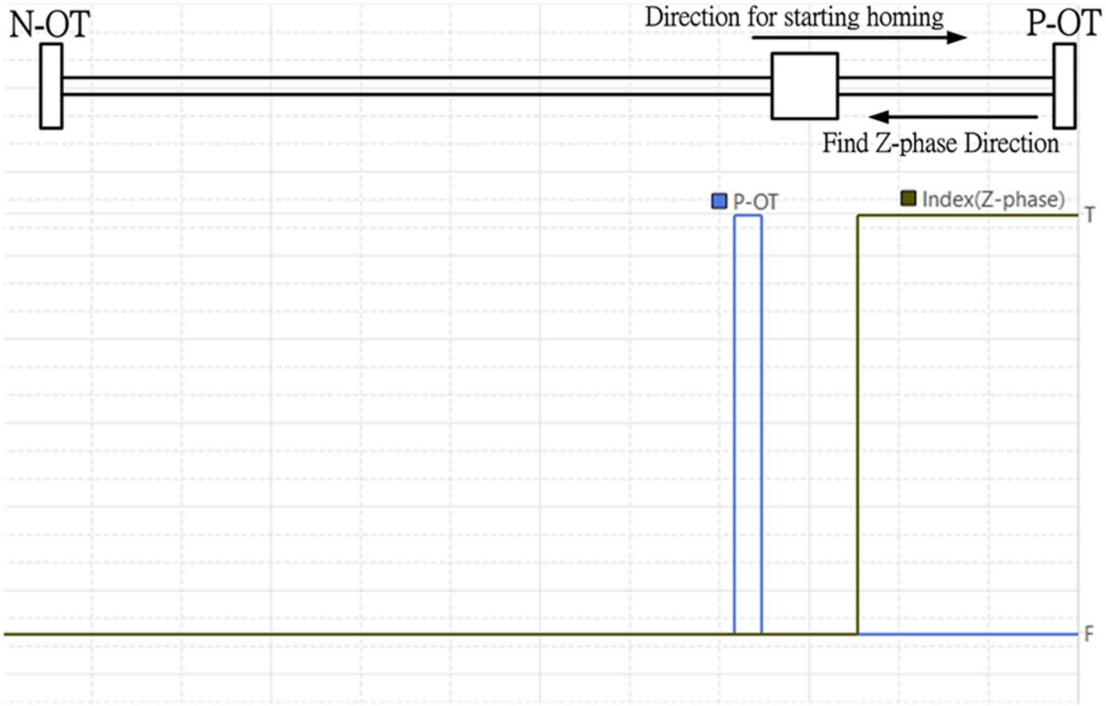
1. Homing with the negative limit (N-OT) switch and index pulse(DS402 Home method 1)



Homing Mode Description

1. Upon receiving the homing return start signal, the servo moves toward the negative limit at the designated homing return speed (parameter Pn634) to locate the negative limit sensor (N-OT).
2. When the servo detects the rising edge signal of the negative limit sensor (N-OT), it reverses direction and decelerates to the speed specified for detecting the Z-phase (Index) signal (parameter Pn635).
3. The servo then moves toward the positive limit until the rising edge of the encoder' s Z-phase (Index) signal is detected, thereby completing the homing return process.

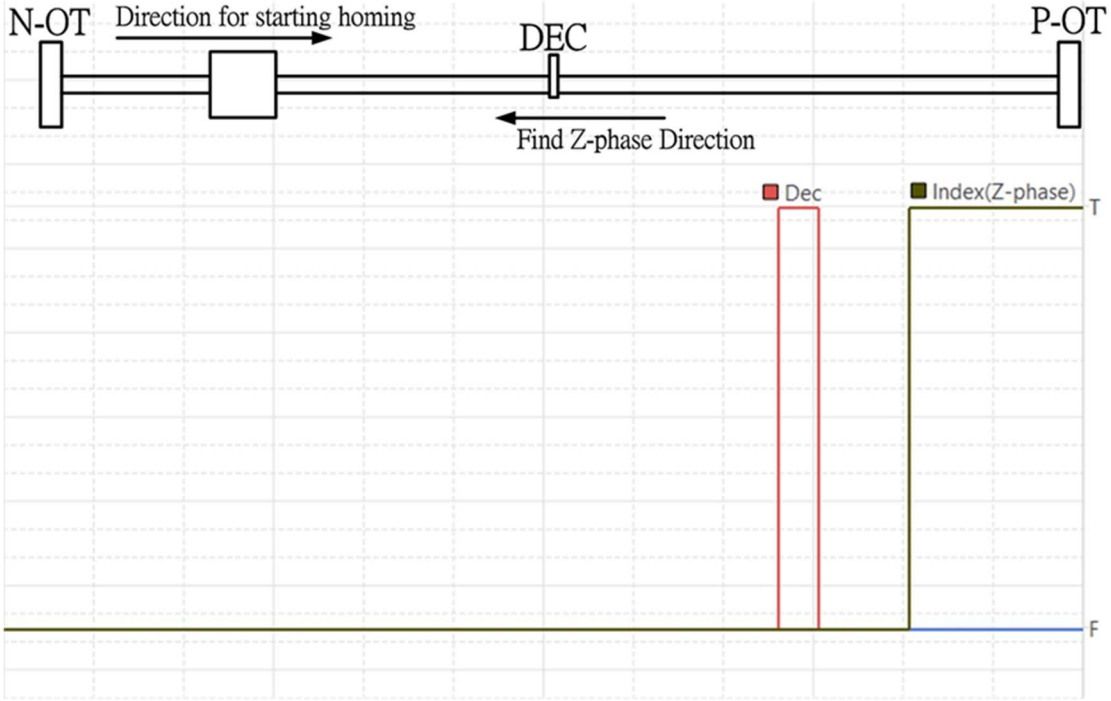
2. Homing with the positive limit (P-OT) switch and index pulse(DS402 Home method 2)



Homing Mode Description

1. Upon receiving the homing return start signal, the servo moves toward the negative limit at the designated homing return speed (parameter Pn634) to locate the positive limit sensor (P-OT).
2. When the servo detects the rising edge signal of the positive limit sensor (P-OT), it reverses direction and decelerates to the speed specified for detecting the Z-phase (Index) signal (parameter Pn635).
3. The servo then moves toward the positive limit until the rising edge of the encoder' s Z-phase (Index) signal is detected, thereby completing the homing return process.

3. Homing on positive home switch and index pulse(DS402 Home method 3)

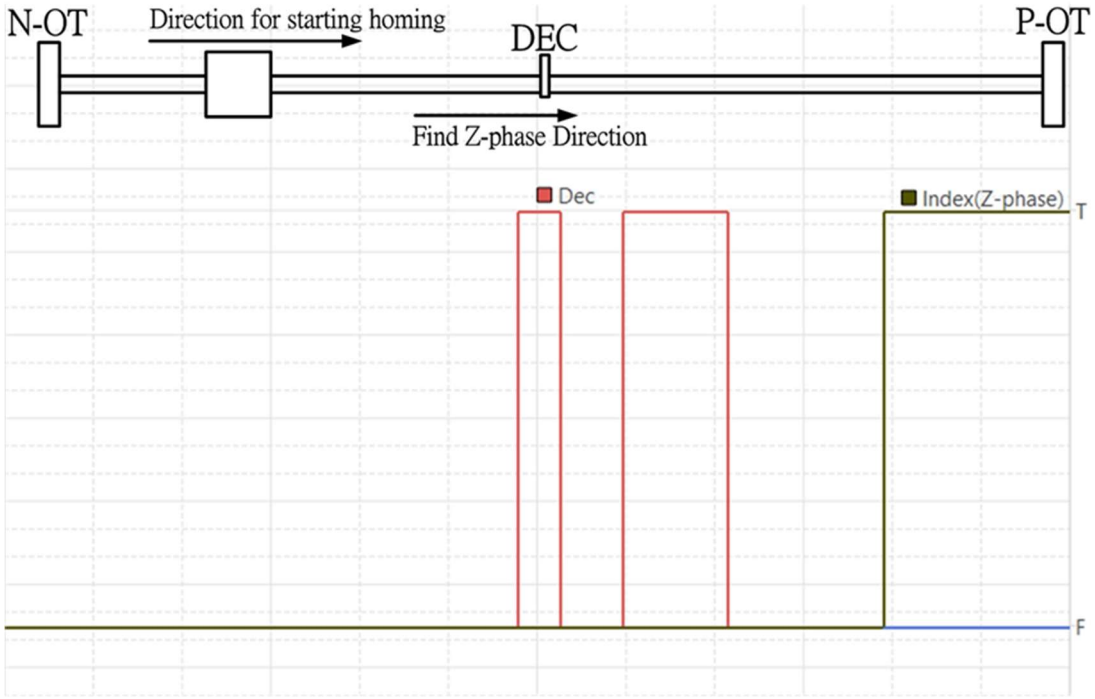


Homing Mode Description

1. Upon receiving the homing return start signal, the servo moves toward the positive limit (P-OT) at the designated homing return speed (parameter Pn634) to locate the homing deceleration sensor (DEC).
2. When the servo detects the rising edge signal of the homing deceleration sensor (DEC), it reverses direction and decelerates to the speed specified for detecting the Z-phase (Index) signal (parameter Pn635).

3. The servo then moves toward the negative limit (N-OT) until the rising edge of the encoder’ s Z-phase (Index) signal is detected, thereby completing the homing return process.

4. Homing on positive home switch and index pulse(DS402 Home method 4)



Homing Mode Description

1. Upon receiving the homing return start signal, the servo moves toward the positive limit (P-OT) at the designated homing return speed (parameter Pn634) to locate the homing deceleration sensor (DEC).
2. When the servo detects the rising edge signal of the homing deceleration sensor (DEC), it decelerates to the speed specified for detecting the Z-phase (Index)
3. The servo continues moving toward the positive limit (P-OT) at the Z-phase detection speed (Pn635) until the rising edge of the encoder’ s Z-phase (Index) signal is detected, thereby completing the homing return process.

5. Homing with the negative home switch and index pulse(DS402 Home method 5)



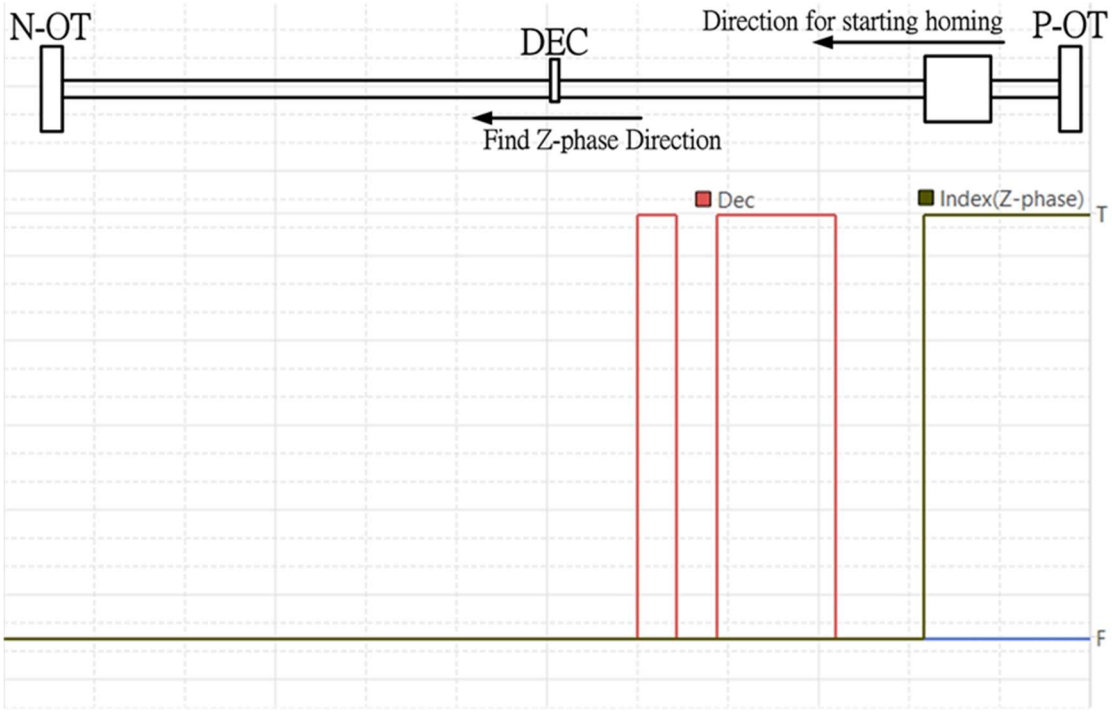
Homing Mode Description

1. Upon receiving the homing return start signal, the servo moves toward the negative limit (N-OT) at the designated homing return speed (parameter Pn634) to locate the homing deceleration sensor (DEC).

2. When the servo detects the falling edge signal of the homing deceleration sensor (DEC), it decelerates to the speed specified for detecting the Z-phase (Index) signal (parameter Pn635).

3. The servo continues moving toward the positive limit (P-OT) at the Z-phase detection speed (Pn635) until the rising edge of the encoder’ s Z-phase (Index) signal is detected, thereby completing the homing return process.

6. Homing with the negative home switch and index pulse(DS402 Home method 6)



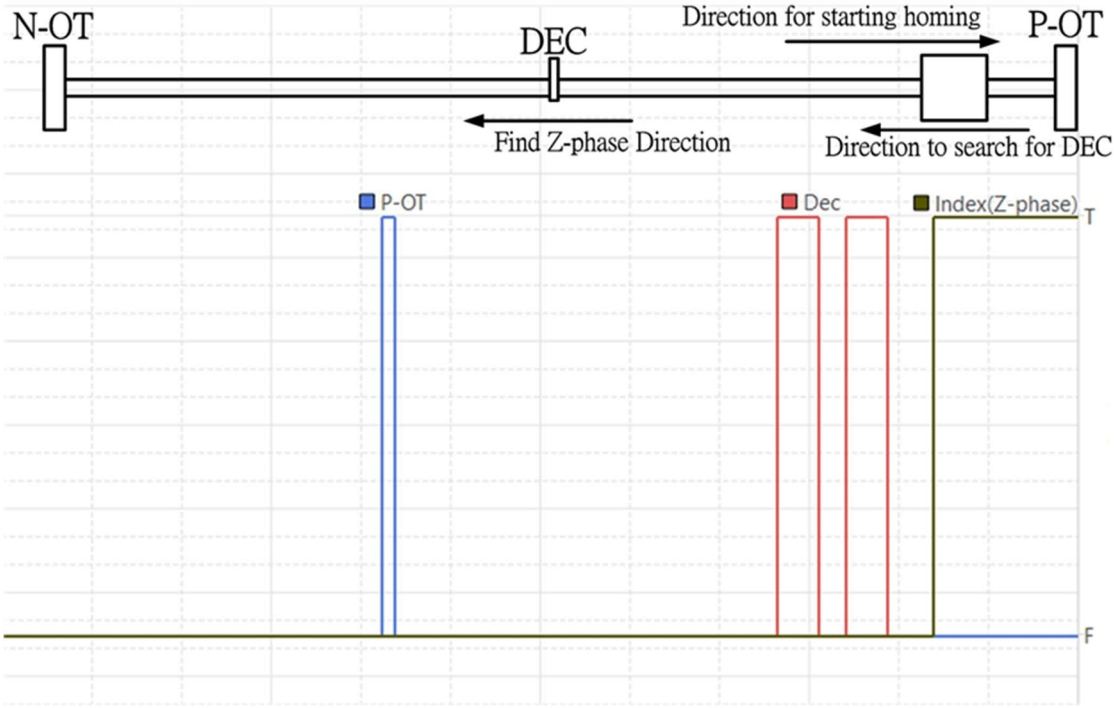
Homing Mode Description

1. Upon receiving the homing return start signal, the servo moves toward the negative limit (N-OT) at the designated homing return speed (parameter Pn634) to locate the homing deceleration sensor (DEC).

2. When the servo detects the falling edge signal of the homing deceleration sensor (DEC), it decelerates to the speed specified for detecting the Z-phase (Index) signal (parameter Pn635).

3. The servo continues moving toward the negative limit (N-OT) at the Z-phase detection speed (Pn635) until the rising edge of the encoder’ s Z-phase (Index) signal is detected, thereby completing the homing return process.

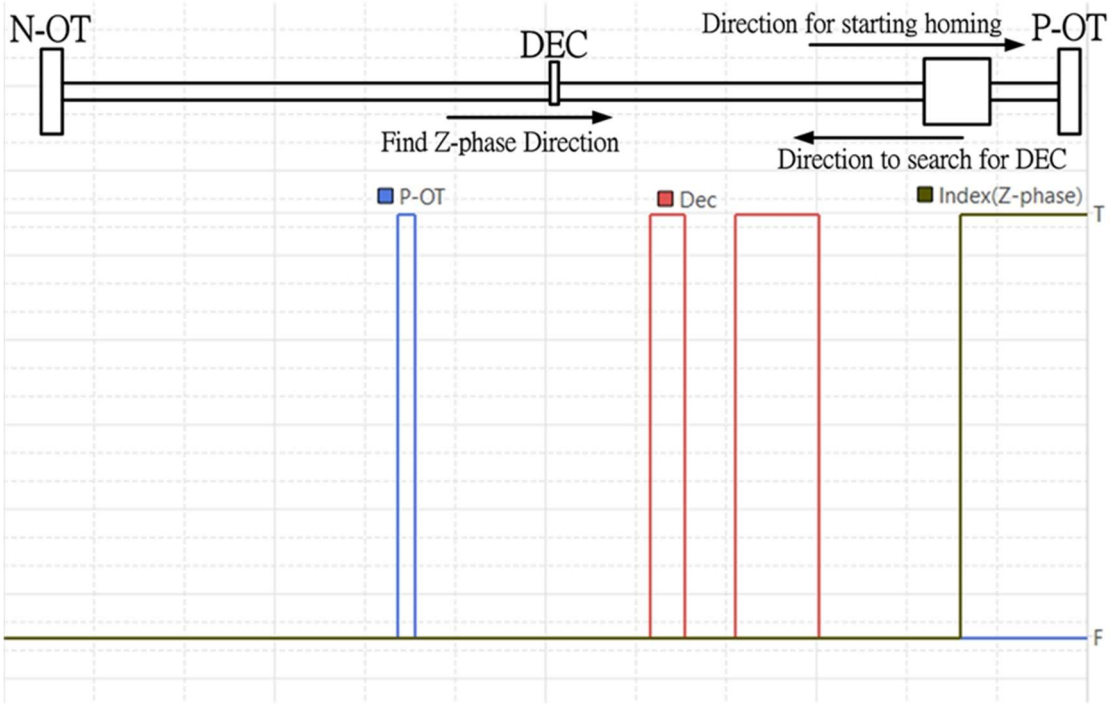
7. Homing with home switch and index pulse(DS402 Home method 7)



Homing Mode Description

1. Upon receiving the homing return start signal, the servo moves toward the positive limit (P-OT) at the designated homing return speed (parameter Pn634) to locate the homing deceleration sensor (DEC).
2. If the positive limit (P-OT) is reached during movement, the servo reverses direction and moves toward the negative limit (N-OT), continuing to search for the homing deceleration sensor (DEC).
3. When the servo detects the rising edge signal of the homing deceleration sensor (DEC), it decelerates to the speed specified for detecting the Z-phase (Index) signal (parameter Pn635).
4. The servo continues moving toward the negative limit (N-OT) at the Z-phase detection speed (Pn635) until the rising edge of the encoder' s Z-phase (Index) signal is detected, thereby completing the homing return process.

8. Homing with home switch and index pulse(DS402 Home method 8)

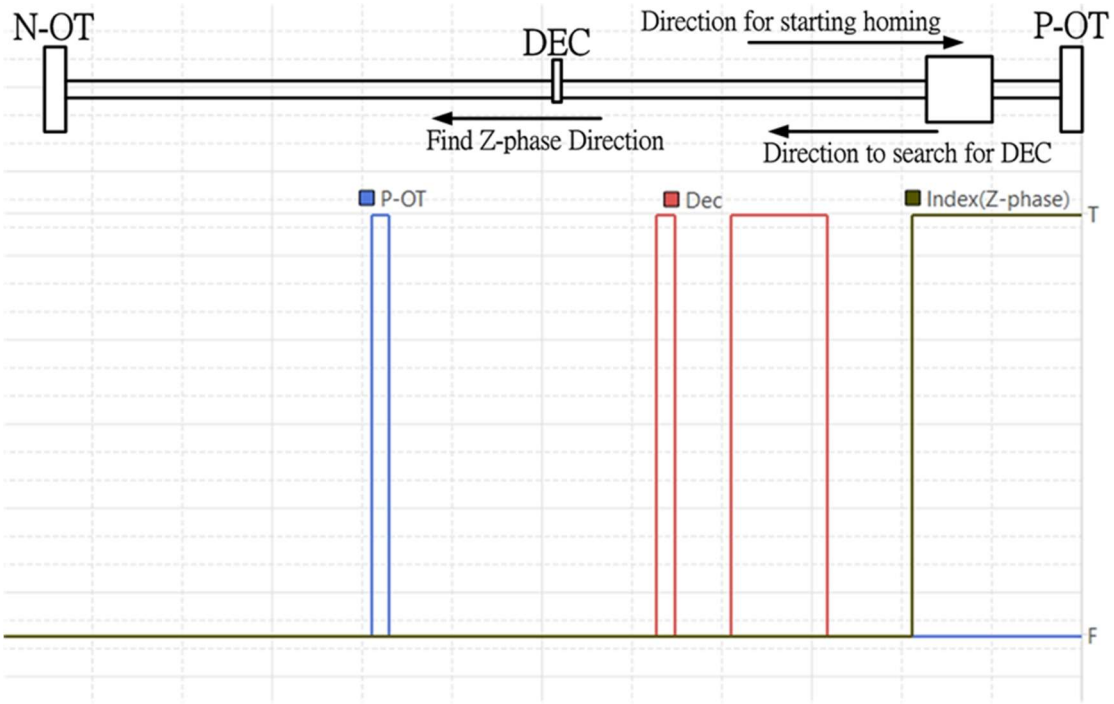


Homing Mode Description

1. Upon receiving the homing return start signal, the servo moves toward the positive limit (P-OT) at the designated homing return speed (parameter Pn634) to locate the homing deceleration sensor (DEC).

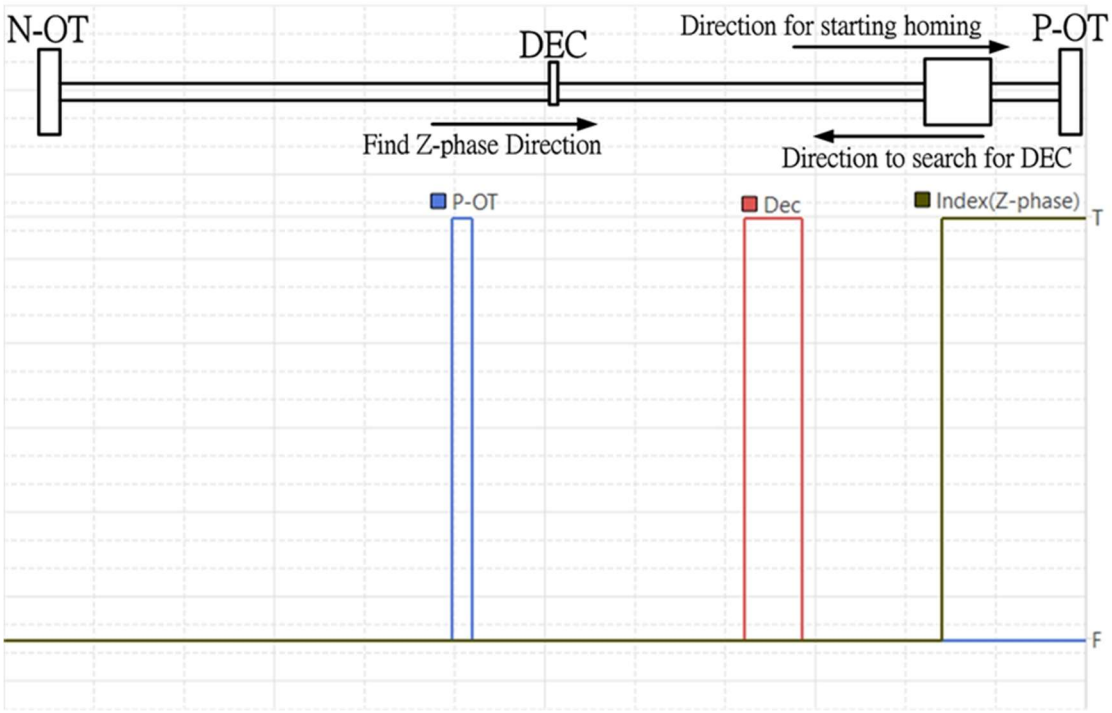
2. If the positive limit (P-OT) is reached during movement, the servo reverses direction and moves toward the negative limit (N-OT), continuing to search for the homing deceleration sensor (DEC).
3. When the servo detects the rising edge signal of the homing deceleration sensor (DEC), it decelerates to the speed specified for detecting the Z-phase (Index) signal (parameter Pn635).
4. The servo continues moving toward the positive limit (P-OT) at the Z-phase detection speed (Pn635) until the rising edge of the encoder' s Z-phase (Index) signal is detected, thereby completing the homing return process.

9. Homing with home switch and index pulse(DS402 Home method 9)



Homing Mode Description
1. Upon receiving the homing return start signal, the servo moves toward the positive limit (P-OT) at the designated homing return speed (parameter Pn634) to locate the homing deceleration sensor (DEC).
2. If the positive limit (P-OT) is reached during movement, the servo reverses direction and moves toward the negative limit (N-OT), continuing to search for the homing deceleration sensor (DEC).
3. When the servo detects the falling edge signal of the homing deceleration sensor (DEC), it decelerates to the speed specified for detecting the Z-phase (Index) signal (parameter Pn635).
4. The servo continues moving toward the negative limit (N-OT) at the Z-phase detection speed (Pn635) until the rising edge of the encoder' s Z-phase (Index) signal is detected, thereby completing the homing return process.

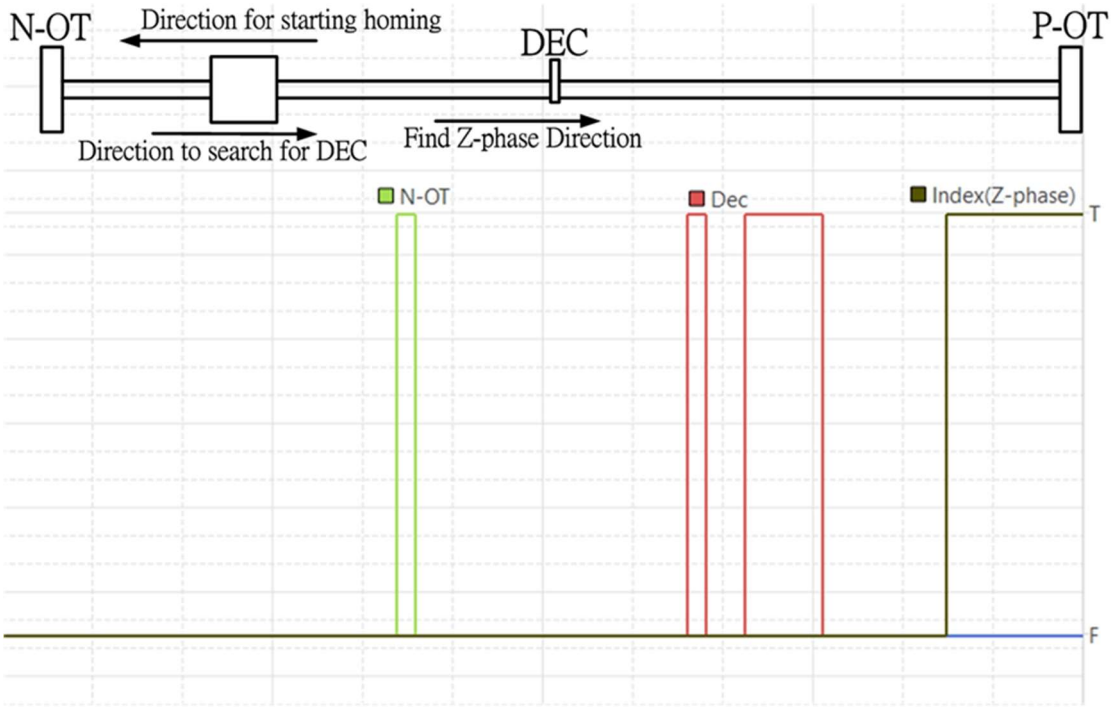
10. Homing with home switch and index pulse(DS402 Home method 10)



Homing Mode Description

1. Upon receiving the homing return start signal, the servo moves toward the positive limit (P-OT) at the designated homing return speed (parameter Pn634) to locate the homing deceleration sensor (DEC).
2. If the positive limit (P-OT) is reached during movement, the servo reverses direction and moves toward the negative limit (N-OT), continuing to search for the homing deceleration sensor (DEC).
3. When the servo detects the falling edge signal of the homing deceleration sensor (DEC), it decelerates to the speed specified for detecting the Z-phase (Index) signal (parameter Pn635).
4. The servo continues moving toward the positive limit (P-OT) at the Z-phase detection speed (Pn635) until the rising edge of the encoder' s Z-phase (Index) signal is detected, thereby completing the homing return process.

11. Homing with home switch and index pulse(DS402 Home method 11)

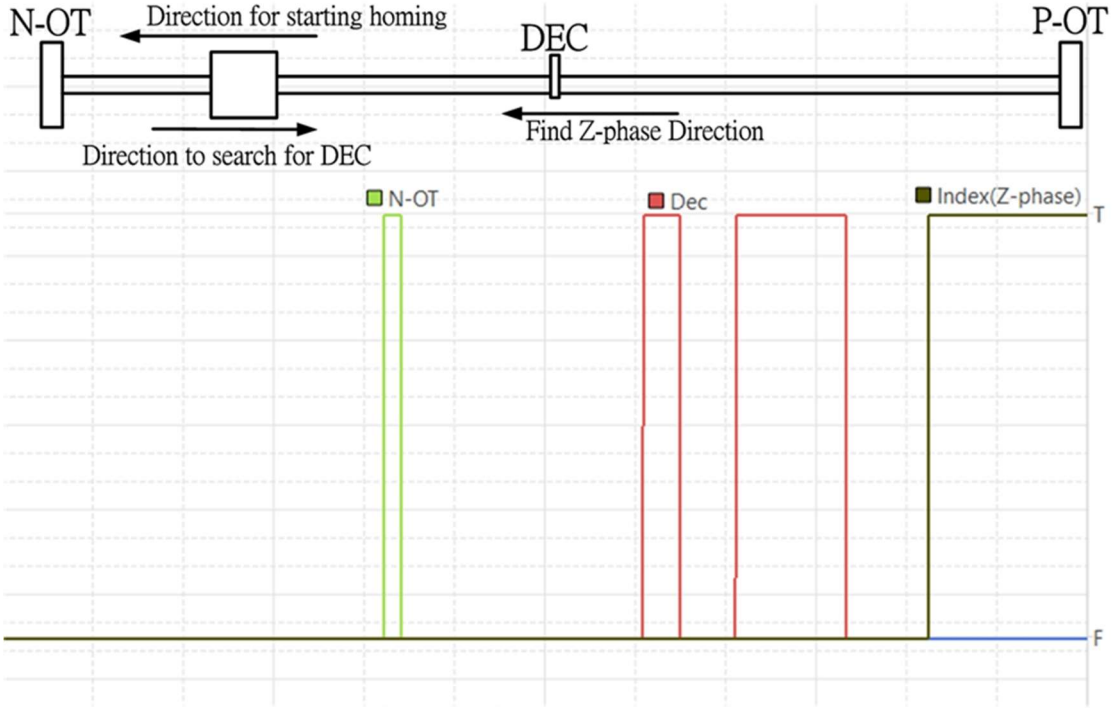


Homing Mode Description

1. Upon receiving the homing return start signal, the servo moves toward the negative limit (N-OT) at the designated homing return speed (parameter Pn634) to locate the homing deceleration sensor (DEC).

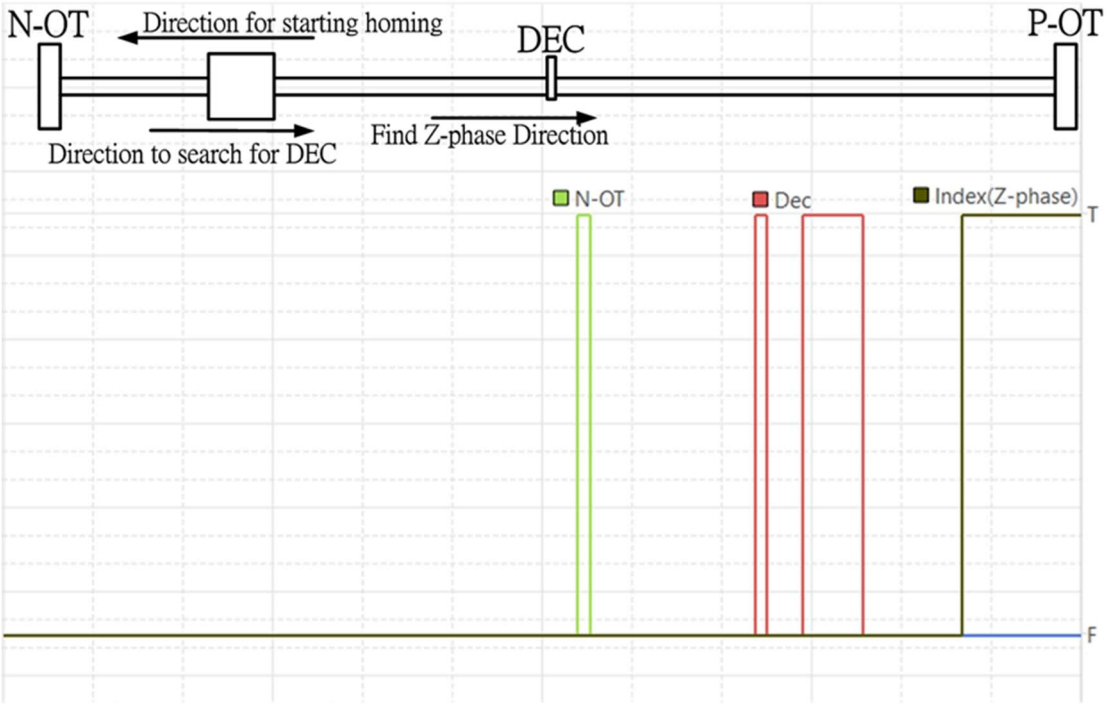
2. If the negative limit (N-OT) is reached during movement, the servo reverses direction and moves toward the positive limit (P-OT), continuing to search for the homing deceleration sensor (DEC).
3. When the servo detects the rising edge signal of the homing deceleration sensor (DEC), it decelerates to the speed specified for detecting the Z-phase (Index) signal (parameter Pn635).
4. The servo continues moving toward the positive limit (P-OT) at the Z-phase detection speed (Pn635) until the rising edge of the encoder' s Z-phase (Index) signal is detected, thereby completing the homing return process.

12. Homing with home switch and index pulse(DS402 Home method 12)



Homing Mode Description
1. Upon receiving the homing return start signal, the servo moves toward the negative limit (N-OT) at the designated homing return speed (parameter Pn634) to locate the homing deceleration sensor (DEC).
2. If the negative limit (N-OT) is reached during movement, the servo reverses direction and moves toward the positive limit (P-OT), continuing to search for the homing deceleration sensor (DEC).
3. When the servo detects the rising edge signal of the homing deceleration sensor (DEC), it decelerates to the speed specified for detecting the Z-phase (Index) signal (parameter Pn635).
4. The servo continues moving toward the negative limit (N-OT) at the Z-phase detection speed (Pn635) until the rising edge of the encoder' s Z-phase (Index) signal is detected, thereby completing the homing return process.

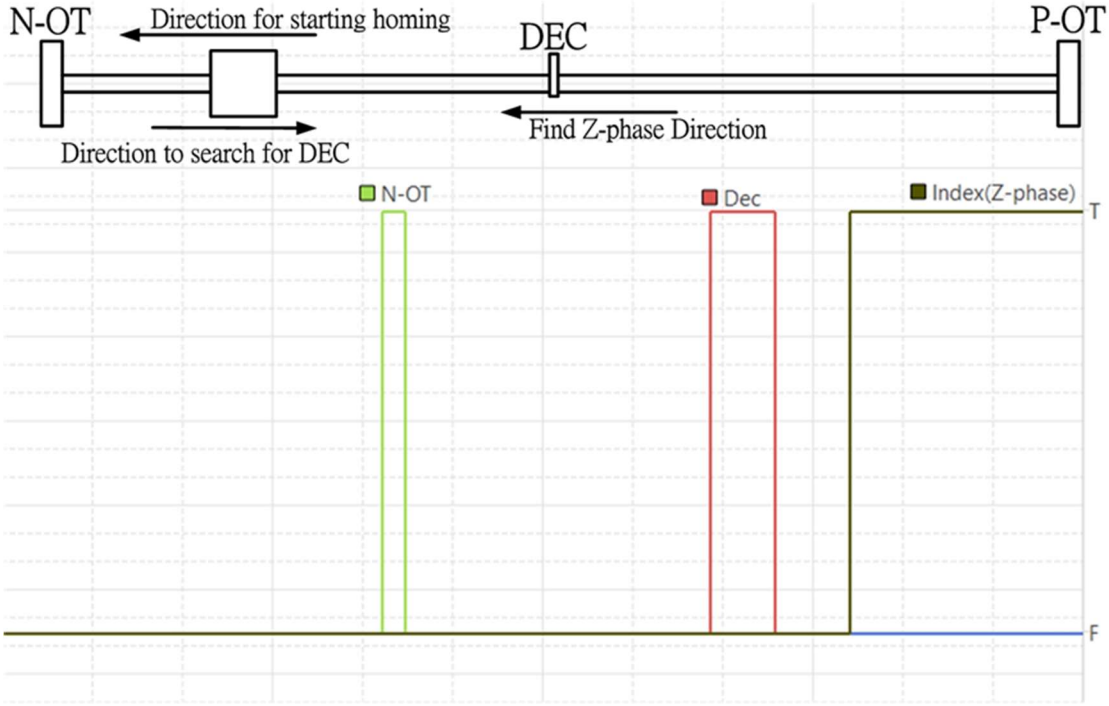
13. Homing with home switch and index pulse(DS402 Home method 13)



Homing Mode Description

1. Upon receiving the homing return start signal, the servo moves toward the negative limit (N-OT) at the designated homing return speed (parameter Pn634) to locate the homing deceleration sensor (DEC).
2. If the negative limit (N-OT) is reached during movement, the servo reverses direction and moves toward the positive limit (P-OT), continuing to search for the homing deceleration sensor (DEC).
3. When the servo detects the falling edge signal of the homing deceleration sensor (DEC), it decelerates to the speed specified for detecting the Z-phase (Index) signal (parameter Pn635).
4. The servo continues moving toward the positive limit (P-OT) at the Z-phase detection speed (Pn635) until the rising edge of the encoder' s Z-phase (Index) signal is detected, thereby completing the homing return process.

14. Homing with home switch and index pulse(DS402 Home method 14)



Homing Mode Description

1. Upon receiving the homing return start signal, the servo moves toward the negative limit (N-OT) at the designated homing return speed (parameter Pn634) to locate the homing deceleration sensor (DEC).

2. If the negative limit (N-OT) is reached during movement, the servo reverses direction and moves toward the positive limit (P-OT), continuing to search for the homing deceleration sensor (DEC).
3. When the servo detects the falling edge signal of the homing deceleration sensor (DEC), it decelerates to the speed specified for detecting the Z-phase (Index) signal (parameter Pn635).
4. The servo continues moving toward the negative limit (N-OT) at the Z-phase detection speed (Pn635) until the rising edge of the encoder’ s Z-phase (Index) signal is detected, thereby completing the homing return process.

Revision History

Version	Revision Date	Revision Content
V1.0	2024/12/23	First Edition
V1.1	2025/4/29	Corrected the flywheel diode orientation in the wiring. Added encoder pin assignments and power line terminals. Added Modbus address communication table. Added explanation for calculating external regenerative resistor.
V1.1.1	2025/7/08	Added Modbus communication program step control example
V1.1.2	2025/11/24	Added Homing return Mode Technical Description