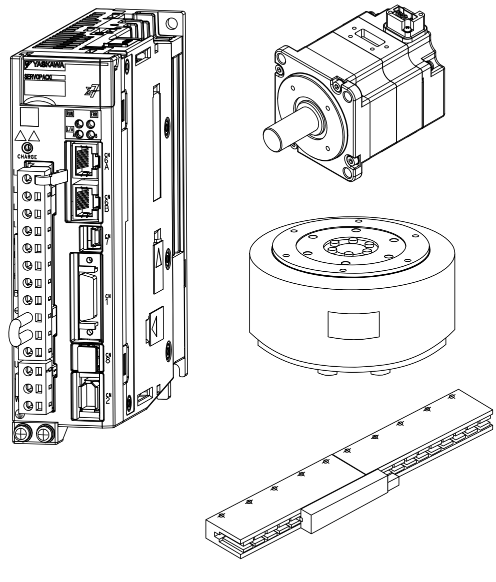
YASKAWA

Σ-7-Series AC Servo Drive
Σ-7S SERVOPACK with EtherCAT (CoE) Communications References
Product Manual

Model: SGD7S



MANUAL NO. SIEP S800001 55A

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About this Manual

This manual provides information required to select Σ-7S SERVOPACKs with EtherCAT Communications References for Σ-7-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 Σ-7-Series AC Servo Drives.

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

Outline of Manual

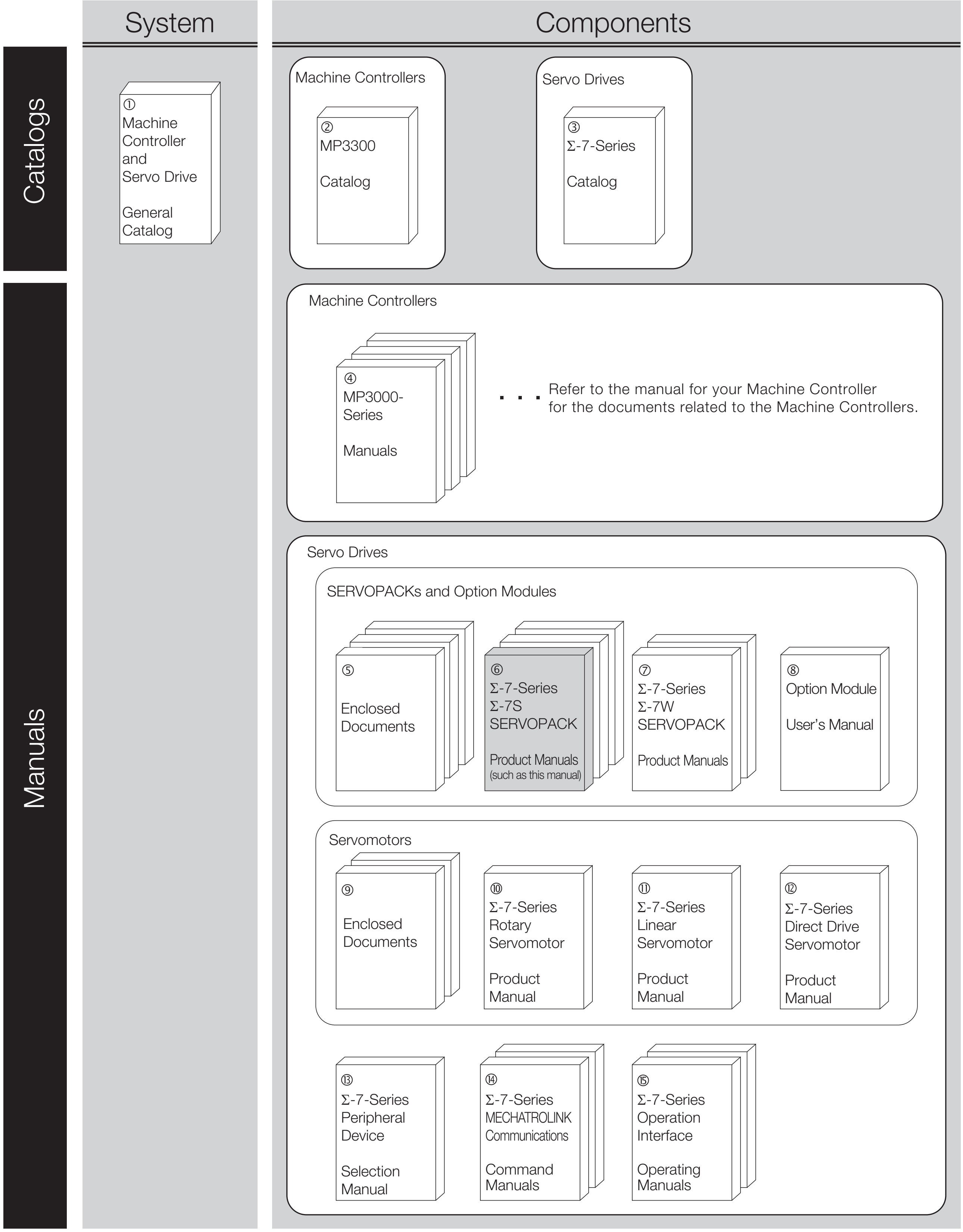
The contents of the chapters of this manual are described in the following table.

Refer to these chapters as required.

Chapter	Chapter Title	Contents
1	Basic Information on SERVOPACKs	Provides information required to select SERVOPACKs, such as SERVOPACK models and combinations with Servomotors.
2	Selecting a SERVOPACK	Provides information required to select SERVOPACKs, such as specifications, block diagrams, dimensional drawings, and connection examples.
3	SERVOPACK Installation	Provides information on installing SERVOPACKs in the required locations.
4	Wiring and Connecting SERVOPACKs	Provides information on wiring and connecting SERVOPACKs to power supplies and peripheral devices.
5	Basic Functions That Require Setting before Operation	Describes the basic functions that must be set before you start servo system operation. It also describes the setting methods.
6	Application Functions	Describes the application functions that you can set before you start servo system operation. It also describes the setting methods.
7	Trial Operation and Actual Operation	Provides information on the flow and procedures for trial operation and convenient functions to use during trial operation.
8	Tuning	Provides information on the flow of tuning, details on tuning functions, and related operating procedures.
9	Monitoring	Provides information on monitoring SERVOPACK product information and SERVOPACK status.
10	Fully-Closed Loop Control	Provides detailed information on performing fully-closed loop control with the SERVOPACK.
11	Safety Functions	Provides detailed information on the safety functions of the SERVOPACK.
12	EtherCAT Communications	Provides basic information on EtherCAT communications.
13	CiA402 Drive Profile	Provides detailed information on the CiA402 drive profile.
14	Object Dictionary	Provides an overview and details on the object dictionary.
15	Maintenance	Provides information on the meaning of, causes of, and corrections for alarms and warnings.
16	Parameter and Object Lists	Provides information on parameters and objects.
17	Appendices	Provides information on interpreting panel displays and tables of corresponding SERVOPACK and SigmaWin+ function names.

Related Documents

The relationships between the documents that are related to the Servo Drives are shown in the following figure. The numbers in the figure correspond to the numbers in the table on the following pages. Refer to these documents as required.



Classification	Document Name	Document No.	Description
① Machine Controller and Servo Drive General Catalog	Machine Controller and AC Servo Drive Solutions Catalog	KAEP S800001 22	Describes the features and application examples for combinations of MP3000-Series Machine Controllers and Σ-7-Series AC Servo Drives.
② MP3300 Catalog	Machine Controller MP3300	KAEP C880725 03	Provides detailed information on MP3300 Machine Controllers, including features and specifications.
③ Σ-7-Series Catalog	AC Servo Drives Σ-7 Series	KAEP S800001 23	Provides detailed information on Σ-7-Series AC Servo Drives, including features and specifications.
④ MP3000-Series Manuals	Machine Controller MP3000 Series MP3300 Product Manual	SIEP C880725 21	Describes the functions, specifications, operating methods, maintenance, inspections, and troubleshooting of the MP3000-series MP3300 Machine Controllers.
⑤ Enclosed Materials	Σ-7-Series AC Servo Drive Σ-7S and Σ-7W SERVOPACK Safety Precautions	TOMP C710828 00	Provides detailed information for the safe usage of Σ-7-Series SERVOPACKs.
	Σ-V-Series/Σ-V-Series for Large-Capacity Models/ Σ-7-Series Safety Precautions Option Module	TOBP C720829 00	Provides detailed information for the safe usage of Option Modules.
	Σ-V-Series/Σ-V-Series for Large-Capacity Models/ Σ-7-Series Installation Guide Command Option Module	TOBP C720829 01	Provides detailed procedures for installing a Command Option Module in a SERVOPACK.
	Σ-V-Series/Σ-V-Series for Large-Capacity Models/ Σ-7-Series Installation Guide Fully-closed Module	TOBP C720829 03	Provides detailed procedures for installing the Fully-closed Module in a SERVOPACK.
	Σ-V-Series/Σ-V-Series for Large-Capacity Models/ Σ-7-Series Installation Guide Safety Module	TOBP C720829 06	Provides detailed procedures for installing the Safety Module in a SERVOPACK.
	Σ-V-Series/Σ-V-Series for Large-Capacity Models/ Σ-7-Series Installation Guide Indexer Module	TOBP C720829 02	Provides detailed procedures for installing the Indexer Module in a SERVOPACK.
	Σ-V-Series/Σ-V-Series for Large-Capacity Models/ Σ-7-Series Installation Guide DeviceNet Module	TOBP C720829 07	Provides detailed procedures for installing the DeviceNet Module in a SERVOPACK.
	Σ-7-Series AC Servo Drive Communications Unit Instructions	TOBP C710828 01	Provides detailed information for the correct usage of Communications Units.

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Classification	Document Name	Document No.	Description
⑥ Σ-7-Series Σ-7S SERVOPACK Product Manuals	Σ-7-Series AC Servo Drive Σ-7S SERVOPACK with MECHATROLINK-III Communications References Product Manual	SIEP S800001 28	Provide detailed information on selecting Σ-7-Series SERVOPACKs and information on installing, connecting, setting, performing trial operation for, tuning, and monitoring the Servo Drives.
	Σ-7-Series AC Servo Drive Σ-7S SERVOPACK with MECHATROLINK-II Communications References Product Manual	SIEP S800001 27	
	Σ-7-Series AC Servo Drive Σ-7S SERVOPACK with Analog Voltage/Pulse Train References Product Manual	SIEP S800001 26	
	Σ-7-Series AC Servo Drive Σ-7S SERVOPACK with Indexer Module Product Manual	SIEP S800001 64	
	Σ-7-Series AC Servo Drive Σ-7S SERVOPACK with DeviceNet Module Product Manual	SIEP S800001 70	
	Σ-7-Series AC Servo Drive Σ-7S SERVOPACK with EtherCAT Communications References Product Manual	This manual (SIEP S800001 55)	Provides detailed information on selecting Σ-7-Series SERVOPACKs and information on installing, connecting, setting, performing trial operation for, tuning, monitoring, and EtherCAT communications commands for the Servo Drives.
⑦ Σ-7-Series Σ-7W SERVOPACK Product Manual	Σ-7-Series AC Servo Drive Σ-7W SERVOPACK with MECHATROLINK-III Communications References Product Manual	SIEP S800001 29	Provides detailed information on selecting Σ-7-Series SERVOPACKs and information on installing, connecting, setting, performing trial operation for, tuning, and monitoring the Servo Drives.
⑧ Safety Module User's Manual	Σ-V-Series/Σ-V-Series for Large-Capacity Models/ Σ-7-Series User's Manual Safety Module	SIEP C720829 06	Describes in detail information required to design and maintain a Safety Module.
⑨ Enclosed Materials	AC Servo Drive Rotary Servomotor Safety Precautions	TOBP C230260 00	Provides detailed information for the safe usage of Σ-7-Series Rotary Servomotors and Direct Drive Servomotors.
	AC Servomotor Linear Σ Series Safety Precautions	TOBP C230800 00	Provides detailed information for the safe usage of Σ-7-Series Linear Servomotors.

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Classification	Document Name	Document No.	Description
⑩ Σ-7-Series Rotary Servomotor Product Manual	Σ-7-Series AC Servo Drive Rotary Servomotor Product Manual	SIEP S800001 36	Provide detailed information on selecting, installing, and connecting the Σ-7-Series Servomotors.
⑪ Σ-7-Series Linear Servomotor Product Manual	Σ-7-Series AC Servo Drive Linear Servomotor Product Manual	SIEP S800001 37	
⑫ Σ-7-Series Direct Drive Servomotor Product Manual	Σ-7-Series AC Servo Drive Direct Drive Servomotor Product Manual	SIEP S800001 38	
⑬ Σ-7-Series Peripheral Device Selection Manual	Σ-7-Series AC Servo Drive Peripheral Device Selection Manual	SIEP S800001 32	Describes the peripheral devices for a Σ-7-Series Servo System.
⑭ Σ-7-Series MECHATROLINK Communications Command Manuals	Σ-7-Series AC Servo Drive MECHATROLINK-II Communications Command Manual	SIEP S800001 30	Provides detailed information on the MECHATROLINK-II communications commands that are used for a Σ-7-Series Servo System.
	Σ-7-Series AC Servo Drive MECHATROLINK-III Communications Standard Servo Profile Command Manual	SIEP S800001 31	Provides detailed information on the MECHATROLINK-III communications standard servo profile commands that are used for a Σ-7-Series Servo System.
⑮ Σ-7-Series Operation Interface Operating Manuals	Σ-7-Series AC Servo Drive Digital Operator Operating Manual	SIEP S800001 33	Describes the operating procedures for a Digital Operator for a Σ-7-Series Servo System.
	AC Servo Drives Engineering Tool SigmaWin+ Online Manual Σ-7 Component	SIEP S800001 48	Provides detailed operating procedures for the SigmaWin+ Engineering Tool for a Σ-7-Series Servo System.

Using This Manual

◆ Technical Terms Used in This Manual

The following terms are used in this manual.

Term	Meaning
Servomotor	A Σ-7-Series Rotary Servomotor, Direct Drive Servomotor, or Linear Servomotor.
Rotary Servomotor	A generic term used for a Σ-7-Series Rotary Servomotor (SGM7J, SGM7A, SGM7P, or SGM7G) or a Direct Drive Servomotor (SGMCS or SGMCV). The descriptions will specify when Direct Drive Servomotors are excluded.
Linear Servomotor	A Σ-7-Series Linear Servomotor (SGLG, SGLF, SGLT, or SGLC).
SERVOPACK	A Σ-7-Series Σ-7S Servo Amplifier with EtherCAT Communications References.
Servo Drive	The combination of a Servomotor and SERVOPACK.
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 ON command (Enable Operation command)	A command that is used to turn ON the servo (i.e., supply power to the motor) when bit 3 of controlword (6040 hex) is changed to 1 (ON) while the control power supply and main circuit power supply are ON. Refer to the following section for details. ☞ *13.1 Device Control* (page 13-3)
Servo OFF command (Disable Operation command)	A command that is used to turn OFF the servo (i.e., power not supplied to the motor) when bit 3 of controlword (6040 hex) is changed to 0 (OFF) while the control power supply and main circuit power supply are ON. Refer to the following section for details. ☞ *13.1 Device Control* (page 13-3)
base block (BB)	Shutting OFF the power supply to the motor by shutting OFF the base current to the power transistor in the SERVOPACK.
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.
SigmaWin+	The Engineering Tool for setting up and tuning Servo Drives or a computer in which the Engineering Tool is installed.

◆ Differences in Terms for Rotary Servomotors and Linear Servomotors

There are differences in the terms that are used for Rotary Servomotors and Linear Servomotors. This manual primarily describes Rotary Servomotors. If you are using a Linear Servomotor, you need to interpret the terms as given in the following table.

Rotary Servomotors	Linear Servomotors
torque	force
moment of inertia	mass
rotation	movement
forward rotation and reverse rotation	forward movement and reverse movement
CW and CCW pulse trains	forward and reverse pulse trains
rotary encoder	linear encoder
absolute rotary encoder	absolute linear encoder
incremental rotary encoder	incremental linear encoder
unit: min^{-1}	unit: mm/s
unit: N·m	unit: N

◆ Notation Used in this Manual

■ Notation for Reverse Signals

The names of reverse signals (i.e., ones that are valid when low) are written with a forward slash (/) before the signal abbreviation.

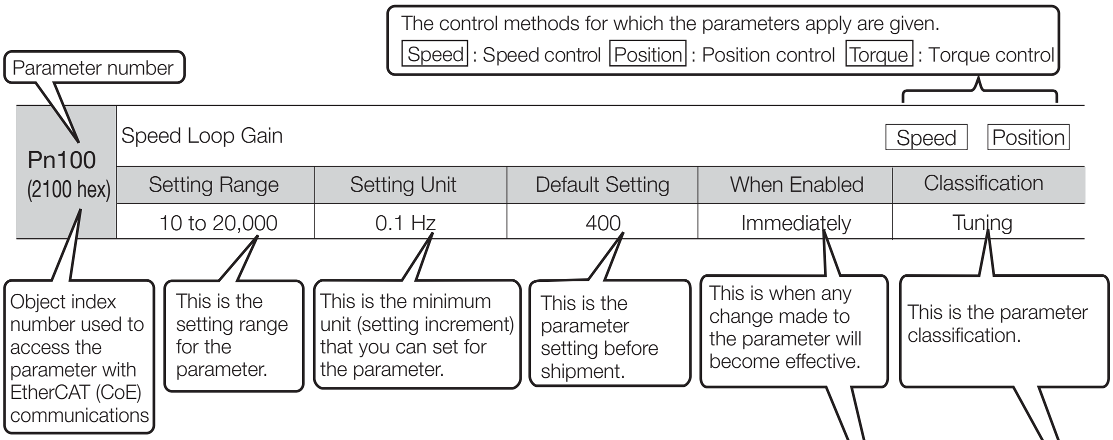
Notation Example

$\overline{\text{BK}}$ is written as /BK.

■ Notation for Parameters

The notation depends on whether the parameter requires a numeric setting (parameter for numeric setting) or requires the selection of a function (parameter for selecting functions).

- Parameters for Numeric Settings



The control methods for which the parameters apply are given.

Speed : Speed control Position : Position control Torque : Torque control

Parameter number

Pn100 (2100 hex)	Speed Loop Gain			Speed	Position
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	10 to 20,000	0.1 Hz	400	Immediately	Tuning

Object index number used to access the parameter with EtherCAT (CoE) communications

This is the setting range for the parameter.

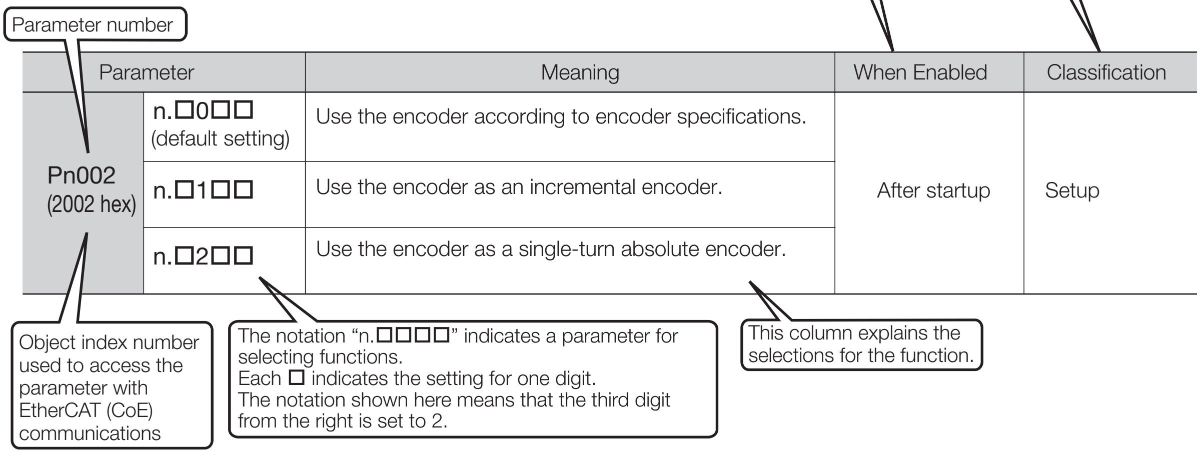
This is the minimum unit (setting increment) that you can set for the parameter.

This is the parameter setting before shipment.

This is when any change made to the parameter will become effective.

This is the parameter classification.

- Parameters for Selecting Functions



Parameter number

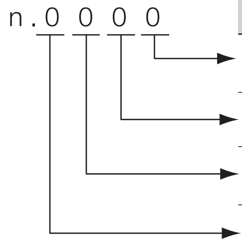
Parameter		Meaning	When Enabled	Classification
Pn002 (2002 hex)	n.□0□□ (default setting)	Use the encoder according to encoder specifications.	After startup	Setup
	n.□1□□	Use the encoder as an incremental encoder.		
	n.□2□□	Use the encoder as a single-turn absolute encoder.		

Object index number used to access the parameter with EtherCAT (CoE) communications

The notation "n.□□□□" indicates a parameter for selecting functions.
Each □ indicates the setting for one digit.
The notation shown here means that the third digit from the right is set to 2.

This column explains the selections for the function.

Notation Example



Notation Examples for Pn002

Digit Notation		Numeric Value Notation	
Notation	Meaning	Notation	Meaning
Pn002 = n.□□□X	Indicates the first digit from the right in Pn002.	Pn002 = n.□□□1	Indicates that the first digit from the right in Pn002 is set to 1.
Pn002 = n.□□X□	Indicates the second digit from the right in Pn002.	Pn002 = n.□□1□	Indicates that the second digit from the right in Pn002 is set to 1.
Pn002 = n.□X□□	Indicates the third digit from the right in Pn002.	Pn002 = n.□1□□	Indicates that the third digit from the right in Pn002 is set to 1.
Pn002 = n.X□□□	Indicates the fourth digit from the right in Pn002.	Pn002 = n.1□□□	Indicates that the fourth digit from the right in Pn002 is set to 1.

◆ Engineering Tools Used in This Manual

This manual uses the interfaces of the SigmaWin+ for descriptions.

◆ Trademarks

- EtherCAT is a registered trademark of Beckhoff Automation GmbH, Germany.
- QR code is a trademark of Denso Wave Inc.
- Other product names and company names are the trademarks or registered trademarks of the respective company. “TM” and the ® mark do not appear with product or company names in this manual.

◆ Visual Aids

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

Important	Indicates precautions or restrictions that must be observed. Also indicates alarm displays and other precautions that will not result in machine damage.
Term	Indicates definitions of difficult terms or terms that have not been previously explained in this manual.
Example	Indicates operating or setting examples.
Information	Indicates supplemental information to deepen understanding or useful information.

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.

◆ Safety Precautions That Must Always Be Observed

■ General Precautions

⚠ DANGER

- Read and understand this manual to ensure the safe usage of the product.
- Keep this manual in a safe, convenient place so that it can be referred to whenever necessary. Make sure that it is delivered to the final user of the product.
- Do not remove covers, cables, connectors, or optional devices while power is being supplied to the SERVOPACK.
  There is a risk of electric shock, operational failure of the product, or burning.

⚠ WARNING

- Use a power supply with specifications (number of phases, voltage, frequency, and AC/DC type) that are appropriate for the product.
  There is a risk of burning, electric shock, or fire.
- Connect the ground terminals on the SERVOPACK and Servomotor to ground poles according to local electrical codes (100 Ω or less for a SERVOPACK with a 100-VAC or 200-VAC power supply, and 10 Ω or less for a SERVOPACK with a 400-VAC power supply).
  There is a risk of electric shock or fire.
- Do not attempt to disassemble, repair, or modify the product.
  There is a risk of fire or failure.
  The warranty is void for the product if you disassemble, repair, or modify it.

⚠ CAUTION

- The SERVOPACK heat sinks, regenerative resistors, Servomotors, and other components can be very hot while power is ON or soon after the power is turned OFF. Implement safety measures, such as installing covers, so that hands and parts such as cables do not come into contact with hot components.
  There is a risk of burn injury.
- For a 24-VDC power supply, use a power supply device with double insulation or reinforced insulation.
  There is a risk of electric shock.
- Do not damage, pull on, apply excessive force to, place heavy objects on, or pinch cables.
  There is a risk of failure, damage, or electric shock.
- The person who designs the system that uses the hard wire base block safety function must have a complete knowledge of the related safety standards and a complete understanding of the instructions in this document.
  There is a risk of injury, product damage, or machine damage.
- Do not use the product in an environment that is subject to water, corrosive gases, or flammable gases, or near flammable materials.
  There is a risk of electric shock or fire.

NOTICE

- Do not attempt to use a SERVOPACK or Servomotor that is damaged or that has missing parts.
- Install external emergency stop circuits that shut OFF the power supply and stops operation immediately when an error occurs.
- In locations with poor power supply conditions, install the necessary protective devices (such as AC reactors) to ensure that the input power is supplied within the specified voltage range.
  There is a risk of damage to the SERVOPACK.
- Use a Noise Filter to minimize the effects of electromagnetic interference.
  Electronic devices used near the SERVOPACK may be affected by electromagnetic interference.
- Always use a Servomotor and SERVOPACK in one of the specified combinations.
- Do not touch a SERVOPACK or Servomotor with wet hands.
  There is a risk of product failure.

■ Storage Precautions

⚠ CAUTION

- Do not place an excessive load on the product during storage. (Follow all instructions on the packages.)
  There is a risk of injury or damage.

NOTICE

- Do not install or store the product in any of the following locations.
  - Locations that are subject to direct sunlight
  - Locations that are subject to ambient temperatures that exceed product specifications
  - Locations that are subject to relative humidities that exceed product specifications
  - Locations that are subject to condensation as the result of extreme changes in temperature
  - Locations that are subject to corrosive or flammable gases
  - Locations that are near flammable materials
  - Locations that are subject to dust, salts, or iron powder
  - Locations that are subject to water, oil, or chemicals
  - Locations that are subject to vibration or shock that exceeds product specifications
  - Locations that are subject to radiation

  If you store or install the product in any of the above locations, the product may fail or be damaged.

■ Transportation Precautions

⚠ CAUTION

- Transport the product in a way that is suitable to the mass of the product.
- Do not use the eyebolts on a SERVOPACK or Servomotor to move the machine.
  There is a risk of damage or injury.
- When you handle a SERVOPACK or Servomotor, be careful of sharp parts, such as the corners.
  There is a risk of injury.
- Do not place an excessive load on the product during transportation. (Follow all instructions on the packages.)
  There is a risk of injury or damage.

NOTICE

- Do not hold onto the front cover or connectors when you move a SERVOPACK.
  There is a risk of the SERVOPACK falling.
- A SERVOPACK or Servomotor is a precision device. Do not drop it or subject it to strong shock.
  There is a risk of failure or damage.
- Do not subject connectors to shock.
  There is a risk of faulty connections or damage.
- If disinfectants or insecticides must be used to treat packing materials such as wooden frames, plywood, or pallets, the packing materials must be treated before the product is packaged, and methods other than fumigation must be used.
  Example: Heat treatment, where materials are kiln-dried to a core temperature of 56°C for 30 minutes or more.
  If the electronic products, which include stand-alone products and products installed in machines, are packed with fumigated wooden materials, the electrical components may be greatly damaged by the gases or fumes resulting from the fumigation process. In particular, disinfectants containing halogen, which includes chlorine, fluorine, bromine, or iodine can contribute to the erosion of the capacitors.
- Do not overtighten the eyebolts on a SERVOPACK or Servomotor.
  If you use a tool to overtighten the eyebolts, the tapped holes may be damaged.

■ Installation Precautions

⚠ CAUTION

- Install the Servomotor or SERVOPACK in a way that will support the mass given in technical documents.
- Install SERVOPACKs, Servomotors, and regenerative resistors on nonflammable materials.
  Installation directly onto or near flammable materials may result in fire.
- Provide the specified clearances between the SERVOPACK and the control panel as well as with other devices.
  There is a risk of fire or failure.
- Install the SERVOPACK in the specified orientation.
  There is a risk of fire or failure.
- Do not step on or place a heavy object on the product.
  There is a risk of failure, damage, or injury.
- Do not allow any foreign matter to enter the SERVOPACK or Servomotor.
  There is a risk of failure or fire.

NOTICE

- **Do not install or store the product in any of the following locations.**
  - Locations that are subject to direct sunlight
  - Locations that are subject to ambient temperatures that exceed product specifications
  - Locations that are subject to relative humidities that exceed product specifications
  - Locations that are subject to condensation as the result of extreme changes in temperature
  - Locations that are subject to corrosive or flammable gases
  - Locations that are near flammable materials
  - Locations that are subject to dust, salts, or iron powder
  - Locations that are subject to water, oil, or chemicals
  - Locations that are subject to vibration or shock that exceeds product specifications
  - Locations that are subject to radiation

  If you store or install the product in any of the above locations, the product may fail or be damaged.
- **Use the product in an environment that is appropriate for the product specifications.**
  If you use the product in an environment that exceeds product specifications, the product may fail or be damaged.
- **A SERVOPACK or Servomotor is a precision device. Do not drop it or subject it to strong shock.**
  There is a risk of failure or damage.
- **Always install a SERVOPACK in a control panel.**
- **Do not allow any foreign matter to enter a SERVOPACK or a Servomotor with a Cooling Fan and do not cover the outlet from the Servomotor's cooling fan.**
  There is a risk of failure.

■ Wiring 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 SERVOPACK terminals.**
  - Connect an AC power supply to the L1, L2, and L3 terminals and the L1C and L2C terminals on the SERVOPACK.
  - Connect a DC power supply to the B1/⊕ and ⊖2 terminals and the L1C and L2C terminals on the SERVOPACK.

  There is a risk of failure or fire.

⚠ CAUTION

- **Wait for six 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 after turning OFF the power supply because high voltage may still remain in the SERVOPACK.**
  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 SERVOPACK 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 SERVOPACK's main circuit terminals.**
  - Turn ON the power supply to the SERVOPACK 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 SERVOPACK 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 Yaskawa.**
  If you use any other cables, confirm the rated current and application environment of your model and use the wiring materials specified by Yaskawa 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.

■ Operation Precautions

⚠ WARNING

- **Before starting operation with a machine connected, change the settings of the switches and parameters to match the machine.**
  Unexpected machine operation, failure, or personal injury may occur if operation is started before appropriate settings are made.
- **Do not radically change the settings of the parameters.**
  There is a risk of unstable operation, machine damage, or injury.
- **Install limit switches or stoppers at the ends of the moving parts of the machine to prevent unexpected accidents.**
  There is a risk of machine damage or injury.
- **For trial operation, securely mount the Servomotor and disconnect it from the machine.**
  There is a risk of injury.
- **Forcing the motor to stop for overtravel is disabled when the Jog (Fn002), Origin Search (Fn003), or Easy FFT (Fn206) utility function is executed. Take necessary precautions.**
  There is a risk of machine damage or injury.
- **When an alarm occurs, the motor will coast to a stop or stop with the dynamic brake according to a setting in the SERVOPACK. The coasting distance will change with the moment of inertia of the load. Check the coasting distance during trial operation and implement suitable safety measures on the machine.**
- **Do not enter the machine's range of motion during operation.**
  There is a risk of injury.
- **Do not touch the moving parts of the Servomotor or machine during operation.**
  There is a risk of injury.

⚠ CAUTION

- **Design the system to ensure safety even when problems, such as broken signal lines, occur. For example, the P-OT and N-OT signals are set in the default settings to operate on the safe side if a signal line breaks. Do not change the polarity of this type of signal.**
- **When overtravel occurs, the power supply to the motor is turned OFF and the brake is released. If you use the Servomotor to drive a vertical load, set the Servomotor to enter a zero-clamped state after the Servomotor stops. Also, install safety devices (such as an external brake or counterweight) to prevent the moving parts of the machine from falling.**
- **Always turn OFF the servo before you turn OFF the power supply. If you turn OFF the main circuit power supply or control power supply during operation before you turn OFF the servo, the Servomotor will stop as follows:**
  - If you turn OFF the main circuit power supply during operation without turning OFF the servo, the Servomotor will stop abruptly with the dynamic brake.
  - If you turn OFF the control power supply without turning OFF the servo, the stopping method that is used by the Servomotor depends on the model of the SERVOPACK. For details, refer to the manual for the SERVOPACK.

NOTICE

- When you adjust the gain during system commissioning, use a measuring instrument to monitor the torque waveform and speed waveform and confirm that there is no vibration.
  If a high gain causes vibration, the Servomotor will be damaged quickly.
- Do not frequently turn the power supply ON and OFF. After you have started actual operation, allow at least one hour between turning the power supply ON and OFF (as a guideline).
  Do not use the product in applications that require the power supply to be turned ON and OFF frequently.
  The elements in the SERVOPACK will deteriorate quickly.
- An alarm or warning may occur if communications are performed with the host controller while the SigmaWin+ or Digital Operator is operating.
  If an alarm or warning occurs, it may interrupt the current process and stop the system.
- After you complete trial operation of the machine and facilities, use the SigmaWin+ to back up the settings of the SERVOPACK parameters. You can use them to reset the parameters after SERVOPACK replacement.
  If you do not copy backed up parameter settings, normal operation may not be possible after a faulty SERVOPACK is replaced, possibly resulting in machine or equipment damage.

■ Maintenance and Inspection 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.

⚠ CAUTION

- Wait for six 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 after turning OFF the power supply because high voltage may still remain in the SERVOPACK.
  There is a risk of electric shock.
- Before you replace a SERVOPACK, back up the settings of the SERVOPACK parameters. Copy the backed up parameter settings to the new SERVOPACK and confirm that they were copied correctly.
  If you do not copy backed up parameter settings or if the copy operation is not completed normally, normal operation may not be possible, possibly resulting in machine or equipment damage.

NOTICE

- Discharge all static electricity from your body before you operate any of the buttons or switches inside the front cover of the SERVOPACK.
  There is a risk of equipment damage.

■ Troubleshooting Precautions

⚠ DANGER

- If the safety device (molded-case circuit breaker or fuse) installed in the power supply line operates, remove the cause before you supply power to the SERVOPACK again. If necessary, repair or replace the SERVOPACK, check the wiring, and remove the factor that caused the safety device to operate.
  There is a risk of fire, electric shock, or injury.

⚠ WARNING

- The product may suddenly start to operate when the power supply is recovered after a momentary power interruption. Design the machine to ensure human safety when operation restarts.
  There is a risk of injury.

⚠ CAUTION

- When an alarm occurs, remove the cause of the alarm and ensure safety. Then reset the alarm or turn the power supply OFF and ON again to restart operation.
  There is a risk of injury or machine damage.
- If the Servo ON signal is input to the SERVOPACK and an alarm is reset, the Servomotor may suddenly restart operation. Confirm that the servo is OFF and ensure safety before you reset an alarm.
  There is a risk of injury or machine damage.
- Always insert a magnetic contactor in the line between the main circuit power supply and the main circuit power supply terminals on the SERVOPACK so that the power supply can be shut OFF at the main circuit power supply.
  If a magnetic contactor is not connected when the SERVOPACK fails, a large current may flow, possibly resulting in fire.
- If an alarm occurs, shut OFF the main circuit power supply.
  There is a risk of fire due to a regenerative resistor overheating as the result of regenerative transistor failure.
- Install a ground fault detector against overloads and short-circuiting or install a molded-case circuit breaker combined with a ground fault detector.
  There is a risk of SERVOPACK failure or fire if a ground fault occurs.
- The holding brake on a Servomotor will not ensure safety if there is the possibility that an external force (including gravity) may move the current position and create a hazardous situation when power is interrupted or an error occurs. If an external force may cause movement, install an external braking mechanism that ensures safety.

■ Disposal Precautions

- When disposing of the product, treat it as ordinary industrial waste. However, local ordinances and national laws must be observed. Implement all labeling and warnings as a final product as required.

General Precautions

- Figures provided in this document are typical examples or conceptual representations. There may be differences between them and actual wiring, circuits, and products.
- The products shown in illustrations in this document are sometimes shown without covers or protective guards. Always replace all covers and protective guards before you use the product.
- If you need a new copy of this document because it has been lost or damaged, contact your nearest Yaskawa representative or one of the offices listed on the back of this document.
- This document is subject to change without notice for product improvements, specifications changes, and improvements to the manual itself.
  We will update the document number of the document and issue revisions when changes are made.
- Any and all quality guarantees provided by Yaskawa are null and void if the customer modifies the product in any way. Yaskawa disavows any responsibility for damages or losses that are caused by modified products.

Warranty

◆ Details of Warranty

■ Warranty Period

The warranty period for a product that was purchased (hereinafter called the “delivered product”) is one year from the time of delivery to the location specified by the customer or 18 months from the time of shipment from the Yaskawa factory, whichever is sooner.

■ Warranty Scope

Yaskawa shall replace or repair a defective product free of charge if a defect attributable to Yaskawa occurs during the above warranty period.
This warranty does not cover defects caused by the delivered product reaching the end of its service life and replacement of parts that require replacement or that have a limited service life.

This warranty does not cover failures that result from any of the following causes.

- Improper handling, abuse, or use in unsuitable conditions or in environments not described in product catalogs or manuals, or in any separately agreed-upon specifications
- Causes not attributable to the delivered product itself
- Modifications or repairs not performed by Yaskawa
- Use of the delivered product in a manner in which it was not originally intended
- Causes that were not foreseeable with the scientific and technological understanding at the time of shipment from Yaskawa
- Events for which Yaskawa is not responsible, such as natural or human-made disasters

◆ Limitations of Liability

- Yaskawa shall in no event be responsible for any damage or loss of opportunity to the customer that arises due to failure of the delivered product.
- Yaskawa shall not be responsible for any programs (including parameter settings) or the results of program execution of the programs provided by the user or by a third party for use with programmable Yaskawa products.
- The information described in product catalogs or manuals is provided for the purpose of the customer purchasing the appropriate product for the intended application. The use thereof does not guarantee that there are no infringements of intellectual property rights or other proprietary rights of Yaskawa or third parties, nor does it construe a license.
- Yaskawa shall not be responsible for any damage arising from infringements of intellectual property rights or other proprietary rights of third parties as a result of using the information described in catalogs or manuals.

◆ Suitability for Use

- It is the customer's responsibility to confirm conformity with any standards, codes, or regulations that apply if the Yaskawa product is used in combination with any other products.
- The customer must confirm that the Yaskawa product is suitable for the systems, machines, and equipment used by the customer.
- Consult with Yaskawa to determine whether use in the following applications is acceptable. If use in the application is acceptable, use the product with extra allowance in ratings and specifications, and provide safety measures to minimize hazards in the event of failure.
    - Outdoor use, use involving potential chemical contamination or electrical interference, or use in conditions or environments not described in product catalogs or manuals
    - Nuclear energy control systems, combustion systems, railroad systems, aviation systems, vehicle systems, medical equipment, amusement machines, and installations subject to separate industry or government regulations
    - Systems, machines, and equipment that may present a risk to life or property
    - Systems that require a high degree of reliability, such as systems that supply gas, water, or electricity, or systems that operate continuously 24 hours a day
    - Other systems that require a similar high degree of safety
- Never use the product for an application involving serious risk to life or property without first ensuring that the system is designed to secure the required level of safety with risk warnings and redundancy, and that the Yaskawa product is properly rated and installed.
- The circuit examples and other application examples described in product catalogs and manuals are for reference. Check the functionality and safety of the actual devices and equipment to be used before using the product.
- Read and understand all use prohibitions and precautions, and operate the Yaskawa product correctly to prevent accidental harm to third parties.

◆ Specifications Change

The names, specifications, appearance, and accessories of products in product catalogs and manuals may be changed at any time based on improvements and other reasons. The next editions of the revised catalogs or manuals will be published with updated code numbers. Consult with your Yaskawa representative to confirm the actual specifications before purchasing a product.

Compliance with UL Standards, EU Directives, and Other Safety Standards

Certification marks for the standards for which the product has been certified by certification bodies are shown on nameplate. Products that do not have the marks are not certified for the standards.

◆ North American Safety Standards (UL)

Product	Model	UL Standards (UL File No.)
SERVOPACKs	SGD7S	UL 61800-5-1
Rotary Servomotors	• SGM7A-A5 to -10 • SGM7A-15 to -30 • SGM7J • SGM7P • SGM7G	UL 1004-1 UL 1004-6
Direct Drive Servomotors[*1]	SGMCV	
Linear Servomotors	• SGLGW • SGLFW • SGLFW2[*2] • SGLTW	UL 1004 (E165827)

*1. Certification is scheduled for October 2014.

*2. Certification is scheduled for April 2015.

◆ European Directives

Product	Model	European Directive	Harmonized Standards
SERVOPACKs	SGD7S	Machinery Directive 2006/42/EC	EN ISO13849-1: 2008/AC: 2009
		EMC Directive 2004/108/EC	EN 55011 group 1, class A EN 61000-6-2 EN 61000-6-4 EN 61800-3
		Low Voltage Directive 2006/95/EC	EN 50178 EN 61800-5-1
Rotary Servomotors	• SGM7J • SGM7A • SGM7P • SGM7G	EMC Directive 2004/108/EC	EN 55011 group 1, class A EN 61000-6-2 EN 61800-3
		Low Voltage Directive 2006/95/EC	EN 60034-1 EN 60034-5
Direct Drive Servomotors	• SGMCS-□□B, □□C, □□D, □□E (Small-Capacity, Coreless Servomotors) • SGMCV	EMC Directive 2004/108/EC	EN 55011 group 1, class A EN 61000-6-2 EN 61800-3[*1]
		Low Voltage Directive 2006/95/EC	EN 60034-1 EN 60034-5
Linear Servomotors	• SGLG • SGLF • SGLFW2[*2] • SGLT • SGLC	EMC Directive 2004/108/EC	EN 55011 group 1, class A EN 61000-6-2 EN 61000-6-4
		Low Voltage Directive 2006/95/EC	EN 60034-1

*1. Only the SGMCV is certified.

*2. Certification is scheduled for April 2015.

Note: We declared the CE Marking based on the harmonized standards in the above table.

◆ Safety Standards

Product	Model	Safety Standards	Standards
SERVOPACKs	SGD7S	Safety of Machinery	EN ISO13849-1: 2008/AC: 2009 IEC 60204-1
		Functional Safety	IEC 61508 series IEC 62061 IEC 61800-5-2
		EMC	IEC 61326-3-1

◆ Safety Parameters

Item	Standards	Performance Level
Safety Integrity Level	IEC 61508	SIL3
	IEC 62061	SILCL3
Probability of Dangerous Failure per Hour	IEC 61508 IEC 62061	PFH = 4.04×10^{-9} [1/h] (4.04% of SIL3)
Performance Level	EN ISO 13849-1	PLe (Category 3)
Mean Time to Dangerous Failure of Each Channel	EN ISO 13849-1	MTTFd: High
Average Diagnostic Coverage	EN ISO 13849-1	DCavg: Medium
Stop Category	IEC 60204-1	Stop category 0
Safety Function	IEC 61800-5-2	STO
Mission Time	IEC 61508	10 years
Hardware Fault Tolerance	IEC 61508	HFT = 1
Subsystem	IEC 61508	B

Contents

1 Basic Information on SERVOPACKs

2 Selecting a SERVOPACK

3 SERVOPACK Installation

4 Wiring and Connecting SERVOPACKs

5 Basic Functions That Require Setting before Operation

6 Application Functions

7 Trial Operation and Actual Operation

8 Tuning

9 Monitoring

10 Fully-Closed Loop Control

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12 EtherCAT Communications

13 CiA402 Drive Profile

14 Object Dictionary

15 Maintenance

16 Parameter and Object Lists

17 Appendices

Basic Information on SERVOPACKs

1

This chapter provides information required to select SERVOPACKs, such as SERVOPACK models and combinations with Servomotors.

1.1 The Σ-7 Series

The Σ-7-series SERVOPACKs are designed for applications that require frequent high-speed and high-precision positioning. The SERVOPACK will make the most of machine performance in the shortest time possible, thus contributing to improving productivity.

The Σ-7-series SERVOPACKs include Σ-7S SERVOPACKs for single-axis control and Σ-7W SERVOPACKs for two-axis control.

1.2 Introduction to EtherCAT

The CANopen over EtherCAT (CoE) Communications Reference SERVOPACKs implement the CiA 402 CANopen drive profile for EtherCAT communications (real-time Ethernet communications).

Basic position, speed, and torque control are supported along with synchronous position, speed, and torque control. You can select the type of control to match your system from basic positioning to high-speed, high-precision path control.

You can also use EtherCAT communications to control the high-level servo control performance, advanced turning functions, and many actuators of the Σ-7 Series.

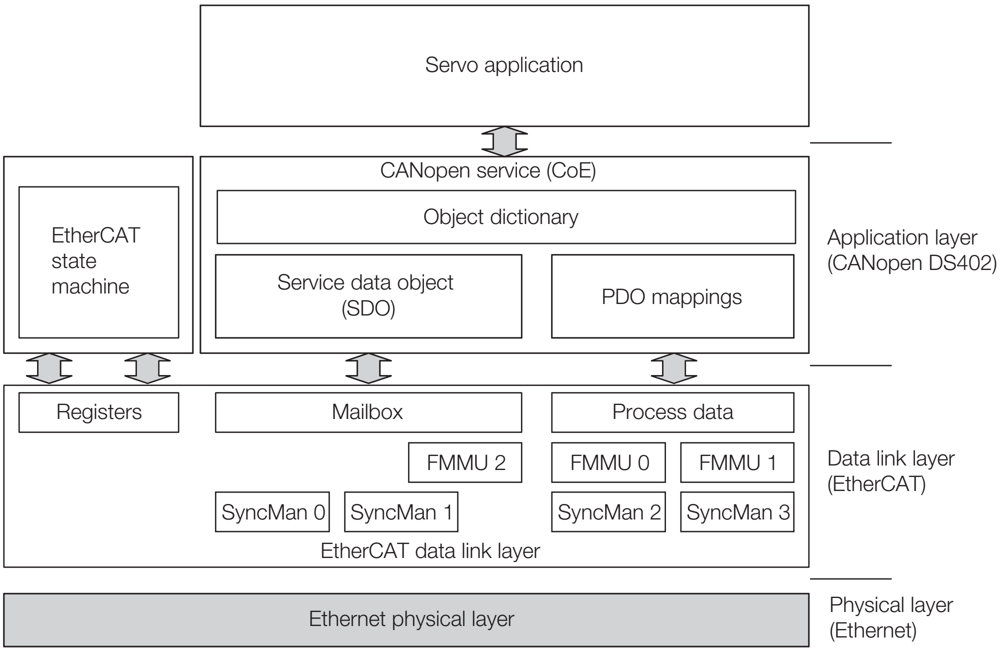
1.2.1 Introduction to CANopen

The CiA 402 CANopen profile is based on the IEC 61800-7-1, IEC61800-7-201, and IEC 61800-7-301 standards for international standardization of drive control and operation control.

1.2.2 CANopen over EtherCAT OSI Model

The OSI model implemented by the SERVOPACKs consists of three layers: the application layer (CANopen), the data link layer (EtherCAT), and the physical layer (Ethernet). The four layers other than the application layer, data link layer, and physical layer are not used. The data link layer is implemented with EtherCAT communications and the application layer is implemented with the DS402 CANopen drive profile.

This manual describes mainly the specifications of the application layer implemented in the SERVOPACKs. For detailed information on the data link layer (EtherCAT), refer to documentation provided by the EtherCAT Technology Group.



The object dictionary in the application layer includes parameters, application data, and PDO mapping information between the master and slaves.

The process data objects (PDOs) consist of the objects in the object dictionary that can be mapped to PDO mappings. The PDO mappings define the structure and contents of the process data.

1.2.3 Sending and Receiving Data in EtherCAT (CoE) Communications

Objects are used to send and receive data in EtherCAT (CoE) communications.

Reading and writing object data is performed in process data communications (PDO service), which transfers data cyclically, and in mailbox communications (SDO service), which transfers data non-cyclically.

Process data communications are used to read and write PDOs. Mailbox communications (SDO) are used to read and write object dictionary data entries.

1.2.4 CoE Terminology

The EtherCAT and CANopen terms that are used in this manual are described in the following table.

Term	Abbreviation	Description
CAN in Automation	CiA	A non-profit organization established in 1992 as a joint venture between companies to provide CAN technical information, product information, and marketing information.
Controller Area Network	CAN	Communications protocol for the physical layer and data link layer established for automotive LANs. It was established as an international standard as ISO 11898.
CANopen	CANopen	An upper-layer protocol based on the international CAN standard (EN 50325-4). It consists of profile specifications for the application layer, communications, applications, devices, and interfaces.
CANopen over EtherCAT	CoE	A network that uses Ethernet for the physical layer, EtherCAT for the data link layer, and CANopen for the application layer in a seven-layer OSI reference model.
Distributed Clocks	DC	A clock distribution mechanism that is used to synchronize the EtherCAT slaves with the EtherCAT master.
Electrically Erasable Programmable Read Only Memory	EEPROM	A ROM that can be electrically overwritten.
EtherCAT Slave Controller	ESC	A hardware chip that processes EtherCAT communications (such as loopbacks) and manages the distributed clock.
EtherCAT State Machine	ESM	A state machine in which the state of EtherCAT (the data link layer) changes according to transition conditions.
EtherCAT Technology Group	ETG	An international organization established in 2003 to provide support for developing EtherCAT technologies and to promote the spread of EtherCAT technologies.
Ethernet for Control Automation Technology	EtherCAT	An open network developed by Beckhoff Automation.
Fieldbus Memory Management Unit	FMMU	A unit that manages fieldbus memory.
INIT	INIT	The Init state in the EtherCAT state machine.
OPERATIONAL	OP	The Operational state in the EtherCAT state machine.
Object Dictionary	OD	A group of objects and structure supported by an EtherCAT SERVOPACK.
Process Data Object	PDO	Objects that are sent and received in cyclic communications.
Process Data Object Mapping	PDO mapping	Definitions of the applications objects that are sent with PDOs.
Service Data Object	SDO	Objects that are sent and received in mailbox communications.
PRE-OPERATIONAL	PREOP	The Pre-operational state in the EtherCAT state machine.

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Term	Abbreviation	Description
Process data	–	The data contained in application objects that are periodically transferred for measurements or controls.
SyncManager	–	The ESC unit that coordinates data exchange between the master and slaves.
Receive Process Data Object	RXPDO	The process data received by the ESC.
Transmit Process Data Object	TXPDO	The process data sent by the ESC.

1.2.5 Data Types

The following table lists the data types and ranges that are used in this manual.

Code	Data Type	Range
SINT	Signed 8-bit integer	-128 to 127
INT	Signed 16-bit integer	-32,768 to 32,767
DINT	Signed 32-bit integer	-2,147,483,648 to 2,147,483,627
USINT	Unsigned 8-bit integer	0 to 255
UINT	Unsigned 16-bit integer	0 to 65,535
UDINT	Unsigned 32-bit integer	0 to 4,294,967,295
STRING	Character string	–

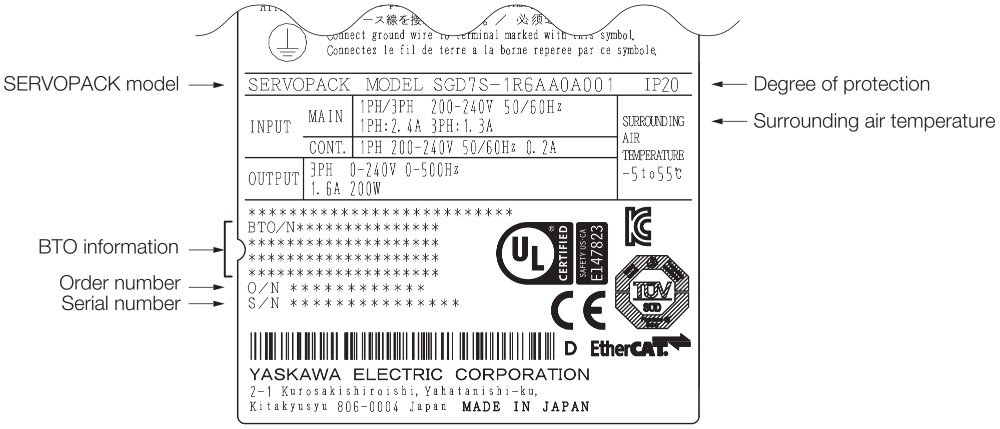
1.2.6 Data Ranges

The following table lists the data units and notations that are used in this manual.

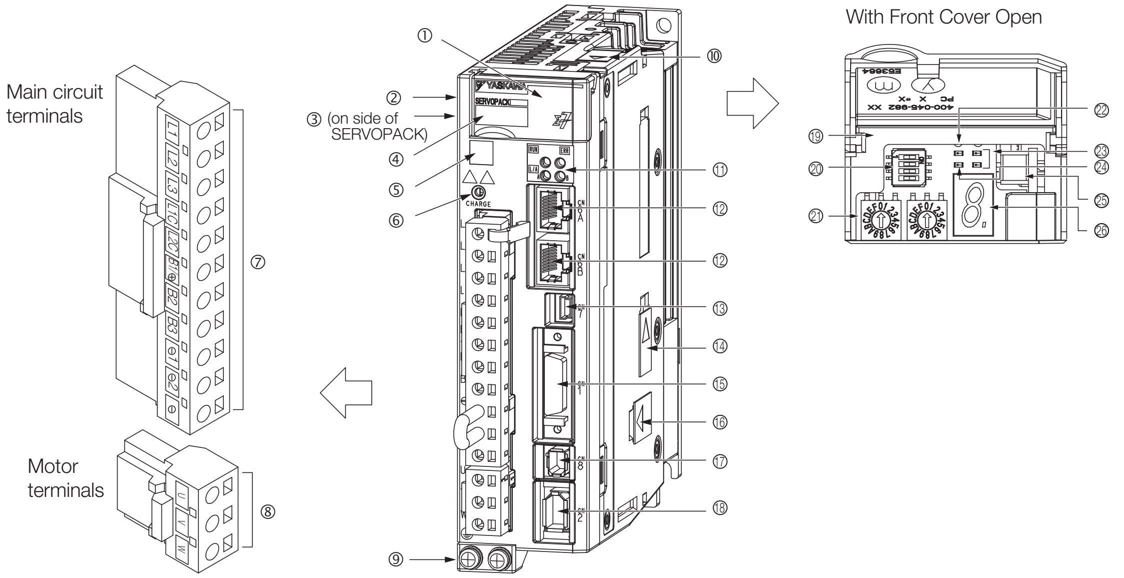
Notation	Description
Pos. unit	The user-defined position reference unit that is set in *position user unit* (2701 hex). 1 [Pos. unit] = 2701: 01 hex/2701: 02 hex [inc]
Vel. unit	The user-defined speed reference unit that is set in *velocity user unit* (2702 hex). 1 [Vel. unit] = 2702: 01 hex/2702: 02 hex [inc/s]
Acc. unit	The user-defined acceleration reference unit that is set in *acceleration user unit* (2703 hex). 1 [Acc. unit] = 2703: 01 hex/2703: 02 hex x 10^4 [inc/s^2]
inc	This is the encoder pulse unit. For a 24-bit encoder, the resolution is 16,777,216 [inc] per rotation.

1.3 Interpreting the Nameplate

The following basic information is provided on the nameplate.



1.4 Part Names



No.	Name	Description	Reference
①	Front Cover	–	–
②	Input Voltage	–	–
③	Nameplate	Indicates the SERVOPACK model and ratings.	page 1-6
④	Model	The model of the SERVOPACK.	page 1-9
⑤	QR Code	The QR code that is used by the MechatroCloud service.	–
⑥	CHARGE	Lit while the main circuit power is being supplied. Note: Even if you turn OFF the main circuit power supply, this indicator will be lit as long as the internal capacitor remains charged. Do not touch the main circuit or motor terminals while this indicator is lit. Doing so may result in electric shock.	–
⑦	Main Circuit Terminals	The terminals depend on the main circuit power supply input specifications of the SERVOPACK.	page 4-11
⑧	Servomotor Terminals (U, V, and W)	The connection terminals for the Servomotor Main Circuit Cable (power line).	page 4-23
⑨	Ground Terminal (⏚)	The ground terminals to prevent electric shock. Always connect this terminal.	–
⑩	Serial Communications Connector (CN502)	Connects to the Digital Operator. However, a Communications Unit (JUSP-JC001-1) is required to connect a Digital Operator.	page 4-40
⑪	Communications Status Indicators	Indicate the status of EtherCAT communications.	–
⑫	EtherCAT Communications Connectors (Input: CN6A, Output: CN6B)	Connects to EtherCAT devices.	page 4-38
⑬	Computer Connector (CN7)	A USB connector to connect a computer.	page 4-40
⑭	Safety Option Module Connector	Connects to a Safety Option Module.	–
⑮	I/O Signal Connector (CN1)	Connects to sequence I/O signals.	page 4-29
⑯	Feedback Option Module Connector	Connects to a Feedback Option Module.	–
⑰	Safety Connector (CN8)	Connects to a safety function device.	page 4-36
⑱	Encoder Connector (CN2)	• Rotary Servomotor: Connects to the encoder in the Servomotor. • Linear Servomotor: Connects to a Serial Converter Unit or linear encoder.	page 4-23
⑲	Serial Number	–	–

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No.	Name	Description	Reference
⑳	DIP Switch (S3)	Not used.	page 5-12
㉑	EtherCAT secondary address (S1 and S2)	Use these switches to set the device ID and address.	
㉒	PWR	Lights when the control power is being supplied.	–
㉓	CN	Not used.	–
㉔	L1 and L2		–
㉕	Analog Monitor Connector (CN5)	You can use a special cable (peripheral device) to monitor the motor speed, torque reference, or other values.	page 4-41
㉖	Panel Display	Displays the servo status with a seven-segment display.	–

1.5 Model Designations

1.5.1 Interpreting SERVOPACK Model Numbers

SGD7S - R70 A A0 A 001

SGD7S	R70	A	A0	A	001
Σ-7-Series Σ-7S SERVOPACKs	1st+2nd+3rd digits	4th digit	5th+6th digits	7th digit	8th+9th+10th digits

1st+2nd+3rd digits Maximum Applicable Motor Capacity

Voltage	Code	Specification
Three-Phase, 200 VA	R70[1]	0.05 kW
	R90[1]	0.1 kW
	1R6[1]	0.2 kW
	2R8[1]	0.4 kW
	3R8	0.5 kW
	5R5[1]	0.75 kW
	7R6	1.0 kW
	120	1.5 kW
	180	2.0 kW
	200	3.0 kW
	330	5.0 kW
	470	6.0 kW
	550	7.5 kW
	590	11 kW
	780	15 kW

4th digit Voltage

Code	Specification
A	200 VAC

5th+6th digits Interface[2]

Code	Specification
A0	EtherCAT communications reference

7th digit Design Revision Order

A

8th+9th+10th digits Hardware Options Specification

Code	Specification	Applicable Models
None	Without options	All models
001	Rack-mounted	SGD7S-R70A to -330A
	Duct-ventilated	SGD7S-470A to -780A
002	Varnished	All models

[1] You can use these models with either a single-phase or three-phase input.

[2] The same SERVOPACKs are used for both Rotary Servomotors and Linear Servomotors.

1.5.2 Interpreting Servomotor Model Numbers

This section outlines the model numbers of Σ-7-series Servomotors. Refer to the relevant manual in the following list for details.

📖 Σ-7-Series Rotary Servomotor Product Manual (Manual No.: SIEP S800001 36)

📖 Σ-7-Series Linear Servomotor Product Manual (Manual No.: SIEP S800001 37)

📖 Σ-7-Series Direct Drive Servomotor Product Manual (Manual No.: SIEP S800001 38)

Rotary Servomotors

SGM7☐ - 01 A F A 2 1

SGM7☐	01	A	F	A	2	1
Series	1st+2nd digits	3rd digit	4th digit	5th digit	6th digit	7th digit

Series Σ-7 Series Servomotors

Code	Specification
SGM7J	Medium inertia, high speed
SGM7A	Low inertia, high speed
SGM7P	Medium inertia, flat
SGM7G	Medium inertia, low speed, high torque

1st+2nd digits Rated Output

3rd digit Power Supply Voltage

Code	Specification
A	200 VAC

4th digit Serial Encoder Specification

Code	Specification
7	24-bit multiturn absolute encoder
F	24-bit incremental encoder

5th digit Design Revision Order

6th digit Shaft End Specification

- Straight
- With key and tap
- With two flat seats

7th digit Option Specification

- With 24-V holding brake
- With oil seal

Direct Drive Servomotors

SGMC☐	-	02	B	3	C	1	1
Series		1st+2nd digits	3rd digit	4th digit	5th digit	6th digit	7th digit

Series Σ-7 Series Servomotors

Code	Specification
SGMCS	Small capacity, coreless
	Medium capacity, with core
SGMCV	Small capacity, with core

1st+2nd digits Rated Torque

3rd digit Servomotor Outer Diameter

4th digit Serial Encoder Specification

Code	Specification
3	20-bit single-turn absolute encoder
D	20-bit incremental encoder
E	22-bit single-turn absolute encoder
I	22-bit multiturn absolute encoder

5th digit Design Revision Order

6th digit Flange Specification

- Cable drawn to load side
- Cable drawn to non-load side

7th digit Option Specification

- High mechanical precision

Linear Servomotors

SGL	☐	☐	-	30	A	050	C	P	☐
Series	1st digit	2nd digit		3rd digit on[1]					

Series Σ-7 Series Servomotors

\+

1st digit Servomotor Type

Code	Specification
SGLG	Coreless models
SGLF	Models with F-type iron core
SGLT	Models with T-type iron core
SGLC	Cylinder models

2nd digit Moving Coil/ Magnetic Way

Code	Specification
W	Moving Coil
W2	
M	Magnetic Way

5th digit for Moving Coil[2] Power Supply Voltage

Code	Specification
A	200 VAC

10th digit for Moving Coil[3] Sensor Specification

Code	Specification
Blank	Without polarity sensor
C	Without polarity sensor
H	With polarity sensor
P	With polarity sensor
S	With polarity sensor and thermal protector
T	Without polarity sensor, with thermal protector

[1] Specifications other than those given above depend on the Servomotor type.

[2] For an SGLC Servomotor, this is the fifth digit in the set model number.

[3] For an SGLC Servomotor, this is the tenth digit in the set model number.

1.6 Combinations of SERVOPACKs and Servomotors

1.6.1 Combinations of Rotary Servomotors and SERVOPACKs

Rotary Servomotor Model		Capacity	SERVOPACK Model
			SGD7S-
SGM7J Models (Medium Inertia, Small Capacity), 3,000 min^{-1}	SGM7J-A5A	50 W	R70A
	SGM7J-01A	100 W	R90A
	SGM7J-C2A	150 W	1R6A
	SGM7J-02A	200 W	
	SGM7J-04A	400 W	2R8A
	SGM7J-06A	600 W	5R5A
	SGM7J-08A	750 W	
SGM7A Models (Low Inertia, Small Capacity), 3,000 min^{-1}	SGM7A-A5A	50 W	R70A
	SGM7A-01A	100 W	R90A
	SGM7A-C2A	150 W	1R6A
	SGM7A-02A	200 W	
	SGM7A-04A	400 W	2R8A
	SGM7A-06A	600 W	5R5A
	SGM7A-08A	750 W	
	SGM7A-10A	1.0 kW	120A
	SGM7A-15A	1.5 kW	
	SGM7A-20A	2.0 kW	180A
	SGM7A-25A	2.5 kW	200A
	SGM7A-30A	3.0 kW	
	SGM7A-40A	4.0 kW	330A
	SGM7A-50A	5.0 kW	
	SGM7A-70A	7.0 kW	550A
SGM7P Models (Medium Inertia, Flat), 3,000 min^{-1}	SGM7P-01A	100 W	R90A
	SGM7P-02A	200 W	2R8A
	SGM7P-04A	400 W	
	SGM7P-08A	750 W	5R5A
	SGM7P-15A	1.5 kW	120A
SGM7G Models (Medium Inertia, Medium Capacity), 1,500 min^{-1}	SGM7G-03A	300 W	3R8A
	SGM7G-05A	450 W	
	SGM7G-09A	850 W	7R6A
	SGM7G-13A	1.3 kW	120A
	SGM7G-20A	1.8 kW	180A
	SGM7G-30A*	2.4 kW	200A
		2.9 kW	330A
	SGM7G-44A	4.4 kW	
	SGM7G-55A	5.5 kW	470A
	SGM7G-75A	7.5 kW	550A
	SGM7G-1AA	11 kW	590A
	SGM7G-1EA	15 kW	780A

* The capacity depends on the SERVOPACK that is used with the Servomotor.

1.6.2 Combinations of Direct Drive Servomotors and SERVOPACKs

Direct Drive Servomotor Model		Rated Torque [N·m]	Instantaneous Maximum Torque [N·m]	SERVOPACK Model
				SGD7S-
Small Capacity, Coreless (SGMCS)	SGMCS-02B	2	6	2R8A
	SGMCS-05B	5	15	
	SGMCS-07B	7	21	
	SGMCS-04C	4	12	
	SGMCS-10C	10	30	
	SGMCS-14C	14	42	
	SGMCS-08D	8	24	
	SGMCS-17D	17	51	
	SGMCS-25D	25	75	
	SGMCS-16E	16	48	5R5A
	SGMCS-35E	35	105	
Medium Capacity, With Core (SGMCS)	SGMCS-45M	45	135	7R6A
	SGMCS-80M	80	240	120A
	SGMCS-80N	80	240	
	SGMCS-1AM	110	330	180A
	SGMCS-1EN	150	450	200A
	SGMCS-2ZN	200	600	
Small Capacity, With Core (SGMCV)	SGMCV-04B	4	12	2R8A
	SGMCV-10B	10	30	
	SGMCV-14B	14	42	5R5A
	SGMCV-08C	8	24	2R8A
	SGMCV-17C	17	51	5R5A
	SGMCV-25C	25	75	7R6A

1.6.3 Combinations of Linear Servomotors and SERVOPACKs

Linear Servomotor Model		Rated Torque [N]	Instantaneous Maximum Torque [N]	SERVOPACK Model
				SGD7S-
SGLG (Coreless Models), Used with Standard-Force Magnetic Way	SGLGW-30A050C	12.5	40	R70A
	SGLGW-30A080C	25	80	R90A
	SGLGW-40A140C	47	140	
	SGLGW-40A253C	93	280	1R6A
	SGLGW-40A365C	140	420	2R8A
	SGLGW-60A140C	70	220	1R6A
	SGLGW-60A253C	140	440	2R8A
	SGLGW-60A365C	210	660	5R5A
	SGLGW-90A200C	325	1300	120A
	SGLGW-90A370C	550	2200	180A
	SGLGW-90A535C	750	3000	200A

Linear Servomotor Model		Rated Torque [N]	Instantaneous Maximum Torque [N]	SERVOPACK Model
				SGD7S-
SGLG (Coreless Models), Used with High-Force Magnetic Way	SGLGW-40A140C	57	230	1R6A
	SGLGW-40A253C	114	460	2R8A
	SGLGW-40A365C	171	690	3R8A
	SGLGW-60A140C	85	360	1R6A
	SGLGW-60A253C	170	720	3R8A
	SGLGW-60A365C	255	1080	7R6A
SGLF (Models with F-type Iron Cores)	SGLFW-20A090A	25	86	1R6A
	SGLFW-20A120A	40	125	
	SGLFW-35A120A	80	220	
	SGLFW-35A230A	160	440	3R8A
	SGLFW-50A200B	280	600	5R5A
	SGLFW-50A380B	560	1200	120A
	SGLFW-1ZA200B			
	SGLFW-1ZA380B	1120	2400	200A
	SGLFW2-30A070A	45	135	1R6A
	SGLFW2-30A120A	90	270	
	SGLFW2-30A230A*	180	540	3R8A
		170	500	2R8A
	SGLFW2-45A200A	280	840	5R5A
	SGLFW2-45A380A*	560	1680	180A
			1500	120A
	SGLFW2-90A200A	560	1680	
	SGLFW2-90A380A	1120	3360	200A
	SGLFW2-1DA380A	1680	5040	
SGLT (Models with T-type Iron Cores)	SGLTW-20A170A	130	380	3R8A
	SGLTW-20A320A	250	760	7R6A
	SGLTW-20A460A	380	1140	120A
	SGLTW-35A170A	220	660	5R5A
	SGLTW-35A170H	300	600	
	SGLTW-35A320A	440	1320	120A
	SGLTW-35A320H	600	1200	
	SGLTW-35A460A	670	2000	180A
	SGLTW-40A400B	670	2600	
	SGLTW-40A600B	1000	4000	330A
	SGLTW-50A170H	450	900	5R5A
	SGLTW-50A320H	900	1800	120A
	SGLTW-80A400B	1300	5000	330A
	SGLTW-80A600B	2000	7500	550A
SGLC (Cylinder Models)	SGLC-D16A085A	17	60	R70A
	SGLC-D16A115A	25	90	
	SGLC-D16A145A	34	120	R90A
	SGLC-D20A100A	30	150	1R6A
	SGLC-D20A135A	45	225	
	SGLC-D20A170A	60	300	2R8A
	SGLC-D25A125A	70	280	1R6A
	SGLC-D25A170A	105	420	2R8A
	SGLC-D25A215A	140	560	5R5A
	SGLC-D32A165A	90	420	2R8A
	SGLC-D32A225A	135	630	5R5A
	SGLC-D32A285A	180	840	

* The force depends on the SERVOPACK that is used with the Servomotor.

1.7 Functions

This section lists the functions provided by SERVOPACKs. Refer to the reference pages for details on the functions.

- Functions Related to the Machine

Function	Reference
Power Supply Type Settings for the Main Circuit and Control Circuit	page 5-12
Automatic Detection of Connected Motor	page 5-14
Motor Direction Setting	page 5-15
Linear Encoder Pitch Setting	page 5-16
Writing Linear Servomotor Parameters	page 5-17
Selecting the Phase Sequence for a Linear Servomotor	page 5-21
Polarity Sensor Setting	page 5-23
Polarity Detection	page 5-24
Overtravel Function and Settings	page 5-27
Holding Brake	page 5-32
Motor Stopping Methods for Servo OFF and Alarms	page 5-37
Resetting the Absolute Encoder	page 5-49
Setting the Origin of the Absolute Encoder	page 5-52
Setting the Regenerative Resistor Capacity	page 5-55
Operation for Momentary Power Interruptions	page 6-13
SEMI F47 Function	page 6-14
Setting the Motor Maximum Speed	page 6-16
Software Limits	page 6-24
Multiturn Limit Setting	page 6-35
Adjustment of Motor Current Detection Signal Offset	page 6-48
Forcing the Motor to Stop	page 6-52
Speed Ripple Compensation	page 8-59
Current Control Mode Selection	page 8-69
Current Gain Level Setting	page 8-70
Speed Detection Method Selection	page 8-70
Fully-Closed Loop Control	page 10-1
Safety Functions	page 11-1
Touch Probe	page 13-22

- Functions Related to the Host Controller

Function	Reference
Setting Unit Systems	page 5-42
I/O Signal Allocations	page 6-3
Servo Alarm (ALM) Signal	page 6-6
Warning Output (/WARN) Signal	page 6-6
Rotation Detection (/TGON) Signal	page 6-7
/S-RDY (Servo Ready) Signal	page 6-7
Speed Coincidence Detection (/V-CMP) Signal	page 6-8
Positioning Completion (/COIN) Signal	page 6-9
Near (/NEAR) Signal	page 6-10

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Function	Reference
Speed Limit during Torque Control	page 6-11
Speed Limit Detection (/VLT) Signal	page 6-11
Encoder Divided Pulse Output	page 6-17
Selecting Torque Limits	page 6-25
Vibration Detection Level Initialization	page 6-45
Alarm Reset	page 15-38
Replacing the Battery	page 15-3
Setting the Position Deviation Overflow Alarm Level	page 8-8

- Functions to Achieve Optimum Motions

Function	Reference
Tuning-less Function	page 8-11
Automatic Adjustment without a Host Reference	page 8-22
Automatic Adjustment with a Host Reference	page 8-33
Custom Adjustment	page 8-41
Anti-Resonance Control Adjustment	page 8-50
Vibration Suppression	page 8-55
Gain Selection	page 8-65
Friction Compensation	page 8-68
Backlash Compensation	page 8-71
Model Following Control	page 8-83
Compatible Adjustment Functions	page 8-86
Mechanical Analysis	page 8-90
Easy FFT	page 8-92

- Functions for Trial Operation during Setup

Function	Reference
Software Reset	page 6-43
Trial Operation of Servomotor without a Load	page 7-7
Program Jogging	page 7-13
Origin Search	page 7-19
Test without a Motor	page 7-21
Monitoring Machine Operation Status and Signal Waveforms	page 9-6

- Functions for Inspection and Maintenance

Function	Reference
Write Prohibition Setting for Parameters	page 5-7
Initializing Parameter Settings	page 5-9
Automatic Detection of Connected Motor	page 5-14
Monitoring Product Information	page 9-2
Monitoring Product Life	page 9-2
Alarm History Display	page 15-38

Selecting a SERVOPACK

2

This chapter provides information required to select SERVOPACKs, such as specifications, block diagrams, dimensional drawings, and connection examples.

2.1 Ratings and Specifications

This section gives the ratings and specifications of SERVOPACKs.

2.1.1 Ratings

Three-Phase, 200 VAC

Model SGD7S-			R70A	R90A	1R6A	2R8A	3R8A	5R5A	7R6A	120A	180A	200A	330A
Maximum Applicable Motor Capacity [kW]			0.05	0.1	0.2	0.4	0.5	0.75	1.0	1.5	2.0	3.0	5.0
Continuous Output Current [Arms]			0.66	0.91	1.6	2.8	3.8	5.5	7.6	11.6	18.5	19.6	32.9
Instantaneous Maximum Output Current [Arms]			2.1	3.2	5.9	9.3	11	16.9	17	28	42	56	84
Main Circuit	Power Supply		200 VAC to 240 VAC, -15% to +10%, 50 Hz/60 Hz										
	Input Current [Arms]*		0.4	0.8	1.3	2.5	3.0	4.1	5.7	7.3	10	15	25
Control Power Supply			200 VAC to 240 VAC, -15% to +10%, 50 Hz/60 Hz										
Power Supply Capacity [kVA]*			0.2	0.3	0.5	1.0	1.3	1.6	2.3	3.2	4.0	5.9	7.5
Power Loss*	Main Circuit Power Loss [W]		5.1	7.3	13.5	24.0	20.1	43.8	53.6	65.8	111.9	113.8	263.7
	Control Circuit Power Loss [W]		17	17	17	17	17	17	17	22	22	22	27
	Built-in Regenerative Resistor Power Loss [W]		–	–	–	–	8	8	8	10	16	16	36
	Total Power Loss [W]		22.1	24.3	30.5	41.0	45.1	68.8	78.6	97.8	149.9	151.8	326.7
Regenerative Resistor	Built-In Regenerative Resistor	Resistance [Ω]	–	–	–	–	40	40	40	20	12	12	8
		Capacity [W]	–	–	–	–	40	40	40	60	60	60	180
	Minimum Allowable External Resistance [Ω]		40	40	40	40	40	40	40	20	12	12	8
Overvoltage Category			III										

* This is the net value at the rated load.

Model SGD7S-		470A	550A	590A	780A
Maximum Applicable Motor Capacity [kW]		6.0	7.5	11	15
Continuous Output Current [Arms]		46.9	54.7	58.6	78.0
Instantaneous Maximum Output Current [Arms]		110	130	140	170
Main Circuit	Power Supply	200 VAC to 240 VAC, -15% to +10%, 50 Hz/60 Hz			
	Input Current [Arms]*1	29	37	54	73
Control Power Supply		200 VAC to 240 VAC, -15% to +10%, 50 Hz/60 Hz			
Power Supply Capacity [kVA]*1		10.7	14.6	21.7	29.6

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Model SGD7S-			470A	550A	590A	780A
Power Loss[*1]	Main Circuit Power Loss [W]		279.4	357.8	431.7	599.0
	Control Circuit Power Loss [W]		33	33	48	48
	External Regenerative Resistor Power Loss [W]		180[*2]	350[*3]	350[*3]	350[*3]
	Total Power Loss [W]		312.4	390.8	479.7	647.0
Regenerative Resistor	External Regenerative Resistor	Resistance [Ω]	6.25[*2]	3.13[*3]	3.13[*3]	3.13[*3]
		Capacity [W]	880[*2]	1760[*3]	1760[*3]	1760[*3]
	Minimum Allowable External Resistance [Ω]		5.8	2.9	2.9	2.9
Overvoltage Category			III			

[*1] This is the net value at the rated load.

[*2] This value is for the optional JUSP-RA04-E Regenerative Resistor Unit.

[*3] This value is for the optional JUSP-RA05-E Regenerative Resistor Unit.

Single-Phase, 200 VAC

Model SGD7S-			R70A	R90A	1R6A	2R8A	5R5A
Maximum Applicable Motor Capacity [kW]			0.05	0.1	0.2	0.4	0.75
Continuous Output Current [Arms]			0.66	0.91	1.6	2.8	5.5
Instantaneous Maximum Output Current [Arms]			2.1	3.2	5.9	9.3	16.9
Main Circuit	Power Supply		200 VAC to 240 VAC, -15% to +10%, 50 Hz/60 Hz				
	Input Current [Arms][*]		0.8	1.6	2.4	5.0	8.7
Control Power Supply			200 VAC to 240 VAC, -15% to +10%, 50 Hz/60 Hz				
Power Supply Capacity [kVA][*]			0.2	0.3	0.6	1.2	1.9
Power Loss[*]	Main Circuit Power Loss [W]		5.1	7.3	13.5	24.0	43.8
	Control Circuit Power Loss [W]		17	17	17	17	17
	Built-in Regenerative Resistor Power Loss [W]		–	–	–	–	8
	Total Power Loss [W]		22.1	24.3	30.5	41.0	68.8
Regenerative Resistor	Built-In Regenerative Resistor	Resistance [Ω]	–	–	–	–	40
		Capacity [W]	–	–	–	–	40
	Minimum Allowable External Resistance [Ω]		40	40	40	40	40
Overvoltage Category			III				

[*] This is the net value at the rated load.

270 VDC

Model SGD7S-		R70A	R90A	1R6A	2R8A	3R8A	5R5A	7R6A	120A
Maximum Applicable Motor Capacity [kW]		0.05	0.1	0.2	0.4	0.5	0.75	1.0	1.5
Continuous Output Current [Arms]		0.66	0.91	1.6	2.8	3.8	5.5	7.6	11.6
Instantaneous Maximum Output Current [Arms]		2.1	3.2	5.9	9.3	11.0	16.9	17.0	28.0
Main Circuit	Power Supply	270 VDC to 324 VDC, -15% to +10%							
	Input Current [Arms][*]	0.5	1.0	1.5	3.0	3.8	4.9	6.9	11
Control Power Supply		270 VDC to 324 VDC, -15% to +10%							
Power Supply Capacity [kVA][*]		0.2	0.3	0.6	1	1.4	1.6	2.3	3.2
Power Loss[*]	Main Circuit Power Loss [W]	4.6	6.3	11.7	20.2	16.9	37.9	46.0	53.2
	Control Circuit Power Loss [W]	17	17	17	17	17	17	17	22
	Total Power Loss [W]	21.6	23.3	28.7	37.2	33.9	54.9	63.0	75.2
Overvoltage Category		III							

[*] This is the net value at the rated load.

Model SGD7S-		180A	200A	330A	470A	550A	590A	780A
Maximum Applicable Motor Capacity [kW]		2.0	3.0	5.0	6.0	7.5	11.0	15.0
Continuous Output Current [Arms]		18.5	19.6	32.9	46.9	54.7	58.6	78.0
Instantaneous Maximum Output Current [Arms]		42.0	56.0	84.0	110	130	140	170
Main Circuit	Power Supply	270 VDC to 324 VDC, -15% to +10%						
	Input Current [Arms]*	14	20	34	36	48	68	92
Control Power Supply		270 VDC to 324 VDC, -15% to +10%						
Power Supply Capacity [kVA]*		4.0	5.9	7.5	10.7	14.6	21.7	29.6
Power Loss*	Main Circuit Power Loss [W]	95.8	87.6	163.7	203.4	261.2	246.6	346.5
	Control Circuit Power Loss [W]	22	22	27	33	33	48	48
	Total Power Loss [W]	117.8	109.6	190.7	236.4	294.2	294.6	394.5
Overvoltage Category		III						

* This is the net value at the rated load.

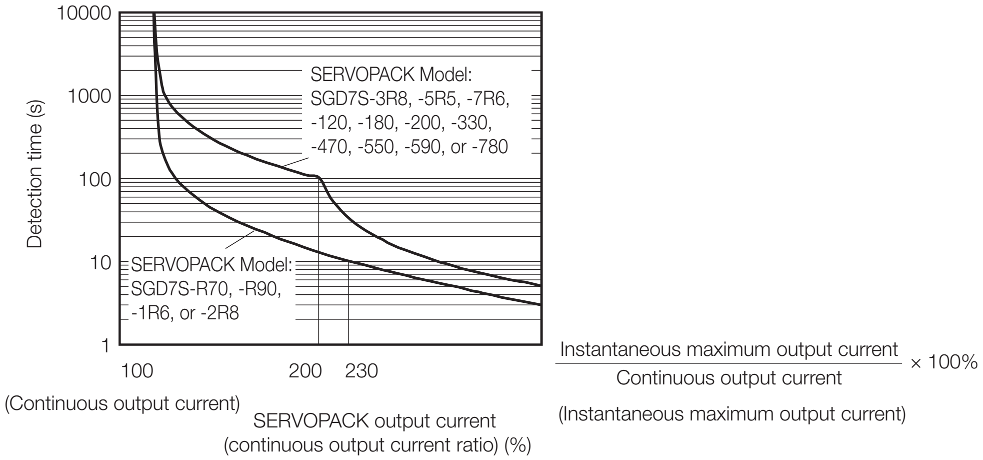
2.1.2 SERVOPACK Overload Protection Characteristics

The overload detection level is set for hot start conditions with a SERVOPACK surrounding air temperature of 55°C.

An overload alarm (A.710 or A.720) will occur if overload operation that exceeds the overload protection characteristics shown in the following diagram (i.e., operation on the right side of the applicable line) is performed.

The actual overload detection level will be the detection level of the connected SERVOPACK or Servomotor that has the lower overload protection characteristics.

In most cases, that will be the overload protection characteristics of the Servomotor.



Note: The above overload protection characteristics do not mean that you can perform continuous duty operation with an output of 100% or higher.
For a Yaskawa-specified combination of SERVOPACK and Servomotor, maintain the effective torque within the continuous duty zone of the torque-motor speed characteristic of the Servomotor.

2.1.3 Specifications

<table>
<tr><th colspan="2">Item</th><th>Specification</th></tr>
<tr><td colspan="2">Control Method</td><td>IGBT-based PWM control, sine wave current drive</td></tr>
<tr><td rowspan="2">Feedback</td><td>With Rotary Servomotor</td><td>Serial encoder: 20 bits or 24 bits (incremental encoder/absolute encoder)
22 bits (absolute encoder)</td></tr>
<tr><td>With Linear Servomotor</td><td>• Absolute linear encoder (The signal resolution depends on the absolute linear encoder.)
• Incremental linear encoder (The signal resolution depends on the incremental linear encoder or Serial Converter Unit.)</td></tr>
<tr><td rowspan="11">Environmental Conditions</td><td>Surrounding Air Temperature</td><td>-5°C to 55°C
(With derating, usage is possible between 55°C and 60°C.)
Refer to the following section for derating specifications.
☞ <i>3.6 Derating Specifications</i> on page 3-7</td></tr>
<tr><td>Storage Temperature</td><td>-20°C to 85°C</td></tr>
<tr><td>Surrounding Air Humidity</td><td>95% relative humidity max. (with no freezing or condensation)</td></tr>
<tr><td>Storage Humidity</td><td>95% relative humidity max. (with no freezing or condensation)</td></tr>
<tr><td>Vibration Resistance</td><td>4.9 m/s^2</td></tr>
<tr><td>Shock Resistance</td><td>19.6 m/s^2</td></tr>
<tr><td>Degree of Protection</td><td><table><tr><th>Degree</th><th>SERVOPACK Model: SGD7S-</th></tr><tr><td>IP20</td><td>R70A, R90A, 1R6A, 2R8A, 3R8A, 5R5A, 7R6A, 120A</td></tr><tr><td>IP10</td><td>180A, 200A, 330A, 470A, 550A, 590A, 780A</td></tr></table></td></tr>
<tr><td>Pollution Degree</td><td>2
• Must be no corrosive or flammable gases.
• Must be no exposure to water, oil, or chemicals.
• Must be no dust, salts, or iron dust.</td></tr>
<tr><td>Altitude</td><td>1,000 m or less. (With derating, usage is possible between 1,000 m and 2,000 m.)
Refer to the following section for derating specifications.
☞ <i>3.6 Derating Specifications</i> on page 3-7</td></tr>
<tr><td>Others</td><td>Do not use the SERVOPACK in the following locations: Locations subject to static electricity noise, strong electromagnetic/magnetic fields, or radioactivity</td></tr>
<tr><td colspan="2">Applicable Standards</td><td>Refer to the following section for details.
☞ <i>Compliance with UL Standards, EU Directives, and Other Safety Standards</i> on page xxiii</td></tr>
<tr><td colspan="2">Mounting</td><td><table><tr><th>Mounting</th><th>SERVOPACK Model: SGD7S-</th></tr><tr><td>Base-mounted</td><td>All Models</td></tr><tr><td>Rack-mounted</td><td>R70A, R90A, 1R6A, 2R8A, 3R8A, 5R5A, 7R6A, 120A, 180A, 200A, 330A</td></tr><tr><td>Duct-ventilated</td><td>470A, 550A, 590A, 780A</td></tr></table></td></tr>
<tr><td rowspan="6">Performance</td><td>Speed Control Range</td><td>1:5000 (At the rated torque, the lower limit of the speed control range must not cause the Servomotor to stop.)</td></tr>
<tr><td rowspan="3">Coefficient of Speed Fluctuation[*1]</td><td>±0.01% of rated speed max. (for a load fluctuation of 0% to 100%)</td></tr>
<tr><td>0% of rated speed max. (for a voltage fluctuation of ±10%)</td></tr>
<tr><td>±0.1% of rated speed max. (for a temperature fluctuation of 25°C ±25°C)</td></tr>
<tr><td>Torque Control Precision (Repeatability)</td><td>±1%</td></tr>
<tr><td>Soft Start Time Setting</td><td>0 s to 10 s (Can be set separately for acceleration and deceleration.)</td></tr>
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Item			Specification
I/O Signals	Encoder Divided Pulse Output		Phase A, phase B, phase C: Line-driver output Number of divided output pulses: Any setting is allowed.
	Linear Servomotor Overheat Protection Signal Input		Number of input points: 1 Input voltage range: 0 V to +5 V
	Sequence Input Signals	Input Signals That Can Be Allocated	Allowable voltage range: 24 VDC ±20% Number of input points: 7
			Input method: Sink inputs or source inputs Input Signals • P-OT (Forward Drive Prohibit) and N-OT (Reverse Drive Prohibit) signals • /Probe1 (Probe 1 Latch Input) signal • /Probe2 (Probe 2 Latch Input) signal • /Home (Home Switch Input) signal • /P-CL (Forward External Torque Limit) and /N-CL (Reverse External Torque Limit) signals • /SI0 and /SI3 (General-Purpose Input) signals A signal can be allocated and the positive and negative logic can be changed.
	Sequence Output Signals	Fixed Output	Allowable voltage range: 5 VDC to 30 VDC Number of output points: 1 Output signal: ALM (Servo Alarm) signal
		Output Signals That Can Be Allocated	Allowable voltage range: 5 VDC to 30 VDC Number of output points: 3 (A photocoupler output (isolated) is used.)
			Output Signals • /COIN (Positioning Completion) signal • /V-CMP (Speed Coincidence Detection) signal • /TGON (Rotation Detection) signal • /S-RDY (Servo Ready) signal • /CLT (Torque Limit Detection) signal • /VLT (Speed Limit Detection) signal • /BK (Brake) signal • /WARN (Warning) signal • /NEAR (Near) signal A signal can be allocated and the positive and negative logic can be changed.
Communications	RS-422A Communications (CN502)	Interfaces	A JUSP-JC001 Communications Unit is required to connect to a Digital Operator (JUSP-OP05A-1-E).
		1:N Communications	Up to N = 15 stations possible for RS-422A port
		Axis Address Setting	Set with parameters.
	USB Communications (CN7)	Interface	Personal computer (with SigmaWin+)
		Communications Standard	Conforms to USB2.0 standard (12 Mbps).
Displays/Indicators			CHARGE, PWR, RUN, ERR, L/A (A, B), and one-digit seven-segment display
EtherCAT Communications Setting Switches			EtherCAT secondary address (S1 and S2), 16 positions

Continued on next page.

Continued from previous page.

Item		Specification
EtherCAT Communications	Applicable Communications Standards	IEC 61158 Type 12, IEC 61800-7 CiA402 Drive Profile
	Physical Layer	100BASE-TX (IEEE 802.3)
	Communications Connectors	CN6A (RJ45): EtherCAT signal input connector CN6B (RJ45): EtherCAT signal output connector
	Cable	Category 5, 4 shielded twisted pairs * The cable is automatically detected with AUTO MDIX.
	Sync Manager	SM0: Mailbox output, SM1: Mailbox input, SM2: Process data output, and SM3: Process data input
	FMMU	FMMU 0: Mapped in process data output (RxPDO) area. FMMU 1: Mapped in process data input (TxPDO) area. FMMU 2: Mapped to mailbox status.
	EtherCAT Commands (Data Link Layer)	APRD, FPRD, BRD, LRD, APWR, FPWR, BWR, LWR, ARMW, and FRMW (APRW, FPRW, BRW, and LRW commands are not supported.)
	Process Data	Assignments can be changed with PDO mapping.
	Mailbox (CoE)	Emergency messages, SDO requests, SDO responses, and SDO information (TxPDO/RxPDO and remote TxPDO/RxPDO are not supported.)
	Distributed Clocks	Free-Run Mode and DC Mode (Can be switched.) Applicable DC cycles: 125 μs to 4 ms in 125-μs increments
	Slave Information Interface	256 bytes (read-only)
	Indicators	EtherCAT communications in progress: Link/Activity x 2 EtherCAT communications status: RUN x 1 EtherCAT error status: ERR x 1
CiA402 Drive Profile		• Homing Mode • Profile Position Mode • Interpolated Position Mode • Profile Velocity Mode • Profile Torque Mode • Cyclic Synchronous Position Mode • Cyclic Synchronous Velocity Mode • Cyclic Synchronous Torque Mode • Touch Probe Function • Torque Limit Function
Analog Monitor (CN5)		Number of points: 2 Output voltage range: ±10 VDC (effective linearity range: ±8 V) Resolution: 16 bits Accuracy: ±20 mV (Typ) Maximum output current: ±10 mA Settling time (±1%): 1.2 ms (Typ)
Dynamic Brake (DB)		Activated when a servo alarm or overtravel (OT) occurs, or when the power supply to the main circuit or servo is OFF.
Regenerative Processing		Built-in (An external resistor must be connected to the SGD7S-470A to -780A.) Refer to the following manual for details. 📖 **Σ-7-Series AC Servo Drive Peripheral Device Selection Manual (Manual No.: SIEP S800001 32)**
Overtravel (OT) Prevention		Stopping with dynamic brake, deceleration to a stop, or coasting to a stop for the P-OT (Forward Drive Prohibit) or N-OT (Reverse Drive Prohibit) signal
Protective Functions		Overcurrent, overvoltage, low voltage, overload, regeneration error , etc.
Utility Functions		Gain adjustment, alarm history, jogging, origin search, etc.
Safety Functions	Inputs	/HWBB1 and /HWBB2: Base block signals for Power Modules
	Output	EDM1: Monitors the status of built-in safety circuit (fixed output).
	Applicable Standards[2]	ISO13849-1 PLe (Category 3), IEC61508 SIL3
Applicable Option Modules		Fully-closed Modules and Safety Modules

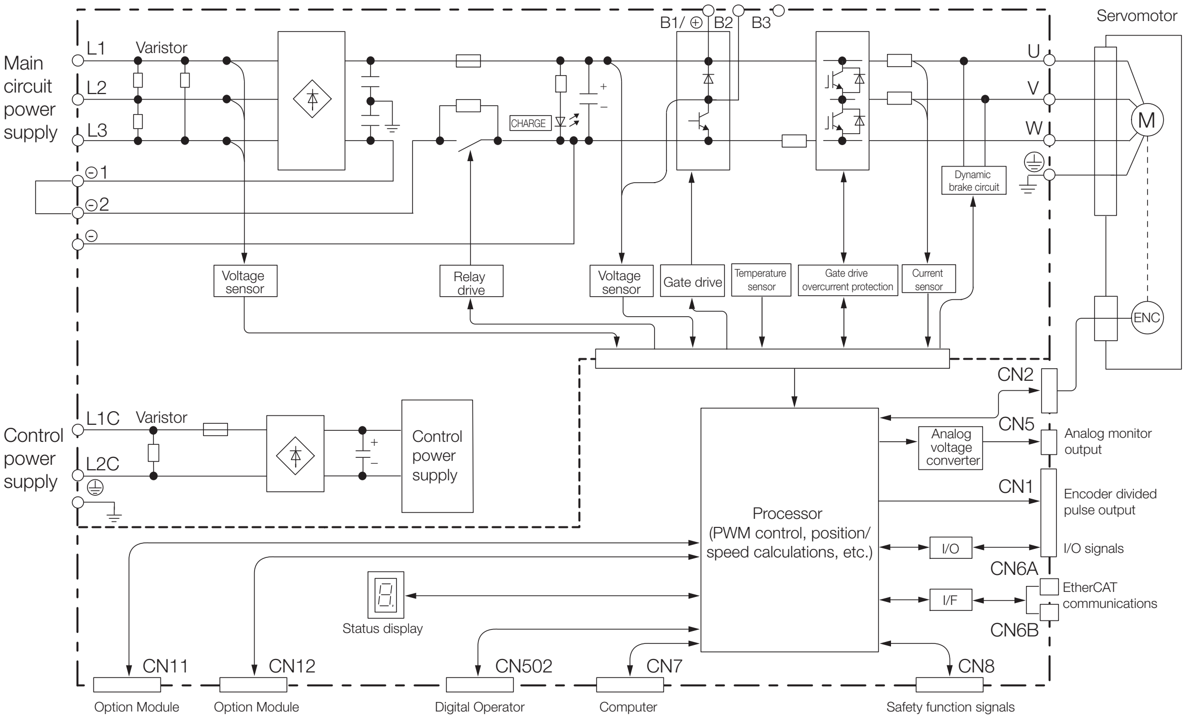
[1] The coefficient of speed fluctuation for load fluctuation is defined as follows:

$$\text{Coefficient of speed fluctuation} = \frac{\text{No-load motor speed - Total-load motor speed}}{\text{Rated motor speed}} \times 100\%$$

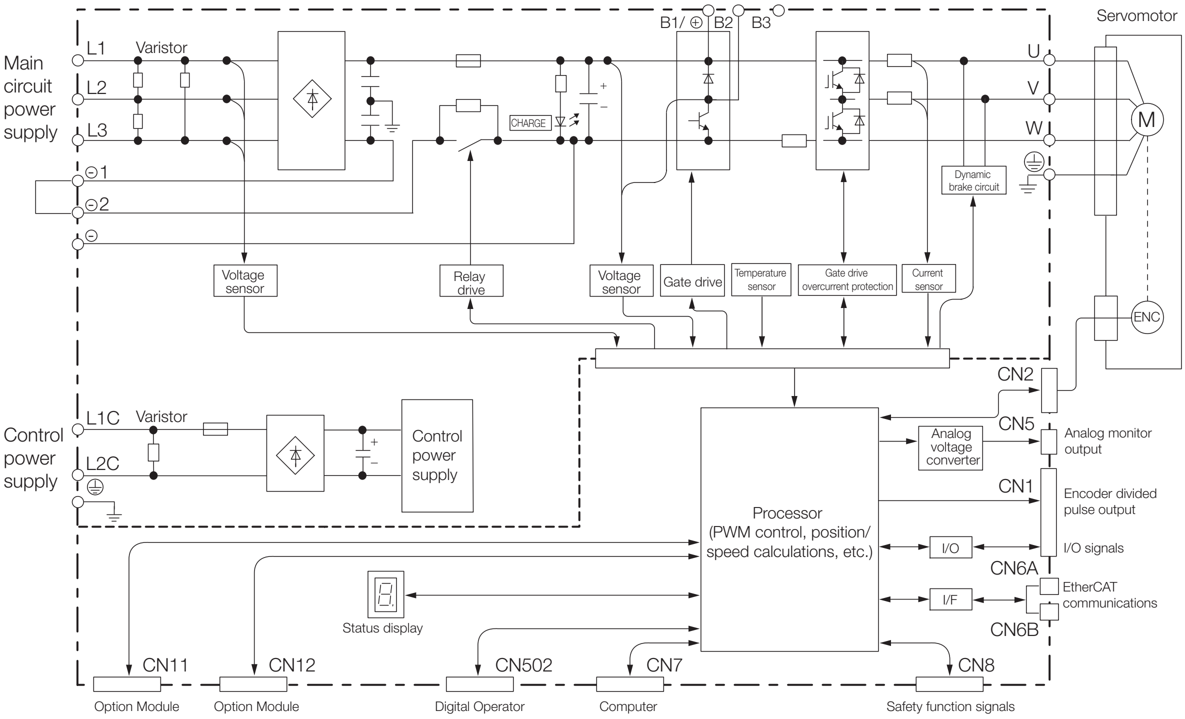
[2] Always perform risk assessment for the system and confirm that the safety requirements are met.

2.2 Block Diagrams

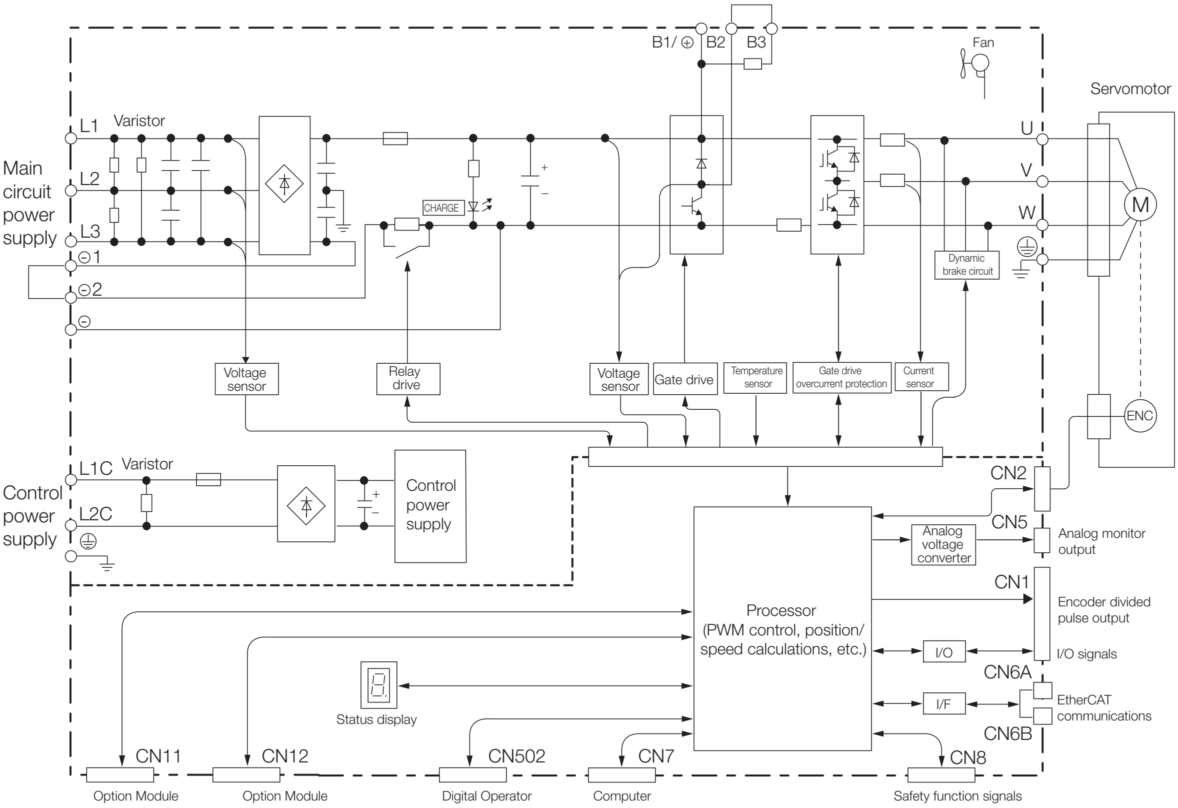
2.2.1 SGD7S-R70A, -R90A, and -1R6A



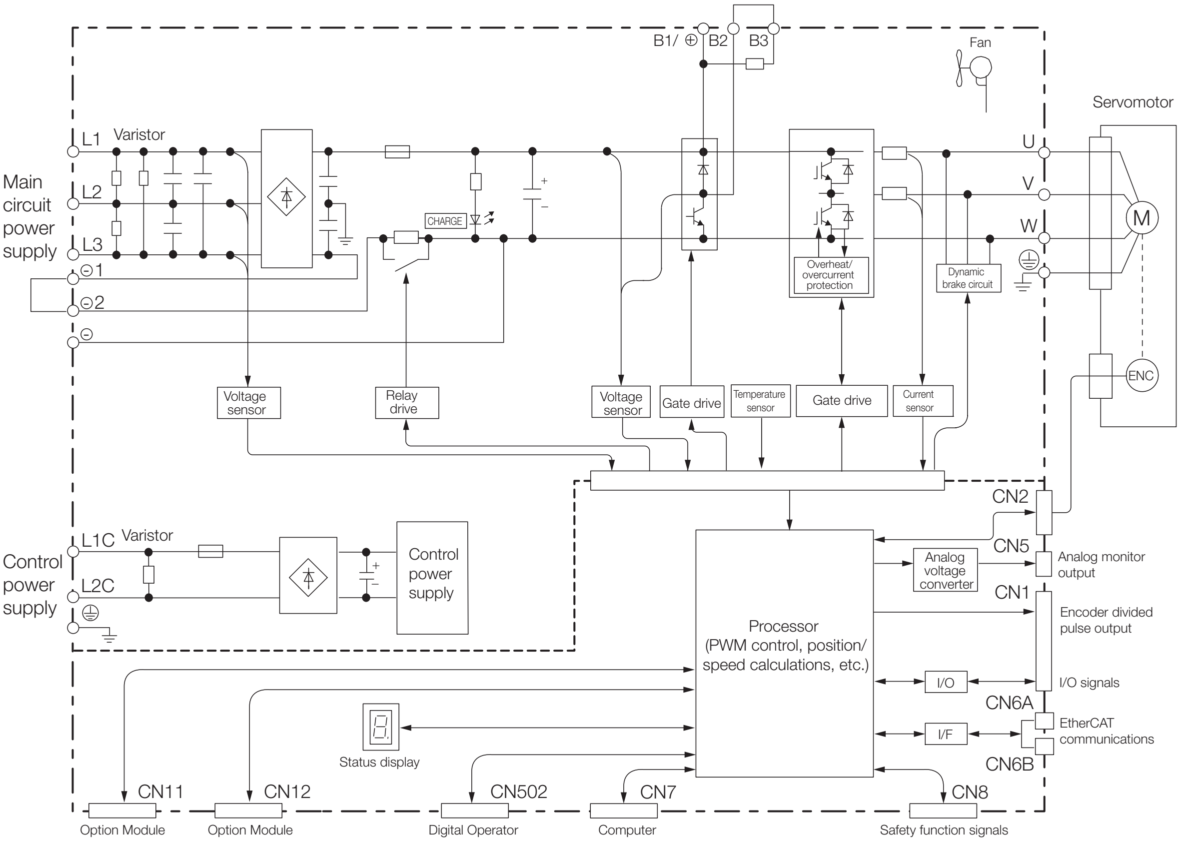
2.2.2 SGD7S-2R8A



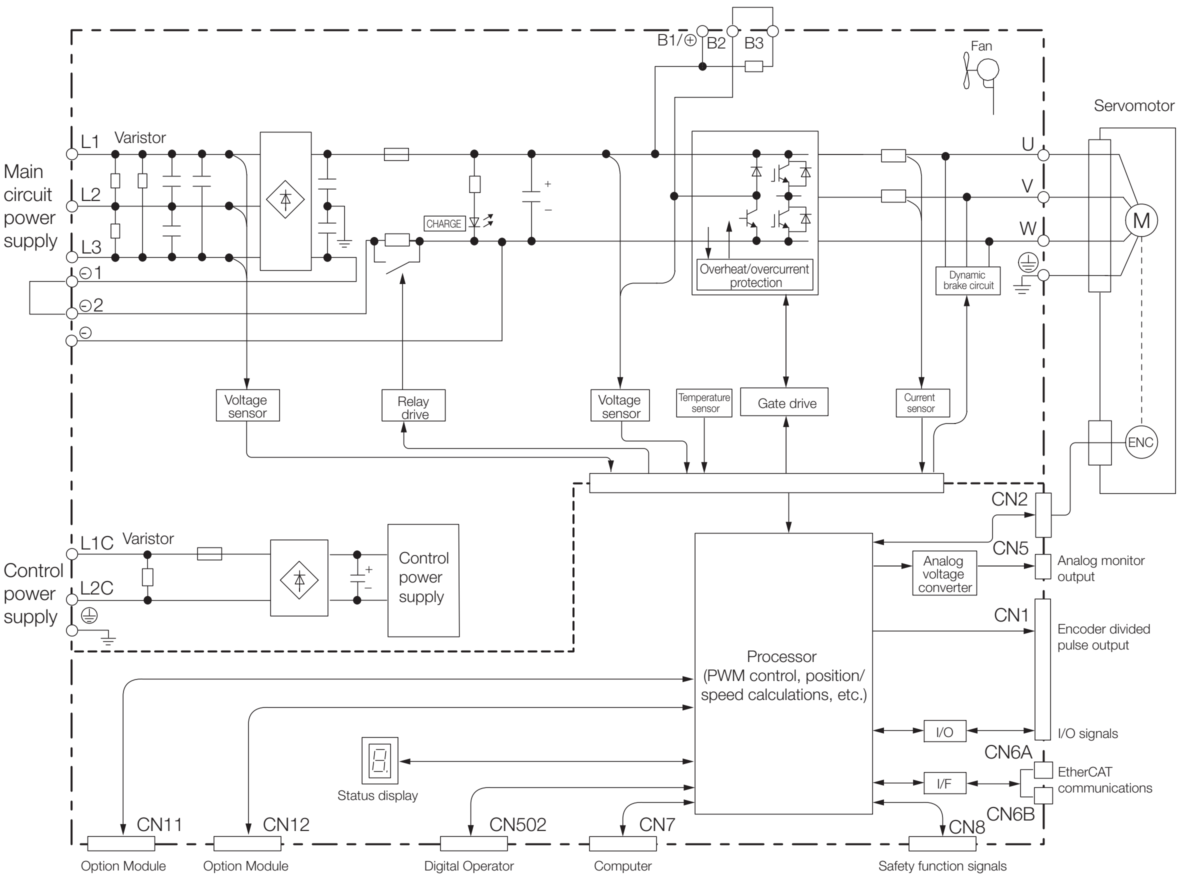
2.2.3 SGD7S-3R8A, -5R5A, and -7R6A



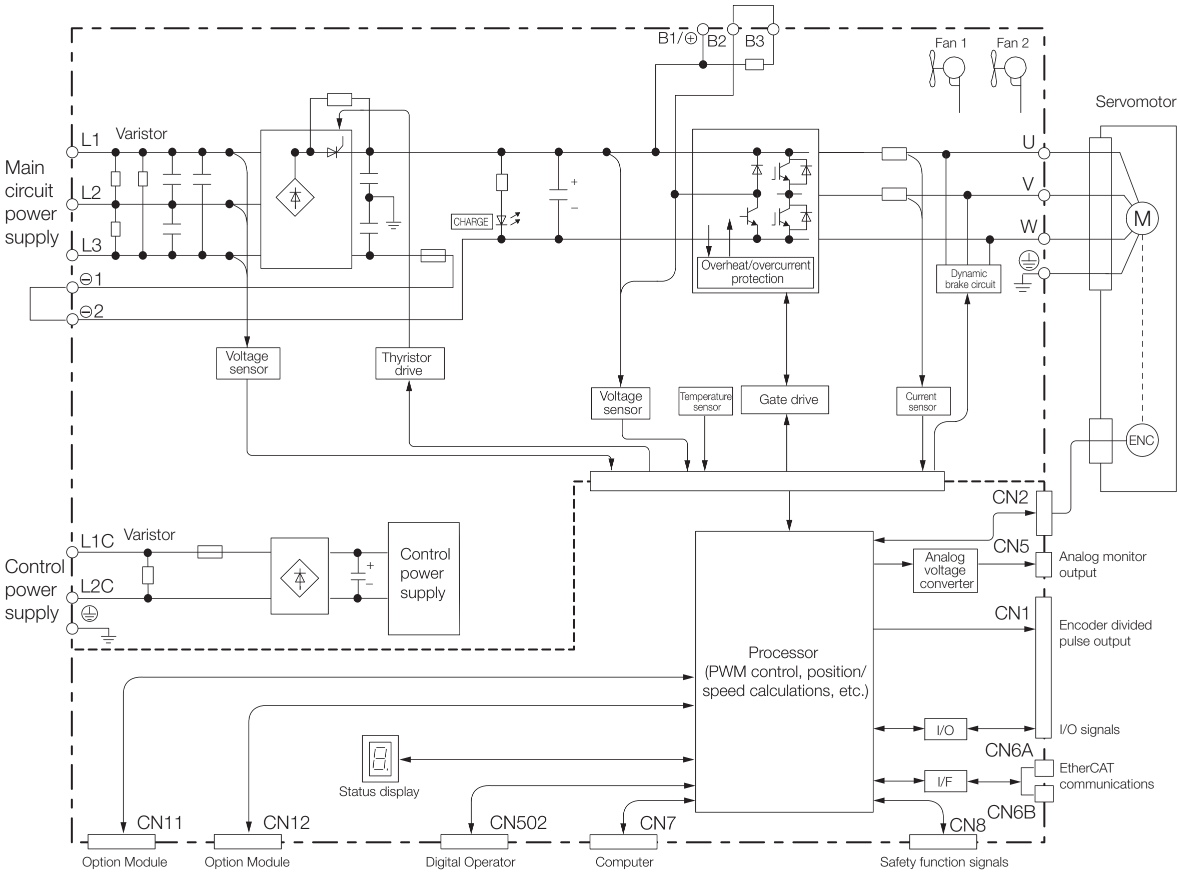
2.2.4 SGD7S-120A



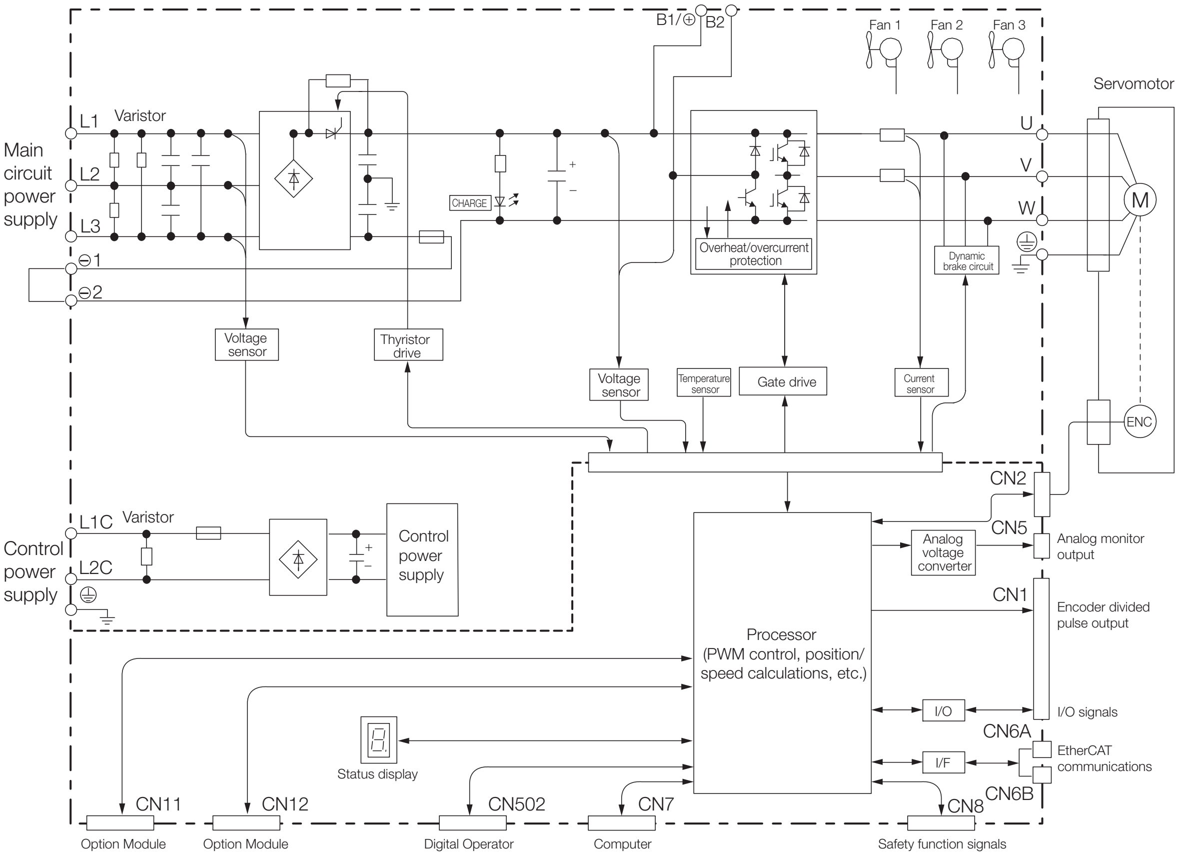
2.2.5 SGD7S-180A and -200A



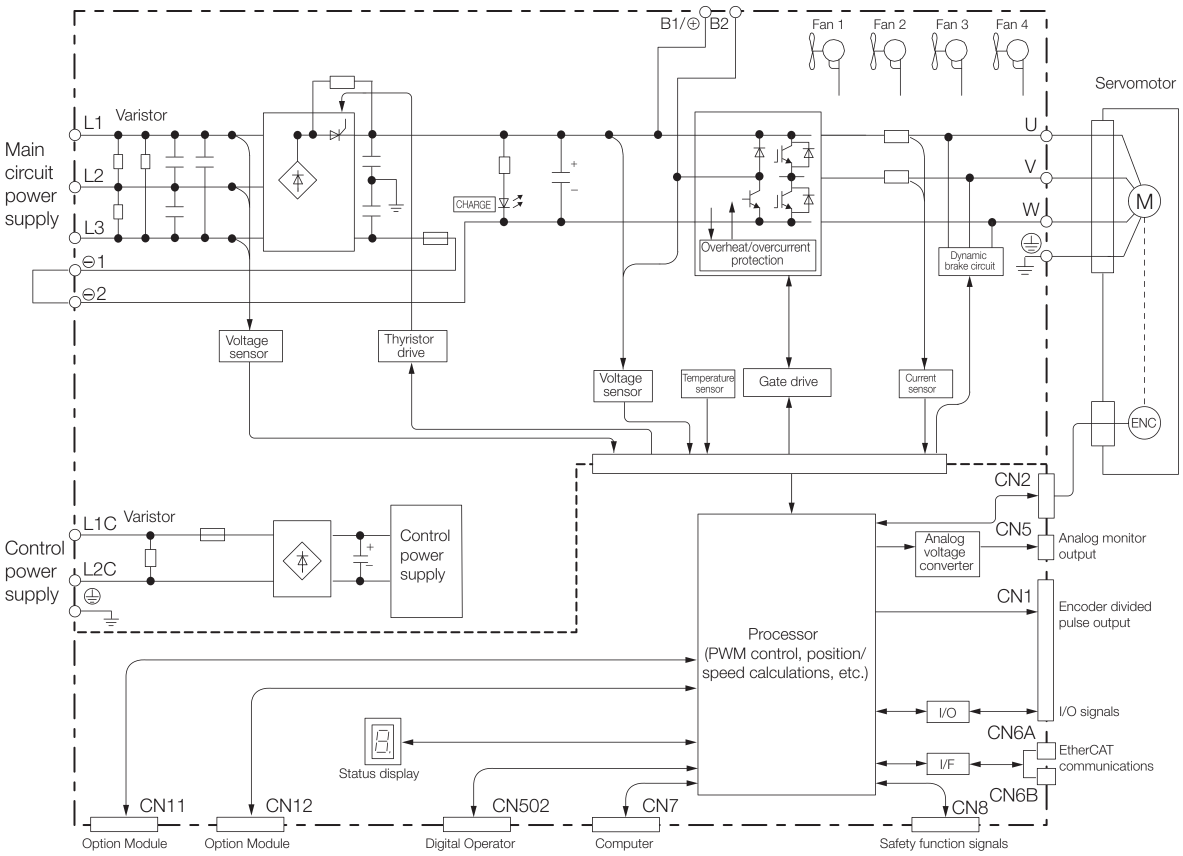
2.2.6 SGD7S-330A



2.2.7 SGD7S-470A and -550A



2.2.8 SGD7S-590A and -780A

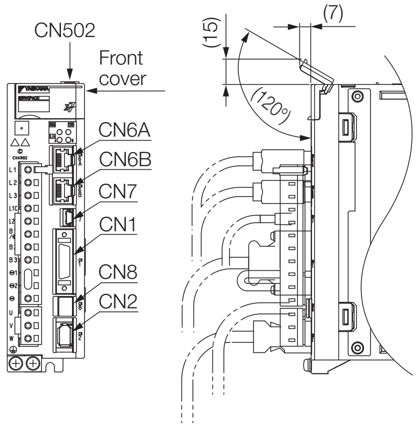


2.3 External Dimensions

2.3.1 Front Cover Dimensions and Connector Specifications

The front cover dimensions and panel connector section are the same for all models. Refer to the following figures and table.

- Front Cover Dimensions



- Connector Specifications

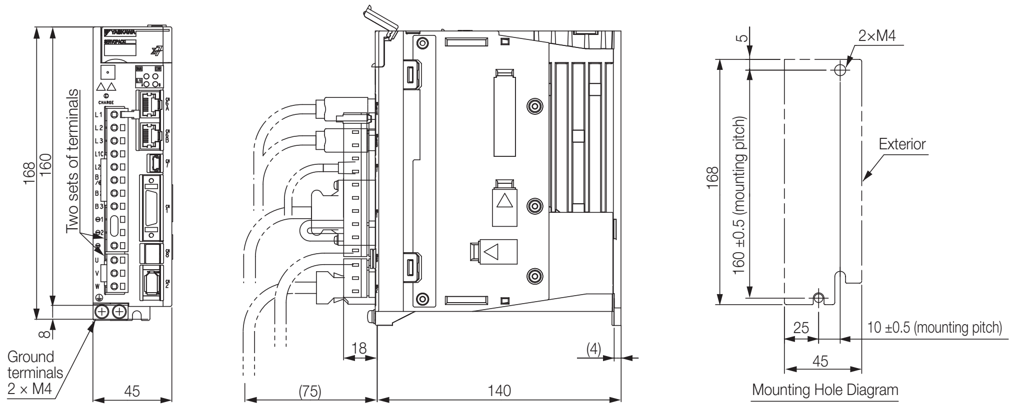
Connector No.	Model	Number of Pins	Manufacturer
CN1	10226-59A3MB	26	Sumitomo 3M Ltd.
CN2	3E106-0220KV	6	Sumitomo 3M Ltd.
CN502	S8B-ZR-SM4A-TF(LF)(SN)	8	J.S.T. Mfg. Co., Ltd.
CN6A/B	1903815-1	8	Tyco Electronics Japan G.K.
CN7	2172034-1	5	Tyco Electronics Japan G.K.
CN8	1981080-1	8	Tyco Electronics Japan G.K.

Note: The above connectors or their equivalents are used for the SERVOPACKs.

2.3.2 SERVOPACK External Dimensions

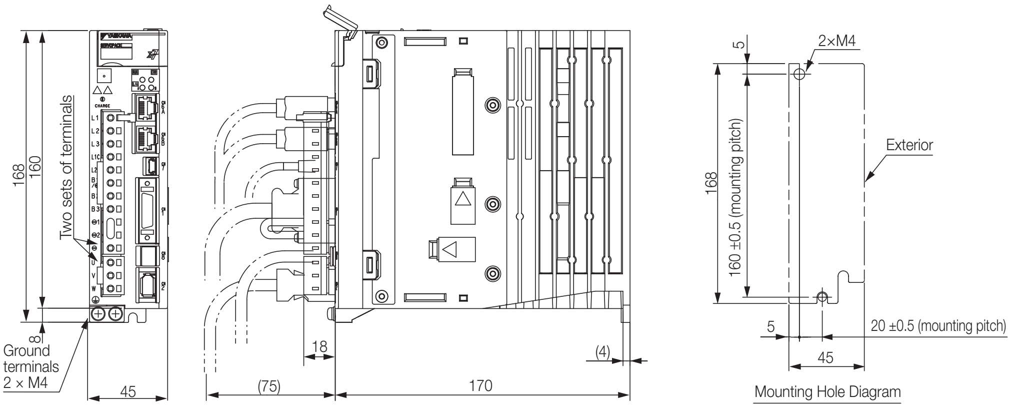
Base-mounted SERVOPACKs

- Three-phase, 200 VAC: SGD7S-R70A, -R90A, and -1R6A



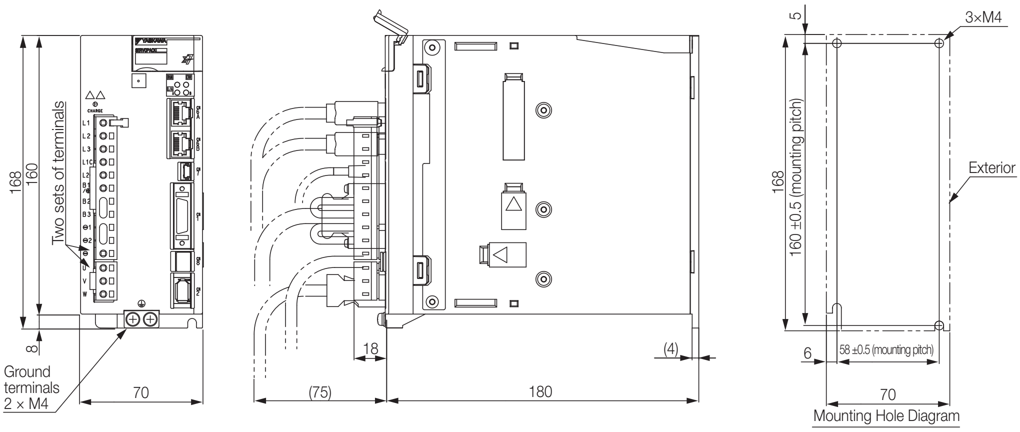
Approx. mass: 0.8 kg
Unit: mm

- Three-phase, 200 VAC: SGD7S-2R8A



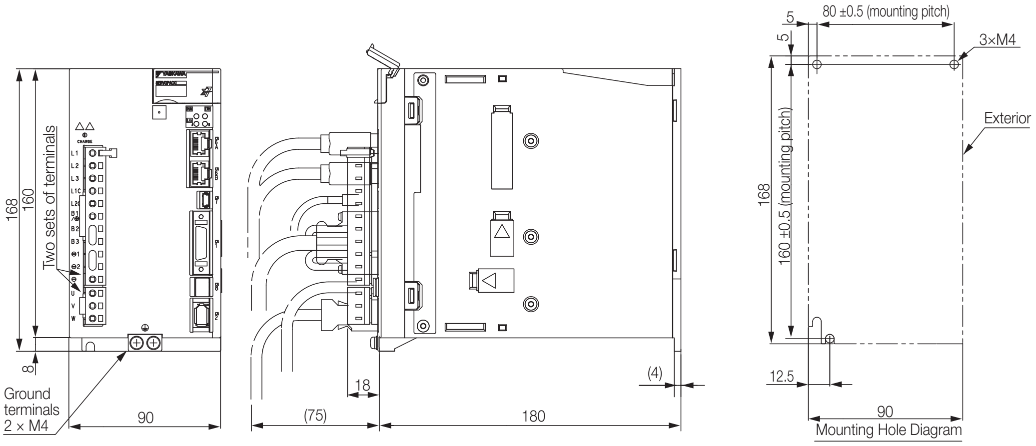
Approx. mass: 1.0 kg
Unit: mm

- Three-phase, 200 VAC: SGD7S-3R8A, -5R5A, and -7R6A



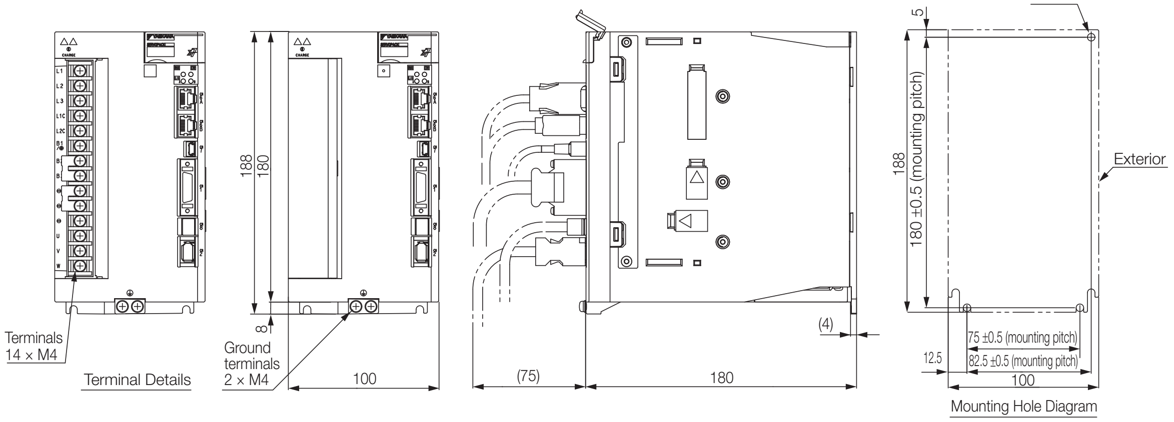
Approx. mass: 1.6 kg
Unit: mm

- Three-phase, 200 VAC: SGD7S-120A



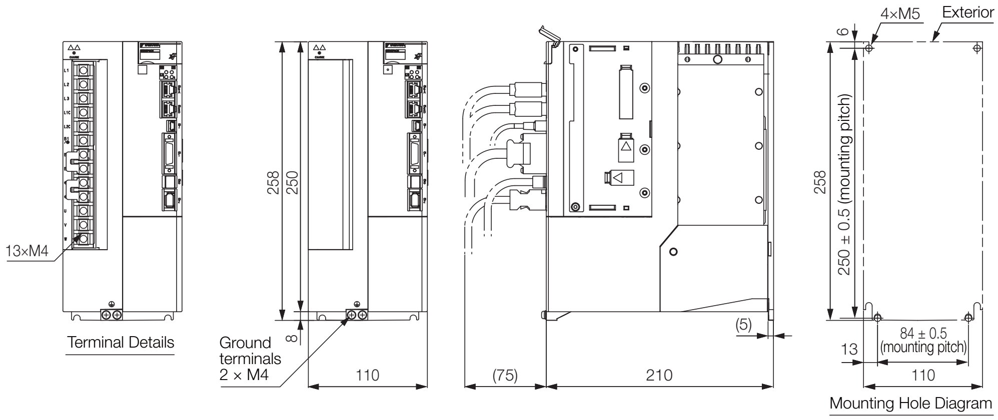
Approx. mass: 2.2 kg
Unit: mm

- Three-phase, 200 VAC: SGD7S-180A and -200A



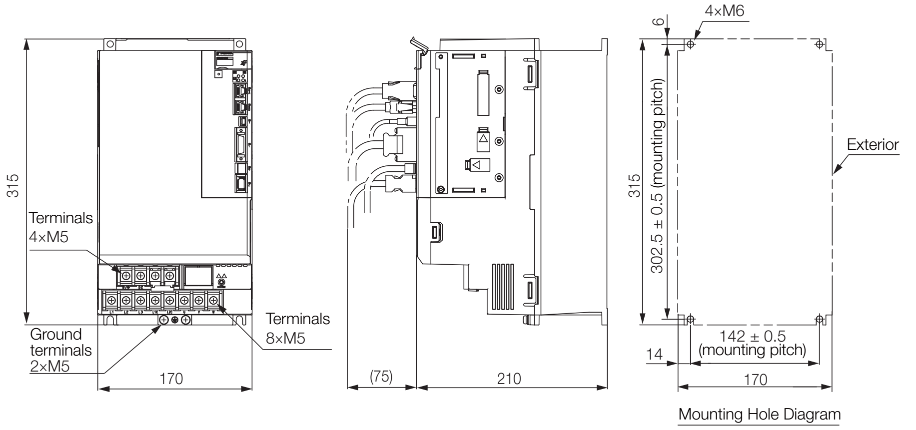
Approx. mass: 2.7 kg
Unit: mm

- Three-phase, 200 VAC: SGD7S-330A



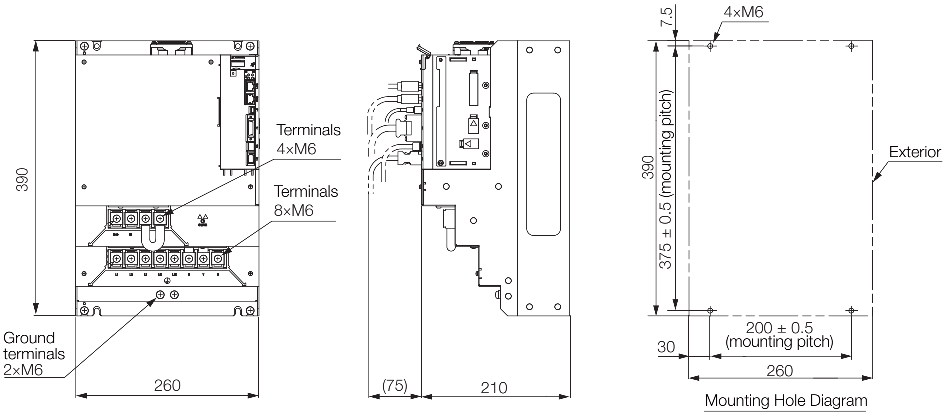
Approx. Mass: 4.4 kg
Unit: mm

- Three-phase, 200 VAC: SGD7S-470A and -550A



Approx. Mass: 8.2 kg
Unit: mm

- Three-phase, 200 VAC: SGD7S-590A and -780A

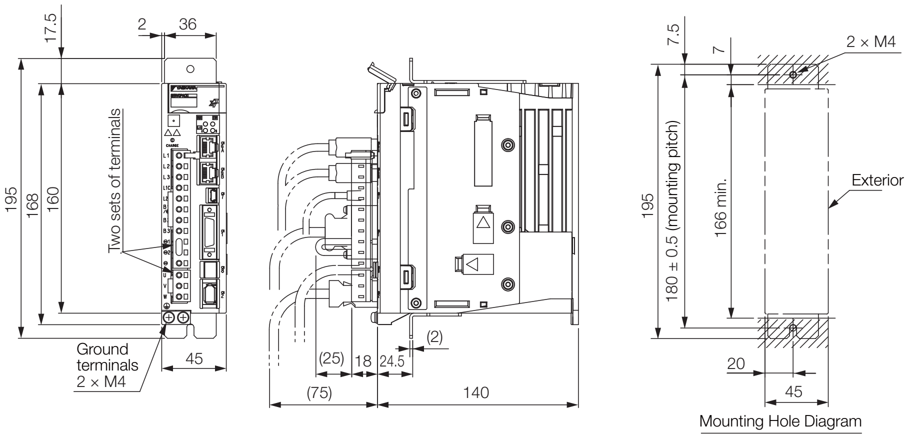


Approx. Mass: 15.5 kg
Unit: mm

Rack-mounted SERVOPACKs

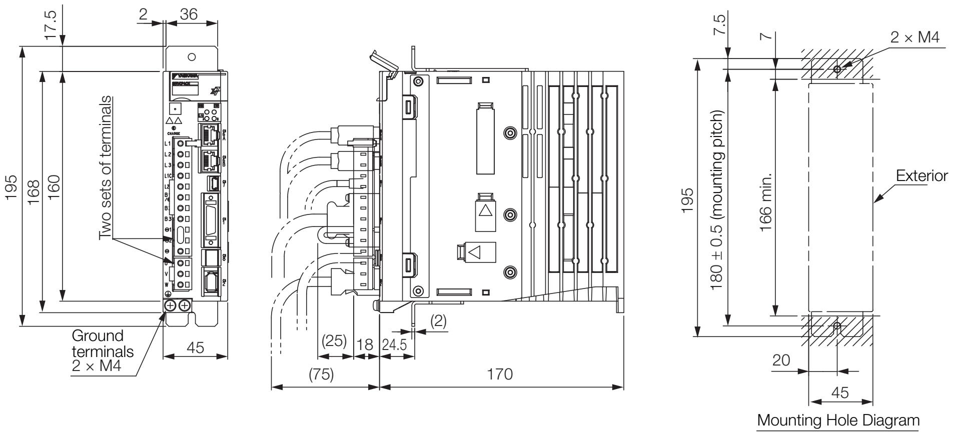
Hardware Option Code: 001

- Three-phase, 200 VAC: SGD7S-R70A, -R90A, and -1R6A



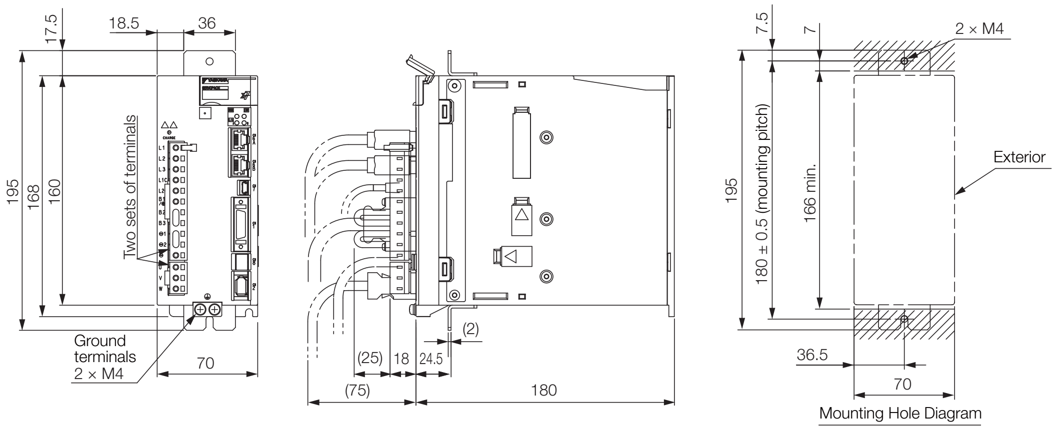
Approx. mass: 0.8 kg
Unit: mm

- Three-phase, 200 VAC: SGD7S-2R8A



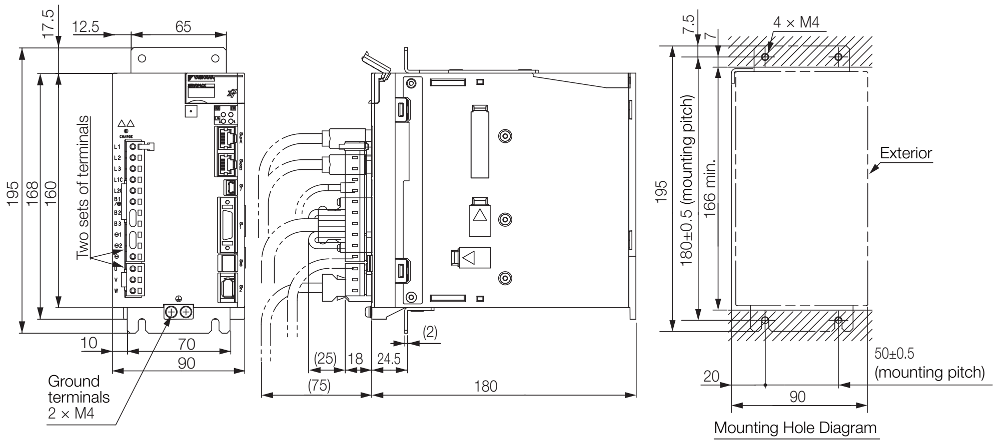
Approx. mass: 1.0 kg
Unit: mm

- Three-phase, 200 VAC: SGD7S-3R8A, -5R5A, and -7R6A



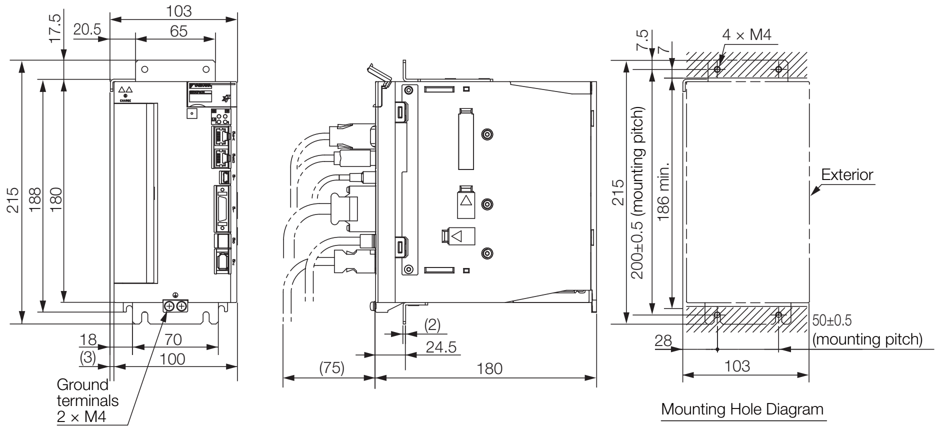
Approx. mass:1.6 kg
Unit: mm

- Three-phase, 200 VAC: SGD7S-120A



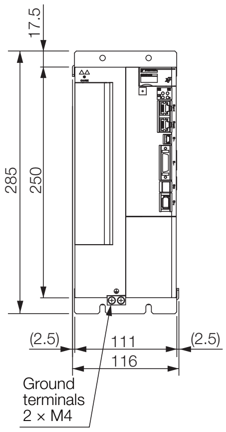
Approx. mass: 2.2 kg
Unit: mm

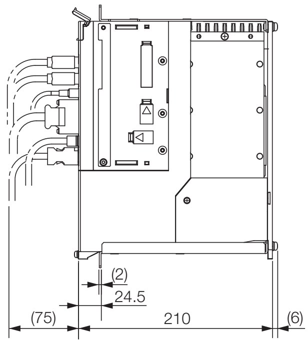
- Three-phase, 200 VAC: SGD7S-180A and -200A

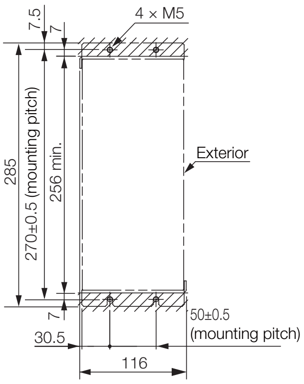


Approx. mass: 2.7 kg
Unit: mm

- Three-phase, 200 VAC: SGD7S-330A





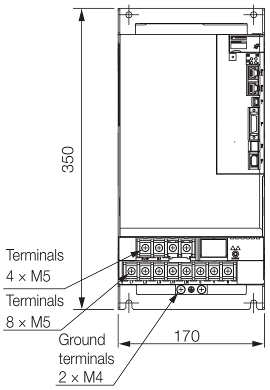


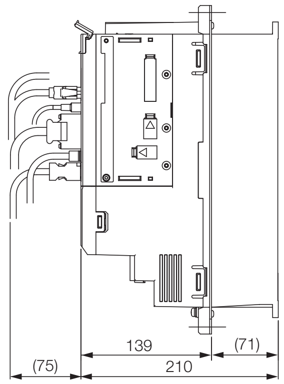
Mounting Hole Diagram

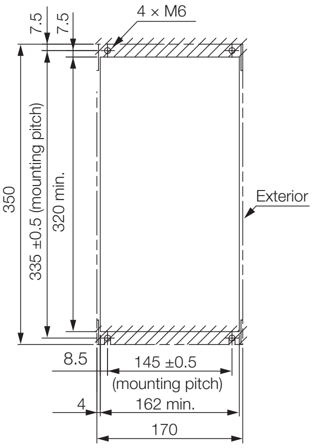
Approx. mass: 4.9 kg
Unit: mm

Duct-ventilated SERVOPACK

- Three-phase, 200 VAC: SGD7S-470A and -550A



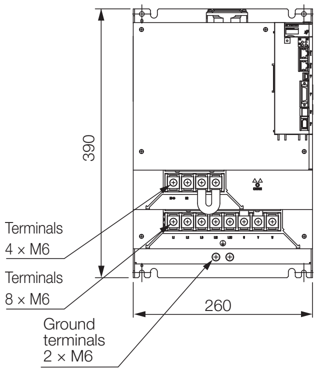


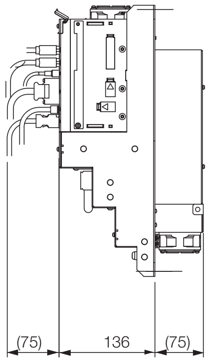


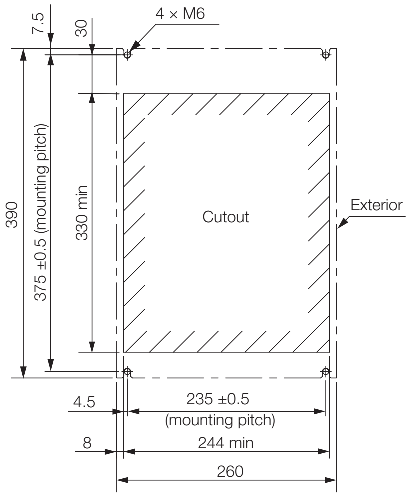
Mounting Hole Diagram

Approx. mass: 8.4 kg
Unit: mm

- Three-phase, 200 VAC: SGD7S-590A or -780A





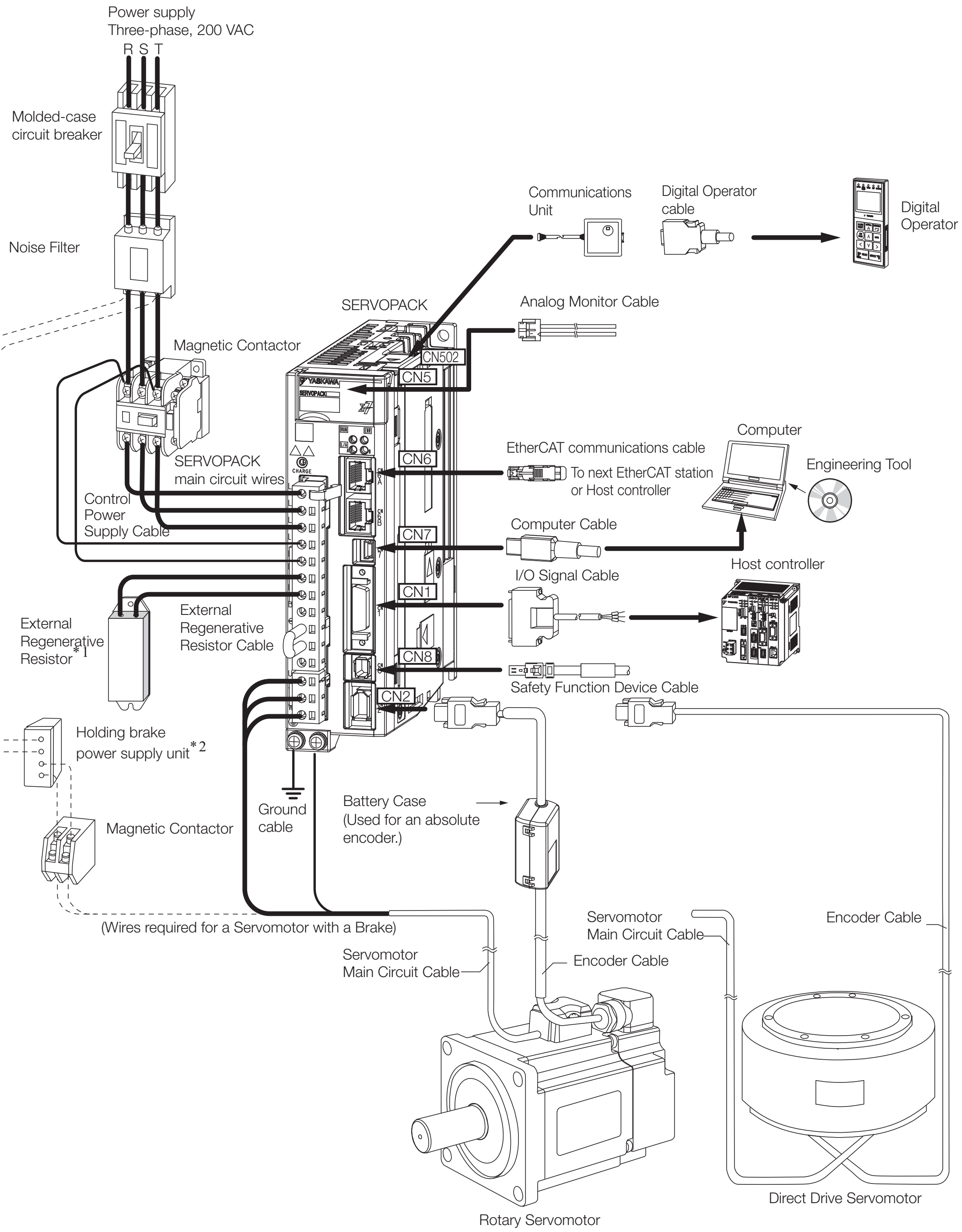


Mounting Hole Diagram

Approx. mass: 13.8 kg
Unit: mm

2.4 Examples of Standard Connections between SERVOPACKs and Peripheral Devices

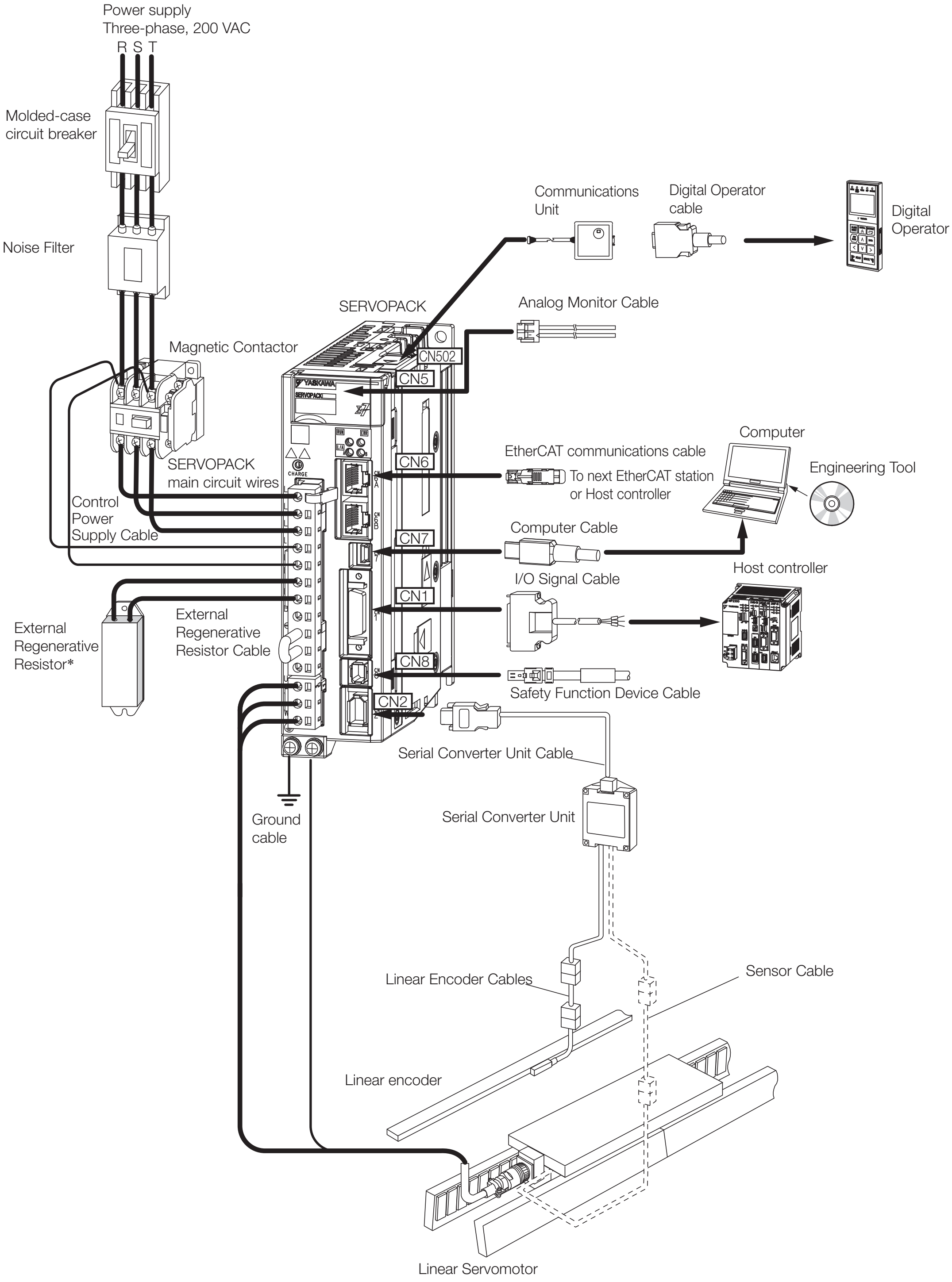
- Rotary Servomotors



*1. External Regenerative Resistors are not provided by Yaskawa.

*2. The power supply for the holding brake is not provided by Yaskawa. Select a power supply based on the holding brake specifications.
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.

- Linear Servomotors



* External Regenerative Resistors are not provided by Yaskawa.

SERVOPACK Installation

3

This chapter provides information on installing SERVOPACKs in the required locations.

3.1 Installation Precautions

Refer to the following section for the ambient installation conditions.

☞ *2.1.3 Specifications* on page 2-5

■ 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 SERVOPACK meets the ambient conditions.

■ Installation Near Sources of Vibration

Install a vibration absorber on the installation surface of the SERVOPACK so that the SERVOPACK will not be subjected to vibration.

■ Other Precautions

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

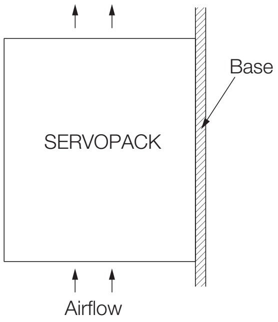
3.2 Mounting Types and Orientation

The SERVOPACKs come in the following mounting types: base-mounted, rack-mounted, and duct-ventilated types. Regardless of the mounting type, mount the SERVOPACK vertically, as shown in the following figures.

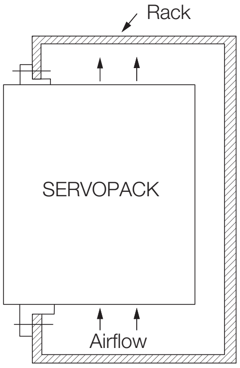
Also, mount the SERVOPACK so that the front panel is facing toward the operator.

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

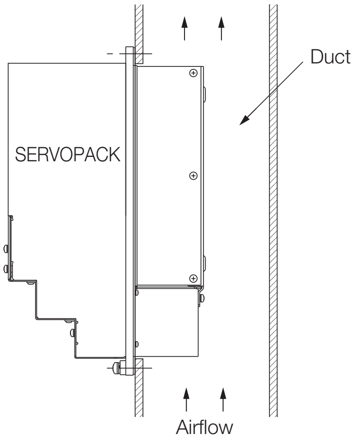
- Base-mounted SERVOPACK



- Rack-mounted SERVOPACK



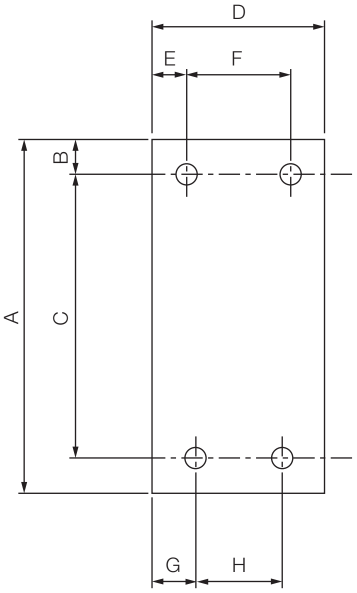
- Duct-ventilated SERVOPACK



3.3 Mounting Hole Dimensions

Use mounting holes to securely mount the SERVOPACK to the mounting surface.

Note: To mount the SERVOPACK, you will need to prepare a screwdriver that is longer than the depth of the SERVOPACK.



◆ Σ-7-series Mounting Hole Dimensions

SERVOPACK Model		Dimensions (mm)								Screw Size	Number of Screws
		A	B	C	D	E	F	G	H		
SGD7S-	R70A, R90A, 1R6A	168	5	160 ±0.5	45	35	–	25	–	M4	2
	2R8A	168	5	160 ±0.5	45	5	–	25	–	M4	2
	3R8A, 5R5A, 7R6A	168	5	160 ±0.5	70	6	58 ±0.5	64	–	M4	3
	120A	168	5	160 ±0.5	90	5	80 ±0.5	12.5	–	M4	3
	180A, 200A	188	5	180 ±0.5	100	95	–	12.5	75±0.5	M4	3
	330A	258	6	250±0.5	110	5	100±0.5	13	84±0.5	M5	4
	470A, 550A	315	6	302.5±0.5	170	14	142±0.5	14	142±0.5	M6	4
	590A, 780A	390	7.5	375±0.5	260	30	200±0.5	30	200±0.5	M6	4

◆ Σ-V-series-Compatible Mounting Hole Dimensions

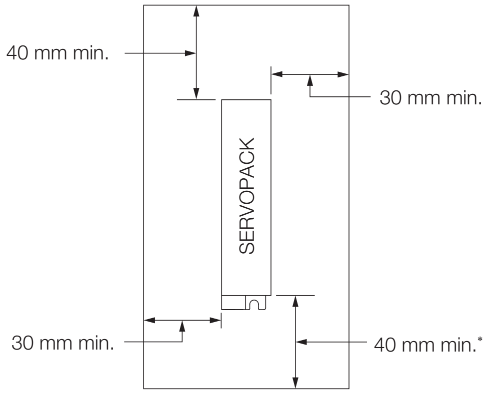
If you are replacing a Σ-V-Series SERVOPACK with a Σ-7-Series SERVOPACK, you can also use the mounting holes that were used for the Σ-V-Series SERVOPACK. Refer to the following table.

SERVOPACK Model		Dimensions (mm)								Screw Size	Number of Screws
		A	B	C	D	E	F	G	H		
SGD7S-	R70A, R90A, 1R6A	168	5	150 ±0.5	45	35	–	35	–	M4	2
	2R8A	168	5	150 ±0.5	45	5	–	35	–	M4	2
	3R8A, 5R5A, 7R6A	168	5	150 ±0.5	70	6	58 ±0.5	6	–	M4	3
	120A	168	5	150 ±0.5	90	5	80 ±0.5	5	–	M4	3
	180A, 200A	188	5	170 ±0.5	100	95	–	5	90 ±0.5	M4	3
	330A	250	6	238.5±0.5	110	5	100±0.5	5	100±0.5	M5	4
	470A, 550A, 590A, 780A	A special attachment is required. Contact your Yaskawa representative for details.									

3.4 Mounting Interval

3.4.1 Installing One SERVOPACK in a Control Panel

Provide the following spaces around the SERVOPACK.

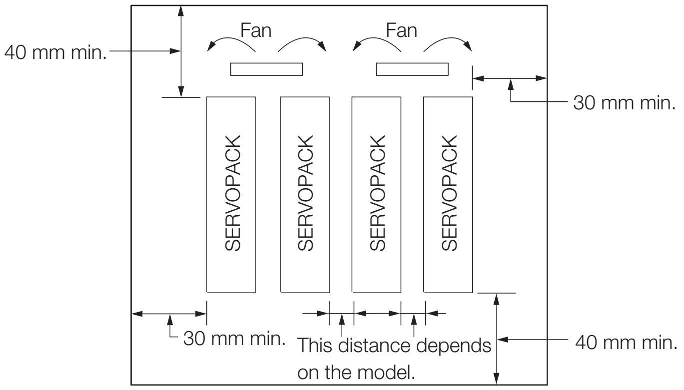


* For this dimension, ignore items protruding from the main body of the SERVOPACK.

3.4.2 Installing More Than One SERVOPACK in a Control Panel

Provide the following intervals between the SERVOPACKs and spaces around the SERVOPACKs.

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



The space required on the right side of a SERVOPACK (when looking at the SERVOPACK from the front) depends on the SERVOPACK models. Refer to the following table.

SERVOPACK Model		Space on Right Side	Cooling Fan Installation Conditions
			10 mm above SERVOPACK's Top Surface
SGD7S-	R70A, R90A, 1R6A, 2R8A, 3R8A, 5R5A, 7R6A	1 mm min.	Air speed: 0.5 m/s min.
	120A, 180A, 200A, 330A, 470A, 550A, 590A, 780A	10 mm min.	Air speed: 0.5 m/s min.

3.5 Monitoring the Installation Environment

You can use the SERVOPACK Installation Environment Monitor parameter to check the operating conditions of the SERVOPACK in the installation environment.

You can check the SERVOPACK installation environment monitor with either of the following methods.

- Using the SigmaWin+: ***Life Monitor - Installation Environment Monitor - SERVOPACK***
- Panel Operator or Digital Operator: Un025 (Installation Environment Monitor [%])

Implement one or more of the following actions if the monitor value exceeds 100%.

- Lower the surrounding temperature.
- Decrease the load.

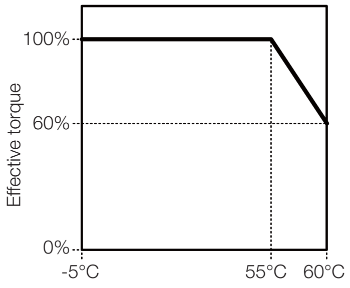
Information The value of the SERVOPACK Installation Environment Monitor parameter will increase by about 10% for each 10°C increase in the ambient temperature.

Important Always observe the surrounding air temperature given in the SERVOPACK environment conditions. Even if the monitor value is 100% or lower, you cannot use a SERVOPACK in a location that exceeds the specified surrounding air temperature.

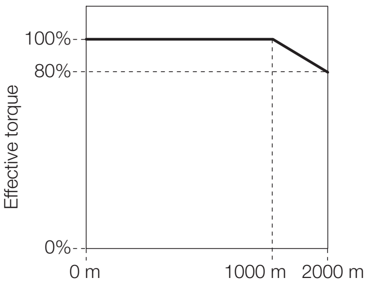
3.6 Derating Specifications

If you use the SERVOPACK at a surrounding air temperature of 55°C to 60°C or at an altitude of 1,000 m to 2,000 m, you must apply the derating rates given in the following graphs.

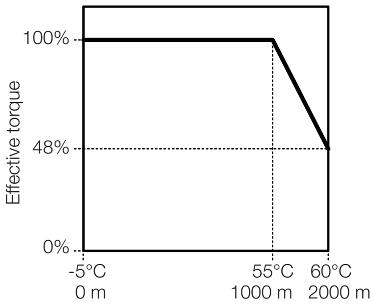
- SGD7S-R70A, -R90A, -1R6A, and -2R8A



Surrounding air temperature

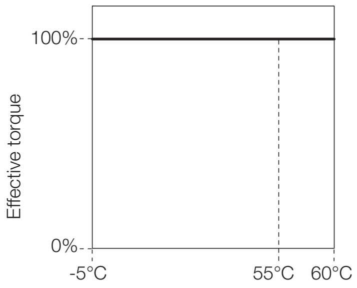


Altitude

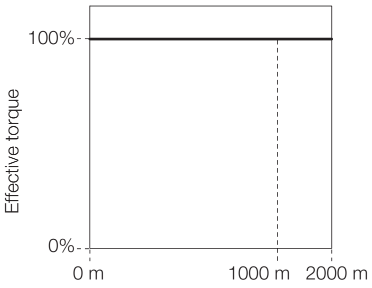


Surrounding air temperature and altitude

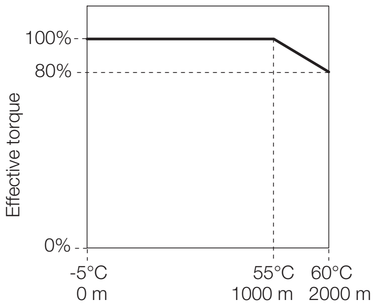
- SGD7S-3R8A, -5R5A, -7R6A, -120A, -180A, -200A, -330A, -470A, -550A, -590A, and -780A



Surrounding air temperature



Altitude



Surrounding air temperature and altitude

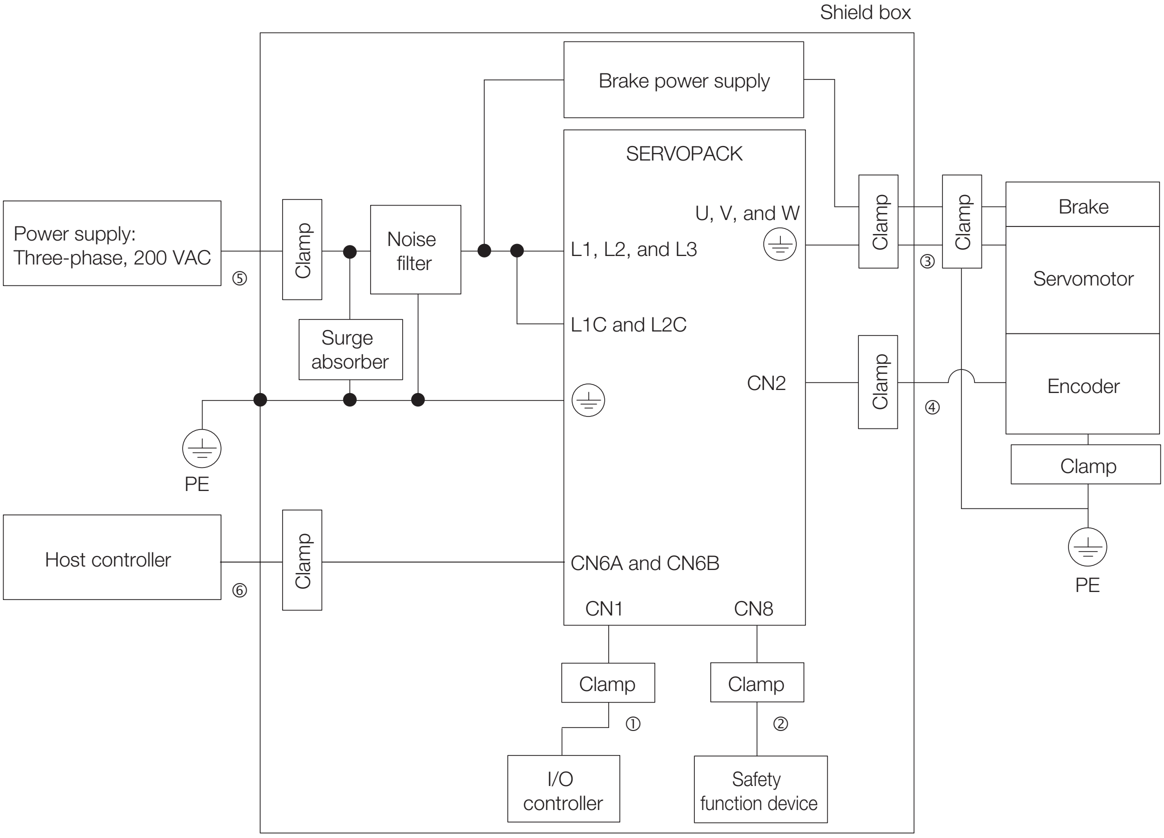
3.7 EMC Installation Conditions

This section gives the installation conditions that were used for EMC certification testing.

The EMC installation conditions that are given here are the conditions that were used to pass testing criteria at Yaskawa. The EMC level may change under other conditions, such as the actual installation structure and wiring conditions. These Yaskawa products are designed to be built into equipment. Therefore, you must implement EMC measures and confirm compliance for the final equipment.

The applicable standards are EN 55011 group 1 class A, EN 61000-6-2, EN 61000-6-4, and EN 61800-3 (category C2, second environment).

- Three-Phase, 200 VAC



Symbol	Cable Name	Specification
①	I/O Signal Cable	Shielded cable
②	Safety Signal Cable	Shielded cable
③	Servomotor Main Circuit Cable	Shielded cable
④	Encoder Cable	Shielded cable
⑤	Main Circuit Power Cable	Shielded cable
⑥	EtherCAT Communications Cable	Shielded cable

Wiring and Connecting SERVOPACKs

4

This chapter provides information on wiring and connecting SERVOPACKs to power supplies and peripheral devices.

4.1 Wiring and Connecting SERVOPACKs

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 SERVOPACK terminals.**
  - Connect an AC power supply to the L1, L2, and L3 terminals and the L1C and L2C terminals on the SERVOPACK.
  - Connect a DC power supply to the B1/⊕ and ⊖2 terminals and the L1C and L2C terminals on the SERVOPACK.

  There is a risk of failure or fire.

⚠ CAUTION

- **Wait for six 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 after turning OFF the power supply because high voltage may still remain in the SERVOPACK.**
  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 SERVOPACK 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 SERVOPACK's main circuit terminals.**
  - Turn ON the power supply to the SERVOPACK 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 SERVOPACK 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 Yaskawa.**
  If you use any other cables, confirm the rated current and application environment of your model and use the wiring materials specified by Yaskawa 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 (1QF) or fuse to protect the main circuit. The SERVOPACK connects directly to a commercial power supply; it is not isolated through a transformer or other device. Always use a molded-case circuit breaker (1QF) or fuse to protect the servo system from accidents involving different power system voltages or other accidents.
- Install an earth leakage breaker. The SERVOPACK 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 SERVOPACK for applications that require the power supply to turn ON and OFF frequently. Such applications will cause elements in the SERVOPACK 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 Yaskawa. Design and arrange the system so that each cable is as short as possible.
  Refer to the following manual for information on the specified cables.
  📖 Σ-7-Series Peripheral Device Selection Manual (Manual No.: SIEP S800001 32)
- The signal cable conductors are as thin as 0.2 mm^2 or 0.3 mm^2. Do not subject them to excessive bending stress or tension.

4.1.2 Countermeasures against Noise

Important

The SERVOPACK is designed as an industrial device. It therefore provides no measures to prevent radio interference. The SERVOPACK 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.

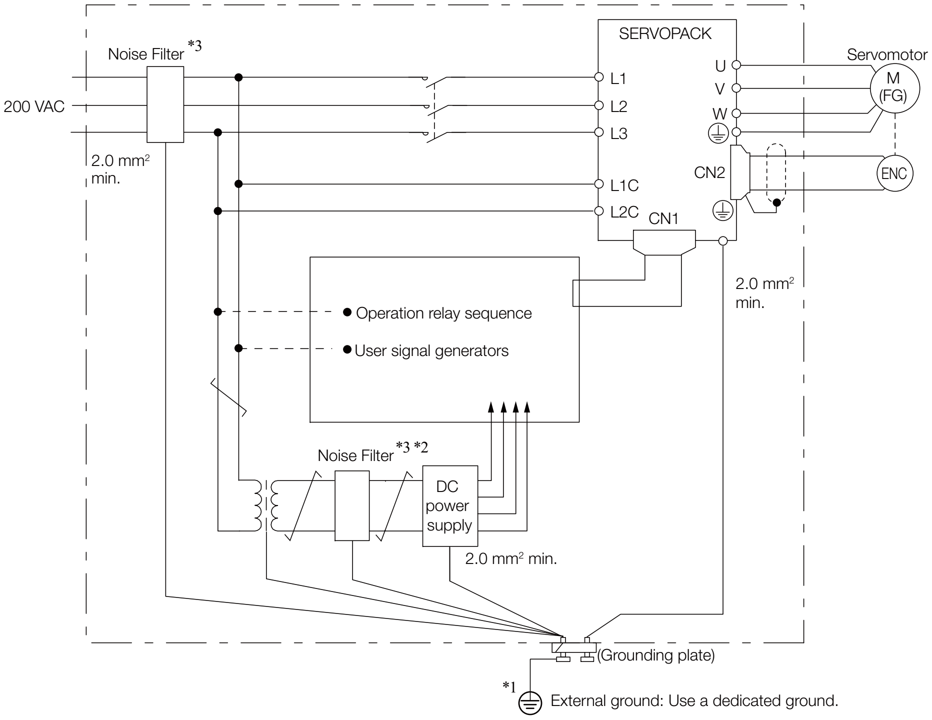
The SERVOPACK uses microprocessors. Therefore, it may be affected by switching noise from peripheral devices.

To prevent the noise from the SERVOPACK 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 SERVOPACK 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 SERVOPACK 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.
  ☞ *Noise Filters* on page 4-6
- Implement suitable grounding measures. Refer to the following section for information on grounding measures.
  ☞ *4.1.3 Grounding* on page 4-8

Noise Filters

You must attach Noise Filters in appropriate places to protect the SERVOPACK 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 mm^2 (preferably, flat braided copper wire).

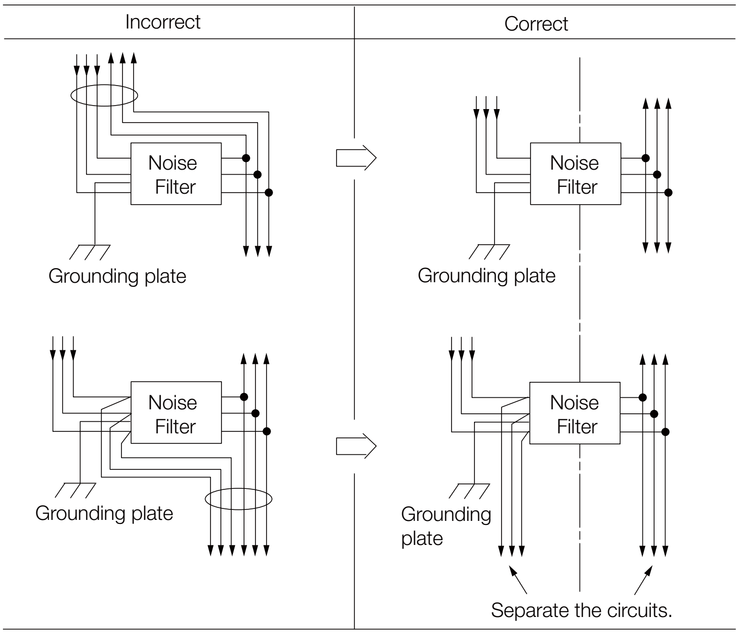
*2. Whenever possible, use twisted-pair wires to wire all connections marked with ⌿.

*3. Refer to the following section for precautions when using Noise Filters.
☞ *Noise Filter Wiring and Connection Precautions* on page 4-7

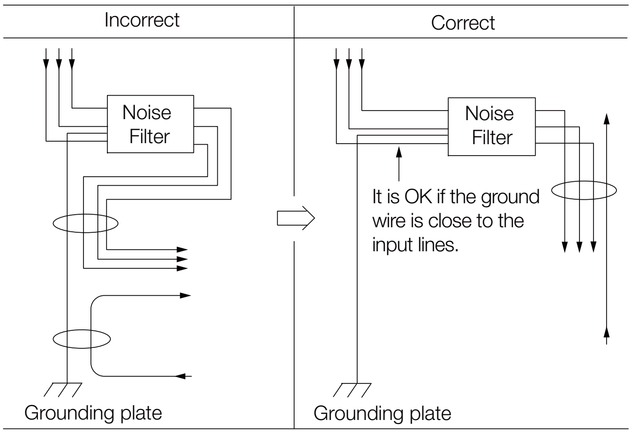
Noise Filter Wiring and Connection Precautions

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

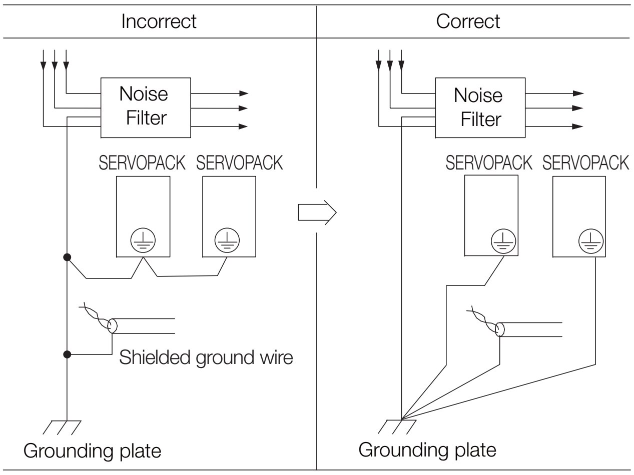
- Separate input lines from output lines. Do not place input lines and output lines in the same duct or bundle them together.



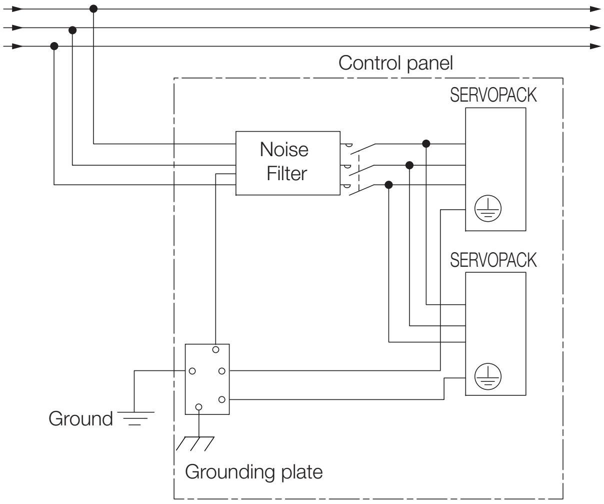
- Separate the Noise Filter ground wire from the output lines. Do not place the Noise Filter ground wire, output lines, and other signal lines in the same duct or bundle them together.



- 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 SERVOPACK 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 SERVOPACK through the stray capacitance of the Servomotor. To prevent this, always connect the motor frame terminal (FG) or ground terminal (FG) of the Servomotor to the ground terminal ⏚ on the SERVOPACK. Also be sure to ground the ground terminal ⏚.

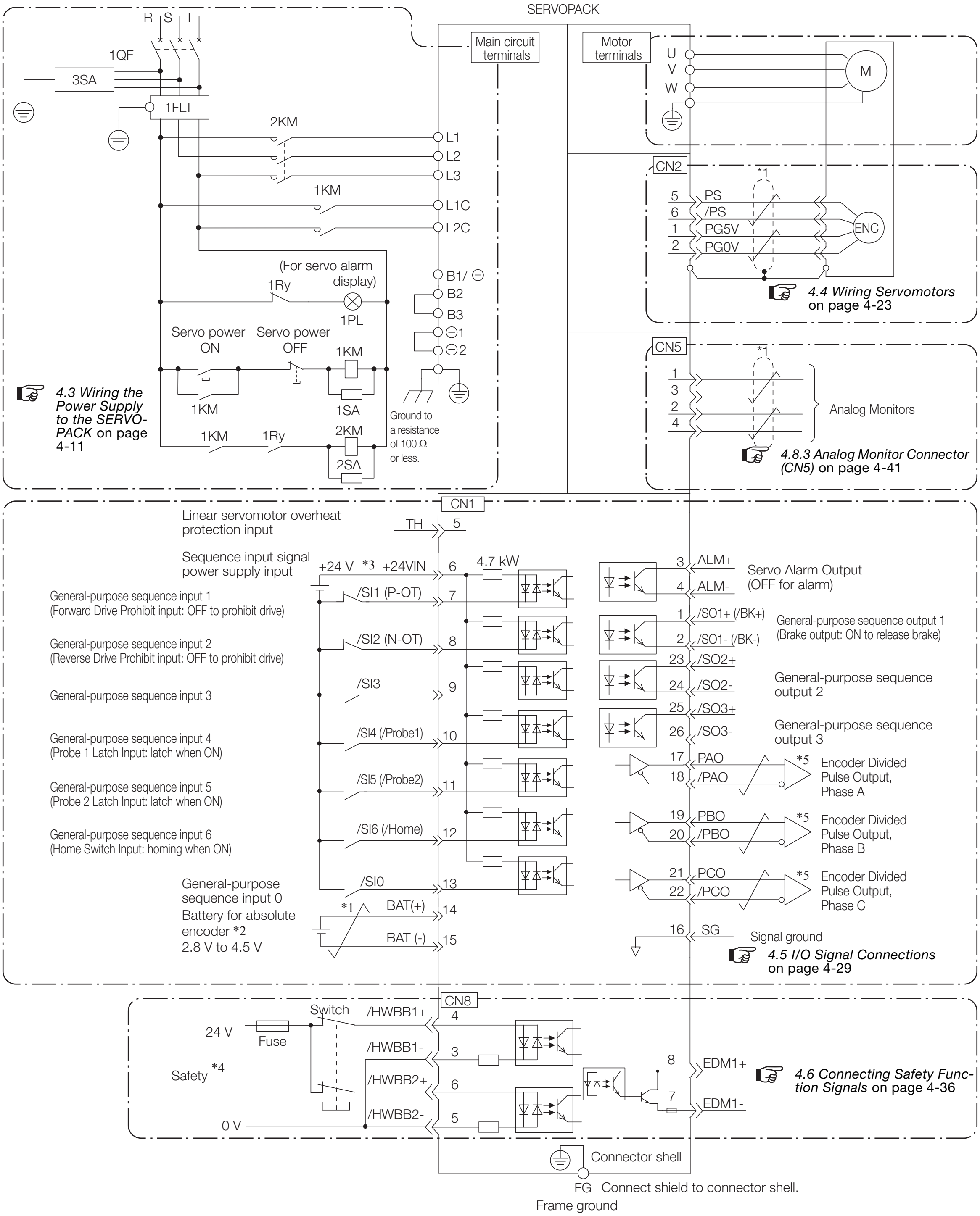
Ground both the Moving Coil and Magnetic Way of a Linear Servomotor.

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

This section provide the basic wiring diagrams. Refer to the reference sections given in the diagrams for details.



*1. represents twisted-pair wires.

*2. Connect these when using an absolute encoder. If the Encoder Cable with a Battery Case is connected, do not connect a backup battery.

*3. The 24-VDC power supply is not provided by Yaskawa. Use a 24-VDC power supply with double insulation or reinforced insulation.

*4. Refer to the following chapter if you use a safety function device.

Chapter 11 Safety Functions

If you do not use the safety function, insert the Safety Jumper Connector (provided as an accessory) into CN8 when you use the SERVOPACK.

*5. Always use line receivers to receive the output signals.

Note: 1. You can use parameters to change the functions allocated to the /SI0, /SI3, P-OT, N-OT, /Probe1, /Probe2, and /Home input signals and the /SO1, /SO2, and /SO3 output signals. Refer to the following section for details.

☞ *6.1 I/O Signal Allocations* on page 6-3

2. 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.
3. Default settings are given in parentheses.

4.3 Wiring the Power Supply to the SERVOPACK

4.3.1 Terminal Symbols and Terminal Names

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

⚠ CAUTION

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

The SERVOPACKs have the following three types of main circuit power supply input specifications.

- Three-Phase, 200-VAC Power Supply Input

Terminal Symbols	Terminal Name	Specifications and Reference
L1, L2, L3	Main circuit power supply input terminals for AC power supply input	Three-phase, 200 VAC to 240 VAC, -15% to +10%, 50 Hz/60 Hz
L1C, L2C	Control power supply terminals	Single-phase, 200 VAC to 240 VAC, -15% to +10%, 50 Hz/60 Hz
B1/⊕, B2, B3	Regenerative Resistor terminals	☞ *4.3.5 Wiring Regenerative Resistors* on page 4-20
		■ For SGD7S-R70A, -R90A, -1R6A, and -2R8A 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.
		■ For SGD7S-3R8A,- 5R5A, -7R6A, -120A, -180A, -200A, and -330A If the internal regenerative resistor is insufficient, remove the lead or short bar between B2 and B3 and connect an External Regenerative Resistor between B1/⊕ and B2. The External Regenerative Resistor is not included. Obtain it separately. ■ For SGD7S-470A, -550A, -590A, and -780A Connect a Regenerative Resistor Unit between B1/⊕ and B2. Obtain a Regenerative Resistor Unit separately.
⊖1, ⊖2	DC Reactor terminals for power supply harmonic suppression	☞ *4.3.6 Wiring DC Reactors* on page 4-22
		These terminals are used to connect a DC Reactor for power supply harmonic suppression or power factor improvement.
⊖	–	None. (Do not connect anything to this terminal.)

- Single-Phase, 200-VAC Power Supply Input

Terminal Symbols	Terminal Name	Specifications and Reference
L1, L2	Main circuit power supply input terminals for AC power supply input	Single-phase, 200 VAC to 240 VAC, -15% to +10%, 50 Hz/60 Hz
L1C, L2C	Control power supply terminals	Single-phase, 200 VAC to 240 VAC, -15% to +10%, 50 Hz/60 Hz

Continued on next page.

Continued from previous page.

Terminal Symbols	Terminal Name	Specifications and Reference
B1/⊕, B2, B3	Regenerative Resistor terminals	☞ *4.3.5 Wiring Regenerative Resistors* on page 4-20
		■ For SGD7S-R70A, -R90A, -1R6A, and -2R8A 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.
		■ For SGD7S-5R5A If the internal regenerative resistor is insufficient, remove the lead or short bar between B2 and B3 and connect an External Regenerative Resistor between B1/⊕ and B2. The External Regenerative Resistor is not included. Obtain it separately.
⊖1, ⊖2	DC Reactor terminals for power supply harmonic suppression	☞ *4.3.6 Wiring DC Reactors* on page 4-22 These terminals are used to connect a DC Reactor for power supply harmonic suppression or power factor improvement.
L3, ⊖	–	None. (Do not connect anything to these terminals.)

You can use a single-phase, 200-V power supply input with the following models.

- SGD7S-R70A, -R90A, -1R6A, -2R8A, -5R5A

If you use a single-phase, 200-VAC power supply input for the SERVOPACK'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). Refer to the following section for details.

☞ *5.2.2 Single-phase AC Power Supply Input/Three-phase AC Power Supply Input Setting* on page 5-13

- DC Power Supply Input

Terminal Symbols	Terminal Name	Specifications and Reference
L1C, L2C	Control power supply terminals	270 VDC to 324 VDC, -15% to +10%
B1/⊕	Main circuit power supply input terminals for DC power supply input	270 VDC to 324 VDC, -15% to +10%
⊖2		0 VDC
L1, L2, L3, B2, B3, ⊖1, ⊖	–	None. (Do not connect anything to these terminals.)

If you use a DC power supply input to the SERVOPACK, make sure to set parameter Pn001 to n.□1□□ (DC power supply input supported) before inputting the power supply. Refer to the following section for details.

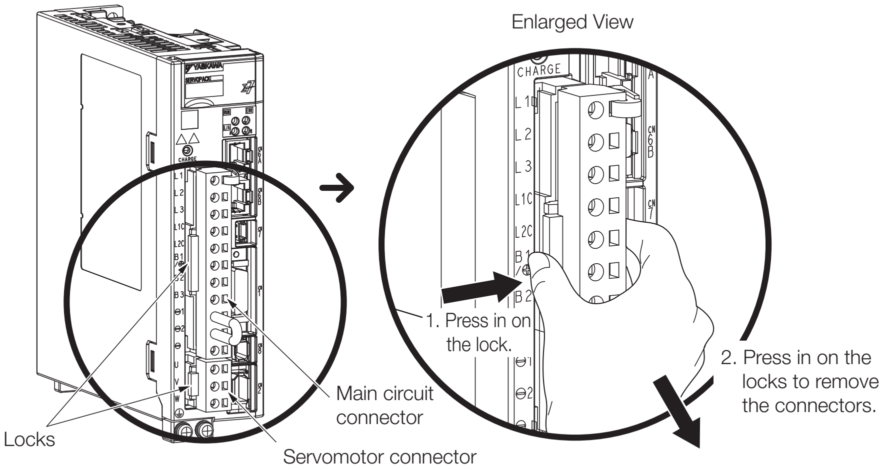
☞ *5.2.1 AC Power Supply Input/DC Power Supply Input Setting* on page 5-12

4.3.2 Wiring Procedure for Main Circuit Connector

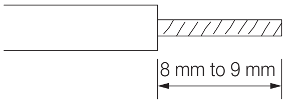
- Required Items

Required Item	Remarks
Spring Opener or Flat-blade Screwdriver	• Spring Opener SERVOPACK accessory (You can also use model 1981045-1 from Tyco Electronics Japan G.K.)
	• Flat-blade screwdriver Commercially available screwdriver with tip width of 3.0 mm to 3.5 mm

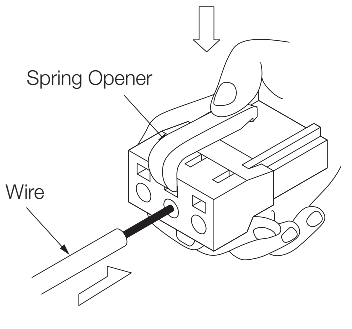
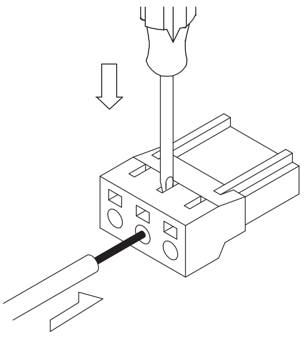
1. Remove the main circuit connector and motor connector from the SERVOPACK.



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.

①Using a Spring Opener	②Using 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 insertion hole. 

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

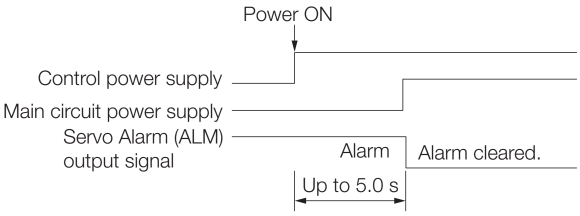
5. Make all other connections in the same way.

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

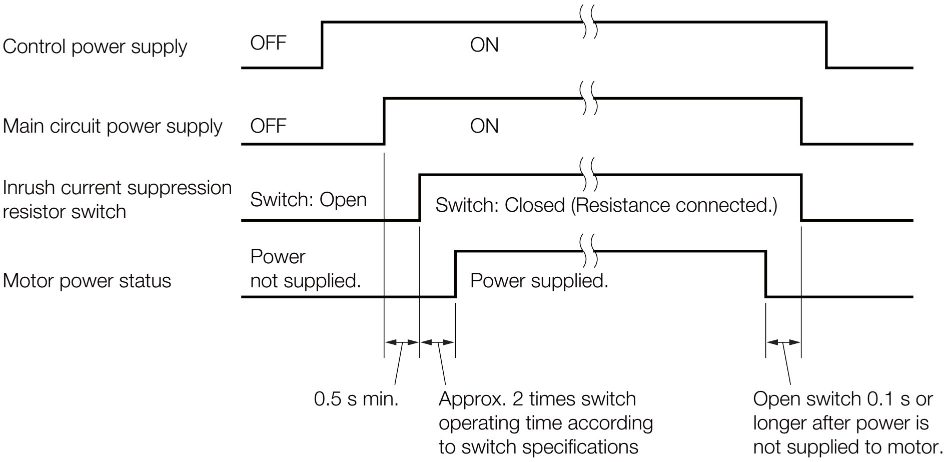
4.3.3 Power ON Sequence

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 SERVOPACK when the ALM signal is OFF (alarm cleared).



- If you use a DC power supply input with any of the following SERVOPACKs, use the power ON sequence shown below: SGD7S-330A, -470A, -550A, -590A, or -780A.



- Design the power ON sequence so that main circuit power supply is turned OFF when an ALM (Servo Alarm) signal is output.
- Make sure that the power supply specifications of all parts are suitable for the input power supply.
- Allow at least 100 ms after the power supply is turned OFF before you turn it ON again.

Important

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

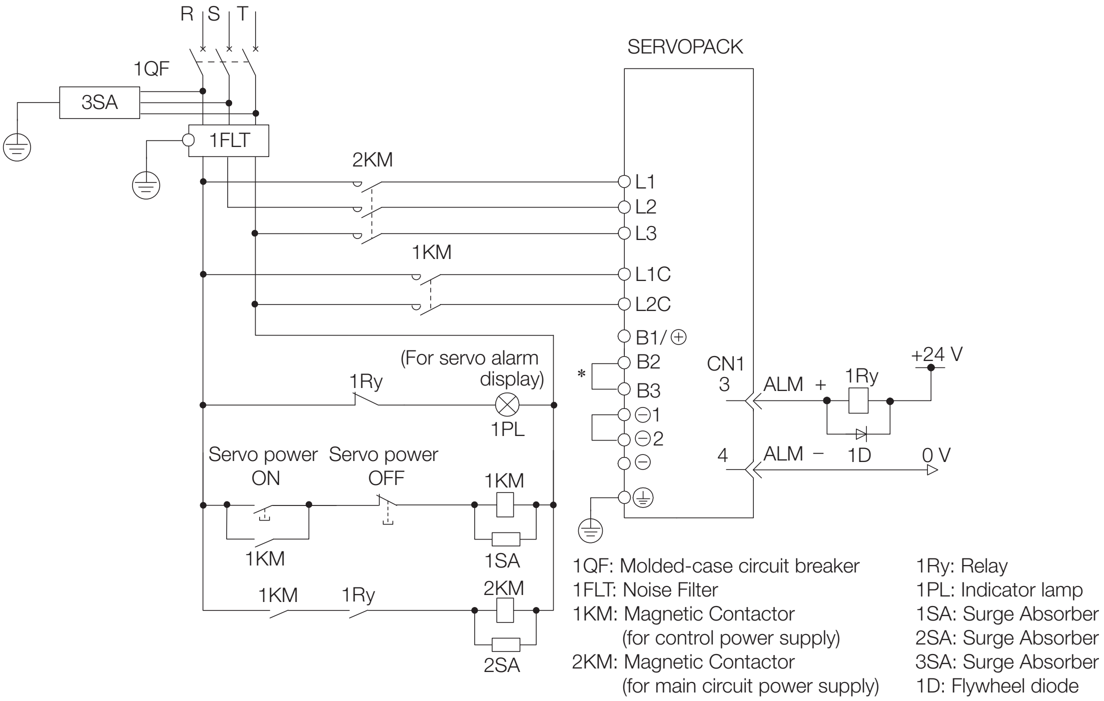
⚠ WARNING

- Even after you turn OFF the power supply, a high residual voltage may still remain in the SERVOPACK. 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.

4.3.4 Power Supply Wiring Diagrams

Using Only One SERVOPACK

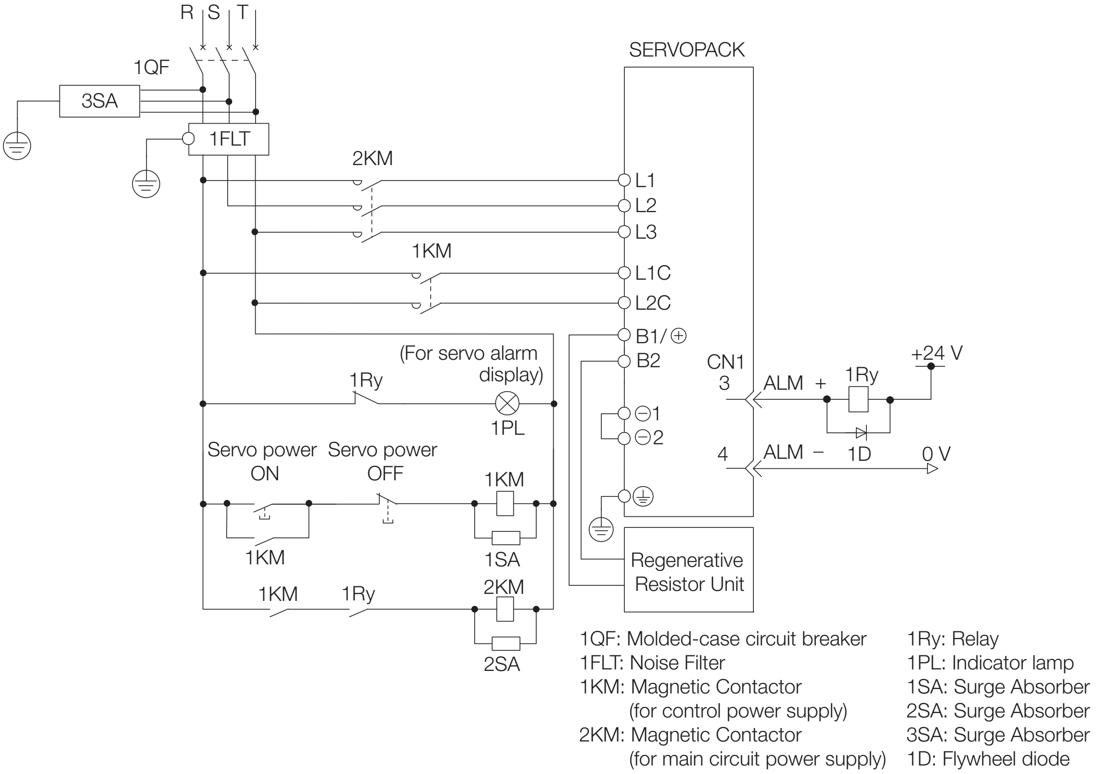
- Wiring Example for Three-Phase, 200-VAC Power Supply Input: SGD7S-R70A, -1R6A, -2R8A, -3R8A, -5R5A, -7R6A, -120A, -180A,-200A, and -330A



1QF: Molded-case circuit breaker
1FLT: Noise Filter
1KM: Magnetic Contactor (for control power supply)
2KM: Magnetic Contactor (for main circuit power supply)
1Ry: Relay
1PL: Indicator lamp
1SA: Surge Absorber
2SA: Surge Absorber
3SA: Surge Absorber
1D: Flywheel diode

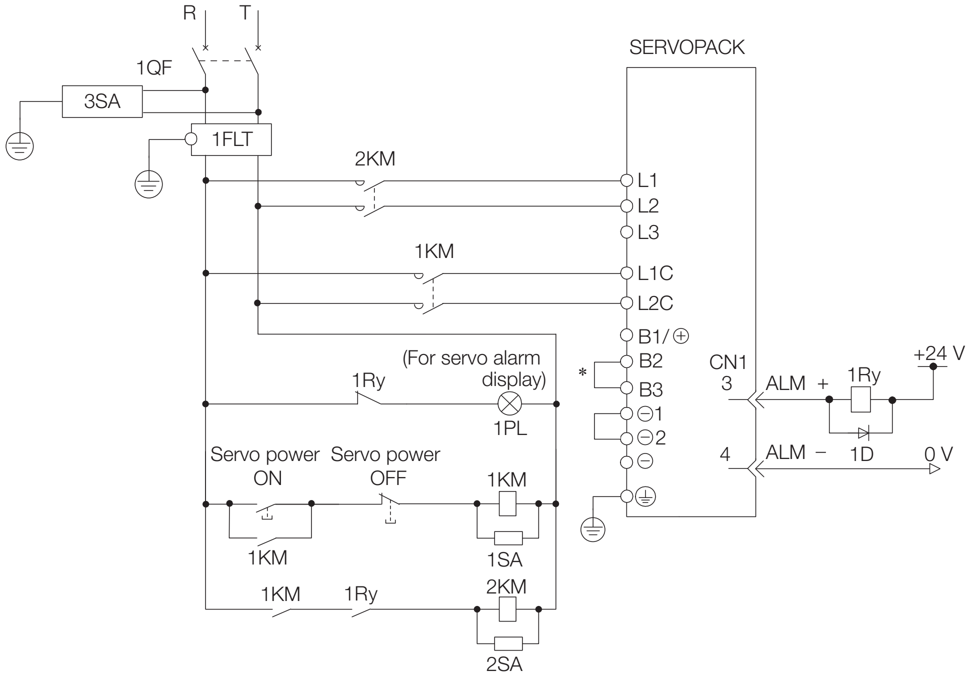
* You do not have to connect B2 and B3 for the following models: SGD7S-R70A, SGD7S-R90A, SGD7S-1R6A, and SGD7S-2R8A. Do not connect them.

- Wiring Example for Three-Phase, 200-VAC Power Supply Input: SGD7S-470A, -550A, -590A, and -780A



1QF: Molded-case circuit breaker
1FLT: Noise Filter
1KM: Magnetic Contactor (for control power supply)
2KM: Magnetic Contactor (for main circuit power supply)
1Ry: Relay
1PL: Indicator lamp
1SA: Surge Absorber
2SA: Surge Absorber
3SA: Surge Absorber
1D: Flywheel diode

- Wiring Example for Single-Phase, 200-VAC Power Supply Input

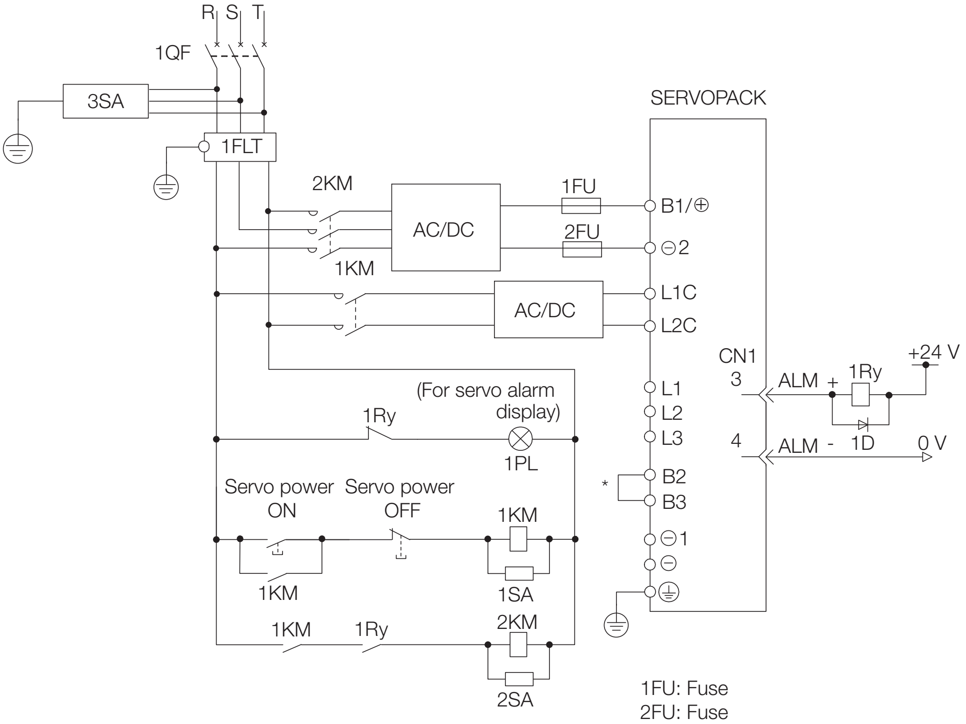


1QF: Molded-case circuit breaker
1FLT: Noise Filter
1KM: Magnetic Contactor
(for control power supply)
2KM: Magnetic Contactor
(for main circuit power supply)

1Ry: Relay
1PL: Indicator lamp
1SA: Surge Absorber
2SA: Surge Absorber
3SA: Surge Absorber
1D: Flywheel diode

* You do not have to connect B2 and B3 for the following models: SGD7S-R70A, SGD7S-R90A, SGD7S-1R6A, and SGD7S-2R8A. Do not connect them.

• Wiring Example for DC Power Supply Input: SGD7S-R70A, -1R6A, -2R8A, -3R8A, -5R5A, -7R6A, -120A, -180A, and -200A

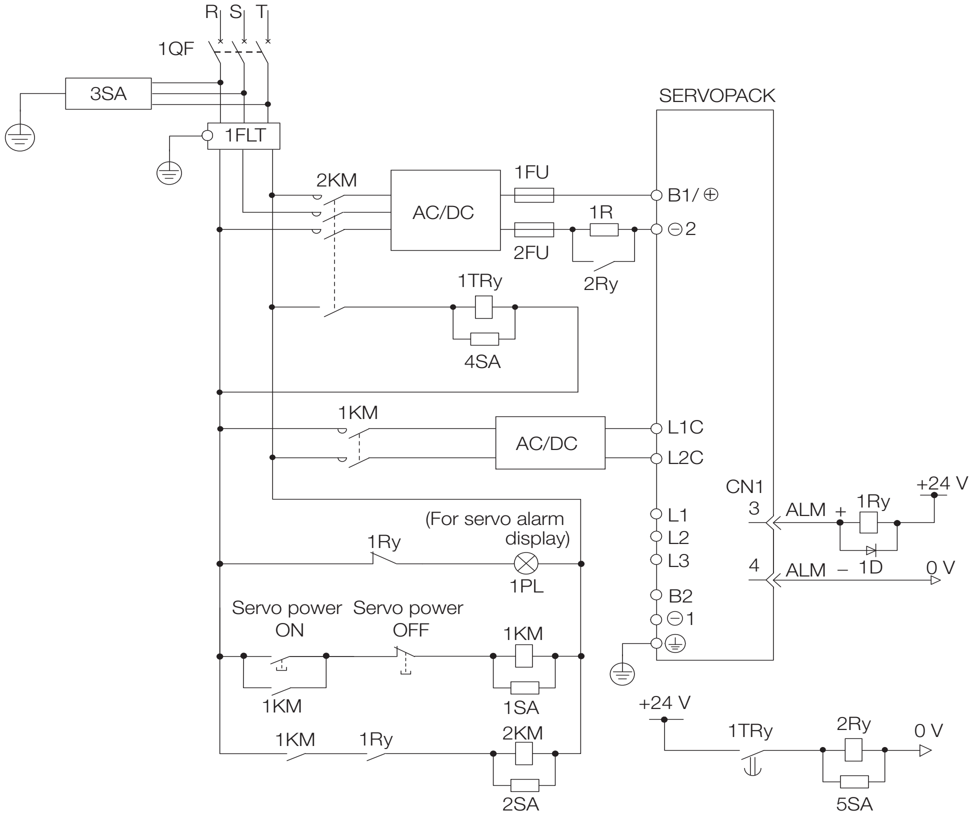


1QF: Molded-case circuit breaker
1FLT: Noise Filter
1KM: Magnetic Contactor
(for control power supply)
2KM: Magnetic Contactor
(for main circuit power supply)

1FU: Fuse
2FU: Fuse
1Ry: Relay
1PL: Indicator lamp
1SA: Surge Absorber
2SA: Surge Absorber
3SA: Surge Absorber
1D: Flywheel diode

* You do not have to connect B2 and B3 for the following models: SGD7S-R70A, SGD7S-R90A, SGD7S-1R6A, and SGD7S-2R8A. Do not connect them.

- Wiring Example for DC Power Supply Input: SGD7S-330A, -470A, -550A, -590A, and -780A



1QF: Molded-case circuit breaker
1FLT: Noise Filter
1KM: Magnetic Contactor
(for control power supply)
2KM: Magnetic Contactor
(for main circuit power supply, auxiliary contact)
1FU: Fuse, positive side
2FU: Fuse, negative side
1Ry: Relay
2Ry: Relay (for inrush current suppression resistor switch)
1TRy: Timer relay
1PL: Indicator lamp

1SA: Surge Absorber
2SA: Surge Absorber
3SA: Surge Absorber
4SA: Surge Absorber
5SA: Surge Absorber
1D: Flywheel diode
1R: External inrush current suppression resistor

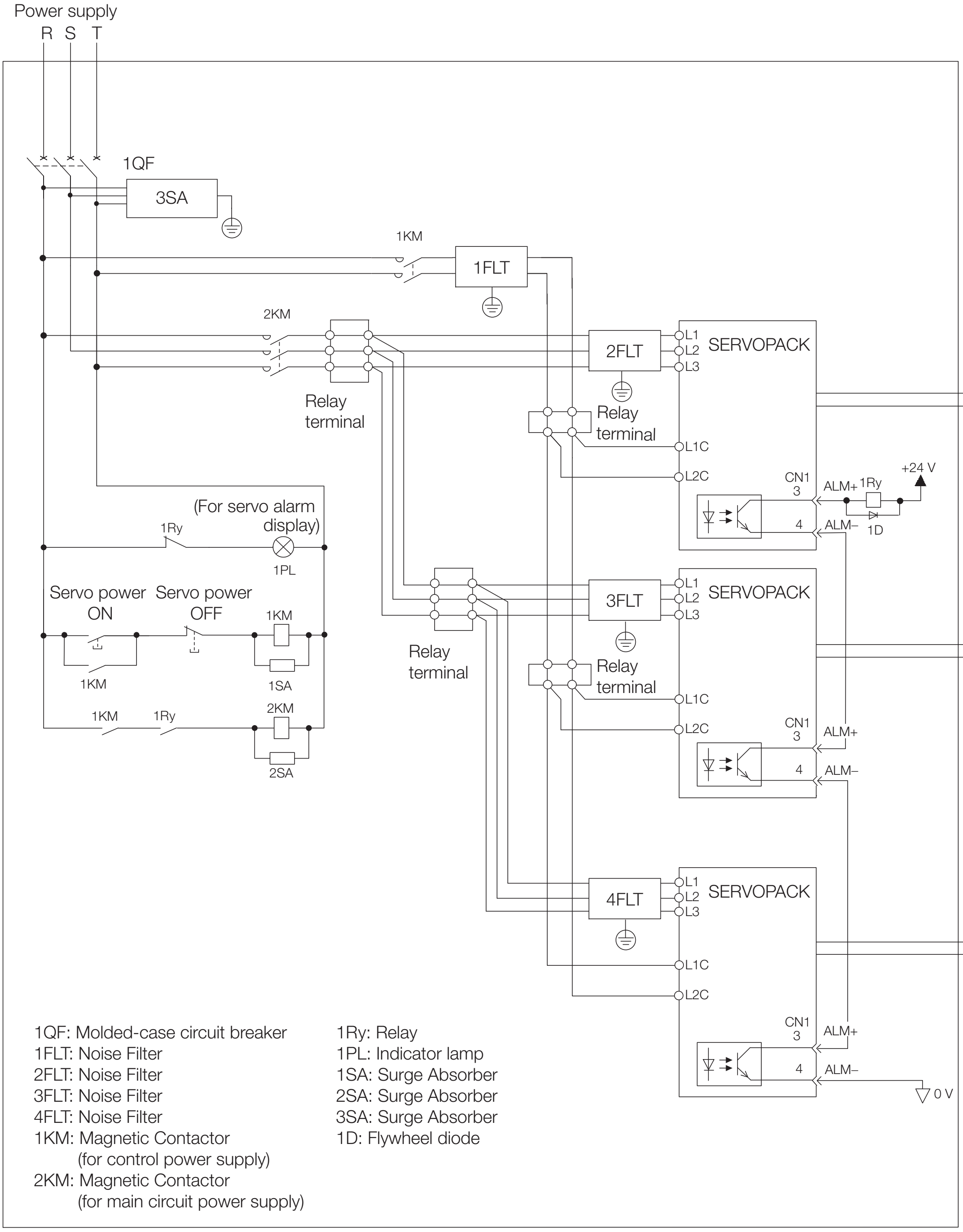
Using More Than One SERVOPACK

Connect the ALM (Servo Alarm) output for these SERVOPACKs in series to operate the alarm detection relay (1RY).

When a SERVOPACK alarm is activated, the ALM output signal transistor turns OFF.

The following diagram shows the wiring to stop all of the Servomotors when there is an alarm for any one SERVOPACK.

More than one SERVOPACK can share a single Noise Filter. However, always select a Noise Filter that has a large enough capacity to handle the total power supply capacity of all the SERVOPACKs. Be sure to consider the load conditions.



1QF: Molded-case circuit breaker
1FLT: Noise Filter
2FLT: Noise Filter
3FLT: Noise Filter
4FLT: Noise Filter
1KM: Magnetic Contactor
(for control power supply)
2KM: Magnetic Contactor
(for main circuit power supply)

1Ry: Relay
1PL: Indicator lamp
1SA: Surge Absorber
2SA: Surge Absorber
3SA: Surge Absorber
1D: Flywheel diode

4.3.5 Wiring Regenerative Resistors

This section describes how to connect External Regenerative Resistors.

Refer to the following manual to select External Regenerative Resistors.

📖 Σ-7-Series Peripheral Device Selection Manual (Manual No.: SIEP S800001 32)

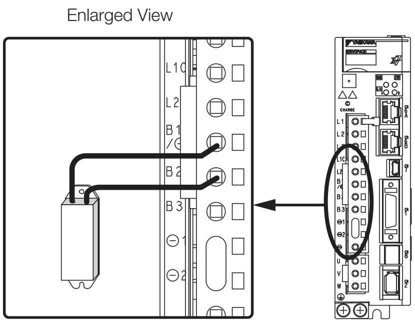
⚠ WARNING

- 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 SERVOPACK.

Connecting Regenerative Resistors

◆ SERVOPACK Models SGD7S-R70A, -R90A, -1R6A, and -2R8A

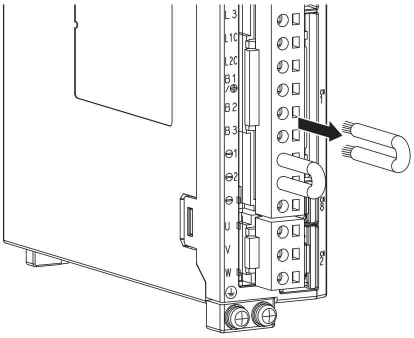
1. Connect the External Regenerative Resistor between the B1/⊕ and B2 terminals on the SERVOPACK.



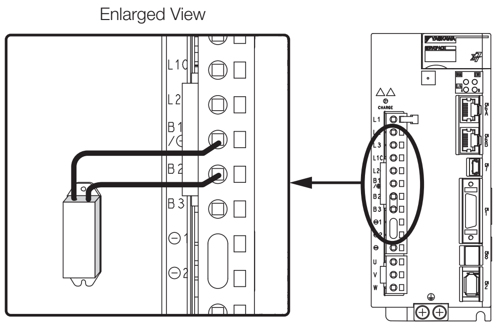
2. Set Pn600 (Regenerative Resistor Capacity) and Pn603 (Regenerative Resistor Resistance).
   Refer to the following section for details on the settings.
   ☞ *5.17 Setting the Regenerative Resistor Capacity* on page 5-55

◆ SERVOPACK Models SGD7S-3R8A, -5R5A, -7R6A, -120A, -180A, -200A, and -330A

1. Remove the lead from between the B2 and B3 terminals on the SERVOPACK.



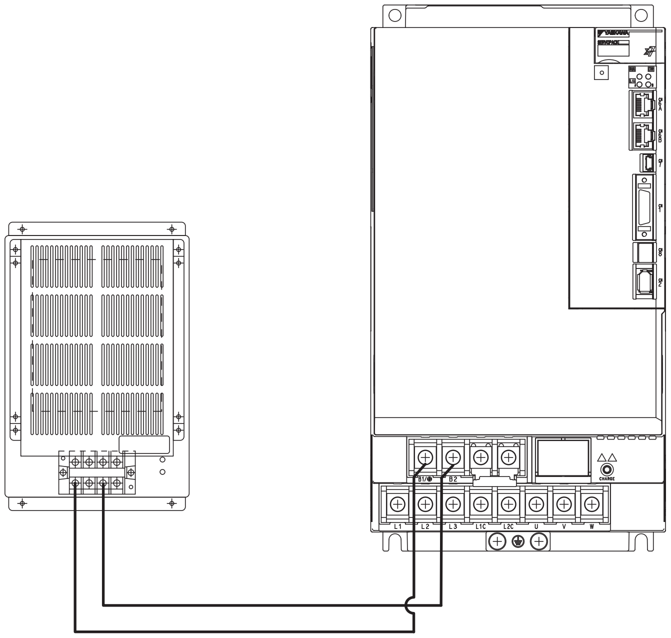
2. **Connect the External Regenerative Resistor between the B1/⊕ and B2 terminals.**



3. **Set Pn600 (Regenerative Resistor Capacity) and Pn603 (Regenerative Resistor Resistance).**
   Refer to the following section for details on the settings.
   ☞ *5.17 Setting the Regenerative Resistor Capacity* on page 5-55

◆ SERVOPACK Models SGD7S-470A, -550A, -590A, and -780A

1. **Connect the R1 and R2 terminals on the Regenerative Resistor Unit to the B1/⊕ and B2 terminals on the SERVOPACK.**

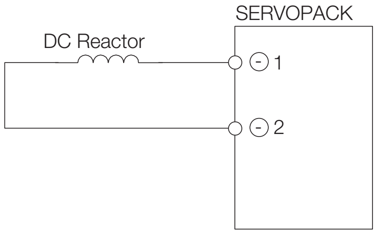


2. **Set Pn600 (Regenerative Resistor Capacity) and Pn603 (Regenerative Resistor Resistance) as required.**
   - When using the Yaskawa-recommended Regenerative Resistor Unit, use the default settings for Pn600 and Pn603.
   - If you use any other external regenerative resistor, set Pn600 and Pn603 according to the specifications of the regenerative resistor.

   Refer to the following section for details on the settings.
   ☞ ***5.17 Setting the Regenerative Resistor Capacity*** on page 5-55

4.3.6 Wiring DC Reactors

You can connect a DC Reactor to the SERVOPACK when power supply harmonic suppression is required. Connection terminals ⊖1 and ⊖2 for a DC Reactor are connected when the SERVOPACK is shipped. Remove the lead wire and connect a DC Reactor as shown in the following diagram.



4.4 Wiring Servomotors

4.4.1 Terminal Symbols and Terminal Names

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

Terminal/Connector Symbols	Terminal/Connector Name	Remarks
U, V, and W	Servomotor terminals	Refer to the following section for the wiring procedure. ☞ *4.3.2 Wiring Procedure for Main Circuit Connector* on page 4-13
⏚	Ground terminal	–
CN2	Encoder connector	–

4.4.2 Pin Arrangement of Encoder Connector (CN2)

- When Using a Rotary Servomotor

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

* You do not need to wire these pins for an incremental encoder.

- When Using a Direct Drive Servomotor

Pin No.	Signal	Function
1	PG5V	Encoder power supply +5 V
2	PG0V	Encoder power supply 0 V
3	–	– (Do not use.)
4	–	– (Do not use.)
5	PS	Serial data (+)
6	/PS	Serial data (-)
Shell	Shield	–

- When Using a Linear Servomotor

Pin No.	Signal	Function
1	PG5V	Linear encoder power supply +5 V
2	PG0V	Linear encoder power supply 0 V
3	–	– (Do not use.)
4	–	– (Do not use.)
5	PS	Serial data (+)
6	/PS	Serial data (-)
Shell	Shield	–

4.4.3 Wiring the SERVOPACK to the Encoder

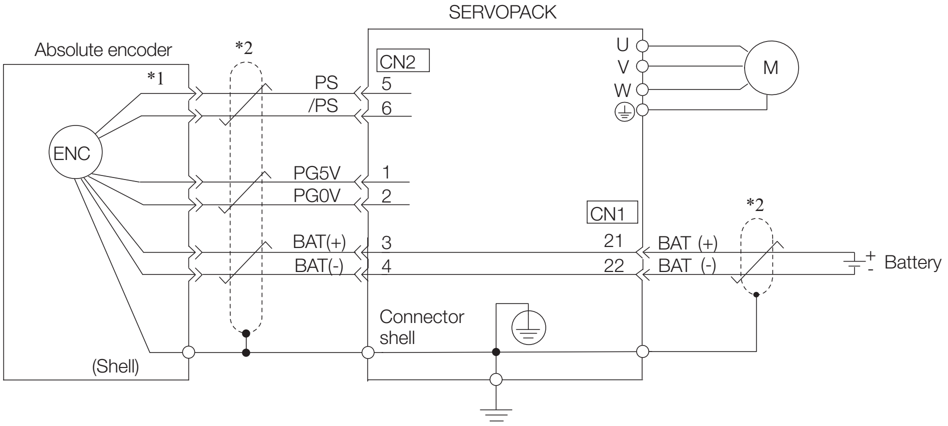
When Using an Absolute Encoder

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.

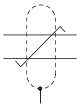
Refer to the following section for the battery replacement procedure.

☞ *15.1.3 Replacing the Battery* on page 15-3

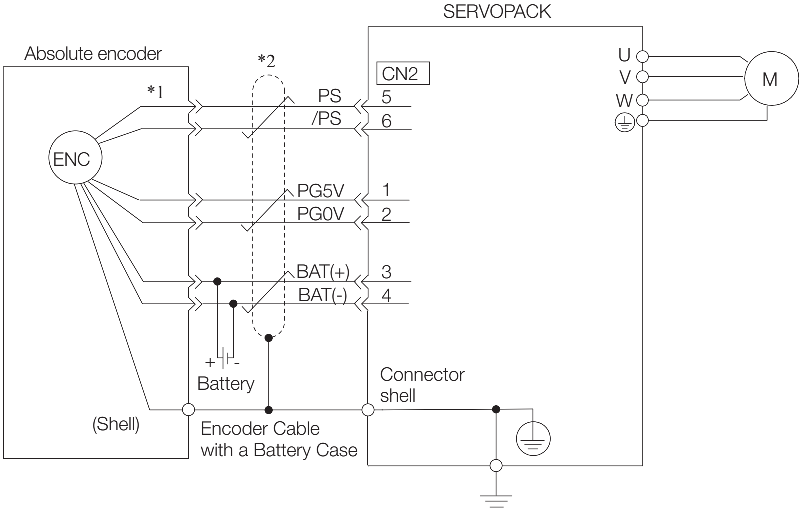
- Wiring Example When Installing a Battery on the Host Controller



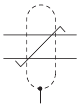
*1. The absolute encoder pin numbers for wiring the connector depend on the Servomotor that you use.

*2.  represents a shielded twisted-pair cable.

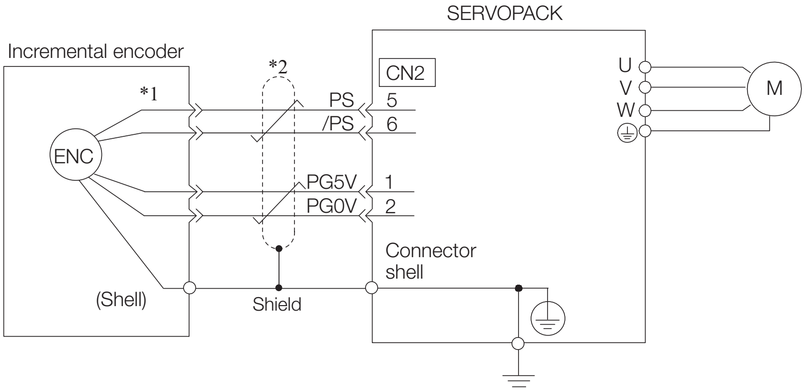
- Wiring Example When Using an Encoder Cable with a Battery Case



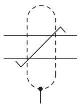
*1. The absolute encoder pin numbers for wiring the connector depend on the Servomotor that you use.

*2.  represents a shielded twisted-pair cable.

When Using an Incremental Encoder



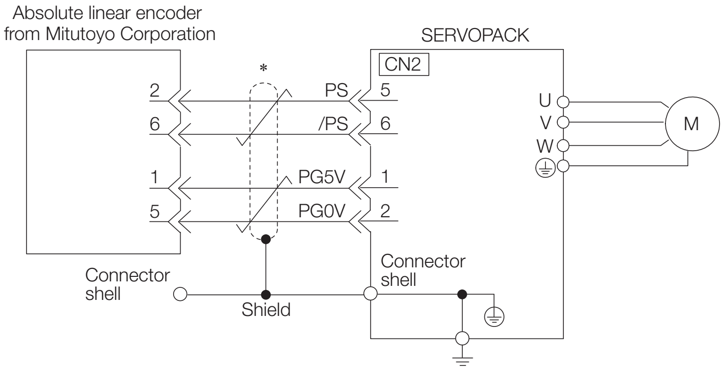
*1. The incremental encoder pin numbers for wiring the connector depend on the Servomotor that you use.

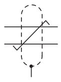
*2.  represents a shielded twisted-pair cable.

When Using an Absolute Linear Encoder

The wiring depends on the manufacturer of the linear encoder.

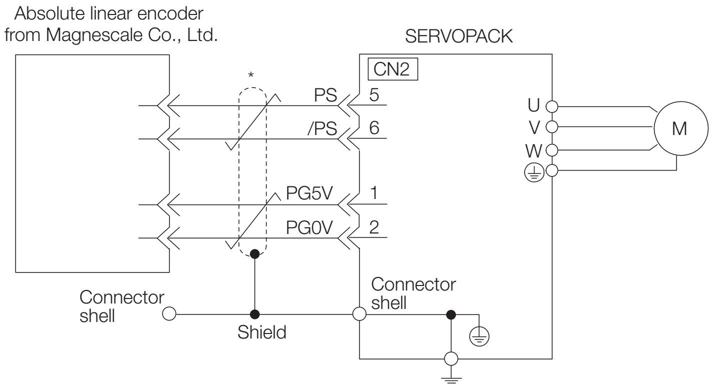
◆ Connections to Linear Encoder from Mitutoyo Corporation

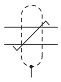


*  represents a shielded twisted-pair cable.

◆ Connections to Absolute Linear Encoder from Magnescale Co., Ltd.

■ SR77 and SR87

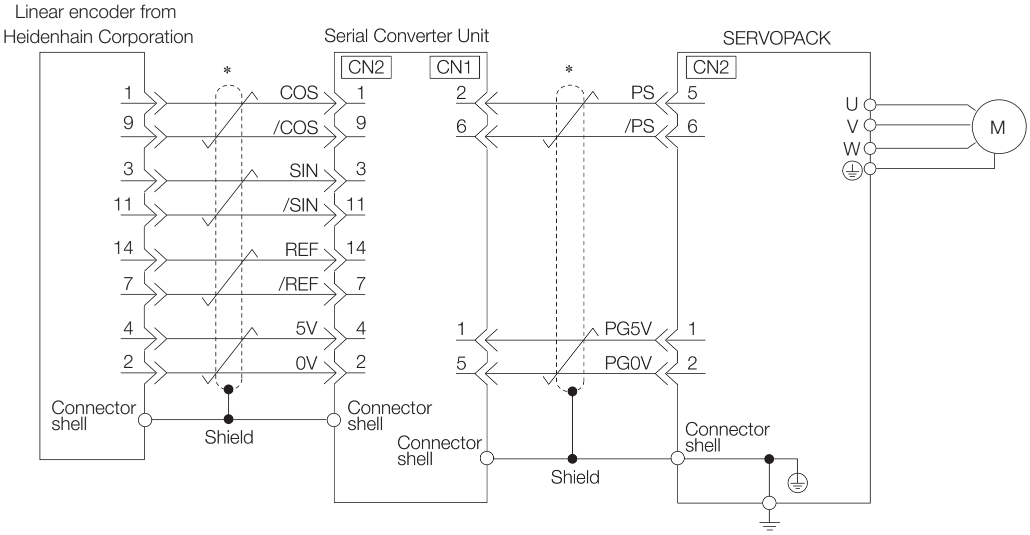


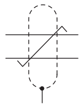
*  represents a shielded twisted-pair cable.

When Using an Incremental Linear Encoder

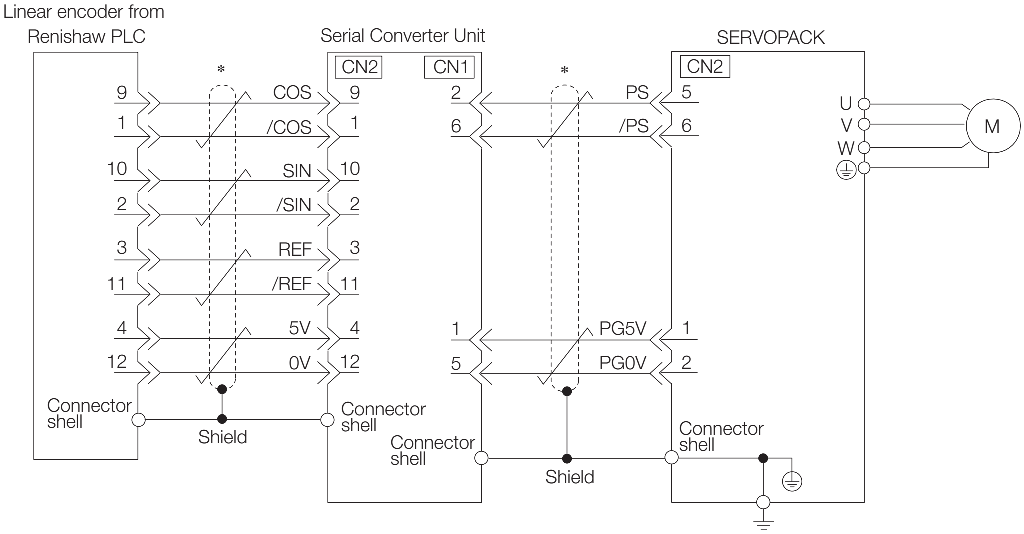
The wiring depends on the manufacturer of the linear encoder.

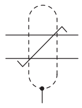
◆ Connections to Linear Encoder from Heidenhain Corporation



 represents a shielded twisted-pair cable.

◆ Connections to Linear Encoder from Renishaw PLC

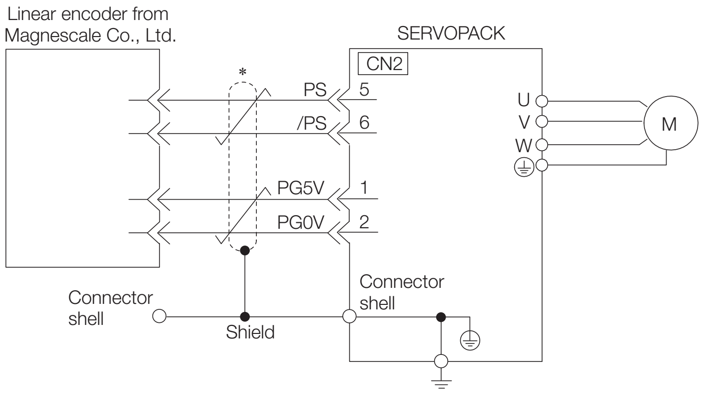


 represents a shielded twisted-pair cable.

◆ Connections to Linear Encoder from Magnescale Co., Ltd.

If you use a linear encoder from Magnescale Co., Ltd., the wiring will depend on the model of the linear encoder.

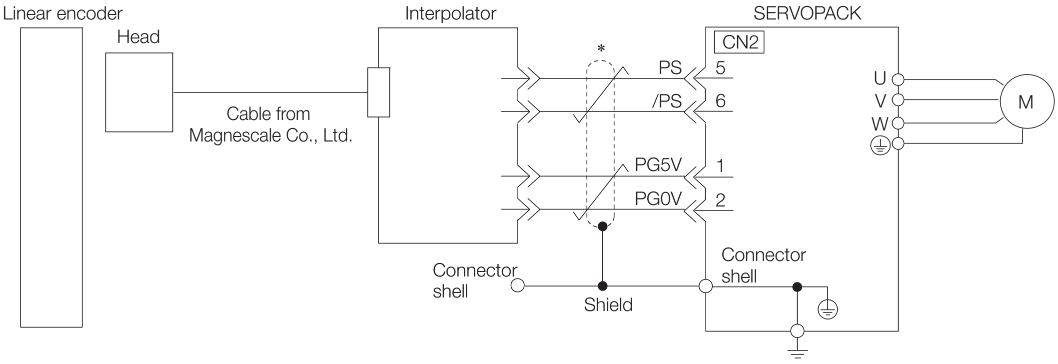
■ SR75 and SR85



* represents a shielded twisted-pair cable.

■ SL700, SL710, SL720, and SL730

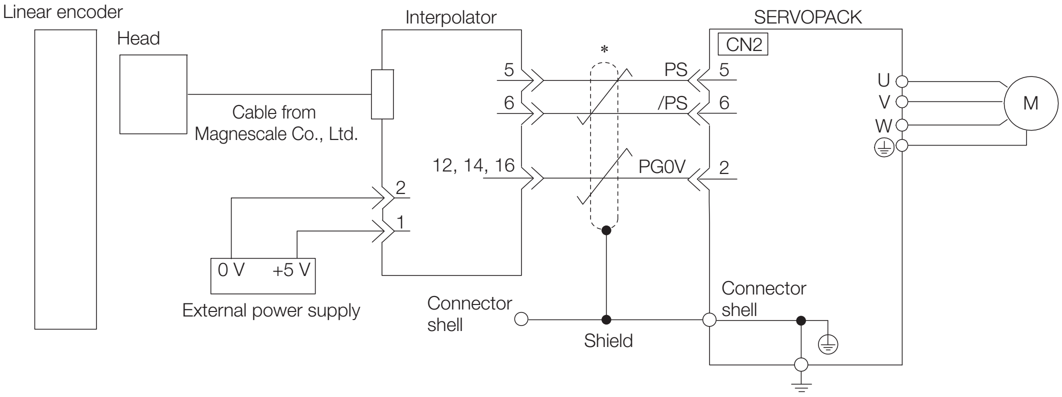
- PL101-RY Head with Interpolator



* represents a shielded twisted-pair cable.

■ SL700, SL710, SL720, and SL730

- MJ620-T13 Interpolator



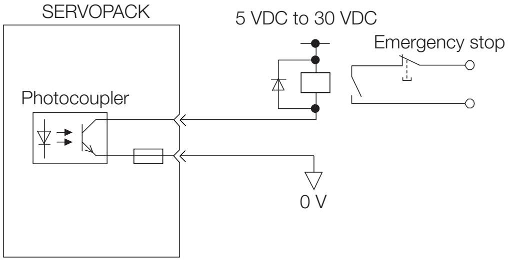
* represents a shielded twisted-pair cable.

4.4.4 Wiring the SERVOPACK to the Holding Brake

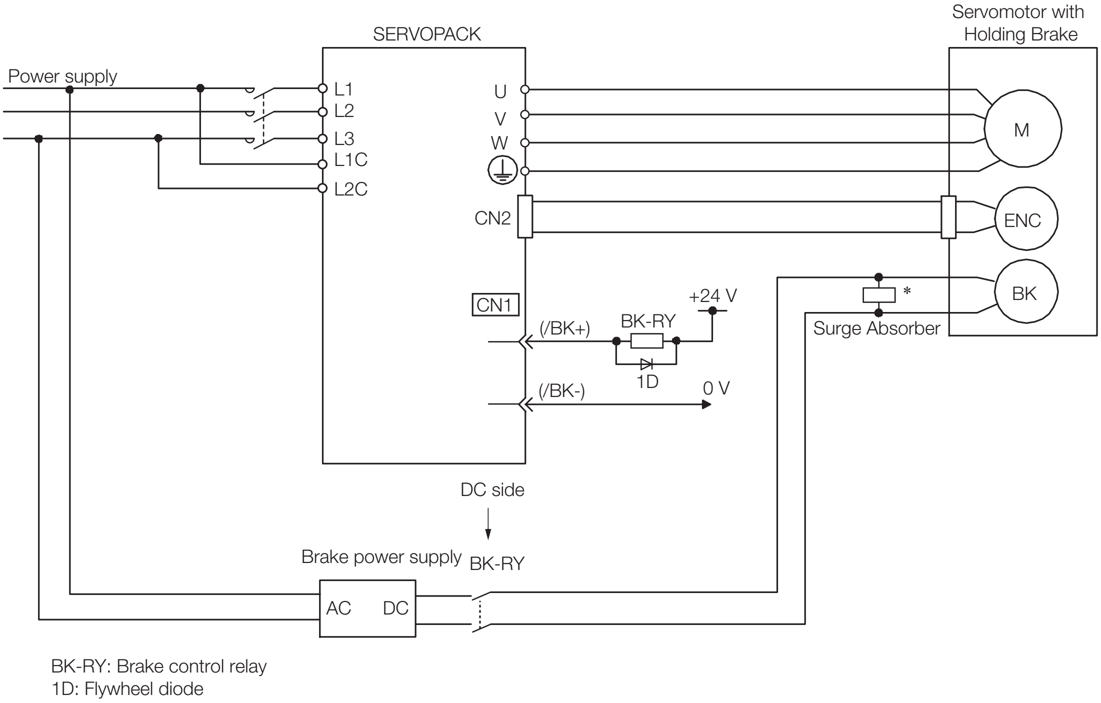
Important

- 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.
  ☞ Σ-7-Series Peripheral Device Selection Manual (Manual No.: SIEP S800001 32)
- After the Surge Absorber is connected, check the time required to brake in your application. The Surge Absorber may affect the time required to brake.
  Configure the relay circuit to activate the holding brake for an emergency stop.

Relay Circuit Example



- You can change the output signal allocation of the /BK signal. Refer to the following section for details.
  ☞ ***Allocating the /BK (Brake) Signal*** on page 5-34
- 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.



* Install the surge absorber near the brake terminals on the Servomotor.

4.5 I/O Signal Connections

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

The following table gives the pin numbers, names, and functions the I/O signal pins for the default settings.

Input Signals

Default settings are given in parentheses.

Signal	Pin No.	Name	Function	Reference
/SI1* (P-OT)	7	General-purpose Sequence Input 1 (Forward Drive Prohibit Input)	You can allocate the input signal to use with a parameter. (Stops Servomotor drive (to prevent overtravel) when the moving part of the machine exceeds the range of movement.)	page 5-27
/SI2* (N-OT)	8	General-purpose Sequence Input 2 (Reverse Drive Prohibit Input)		
/SI3*	9	General-purpose Sequence Input 3	You can allocate the input signal to use with parameters. (Used for general-purpose input.)	–
/SI4* (/Probe1)	10	General-purpose Sequence Input 4 (Probe 1 Latch Input)	You can allocate the input signals to use with parameters. (Connect the external signals that latch the current feedback pulse counter.)	–
/SI5* (/Probe2)	11	General-purpose Sequence Input 5 (Probe 2 Latch Input)		
/SI6* (/Home)	12	General-purpose Sequence Input 6 (Home Switch Input)	You can allocate the input signal to use with parameters. (Connect the switch that starts homing.)	
/SI0*	13	General-purpose Sequence Input 0	You can allocate the input signal to use with a parameter. (Used for general-purpose input.)	–
+24VIN	6	Sequence Input Signal Power Supply Input	Inputs the sequence input signal power supply. Allowable voltage range: 24 VDC ±20% The 24-VDC power supply is not provided by Yaskawa.	–
BAT+	14	Battery for Absolute Encoder (+)	These are the pins to connect the absolute encoder backup battery. Do not connect these pins if you use the Encoder Cable with a Battery Case.	–
BAT-	15	Battery for Absolute Encoder (-)		
TH	5	Linear Servomotor Overheat Protection Input	Inputs the overheat protection signal from a Linear Servomotor.	–

* You can change the allocations. Refer to the following section for details.
☞ *6.1.1 Input Signal Allocations* on page 6-3

Note: If forward drive prohibition or reverse drive prohibition is used, the SERVOPACK is stopped by software controls. If the application does not satisfy the safety requirements, add external safety circuits as required.

Output Signals

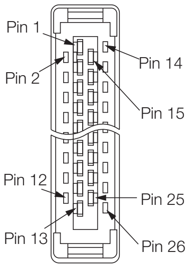
Default settings are given in parentheses.

Signal	Pin No.	Name	Function	Reference
ALM+	3	Servo Alarm Output	Turns OFF (opens) when an error is detected.	page 6-6
ALM-	4			
/SO1+* (/BK+)	1	General-purpose Sequence Output 1 (Brake Output)	You can allocate the output signal to use with a parameter. (Controls the brake. The brake is released when the signal turns ON (closes).)	page 5-32
/SO1-* (/BK-)	2			
/SO2+*	23	General-purpose Sequence Output 2	Used for general-purpose outputs. Set the parameters to allocate functions.	page 14-47
/SO2-*	24			
/SO3+*	25	General-purpose Sequence Output 3		
/SO3-*	26			
PAO	17	Encoder Divided Pulse Output, Phase A	Output the encoder divided pulse output signals with a 90° phase differential.	page 6-30 page 6-39
/PAO	18			
PBO	19	Encoder Divided Pulse Output, Phase B		
/PBO	20			
PCO	21	Encoder Divided Pulse Output, Phase C	Outputs the origin signal once every encoder rotation.	
/PCO	22			
SG	16	Signal ground	This is the 0-V signal for the control circuits.	–
FG	Shell	Frame ground	Connected to the frame ground if the shield of the I/O Signal Cable is connected to the connector shell.	–

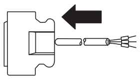
* You can change the allocations. Refer to the following section for details.
☞ *6.1.2 Output Signal Allocations* on page 6-4

4.5.2 I/O Signal Connector (CN1) Pin Arrangement

The following figure gives the pin arrangement of the of the I/O signal connector (CN1) for the default settings.



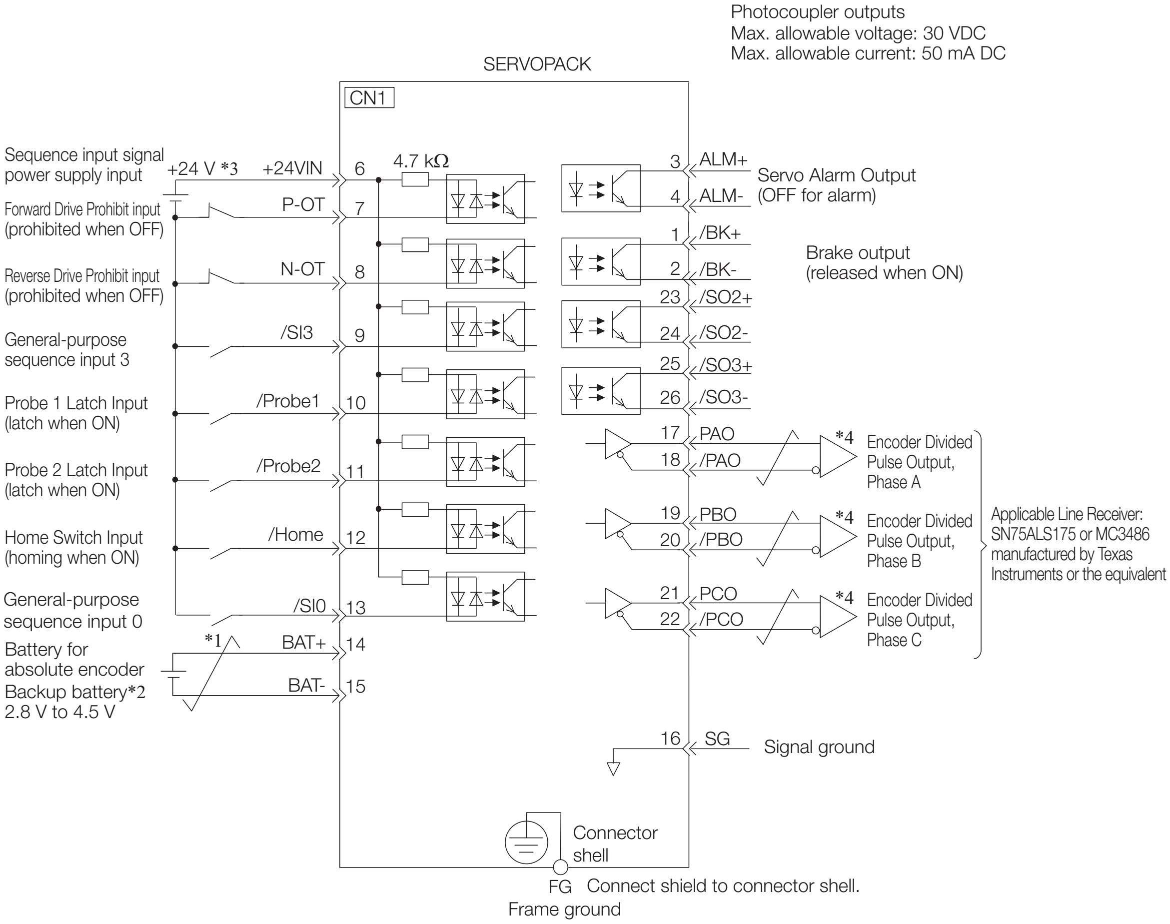
The above view is from the direction of the following arrow without the connector shell attached.



2	/SO1- (/BK-)	General-purpose Sequence Output 1	1	/SO1+ (/BK+)	General-purpose Sequence Output 1	15	BAT-	Battery for Absolute Encoder (-)	14	BAT+	Battery for Absolute Encoder (+)
4	ALM-	Servo Alarm Output	3	ALM+	Servo Alarm Output	17	PAO	Encoder Divided Pulse Output, Phase A	16	SG	Signal Ground
6	+24VIN	Sequence Input Signal Power Supply Input	5	TH	Linear Servomotor Overheat Protection Input	19	PBO	Encoder Divided Pulse Output, Phase B	18	/PAO	Encoder Divided Pulse Output, Phase A
8	/SI2 (N-OT)	General-purpose Sequence Input 2	7	/SI1 (P-OT)	General-purpose Sequence Input 1	21	PCO	Encoder Divided Pulse Output, Phase C	20	/PBO	Encoder Divided Pulse Output, Phase B
10	/SI4 (/Probe1)	General-purpose Sequence Input 4	9	/SI3 (/DEC)	General-purpose Sequence Input 3	23	/SO2+	General-purpose Sequence Output 2	22	/PCO	Encoder Divided Pulse Output, Phase C
12	/SI6 (/Home)	General-purpose Sequence Input 6	11	/SI5 (/Probe2)	General-purpose Sequence Input 5	25	/SO3+	General-purpose Sequence Output 3	24	/SO2-	General-purpose Sequence Output 2
			13	/SI0	General-purpose Sequence Input 0				26	/SO3-	General-purpose Sequence Output 3

4.5.3 I/O Signal Wiring Examples

Using a Rotary Servomotor



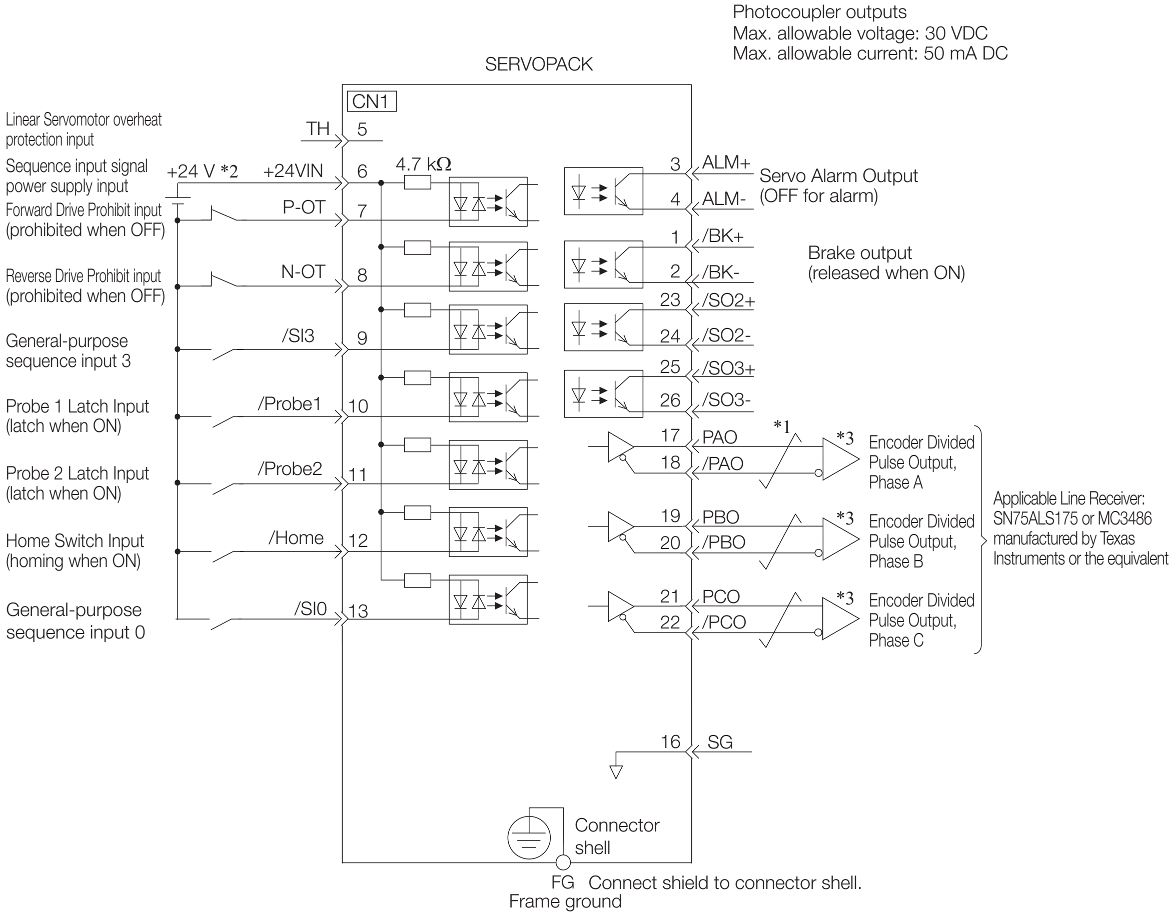
*1. represents twisted-pair wires.
*2. Connect these when using an absolute encoder. If the Encoder Cable with a Battery Case is connected, do not connect a backup battery.
*3. The 24-VDC power supply is not provided by Yaskawa. Use a 24-VDC power supply with double insulation or reinforced insulation.
*4. Always use line receivers to receive the output signals.

Note: 1. You can use parameters to change the functions allocated to the /SI0, /SI3, P-OT, N-OT, /Probe1, /Probe2, and /Home input signals and the /SO1, /SO2, and /SO3 output signals.

☞ *6.1 I/O Signal Allocations* on page 6-3

2. 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.

Using a Linear Servomotor



*1. represents twisted-pair wires.

*2. The 24-VDC power supply is not provided by Yaskawa. Use a 24-VDC power supply with double insulation or reinforced insulation.

*3. Always use line receivers to receive the output signals.

Note: 1. You can use parameters to change the functions allocated to the /SI0, /SI3, P-OT, N-OT, /Probe1, /Probe2, and /Home input signals and the /SO1, /SO2, and /SO3 output signals.
☞ *6.1 I/O Signal Allocations* on page 6-3

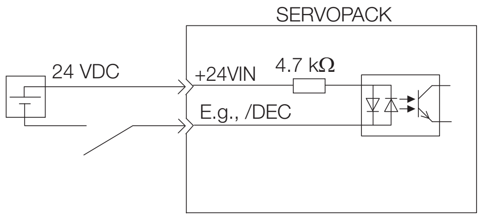
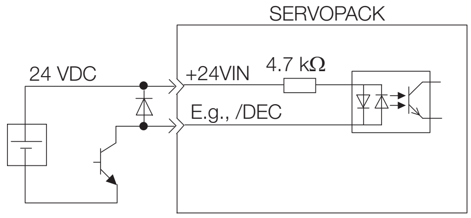
2. If you use a 24-V brake, install a separate power supply for the 24-VDC power supply from other power supplies, such as the one for the I/O signals of the CN1 connector.
If the power supply is shared, the I/O signals may malfunction.

4.5.4 I/O Circuits

Sequence Input Circuits

◆ Photocoupler Input Circuits

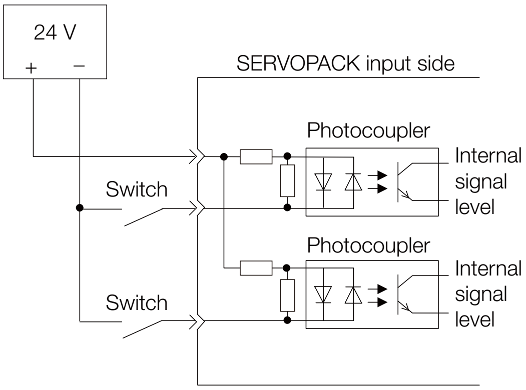
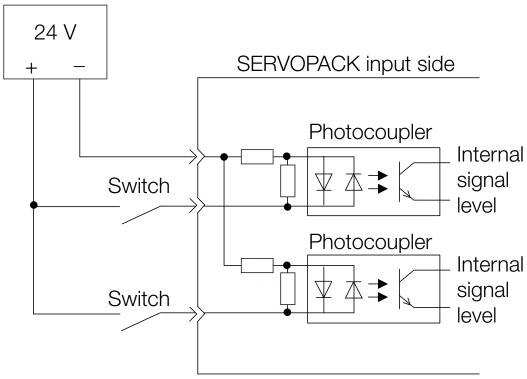
This section describes CN1 connector terminals 6 to 13.

Examples for Relay Circuits	Examples for Open-Collector Circuits
	

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

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

Note: The connection examples in *4.5.3 I/O Signal Wiring Examples* on page 4-32 are for sink circuit connections.

Sink Circuits	Source Circuits
	

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

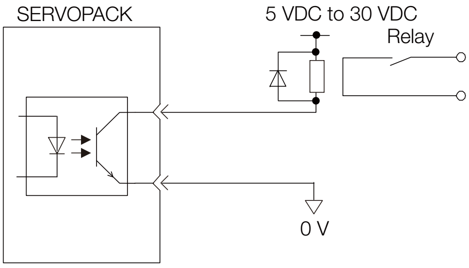
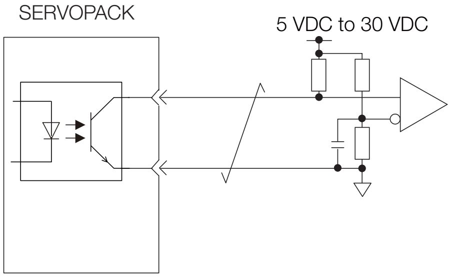
Sequence Output Circuits

Important

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.

◆ Photocoupler Output Circuits

Photocoupler output circuits are used for the ALM (Servo Alarm), /S-RDY (Servo Ready), and other sequence output signals. Connect a photocoupler output circuit to a relay or line-receiver circuit.

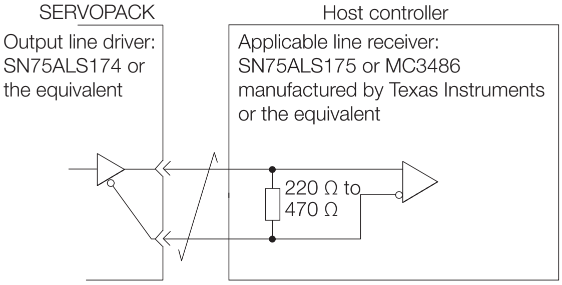
Example for Relay Circuit	Example for Line-Receiver Circuit
	

Note: The maximum allowable voltage and current range for photocoupler output circuits are as follows:
- Maximum allowable voltage: 30 VDC
- Current range: 5 mA to 50 mA DC

◆ Line-Driver Output Circuits

This section describes CN1 connector terminals 17-18 (Phase-A Signal), 19-20 (Phase-B Signal), and 21-22 (Phase-C 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) and origin pulse signal (PCO and /PCO) 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 Connecting Safety Function Signals

This section describes the wiring required to use a safety function.

Refer to the following chapter for details on the safety function.

☞ *Chapter 11 Safety Functions*

4.6.1 Pin Arrangement of Safety Function Signals (CN8)

Pin No.	Signal	Name	Function
1	–	- (Do not use these pins because they are connected to internal circuits.)	
2	–		
3	/HWBB1-	Hard Wire Base Block Input 1	For a hard wire base block input. The base block (motor power turned OFF) is in effect when the signal is OFF.
4	/HWBB1+		
5	/HWBB2-	Hard Wire Base Block Input 2	
6	/HWBB2+		
7	EDM1-	External Device Monitor Output	Turns ON when the /HWBB1 and the /HWBB2 signals are input and the SERVOPACK enters a base block state.
8	EDM1+		

4.6.2 I/O Circuits

Important

For safety function signal connections, the input signal is the 0-V common and the output signal is a source output. This is opposite to other signals described in this manual.
To avoid confusion, the ON and OFF status of signals for the safety function are defined as follows:

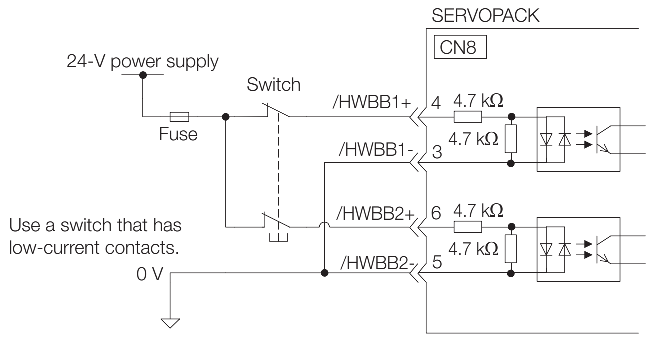
ON: The state in which the relay contacts are closed or the transistor is ON and current flows into the signal line.

OFF: The state in which the relay contacts are open or the transistor is OFF and no current flows into the signal line.

Safety Input Circuits

Use a 0-V common to connect the safety function signals. You must connect redundant input signals.

Input Signal Connection Example



◆ Input (HWBB) Signal Specifications

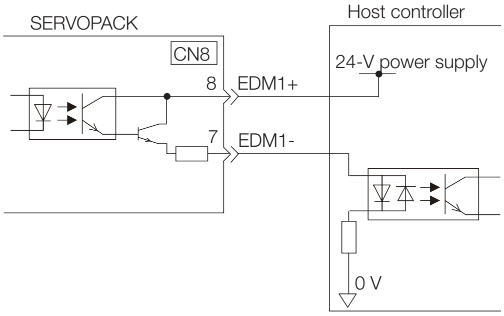
Type	Signal	Connector Pin No.	Status	Meaning
Inputs	/HWBB1	CN8-4 CN8-3	ON (closed)	Does not activate the HWBB (normal operation).
			OFF (open)	Activates the HWBB (motor current shut-OFF request).
	/HWBB2	CN8-6 CN8-5	ON (closed)	Does not activate the HWBB (normal operation).
			OFF (open)	Activates the HWBB (motor current shut-OFF request).

The input (HWBB) signals have the following electrical characteristics.

Item	Characteristics	Remarks
Internal Impedance	4.7 kΩ	–
Operating Voltage Range	+24 V ±20%	–
Maximum Delay Time	8 ms	Time from /HWBB1 and /HWBB2 signals turning OFF until HWBB is activated

Diagnostic Output Circuits

The EDM1 output signal uses a source circuit. The following figure shows a connection example.



◆ EDM1 Output Signal Specifications

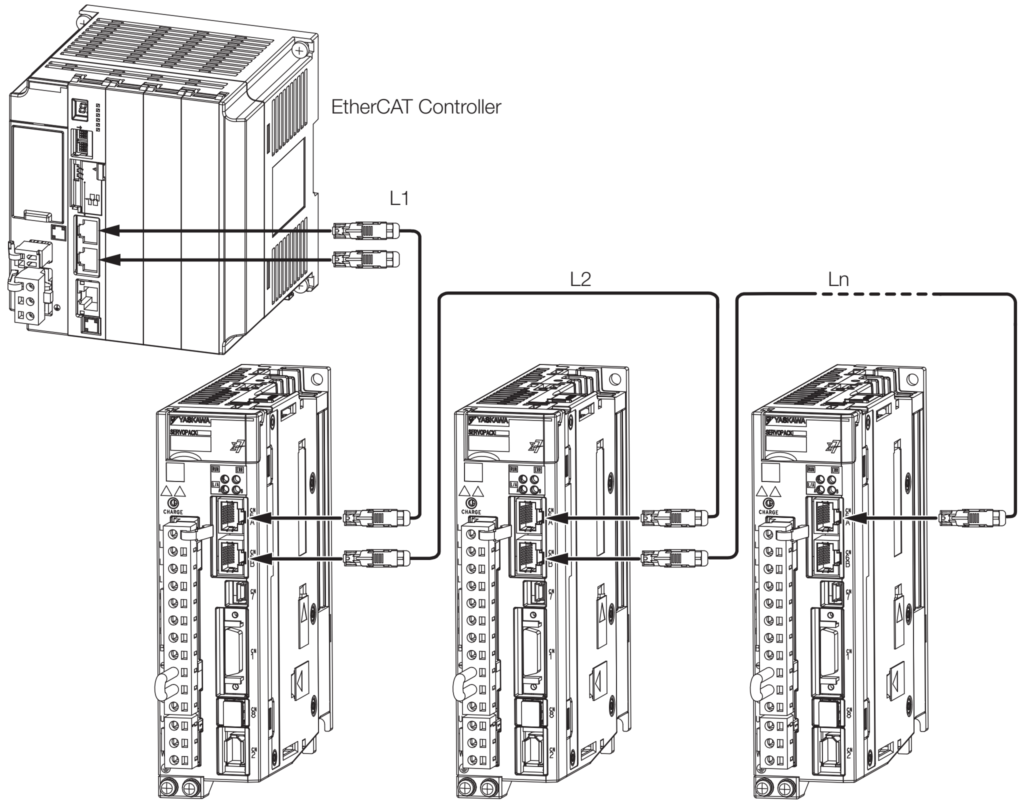
Type	Signal	Pin No.	Output Status	Meaning
Output	EDM1	CN8-8 CN8-7	ON	Both the /HWBB1 and /HWBB2 signals are operating normally.
			OFF	The /HWBB1 signal, the /HWBB2 signal, or both are not operating.

The electrical characteristics of the EDM1 signal are as follows:

Item	Characteristics	Remarks
Maximum Allowable Voltage	30 VDC	–
Maximum Allowable Current	50 mA DC	–
Maximum ON Voltage Drop	1.0 V	Voltage between EDM1+ and EDM1- when current is 50 mA
Maximum Delay Time	8 ms	Time from a change in /HWBB1 or /HWBB2 until a change in EDM1

4.7 Connecting EtherCAT Communications Cables

Connect the EtherCAT Communications Cables to the CN6A and CN6B connectors.



Note: The length of the cable between stations (L1, L2, ... Ln) must be 50 m or less.

4.7.1 EtherCAT Connectors (RJ45)

Connector	Description
CN6A	EtherCAT input signals
CN6B	EtherCAT output signals

■ Connector Pin Assignments

Pin	Signal	Remarks
1	TD+	Send data
2	TD–	
3	RD+	Receive data
4	–	N.C.*
5	–	N.C.*
6	RD–	Receive data
7	–	N.C.*
8	–	N.C.*

* These pins are not connected to any signals.

4.7.2 Ethernet Communications Cables

Use Category 5e Ethernet communications cables to make the connections.

Use cables with the following specifications.

Shielded: S/STP or S/UTP

Length: 50 m max. (between nodes)

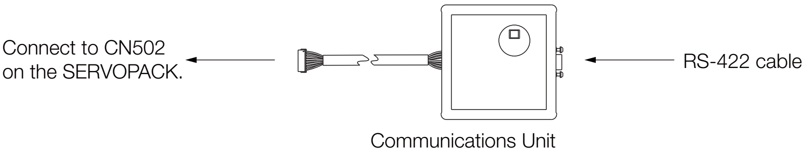
The following cable is recommended.

Manufacturer	Model
Beckhoff	ZB9020

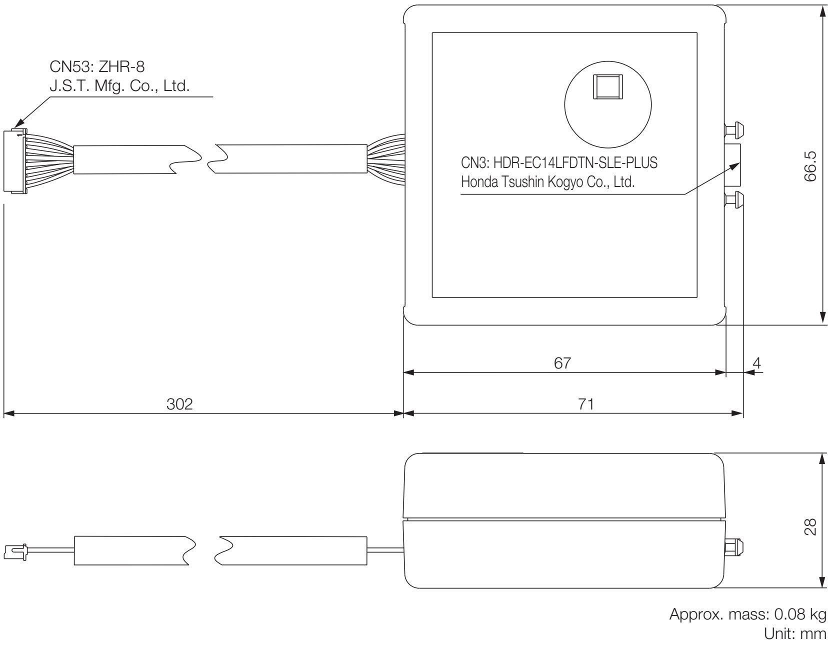
4.8 Connecting the Other Connectors

4.8.1 Serial Communications Connector (CN502)

To use an RS-422 cable to connect a Digital Operator, connect it to CN502 on the SERVOPACK. A JUSP-JC001-1 Communications Unit is required to make the connection.



Communications Unit

Item	Description
Inquiries	Your Yaskawa representative
Order Number	JUSP-JC001-1
External Dimensions	 Approx. mass: 0.08 kg Unit: mm

Refer to the following manual for the operating procedures for the Digital Operator.

Σ-7-Series Digital Operator Operating Manual (Manual No.: SIEP S800001 33)

4.8.2 Computer Connector (CN7)

To use the SigmaWin+ Engineering Tool, connect the computer on which the SigmaWin+ is installed to CN7 on the SERVOPACK.

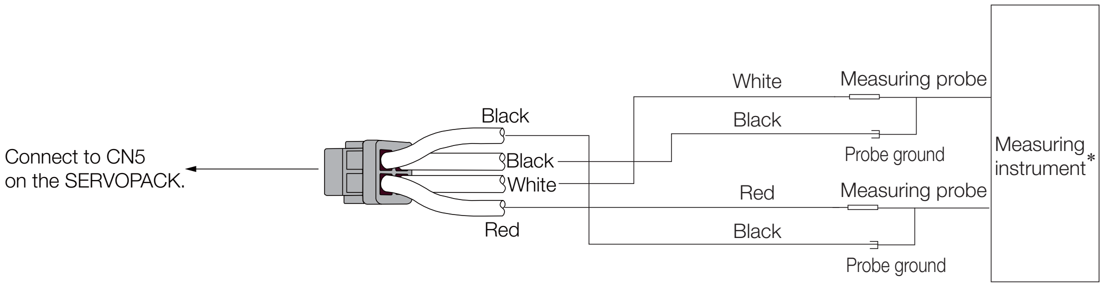
Refer to the following manual for the operating procedures for the SigmaWin+.

Engineering Tool SigmaWin+ Online Manual (Manual No.: SIEP S800001 48)

4.8.3 Analog Monitor Connector (CN5)

To use an analog monitor, connect CN5 on the SERVOPACK.

- Wiring Example



* The measuring instrument is not provided by Yaskawa.

Refer to the following section for information on the monitoring methods for an analog monitor.

☞ *9.3 Monitoring Machine Operation Status and Signal Waveforms* on page 9-6

Basic Functions That Require Setting before Operation

5

This chapter describes the basic functions that must be set before you start servo system operation. It also describes the setting methods.

5.1 Manipulating SERVOPACK Parameters (Pn□□□)

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

5.1.1 Classifications of SERVOPACK Parameters

There are the following two types of SERVOPACK 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.

Information The tuning parameters are not displayed by default when you use the Digital Operator. To display and set the tuning parameters, set Pn00B to n.□□□1 (Display all parameters).

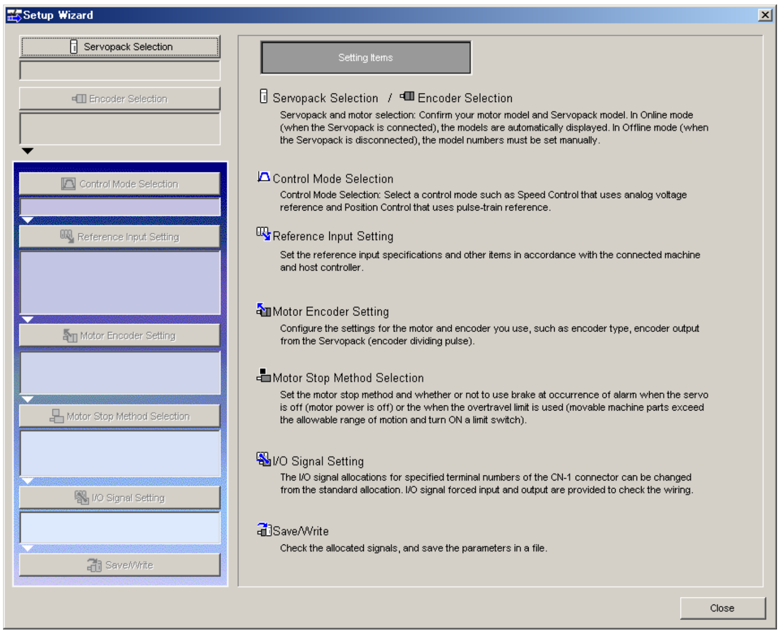
Parameter		Meaning	When Enabled	Classification
Pn00B	n.□□□0 (default setting)	Display only setup parameters.	After restart	Setup
	n.□□□1	Display all parameters.		

The setting method for each type of parameter is described below.

Setup Parameters

You can use the Digital Operator, or SigmaWin+ to set the setup parameters individually.

Information We recommend that you use the Setup Wizard of the SigmaWin+ to easily set the required setup parameters by setting the operating methods, machine specifications, and I/O signals according to on-screen Wizard instructions.



Servopack Selection / Encoder Selection

Servopack and motor selection: Confirm your motor model and Servopack model. In Online mode (when the Servopack is connected), the models are automatically displayed. In Offline mode (when the Servopack is disconnected), the model numbers must be set manually.

Control Mode Selection

Control Mode Selection: Select a control mode such as Speed Control that uses analog voltage reference and Position Control that uses pulse-train reference.

Reference Input Setting

Set the reference input specifications and other items in accordance with the connected machine and host controller.

Motor Encoder Setting

Configure the settings for the motor and encoder you use, such as encoder type, encoder output from the Servopack (encoder dividing pulse).

Motor Stop Method Selection

Set the motor stop method and whether or not to use brake at occurrence of alarm when the servo is off (motor power is off) or the when the overtravel limit is used (movable machine parts exceed the allowable range of motion and turn ON a limit switch).

I/O Signal Setting

The I/O signal allocations for specified terminal numbers of the CN-1 connector can be changed from the standard allocation. I/O signal forced input and output are provided to check the wiring.

Save/Write

Check the allocated signals, and save the parameters in a file.

Tuning Parameters

Normally the user does not need to set the tuning parameters individually.

Use the various SigmaWin+ tuning functions to set the related tuning parameters to increase the response even further for the conditions of your machine. Refer to the following sections for details.

☞ *8.6 Autotuning without Host Reference* on page 8-22

☞ *8.7 Autotuning with a Host Reference* on page 8-33

☞ *8.8 Custom Tuning* on page 8-41

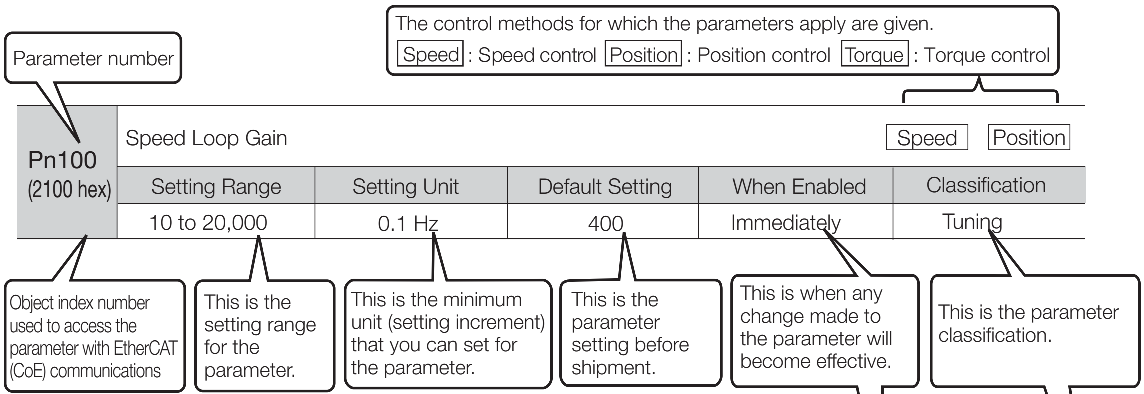
You can also set the tuning parameters individually to make adjustments. Refer to the following section for details.

☞ *8.13 Manual Tuning* on page 8-76

5.1.2 Notation for SERVOPACK Parameters

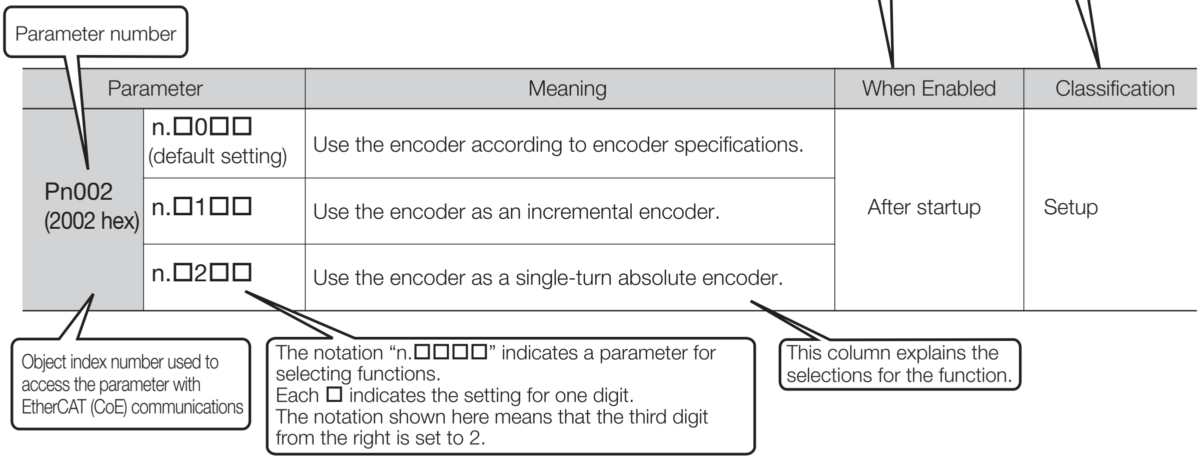
There are two types of notation used for SERVOPACK parameters that depend on whether the parameter requires a numeric setting (parameter for numeric setting) or requires the selection of a function (parameter for selecting a function).

- Parameters for Numeric Settings



Pn100 (2100 hex)	Speed Loop Gain			Speed Position	
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	10 to 20,000	0.1 Hz	400	Immediately	Tuning

- Parameters for Selecting Functions



Parameter		Meaning	When Enabled	Classification
Pn002 (2002 hex)	n.□0□□ (default setting)	Use the encoder according to encoder specifications.	After startup	Setup
	n.□1□□	Use the encoder as an incremental encoder.		
	n.□2□□	Use the encoder as a single-turn absolute encoder.		

5.1.3 Setting Methods for SERVOPACK Parameters

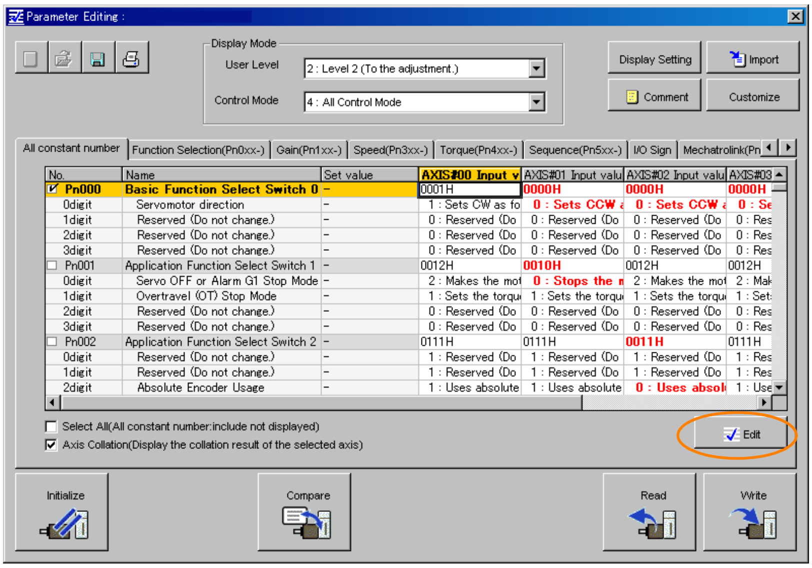
You can use the SigmaWin+ or a Digital Operator to set the SERVOPACK parameters.
A sample operating procedure is given below.

Setting SERVOPACK Parameters with the SigmaWin+

1. Select ***Parameters - Edit Parameters*** from the menu bar of the Main Window of the SigmaWin+.

2. Select the cell of the parameter to edit.
   If the parameter to edit is not displayed in the Parameter Editing Dialog Box, click the ▲ or ▼ Button to display the parameter to edit.

3. Click the **Edit** Button.



User Level: 2 : Level 2 (To the adjustment.)

Control Mode: 4 : All Control Mode

No.	Name	Set value	AXIS#00 Input v	AXIS#01 Input valu	AXIS#02 Input valu	AXIS#03
☑ Pn000	Basic Function Select Switch 0	-	0001H	0000H	0000H	0000H
0digit	Servomotor direction	-	1 : Sets CW as fo	0 : Sets CCW a	0 : Sets CCW a	0 : Se
1digit	Reserved (Do not change.)	-	0 : Reserved (Do	0 : Reserved (Do	0 : Reserved (Do	0 : Res
2digit	Reserved (Do not change.)	-	0 : Reserved (Do	0 : Reserved (Do	0 : Reserved (Do	0 : Res
3digit	Reserved (Do not change.)	-	0 : Reserved (Do	0 : Reserved (Do	0 : Reserved (Do	0 : Res
☐ Pn001	Application Function Select Switch 1	-	0012H	0010H	0012H	0012H
0digit	Servo OFF or Alarm G1 Stop Mode	-	2 : Makes the mot	0 : Stops the m	2 : Makes the mot	2 : Mak
1digit	Overtravel (OT) Stop Mode	-	1 : Sets the torqu	1 : Sets the torqu	1 : Sets the torqu	1 : Set:
2digit	Reserved (Do not change.)	-	0 : Reserved (Do	0 : Reserved (Do	0 : Reserved (Do	0 : Res
3digit	Reserved (Do not change.)	-	0 : Reserved (Do	0 : Reserved (Do	0 : Reserved (Do	0 : Res
☐ Pn002	Application Function Select Switch 2	-	0111H	0111H	0011H	0111H
0digit	Reserved (Do not change.)	-	1 : Reserved (Do	1 : Reserved (Do	1 : Reserved (Do	1 : Res
1digit	Reserved (Do not change.)	-	1 : Reserved (Do	1 : Reserved (Do	1 : Reserved (Do	1 : Res
2digit	Absolute Encoder Usage	-	1 : Uses absolute	1 : Uses absolute	0 : Uses absol	1 : Use

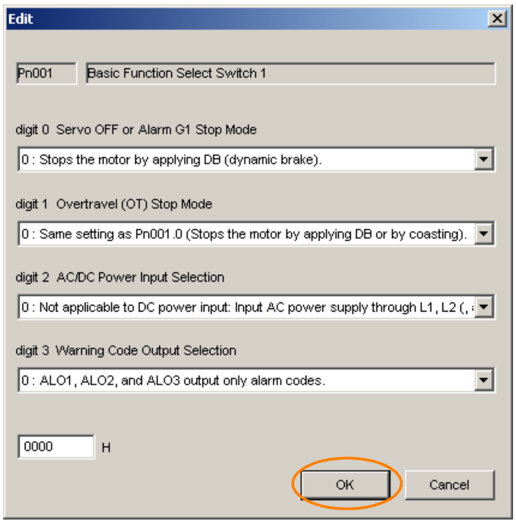
☐ Select All(All constant number:include not displayed)

☑ Axis Collation(Display the collation result of the selected axis)

4. Change the setting of the parameter.

Information
1. For a parameter for a numeric setting, input the numeric setting.
2. For a parameter for a function selection, select the setting from the list for the individual digit.

5. Click the **OK** Button.



Pn001 Basic Function Select Switch 1

digit 0 Servo OFF or Alarm G1 Stop Mode: 0 : Stops the motor by applying DB (dynamic brake).

digit 1 Overtravel (OT) Stop Mode: 0 : Same setting as Pn001.0 (Stops the motor by applying DB or by coasting).

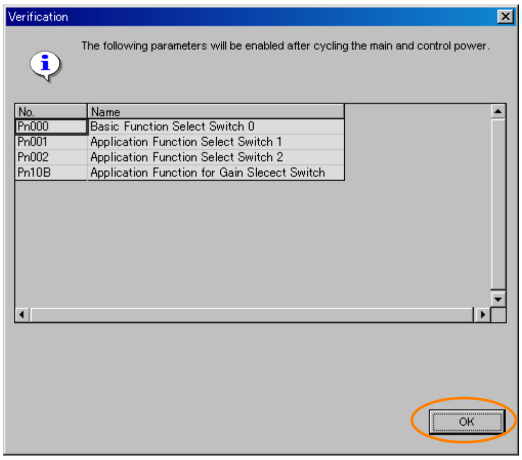
digit 2 AC/DC Power Input Selection: 0 : Not applicable to DC power input: Input AC power supply through L1, L2 (, :

digit 3 Warning Code Output Selection: 0 : ALO1, ALO2, and ALO3 output only alarm codes.

0000 H

6. Click the **Write** Button.
Writing will start.
This concludes the procedure to edit the parameter. Proceed to step 7 only when the dialog box shown in step 7 is displayed.

7. Click the **OK** Button.



The following parameters will be enabled after cycling the main and control power.

No.	Name
Pn000	Basic Function Select Switch 0
Pn001	Application Function Select Switch 1
Pn002	Application Function Select Switch 2
Pn10B	Application Function for Gain Slecect Switch

8. To enable changes to the settings, turn the power supply to the SERVOPACK OFF and ON again.

Setting SERVOPACK Parameters with a Digital Operator

Refer to the following manual for information on setting the SERVOPACK parameters with a Digital Operator.

📖 Σ-7-Series Digital Operator Operating Manual (Manual No.: SIEP S800001 33)

Setting SERVOPACK Parameters with EtherCAT (CoE) Communications

You can set objects 2000 hex to 26FF hex with EtherCAT(CoE) communications to set the SERVOPACK parameters (Pn000 to Pn6FF).

Object index 2□□□ hex corresponds to SERVOPACK parameter number Pn□□□.

Example Index 2100 hex is the same as parameter number Pn100 (2100 hex = Pn100).

When you use EtherCAT (CoE) communications objects, you must write the SERVOPACK parameters to non-volatile memory.

To write the SERVOPACK parameters to non-volatile memory, set the *store parameters* (1010 hex) object.

Refer to the following section for information on *store parameters* (1010 hex).

☞ *14.2 General Objects* on page 14-5

5.1.4 Write Prohibition Setting for SERVOPACK Parameters

You can prohibit writing SERVOPACK parameters from a Digital Operator. Even if you do, you will still be able to change SERVOPACK parameter settings from the SigmaWin+ or with EtherCAT (CoE) communications.

Preparations

No preparations are required.

Applicable Tools

The following table lists the tools that you can use to change the Write Prohibition Setting for SERVOPACK parameters and the applicable tool functions.

Tool	Function	Reference
Digital Operator	Fn010	🕮 Σ-7-Series Digital Operator Operating Manual (Manual No.: SIEP S800001 33)
SigmaWin+	*Setup - Write Prohibited Setting*	☞ *Operating Procedure* on page 5-7

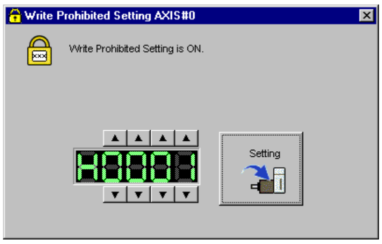
Operating Procedure

Use the following procedure to prohibit or permit writing parameter settings.

1. Select ***Setup - Write Prohibited Setting*** from the menu bar of the Main Window of the SigmaWin+.

2. Press the ▼ or ▲ for the rightmost digit and set one of the following.
   0000: Writing is permitted (default setting).
   0001: Writing is prohibited.

3. Click the **Setting** Button.



Write Prohibited Setting is ON.

4. Click the **OK** Button.
   The setting will be written to the SERVOPACK.

5. To enable the new setting, turn the power supply to the SERVOPACK OFF and ON again.

This concludes the procedure to prohibit or permit writing SERVOPACK parameter settings.

Restrictions

If you prohibit writing parameter settings, you will no longer be able to execute some functions. Refer to the following table.

SigmaWin+		Digital Operator		When Writing Is Prohibited	Reference
Menu Bar Button	SigmaWin+ Function Name	Fn No.	Utility Function Name		
Setup	Origin Search	Fn003	Origin Search	Cannot be executed.	page 7-19
	Absolute Encoder Reset	Fn008	Reset Absolute Encoder	Cannot be executed.	page 5-50
	Adjusting the Analog Monitor Output	Fn00C	Adjust Analog Monitor Output Offset	Cannot be executed.	page 9-9
		Fn00D	Adjust Analog Monitor Output Gain	Cannot be executed.	page 9-9
	Motor Current Detection Offset Adjustment	Fn00E	Autotune Motor Current Detection Signal Offset	Cannot be executed.	page 6-48
		Fn00F	Manually Adjust Motor Current Detection Signal Offset	Cannot be executed.	
	Multiturn Limit Setting	Fn013	Multiturn Limit Setting after Multiturn Limit Disagreement Alarm	Cannot be executed.	page 6-36
	Reset Configuration Error of Option Module	Fn014	Reset Option Module Configuration Error	Cannot be executed.	page 15-40
	Vibration Detection Level Initialization	Fn01B	Initialize Vibration Detection Level	Cannot be executed.	page 6-45
	Setting the Origin of the Absolute Linear Encoder	Fn020	Set Absolute Linear Encoder Origin	Cannot be executed.	page 5-52
	Reset Motor Type Alarm	Fn021	Reset Motor Type Alarm	Cannot be executed.	page 5-14
	Software Reset	Fn030	Software Reset	Can be executed.	page 6-43
	Polarity Detection	Fn080	Polarity Detection	Cannot be executed.	page 5-26
	Tuning-less Level Setting	Fn200	Tuning-less Level Setting	Cannot be executed.	page 8-15
	EasyFFT	Fn206	Easy FFT	Cannot be executed.	page 8-92
Parameters	Initialize Servo*	Fn005	Initialize Parameters	Cannot be executed.	page 5-9
Tuning	Autotuning without Reference Input	Fn201	Advanced Autotuning without Reference	Cannot be executed.	page 8-22
	Autotuning with Reference Input	Fn202	Advanced Autotuning with Reference	Cannot be executed.	page 8-33
	Custom Tuning	Fn203	One-Parameter Tuning	Cannot be executed.	page 8-41
	Anti-Resonance Control Adjustment	Fn204	Adjust Anti-resonance Control	Cannot be executed.	page 8-50
	Vibration Suppression	Fn205	Vibration Suppression	Cannot be executed.	page 8-55
Monitor	Product Information	Fn011	Display Servomotor Model	Can be executed.	page 9-2
		Fn012	Display Software Version	Can be executed.	
		Fn01E	Display SERVOPACK and Servomotor IDs	Can be executed.	page 9-2
		Fn01F	Display Servomotor ID from Feedback Option Module	Can be executed.	

Continued on next page.

Continued from previous page.

SigmaWin+		Digital Operator		When Writing Is Prohibited	Reference
Menu Bar Button	SigmaWin+ Function Name	Fn No.	Utility Function Name		
Test Operation	Jogging	Fn002	Jog	Cannot be executed.	page 7-7
	Program Jogging	Fn004	Jog Program	Cannot be executed.	page 7-13
Alarm	Alarm History Display	Fn000	Display Alarm History	Can be executed.	page 15-38
	Alarm History Clear	Fn006	Clear Alarm History	Cannot be executed.	page 15-39

* The **Initialize** Button will be displayed when you select *Parameters - Edit Parameters* from the menu bar.

5.1.5 Initializing SERVOPACK Parameter Settings

You can return the SERVOPACK parameters to their default settings.

This function will not initialize the settings of the parameters that are adjusted for the Fn00C, Fn00D, Fn00E, and Fn00F utility functions.

> Important
>
> To enable the new settings, turn the power supply to the SERVOPACK OFF and ON again after you complete the operation.

Preparations

Check the following settings before you initialize the SERVOPACK parameter settings.

- The SERVOPACK 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 SERVOPACK parameter settings and the applicable tool functions.

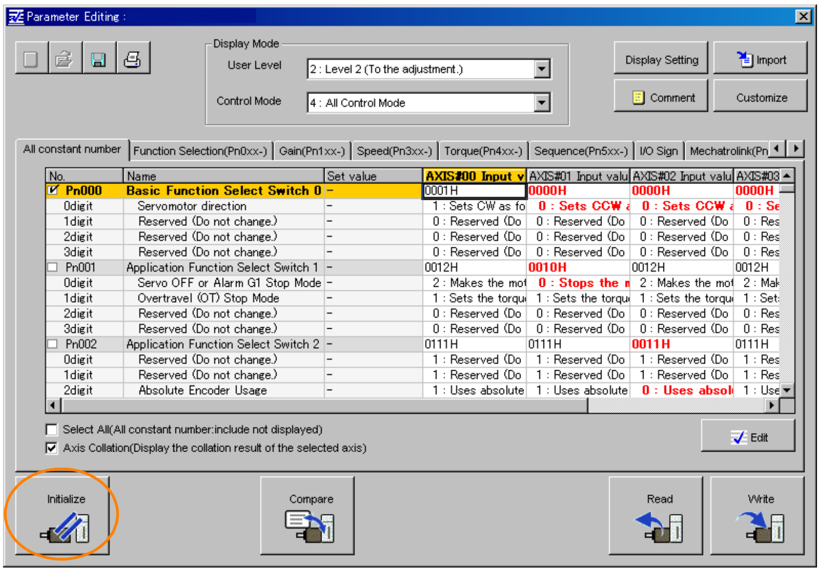
Tool	Function	Reference
Digital Operator	Fn005	📖 Σ-7-Series Digital Operator Operating Manual (Manual No.: SIEP S800001 33)
SigmaWin+	***Parameters - Edit Parameters***	☞ *Operating Procedure* on page 5-9
EtherCAT Communications	Restore Default Parameters (1011 Hex)	☞ *Restore Default Parameters (1011 Hex)* on page 14-7

Operating Procedure

Use the following procedure.

1. Select ***Parameters - Edit Parameters*** from the menu bar of the Main Window of the SigmaWin+.

2. Click the **Initialize** Button.



User Level: 2 : Level 2 (To the adjustment.)

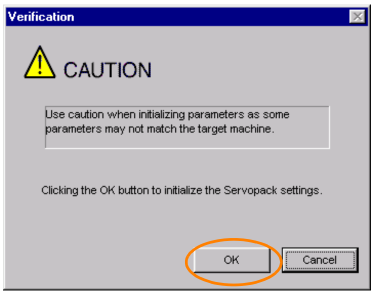
Control Mode: 4 : All Control Mode

No.	Name	Set value	AXIS#00 Input v	AXIS#01 Input valu	AXIS#02 Input valu	AXIS#03
☑ Pn000	Basic Function Select Switch 0	–	0001H	0000H	0000H	0000H
0digit	Servomotor direction	–	1 : Sets CW as fo	0 : Sets CCW a	0 : Sets CCW a	0 : Se
1digit	Reserved (Do not change.)	–	0 : Reserved (Do	0 : Reserved (Do	0 : Reserved (Do	0 : Res
2digit	Reserved (Do not change.)	–	0 : Reserved (Do	0 : Reserved (Do	0 : Reserved (Do	0 : Res
3digit	Reserved (Do not change.)	–	0 : Reserved (Do	0 : Reserved (Do	0 : Reserved (Do	0 : Res
☐ Pn001	Application Function Select Switch 1	–	0012H	0010H	0012H	0012H
0digit	Servo OFF or Alarm G1 Stop Mode	–	2 : Makes the mot	0 : Stops the m	2 : Makes the mot	2 : Mak
1digit	Overtravel (OT) Stop Mode	–	1 : Sets the torqu	1 : Sets the torqu	1 : Sets the torqu	1 : Set
2digit	Reserved (Do not change.)	–	0 : Reserved (Do	0 : Reserved (Do	0 : Reserved (Do	0 : Res
3digit	Reserved (Do not change.)	–	0 : Reserved (Do	0 : Reserved (Do	0 : Reserved (Do	0 : Res
☐ Pn002	Application Function Select Switch 2	–	0111H	0111H	0011H	0111H
0digit	Reserved (Do not change.)	–	1 : Reserved (Do	1 : Reserved (Do	1 : Reserved (Do	1 : Res
1digit	Reserved (Do not change.)	–	1 : Reserved (Do	1 : Reserved (Do	1 : Reserved (Do	1 : Res
2digit	Absolute Encoder Usage	–	1 : Uses absolute	1 : Uses absolute	0 : Uses absol	1 : Use

☐ Select All(All constant number:include not displayed)

☑ Axis Collation(Display the collation result of the selected axis)

3. Click the **OK** Button.



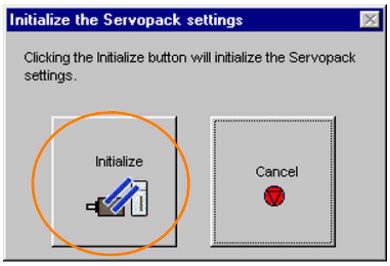
CAUTION

Use caution when initializing parameters as some parameters may not match the target machine.

Clicking the OK button to initialize the Servopack settings.

Click the **Cancel** Button to cancel initialization. The Parameter Editing Dialog Box will return.

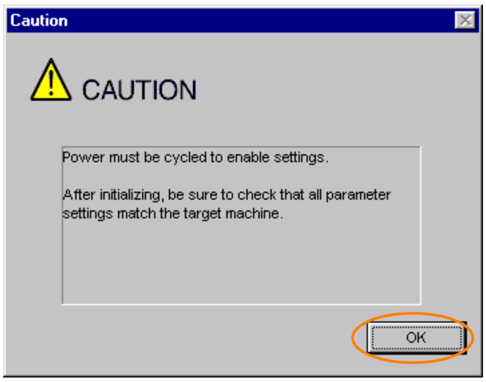
4. Click the **Initialize** Button.



Clicking the Initialize button will initialize the Servopack settings.

Click the **Cancel** Button to cancel initialization. The Parameter Editing Dialog Box will return.

5. Click the **OK** Button.



Power must be cycled to enable settings.

After initializing, be sure to check that all parameter settings match the target machine.

6. Turn the power supply to the SERVOPACK OFF and ON again after the parameter settings have been initialized.

This concludes the procedure to initialize the parameter settings.

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

A SERVOPACK can 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 SERVOPACK 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.

5.2.1 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 SERVOPACK.

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 (2001 hex)	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 SERVOPACK terminals.**
  - Connect an AC power supply to the L1, L2, and L3 terminals and the L1C and L2C terminals on the SERVOPACK.
  - Connect a DC power supply to the B1/⊕ and ⊖2 terminals and the L1C and L2C terminals on the SERVOPACK.

  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 SERVOPACK'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 SERVOPACK 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 SERVOPACK with a DC power supply input, regenerative energy is not processed. Process the regenerative energy at the power supply.**
- **If you use a DC power supply input with any of the following SERVOPACKs, externally connect an inrush current limiting circuit and use the power ON and OFF sequences recommended by Yaskawa: SGD7S-330A, -470A, -550A, -590A, or -780A.**
  There is a risk of equipment damage.
  Refer to the following section for the power ON and OFF sequences.
  ☞ ***4.3.3 Power ON Sequence*** on page 4-14

Refer to the following section for information on wiring the SERVOPACK.
☞ *4.3.4 Power Supply Wiring Diagrams* on page 4-15

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

Some models of Three-phase 200-VAC SERVOPACKs can also operate on a single-phase 200-VAC power supply.

You can use a single-phase, 200-V power supply input with the following models.

- SGD7S-R70A, -R90A, -1R6A, -2R8A, and -5R5A

If you use a single-phase, 200-VAC power supply input for the SERVOPACK's main circuit power supply, change the setting to specify a signal-phase AC power supply input (Pn00B = n.□1□□).

Parameter		Meaning	When Enabled	Classification
Pn00B (200B hex)	n.□0□□ (default setting)	Use a three-phase power supply input.	After restart	Setup
	n.□1□□	Use a three-phase power supply input and as a single-phase power supply input.		

Important

1. If you use a single-phase power supply input without specifying a signal-phase AC power supply (Pn00B = n.□1□□), an A.F10 alarm (Power Supply Line Open Phase) will occur.
2. Not all SERVOPACKs can be run on a single-phase AC power supply input. If you connect a single-phase AC power supply input to a SERVOPACK 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 200-VAC 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.

Refer to the following section for information on wiring a single-phase AC power supply input to the SERVOPACK.

☞ • *Wiring Example for Single-Phase, 200-VAC Power Supply Input* on page 4-16

5.3 Automatic Detection of Connected Motor

You can use a SERVOPACK to operate either a Rotary Servomotor or a Linear Servomotor.

If you connect the Servomotor encoder to the CN2 connector on the SERVOPACK, the SERVOPACK will automatically determine which type of Servomotor is connected. Therefore, you normally do not need to specify the motor type.

Information If an encoder is not connected, e.g., for a test without a motor, you can specify a Rotary Servomotor or a Linear Servomotor in Pn000 = n.X□□□ (Rotary/Linear Startup Selection When Encoder Is Not Connected). If you specify either a Rotary or Linear Servomotor, only the parameters, monitors, alarms, and functions for the specified motor type will be enabled.

Parameter		Meaning	When Enabled	Classification
Pn000 (2000 hex)	n.0□□□ (default setting)	When an encoder is not connected, start as SERVOPACK for Rotary Servomotor.	After restart	Setup
	n.1□□□	When an encoder is not connected, start as SERVOPACK for Linear Servomotor.		

5.4 Motor Direction Setting

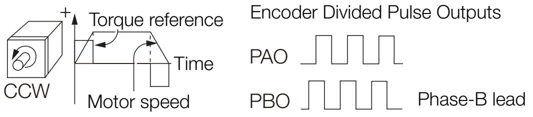
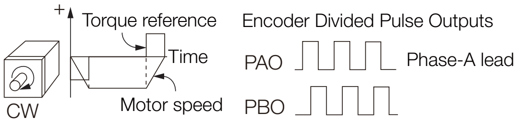
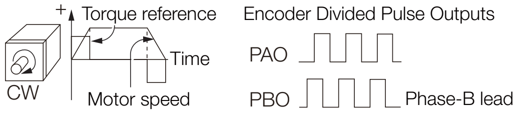
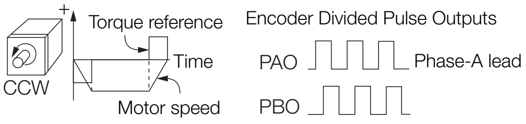
You can reverse the direction of Servomotor rotation by changing the setting of Pn000 = n.□□□X (Direction Selection) without changing the polarity of the speed or position reference. This causes the rotation direction of the motor to change, but the polarity of the signals, such as encoder output pulses, output from the SERVOPACK do not change. Set the appropriate direction for your system.

Refer to the following section for details on the encoder divided pulse output.

☞ *6.5 Encoder Divided Pulse Output* on page 6-17

- Rotary Servomotors

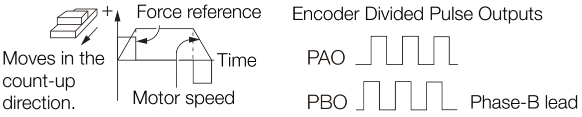
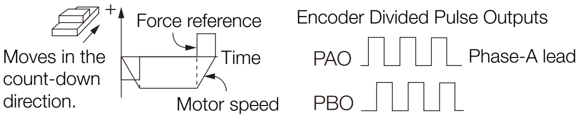
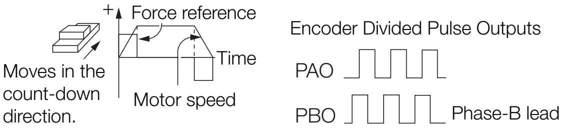
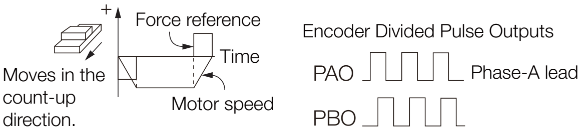
The default setting for forward rotation is counterclockwise (CCW) as viewed from the load end of the Servomotor.

Parameter		Forward/Reverse Reference	Motor Direction and Encoder Divided Pulse Outputs	Applicable Overtravel Signal (OT)
Pn000 (2000 hex)	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
		Reverse reference		N-OT (Reverse Drive Prohibit) signal

Note: The trace waveforms of the SigmaWin+ are shown in the above table for the torque reference and motor speed diagrams. If you measure them on a measuring instrument, e.g., with an analog monitor, the polarity will be reversed.

- Linear Servomotors

Before you set this parameter, make sure that Pn080 = n.□□X□ (Motor Phase Sequence Selection) is set correctly.

Parameter		Forward/Reverse Reference	Motor Moving Direction and Encoder Divided Pulse Outputs	Applicable Overtravel Signal (OT)
Pn000 (2000 hex)	n.□□□0 Use the direction in which the linear encoder counts up 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 the direction in which the linear encoder counts down as the forward direction.	Forward reference		P-OT (Forward Drive Prohibit) signal
		Reverse reference		N-OT (Reverse Drive Prohibit) signal

Note: The trace waveforms of the SigmaWin+ are shown in the above table for the force reference and motor speed diagrams. If you measure them on a measuring instrument, e.g., with an analog monitor, the polarity will be reversed.

5.5 Setting the Linear Encoder Pitch

If you connect a linear encoder to the SERVOPACK through a Serial Converter Unit, you must set the scale pitch of the linear encoder in Pn282.

If a Serial Converter Unit is not connected, you do not need to set Pn282.

Term

Serial Converter Unit
The Serial Converter Unit converts the signal from the linear encoder into a form that can be read by the SERVOPACK.

Scale Pitch
A linear encoder has a scale for measuring lengths (positions). The length of one division on this scale is the scale pitch.

Pn282 (2282 hex)	Linear Encoder Pitch				Speed Position Force
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 to 6,553,600	0.01 μm	0	After restart	Setup

You will not be able to control the Linear Servomotor if Pn282 is not set correctly. Check the above table and always set the correct value before you operate the Linear Servomotor.

Type of Linear Encoder	Manufacturer	Model	Serial Converter Unit Model	Linear Encoder Pitch [μm]
Incremental	Heidenhain Corporation	LIDA48□	JZDP-H003-□□□-E	20
			JZDP-J003-□□□-E	
		LIF48□	JZDP-H003-□□□-E	4
			JZDP-J003-□□□-E	
	Renishaw PLC	RGH22B	JZDP-H005-□□□-E	20
			JZDP-J005-□□□-E	

The first time you supply power to the SERVOPACK, the panel display on the front of the Servomotor will display an A.080 alarm (Linear Encoder Pitch Setting Error). The A.080 alarm is displayed because the setting of Pn282 has not been changed. The A.080 alarm will be cleared when you change the setting of Pn282 and then turn the power supply OFF and ON again.

Information

Linear Encoder Pitch
If you do not use a Serial Converter Unit, the linear encoder pitch is automatically set. It is not necessary to set Pn282. You can use the SigmaWin+ to check the linear encoder pitch that was automatically set. Refer to the following section for details.

☞ *9.1 Monitoring Product Information* on page 9-2

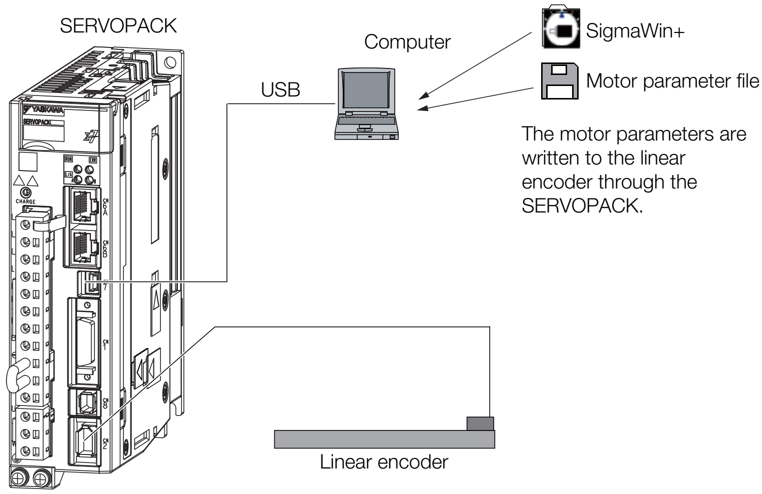
5.6 Writing Linear Servomotor Parameters

If you connect a linear encoder to the SERVOPACK without going through a Serial Converter Unit, you must use the SigmaWin+ to write the motor parameters to the linear encoder. The motor parameters contain the information that is required by the SERVOPACK to operate the Linear Servomotor.

You can download the motor parameters from our web site (http://www.e-mechatronics.com/).

⚠ WARNING

- **Check the motor and linear encoder information before you write the motor parameters.**
  If you do not write the correct motor parameters, the motor may run out of control or burning may occur, possibly resulting in equipment damage or fire.



The motor parameters are written to the linear encoder through the SERVOPACK.

Important

Serial number information is not included in the motor parameters. You cannot use the monitor functions of the SERVOPACK to monitor the serial number.
If you attempt to monitor the serial number, ********** will be displayed.

Precautions

- If the encoder parameters are not written to the linear encoder, an A.CA0 alarm (Encoder Parameter Error) will occur. Consult the manufacturer of the linear encoder.
- If the motor parameters are not written to the linear encoder, an A.CA0 alarm (Encoder Parameter Error) will not occur, but the following alarms will occur.
  A.040 (Parameter Setting Error), A.041 (Encoder Output Pulse Setting Error),
  A.050 (Combination Error), A.051 (Unsupported Device Alarm),
  A.550 (Maximum Speed Setting Error), A.710 (Instantaneous Overload),
  A.720 (Continuous Overload), and A.C90 (Encoder Communications Error)

Applicable Tools

The following table lists the tools that you can use to write the parameters to the Linear Servomotor and the applicable tool functions.

Tool	Function	Reference
Digital Operator	You cannot write Linear Servomotor parameters from the Digital Operator.	
SigmaWin+	***Setup - Motor Parameters***	☞ *Operating Procedure* on page 5-18

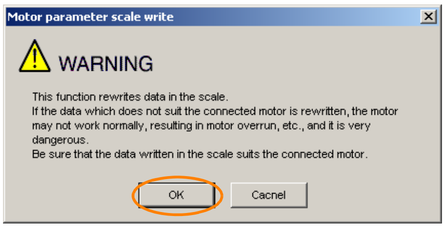
Operating Procedure

Use the following procedure to write the motor parameters to the linear encoder.

1. You can download the motor parameter file to write to the linear encoder from our web site (http://www.e-mechatronics.com/).

2. Select ***Setup - Motor Parameter Scale Write*** from the menu bar of the Main Window of the SigmaWin+.

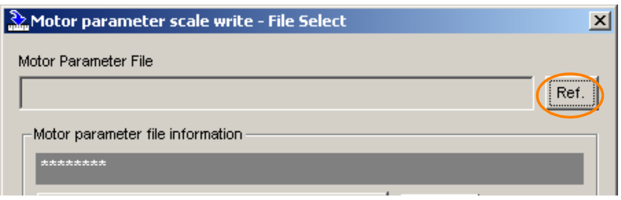
3. Click the **OK** Button.



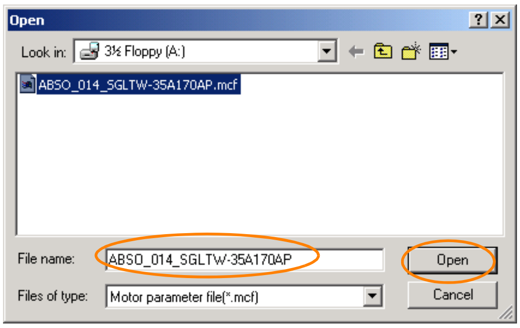
This function rewrites data in the scale.
If the data which does not suit the connected motor is rewritten, the motor may not work normally, resulting in motor overrun, etc., and it is very dangerous.
Be sure that the data written in the scale suits the connected motor.

Click the **Cancel** Button to cancel writing the motor parameters to the linear encoder. The Main Window will return.
If the write is completed normally, the Motor Parameter Scale Write - File Select Dialog Box will be displayed.

4. Click the **Ref.** Button.

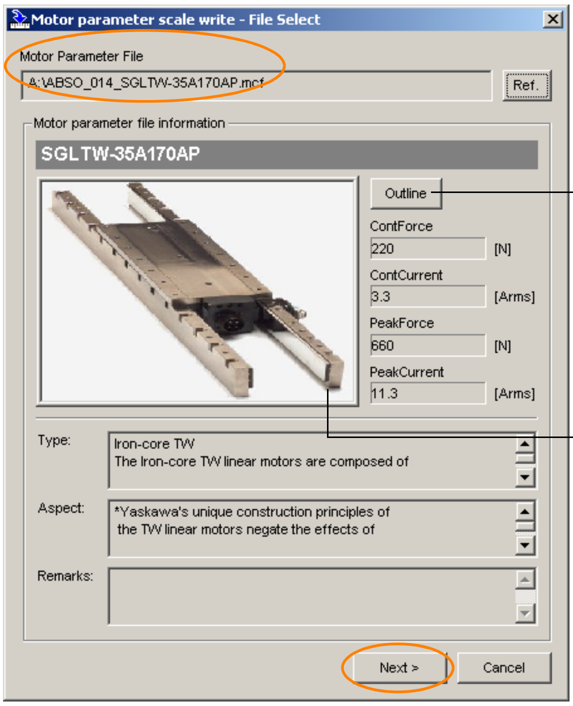


5. Select the motor parameter file that you downloaded and click the **Open** Button.



Look in: 3½ Floppy (A:)
ABSO_014_SGLTW-35A170AP.mcf
File name: ABSO_014_SGLTW-35A170AP
Files of type: Motor parameter file(*.mcf)

6. Confirm that the motor parameter file information that is displayed is suitable for your motor, and then click the **Next** Button.



Motor Parameter File: A:\ABSO_014_SGLTW-35A170AP.mcf

Motor parameter file information

SGLTW-35A170AP

ContForce: 220 [N]
ContCurrent: 3.3 [Arms]
PeakForce: 660 [N]
PeakCurrent: 11.3 [Arms]

Type: Iron-core TW
The Iron-core TW linear motors are composed of

Aspect: *Yaskawa's unique construction principles of
the TW linear motors negate the effects of

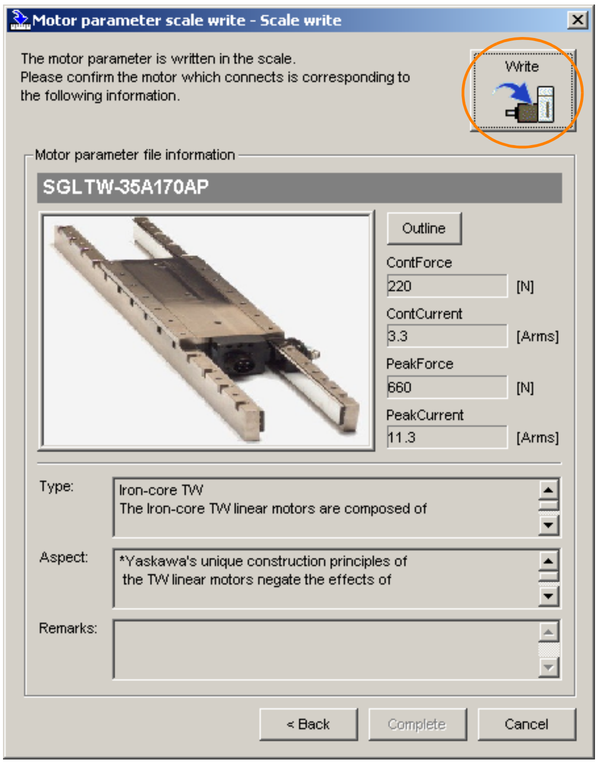
Remarks:

Displays an exterior view of the motor.

Click the image to enlarge it.

Click the **Cancel** Button to cancel writing the motor parameters to the linear encoder. The Main Window will return.

7. Click the **Write** Button.



The motor parameter is written in the scale.
Please confirm the motor which connects is corresponding to the following information.

Motor parameter file information

SGLTW-35A170AP

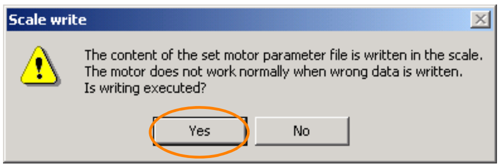
ContForce: 220 [N]
ContCurrent: 3.3 [Arms]
PeakForce: 660 [N]
PeakCurrent: 11.3 [Arms]

Type: Iron-core TW
The Iron-core TW linear motors are composed of

Aspect: *Yaskawa's unique construction principles of
the TW linear motors negate the effects of

Remarks:

8. Click the **Yes** Button.

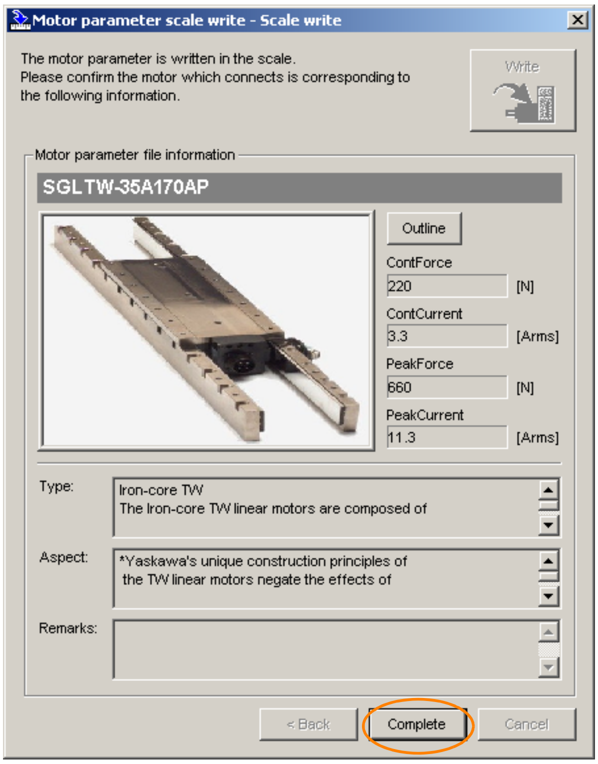


The content of the set motor parameter file is written in the scale.
The motor does not work normally when wrong data is written.
Is writing executed?

Click the **No** Button to cancel writing the motor parameters to the linear encoder.

If you click the **Yes** Button, writing the motor parameter scale will start.

9. Click the **Complete** Button.



Motor parameter scale write - Scale write

The motor parameter is written in the scale.
Please confirm the motor which connects is corresponding to the following information.

Motor parameter file information

SGLTW-35A170AP

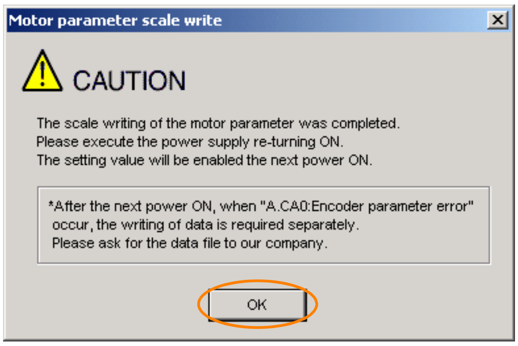
ContForce 220 [N]
ContCurrent 3.3 [Arms]
PeakForce 660 [N]
PeakCurrent 11.3 [Arms]

Type: Iron-core TW
The Iron-core TW linear motors are composed of

Aspect: *Yaskawa's unique construction principles of
the TW linear motors negate the effects of

Remarks:

10. Click the **OK** Button.



Motor parameter scale write

CAUTION

The scale writing of the motor parameter was completed.
Please execute the power supply re-turning ON.
The setting value will be enabled the next power ON.

*After the next power ON, when "A.CA0:Encoder parameter error" occur, the writing of data is required separately.
Please ask for the data file to our company.

11. Turn the power supply to the SERVOPACK OFF and ON again.

This concludes the procedure to write the motor parameters.

Confirming If the Motor Parameters Have Been Written

After you write the motor parameters, you can use a monitor function to confirm that the motor parameters are in the encoder.

If the motor parameters have not been written, no information on the Servomotor will be displayed.

☞ *9.1 Monitoring Product Information* on page 9-2

5.7 Selecting the Phase Sequence for a Linear Servomotor

You must select the phase sequence of the Linear Servomotor so that the forward direction of the Linear Servomotor is the same as the encoder’s count-up direction.

Before you set the Linear Servomotor phase sequence (Pn080 = n.□□X□), check the following items.

- Confirm that the signal from the linear encoder is being received normally.
- Make sure that the forward direction of the Linear Servomotor and the count-up direction of the linear encoder are in the same direction.

> **Important** If you do not confirm the above items before you attempt to operate the motor, the motor may not operate or it may run out of control. Always confirm these items before you operate the motor.

- Related Parameters

Parameter		Meaning	When Enabled	Classification
Pn080 (2080 hex)	n.□□0□ (default setting)	Set a phase-A lead as a phase sequence of U, V, and W.	After restart	Setup
	n.□□1□	Set a phase-B lead as a phase sequence of U, V, and W.		

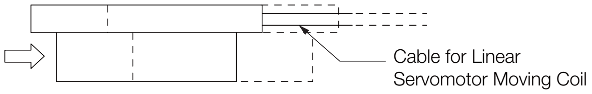
- Setting Procedure

1. **Set Pn000 to n.□□□0 (Set a phase-A lead as a phase sequence of U, V, and W).**
This setting is to make following confirmation work easier to understand.

2. **Select *Monitor - Monitor - Motion Monitor* from the menu bar of the Main Window of the SigmaWin+.**
A dialog box will be displayed so that you can check the feedback pulse counter.
To check the feedback pulse counter with the Digital Operator, use Un00D (Feedback Pulse Counter).

3. **Manually move the Moving Coil from one end to the other of the stroke and confirm that only the correct number of feedback pulses is returned.**
If the correct number and only the correct number of pulses is returned, the signal is being received correctly from the linear encoder.

Example In this example, assume that a linear encoder with a scale pitch of 20 μm and a resolution of 256 is used. If you manually move the Moving Coil 1 cm in the count-up direction of the linear encoder, the number of feedback pulses would be as follows:
1 cm/(20 μm/256) = 128,000 pulses



If there are 128,000 pulses on the feedback pulse counter after you manually move the Moving Coil in the direction of the cable, you have completed the confirmation.

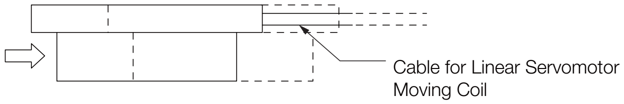
Note: The actual monitor display will be offset by the error in the travel distance. There is no problem as long as the above value is close to the calculated value.

Information If the correct value is not displayed for the feedback pulse counter, the following conditions may exist. Check the situation and correct any problems.

- The linear encoder pitch is not correct.
  If the scale pitch that is set in Pn282 does not agree with the actual scale pitch, the expected number of feedback pulses will not be returned. Check the specifications of the linear encoder.
- The linear encoder is not adjusted properly.
  If the linear encoder is not adjusted properly, the output signal level from the linear encoder will drop and the correct number of pulses will not be counted. Check the adjustment of the linear encoder. Contact the manufacturer of the linear encoder for details.
- There is a mistake in the wiring between the linear encoder and the Serial Converter Unit.
  If the wiring is not correct, the correct number of pulses will not be counted. Correct the wiring.

4. **Manually move the Moving Coil in the direction of the cable and check the value of the feedback pulse counter on the SigmaWin+ to confirm that it is counting up.**

If the pulses are counted up, the forward direction of the Linear Servomotor is the same as the count-up direction of the linear encoder.



If the feedback pulse counter counts up when you manually move the Moving Coil in the direction of the cable, you have completed the confirmation.

5. **If the feedback pulse counter counts down, set a phase-B lead as a phase sequence of U, V, and W (Pn080 = n.□□1□) and turn the power supply OFF and ON again.**

6. **If necessary, return Pn000 = n.□□□X (Direction Selection) to its original setting.**

This concludes the procedure to set the phase sequence of the Linear Servomotor.

5.8 Polarity Sensor Setting

The polarity sensor detects the polarity of the Servomotor. You must set a parameter to specify whether the Linear Servomotor that is connected to the SERVOPACK has a polarity sensor. Specify whether there is a polarity sensor in Pn080 = n.□□□X (Polarity Sensor Selection).

If the Linear Servomotor has a polarity sensor, set Pn080 to n.□□□0 (Use polarity sensor) (default setting).

If the Linear Servomotor does not have a polarity sensor, set Pn080 to n.□□□1 (Do not use polarity sensor). Turn the power supply OFF and ON again to enable the new setting.

Parameter		Meaning	When Enabled	Classification
Pn080 (2080 hex)	n.□□□0 (default setting)	Use polarity sensor.	After restart	Setup
	n.□□□1	Do not use polarity sensor.		

Information If you set Pn080 to n.□□□0 (Use polarity sensor) and the Linear Servomotor that is connected to the SERVOPACK does not have a polarity sensor, an A.C21 alarm (Polarity Sensor Error) will occur when you turn the power supply OFF and ON again.

5.9 Polarity Detection

If you use a Linear Servomotor that does not have a polarity sensor, then you must detect the polarity.

Detecting the polarity means that the position of the electrical phase angle on the electrical angle coordinates of the Servomotor is detected. The SERVOPACK cannot control the Servomotor correctly unless it accurately knows the position of the electrical angle coordinate of the Servomotor.

The execution timing and execution method for polarity detection depend on the encoder specification as described in the following table.

Encoder Specification	Polarity Detection Execution Timing	Polarity Detection Execution Method
Incremental encoder	Each time the control power supply to the SERVOPACK is turned ON (Even after you execute polarity detection, the position of the polarity will be lost the next time the control power supply to the SERVOPACK is turned OFF.)	• Use the Servo ON command (Enable Operation command). • Use the polarity detection function of the SigmaWin+. • Execute the Fn080 (Polarity Detection) utility function from the Digital Operator.
Absolute encoder	Only for initial setup, or after the SERVOPACK, linear encoder, or motor has been replaced (The results of polarity detection is stored in the absolute encoder, so the polarity position is not lost when the control power supply is turned OFF.)	• Use the polarity detection function of the SigmaWin+. • Execute the Fn080 (Polarity Detection) utility function from the Digital Operator.

Information If you use a Linear Servomotor that does not have a polarity sensor, you will not be able to turn ON the servo until polarity detection has been completed.

5.9.1 Restrictions

Assumed Conditions

The Servomotor will move when you execute polarity detection. The following conditions must be met before you start.

- It must be OK to move the Moving Coil about 10 mm.
  (If polarity detection fails, the Moving Coil may move approximately 5 cm. The amount of movement depends on conditions.)
- The linear encoder pitch must be 100 μm or less. (We recommend a pitch of 40 μm or less for an incremental encoder.)
- As much as possible, the motor must not be subjected to an imbalanced external force. (We recommend 5% or less of the rated force.)
- The mass ratio must be 50x or less.
- The axis must be horizontal.
- There must be friction equivalent to a few percent of the rated force applied to the guides. (Air sliders cannot be used.)

Preparations

Check the following settings before you execute polarity detection.

- Not using a polarity sensor must be specified (Pn080 = n.□□□1).
- The servo must be OFF.
- The main circuit power supply must be ON.
- There must be no hard wire base block (HWBB).
- There must be no alarms except for an A.C22 alarm (Phase Information Disagreement).

- The parameters must not be write prohibited. (This item applies only when using the SigmaWin+ or Digital Operator.)
- The test without a motor function must be disabled (Pn00C = n.☐☐☐0).
- There must be no overtravel.
- If the motor parameters have been written or the origin of the absolute linear encoder has been set, the power supply to the SERVOPACK must be turned OFF and ON again after completion of the writing or setting operation.

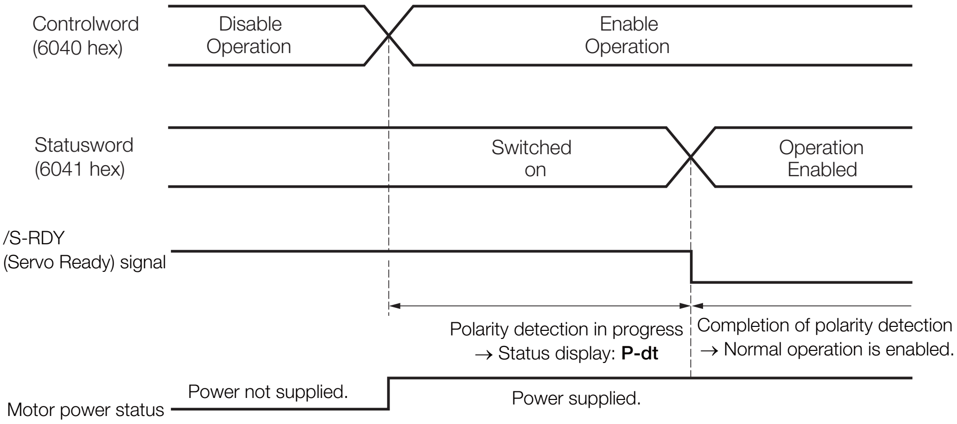
Important

1. Power is supplied to the Servomotor during polarity detection. Be careful not to get an electric shock. Also, the Moving Coil of the Linear Servomotor may greatly move during detection. Do not approach the moving parts of the Servomotor.
2. Polarity detection is affected by many factors.
   For example, polarity detection may fail if the mass ratio or friction is too large or the cable tension is too strong.

5.9.2 Using the Servo ON Command (Enable Operation Command) to Perform Polarity Detection

You can use the Servo ON command (Enable Operation command) to perform polarity detection only with an incremental linear encoder.

Polarity detection will start simultaneously with execution of the Servo ON command (Enable Operation command). As soon as polarity detection is completed, the /S-RDY will turn ON and the servo will change to ON status (*statusword = operation enabled*).



5.9.3 Using a Tool Function to Perform Polarity Detection

Applicable Tools

The following table lists the tools that you can use to perform polarity detection and the applicable tool functions.

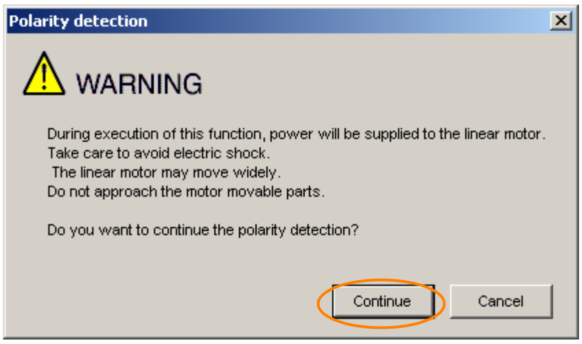
Tool	Function	Reference
Digital Operator	Fn080	📖 Σ-7-Series Digital Operator Operating Manual (Manual No.: SIEP S800001 33)
SigmaWin+	***Setup - Polarity Detection***	☞ *Operating Procedure* on page 5-26

Operating Procedure

Use the following procedure.

1. Select ***Setup - Polarity Detection*** from the menu bar of the Main Window of the SigmaWin+.

2. Click the **Continue** Button.


Polarity detection

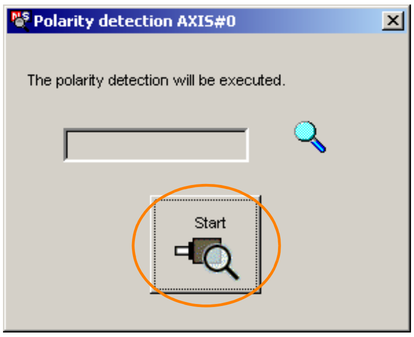
WARNING

During execution of this function, power will be supplied to the linear motor.
Take care to avoid electric shock.
The linear motor may move widely.
Do not approach the motor movable parts.

Do you want to continue the polarity detection?

Click the **Cancel** Button to cancel polarity detection. The Main Window will return.

3. Click the **Start** Button.
Polarity detection will be executed.


Polarity detection AXIS#0

The polarity detection will be executed.

This concludes the procedure to execute polarity detection.

5.10 Overtravel and Related Settings

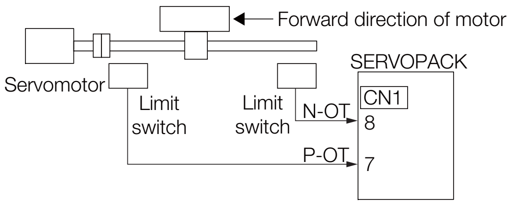
Overtravel is a safety function of the SERVOPACK that forces the Servomotor to stop in response to a signal input from a limit switch that is activated when a moving part of the machine exceeds the safe range of movement.

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

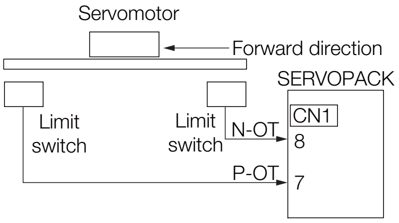
You use the P-OT and N-OT signals to stop the machine by installing limit switches at the positions where you want to stop the machine that is operated by the Servomotor.

A SERVOPACK wiring example is provided below.

Rotary Servomotors



Linear Servomotors



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.

5.10.1 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	CN1-7	ON	Forward drive is enabled (actual operation).
			OFF	Forward drive is prohibited (forward overtravel).
	N-OT	CN1-8	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.

5.10.2 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 (250A hex)	n.1□□□ (default setting)	The forward overtravel function is enabled and the P-OT (Forward Drive Prohibit) signal is input from CN1-7.	After restart	Setup
	n.8□□□	The reverse overtravel function is disabled. Forward drive is always enabled.		
Pn50B (250B hex)	n.□□□2 (default setting)	The reverse overtravel function is enabled and the N-OT (Reverse Drive Prohibit) signal is input from CN1-8.		
	n.□□□8	The reverse overtravel function is disabled. Reverse drive is always enabled.		

You can allocate the P-OT and N-OT signals to other connector pins. Refer to the following section for details.

☞ *6.1.1 Input Signal Allocations* on page 6-3

5.10.3 Motor Stopping Method for Overtravel

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

Parameter		Motor Stopping Method*	Status after Stopping	When Enabled	Classification
Pn001 (2001 hex)	n.□□00 (default setting)	Dynamic brake	Coasting	After restart	Setup
	n.□□01				
	n.□□02	Coasting			
	n.□□1□	Deceleration according to setting of Pn406 (2406 hex)	Zero clamp		
	n.□□2□		Coasting		
	n.□□3□	Deceleration according to setting of Pn30A (230A hex)	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 (Servo OFF or Alarm Group 1 Stopping Method)), and then the Servomotor will enter a coasting state.

Refer to the following section for information on stopping methods other than those for overtravel.

☞ *5.12.1 Stopping Method for Servo OFF* on page 5-38

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.

Pn406 (2406 hex)	Emergency Stop Torque			Speed Position Torque	
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 to 800	1%*	800	Immediately	Setup

* Set a percentage of the motor rated torque.

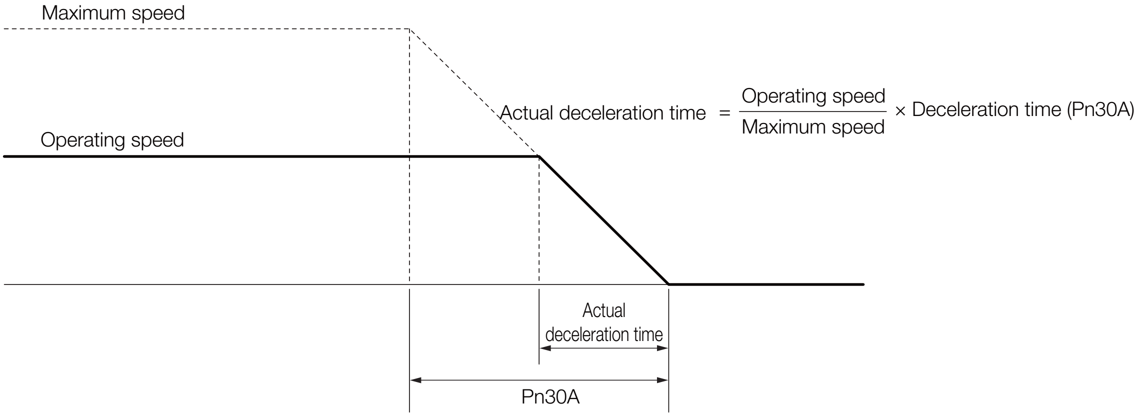
Stopping the Servomotor by Setting the Deceleration Time

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

Pn30A (230A hex)	Deceleration Time for Servo OFF and Forced Stops			Speed Position	
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 to 10,000	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 motor from the maximum motor speed.



5.10.4 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 SERVOPACK 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.

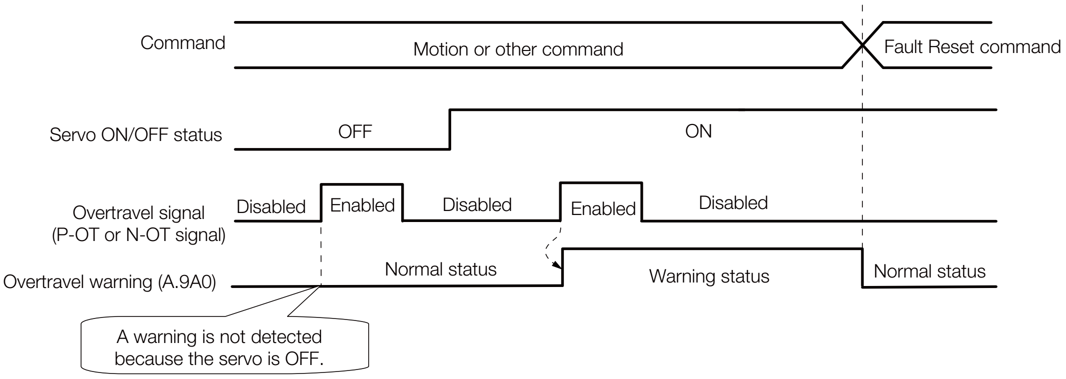
Important

1. The occurrence of an A.9A0 warning will not stop the motor or have any effect 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.
2. When overtravel occurs, the SERVOPACK 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 (200D hex)	n.0□□□ (default setting)	Do not detect overtravel warnings.	Immediately	Setup
	n.1□□□	Detect overtravel warnings.		

A timing chart for warning detection is provided below.



Information

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 can be detected in either the forward or reverse direction if there is no reference.
4. A warning will not be detected when the servo is turned ON even if overtravel status exists.
5. You can use the ALM_CLR (Clear Alarms and Warnings) command to clear the warning regardless of the servo ON/OFF status and overtravel signal status.
6. If you clear the warning with the Fault Reset command during overtravel status, a warning will not be detected again until the overtravel status is left.
7. An overtravel warning will be detected even when the software limit has been detected.

5.10.5 Overtravel Status

If an overtravel signal is input, the following SERVOPACK status will change to 1 and the Servomotor will be stopped according to the overtravel stopping method set in Pn001. When the overtravel signal is reset, the status changes to 0.

Internal limit active (bit 11) in *statusword* (6041 hex)

Negative limit switch (bit 0) or *positive limit switch* (bit 1) in *digital inputs* (60FD hex)

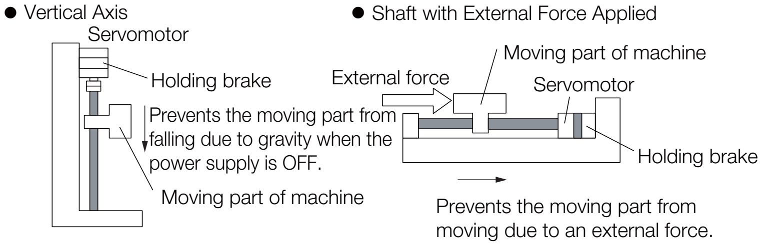
5.10.6 Overtravel Operation by Mode

Operation Mode	Operation
Profile position mode	• If an overtravel signal is input, the positioning operation to the current target position will be canceled and, after the motor stops, *target reached* in *statusword* will be reset. • A positioning operation (return operation) is started only when a movement reference to a target position in the opposite direction from the overtravel signal is specified in the current Position Actual Value (e.g., a negative movement reference if the P-OT signal is input).
Homing mode	• For Homing Method 1, 11, 12, 13, 14, 28, or 34: If the P-OT signal is input, *homing error* (bit 13) in *statusword* (6041 hex) changes to 1 and the homing operation is canceled. • For Homing Method 2, 7, 8, 9, 10, 24, or 33: If the N-OT signal is input, *homing error* (bit 13) in *statusword* (6041 hex) changes to 1 and the homing operation is canceled.
Interpolated position mode, Cyclic synchronous position mode	• If an overtravel signal is input, the positioning operation to the current target position will be canceled and, after the motor stops, *target reached* in *statusword* will be reset. • A positioning operation (return operation) is started only when a movement reference to a target position in the opposite direction from the overtravel signal is specified in the current *position actual value* (e.g., a negative movement references if the P-OT signal is input).
Profile velocity mode, Cyclic synchronous velocity mode	• During overtravel, the motor is operated only when a speed in the direction opposite from the overtravel signal is specified (e.g., a negative target speed when the P-OT signal is input).
Profile torque mode, Cyclic synchronous torque mode	• During overtravel, torque is applied only when a torque in the direction opposite from the overtravel signal is specified (e.g., a negative torque when the P-OT signal is input).

5.11 Holding Brake

A holding brake is used to hold the position of the moving part of the machine when the SERVOPACK 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.



Important 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.

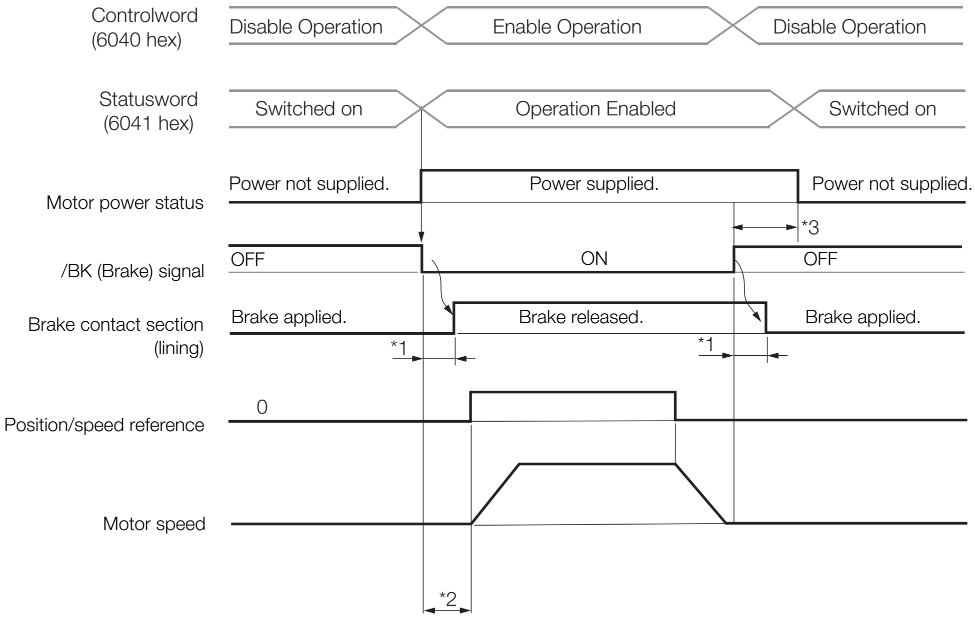
5.11.1 Brake Operating Sequence

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

Term

Time Required to Release Brake
The time from when the /BK (Brake) signal is turned ON until the brake is actually released.

Time Required to Brake
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.

Model	Voltage	Time Required to Release Brake [ms]	Time Required to Brake [ms]
SGM7J-A5 to -04	24 VDC	60	100
SGM7J-06 and -08		80	
SGM7A-A5 to -04		60	
SGM7A-06 to -10		80	
SGM7A-15 to -25		170	80
SGM7A-30 to -50		100	
SGM7P-01		20	100
SGM7P-02 and -04		40	
SGM7P-08 and -15		20	
SGM7G-03 to -20		100	80
SGM7G-30 to -44		170	100
SGM7G-55 to -1A			80
SGM7G-1E		250	

Linear Servomotors: The brake delay times depend on the brake that you use. Set the parameters related to /BK signal output timing according to the delay times for the brake that you will actually use.

*2. Before you output a reference from the host controller to the SERVOPACK, wait for at least 50 ms plus the time required to release the brake after you send the Servo ON command (Enable Operation command).

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

Connection Examples

Refer to the following section for information on brake wiring.

☞ *4.4.4 Wiring the SERVOPACK to the Holding Brake* on page 4-28

5.11.2 /BK (Brake) Signal

The following settings are for the output signal that controls the brake. You can change the connector pin that is allocated. For details, refer to *Allocating the /BK (Brake) Signal.*
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	Signal	Connector Pin No.	Signal Status	Meaning
Output	/BK	CN1-1, CN1-2	ON (closed)	Releases the brake.
			OFF (open)	Activates the brake.

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

Allocating the /BK (Brake) Signal

Set the allocation for the /BK signal in Pn50F = n.□X□□ (/BK (Brake Output) Signal Allocation).

Parameter		Connector Pin No.		Meaning	When Enabled	Classification
		+ Pin	- Pin			
Pn50F (250F hex)	n.□0□□	–	–	The /BK signal is not used.	After restart	Setup
	n.□1□□ (default setting)	CN1-1	CN1-2	The /BK signal is output from CN1-1 and CN1-2.		
	n.□2□□	CN1-23	CN1-24	The /BK signal is output from CN1-23 and CN1-24.		
	n.□3□□	CN1-25	CN1-26	The /BK signal is output from CN1-25 and CN1-26.		

Important

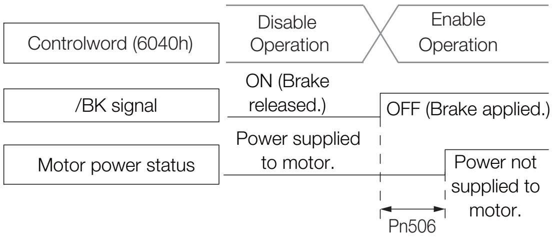
If you allocate more than one signal to the same output connector pin, a logical OR of the signals is output. Allocate the /BK signal to its own output connector pin, i.e., do not use the same output terminal for another signal.
For example, never allocate the /TGON (Rotation Detection) signal and /BK 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.

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

When the Servomotor is stopped, the /BK signal turns OFF as soon as the Servo OFF command (Disable Operation command) is received. Use the servo OFF delay time (Pn506) to change the timing to turn OFF power supply to the motor after the Servo OFF command (Disable Operation command) is input.

Pn506 (2506 hex)	Brake Reference-Servo OFF Delay Time			Speed Position Torque	
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 to 50	10 ms	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.



Important

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.

5.11.4 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 reference 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.

- Rotary Servomotors

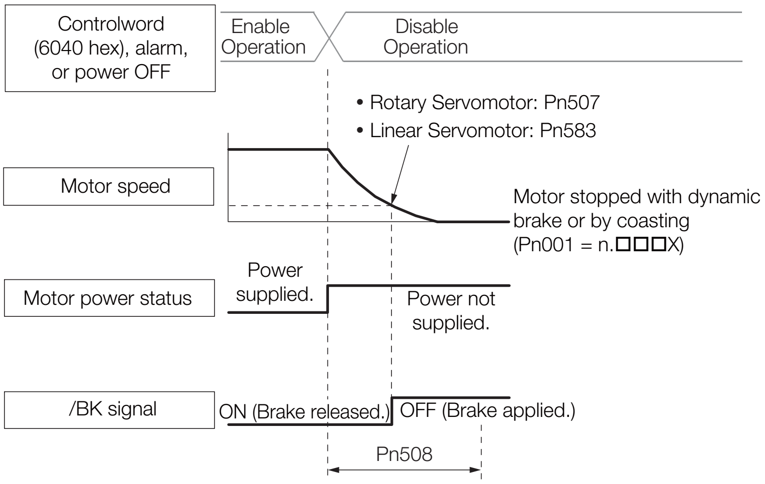
Pn507 (2507 hex)	Brake Reference Output Speed Level				Speed Position Torque
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 to 10,000	1 min^{-1}	100	Immediately	Setup
Pn508 (2508 hex)	Servo OFF-Brake Reference Waiting Time				Speed Position Torque
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	10 to 100	10 ms	50	Immediately	Setup

- Linear Servomotors

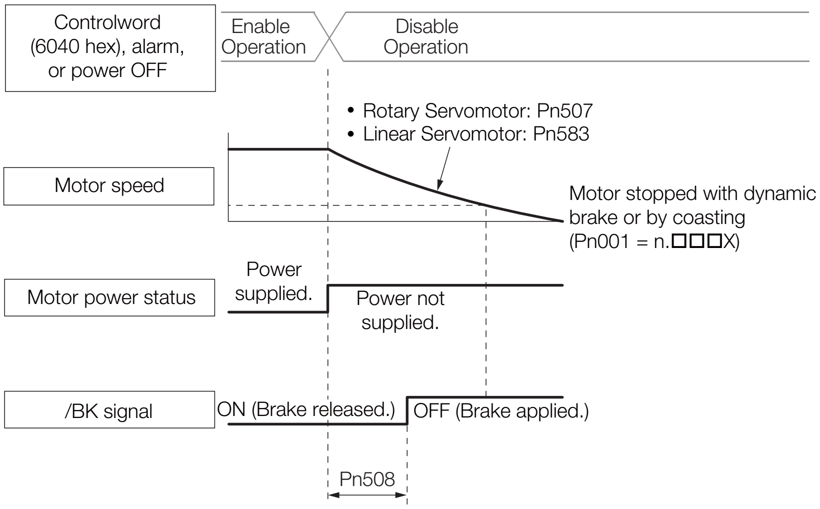
Pn583 (2583 hex)	Brake Reference Output Speed Level				Speed Position Force
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 to 10,000	1 mm/s	10	Immediately	Setup
Pn508 (2508 hex)	Servo OFF-Brake Reference Waiting Time				Speed Position Force
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	10 to 100	10 ms	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



Important

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.

5.12 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 Clamping	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
Dynamic Brake Applied	The electric circuits are internally connected to hold the Servomotor.
Coasting	The SERVOPACK 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.)

Important

- 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 a reference input is applied to start and stop the Servomotor. This may result in deterioration of the internal elements in the SERVOPACK. Use speed input references or position references to start and stop the Servomotor.
- If you turn OFF the main circuit power supply or control power supply during operation before you turn OFF the servo, the Servomotor stopping method depends on the SERVOPACK model as shown in the following table.

Condition	Servomotor Stopping Method	
	SGD7S-R70A, -1R6A, -2R8A, -3R8A, -5R5A, -7R6A, -120A, -180A, or -200A	SGD7S-330A, -470A, -550A, -590A, or -780A
Main circuit power supply turned OFF before turning OFF the servo	Stopping with dynamic brake	
Control power supply turned OFF before turning OFF the servo	Stopping with dynamic brake	Coasting to a stop

- 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.
  For example, when coupling two shafts (twin-drive operation), machine damage may occur if a zero-speed stopping alarm occurs for one of the coupled shafts and the other shaft stops with a dynamic brake. In such cases, change the stopping method to the dynamic brake.

5.12.1 Stopping Method for Servo OFF

Set the stopping method for when the servo is turned OFF in Pn001 = n.□□□X (Servo OFF or Alarm Group 1 Stopping Method).

Parameter		Servomotor Stopping Method	Status after Servomotor Stops	When Enabled	Classification
Pn001 (2001 hex)	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.

5.12.2 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.
☞ *15.2.1 List of Alarms* on page 15-5

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.

Refer to the following section for details.
☞ *5.12.1 Stopping Method for Servo OFF* on page 5-38

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 (Servo OFF or Alarm Group 1 Stopping Method)
- 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			Servomotor Stopping Method	Status after Servomotor Stops	When Enabled	Classification
Pn00B (200B hex)	Pn00A (200A hex)	Pn001 (2001 hex)				
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 (2406 hex) 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 (230A hex).	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 Pn001 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.

3. Refer to the following section for details on Pn406 (Emergency Stop Torque).

☞ *Stopping the Servomotor by Setting Emergency Stop Torque* on page 5-29

4. Refer to the following section for details on Pn30A (Deceleration Time for Servo OFF and Forced Stops).

☞ *Stopping the Servomotor by Setting the Deceleration Time* on page 5-29

5.13 Motor Overload Detection Level

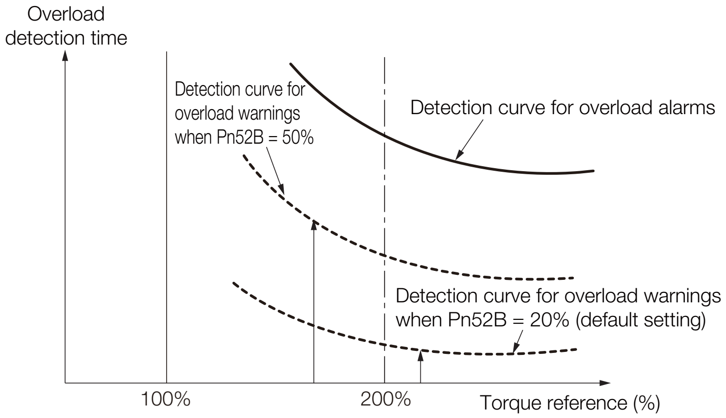
The motor overload detection level is the threshold used to detect overload alarms and overload warnings when the Servomotor is subjected to a continuous load that exceeds the Servomotor ratings.

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).

5.13.1 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 (252B hex)	Overload Warning Level			Speed Position Torque	
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	1 to 100	1%	20	Immediately	Setup

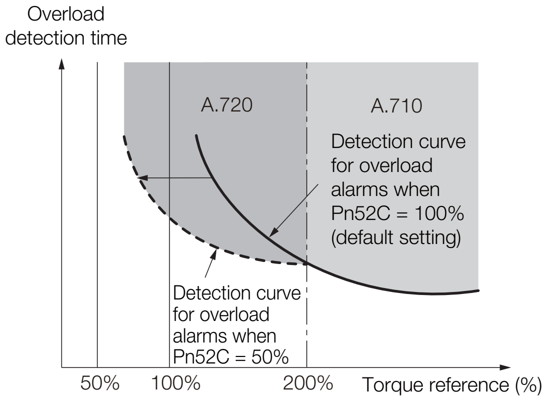
5.13.2 Detection Timing for Overload Alarms (A.720)

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 (252C hex)	Base Current Derating at Motor Overload Detection			Speed Position Torque	
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	10 to 100	1%	100	After restart	Setup

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



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

Refer to the relevant manual given below for a diagram that shows the relationships between the motor heat dissipation conditions (heat sink size, surrounding air temperature, and derating). You can protect the motor from overloads more effectively by setting this derating value in Pn52C.

📖 Σ-7-Series Rotary Servomotor Product Manual (Manual No.: SIEP S800001 36)

📖 Σ-7-Series Linear Servomotor Product Manual (Manual No.: SIEP S800001 37)

📖 Σ-7-Series Direct Drive Servomotor Product Manual (Manual No.: SIEP S800001 38)

5.14 Setting Unit Systems

You can set the SERVOPACK reference units with EtherCAT (CoE) communications. You can set the following four reference units with EtherCAT communications.

- Position reference unit
- Speed reference unit
- Acceleration reference unit
- Torque reference unit

The setting procedures are given below.

5.14.1 Setting the Position Reference Unit

Set the position reference unit in *position user unit* (2701 hex). The position reference unit setting will be used for the electronic gear ratio setting.

Important

Set the position reference unit within the following range.
1/4,096 < Numerator/Denominator < 65,536
If the setting range is exceeded, an A.A20 alarm (Parameter Setting Error) will occur.

Index	Subindex	Name	Data Type	Access	PDO Mappings	Value	Saving to EEPROM
2701 hex	0	Number of entries	USINT	RO	No	2	No
	1	Numerator	UDINT	RW	No	1 to 1,073,741,823 (default: 1)	Yes
	2	Denominator	UDINT	RW	No	1 to 1,073,741,823 (default: 1)	Yes

Note: Refer to the following section for information on *position user unit* (2701 hex).
☞ *Position User Unit (2701 Hex)* on page 14-17

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.

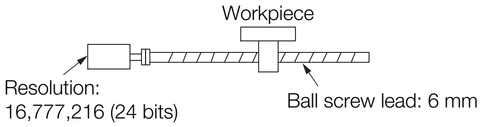
With the electronic gear, one reference unit is equal to the workpiece travel distance per reference pulse input to the SERVOPACK. In other words, if you use the SERVOPACK's electronic gear, pulses can be read as reference units.

Note: If you set an electronic gear in the host controller, normally set the electronic gear ratio in the SERVOPACK to 1:1.

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

- Rotary Servomotors

In this example, the following machine configuration is used to move the workpiece 10 mm.



When the Electronic Gear Is Not Used

To move a workpiece 10 mm:
①Calculate the number of revolutions.
The motor will move 6 mm for each revolution, so 10/6 revolutions are required to move 10 mm.
②Calculate the required number of reference pulses.
One revolution is 16,777,216 pulses, therefore 10/6 × 16,777,216 = 27,962,026.66 pulses.
③Input 27,962,027 pulses as the reference.

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

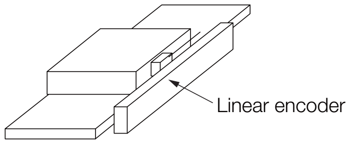
When the Electronic Gear Is Used

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.

- Linear Servomotors

In this example, the following machine configuration is used to move the load 10 mm. We'll assume that the resolution of the Serial Converter Unit is 256 and that the linear encoder pitch is 20 μm.



When the Electronic Gear Is Not Used

To move the load 10 mm:
10 × 1000 ÷ 20 × 256 = 128,000 pulses, so 128,000 pulses are input as the reference.

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

When the Electronic Gear Is Used

To use reference units to move the load 10 mm:
If we set the reference unit to 1 μm, the travel distance is 1 μm per pulse. To move the load 10 mm (10,000 μm), 10,000/1 = 10,000 pulses, so 10,000 pulses would be input as the reference.

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

Calculating the Settings for the Electronic Gear Ratio

◆ Rotary Servomotors

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:

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

■ Encoder Resolution

You can check the encoder resolution in the Servomotor model number.

SGM7J, SGM7A,
SGM7P, or SGM7G -□□□□□□□

Code	Specification	Encoder Resolution
7	24-bit multiturn absolute encoder	16,777,216
F	24-bit incremental encoder	16,777,216

SGMCS -□□□□□□□

Code	Specification	Encoder Resolution
3	20-bit single-turn absolute encoder	1,048,576
D	20-bit incremental encoder	1,048,576

SGMCV -□□□□□□□

Code	Specification	Encoder Resolution
E	22-bit single-turn absolute encoder	4,194,304
I	22-bit multiturn absolute encoder	4,194,304

◆ Linear Servomotors

You can calculate the settings for the electronic gear ratio with the following equation:

When Not Using a Serial Converter Unit

Use the following formula if the linear encoder and SERVOPACK are connected directly or if a linear encoder that does not require a Serial Converter Unit is used.

$$\text{Electronic gear ratio } \frac{B}{A} = \frac{\text{Numerator}}{\text{Denominator}} = \frac{\text{Travel distance per reference unit (reference units)} \times \text{Linear encoder resolution}}{\text{Linear encoder pitch (the value from the following table)}}$$

When Using a Serial Converter Unit

$$\text{Electronic gear ratio } \frac{B}{A} = \frac{\text{Numerator}}{\text{Denominator}} = \frac{\text{Travel distance per reference unit (reference units)} \times \text{Resolution of the Serial Converter Unit}}{\text{Linear encoder pitch (setting of Pn282)}}$$

■ Feedback Resolution of Linear Encoder

The linear encoder pitches and resolutions are given in the following table.

Calculate the electronic gear ratio using the values in the following table.

Type of Linear Encoder	Manufacturer	Linear Encoder Model	Linear Encoder Pitch [μm]	Model of Serial Converter Unit or Model of Head with Interpolator	Resolution	Resolution
Incremental	Heidenhain Corporation	LIDA48□	20	JZDP-H003-□□□-E*1	256	0.078 μm
				JZDP-J003-□□□-E*1	4,096	0.0049 μm
		LIF48□	4	JZDP-H003-□□□-E*1	256	0.016 μm
				JZDP-J003-□□□-E*1	4,096	0.00098 μm
	Renishaw PLC	RGH22B	20	JZDP-H005-□□□-E*1	256	0.078 μm
				JZDP-J005-□□□-E*1	4,096	0.0049 μm
	Magnescale Co., Ltd.	SR75-□□□□□LF*4	80	–	8,192	0.0098 μm
		SR75-□□□□□MF	80	–	1,024	0.078 μm
		SR85-□□□□□LF*4	80	–	8,192	0.0098 μm
		SR85-□□□□□MF	80	–	1,024	0.078 μm
		SL700*4, SL710*4, SL720*4, SL730*4	800	PL101-RY*2	8,192	0.0977 μm
				MJ620-T13*3		
Absolute	Heidenhain Corporation	LIC4100 Series	20.48	EIB3391Y*3	4,096	0.005 μm
	Mitutoyo Corporation	ST781A/ST781AL	256	–	512	0.5 μm
		ST782A/ST782AL	256	–	512	0.5 μm
		ST783/ST783AL	51.2	–	512	0.1 μm
		ST784/ST784AL	51.2	–	512	0.1 μm
		ST788A/ST788AL	51.2	–	512	0.1 μm
		ST789A/ST789AL	25.6	–	512	0.05 μm
	Magnescale Co., Ltd.	SR77-□□□□□LF*4	80	–	8,192	0.0098 μm
		SR77-□□□□□MF	80	–	1,024	0.078 μm
		SR87-□□□□□LF*4	80	–	8,192	0.0098 μm
		SR87-□□□□□MF	80	–	1,024	0.078 μm

*1. This is the model of the Serial Converter Unit.

*2. This is the model of the Head with Interpolator.

*3. This is the model of the Interpolator.

*4. If you use an encoder pulse output with this linear encoder, the setting range of the encoder output resolution (Pn281) is restricted. Refer to the following section for details on the encoder output resolution (Pn281).
☞ *6.5.2 Setting for the Encoder Divided Pulse Output* on page 6-22

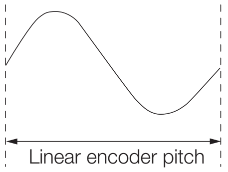
Information

Resolution

You can calculate the resolution that is used inside the SERVOPACK (i.e., the travel distance per feedback pulse) with the following formula.

$$\text{Resolution (travel distance per feedback pulse)} = \frac{\text{Linear encoder pitch}}{\text{Resolution of Serial Converter Unit or linear encoder}}$$

The SERVOPACK uses feedback pulses as the unit to control a Servomotor.

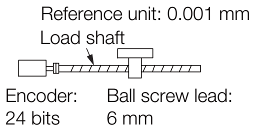
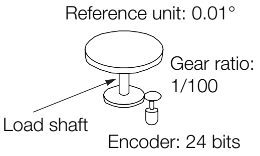
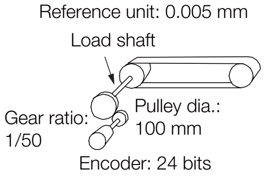


Linear encoder pitch
=Distance for one cycle of the analog voltage feedback signal from the linear encoder

Electronic Gear Ratio Setting Examples

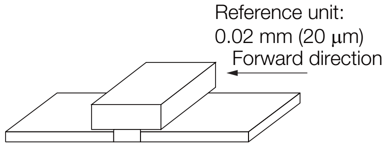
Setting examples are provided in this section.

- Rotary Servomotors

Step	Description	Machine Configuration		
		Ball Screw	Rotary Table	Belt and Pulley
				
1	Machine Specifications	• Ball screw lead: 6 mm • Gear ratio: 1/1	• Rotation angle per revolution: 360° • Gear ratio: 1/100	• Pulley dia.: 100 mm (Pulley circumference: 314 mm) • Gear ratio: 1/50
2	Encoder Resolution	16,777,216 (24 bits)	16,777,216 (24 bits)	16,777,216 (24 bits)
3	Reference Unit	0.001 mm (1 μm)	0.01°	0.005 mm (5 μm)
4	Travel Distance per Load Shaft Revolution (Reference Units)	6 mm/0.001 mm = 6,000	360°/0.01° = 36,000	314 mm/0.005 mm = 62,800
5	Electronic Gear Ratio	$\frac{B}{A} = \frac{16,777,216}{6,000} \times \frac{1}{1}$	$\frac{B}{A} = \frac{16,777,216}{36,000} \times \frac{100}{1}$	$\frac{B}{A} = \frac{16,777,216}{62,800} \times \frac{50}{1}$
6	Position User Unit (2701 hex)	Numerator: 16,777,216	Numerator: 1,677,721,600	Numerator: 838,860,800
		Denominator: 6,000	Denominator: 36,000	Denominator: 62,800

- Linear Servomotors

A setting example for a Serial Converter Unit resolution of 256 is given below.

Step	Description	Machine Configuration
		
1	Linear Encoder Pitch	0.02 mm (20 μm)
2	Reference Unit	0.001 mm (1 μm)
3	Electronic Gear Ratio	$\frac{B}{A} = \frac{1\ (\mu m)}{20\ (\mu m)} \times 256$
4	Position User Unit (2701 hex)	Numerator: 256
		Denominator: 20

5.14.2 Setting the Speed Reference Unit

Set the speed reference unit [Vel Unit] in *velocity user unit* (2702 hex).

Index	Subindex	Name	Data Type	Access	PDO Mappings	Value	Saving to EEPROM
2702 hex	0	Number of entries	USINT	RO	No	2	No
	1	Numerator	UDINT	RW	No	1 to 1,073,741,823 (default: 1)	Yes
	2	Denominator	UDINT	RW	No	1 to 1,073,741,823 (default: 1)	Yes

Setting range: 1/128 ≤ Numerator/Denominator ≤ 8,388,608
(Alarm A.A20 will be detected if the setting exceeds the setting range.)

Example **Speed Reference Unit Setting Example**

- Velocity User Unit (2702 Hex)
  Converting one user-defined velocity reference unit [0.1 mm/s] into [inc/s]:

$$1\ [\text{Vel unit}]$$

$$= \frac{16{,}777{,}216\ [\text{inc}] \times (2/1)}{6\ [\text{mm}]} \times 0.1\ [\text{mm/s}]$$

$$= \frac{33{,}554{,}432}{60}\ [\text{inc/s}]$$

Therefore, the objects are set as follows:
Object 2702 hex: 01 (Numerator) = 33,554,432
Object 2702 hex: 02 (Denominator) = 60

5.14.3 Setting the Acceleration Reference Unit

Set the acceleration reference unit [Acc Unit] in *acceleration user unit* (2703 hex).

Index	Subindex	Name	Data Type	Access	PDO Mappings	Value	Saving to EEPROM
2703 hex	0	Number of entries	USINT	RO	No	2	No
	1	Numerator	UDINT	RW	No	1 to 1,073,741,823 (default: 1)	Yes
	2	Denominator	UDINT	RW	No	1 to 1,073,741,823 (default: 1)	Yes

Setting range: 1/128 ≤ Numerator/Denominator ≤ 262,144
(Alarm A.A20 will be detected if the setting exceeds the setting range.)

Example **Acceleration Reference Unit Setting Example**

- Acceleration User Unit (2703 hex)
  Converting one user-defined acceleration reference unit [0.1 mm/s^2] into [10^4 inc/s^2]:

$$1\ [\text{Acc unit}]$$

$$= \frac{16{,}777{,}216\ [\text{inc}] \times (2/1)}{6\ [\text{mm}]} \times 0.1\ [\text{mm/s}^2] \times 10^{-4}$$

$$= \frac{33{,}554{,}432^2}{6 \times 10^5}\ [10^4\ \text{inc/s}^2]$$

Therefore, the objects are set as follows:
Object 2703 hex: 01 (Numerator) = 33,554,432
Object 2703 hex: 02 (Denominator) = 600,000

5.14.4 Setting the Torque Reference Unit

Set the torque reference unit [Torque Unit] in *torque user unit* (2704 hex).

Index	Subin-dex	Name	Data Type	Access	PDO Mappings	Value	Saving to EEPROM
2704 hex	0	Number of entries	USINT	RO	No	2	No
	1	Numerator	UDINT	RW	No	1 to 1,073,741,823 (default: 1)	Yes
	2	Denominator	UDINT	RW	No	1 to 1,073,741,823 (default: 1)	Yes

Setting range: 1/128 ≤ Numerator/Denominator ≤ 262,144
(Alarm A.A20 will be detected if the setting exceeds the setting range.)

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

⚠ 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.

Information The multiturn data will always be zero in the following cases. It is never necessary to reset the absolute encoder in these cases.
- 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□□)

Also, an alarm related to the absolute encoder (A.810 or A.820) will not occur.

5.15.1 Precautions on Resetting

- The parameters must not be write prohibited.
- The servo must be OFF to reset the absolute encoder.
- You cannot use the Alarm/Warning Clear (Fault Reset) command from the SERVOPACK 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.

5.15.2 Applicable Tools

The following table lists the tools that you can use to reset the absolute encoder and the applicable tool functions.

Tool	Function	Reference
Digital Operator	Fn008	📖 Σ-7-Series Digital Operator Operating Manual (Manual No.: SIEP S800001 33)
SigmaWin+	***Setup - Absolute Encoder Reset***	☞ *5.15.3 Operating Procedure* on page 5-50
EtherCAT (CoE) communications	SERVOPACK Adjusting Command (2710 hex)	☞ *SERVOPACK Adjusting Command (2710 Hex)* on page 14-19

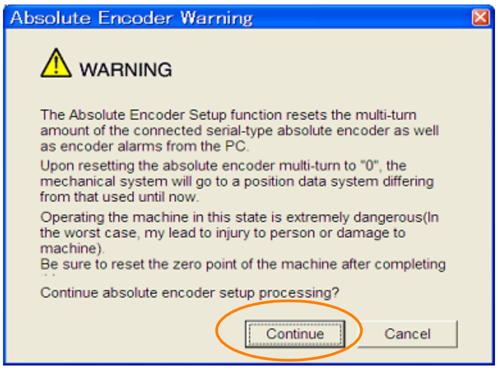
5.15.3 Operating Procedure

Use the following procedure to reset the absolute encoder

1. Confirm that the servo is OFF.

2. Select ***Setup - Reset Absolute Encoder*** from the menu bar of the Main Window of the SigmaWin+.

3. Click the **Continue** Button.



WARNING

The Absolute Encoder Setup function resets the multi-turn amount of the connected serial-type absolute encoder as well as encoder alarms from the PC.

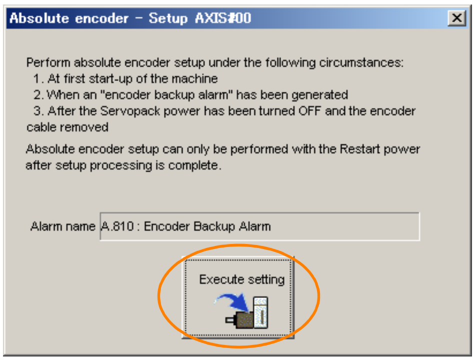
Upon resetting the absolute encoder multi-turn to "0", the mechanical system will go to a position data system differing from that used until now.

Operating the machine in this state is extremely dangerous(In the worst case, my lead to injury to person or damage to machine).
Be sure to reset the zero point of the machine after completing

Continue absolute encoder setup processing?

Click the **Cancel** Button to cancel resetting the absolute encoder. The Main Window will return.

4. Click the **Execute setting** Button.



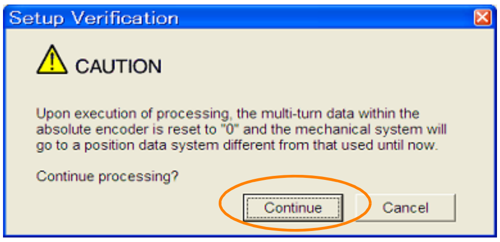
Perform absolute encoder setup under the following circumstances:
1. At first start-up of the machine
2. When an "encoder backup alarm" has been generated
3. After the Servopack power has been turned OFF and the encoder cable removed

Absolute encoder setup can only be performed with the Restart power after setup processing is complete.

Alarm name A.810 : Encoder Backup Alarm

The current alarm code and name will be displayed in the **Alarm name** Box.

5. Click the **Continue** Button.



CAUTION

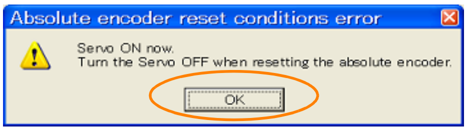
Upon execution of processing, the multi-turn data within the absolute encoder is reset to "0" and the mechanical system will go to a position data system different from that used until now.

Continue processing?

Click the **Cancel** Button to cancel resetting the absolute encoder. The previous dialog box will return.

6. Click the **OK** Button.
The absolute encoder will be reset.

When Resetting Fails
If you attempted to reset the absolute encoder when the servo was ON in the SERVOPACK, the following dialog box will be displayed and processing will be cancelled.

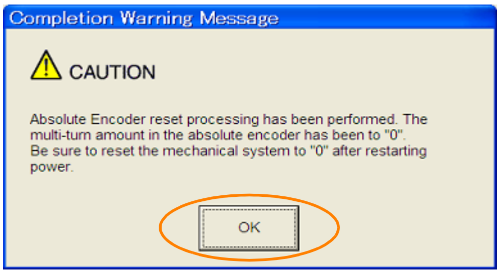


Absolute encoder reset conditions error

Servo ON now.
Turn the Servo OFF when resetting the absolute encoder.

Click the **OK** Button. The Main Window will return. Turn OFF the servo and repeat the procedure from step 1.

When Resetting Is Successful
The following dialog box will be displayed when the absolute encoder has been reset.



Completion Warning Message

CAUTION

Absolute Encoder reset processing has been performed. The multi-turn amount in the absolute encoder has been to "0".
Be sure to reset the mechanical system to "0" after restarting power.

The Main Window will return.

7. To enable the change to the settings, turn the power supply to the SERVOPACK OFF and ON again.

This concludes the procedure to reset the absolute encoder.

5.16 Setting the Origin of the Absolute Encoder

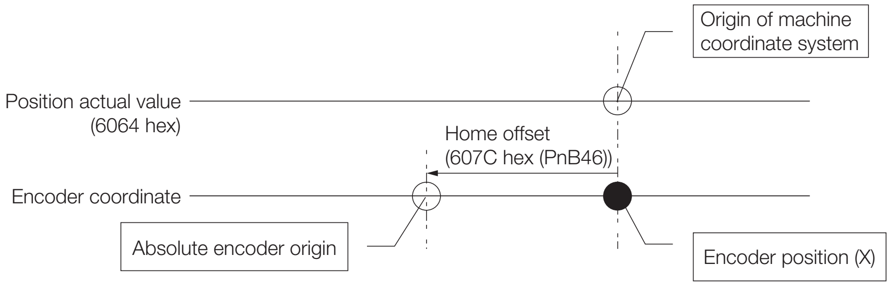
5.16.1 Absolute Encoder Origin Offset

The origin offset of the absolute encoder is a correction that is used to set the origin of the machine coordinate system in addition to the origin of the absolute encoder. Set the offset between the absolute encoder origin and the machine coordinate system position in *home offset* (607C hex).

The offset is added to *position actual value* (6064 hex) after the parameters are enabled when the power supply is turned ON or with *user parameter configuration* (2700 hex).

Index	Subindex	Name	Data Type	Access	Data Ranges	Default Value	Saving to EEPROM
607C hex	0	Home offset	DINT	RW	-536,870,912 to 536,870,911	0	Yes

Example If the encoder position (X) is at the origin (0), then *home offset* (607C hex) would be set to the value of -X.



5.16.2 Setting the Origin of the Absolute Linear Encoder

You can set any position as the origin in the following Linear Encoders.

- Mitutoyo Corporation
  ABS ST780A Series
  Models: ABS ST78□A/ST78□AL

Important

1. After you set the origin, the /S-RDY (Servo Ready) signal will become inactive because the system position data was changed. Always turn the SERVOPACK power supply OFF and ON again.
2. After you set the origin, the Servomotor phase data in the SERVOPACK will be discarded. If you are using a Linear Servomotor without a Polarity Sensor, execute polarity detection again to save the Servomotor phase data in the SERVOPACK.

Preparations

The following conditions must be met to set the origin of the absolute linear encoder.

- 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 set the origin of the absolute linear encoder and the applicable tool functions.

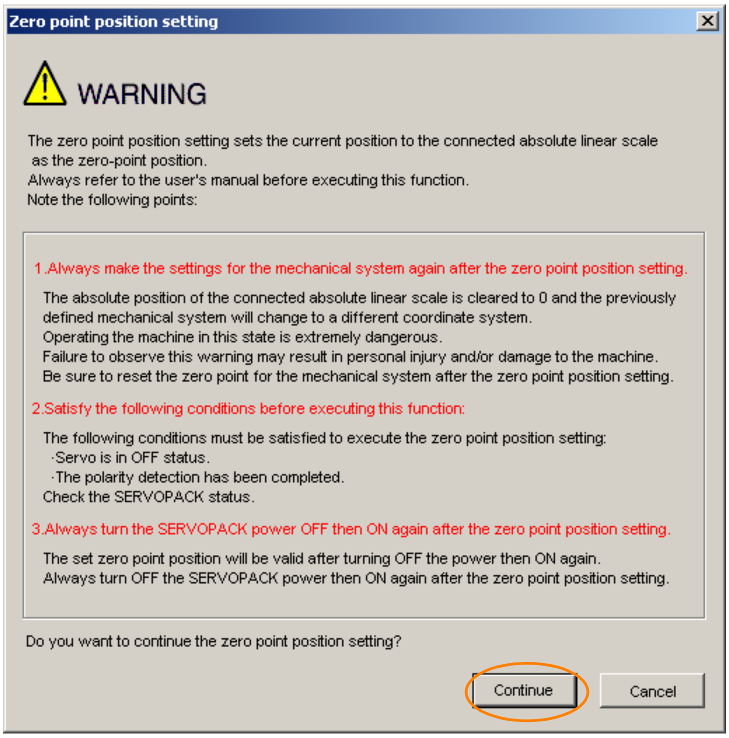
Tool	Function	Reference
Digital Operator	Fn020	🕮 Σ-7-Series Digital Operator Operating Manual (Manual No.: SIEP S800001 33)
SigmaWin+	***Setup - Set Origin***	☞ *Operating Procedure* on page 5-53

Operating Procedure

Use the following procedure.

1. Select ***Setup - Set Origin*** from the menu bar of the Main Window of the SigmaWin+.
   Click the **Cancel** Button to cancel setting the origin of the absolute linear encoder. The Main Window will return.

2. Click the **Continue** Button.



Zero point position setting

WARNING

The zero point position setting sets the current position to the connected absolute linear scale as the zero-point position.
Always refer to the user's manual before executing this function.
Note the following points:

1.Always make the settings for the mechanical system again after the zero point position setting.

The absolute position of the connected absolute linear scale is cleared to 0 and the previously defined mechanical system will change to a different coordinate system.
Operating the machine in this state is extremely dangerous.
Failure to observe this warning may result in personal injury and/or damage to the machine.
Be sure to reset the zero point for the mechanical system after the zero point position setting.

2.Satisfy the following conditions before executing this function:

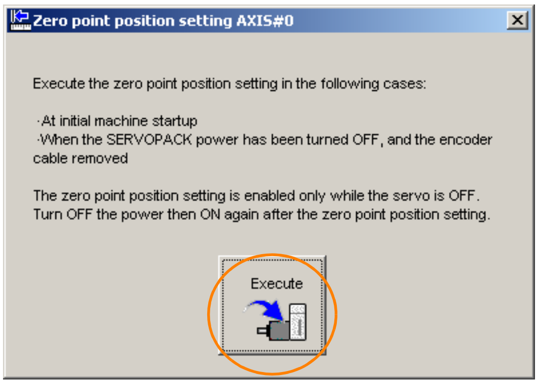
The following conditions must be satisfied to execute the zero point position setting:
·Servo is in OFF status.
·The polarity detection has been completed.
Check the SERVOPACK status.

3.Always turn the SERVOPACK power OFF then ON again after the zero point position setting.

The set zero point position will be valid after turning OFF the power then ON again.
Always turn OFF the SERVOPACK power then ON again after the zero point position setting.

Do you want to continue the zero point position setting?

3. Click the **Execute setting** Button.



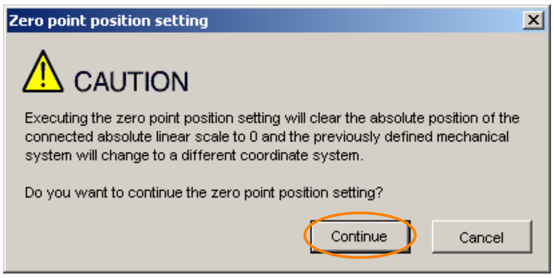
Zero point position setting AXIS#0

Execute the zero point position setting in the following cases:

·At initial machine startup
·When the SERVOPACK power has been turned OFF, and the encoder cable removed

The zero point position setting is enabled only while the servo is OFF.
Turn OFF the power then ON again after the zero point position setting.

4. Click the **Continue** Button.



Zero point position setting

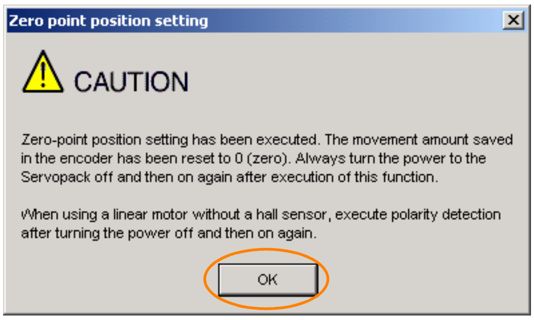
CAUTION

Executing the zero point position setting will clear the absolute position of the connected absolute linear scale to 0 and the previously defined mechanical system will change to a different coordinate system.

Do you want to continue the zero point position setting?

Click the **Cancel** Button to cancel setting the origin of the absolute linear encoder. The previous dialog box will return.

5. Click the **OK** Button.



Zero point position setting

CAUTION

Zero-point position setting has been executed. The movement amount saved in the encoder has been reset to 0 (zero). Always turn the power to the Servopack off and then on again after execution of this function.

When using a linear motor without a hall sensor, execute polarity detection after turning the power off and then on again.

6. Turn the power supply to the SERVOPACK OFF and ON again.

7. If you use a Linear Servomotor that does not have a polarity sensor, perform polarity detection.
   Refer to the following section for details on the polarity detection.
   ☞ *5.9 Polarity Detection* on page 5-24

This concludes the procedure to set the origin of the absolute linear encoder.

5.17 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) and Pn603 (Regenerative Resistor Resistance).

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 (2600 hex)	Regenerative Resistor Capacity				Speed Position Torque
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 to SERVOPACK's maximum applicable motor capacity	10 W	0	Immediately	Setup
Pn603 (2603 hex)	Regenerative Resistor Resistance				Speed Position Torque
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 to 65,535	10 mΩ	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.

Example 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 SERVOPACK's built-in regenerative resistor or Yaskawa's Regenerative Resistor Unit is being used.

Important

1. 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.
2. For safety, use an External Regenerative Resistor with a thermoswitch.

Application Functions

6

This chapter describes the application functions that you can set before you start servo system operation. It also describes the setting methods.

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

Important

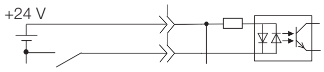
- If you change the default polarity settings for the P-OT (Forward Drive Prohibit) or N-OT (Reverse Drive Prohibit) signal, the overtravel function will not operate if there are signal line disconnections or other problems. If you must change the polarity of one of these signals, verify operation and 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.

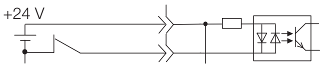
The input signals that you can allocate to the pins on the I/O signal connector (CN1) and the related parameters are given in the following table.

Input Signal	Input Signal Name	Parameter
P-OT	Forward Drive Prohibit	Pn50A (250A hex) = n.X□□□
N-OT	Reverse Drive Prohibit	Pn50B (250B hex) = n.□□□X
/P-CL	Forward External Torque Limit	Pn50B (250B hex) = n.□X□□
/N-CL	Reverse External Torque Limit	Pn50B (250B hex) = n.X□□□
/Probe1	Probe 1 Latch Input	Pn511 (2511 hex) = n.□□X□
/Probe2	Probe 2 Latch Input	Pn511 (2511 hex) = n.□X□□
/Home	/Home Input	Pn511 (2511 hex) = n.X□□□
FSTP	Forced Stop	Pn516 (2516 hex) = 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	13	 A reverse signal (a signal with "/" before the signal abbreviation, such as the /P-CL 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	7	
2	8	
3	9	
4	10	
5	11	
6	12	
7	–	The input signal is not allocated to a connector pin and it is always active. If the signal is processed on a signal edge, then it is always inactive.
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.

Parameter Setting	Pin No.	Description
9	13	 A reverse signal (a signal with “/” before the signal abbreviation, such as the /P-CL signal) is active when the contacts are OFF (open). A signal that does not have “/” before the signal abbreviation (such as the P-OT signal) is active when the contacts are ON (closed).
A	7	
B	8	
C	9	
D	10	
E	11	
F	12	

Note: 1. You can allocate the /Probe1, /Probe2, and /Home input signals only to pins 10 to 12 on the I/O signal connector (CN1).
2. Refer to the following section for details on input signal parameter settings.
☞ *16.1.2 List of Parameters* on page 16-3

Example of Changing Input Signal Allocations

The following example shows reversing the P-OT (Forward Drive Prohibit) signal allocated to CN1-7 and the /DEC (Origin Return Deceleration Switch) signal allocated to CN1-9.

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

↓ ↓

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

Refer to the following section for the parameter setting procedure.
☞ ***5.1.3 Setting Methods for SERVOPACK Parameters*** on page 5-5

Confirming Input Signals

You can confirm the status of input signals on the I/O signal monitor. Refer to the following section for information on the I/O signal monitor.
☞ *9.2.3 I/O Signal Monitor* on page 9-5

6.1.2 Output Signal Allocations

You can allocate the desired output signals to pins 1, 2, and 23 to 26 on the I/O signal connector (CN1). You set the allocations in the following parameters: Pn50E, Pn50F, Pn510, and Pn514.

Important

- 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.

Output signals are allocated as shown in the following table.

Refer to *Interpreting the Output Signal Allocation Tables* and change the allocations accordingly.

Interpreting the Output Signal Allocation Tables

These columns give the parameter settings to use. Signals are allocated to CN1 pins according to the settings.

□ : Default settings.

Output Signal Name and Parameter	Output Signals	CN1 Pin No.			Disabled (Not Used)
		1 and 2	23 and 24	25 and 26	
Brake Pn50F (250F hex) = □X□□	/BK	1	2	3	0

Output Signal Name and Parameter	Output Signals	CN1 Pin No.			Disabled (Not Used)
		1 and 2	23 and 24	25 and 26	
Positioning Completion Pn50E (250E hex) = n.□□□X	/COIN	1	2	3	0
Speed Coincidence Detection Pn50E (250E hex) = n.□□X□	/V-CMP	1	2	3	0
Rotation Detection Pn50E (250E hex) = n.□X□□	/TGON	1	2	3	0
Servo Ready Pn50E (250E hex) = n.X□□□	/S-RDY	1	2	3	0
Torque Limit Detection Pn50F (250F hex) = n.□□□X	/CLT	1	2	3	0
Speed Limit Detection Pn50F (250F hex) = n.□□X□	/VLT	1	2	3	0
Brake Pn50F (250F hex) = n.□X□□	/BK	1	2	3	0
Warning Pn50F (250F hex) = n.X□□□	/WARN	1	2	3	0
Near Pn510 (2510 hex) = n.□□□X	NEAR	1	2	3	0
Preventative Maintenance Pn514 (2514 hex) = n.□X□□	/PM	1	2	3	0
Pn512 (2512 hex) = n.□□□1	Reverse polarity for CN1-1 and CN1-2				0 (The polarity is not reversed in the default settings.)
Pn512 (2512 hex) = n.□□1□	Reverse polarity for CN1-23 and CN1-24				
Pn512 (2512 hex) = n.□1□□	Reverse polarity for CN1-25 and CN1-26				

Example of Changing Output Signal Allocations

The following example shows disabling the /COIN (Positioning Completion) signal allocated to CN1-25 and CN1-26 and allocating the /SRDY (Servo Ready) signal.

Pn50E = n.0□□3 Before change

↓

Pn50E = n.3□□0 After change

Refer to the following section for the parameter setting procedure.

☞ ***5.1.3 Setting Methods for SERVOPACK Parameters*** on page 5-5

Checking Output Signal Status

You can confirm the status of output signals on the I/O signal monitor. Refer to the following section for information on the I/O signal monitor.

☞ *9.2.3 I/O Signal Monitor* on page 9-5

6.1.3 ALM (Servo Alarm) Signal

This signal is output when the SERVOPACK detects an error.

Important

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

Type	Signal	Connector Pin No.	Signal Status	Meaning
Output	ALM	CN1-3 and CN1-4	ON (closed)	Normal SERVOPACK status
			OFF (open)	SERVOPACK alarm

Alarm Reset Methods

Refer to the following section for information on the alarm reset methods.

☞ *15.2.3 Resetting Alarms* on page 15-38

6.1.4 /WARN (Warning) Signal

Both alarms and warnings are generated by the SERVOPACK. Alarms indicate errors in the SERVOPACK 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.

☞ *6.1.2 Output Signal Allocations* on page 6-4

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 (Rotation Detection Level) or faster or the setting of Pn581 (Zero Speed Level) or faster.

Type	Signal	Connector Pin No.	Signal Status	Servomotor	Meaning
Output	/TGON	Must be allocated.	ON (closed)	Rotary Servomotors	The Servomotor is operating at the setting of Pn502 or faster.
				Linear Servomotors	The Servomotor is operating at the setting of Pn581 or faster.
			OFF (open)	Rotary Servomotors	The Servomotor is operating at a speed that is slower than the setting of Pn502.
				Linear Servomotors	The Servomotor is operating at a speed that is slower than the setting of Pn581.

Note: You must allocate the /TGON signal to use it. Use Pn50E = n.□X□□ (/TGON (Rotation Detection Output) Signal Allocation) to allocate the signal to a connector pin. Refer to the following section for details.

☞ *6.1.2 Output Signal Allocations* on page 6-4

Setting the Rotation Detection Level

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

- Rotary Servomotors

Pn502 (2502 hex)	Rotation Detection Level		Speed	Position	Torque
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	1 to 10,000	1 min^{-1}	20	Immediately	Setup

- Linear Servomotors

Pn581 (2581 hex)	Zero Speed Level		Speed	Position	Force
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	1 to 10,000	1 mm/s	20	Immediately	Setup

6.1.6 /S-RDY (Servo Ready) Signal

The /S-RDY (Servo Ready) signal turns ON when the SERVOPACK is ready to accept the Servo ON command (Enable Operation command).

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 a Servomotor without a polarity sensor is used, polarity detection has been completed. *

* Do not include this condition if the Servo ON command (Enable Operation command) is input for the first time after the control power supply was turned ON. In that case, when the first Servo ON command (Enable Operation command) 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 Servo ON command (Enable Operation command).
			OFF (open)	Not ready to receive Servo ON command (Enable Operation command).

Note: 1. You must allocate the /S-RDY signal to use it. Use Pn50E = n.X□□□ (/S-RDY (Servo Ready) Signal Allocation) to allocate the signal to a connector pin. Refer to the following section for details.
☞ *6.1.2 Output Signal Allocations* on page 6-4

2. Refer to the following section for information on the hard wire base block and the /S-RDY signal.
☞ *11.2.8 /S-RDY (Servo Ready Output) Signal* on page 11-10

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 SERVOPACK 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 must allocate the /V-CMP signal to use it. Use Pn50E = n.□□X□ (/V-CMP (Speed Coincidence Detection Output) Signal Allocation) to allocate the signal to connector pins.
Refer to the following section for details on allocations.
☞ *6.1.2 Output Signal Allocations* on page 6-4

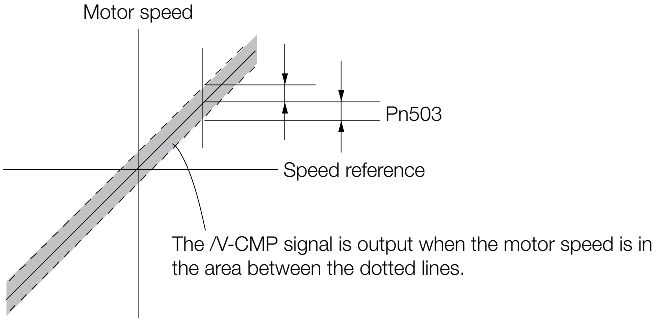
You can set the speed detection width for the /V-CMP signal in Pn503 (Speed Coincidence Signal Detection Width) for a Rotary Servomotor or in Pn582 (Speed Coincidence Signal Detection Width) for a Linear Servomotor.

- Rotary Servomotors

Pn503 (2503 hex)	Speed Coincidence Signal Detection Width		Speed		
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 to 100	1 min^{-1}	10	Immediately	Setup

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

Example 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 and 2,100 min^{-1}.

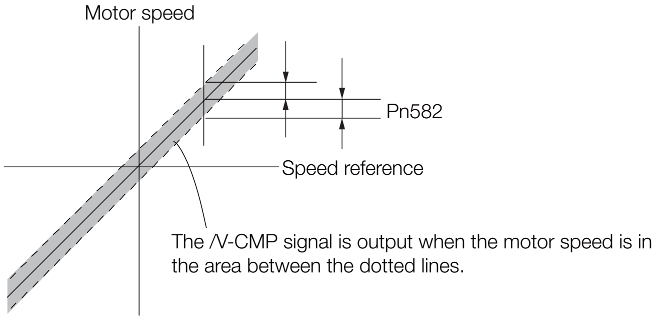


- Linear Servomotors

Pn582 (2582 hex)	Speed Coincidence Signal Detection Width		Speed		
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 to 100	1 mm/s	10	Immediately	Setup

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

Example If Pn582 is set to 100 and the speed reference is 2,000 mm/s the signal would be output when the motor speed is between 1,900 and 2,100 mm/s.



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: You must allocate the /COIN signal to use it. Use Pn50E = n.□□□X (/COIN (Positioning Completion Output) Signal Allocation) to allocate the signal to connector pins. Refer to the following section for details on allocations.

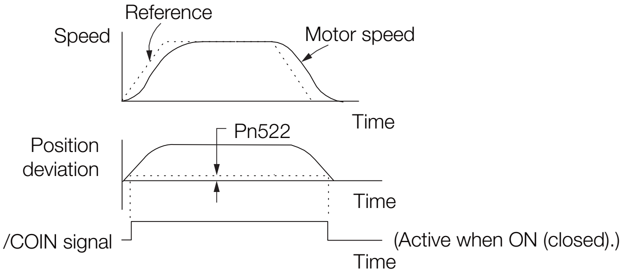
☞ *6.1.2 Output Signal Allocations* on page 6-4

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).

Pn522 (2522 hex)	Positioning Completed Width			Position	
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 to 1,073,741,824	1 reference unit	7	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		Description	When Enabled	Classification
Pn207 (2207 hex)	n.0□□□ (default setting)	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.

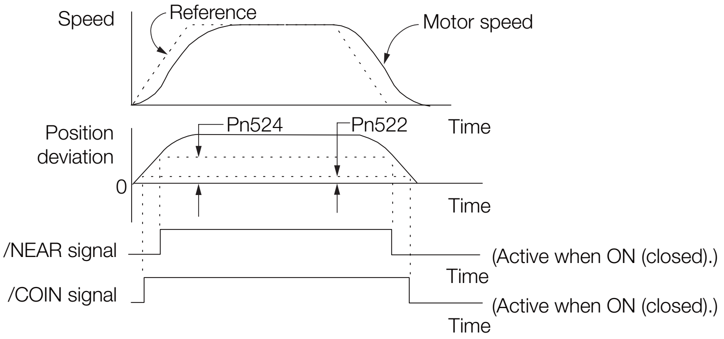
Type	Signal	Connector Pin No.	Signal Status	Meaning
Output	/NEAR	Must be allocated.	ON (closed)	The Servomotor has reached a point near to positioning completion.
			OFF (open)	The Servomotor has not reached a point near to positioning completion.

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.
☞ *6.1.2 Output Signal Allocations* on page 6-4

/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).

Pn524 (2524 hex)	Near Signal Width			Position	
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	1 to 1,073,741,824	1 reference unit	1,073,741,824	Immediately	Setup



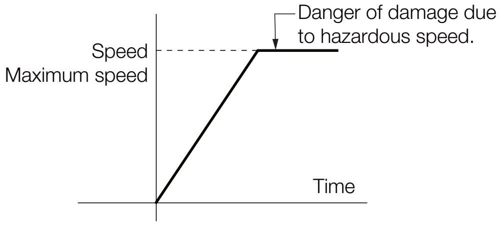
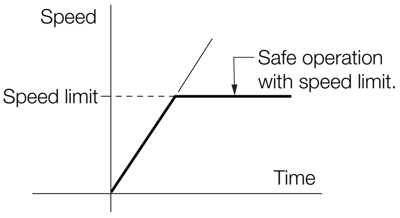
Note: Normally, set Pn524 to a value that is larger than the setting of Pn522 (Positioning Completed Width).

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 motor 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.

☞ *6.1.2 Output Signal Allocations* on page 6-4

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 (2002 hex)	n.□□0□ (default setting)	Ignore the setting of the speed limit for the VLIM (Limit Speed for Torque Control) command and use the speed limit set in Pn407 or Pn480. (Use internal speed limiting.)	After restart	Setup
	n.□□1□	Use the speed limit from the VLIM (Limit Speed for Torque Control) command as the speed limit. (Use external speed limiting.)		

Note: If you are using a Rotary Servomotor, set Pn407 (Speed Limit during Torque Control). If you are using a Linear Servomotor, set Pn480 (Speed Limit during Force Control).

◆ Internal Speed Limiting

If you select internal speed limiting for the torque control option (Pn002 = n.□□X□), 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 (2408 hex)	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). If you are using a Linear Servomotor, set Pn480 (Speed Limit during Force Control).

- Rotary Servomotors

Pn407 (2407 hex)	Speed Limit during Torque Control				Torque
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 to 10,000	1 min^{-1}	10000	Immediately	Setup

- Linear Servomotors

Pn480 (2480 hex)	Speed Limit during Force Control				Force
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 to 10,000	1 mm/s	10000	Immediately	Setup

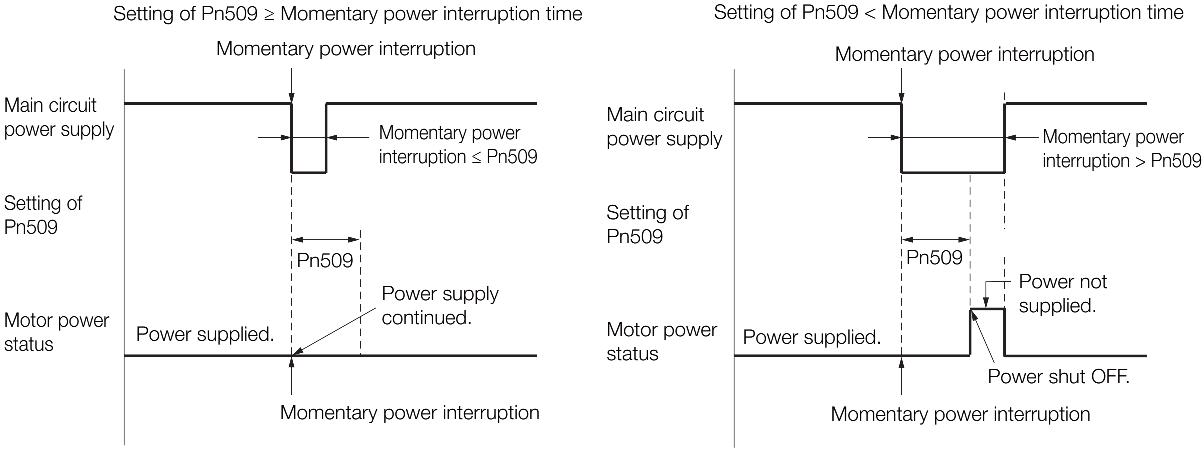
Note: If the parameter setting exceeds the maximum speed of the Servomotor, the Servomotor's maximum speed or the overspeed alarm detection speed will be used.

6.2 Operation for Momentary Power Interruptions

Even if the main power supply to the SERVOPACK 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).

Pn509 (2509 hex)	Momentary Power Interruption Hold Time			Speed Position Torque	
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	20 to 50,000	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.



Information

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 SERVOPACK can withstand a power interruption that lasts longer than 50,000 ms.
3. The holding time of the SERVOPACK 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.

Important

The holding time of the main circuit power supply depends on the output from the SERVOPACK. 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 SERVOPACK 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.

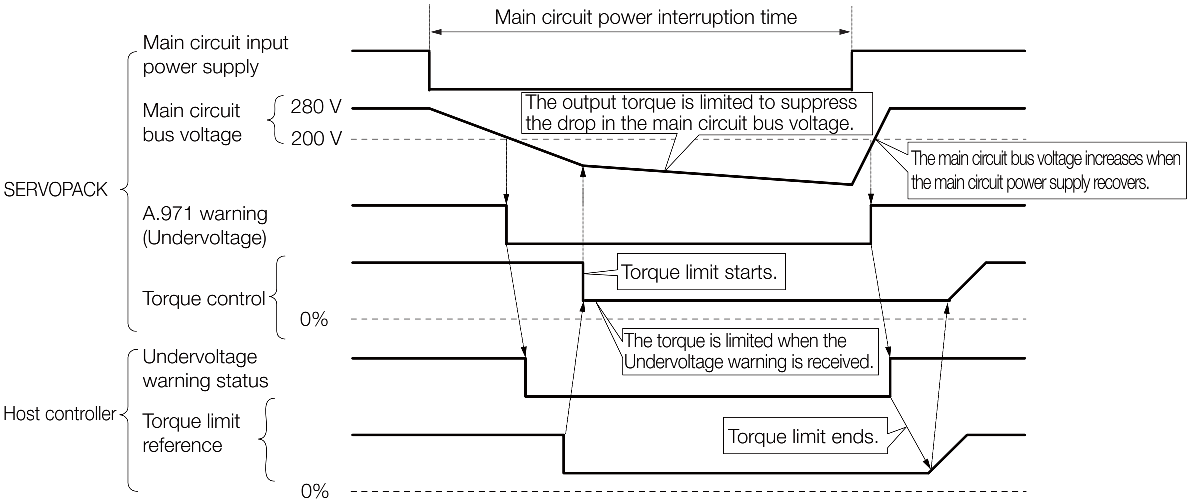
Execution Sequence

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

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

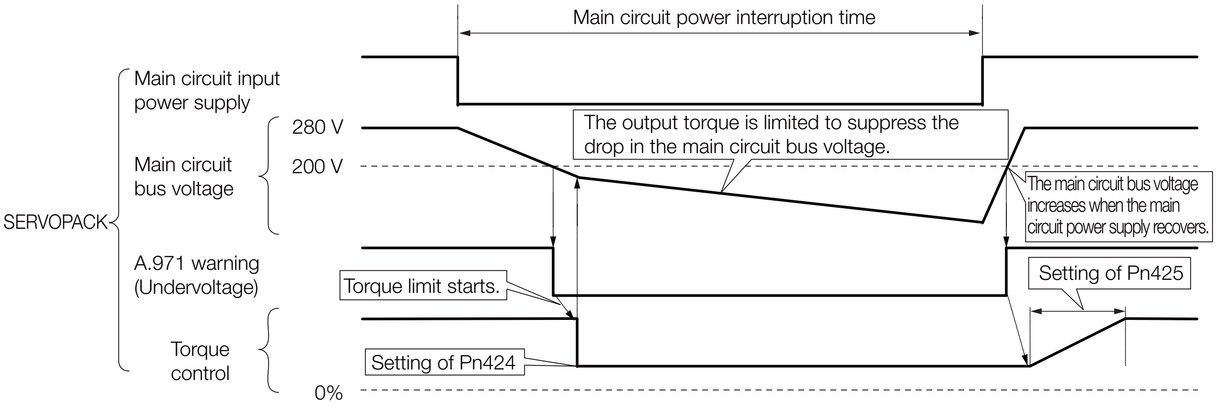
The host controller limits the torque in response to an A.971 warning (Undervoltage).

The host controller removes the torque limit after the Undervoltage warning is cleared.



◆ Execution with the SERVOPACK (Pn008 = n.□□2□)

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



Setting for A.971 Warnings (Undervoltage)

You can set whether or not to detect A.971 warnings (Undervoltage).

Parameter		Meaning	When Enabled	Classification
Pn008 (2008 hex)	n.□□0□ (default setting)	Do not detect undervoltage warning.	After restart	Setup
	n.□□1□	Detect undervoltage warning and limit torque at host controller.		
	n.□□2□	To detect undervoltage warnings, use Pn424 (Torque Limit at Main Circuit Voltage Drop) and Pn425 (Release Time for Torque Limit at Main Circuit Voltage Drop). (i.e., only in SERVOPACK).		

◆ Related Parameters

The following parameters are related to the SEMI F47 function.

Pn424 (2424 hex)	Torque Limit at Main Circuit Voltage Drop			Speed Position	Torque
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 to 100	1%*	50	Immediately	Setup
Pn425 (2425 hex)	Release Time for Torque Limit at Main Circuit Voltage Drop			Speed Position	Torque
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 to 1,000	1 ms	100	Immediately	Setup
Pn509 (2509 hex)	Momentary Power Interruption Hold Time			Speed Position	Torque
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	20 to 50,000	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.

Important

- 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 SERVOPACK 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 SERVOPACK'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 Servo OFF command (Disable Operation command).

6.4 Setting the Motor Maximum Speed

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

- Rotary Servomotors

Pn316 (2316 hex)	Maximum Motor Speed			Speed Position Torque	
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 to 65,535	1 min^{-1}	10,000	After restart	Setup

- Linear Servomotors

Pn385 (2385 hex)	Maximum Motor Speed			Speed Position Force	
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	1 to 100	100 mm/s	50	After restart	Setup

You can achieve the following by lowering the maximum speed of the Servomotor.

- If the motor speed exceeds the setting, an A.510 alarm (Overspeed) will occur.
- With a Linear Servomotor, you can increase the upper limit for the setting of Pn281 (Encoder Output Resolution). Refer to the following section for details.
  ☞ *6.5 Encoder Divided Pulse Output* on page 6-17

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 not 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.
  📖 Σ-7-Series Rotary Servomotor Product Manual (Manual No.: SIEP S800001 36)
  📖 Σ-7-Series Direct Drive Servomotor Product Manual (Manual No.: SIEP S800001 38)
  📖 Σ-7-Series Linear Servomotor Product Manual (Manual No.: SIEP S800001 37)
- To increase the encoder output resolution and increase the position resolution managed by the host controller (for a Linear Servomotor)

6.5 Encoder Divided Pulse Output

The encoder divided pulse output is a signal that is output from the encoder and processed inside the SERVOPACK. 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.

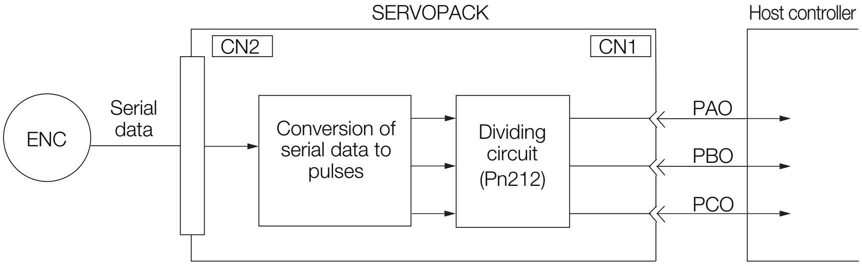
The following table describes the signals and output phase forms.

6.5.1 Encoder Divided Pulse Output Signals

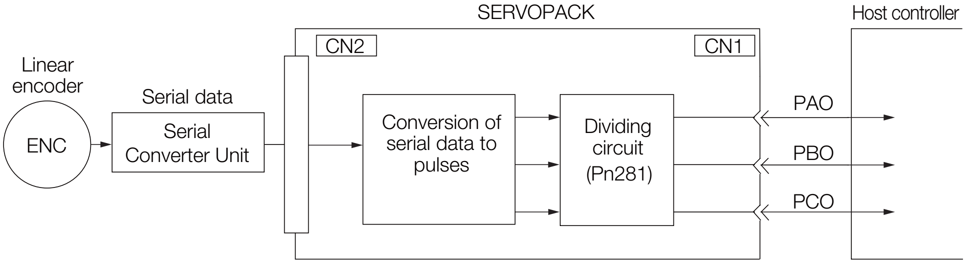
Type	Signal	Connector Pin No.	Name	Remarks
Output	PAO	CN1-17	Encoder Divided Pulse Output, Phase A	• Rotary Servomotors These encoder divided pulse output pins output the number of pulses per motor resolution that is set in Pn212 (Number of Encoder Output Pulses). The phase difference between phase A and phase B is an electric angle of 90°. • Linear Servomotors These encoder divided pulse output pins output pulses at the resolution that is set in Pn281 (Encoder Output Resolution). The phase difference between phase A and phase B is an electric angle of 90°.
	/PAO	CN1-18		
	PBO	CN1-19	Encoder Divided Pulse Output, Phase B	
	/PBO	CN1-20		
	PCO	CN1-21	Encoder Divided Pulse Output, Phase C*	These pins output one pulse every motor rotation.
	/PCO	CN1-22		

* Refer to the following section for information on the origin within one encoder rotation.
☞ ◆ *Encoder Output Pulse Signal from SERVOPACK with a Linear Encoder from Renishaw PLC* on page 6-18

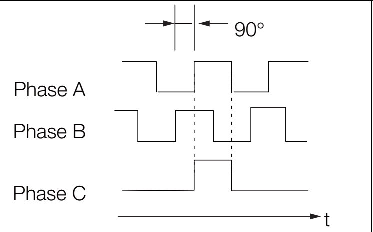
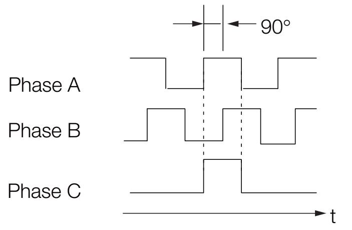
- Rotary Servomotor



- Linear Servomotors



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.

Important If you use the SERVOPACK'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.

Linear Encoder Application Precautions

The following precautions apply to the encoder output pulses when an external linear encoder is used.

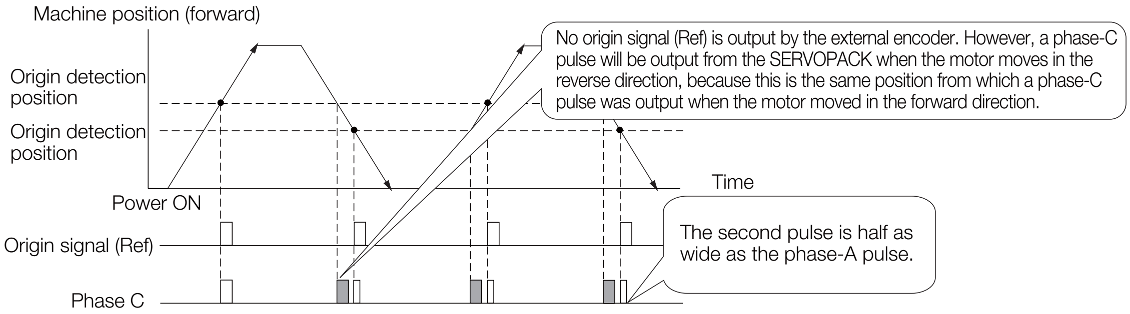
◆ Encoder Output Pulse Signal from SERVOPACK with a Linear Encoder from Renishaw PLC

The output position of the origin signal (Ref) will depend on the direction of movement for some models of linear encoders from Renishaw PLC.

In that case, the phase-C pulse of the SERVOPACK is output at two positions.

For detailed specifications on the origin signal for the linear encoder, refer to the manual for the Renishaw PLC linear encoder.

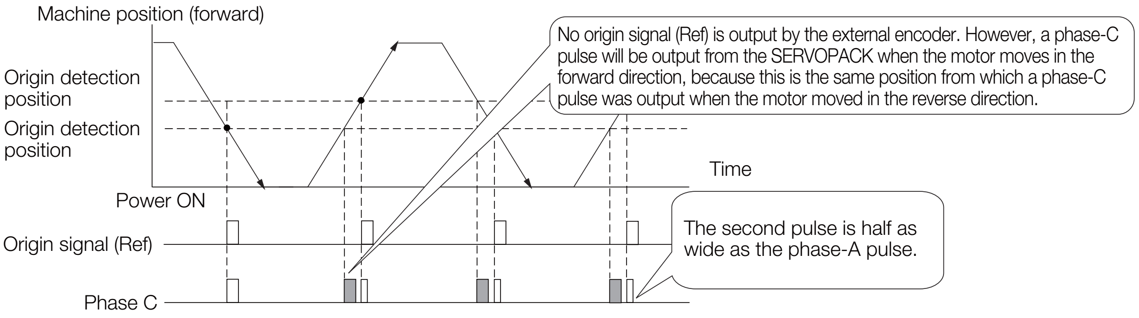
■ When Passing the First Origin Signal (Ref) in the Forward Direction and Returning after Turning ON the Power Supply



No origin signal (Ref) is output by the external encoder. However, a phase-C pulse will be output from the SERVOPACK when the motor moves in the reverse direction, because this is the same position from which a phase-C pulse was output when the motor moved in the forward direction.

The second pulse is half as wide as the phase-A pulse.

■ When Passing the First Origin Signal (Ref) in the Reverse Direction and Returning after Turning ON the Power Supply



No origin signal (Ref) is output by the external encoder. However, a phase-C pulse will be output from the SERVOPACK when the motor moves in the forward direction, because this is the same position from which a phase-C pulse was output when the motor moved in the reverse direction.

The second pulse is half as wide as the phase-A pulse.

◆ Precautions When Using a Linear Incremental Encoder from Magnescale Co., Ltd.

■ Encoder Divided Phase-C Pulse Output Selection

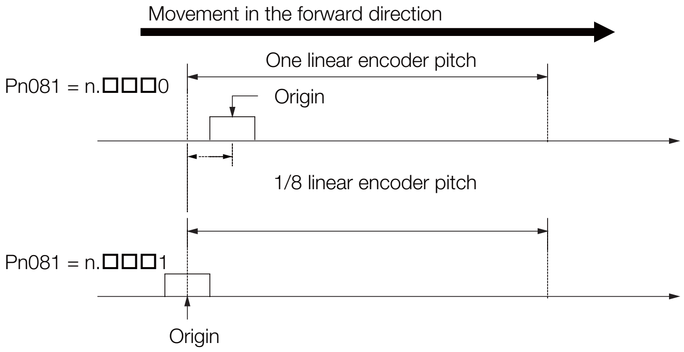
You can also output the encoder's phase-C pulse for reverse movement. To do so, set Pn081 to n.□□□1.

Parameter		Meaning	When Enabled	Classification
Pn081 (2081 hex)	n.□□□0 (default setting)	Output phase-C pulses only in the forward direction.	After restart	Setup
	n.□□□1	Output phase-C pulses in both the forward and reverse directions.		

Important

Precautions on Setting the Phase-C Pulse Output Selection (Pn081 = n.□□□X)

- If you set Pn081 to n.□□□1 (Output phase-C pulses in both the forward and reverse directions), the width of the phase-C pulse output may be narrower than the width of the phase-A pulse.
- There is a difference of 1/8th of the scale pitch in the phase-C detection position for the encoder's phase-C pulse output position, origin return command, or phase-C latch between when Pn081 = n.□□□X is set to 0 (Output phase-C pulses only in the forward direction) and when it is set to 1 (Output phase-C pulses in both the forward and reverse directions).



Observe the following precaution if you set Pn081 to n.□□□0 (Output phase-C pulses only in the forward direction).

When a linear incremental encoder from Magnescale Co., Ltd. is used, the count direction of the encoder determines how the phase-C pulse (CN1-21 and CN1-22) is output.

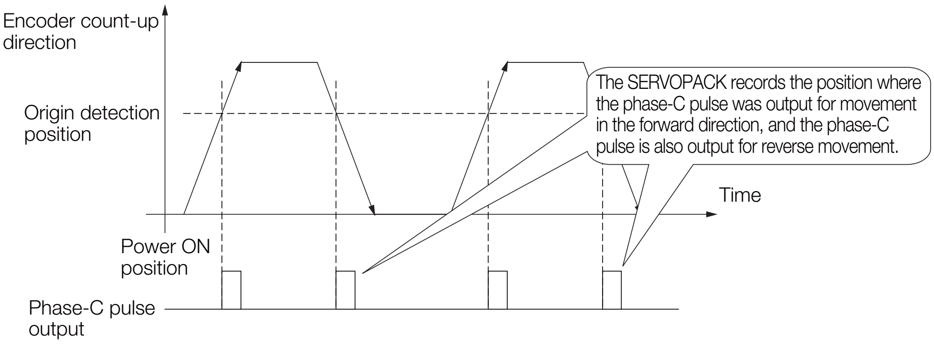
Note: The count direction (up or down) of the linear encoder determines whether a phase-C pulse is output. The output of the pulse does not depend on the setting of the movement direction (Pn000 = n.□□□1).

Encoder Model	Interpolator	Linear Encoder Pitch [µm]
SL710	PL101-RY MJ620-T13	800
SL720		800
SL730		800
SR75		80
SR85		80

■ When First Passing the Origin Signal in the Forward Direction and Returning after Turning ON the Power Supply

The encoder’s phase-C pulse (CN1-21 and CN1-22) is output when the origin detection position is passed for the first time in the forward direction after the power supply is turned ON.

After that, the phase-C pulse is output whenever the origin detection position is passed in the forward or reverse direction.

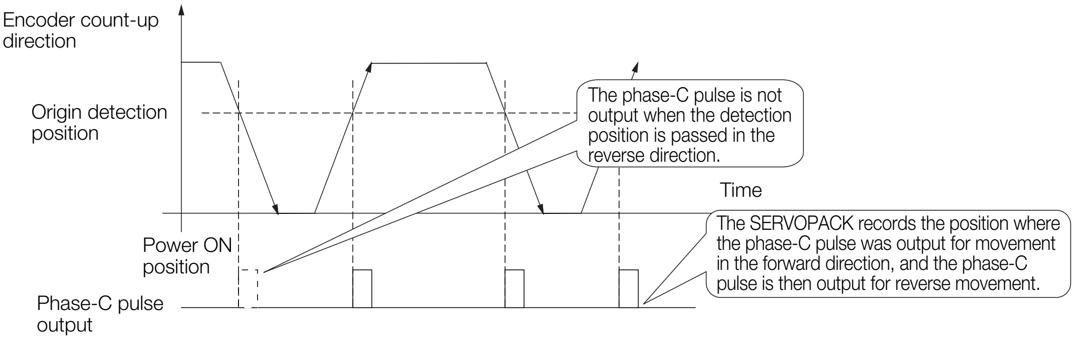


The SERVOPACK records the position where the phase-C pulse was output for movement in the forward direction, and the phase-C pulse is also output for reverse movement.

■ When First Passing the Origin Signal in the Reverse Direction and Returning after Turning ON the Power Supply

The encoder's phase-C pulse (CN1-19 and CN1-20) is not output when the origin detection position is passed for the first time in the reverse direction after the power supply is turned ON.

However, after the origin detection position is passed in the forward direction and the encoder’s phase-C pulse is output, it will then also be output when the origin detection point is passed in the reverse direction.

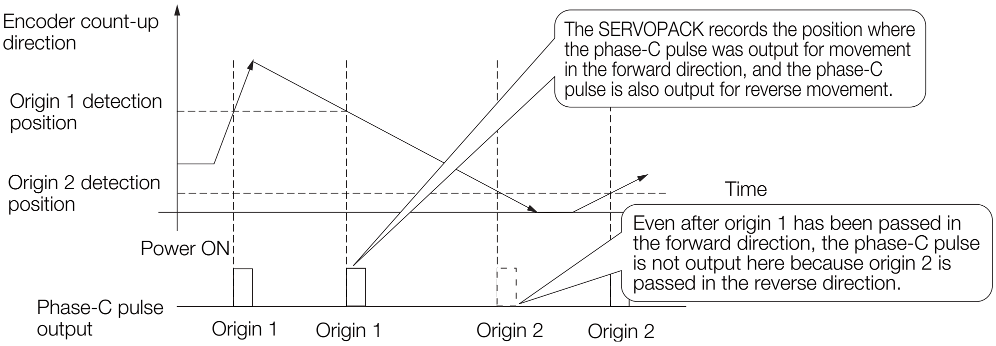


The phase-C pulse is not output when the detection position is passed in the reverse direction.

The SERVOPACK records the position where the phase-C pulse was output for movement in the forward direction, and the phase-C pulse is then output for reverse movement.

■ When Using a Linear Encoder with Multiple Origins and First Passing the Origin Position in the Forward Direction and Returning after Turning ON the Power Supply

The encoder’s phase-C pulse is output when the origin detection position is passed for the first time in the forward direction after the power supply is turned ON. After that, the phase-C pulse is output whenever the origin detection position is passed in the forward or reverse direction.

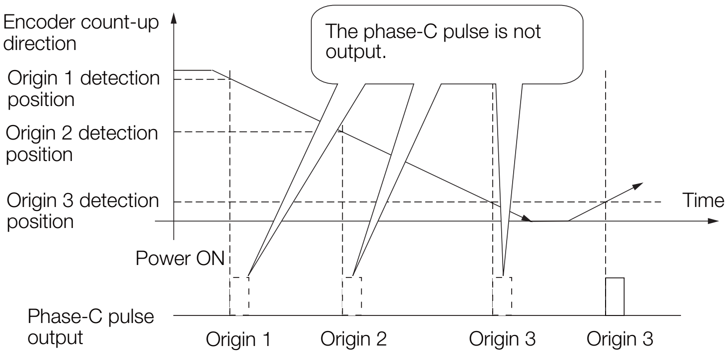


The SERVOPACK records the position where the phase-C pulse was output for movement in the forward direction, and the phase-C pulse is also output for reverse movement.

Even after origin 1 has been passed in the forward direction, the phase-C pulse is not output here because origin 2 is passed in the reverse direction.

■ When Using a Linear Encoder with Multiple Origins and First Passing the Origin Position in the Reverse Direction after Turning ON the Power Supply

The encoder’s phase-C pulse is not output when the origin detection position is passed for the first time in the reverse direction after the power supply is turned ON.
However, after the origin detection position is passed in the forward direction and the encoder’s phase-C pulse it output, it will then also be output when the origin detection point is passed in the reverse direction.



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.

Encoder Divided Pulse Output When Using a Rotary Servomotor

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

Pn212 (2212 hex)	Number of Encoder Output Pulses				Speed Position Torque
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	16 to 1,073,741,824	1 P/Rev	2,048	After restart	Setup

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

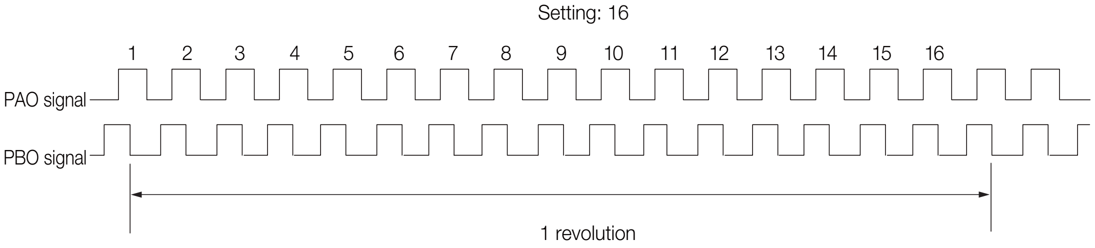
Set the number of encoder divided output pulses according to the system specifications of the machine or host controller.

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

Setting of the Number of Encoder Output Pulses [P/Rev]	Setting Increment	Encoder Resolution			Upper Limit of Servomotor Speed for Set Number of Encoder Output Pulses [min^{-1}]
		20 bits (1,048,576 pulses)	22 bits (4,194,304 pulses)	24 bits (16,777,216 pulses)	
16 to 16,384	1	○	○	○	6,000
16,386 to 32,768	2	○	○	○	3,000
32,772 to 65,536	4	○	○	○	1,500
65,544 to 131,072	8	○	○	○	750
131,088 to 262,144	16	○	○	○	375
262,176 to 524,288	32	–	○	○	187
524,352 to 1,048,576	64	–	○	○	93
1,048,704 to 2,097,152	128	–	–	○	46
2,097,408 to 4,194,304	256	–	–	○	23

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).



Encoder Divided Pulse Output When Using a Linear Servomotor

If you will use a Linear Servomotor, set the encoder output resolution (Pn281).

Pn281 (2281 hex)	Encoder Output Resolution		Speed Position Force		
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	1 to 4,096	1 edge/pitch	20	After restart	Setup

Note: The maximum setting for the encoder output resolution is 4,096. Pulse output at a linear encoder resolution of 4,096 or higher is not possible.

Set the encoder output resolution for the encoder pulse output signals (PAO, /PAO, PBO, and /PBO) from the SERVOPACK to the host controller.

The number of feedback pulses per linear encoder pitch is divided by the setting of Pn281 (after multiplication by 4) inside the SERVOPACK and then the resulting number of pulses is output. Set the parameter according to the system specifications of the machine or host controller.

The setting range depends on the Servomotor's maximum speed (Pn385) and the linear scale pitch (Pn282).* You can calculate the upper limit of the setting of Pn281 with the following formula.

$$\text{Upper limit of Pn281} = \frac{\text{Linear Encoder Pitch*/100}}{\text{Pn385}} \times 72$$

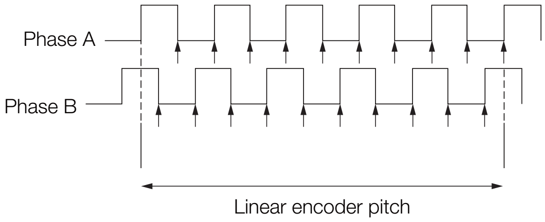
* The value depends on whether a Serial Converter Unit is used.

Using a Serial Converter Unit	Setting of Pn282
Not Using a Serial Converter Unit (when the linear encoder and SERVOPACK are connected directly or when a linear encoder that does not require a Serial Converter Unit is used)	The linear encoder pitch is automatically detected by the SERVOPACK, so the setting of Pn282 is ignored. You can use the monitor functions of the SigmaWin+ to check the linear encoder pitch that was automatically detected.

Information When the linear encoder pitch is 4 μm, the maximum motor speed is limited to 1 mm/s because of the maximum response frequency of the Serial Converter Unit.
If the setting is out of range or does not satisfy the setting conditions, an A.041 alarm (Encoder Output Pulse Setting Error) will be output. If the motor speed exceeds the upper limit for the set encoder output resolution, an A.511 alarm (Encoder Output Pulse Overspeed) will be output.
The upper limit of the encoder output resolution is restricted by the dividing specifications of the Serial Converter Unit.

Example Setting Example
Correct setting for a linear encoder pitch of 20 μm and a maximum motor speed of 5 m/s (Pn385 = 50): Pn281 = 28 (edges/pitch)
Incorrect setting: Pn281 = 29 (edges/pitch) (An A.041 alarm would be output.)

Example Pulse Output Example
When Pn281 = 20 (20-edge output (5-pulse output) per linear encoder pitch)



6.6 Software Limits

You can set limits in the software for machine movement that do not use the overtravel signals (P-OT and N-OT). If a software limit is exceeded, an emergency stop will be executed in the same way as it is for overtravel.

Refer to the following section for details on this function.

☞ ***Software Position Limits (607D Hex)*** on page 14-30

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	Reference
Internal Torque Limits	The torque is always limited with the setting of a parameter.	Speed control, position control, or torque control	6.7.1
External Torque Limits	The torque is limited with an input signal from the host computer.		6.7.2
Limiting Torque with *controlword* (6040 hex)	A command from the Controller enables the torque limit that is set in a parameter.	Speed control or position control	14.6
Limiting Torque with *positive torque limit value* (60E0 hex) and *negative torque limit value* (60E1 hex)	Torque is controlled with torque limits from the Controller.		13.7

Note: If you set a value that exceeds the maximum torque of the Servomotor, the torque will be limited to the maximum torque of the Servomotor.

6.7.1 Internal Torque Limits

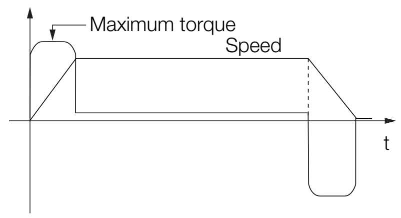
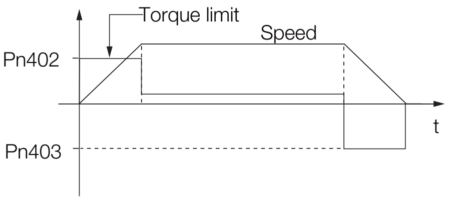
If you use internal torque limits, the maximum output torque will always be limited to the specified forward torque limit (Pn402) and reverse torque limit (Pn403).

- Rotary Servomotors

Pn402 (2402 hex)	Forward Torque Limit				Speed Position Torque
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 to 800	1%*	800	Immediately	Setup
Pn403 (2403 hex)	Reverse Torque Limit				Speed Position Torque
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 to 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.

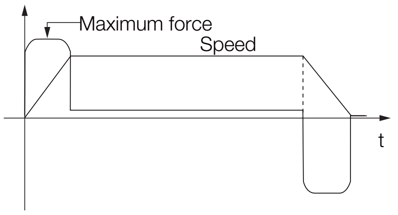
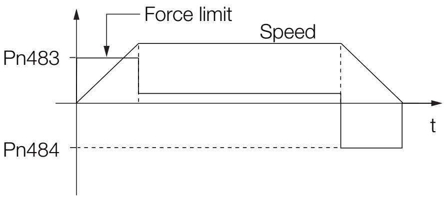
Without Internal Torque Limits (Output to the maximum torque is possible.)	With Internal Torque Limits
	

- Linear Servomotors

Pn483 (2483 hex)	Forward Force Limit			Speed Position Force	
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 to 800	1%*	30	Immediately	Setup
Pn484 (2484 hex)	Reverse Force Limit			Speed Position Force	
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 to 800	1%*	30	Immediately	Setup

* Set a percentage of the rated motor force.

Note: If the setting of Pn483 or Pn484 is too low, the force may be insufficient for acceleration or deceleration of the Servomotor.

Without Internal Torque Limits (Output to the maximum force is possible.)	With Internal Force 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[1] and Pn404.
			OFF (open)	Cancels the forward external torque limit. The torque is limited to the setting of Pn402[1].
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[2] and Pn404.
			OFF (open)	Cancels the reverse external torque limit. The torque is limited to the setting of Pn403[2].

[1] Pn483 is used for a Linear Servomotor.
[2] Pn484 is used for a Linear Servomotor.

Note: You must allocate the /P-CL and /N-CL signals to use them. You can use the following parameters to allocate the signal to a terminal.
- Pn50B = n.□X□□ (/P-CL (Forward External Torque Limit Input) Signal Allocation)
- Pn50B = n.X□□□ (/N-CL (Reverse External Torque Limit Input) Signal Allocation)

Refer to the following section for details.

☞ *6.1.1 Input Signal Allocations* on page 6-3

Setting the Torque Limits

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

- Rotary Servomotors
  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 (2402 hex)	Forward Torque Limit			Speed Position Torque	
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 to 800	1%*	800	Immediately	Setup
Pn403 (2403 hex)	Reverse Torque Limit			Speed Position Torque	
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 to 800	1%*	800	Immediately	Setup
Pn404 (2404 hex)	Forward External Torque Limit			Speed Position Torque	
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 to 800	1%*	100	Immediately	Setup
Pn405 (2405 hex)	Reverse External Torque Limit			Speed Position Torque	
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 to 800	1%*	100	Immediately	Setup

* Set a percentage of the rated motor torque.

- Linear Servomotors
  If the setting of Pn483 (Forward Force Limit), Pn484 (Reverse Force Limit), Pn404 (Forward External Force Limit), or Pn405 (Reverse External Force Limit) is too low, the force may be insufficient for acceleration or deceleration of the Servomotor.

Pn483 (2483 hex)	Forward Force Limit			Speed Position Force	
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 to 800	1%*	30	Immediately	Setup
Pn484 (2484 hex)	Reverse Force Limit			Speed Position Force	
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 to 800	1%*	30	Immediately	Setup
Pn404 (2404 hex)	Forward External Force Limit			Speed Position Force	
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 to 800	1%*	100	Immediately	Setup
Pn405 (2405 hex)	Reverse External Force Limit			Speed Position Force	
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 to 800	1%*	100	Immediately	Setup

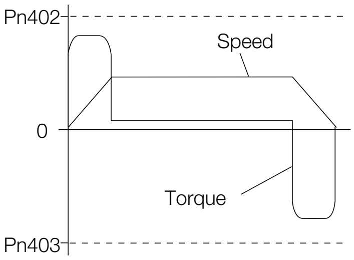
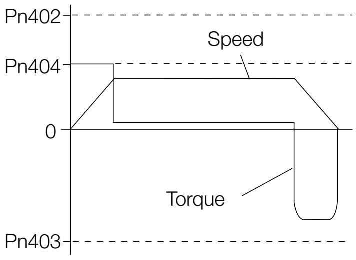
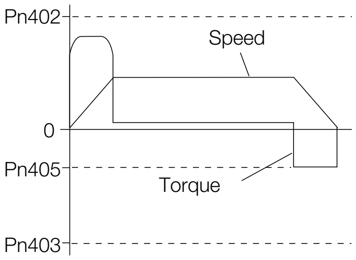
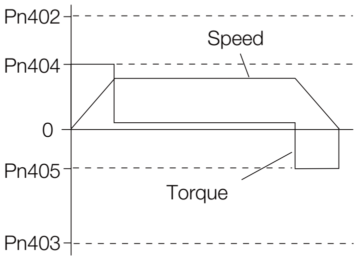
* Set a percentage of the rated motor force.

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%.

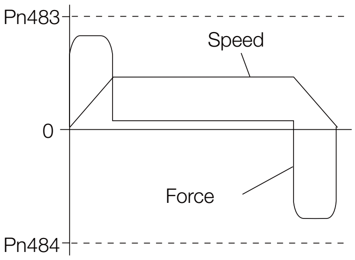
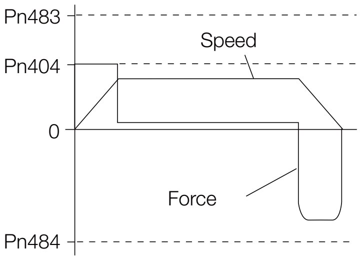
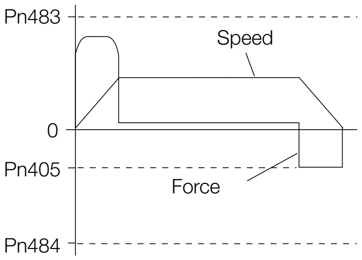
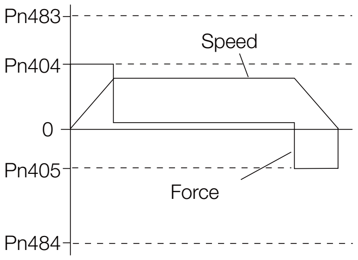
- Rotary Servomotors

It is assumed that counterclockwise is set as the forward direction of motor rotation (Pn000 = n.□□□0).

<table>
<tr><th colspan="2" rowspan="2"></th><th colspan="2">/P-CL signal</th></tr>
<tr><th>OFF</th><th>ON</th></tr>
<tr><td rowspan="2">/N-CL signal</td><td>OFF</td><td>
</td><td>
</td></tr>
<tr><td>ON</td><td>
</td><td>
</td></tr>
</table>

- Linear Servomotors

It is assumed that the linear encoder count-up direction is set as the forward direction of motor movement (Pn000 = n.□□□0).

<table>
<tr><th colspan="2" rowspan="2"></th><th colspan="2">/P-CL signal</th></tr>
<tr><th>OFF</th><th>ON</th></tr>
<tr><td rowspan="2">/N-CL signal</td><td>OFF</td><td>
</td><td>
</td></tr>
<tr><td>ON</td><td>
</td><td>
</td></tr>
</table>

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
Output	/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) Signal Allocation) to allocate the signal to a connector pin. Refer to the following section for details.

☞ *6.1.2 Output Signal Allocations* on page 6-4

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 three types of encoders for Rotary Servomotors. The usage of the encoder is specified in Pn002 = n.□X□□.

Refer to the following section for encoder models.

☞ *■ Encoder Resolution* on page 5-44

- Parameter Settings When Using an Incremental Encoder

Parameter		Meaning	When Enabled	Classification
Pn002 (2002 hex)	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 (2002 hex)	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 Multiturn Absolute Encoder

Parameter		Meaning	When Enabled	Classification
Pn002 (2002 hex)	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.

6.8.1 Connecting an Absolute Encoder

You can get the position data from the absolute encoder with EtherCAT communications. Therefore, it is not necessary to wire the PAO, PBO, and PCO (Encoder Divided Pulse Output) signals.

If they need to be wired, refer to the following section.

☞ ***4.4.3 Wiring the SERVOPACK to the Encoder*** on page 4-24

☞ ***4.5.3 I/O Signal Wiring Examples*** on page 4-32

6.8.2 Structure of the Position Data of the Absolute Encoder

The position data of the absolute encoder is the position coordinate from the origin of the absolute encoder.

The position data from the absolute encoder contains the following two items.

- The number of rotations from the origin of the encoder coordinate system (called the multiturn data)
- The position (number of pulses) within one rotation

The position data of the absolute encoder is as follows:

Position data of absolute encoder = Multiturn data × Number of pulses within one encoder rotation (setting of Pn212) + Position (number of pulses) within one rotation.

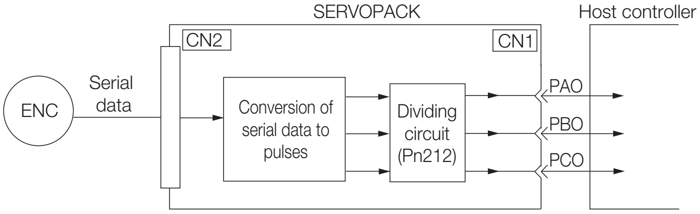
For a single-turn absolute encoder, the multiturn data is 0.

6.8.3 Output Ports for the Position Data from the Absolute Encoder

You can read the position data of the absolute encoder from the PAO, PBO, and PCO (Encoder Divided Pulse Output) signals.

The output method and timing for the position data of the absolute encoder are different in each case.

A conceptual diagram of the connections of the PAO, PBO, and PCO (Encoder Divided Pulse Output) signals to the host controller is provided below.



Signal	Status	Signal Contents
		When Using an Absolute Encoder
PAO	First signal	Multiturn data position within one rotation (pulse train)
	During normal operation	Incremental pulses
PBO	First signal	Position within one rotation (pulse train)
	During normal operation	Incremental pulses
PCO	Always	Origin pulse

The PAO (Encoder Divided Pulse Output) signal outputs the position data from the absolute encoder after the control power supply is turned ON.

The position data of the absolute encoder is the current stop position. The absolute encoder outputs the multiturn data with the specified protocol. The absolute encoder outputs the position within one rotation as a pulse train. It then outputs pulses as an incremental encoder (incremental operation status).

The host controller must have a reception circuit (e.g., UART) for the position data from the absolute encoder. The pulse counter at the host controller will not count pulses when the multiturn data (communications message) is input because only phase A is input. Counting starts from the position of the absolute encoder within one rotation.

The output circuits for the PAO, PBO, and PCO signals use line drivers. Refer to the following section for details on line drivers.

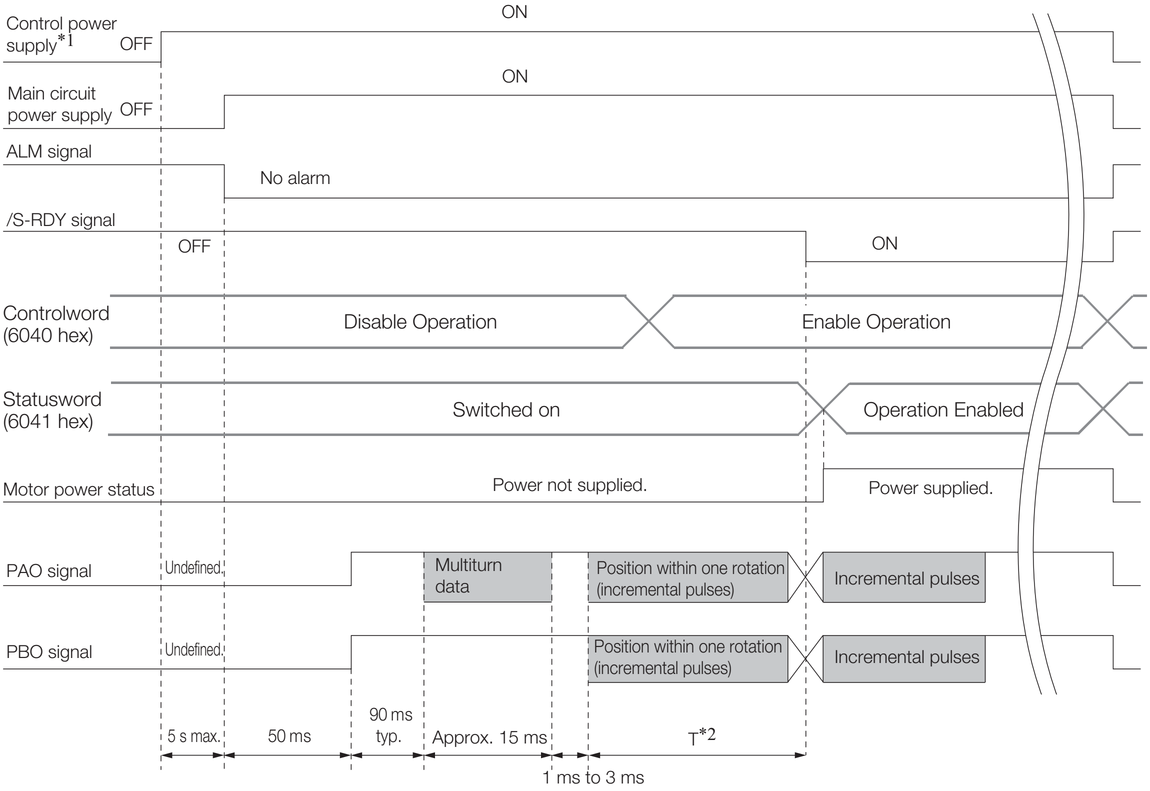
☞ ***4.5.4 I/O Circuits*** on page 4-34

6.8.4 Reading the Position Data from the Absolute Encoder

The sequence to read the position data from the absolute encoder of a Rotary Servomotor is given below.

The multiturn data is sent according to the transmission specifications.

The position of the absolute encoder within one rotation is output as a pulse train.



*1. The pulse output time T for the position of the absolute encoder within one rotation depends on the setting of Pn212 (Number of Encoder Output Pulses). Refer to the following table.

Setting of Pn212	Calculation of the Pulse Output Speed for the Position of the Absolute Encoder within One Rotation	Calculation of the Pulse Output Time T for the Position of the Absolute Encoder within One Rotation
16 to 16,384	680 × Pn212/16,384 [kpps]	25 ms max.
16,386 to 32,768	680 × Pn212/32,768 [kpps]	50 ms max.
32,722 to 65,536	680 × Pn212/65,536 [kpps]	100 ms max.
65,544 to 131,072	680 × Pn212/131,072 [kpps]	200 ms max.
131,088 to 262,144	680 × Pn212/262,144 [kpps]	400 ms max.
262,176 to 524,288	680 × Pn212/524,288 [kpps]	800 ms max.
524,352 to 1,048,576	680 × Pn212/1,048,576 [kpps]	1,600 ms max.
1,048,704 to 2,097,152	680 × Pn212/2,097,152 [kpps]	3,200 ms max.
2,097,408 to 4,194,304	680 × Pn212/4,194,304 [kpps]	6,400 ms max.

6.8.5 Transmission Specifications

The position data transmission specifications for the PAO (Encoder Divided Pulse Output) signal are given in the following table.

The PAO signal sends only the multiturn data.

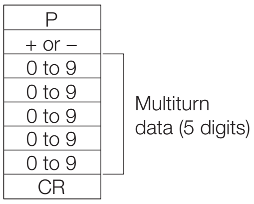
Refer to the following section for the timing of sending the position data from the absolute encoder.

☞ ***6.8.4 Reading the Position Data from the Absolute Encoder*** on page 6-32

Item	PAO signal
Synchronization Method	Start-stop synchronization (ASYNC)
Baud Rate	9,600 bps
Start Bits	1 bit
Stop Bits	1 bit
Parity	Even
Character Code	ASCII, 7 bits
Data Format	Refer to *Data Format of PAO Signal*.
Data Output Period	Only once after the control power supply is turned ON

Data Format of PAO Signal

As shown below, the message format consists of eight characters: “P,” the sign, the 5-digit multiturn data, and “CR” (which indicates the end of the message).



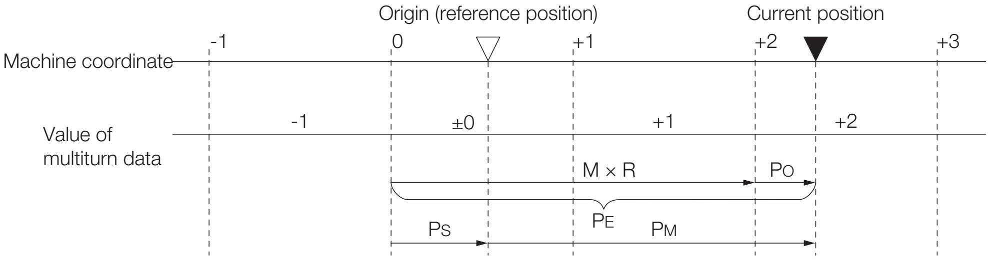
6.8.6 Calculating the Current Position in Machine Coordinates

When you reset the absolute encoder, the reset position becomes the reference position.

The host controller reads the coordinate Ps from the origin of the encoder coordinate system. The host controller must record the value of coordinate Ps.

This section describes the reference position in the machine coordinate system.

The method to calculate the coordinate value of the present position from the origin of the machine coordinate system is given below.



The current position P_M in the machine coordinate system is calculated as follows:

$P_M = P_E - P_S$

$P_E = M \times R + P_O$

$P_S = M_S \times R + P_S'$

Symbol	Meaning
P_E	Position data for the current position of the absolute encoder
M	Current position of the multiturn data of the absolute encoder
P_O	Position of the current position within one rotation
P_S	Position data of the absolute encoder when absolute encoder was reset
M_S	Multiturn data of the absolute encoder when absolute encoder was reset
P_S'	Position of the absolute encoder within one rotation when absolute encoder was reset
P_M	Current position in machine coordinate system
R	Pulses output per encoder rotation (value after dividing; setting of Pn212)

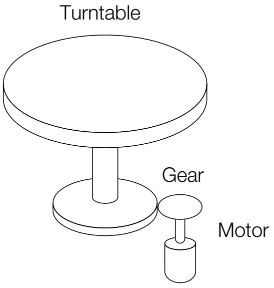
Note: The following formulas apply in reverse rotation mode (Pn000 = n.☐☐☐1).
$P_M = P_E - P_S$
$P_E = -M \times R + P_O$
$P_S = M_S \times R + P_S'$

Information

1. If you are using a Rotary Servomotor, you must reset the absolute encoder. Refer to the following section for information on resetting the absolute encoder.
   ☞ *5.15 **Resetting the Absolute Encoder*** on page 5-49
2. You can set the origin to a different position from the reset position. Refer to the following section for information on the origin position offset.
   ☞ *5.16 **Setting the Origin of the Absolute Encoder*** on page 5-52

6.8.7 Multiturn Limit Setting

The multiturn limit is used in position control for a turntable or other rotating body.
For example, consider a machine that moves the turntable shown in the following diagram in only one direction.



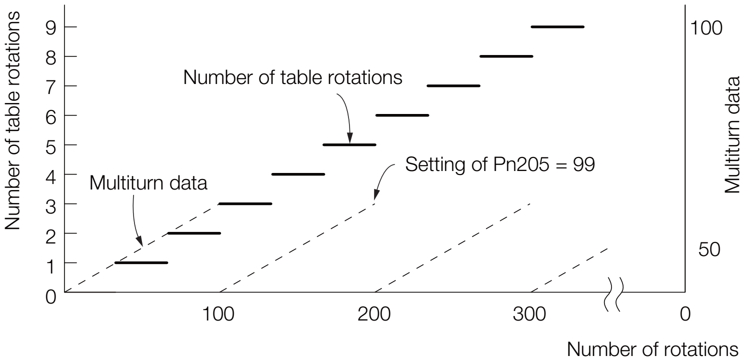
Because the turntable moves in only one direction, the upper limit to the number of revolutions that can be counted by an absolute encoder will eventually be exceeded.
The multiturn limit is used in cases like this to prevent fractions from being produced by the integral ratio of the number motor revolutions and the number of turntable revolutions.

For a machine with a gear ratio of n:m, as shown above, the value of m minus 1 will be the setting for the multiturn limit setting (Pn205).

Multiturn limit (Pn205) = m - 1

The relationship between the number of turntable revolutions and the number of motor revolutions is shown in the following graph for when m is 100 and n is 3.

Set Pn205 to 99.
Pn205 = 100 - 1 = 99



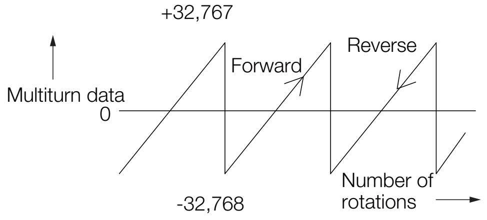
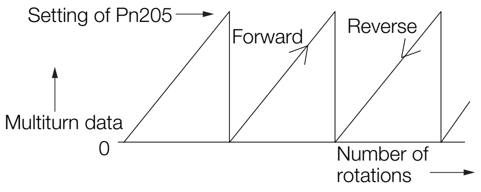
Pn205 (2205 hex)	Multiturn Limit			Speed Position Torque	
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 to 65,535	1 Rev	65,535	After restart	Setup

Note: This parameter is enabled when you use an absolute encoder.

The data will change as shown below when this parameter is set to anything other than the default setting.

- If the motor operates in the reverse direction when the multiturn data is 0, the multiturn data will change to the value set in Pn205.
- If the motor operates in the forward direction when the multiturn data is at the value set in Pn205, the multiturn data will change to 0.

Set Pn205 to one less than the desired multiturn data.

Default Setting	Not Default Setting
	

Information The multiturn data will always be 0 in the following cases. It is not necessary to reset the absolute encoder in these cases.
- 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□□)

Absolute encoder-related alarms (A.810 and A.820) will not occur.

6.8.8 Multiturn Limit Disagreement Alarm (A.CC0)

If you change the multiturn limit in Pn205 (Multiturn Limit), an A.CC0 alarm (Multiturn Limit Disagreement) will be displayed because the setting disagrees with the value in the encoder.

Display	Name	Meaning
A.CC0	Multiturn Limit Disagreement	Different multiturn limits are set in the encoder and SERVOPACK.

If this alarm is displayed, use the following procedure to change the multiturn limit in the encoder to the same value as the setting of Pn205.

Applicable Tools

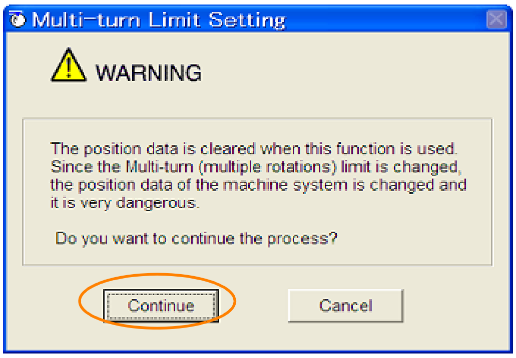
The following table lists the tools that you can use to set the multiturn limit.

Tool	Function	Operating Procedure Reference
Digital Operator	Fn013	🕮 Σ-7-Series Digital Operator Operating Manual (Manual No.: SIEP S800001 33)
SigmaWin+	***Setup - Multiturn Limit Setting***	☞ *Operating Procedure* on page 6-37
EtherCAT communications	SERVOPACK Adjusting Command (2710 hex)	☞ *SERVOPACK Adjusting Command (2710 Hex)* on page 14-19

Operating Procedure

1. Select ***Setup - Multiturn Limit Setting*** from the menu bar of the Main Window of the SigmaWin+.

2. Click the **Continue** Button.

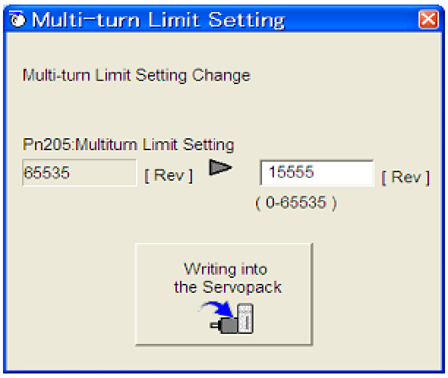


The position data is cleared when this function is used.
Since the Multi-turn (multiple rotations) limit is changed, the position data of the machine system is changed and it is very dangerous.

Do you want to continue the process?

Click the **Cancel** Button to cancel setting the multiturn limit.
The Main Window will return.

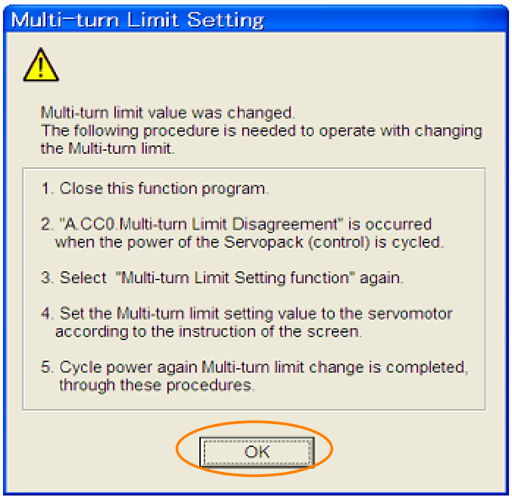
3. Change the setting.



Multi-turn Limit Setting Change

Pn205:Multiturn Limit Setting
65535 [Rev] 15555 [Rev]
(0-65535)

4. Click the **Writing into the Servopack** Button.



Multi-turn limit value was changed.
The following procedure is needed to operate with changing the Multi-turn limit.

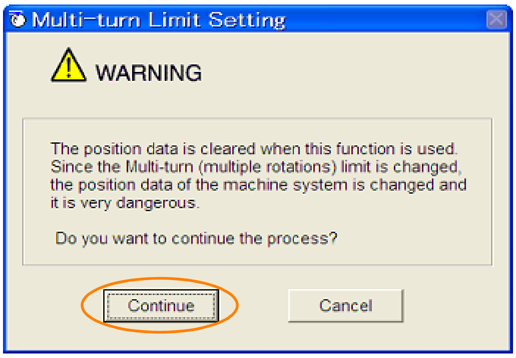
1. Close this function program.
2. "A.CC0.Multi-turn Limit Disagreement" is occurred when the power of the Servopack (control) is cycled.
3. Select "Multi-turn Limit Setting function" again.
4. Set the Multi-turn limit setting value to the servomotor according to the instruction of the screen.
5. Cycle power again Multi-turn limit change is completed, through these procedures.

5. Click the **OK** Button.

6. Turn the power supply to the SERVOPACK OFF and ON again.
An A.CC0 alarm (Multiturn Limit Disagreement) will occur because setting the multiturn limit in the Servomotor is not yet completed even though the setting has been changed in the SERVOPACK.

7. Select ***Setup - Multiturn Limit Setting*** from the menu bar of the Main Window of the SigmaWin+.

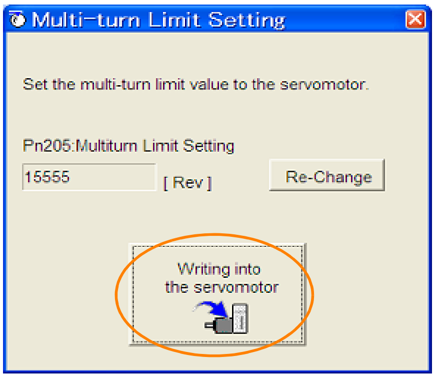
8. Click the **Continue** Button.



The position data is cleared when this function is used. Since the Multi-turn (multiple rotations) limit is changed, the position data of the machine system is changed and it is very dangerous.

Do you want to continue the process?

9. Click the **Writing into the Motor** Button.



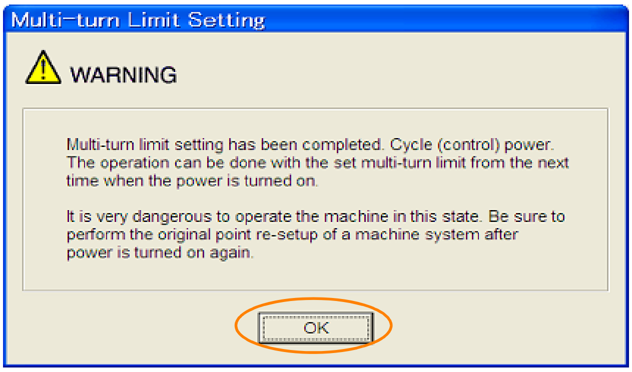
Set the multi-turn limit value to the servomotor.

Pn205:Multiturn Limit Setting

15555 [Rev]

Click the **Re-change** Button to change the setting.

10. Click the **OK** Button.



Multi-turn limit setting has been completed. Cycle (control) power. The operation can be done with the set multi-turn limit from the next time when the power is turned on.

It is very dangerous to operate the machine in this state. Be sure to perform the original point re-setup of a machine system after power is turned on again.

6.9 Absolute Linear Encoders

The absolute linear encoder records the current position of the stop position even when the power supply is OFF.

With a system that uses an absolute linear 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 three types of linear encoders for Linear Servomotors. The usage of the linear encoder is specified in Pn002 = n.□X□□.

Refer to the following section for linear encoder models.

☞ *■ Feedback Resolution of Linear Encoder* on page 5-45

- Parameter Settings When Using an Incremental Linear Encoder

Parameter		Meaning	When Enabled	Classification
Pn002 (2002 hex)	n.□0□□ (default setting)	Use the encoder as an incremental linear encoder.	After restart	Setup
	n.□1□□	Use the encoder as an incremental linear encoder.		

- Parameter Settings When Using an Absolute Linear Encoder

Parameter		Meaning	When Enabled	Classification
Pn002 (2002 hex)	n.□0□□ (default setting)	Use the encoder as an absolute linear encoder.	After restart	Setup
	n.□1□□	Use the encoder as an incremental linear encoder.		

6.9.1 Connecting an Absolute Linear Encoder

You can get the position data from the absolute linear encoder with EtherCAT communications. Therefore, it is not necessary to wire the PAO, PBO, and PCO (Encoder Divided Pulse Output) signals.

If they need to be wired, refer to the following section.

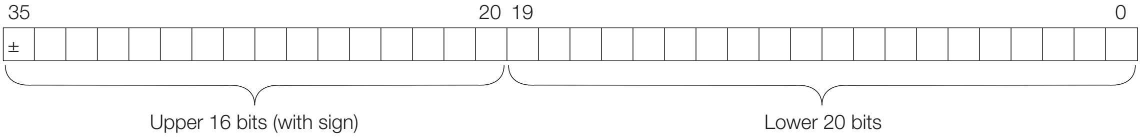
☞ ***4.4.3 Wiring the SERVOPACK to the Encoder*** on page 4-24

☞ ***4.5.3 I/O Signal Wiring Examples*** on page 4-32

6.9.2 Structure of the Position Data of the Absolute Linear Encoder

The position data of the absolute linear encoder is the distance (number of pulses) from the origin of the absolute linear encoder.

The position data is signed 36-bit data.



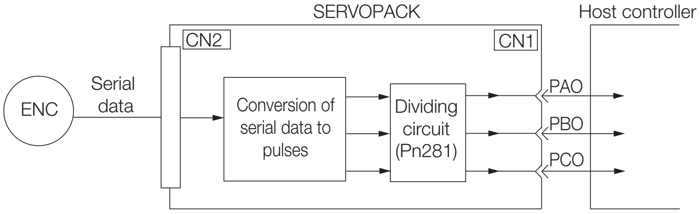
When the SERVOPACK sends the position data, it sends the upper 16-bit data (with sign) separately from the lower 20-bit data.

6.9.3 Output Ports for the Position Data from the Absolute Linear Encoder

You can read the position data of the absolute linear encoder from the PAO, PBO, and PCO (Encoder Divided Pulse Output) signals.

The output method and timing for the position data of the absolute linear encoder are different in each case.

A conceptual diagram of the connections of the PAO, PBO, and PCO (Encoder Divided Pulse Output) ports to the host controller is provided below.



Signal	Status	Signal Contents
		When Using an Absolute Linear Encoder
PAO	First signal	Upper 16-bit data (with sign) Lower 20-bit data (pulse train)
	During normal operation	Incremental pulses
PBO	First signal	Lower 20-bit data (pulse train)
	During normal operation	Incremental pulses
PCO	Always	Origin pulse

The PAO (Encoder Divided Pulse Output) signal outputs the position data from the absolute linear encoder after the control power supply is turned ON.

The position data of the absolute linear encoder is the current stop position. The absolute linear encoder outputs the upper 16-bit data (with sign) according to the specified protocol. The absolute encoder outputs the lower 20-bit data as a pulse train. It then outputs pulses as an incremental linear encoder (incremental operation status).

The host controller must have a reception circuit (e.g., UART) for the position data from the absolute linear encoder. The pulse counter at the host controller will not count pulses when the upper 16-bit data (with sign) (communications message) is input because only phase A is input.

The output circuits for the PAO, PBO, and PCO signals use line drivers. Refer to the following section for details on line drivers.

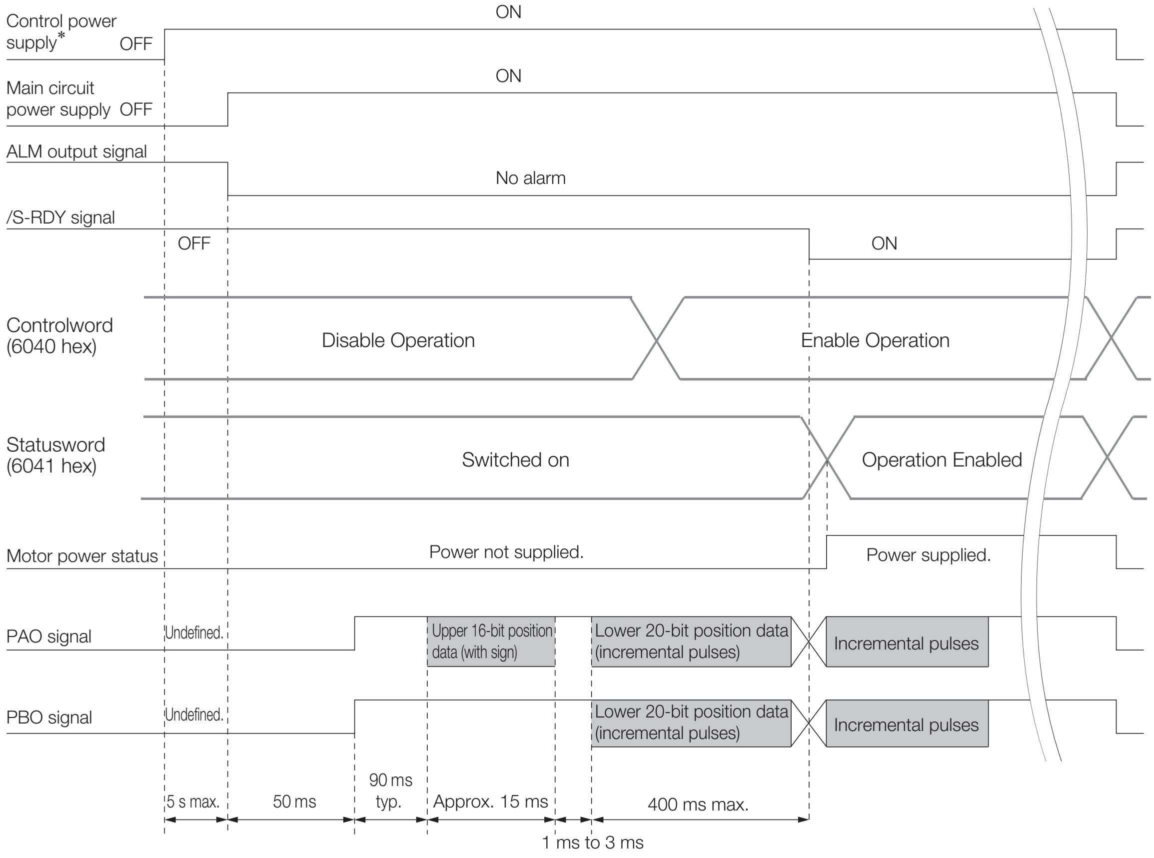
☞ *4.5.4* ***I/O Circuits*** on page 4-34

6.9.4 Reading the Position Data from the Absolute Linear Encoder

The sequence to read the position data from the absolute linear encoder of a Linear Servomotor is given below.

The upper 16-bit position data (with sign) are sent according to the transmission specifications.

The lower 20-bit data is output as a pulse train.



6.9.5 Transmission Specifications

The position data transmission specifications for the PAO (Encoder Divided Pulse Output) signal are given in the following table.

The PAO signal sends only the 16-bit data (with sign).

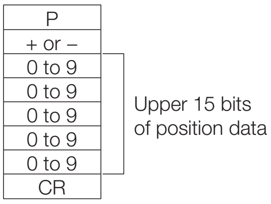
Refer to the following section for the timing of sending the position data from the absolute encoder.

☞ ***6.9.4 Reading the Position Data from the Absolute Linear Encoder*** on page 6-41

Item	PAO signal
Synchronization Method	Start-stop synchronization (ASYNC)
Baud Rate	9,600 bps
Start Bits	1 bit
Stop Bits	1 bit
Parity	Even
Character Code	ASCII, 7 bits
Data Format	Refer to *Data Format of PAO Signal*.
Data Output Period	Only once after the control power supply is turned ON

Data Format of PAO Signal

As shown below, the message format consists of eight characters: “P,” the sign, the 5-digit upper 15-bit position data, and “CR” (which indicates the end of the message).



6.9.6 Calculating the Current Position in Machine Coordinates

With an absolute linear encoder, you must set the position of the origin (i.e., the origin of the machine coordinate system).

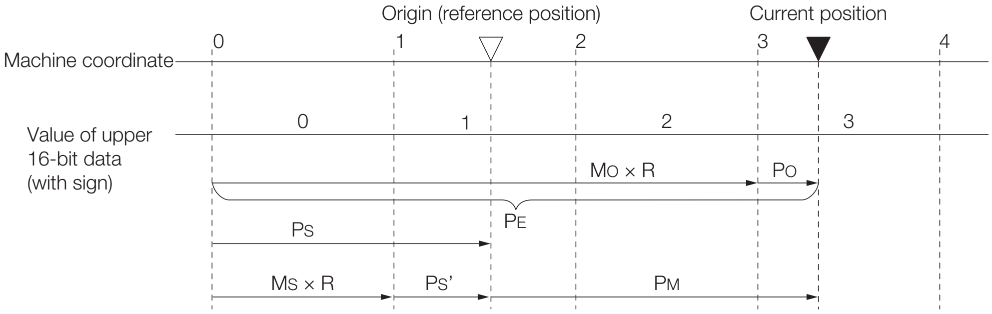
The host controller reads the coordinate from the origin of the encoder coordinate system. The host controller must record the value of this coordinate.

The method to calculate the coordinate value of the present position from the origin of the machine coordinate system is given below.

The position data from the absolute linear encoder is signed 36-bit data, but the upper 16 bits (with sign) and the lower 20 bits are output separately.

For the upper 16-bit data (with sign), the upper bits (16 bits, including the sign) of the current position after dividing by the setting of Pn281 are output with serial communications according to the transmission specifications.

For the lower 20-bit data , the lower bits (20 bits) of the current position after dividing by the setting of Pn281 are output as a pulse train.



The current position P_M in the machine coordinate system is calculated as follows:

$$P_M = P_E - P_S$$

$$P_E = M_O \times R + P_O$$

$$P_S = M_S \times R + P_S'$$

Symbol	Meaning
P_E	Position data for the current position of the absolute linear encoder
M_O	Upper 16 bits (with sign) of the position data for the current position of the absolute linear encoder
P_O	Lower 20 bits of the position data for the current position of the absolute linear encoder
P_S	Position data of the origin
M_S	Upper 16 bits (with sign) of the position data of the origin
P_S'	Lower 20 bits of the position data of the origin
P_M	Current position in machine coordinate system
R	1048576 (=2^{20})

Note: The above formulas also apply in reverse movement mode (Pn000 = n.□□□1).

Information If you are using a Linear Servomotor, you do not need to reset the absolute linear encoder to define the origin. (Some absolute linear encoders also allow you to set any position as the origin.)

6.10 Software Reset

You can reset the SERVOPACK internally with the software. A software reset is used when resetting alarms and changing the settings of parameters that normally require turning the power supply to the SERVOPACK OFF and ON again. This can be used to change those parameters without turning the power supply to the SERVOPACK OFF and ON again.

Information
1. Always confirm that the servo is OFF and that the motor is stopped before you start a software reset.
2. This function resets the SERVOPACK independently of the host controller. The SERVOPACK carries out the same processing as when the power supply is turned ON and outputs the ALM (Servo Alarm) signal. The status of other output signals may be forcibly changed.
3. When you execute a software reset, the SERVOPACK will not respond for approximately five seconds.
   Before you execute a software reset, check the status of the SERVOPACK and Servomotor and make sure that no problems will occur.

6.10.1 Preparations

Confirm that the following conditions are met before you perform a software reset.
- The servo must be OFF.
- The motor must be stopped.

6.10.2 Applicable Tools

The following table lists the tools that you can use to perform a software reset.

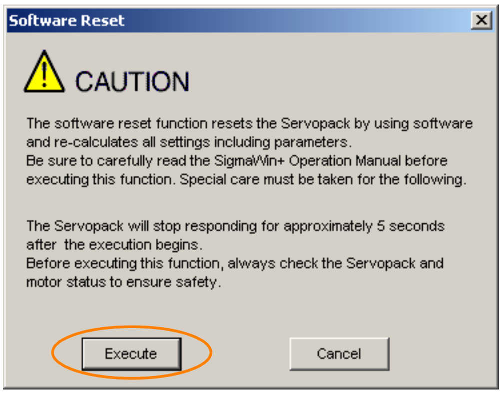
Tool	Function	Operating Procedure Reference
Digital Operator	Fn030	🕮 Σ-7-Series Digital Operator Operating Manual (Manual No.: SIEP S800001 33)
SigmaWin+	***Setup - Software Reset***	☞ *6.10.3 Operating Procedure* on page 6-44

6.10.3 Operating Procedure

Use the following procedure to perform a software reset.

1. Select ***Setup - Software Reset*** from the menu bar of the Main Window of the SigmaWin+.

2. Click the **Execute** Button.

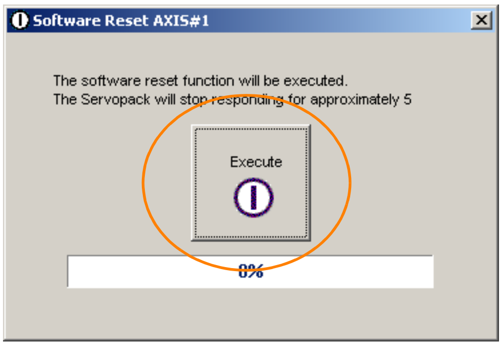


The software reset function resets the Servopack by using software and re-calculates all settings including parameters.
Be sure to carefully read the SigmaWin+ Operation Manual before executing this function. Special care must be taken for the following.

The Servopack will stop responding for approximately 5 seconds after the execution begins.
Before executing this function, always check the Servopack and motor status to ensure safety.

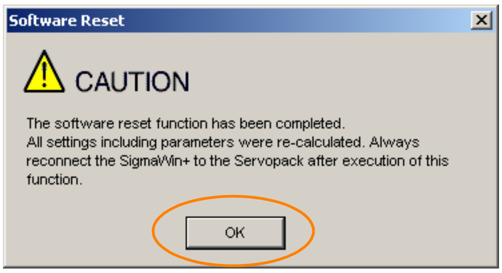
Click the **Cancel** Button to cancel the software reset. The Main Window will return.

3. Click the **Execute** Button.



The software reset function will be executed.
The Servopack will stop responding for approximately 5

4. Click the **OK** Button to end the software reset operation.
All settings including parameters will have been re-calculated. When you finish this operation, disconnect the SigmaWin+ from the SERVOPACK, and then connect it again.



The software reset function has been completed.
All settings including parameters were re-calculated. Always reconnect the SigmaWin+ to the Servopack after execution of this function.

6.11 Initializing the Vibration Detection Level

You can detect machine vibration during operation to automatically adjust the settings of Pn312 or Pn384 (Vibration Detection Level) to detect A.520 alarms (Vibration Alarm) and A.911 warnings (Vibration Warning) more precisely.

This function detects specific vibration components in the Servomotor speed.

Parameter		Meaning	When Enabled	Classification
Pn310 (2310 hex)	n.□□□0 (default setting)	Do not detect vibration.	Immediately	Setup
	n.□□□1	Output a warning (A.911) if vibration is detected.		
	n.□□□2	Output an alarm (A.520) if vibration is detected.		

If the vibration exceeds the detection level calculated with the following formula, an alarm or warning occurs according to Pn310 (Vibration Detection Selection).

- Rotary Servomotors

$$\text{Detection level} = \frac{\text{Vibration detection level (Pn312 [min-1])} \times \text{Vibration detection sensitivity (Pn311 [\%])}}{100}$$

- Linear Servomotors

$$\text{Detection level} = \frac{\text{Vibration detection level (Pn384 [mm/s])} \times \text{Vibration detection sensitivity (Pn311 [\%])}}{100}$$

Use this function only if A.520 or A.911 alarms are not output at the correct times when vibration is detected with the default vibration detection level (Pn312 or Pn384).

There will be discrepancies in the detection sensitivity for vibration alarms and warnings depending on the condition of your machine. If there is a discrepancy, use the above formula to adjust Pn311 (Vibration Detection Sensitivity).

Pn311 (2311 hex)	Vibration Detection Sensitivity			Speed Position Torque	
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	50 to 500	1%	100	Immediately	Tuning

Information

1. Vibration may not be detected because of unsuitable servo gains. Also, not all kinds of vibrations can be detected.
2. Set a suitable moment of inertia ratio (Pn103). An unsuitable setting may result in falsely detecting or not detecting vibration alarms or vibration warnings.
3. To use this function, you must input the actual references that will be used to operate your system.
4. Execute this function under the operating conditions for which you want to set the vibration detection level.
5. Execute this function while the motor is operating at 10% of its maximum speed or faster.

6.11.1 Preparations

Check the following settings before you initialize the vibration detection level.

- The parameters must not be write prohibited.
- The test without a motor function must be disabled (Pn00C = n.□□□0).

6.11.2 Applicable Tools

The following table lists the tools that you can use to initialize the vibration detection level and the applicable tool functions.

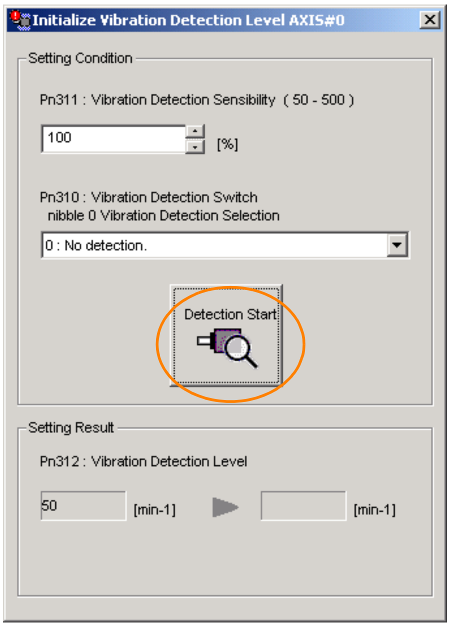
Tool	Function	Operating Procedure Reference
Digital Operator	Fn01B	📖 Σ-7-Series Digital Operator Operating Manual (Manual No.: SIEP S800001 33)
SigmaWin+	***Setup - Initialize Vibration Detection Level***	☞ *6.11.3 Operating Procedure* on page 6-46

6.11.3 Operating Procedure

Use the following procedure.

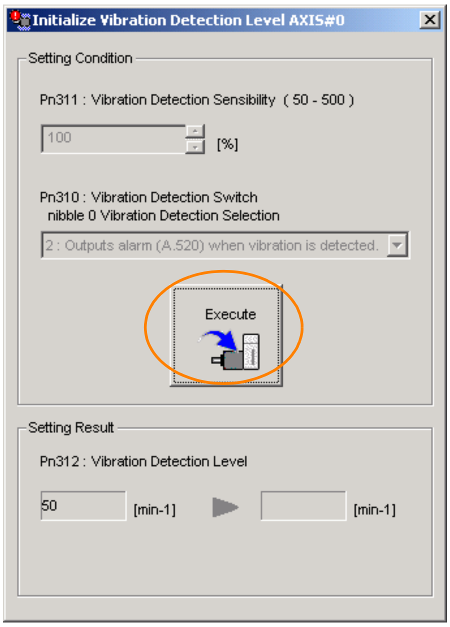
1. Select ***Setup - Initialize Vibration Detection Level*** from the menu bar of the Main Window of the SigmaWin+.

2. Select **Pn311: Vibration Detection Sensitivity** and **Pn310: Vibration Detection Selections** and then click the **Detection Start** Button.
   A setting execution standby mode will be entered.



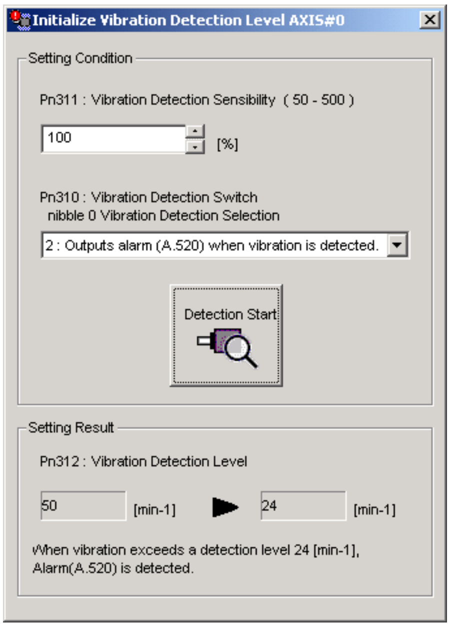
Pn311 : Vibration Detection Sensibility (50 - 500)
100 [%]
Pn310 : Vibration Detection Switch
nibble 0 Vibration Detection Selection
0 : No detection.
Pn312 : Vibration Detection Level
50 [min-1] [min-1]

3. Click the **Execute setting** Button.



Pn311 : Vibration Detection Sensibility (50 - 500)
100 [%]
Pn310 : Vibration Detection Switch
nibble 0 Vibration Detection Selection
2 : Outputs alarm (A.520) when vibration is detected.
Pn312 : Vibration Detection Level
50 [min-1] [min-1]

The newly set vibration detection level will be displayed and the value will be saved in the SERVOPACK.



Pn311 : Vibration Detection Sensibility (50 - 500)

100 [%]

Pn310 : Vibration Detection Switch
nibble 0 Vibration Detection Selection

2 : Outputs alarm (A.520) when vibration is detected.

Pn312 : Vibration Detection Level

50 [min-1] ▶ 24 [min-1]

When vibration exceeds a detection level 24 [min-1], Alarm(A.520) is detected.

6.11.4 Related Parameters

The following three items are given in the following table.

- Parameters Related to this Function
  These are the parameters that are used or referenced when this function is executed.
- Changes during Function Execution
  Not allowed: The parameter cannot be changed using the SigmaWin+ or other tool while this function is being executed.
  Allowed: The parameter can be changed using the SigmaWin+ or other tool while this function is being executed.
- Automatic Changes after Function Execution
  Yes: The parameter is automatically set or adjusted after execution of this function.
  No: The parameter is not automatically set or adjusted after execution of this function.

Parameter	Name	Setting Changes	Automatic Changes
Pn311 (2311 hex)	Vibration Detection Sensitivity	Allowed	No
Pn312 (2312 hex)	Vibration Detection Level	Not allowed	Yes
Pn384 (2384 hex)	Vibration Detection Level	Not allowed	Yes

6.12 Adjusting the Motor Current Detection Signal Offset

The motor current detection signal offset is used to reduce ripple in the torque. You can adjust the motor current detection signal offset either automatically or manually.

6.12.1 Automatic Adjustment

Perform this adjustment only if highly accurate adjustment is required to reduce torque ripple. It is normally not necessary to adjust this offset.

Important

Execute the automatic offset adjustment if the torque ripple is too large when compared with other SERVOPACKs.

Information

The offset does not use a parameter, so it will not change even if the parameter settings are initialized.

Preparations

The following conditions must be met to automatically adjust the motor current detection signal offset.

- The parameters must not be write prohibited.
- The servo must be in ready status.
- The servo must be OFF.

Applicable Tools

The following table lists the tools that you can use to automatically adjust the offset.

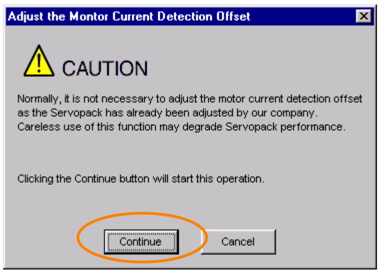
Tool	Function	Operating Procedure Reference
Digital Operator	Fn00E	🕮 Σ-7-Series Digital Operator Operating Manual (document No. SIEP S800001 33)
SigmaWin+	***Setup - Adjust Offset - Adjust the Motor Current Detection Offset***	☞ *Operating Procedure* on page 6-48
EtherCAT communications	SERVOPACK Adjusting Command (2710 hex)	☞ *SERVOPACK Adjusting Command (2710 Hex)* on page 14-19

Operating Procedure

Use the following procedure.

1. Select ***Setup - Adjust Offset - Adjust the Motor Current Detection Offset.*** from the menu bar of the Main Window of the SigmaWin+.

2. Click the **Continue** Button.



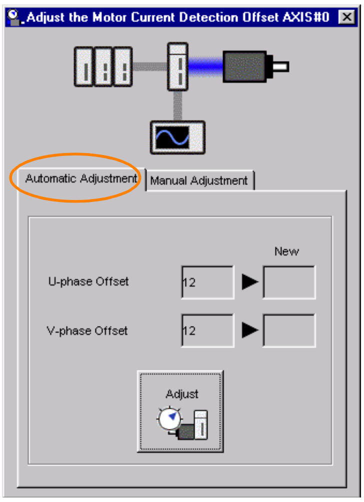
Adjust the Montor Current Detection Offset

CAUTION

Normally, it is not necessary to adjust the motor current detection offset as the Servopack has already been adjusted by our company. Careless use of this function may degrade Servopack performance.

Clicking the Continue button will start this operation.

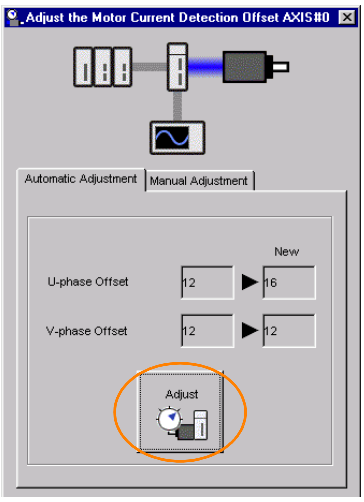
3. Click the **Automatic Adjustment** Tab in the Adjust the Motor Current Detection Offset Dialog Box.



U-phase Offset 12

V-phase Offset 12

4. Click the **Adjust** Button.
The values that result from automatic adjustment will be displayed in the **New** Boxes.



U-phase Offset 12 ▶ 16

V-phase Offset 12 ▶ 12

6.12.2 Manual Adjustment

You can use this function if you automatically adjust the motor current detection signal offset and the torque ripple is still too large.

Important

If the offset is incorrectly adjusted with this function, the Servomotor characteristics may be adversely affected.
Observe the following precautions when you manually adjust the offset.

- Operate the Servomotor at a speed of approximately 100 min^{-1}.
- Adjust the offset while monitoring the torque reference with the analog monitor until the ripple is minimized.
- Adjust the offsets for the phase-U current and phase-V current of the Servomotor so that they are balanced. Alternately adjust both offsets several times.

Information

The offset does not use a parameter, so it will not change even if the parameter settings are initialized.

Preparations

The following conditions must be met to manually adjust the motor current detection signal offset.

- The parameters must not be write prohibited.

Applicable Tools

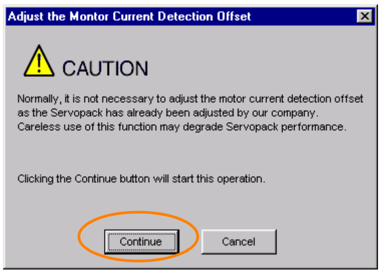
The following table lists the tools that you can use to manually adjust the offset and the applicable tool functions.

Tool	Function	Operating Procedure Reference
Digital Operator	Fn00F	📖 Σ-7-Series Digital Operator Operating Manual (Manual No.: SIEP S800001 33)
SigmaWin+	***Setup - Adjust Offset - Adjust the Motor Current Detection Offset***	☞ *Operating Procedure* on page 6-50

Operating Procedure

Use the following procedure.

1. Operate the motor at approximately 100 min^{-1}.
2. Select ***Setup - Adjust Offset - Adjust the Motor Current Detection Offset.*** from the menu bar of the Main Window of the SigmaWin+.
3. Click the **Continue** Button.



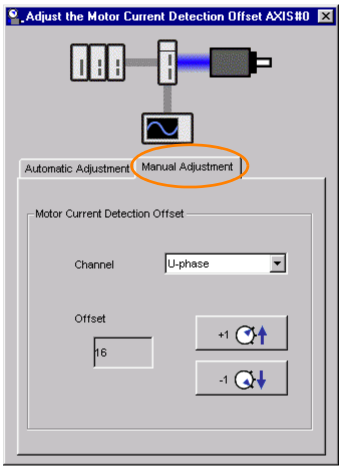
Adjust the Montor Current Detection Offset

CAUTION

Normally, it is not necessary to adjust the motor current detection offset as the Servopack has already been adjusted by our company.
Careless use of this function may degrade Servopack performance.

Clicking the Continue button will start this operation.

4. Click the **Manual Adjustment** Tab in the Adjust the Motor Current Detection Offset Dialog Box.



Channel U-phase

Offset 16

5. Set the **Channel** Box in the **Motor Current Detection Offset** Area to **U-phase**.

6. Use the **+1** and **-1** Buttons to adjust the offset for phase U.
   Change the offset by about 10 in the direction that reduces the torque ripple.
   Adjustment range: -512 to +511

7. Set the **Channel** Box in the **Motor Current Detection Offset** Area to V-**phase**.

8. Use the **+1** and **-1** Buttons to adjust the offset for phase V.
   Change the offset by about 10 in the direction that reduces the torque ripple.

9. Repeat steps 4 to 8 until the torque ripple cannot be improved any further regardless of whether you increase or decrease the offsets.

10. Reduce the amount by which you change the offsets each time and repeat steps 4 to 8.

6.13 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).

Information Panel Operator and Digital Operator Displays
When a forced stop is performed, the panel and the Digital Operator will display FSTP.

⚠ CAUTION

- To prevent accidents that may result from contact faults or disconnections, use a normally closed switch for the Forced Stop Input signal.

6.13.1 FSTP (Forced Stop Input) Signal

Classification	Signal	Connector Pin No.	Signal Status	Description
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.
☞ *6.1.1 Input Signal Allocations* on page 6-3

6.13.2 Stopping Method Selection for Forced Stops

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

Parameter		Description	When Enabled	Classification
Pn00A (200A hex)	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 (Servo OFF or Alarm Group 1 Stopping Method).

Stopping the Servomotor by Setting Emergency Stop Torque (Pn406)

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.

Pn406 (2406 hex)	Emergency Stop Torque			Speed Position Torque	
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 to 800	1%*	800	Immediately	Setup

* Set a percentage of the motor rated torque.

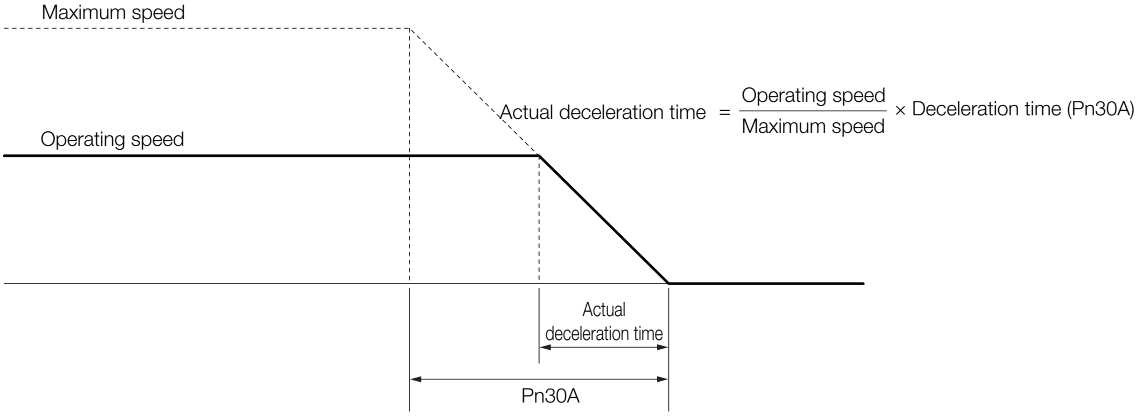
Stopping the Servomotor by Setting the Deceleration Time for Servo OFF and Forced Stops (Pn30A)

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

Pn30A (230A hex)	Deceleration Time for Servo OFF and Forced Stops			Speed Position	
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 to 10,000	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 motor from the maximum motor speed.

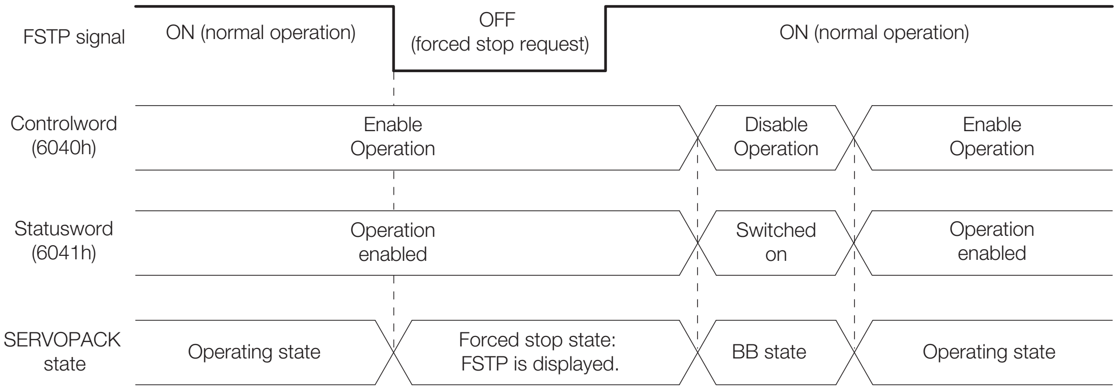


6.13.3 Resetting Method for Forced Stops

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 Servo ON command (Enable Operation command) is input, the forced stop state will be maintained even after the FSTP signal is turned ON.

Send the Servo OFF command (Disable Operation command) to place the SERVOPACK in the base block (BB) state and then send the Servo ON command (Enable Operation command).



Trial Operation and Actual Operation

7

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

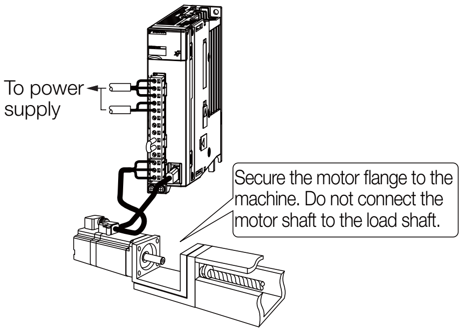
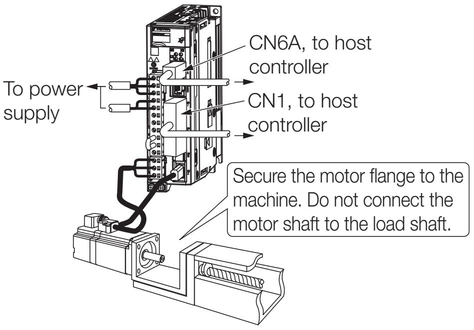
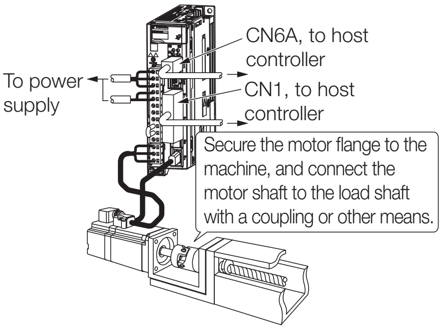
7.1.1 Flow of Trial Operation for Rotary Servomotors

The procedure for trial operation is given below.

- Preparations for Trial Operation

Step	Meaning	Reference
1	Installation Install the Servomotor and SERVOPACK according to the installation conditions. First, operation is checked with no load. Do not connect the Servomotor to the machine.	☞ *Chapter 3 SERVOPACK Installation*
2	Wiring and Connections Wire and connect the SERVOPACK. First, Servomotor operation is checked without a load. Do not connect the CN1 connector on the SERVOPACK.	☞ *Chapter 4 Wiring and Connecting SERVOPACKs*
3	Confirmations before Trial Operation	☞ *7.2 Inspections and Confirmations before Trial Operation* on page 7-6
4	Power ON	–
5	Resetting the Absolute Encoder This step is necessary only for a Servomotor with an Absolute Encoder.	☞ *5.15 Resetting the Absolute Encoder* on page 5-49

- Trial Operation

Step	Meaning	Reference
1	Trial Operation for the Servomotor without a Load 	☞ *7.3 Trial Operation for the Servomotor without a Load* on page 7-7
2	Trial Operation with EtherCAT (CoE) Communications 	☞ *7.4 Trial Operation with EtherCAT (CoE) Communications* on page 7-10
3	Trial Operation with the Servomotor Connected to the Machine 	☞ *7.5 Trial Operation with the Servomotor Connected to the Machine* on page 7-11

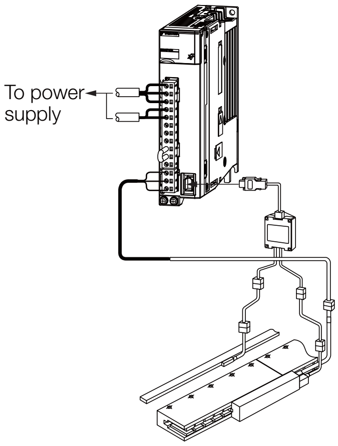
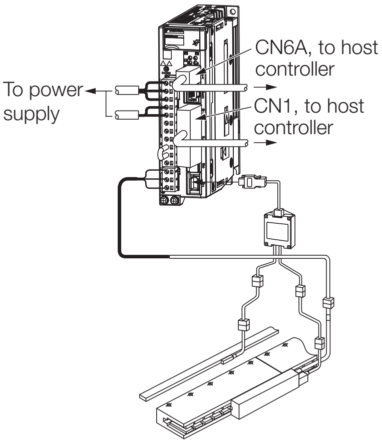
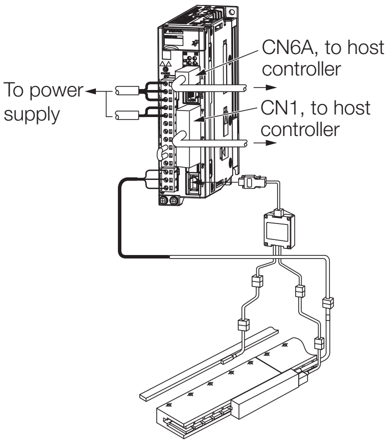
7.1.2 Flow of Trial Operation for Linear Servomotors

The procedure for trial operation is given below.

- Preparations for Trial Operation

<table>
<tr><th>Step</th><th>Meaning</th><th>Reference</th></tr>
<tr><td>1</td><td>Installation
Install the Servomotor and SERVOPACK according to the installation conditions. First, operation is checked with no load. Do not connect the Servomotor to the machine.</td><td>☞ <i>Chapter 3 SERVOPACK Installation</i></td></tr>
<tr><td>2</td><td>Wiring and Connections
Wire and connect the SERVOPACK. First, Servomotor operation is checked without a load. Do not connect the CN1 connector on the SERVOPACK.</td><td>☞ <i>Chapter 4 Wiring and Connecting SERVOPACKs</i></td></tr>
<tr><td>3</td><td>Confirmations before Trial Operation</td><td>☞ <i>7.2 Inspections and Confirmations before Trial Operation</i> on page 7-6</td></tr>
<tr><td>4</td><td>Power ON</td><td>–</td></tr>
<tr><td>5</td><td colspan="2">Setting Parameters in the SERVOPACK
<table>
<tr><th>Step</th><th>No. of Parameter to Set</th><th>Description</th><th>Remarks</th><th>Reference</th></tr>
<tr><td>5-1</td><td>Pn282 (2282 hex)</td><td>Linear Encoder Pitch</td><td>Set this parameter only if you are using a Serial Converter Unit.</td><td>page 5-16</td></tr>
<tr><td>5-2</td><td>–</td><td>Writing Parameters to the Linear Servomotor</td><td>Set this parameter only if you are not using a Serial Converter Unit.</td><td>page 5-17</td></tr>
<tr><td>5-3</td><td>Pn080 (2080 hex) = n.□□X□</td><td>Motor Phase Sequence Selection</td><td>–</td><td>page 5-21</td></tr>
<tr><td>5-4</td><td>Pn080 (2080 hex) = n.□□□X</td><td>Polarity Sensor Selection</td><td>–</td><td>page 5-23</td></tr>
<tr><td>5-5</td><td>–</td><td>Polarity Detection</td><td>This step is necessary only for a Linear Servomotor with a Polarity Sensor.</td><td>page 5-24</td></tr>
<tr><td>5-6</td><td>Pn50A (250A hex) = n.X□□□ and Pn50B (250B hex) = n.□□□X</td><td>Overtravel Signal Allocations</td><td>–</td><td>page 5-27</td></tr>
<tr><td>5-7</td><td>Pn483 (2483 hex), Pn484 (2484 hex)</td><td>Force Control</td><td>–</td><td>page 6-25</td></tr>
</table>
</td></tr>
<tr><td>6</td><td>Setting the Origin of the Absolute Linear Encoder
Note: This step is necessary only for an Absolute Linear Servomotor from Mitutoyo Corporation.</td><td>☞ <i>5.16.2 Setting the Origin of the Absolute Linear Encoder</i> on page 5-52</td></tr>
</table>

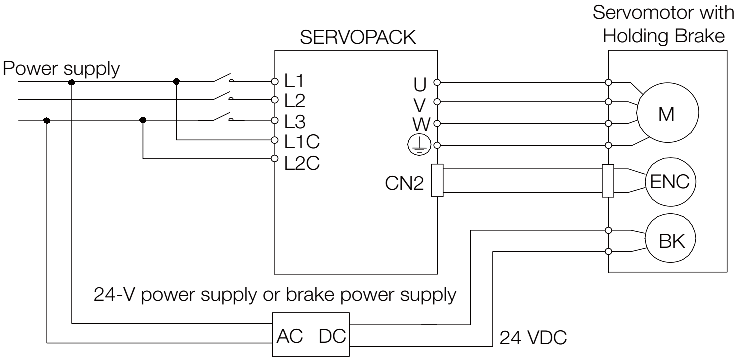
- Trial Operation

Step	Meaning	Reference
1	Trial Operation for the Servomotor without a Load  	☞ *7.3 Trial Operation for the Servomotor without a Load* on page 7-7
2	Trial Operation with EtherCAT (CoE) Communications  	☞ *7.4 Trial Operation with EtherCAT (CoE) Communications* on page 7-10
3	Trial Operation with the Servomotor Connected to the Machine  	☞ *7.5 Trial Operation with the Servomotor Connected to the Machine* on page 7-11

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 SERVOPACK and Servomotor are installed, wired, and connected correctly.
- Make sure that the correct power supply voltage is supplied to the SERVOPACK.
- 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 SERVOPACK 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

Confirm the following conditions before you jog the Servomotor.

- 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.
  - Rotary Servomotors

Pn304 (2304 hex)	Jogging Speed				Speed Position Torque
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 to 10,000	1 min^{-1}	500	Immediately	Setup
Pn305 (2305 hex)	Soft Start Acceleration Time			Speed	
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 to 10,000	1 ms	0	Immediately	Setup
Pn306 (2306 hex)	Soft Start Deceleration Time			Speed	
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 to 10,000	1 ms	0	Immediately	Setup

  - Direct Drive Servomotors

Pn304 (2304 hex)	Jogging Speed				Speed Position Torque
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 to 10,000	0.1 min^{-1}	500	Immediately	Setup
Pn305 (2305 hex)	Soft Start Acceleration Time			Speed	
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 to 10,000	1 ms	0	Immediately	Setup
Pn306 (2306 hex)	Soft Start Deceleration Time			Speed	
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 to 10,000	1 ms	0	Immediately	Setup

  - Linear Servomotors

Pn383 (2383 hex)	Jogging Speed				Speed Position Force
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 to 10,000	1 mm/s	50	Immediately	Setup
Pn305 (2305 hex)	Soft Start Acceleration Time			Speed	
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 to 10,000	1 ms	0	Immediately	Setup
Pn306 (2306 hex)	Soft Start Deceleration Time			Speed	
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 to 10,000	1 ms	0	Immediately	Setup

7.3.2 Applicable Tools

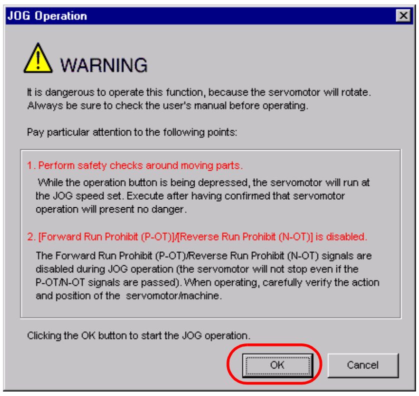
The following table lists the tools that you can use to perform jogging and the applicable tool functions.

Tool	Function	Operating Procedure Reference
Digital Operator	Fn002	📖 Σ-7-Series Digital Operator Operating Manual (Manual No.: SIEP S800001 33)
SigmaWin+	***Test Run - Jog***	☞ *Operating Procedure* on page 7-8

7.3.3 Operating Procedure

Use the following procedure.

1. Select ***Test Run - Jog*** from the menu bar of the Main Window of the SigmaWin+.
   The Jog Operation Dialog Box will be displayed.
2. Read the warnings and then click the **OK** Button.



WARNING

It is dangerous to operate this function, because the servomotor will rotate.
Always be sure to check the user's manual before operating.

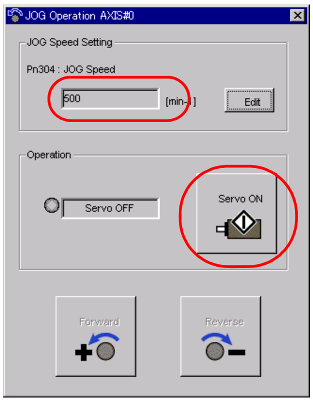
Pay particular attention to the following points:

1. Perform safety checks around moving parts.
While the operation button is being depressed, the servomotor will run at the JOG speed set. Execute after having confirmed that servomotor operation will present no danger.

2. [Forward Run Prohibit (P-OT)]/[Reverse Run Prohibit (N-OT)] is disabled.
The Forward Run Prohibit (P-OT)/Reverse Run Prohibit (N-OT) signals are disabled during JOG operation (the servomotor will not stop even if the P-OT/N-OT signals are passed). When operating, carefully verify the action and position of the servomotor/machine.

Clicking the OK button to start the JOG operation.

3. Check the jogging speed and then click the **Servo ON** Button.



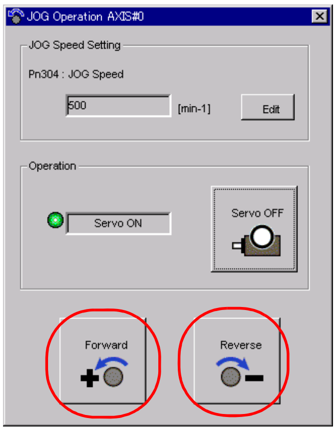
Pn304 : JOG Speed 500 [min-1]

The display in the **Operation** Area will change to **Servo ON**.

Information To change the speed, click the **Edit** Button and enter the new speed.

4. Click the **Forward** Button or the **Reverse** Button.

Jogging will be performed only while you hold down the mouse button.



Pn304 : JOG Speed 500 [min-1]

5. After you finish jogging, turn the power supply to the SERVOPACK OFF and ON again.

This concludes the jogging procedure.

7.4 Trial Operation with EtherCAT (CoE) Communications

A trial operation example for EtherCAT (CoE) communications is given below.

In this example, operation in Profile Position Mode is described.

Refer to the following chapter for details on operation with EtherCAT (CoE) communications.

☞ *Chapter 13 CiA402 Drive Profile*

1. **Confirm that the wiring is correct, and then connect the I/O signal connector (CN1) and EtherCAT communications connector (CN6A).**
   Refer to the following chapter for details on wiring.
   ☞ *Chapter 4 Wiring and Connecting SERVOPACKs*

2. **Set the EtherCAT (CoE) communications station address and PDO mappings.**

3. **Turn ON the power supplies to the SERVOPACK.**
   If power is being supplied correctly, the CHARGE indicator on the SERVOPACK will light.
   Note: If the COM indicator does not light, recheck the settings of EtherCAT setting switches (S1 and S2) and then turn the power supply OFF and ON again.

4. **Place the EtherCAT communications in the Operational state.**
   Refer to the following chapter for details on the EtherCAT communications status.
   ☞ *12.2 EtherCAT State Machine* on page 12-3

5. **Set the Modes of Operation to Profile Position Mode.**
   Refer to the following section for details on Modes of Operation.
   ☞ *Modes of Operation (6060 Hex)* on page 14-28

6. **Change the *controlword* to supply power to the motor.**
   When *statusword* shows the Operation Enabled state, power is supplied to the motor.
   Note: Manipulate the objects that were mapped to PDOs.
   Values will not be written if you manipulate SDOs.

7. **Set *target position*, *profile velocity*, *profile acceleration*, and *profile deceleration*, and then manipulate *controlword* to start positioning.**
   Note: Manipulate the objects that were mapped to PDOs.
   Values will not be written if you manipulate SDOs.

8. **While operation is in progress for step 6, confirm the following items.**

Confirmation Item	Reference
Confirm that the rotational direction of the Servomotor agrees with the forward or reverse reference. If they do not agree, correct the rotation direction of the Servomotor.	☞ *5.4 Motor Direction Setting* on page 5-15
Confirm that no abnormal vibration, noise, or temperature rise occurs. If any abnormalities are found, implement corrections.	☞ *15.4 Troubleshooting Based on the Operation and Conditions of the Servomotor* on page 15-49

Note: If the load machine is not sufficiently broken in before trial operation, the Servomotor may become overloaded.

7.5 Trial Operation with the Servomotor Connected to the Machine

This section provides the procedure for trial operation with both the machine and Servomotor.

7.5.1 Precautions

⚠ WARNING

- Operating mistakes that occur after the Servomotor is connected to the machine may not only damage the machine, but they may also cause accidents resulting in personal injury.

Important

If you disabled the overtravel function for trial operation of the Servomotor without a load, enable the overtravel function (P-OT and N-OT signal) before you perform trial operation with the Servomotor connected to the machine in order to provide protection.

If you will use a brake, observe the following precautions during trial operation.

- Before you check the operation of the brake, implement measures to prevent vibration from being caused by the machine falling due to gravity or an external force.
- First check the Servomotor operation and brake operation with the Servomotor uncoupled from the machine. If no problems are found, connect the Servomotor to the machine and perform trial operation again.

Control the operation of the brake with the /BK (Brake) signal output from the SERVOPACK.

Refer to the following sections for information on wiring and the related parameter settings.

☞ *4.4.4 Wiring the SERVOPACK to the Holding Brake* on page 4-28

☞ *5.11 Holding Brake* on page 5-32

Important

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

7.5.2 Preparations

Confirm the following items before you perform the trial operation procedure for both the machine and Servomotor.

- Make sure that the procedure described in *7.4 Trial Operation with EtherCAT (CoE) Communications* on page 7-10 has been completed.
- Make sure that the SERVOPACK is connected correctly to both the host controller and the peripheral devices.
  - Safety Function Wiring
    - If you are not using the safety function, leave the Safety Jumper Connector (provided as an accessory with the SERVOPACK) connected to CN8.
    - If you are using the safety function, remove the Safety Jumper Connector from CN8 and connect the safety function device.
  - Overtravel wiring
  - Brake wiring
  - Allocation of the /BK (Brake) signal to a pin on the I/O signal connector (CN1)
  - Emergency stop circuit wiring
  - Host controller wiring

7.5.3 Operating Procedure

1. Enable the overtravel signals.

5.10.2 Setting to Enable/Disable Overtravel on page 5-28

2. Make the settings for the protective functions, such as the safety function, overtravel, and the brake.

4.6 Connecting Safety Function Signals on page 4-36

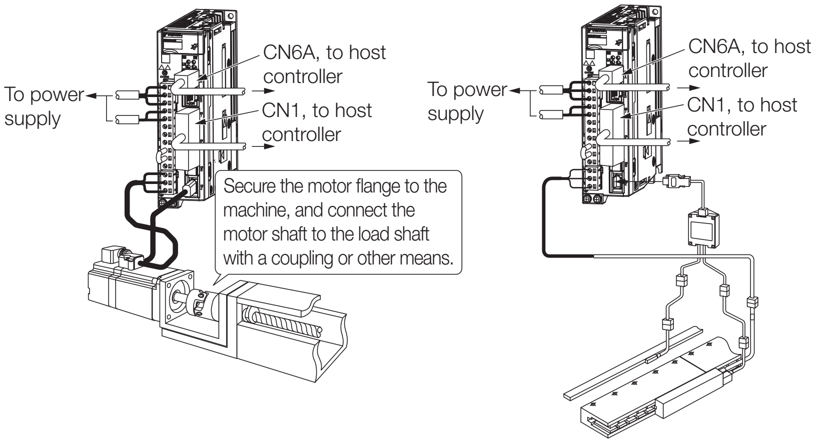
5.10 Overtravel and Related Settings on page 5-27

5.11 Holding Brake on page 5-32

3. Turn OFF the power supplies to the SERVOPACK.

The control power supply and main circuit power supply will turn OFF.

4. Couple the Servomotor to the machine.



5. Turn ON the power supplies to the machine and host controller and turn ON the control power supply and main circuit power supply to the SERVOPACK.

6. Check the protective functions, such overtravel and the brake, to confirm that they operate correctly.

Note: Enable activating an emergency stop so that the Servomotor can be stopped safely should an error occur during the remainder of the procedure.

7. Input the Enable Operation command from the host controller.

The servo will turn ON.

8. Perform trial operation according to *7.4 Trial Operation with EtherCAT (CoE) Communications* on page 7-10 and confirm that the same results are obtained as when trial operation was performed on the Servomotor without a load.

9. If necessary, adjust the servo gain to improve the Servomotor response characteristics.

The Servomotor and machine may not be broken in completely for the trial operation. Therefore, let the system run for a sufficient amount of time to ensure that it is properly broken in.

10. For future maintenance, save the parameter settings with one of the following methods.

- Use the SigmaWin+ to save the parameters as a file.
- Use the Parameter Copy Mode of the Digital Operator.
- Record the settings manually.

This concludes the procedure for trial operation with both the machine and Servomotor.

7.6 Convenient Function to Use during Trial Operation

This section describes some convenient operations that you can use during trial operation.

Use them as required.

7.6.1 Program Jogging

You can use program jogging to perform continuous operation with a preset operation pattern, travel distance, movement speed, acceleration/deceleration time, waiting time, and number of movements.

You can use this operation when you set up the system in the same way as for normal jogging to move the Servomotor without connecting it to the host controller in order to check Servomotor operation and execute simple positioning operations.

Preparations

Confirm the following conditions before you perform program jogging.

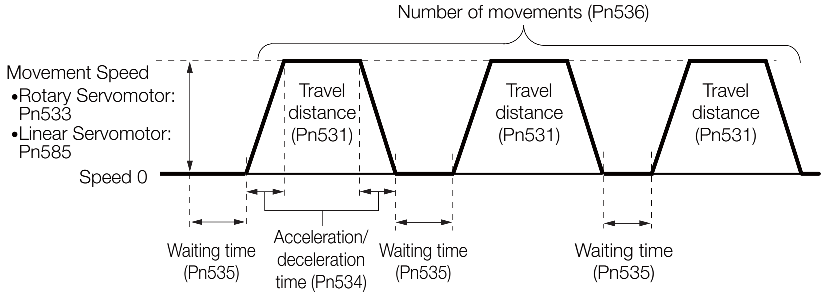
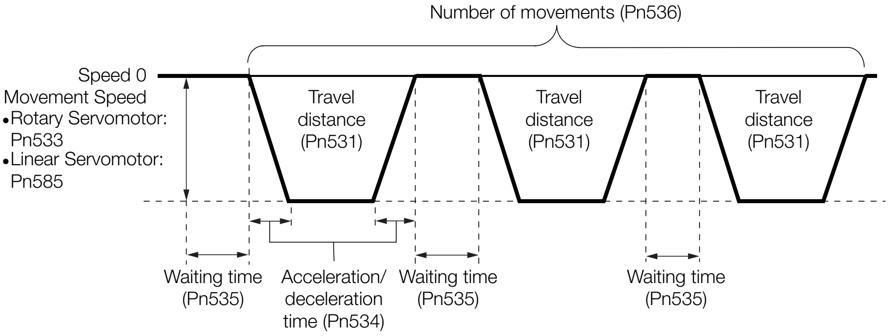
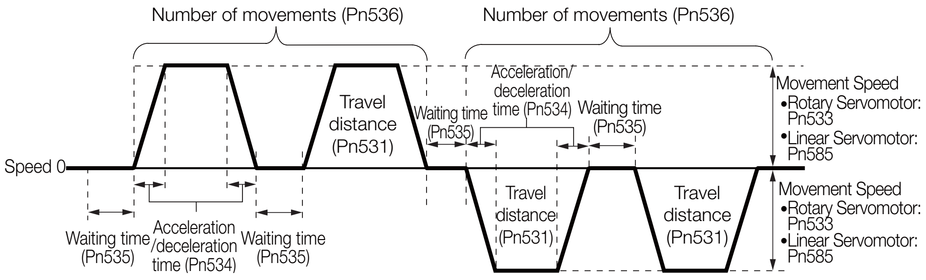
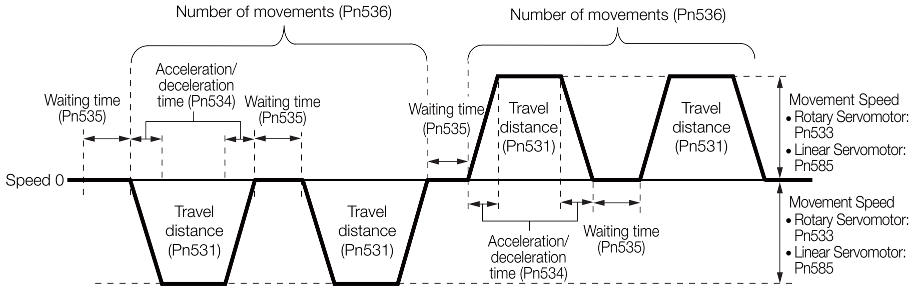
- The parameters must not be write prohibited.
- The main circuit power supply must be ON.
- There must be no alarms.
- There must be no hard wire base block (HWBB).
- The servo must be OFF.
- The range of machine motion and the safe movement speed of your machine must be considered when you set the travel distance and movement speed.
- There must be no overtravel.

Additional Information

- You can use the functions that are applicable to position control, such as the position reference filter.
- The overtravel function is enabled.

Program Jogging Operation Pattern

An example of a program jogging operation pattern is given below. In this example, the Servomotor direction is set to Pn000 = n.□□□0 (Use CCW as the forward direction).

Setting of Pn530 (2530 hex)	Setting	Operation Pattern
n.□□□0	(Waiting time → Forward travel distance) × Number of movements	
n.□□□1	(Waiting time → Reverse by travel distance) × Number of movements	
n.□□□2	(Waiting time → Forward by travel distance) × Number of movements → (Waiting time → Reserve by travel distance) × Number of movements	
n.□□□3	(Waiting time → Reverse by travel distance) × Number of movements → (Waiting time → Forward by travel distance) × Number of movements	

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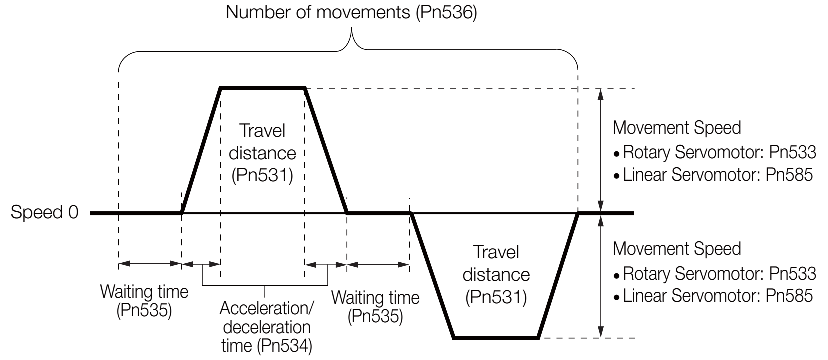
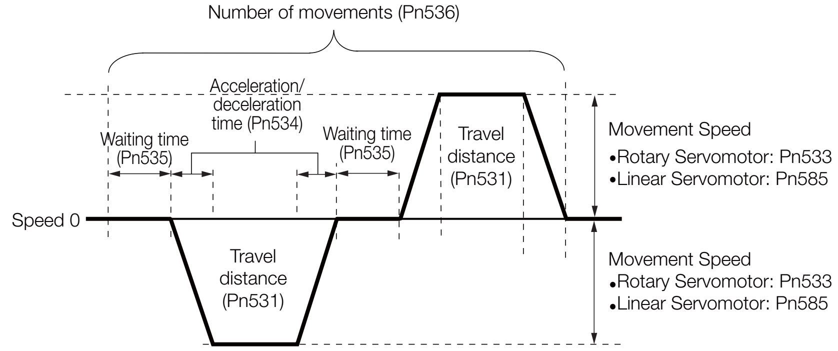
Setting of Pn530 (2530 hex)	Setting	Operation Pattern
n.□□□4	(Waiting time → Forward by travel distance → Waiting time → Reserve by travel distance) × Number of movements	
n.□□□5	(Waiting time → Reverse by travel distance → Waiting time → Forward by travel distance) × Number of movements	

Information If Pn530 is set to n.□□□0, n.□□□1, n.□□□4, or n.□□□5, you can set Pn536 (Program Jogging Number of Movements) to 0 to perform infinite time operation.
You cannot use infinite time operation if Pn530 is set to n.□□□2 or n.□□□3.
If you perform infinite time operation from the Digital Operator, press the **JOG/SVON** Key to turn OFF the servo to end infinite time operation.

Related Parameters

Use the following parameters to set the program jogging operation pattern. Do not change the settings while the program jogging operation is being executed.

- Rotary Servomotors

Pn530 (2530 hex)	Program Jogging-Related Selections				Speed Position Torque
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0000 to 0005	–	0000	Immediately	Setup
Pn531 (2531 hex)	Program Jogging Travel Distance				Speed Position Torque
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	1 to 1,073,741,824	1 reference unit	32,768	Immediately	Setup
Pn533 (2533 hex)	Program Jogging Movement Speed				Speed Position Torque
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	1 to 10,000	1 min^{-1}	500	Immediately	Setup
Pn534 (2534 hex)	Program Jogging Acceleration/Deceleration Time				Speed Position Torque
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	2 to 10,000	1 ms	100	Immediately	Setup
Pn535 (2535 hex)	Program Jogging Waiting Time				Speed Position Torque
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 to 10,000	1 ms	100	Immediately	Setup
Pn536 (2536 hex)	Program Jogging Number of Movements				Speed Position Torque
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 to 1,000	1	1	Immediately	Setup

- Direct Drive Servomotors

Pn530 (2530 hex)	Program Jogging-Related Selections				Speed Position Torque
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0000 to 0005	–	0000	Immediately	Setup
Pn531 (2531 hex)	Program Jogging Travel Distance				Speed Position Torque
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	1 to 1,073,741,824	1 reference unit	32,768	Immediately	Setup
Pn533 (2533 hex)	Program Jogging Movement Speed				Speed Position Torque
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	1 to 10,000	0.1 min^{-1}	500	Immediately	Setup
Pn534 (2534 hex)	Program Jogging Acceleration/Deceleration Time				Speed Position Torque
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	2 to 10,000	1 ms	100	Immediately	Setup
Pn535 (2535 hex)	Program Jogging Waiting Time				Speed Position Torque
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 to 10,000	1 ms	100	Immediately	Setup
Pn536 (2536 hex)	Program Jogging Number of Movements				Speed Position Torque
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 to 1,000	1	1	Immediately	Setup

- Linear Servomotors

Pn530 (2530 hex)	Program Jogging-Related Selections				Speed Position Force
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0000 to 0005	–	0000	Immediately	Setup
Pn531 (2531 hex)	Program Jogging Travel Distance				Speed Position Force
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	1 to 1,073,741,824	1 reference unit	32,768	Immediately	Setup
Pn585 (2585 hex)	Program Jogging Movement Speed				Speed Position Force
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	1 to 10,000	1 mm/s	50	Immediately	Setup
Pn534 (2534 hex)	Program Jogging Acceleration/Deceleration Time				Speed Position Force
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	2 to 10,000	1 ms	100	Immediately	Setup
Pn535 (2535 hex)	Program Jogging Waiting Time				Speed Position Force
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 to 10,000	1 ms	100	Immediately	Setup
Pn536 (2536 hex)	Program Jogging Number of Movements				Speed Position Force
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 to 1,000	1	1	Immediately	Setup

Applicable Tools

The following table lists the tools that you can use to perform program jogging and the applicable tool functions.

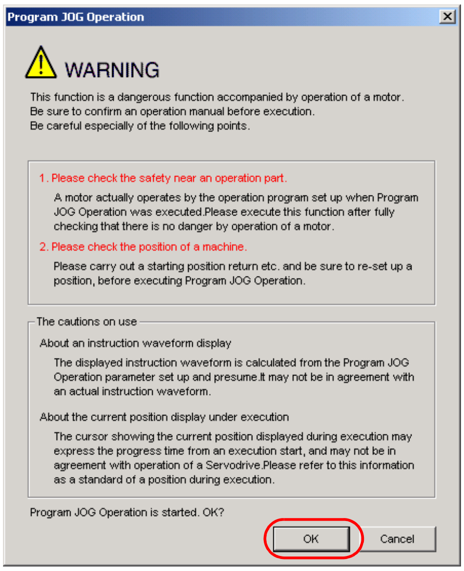
Tool	Function	Reference
Digital Operator	Fn004	📖 Σ-7-Series Digital Operator Operating Manual (Manual No.: SIEP S800001 33)
SigmaWin+	***Test Run - Program JOG Operation***	☞ *Operating Procedure* on page 7-17

Operating Procedure

Use the following procedure.

1. Select ***Test Run - Program JOG Operation*** from the menu bar of the Main Window of the SigmaWin+.
   The Program Jog Operation Dialog Box will be displayed.

2. Read the warnings and then click the **OK** Button.



This function is a dangerous function accompanied by operation of a motor.
Be sure to confirm an operation manual before execution.
Be careful especially of the following points.

1. Please check the safety near an operation part.
   A motor actually operates by the operation program set up when Program JOG Operation was executed.Please execute this function after fully checking that there is no danger by operation of a motor.
2. Please check the position of a machine.
   Please carry out a starting position return etc. and be sure to re-set up a position, before executing Program JOG Operation.

The cautions on use

About an instruction waveform display

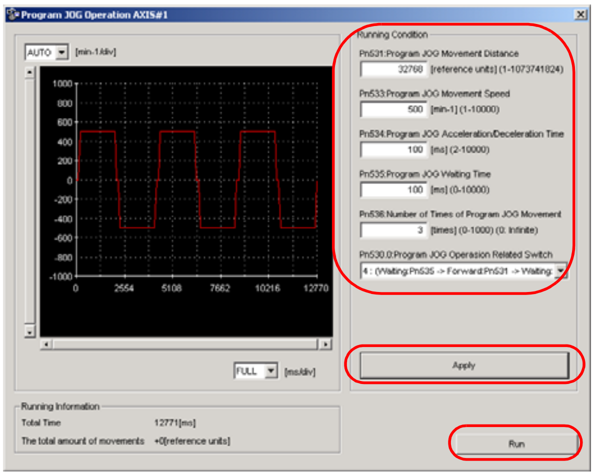
The displayed instruction waveform is calculated from the Program JOG Operation parameter set up and presume.It may not be in agreement with an actual instruction waveform.

About the current position display under execution

The cursor showing the current position displayed during execution may express the progress time from an execution start, and may not be in agreement with operation of a Servodrive.Please refer to this information as a standard of a position during execution.

Program JOG Operation is started. OK?

3. Set the operating conditions, click the **Apply** Button, and then click the **Run** Button.
   A graph of the operation pattern will be displayed.



Program JOG Operation AXIS#1

Running Condition

Pn531:Program JOG Movement Distance: 32768 [reference units] (1-1073741824)

Pn533:Program JOG Movement Speed: 500 [min-1] (1-10000)

Pn534:Program JOG Acceleration/Deceleration Time: 100 [ms] (2-10000)

Pn535:Program JOG Waiting Time: 100 [ms] (0-10000)

Pn536:Number of Times of Program JOG Movement: 3 [times] (0-1000) (0: Infinite)

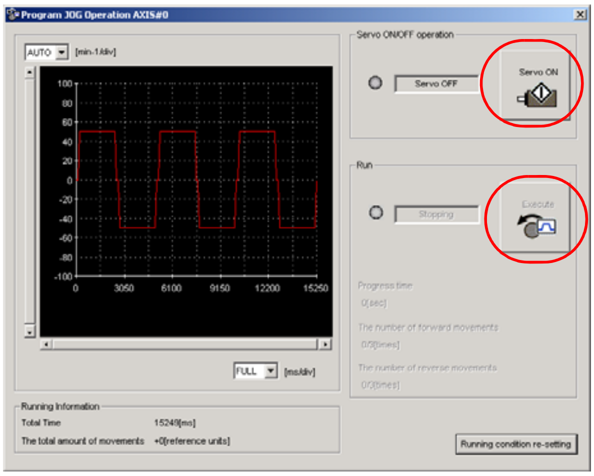
Pn530.0:Program JOG Operasion Related Switch: 4 : (Waiting:Pn535 -> Forward:Pn531 -> Waiting:

Running Information

Total Time: 12771[ms]

The total amount of movements: +0[reference units]

4. Click the **Servo ON** Button and then the **Execute** Button. The program jogging operation will be executed.



Program JOG Operation AXIS#0

Servo ON/OFF operation: Servo OFF

Run: Stopping

Progress time: 0[sec]

The number of forward movements: 0/3[times]

The number of reverse movements: 0/3[times]

Running Information

Total Time: 15249[ms]

The total amount of movements: +0[reference units]

⚠ CAUTION

- Be aware of the following points if you cancel the program jogging operation while the motor is operating.
  - If you cancel operation with the **Servo OFF** Button, the motor will stop according to setting of the Servo OFF stopping method (Pn001 = n.□□□X).
  - If you cancel operation with the **Cancel** Button, the motor will decelerate to a stop and then enter a zero-clamped state.

This concludes the program jogging procedure.

7.6.2 Origin Search

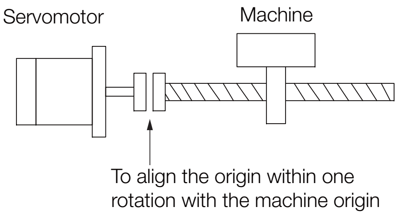
The origin search operation positions the motor to the origin within one rotation and the clamps it there.

⚠ CAUTION

- **Make sure that the load is not coupled when you execute an origin search.**
  The Forward Drive Prohibit (P-OT) signal and Reverse Drive Prohibit (N-OT) signal are disabled during an origin search.

Use an origin search when it is necessary to align the origin within one rotation with the machine origin. The following speeds are used for origin searches.

- Rotary Servomotors: 60 min^{-1}
- Direct Drive Servomotors: 6 min^{-1}
- Linear Servomotors: 15 mm/s



Preparations

Confirm the following conditions before you start an origin search.

- 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.

Applicable Tools

The following table lists the tools that you can use to perform an origin search and the applicable tool functions.

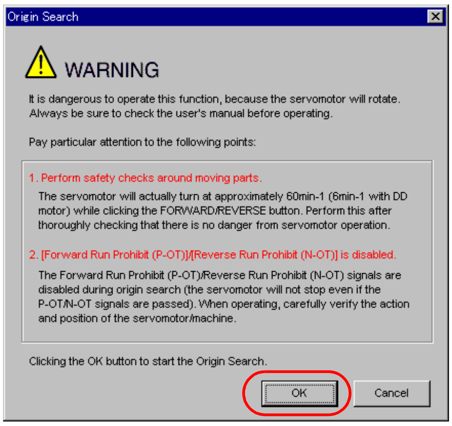
Tool	Function	Reference
Digital Operator	Fn003	📖 Σ-7-Series Digital Operator Operating Manual (Manual No.: SIEP S800001 33)
SigmaWin+	**Setup - Origin Search**	☞ *Operating Procedure* on page 7-20

Operating Procedure

Use the following procedure.

1. Select ***Setup - Origin Search*** from the menu bar of the Main Window of the SigmaWin+.
   The Origin Search Dialog Box will be displayed.

2. Read the warnings and then click the **OK** Button.



Origin Search

WARNING

It is dangerous to operate this function, because the servomotor will rotate.
Always be sure to check the user's manual before operating.

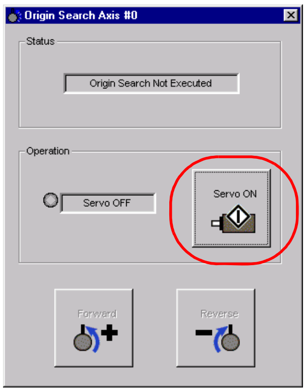
Pay particular attention to the following points:

1. Perform safety checks around moving parts.
The servomotor will actually turn at approximately 60min-1 (6min-1 with DD motor) while clicking the FORWARD/REVERSE button. Perform this after thoroughly checking that there is no danger from servomotor operation.

2. [Forward Run Prohibit (P-OT)]/[Reverse Run Prohibit (N-OT)] is disabled.
The Forward Run Prohibit (P-OT)/Reverse Run Prohibit (N-OT) signals are disabled during origin search (the servomotor will not stop even if the P-OT/N-OT signals are passed). When operating, carefully verify the action and position of the servomotor/machine.

Clicking the OK button to start the Origin Search.

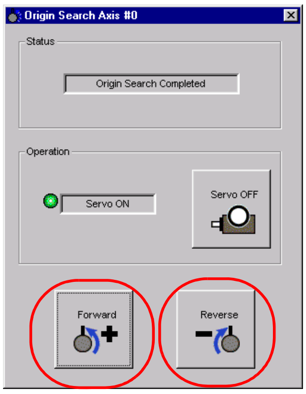
3. Click the **Servo ON** Button.



Origin Search Not Executed

Servo OFF

4. Click the **Forward** Button or the **Reverse** Button.
   An origin search will be performed only while you hold down the mouse button. The motor will stop when the origin search has been completed.



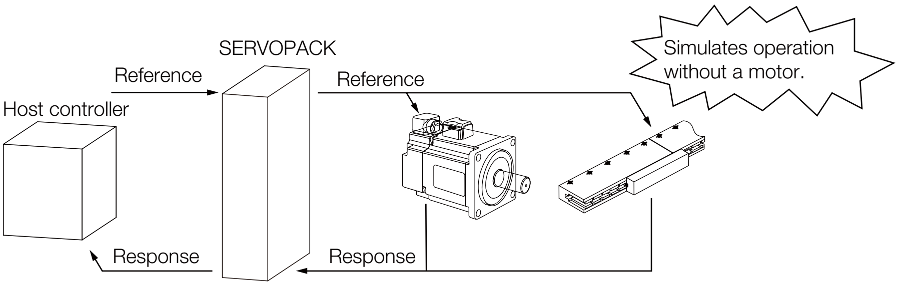
Origin Search Completed

Servo ON

This concludes the origin search procedure.

7.6.3 Test without a Motor

A test without a motor is used to check the operation of the host controller and peripheral devices by simulating the operation of the Servomotor in the SERVOPACK, i.e., without actually operating a Servomotor. This test allows you to check wiring, debug the system, and verify parameters to shorten the time required for setup work and to prevent damage to the machine that may result from possible malfunctions. The operation of the motor can be checked with this test regardless of whether the motor is actually connected or not.



Use Pn00C = n.□□□X to enable or disable the test without a motor.

Parameter		Meaning	When Enabled	Classification
Pn00C (200C hex)	n.□□□0 (default setting)	Disable tests without a motor.	After restart	Setup
	n.□□□1	Enable tests without a motor.		

Information An asterisk is displayed on the status display of the Digital Operator while a test without a motor is being executed.

Motor Information and Encoder Information

The motor and encoder information is used during tests without a motor. The source of the information depends on the device connection status.

- Rotary Servomotor

Motor Connection Status	Information That Is Used	Source of Information
Connected	Motor information	Information in the motor that is connected
	Encoder information • Encoder resolution • Encoder type	
Not connected	Motor information	Setting of Pn000 = n.X□□□ (Rotary/Linear Startup Selection When Encoder Is Not Connected)
	Encoder information • Encoder resolution • Encoder type	• Encoder resolution: Setting of Pn00C = n.□□X□ (Encoder Resolution for Tests without a Motor) • Encoder type: Setting of Pn00C = n.□X□□ (Encoder Type Selection for Tests without a Motor)

If you use fully-closed loop control, the external encoder information is also used.

External Encoder Connection Status	Information That Is Used	Source of Information
Connected	External encoder information • Resolution • Encoder type	Information in the external encoder that is connected
Not connected		• Resolution: 256 • Encoder type: Incremental encoder

- Linear Servomotors

Motor Connection Status	Information That Is Used	Source of Information
Connected	Motor information	Information in the motor that is connected
	Linear encoder information • Resolution • Encoder pitch • Encoder type	Information in the linear encoder that is connected
Not connected	Motor information	Setting of Pn000 = n.X□□□ (Rotary/Linear Startup Selection When Encoder Is Not Connected)
	Linear encoder information • Resolution • Encoder pitch • Encoder type	• Resolution: 256 • Encoder pitch: Setting of Pn282 (Linear Encoder Pitch) • Encoder type: Setting of Pn00C = n.□X□□ (Encoder Type Selection for Tests without a Motor)

- Related Parameters

Parameter		Meaning	When Enabled	Classification
Pn000 (2000 hex)	n.0□□□ (default setting)	When an encoder is not connected, start as SERVOPACK for Rotary Servomotor.	After restart	Setup
	n.1□□□	When an encoder is not connected, start as SERVOPACK for Linear Servomotor.		

Pn282 (2282 hex)	Linear Encoder Pitch				Speed Position Force
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 to 6,553,600	0.01 μm	0	After restart	Setup

Parameter		Meaning	When Enabled	Classification
Pn00C (200C hex)	n.□□0□ (default setting)	Use 13 bits as encoder resolution for tests without a motor.	After restart	Setup
	n.□□1□	Use 20 bits as encoder resolution for tests without a motor.		
	n.□□2□	Use 22 bits as encoder resolution for tests without a motor.		
	n.□□3□	Use 24 bits as encoder resolution for tests without a motor.		
	n.□0□□ (default setting)	Use an incremental encoder for tests without a motor.		
	n.□1□□	Use an absolute encoder for tests without a motor.		

Motor Position and Speed Responses

For a test without a motor, the following responses are simulated for references from the host controller according to the gain settings for position or speed control.

- Servomotor position
- Motor speed
- External encoder position

The load model will be for a rigid system with the moment of inertia ratio that is set in Pn103.

Restrictions

The following functions cannot be used during the test without a motor.

- Regeneration and dynamic brake operation
- Brake output signal
  Refer to the following section for information on confirming the brake output signal.
  ☞ *9.2.3 I/O Signal Monitor* on page 9-5
- Items marked with "×" in the following utility function table

SigmaWin+		Digital Operator		Executable?		Reference
Menu Bar Button	SigmaWin+ Function Name	Fn No.	Utility Function Name	Motor Not Connected	Motor Connected	
Setup	Origin Search	Fn003	Origin Search	○	○	page 7-19
	Resetting the Absolute Encoder	Fn008	Reset Absolute Encoder	×	○	page 5-50
	Analog Monitor Output Adjustment	Fn00C	Adjust Analog Monitor Output Offset	○	○	page 9-9
		Fn00D	Adjust Analog Monitor Output Gain	○	○	page 9-9
	Motor Current Detection Offset Adjustment	Fn00E	Autotune Motor Current Detection Signal Offset	×	○	page 6-48
		Fn00F	Manually Adjust Motor Current Detection Signal Offset	×	○	
	Parameter Write Prohibition Setting	Fn010	Write Prohibition Setting	○	○	page 5-7
	Multiturn Limit Setting	Fn013	Multiturn Limit Setting after Multiturn Limit Disagreement Alarm	×	○	page 6-36
	Reset Configuration Error of Option Module	Fn014	Reset Option Module Configuration Error	○	○	page 15-40
	Initializing the Vibration Detection Level	Fn01B	Initialize Vibration Detection Level	×	×	page 6-45
	Setting the Origin of the Absolute Linear Encoder	Fn020	Set Absolute Linear Encoder Origin	×	○	page 5-52
	Reset Motor Type Alarm	Fn021	Reset Motor Type Alarm	○	○	–
	Software Reset	Fn030	Software Reset	○	○	page 6-43
	Polarity Detection	Fn080	Polarity Detection	×	×	page 5-24
	Tuning-less Level Setting	Fn200	Tuning-less Level Setting	×	×	page 8-15
	Easy FFT	Fn206	Easy FFT	×	×	page 8-92
Parameter	Initialize Servo*	Fn005	Initialize Parameters	○	○	page 5-9
Tuning	Autotuning without Host Reference	Fn201	Advanced Autotuning without Reference	×	×	page 8-22
	Autotuning with Host Reference	Fn202	Advanced Autotuning with Reference	×	×	page 8-33
	Custom Tuning	Fn203	One-Parameter Tuning	×	×	page 8-41
	Adjust Anti-resonance Control	Fn204	Adjust Anti-resonance Control	×	×	page 8-50
	Vibration Suppression	Fn205	Vibration Suppression	×	×	page 8-55

Continued on next page.

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SigmaWin+		Digital Operator		Executable?		Reference
Menu Bar Button	SigmaWin+ Function Name	Fn No.	Utility Function Name	Motor Not Connected	Motor Connected	
Monitoring	Product Information	Fn011	Display Servomotor Model	○	○	page 9-2
		Fn012	Display Software Version	○	○	
		Fn01E	Display SERVOPACK and Servomotor IDs	○	○	page 9-2
		Fn01F	Display Servomotor ID from Feedback Option Module	○	○	
Test Operation	Jogging	Fn002	Jogging	○	○	page 7-7
	Program Jogging	Fn004	Program Jogging	○	○	page 7-13
Alarms	Alarm History Display	Fn000	Display Alarm History	○	○	page 15-38
	Clearing the Alarm History	Fn006	Clear Alarm History	○	○	page 15-39

* The **Initialize** Button will be displayed when you select ***Parameters - Edit Parameters*** from the menu bar.

Tuning

8

This chapter provides information on the flow of tuning, details on tuning functions, and related operating procedures.

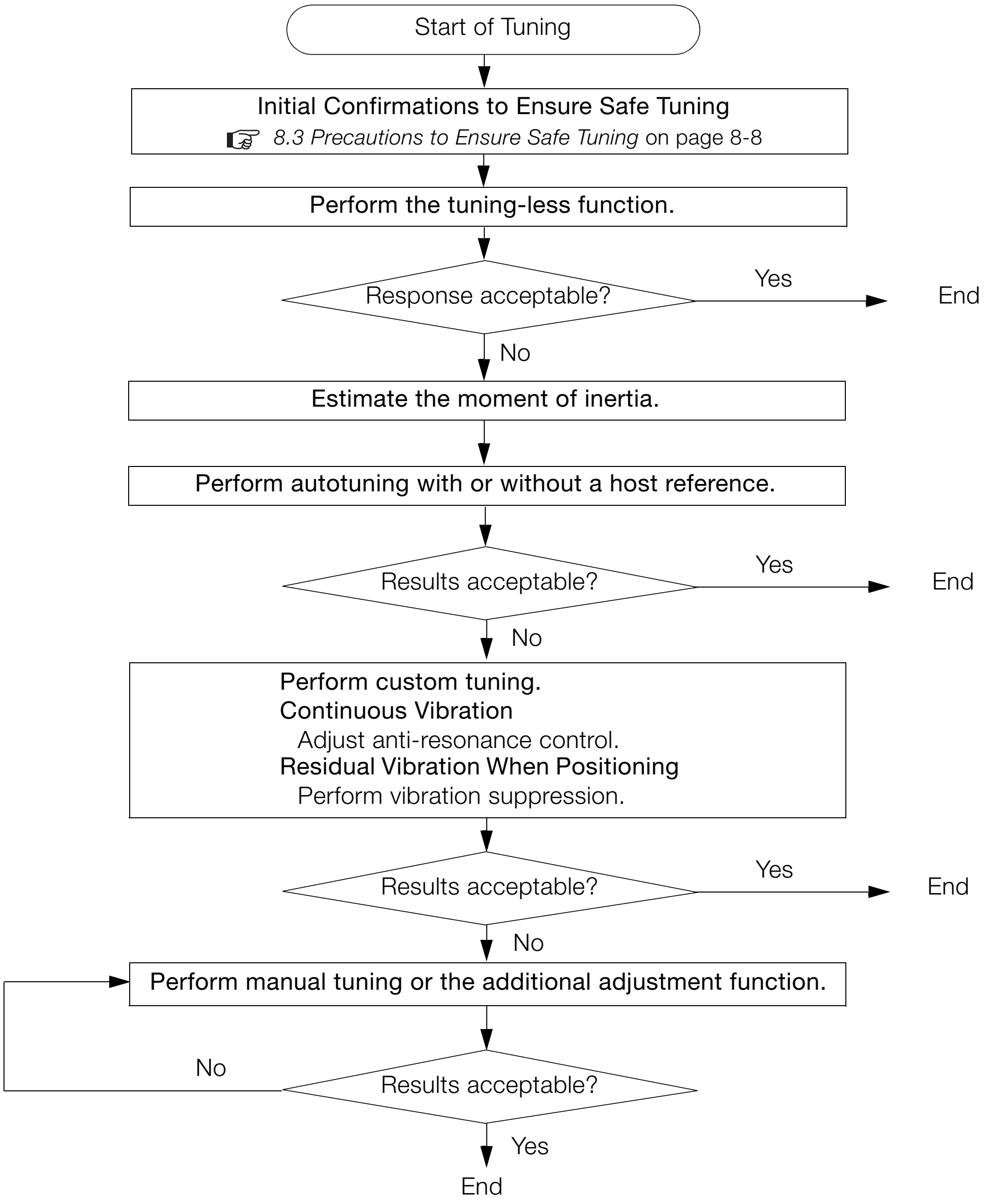
8.1 Overview and Flow of Tuning

Tuning is performed to optimize response by adjusting the servo gains in the SERVOPACK.

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.



8.1.1 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 8-11
Moment of Inertia Estimation	The moment of inertia ratio is calculated by operating 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 8-15
Autotuning without Host Reference	The following parameters are automatically adjusted in the internal references in the SERVOPACK 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 8-22
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 8-33
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 8-41
Anti-resonance Control Adjustment	This function effectively suppresses continuous vibration.	Speed control or position control	page 8-50
Vibration Suppression	This function effectively suppresses residual vibration if it occurs when positioning.	Position control	page 8-55
Speed Ripple Compensation	This function reduces the ripple in the motor speed.	Speed control, position control, or torque control	page 8-59
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 8-65
Manual Tuning	You can manually adjust the servo gains to adjust the response.	Speed control, position control, or torque control	page 8-76

8.1.2 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
Mechanical Analysis	The machine is subjected to vibration to detect resonance frequencies. The measurement results are displayed as waveforms or numeric data.	Speed control, position control, or torque control	page 8-90
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 8-92

8.2 Monitoring Methods

You can use the data tracing function of the SigmaWin+ or the analog monitor signals of the SERVOPACK for monitoring. If you perform custom tuning or manual tuning, always use the above functions to monitor the machine operating status and SERVOPACK 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

8.3 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.

8.3.1 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.

Refer to the following section for details.

☞ *5.10 Overtravel and Related Settings* on page 5-27

8.3.2 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. Refer to the following section for details.

☞ *6.7 Selecting Torque Limits* on page 6-25

8.3.3 Setting the Position Deviation Overflow Alarm Level

The position deviation overflow alarm is a protective function that is enabled when the SERVOPACK is used in position control.

If the alarm level is set to a suitable value, the SERVOPACK will detect excessive position deviation and will stop the Servomotor if the Servomotor operation does not agree with the reference.

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

$$\text{Position deviation [reference units]} = \frac{\text{Motor speed [min}^{-1}\text{]}}{60} \times \frac{\text{Encoder resolution}^{*1}}{\text{Pn102 [0.1/s]}/10^{*2,\ *3}} \times \frac{\text{Denominator}}{\text{Numerator}}$$

- Linear Servomotors

$$\text{Position deviation [reference units]} = \frac{\text{Motor speed [mm/s]}}{\text{Pn102 [0.1/s]}/10^{*2,\ *3}} \times \frac{\text{Resolution}}{\text{Linear encoder pitch [}\mu\text{m]}/1{,}000} \times \frac{\text{Denominator}}{\text{Numerator}}$$

Position Deviation Overflow Alarm Level (Pn520) [setting unit: reference units]

- Rotary Servomotors

$$\text{Pn520} > \frac{\text{Maximum motor speed [min}^{-1}\text{]}}{60} \times \frac{\text{Encoder resolution}^{*1}}{\text{Pn102 [0.1/s]/10}^{*2,\ *3}} \times \frac{\text{Denominator}}{\text{Numerator}} \times \underline{\underline{\text{(1.2 to 2)}}}^{*4}$$

- Linear Servomotors

$$\text{Pn520} > \frac{\text{Maximum motor speed [mm/s]}}{\text{Pn102 [0.1/s]/10}^{*2,\ *3}} \times \frac{\text{Resolution}}{\text{Linear encoder pitch [μm]/1,000}} \times \frac{\text{Denominator}}{\text{Numerator}} \times \underline{\underline{\text{(1.2 to 2)}}}^{*4}$$

*1. Refer to the following section for details.
☞ *5.14 Setting Unit Systems* on page 5-42

*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 motor 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. $\frac{\text{Denominator}}{\text{Numerator}} = \frac{1}{16}$

$$\text{Pn520} = \frac{6{,}000}{60} \times \frac{16{,}777{,}216}{400/10} \times \frac{1}{16} \times 2$$

$$= 2{,}621{,}440 \times 2$$

$$= 5{,}242{,}880 \text{ (default setting of Pn520)}$$

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 overflow alarm level.

Related Parameters

Pn520 (2520 hex)	Position Deviation Overflow Alarm Level			Position	
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	1 to 1,073,741,823	1 reference unit	5,242,880	Immediately	Setup

Related Alarms

Alarm Number	Alarm Name	Alarm Meaning
A.d00	Position Deviation Overflow Alarm	This alarm is displayed when the position deviation exceeds the setting of Pn520 (2520 hex) (Position Deviation Overflow Alarm Level).

8.3.4 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 Warning) when vibration is detected during machine operation.

Set the initial vibration detection level to an appropriate value. Refer to the following section for details.

☞ *6.11 Initializing the Vibration Detection Level* on page 6-45

8.3.5 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 (2526 hex)	Position Deviation Overflow Alarm Level at Servo ON			Position	
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	1 to 1,073,741,823	1 reference unit	5,242,880	Immediately	Setup
Pn528 (2528 hex)	Position Deviation Overflow Warning Level at Servo ON			Position	
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	10 to 100	1%	100	Immediately	Setup

- Rotary Servomotors

Pn529 (2529 hex)	Speed Limit Level at Servo ON			Position	
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 to 10,000	1 min^{-1}	10,000	Immediately	Setup

- Linear Servomotors

Pn584 (2584 hex)	Speed Limit Level at Servo ON			Position	
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 to 10,000	1 mm/s	10,000	Immediately	Setup

Related Alarms

Alarm Number	Alarm Name	Alarm Meaning
A.d01	Position Deviation Overflow Alarm at Servo ON	This alarm occurs if Servo ON command (Enable Operation command) is executed after the position deviation exceeded the setting of Pn526 (Excessive Position Deviation 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 a position reference is input and the setting of Pn520 (Excessive Position Deviation Alarm Level) is exceeded.

Refer to the following section for information on troubleshooting alarms.

☞ *15.2.3 Resetting Alarms* on page 15-38

8.4 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 Tuning-less 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.

8.4.1 Application Restrictions

The following application restrictions apply to the tuning-less function.

Function	Executable?	Remarks
Vibration Detection Level Initialization	○	–
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	×	–
Easy FFT	○	The tuning-less function is disabled while you execute Easy FFT and then it is enabled when Easy FFT has been completed.
Friction Compensation	×	–
Gain Selection	×	–
Mechanical Analysis	○	The tuning-less function is disabled while you execute mechanical analysis and then it is enabled when mechanical analysis has been completed.

* ○: Yes ×: No

8.4.2 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 (2170 hex)	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 (214F hex)	n.☐☐0☐	Use tuning-less type 1.	After restart	Tuning
	n.☐☐1☐	Use tuning-less type 2. (The noise level is improved more than with tuning-less type 1.)		
	n.☐☐2☐ (default setting)	Use tuning-less type 3.		

Tuning-less Level Settings

If vibration or other problems occur, change the tuning-less levels. To change the tuning-less levels, use the SigmaWin+.

◆ Preparations

Check the following settings before you set the tuning-less levels.

- The tuning-less function must be enabled (Pn170 = n.☐☐☐1).
- The test without a motor function must be disabled (Pn00C = n.☐☐☐0).

◆ Step

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 ***Setup - Response Level Setting*** from the menu bar of the Main Window of the SigmaWin+.
   The Response Level Setting Dialog Box will be displayed.

2. **Click the ▲ or ▼ Button to adjust the response level setting. Increase the response level setting to increase the response. Decrease the response level setting to suppress vibration.**
   The default response level setting is 4.

Response Level Setting	Description	Remarks
7	Response level: High	You cannot select these levels if tuning-less type 1 or 2 (Pn14F = n.□□0□ or n.□□1□) is used.
6		
5		
4 (default setting)		–
3		
2		
1		
0	Response level: Low	

3. **Click the Completed Button.**
   The adjustment results will be saved in the SERVOPACK.

◆ Related Parameters

■ Tuning-less Rigidity Level

If you use tuning-less type 1 or 2 (Pn14F = n.□□0□ or n.□□1□), set the tuning-less level to between 0 and 4 (Pn170 = n.□0□□ to n.□4□□). Do not set the tuning-less level to between 5 and 7 (Pn170 = n.□5□□ to n.□7□□).

Parameter		Description	When Enabled	Classification
Pn170 (2170 hex)	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 (2170 hex)	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		

8.4.3 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□□.

8.4.4 Parameters Disabled by Tuning-less Function

When the tuning-less function is enabled (Pn170 = n.□□□1) (default setting), the parameters in the following table are disabled.

Item	Parameter Name	Parameter Number
Gain-Related Parameters	Speed Loop Gain Second Speed Loop Gain	Pn100 (2100 hex) Pn104 (2104 hex)
	Speed Loop Integral Time Constant Second Speed Loop Integral Time Constant	Pn101 (2101 hex) Pn105 (2105 hex)
	Position Loop Gain Second Position Loop Gain	Pn102 (2102 hex) Pn106 (2106 hex)
	Moment of Inertia Ratio	Pn103 (2103 hex)
Advanced Control-Related Parameters	Friction Compensation Function Selection	Pn408 (2408 hex) = n.X□□□
	Anti-Resonance Control Selection	Pn160 (2160 hex)= n.□□□X
Gain Selection-Related Parameters	Gain Switching Selection	Pn139 (2139 hex)= 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.

8.4.5 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 (2460 hex)	n.□0□□	Do not adjust the second stage notch filter automatically 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 automatically during execution of autotuning without a host reference, autotuning with a host reference, and custom tuning.		

8.4.6 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 (2401 hex)	First Stage First Torque Reference Filter Time Constant
Pn40C (240C hex)	Second Stage Notch Filter Frequency
Pn40D (240D hex)	Second Stage Notch Filter Q Value

8.5 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.

☞ *8.6.4 Operating Procedure* on page 8-24

8.5.1 Outline

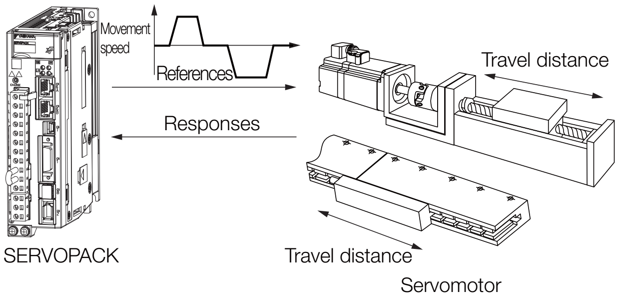
The moment of inertia during operation is automatically calculated by the SERVOPACK for round-trip (forward and reverse) operation. A reference from the host controller is not used.

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 motor in the actual system in forward and reverse a few times.

The motor 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.

8.5.2 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

Preparations

Check the following settings 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.
- The test without a motor function must be disabled (Pn00C = n.□□□0).
- 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).

8.5.3 Applicable Tools

The following table lists the tools that you can use to estimate the moment of inertia and the applicable tool functions.

Tool	Function	Operating Procedure Reference
SigmaWin+	***Tuning - Tuning***	☞ *8.5.4 Operating Procedure* on page 8-16

8.5.4 Operating Procedure

Use the following procedure to set the moment of inertia ratio.

⚠ WARNING

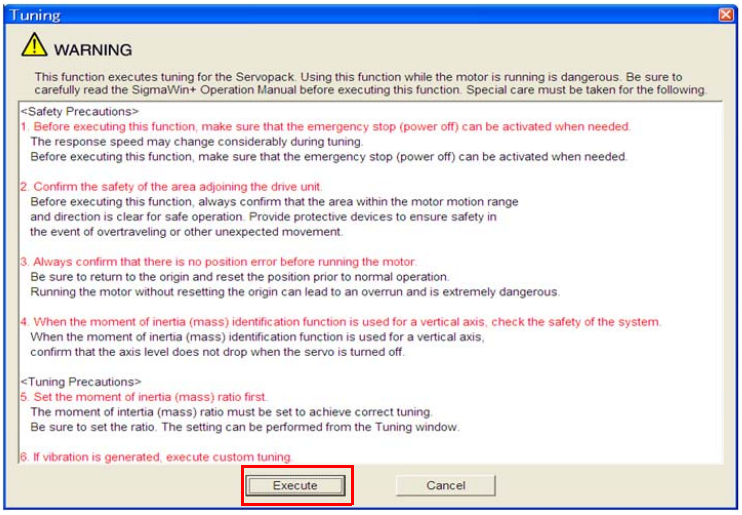
- **Estimating the moment of inertia requires operating the motor and therefore presents hazards. Observe the following precaution.**
  - Confirm safety around moving parts.
    This function involves automatic operation with vibration. Make sure that you can perform an emergency stop (to turn OFF the 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.

⚠ CAUTION

- **Be aware of the following points if you cancel the moment of inertia estimation while the motor is operating.**
  - If you cancel operation with the **Servo OFF** Button, the motor will stop according to setting of the Servo OFF stopping method (Pn001 = n.□□□X).
  - If you cancel operation with the **Cancel** Button, the motor will decelerate to a stop and then enter a zero-clamped state.

1. Select ***Tuning - Tuning*** from the menu bar of the Main Window of the SigmaWin+.
   The Tuning Dialog Box will be displayed.
   Click the **Cancel** Button to cancel tuning.

2. Click the **Execute** Button.



This function executes tuning for the Servopack. Using this function while the motor is running is dangerous. Be sure to carefully read the SigmaWin+ Operation Manual before executing this function. Special care must be taken for the following.

<Safety Precautions>
1. Before executing this function, make sure that the emergency stop (power off) can be activated when needed.
The response speed may change considerably during tuning.
Before executing this function, make sure that the emergency stop (power off) can be activated when needed.

2. Confirm the safety of the area adjoining the drive unit.
Before executing this function, always confirm that the area within the motor motion range
and direction is clear for safe operation. Provide protective devices to ensure safety in
the event of overtraveling or other unexpected movement.

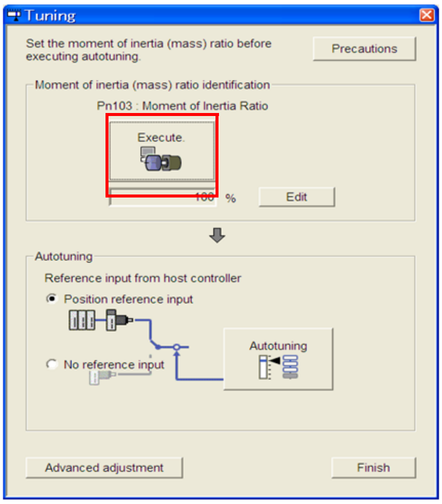
3. Always confirm that there is no position error before running the motor.
Be sure to return to the origin and reset the position prior to normal operation.
Running the motor without resetting the origin can lead to an overrun and is extremely dangerous.

4. When the moment of inertia (mass) identification function is used for a vertical axis, check the safety of the system.
When the moment of inertia (mass) identification function is used for a vertical axis,
confirm that the axis level does not drop when the servo is turned off.

<Tuning Precautions>
5. Set the moment of inertia (mass) ratio first.
The moment of intertia (mass) ratio must be set to achieve correct tuning.
Be sure to set the ratio. The setting can be performed from the Tuning window.

6. If vibration is generated, execute custom tuning.

3. Click the **Execute** Button.

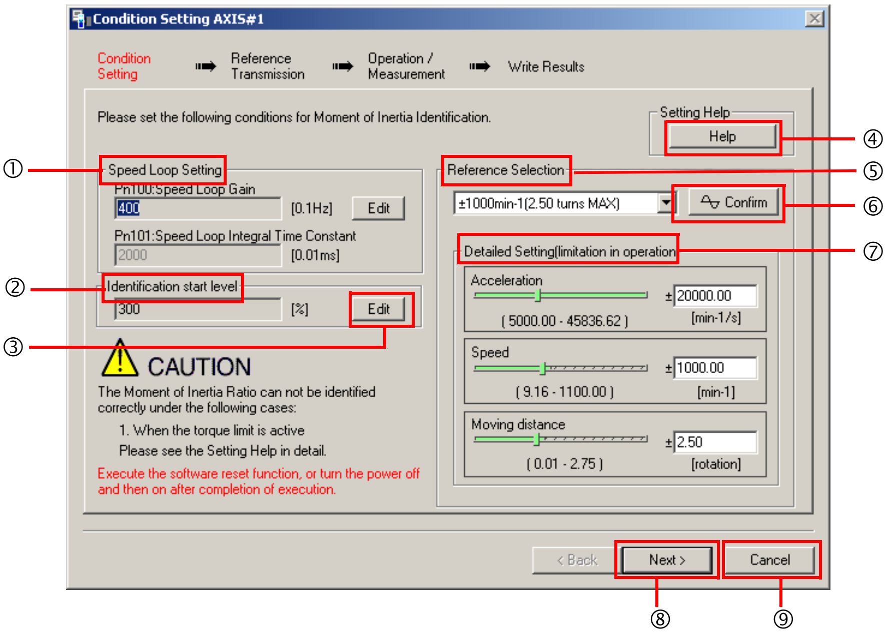


Set the moment of inertia (mass) ratio before executing autotuning.

Pn103 : Moment of Inertia Ratio 100 %

● Position reference input
○ No reference input

4. Set the conditions as required.



Please set the following conditions for Moment of Inertia Identification.

Pn100:Speed Loop Gain 400 [0.1Hz]
Pn101:Speed Loop Integral Time Constant 2000 [0.01ms]
Identification start level 300 [%]
Reference Selection: ±1000min-1(2.50 turns MAX)
Acceleration ±20000.00 [min-1/s] (5000.00 - 45836.62)
Speed ±1000.00 [min-1] (9.16 - 1100.00)
Moving distance ±2.50 [rotation] (0.01 - 2.75)

CAUTION
The Moment of Inertia Ratio can not be identified correctly under the following cases:
1. When the torque limit is active
Please see the Setting Help in detail.
Execute the software reset function, or turn the power off and then on after completion of execution.

① **Speed Loop Setting** Area
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** Group
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, causing moment of inertia estimation to fail.
If that occurs, estimation may be possible if you double the setting of the start level.

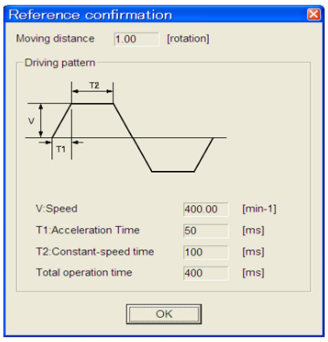
③ **Edit** Buttons
Click the button to display a dialog box to change the settings related to the speed loop or estimation start level.

④**Help** Button
Click this button to display guidelines for setting the reference conditions. Make the following settings as required.

- Operate the motor to measure the load moment of inertia of the machine in comparison with the rotor moment of inertia.
- Set the operation mode, reference pattern (maximum acceleration rate, maximum speed, and maximum travel distance), and speed loop-related parameters.
- Correct measurement of the moment of inertia ratio may not be possible depending on the settings. Set suitable settings using the measurement results as reference.

⑤ **Reference Selection** Area
Either select the reference pattern for estimation processing from the box, or set the values in the **Detailed Setting** Group. Generally speaking, the larger the maximum acceleration 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.

⑥ **Confirm** Button
Click this button to display the Reference Confirmation Dialog Box.



Moving distance 1.00 [rotation]

V:Speed 400.00 [min-1]
T1:Acceleration Time 50 [ms]
T2:Constant-speed time 100 [ms]
Total operation time 400 [ms]

⑦ **Detailed Setting** Area
You can change the settings by moving the bars or directly inputting the settings to create the required reference pattern.

⑧ **Next** Button
Click this button to display the Reference Transmission Dialog Box.

⑨ **Cancel** Button
Click this button to return to the Tuning Dialog Box.

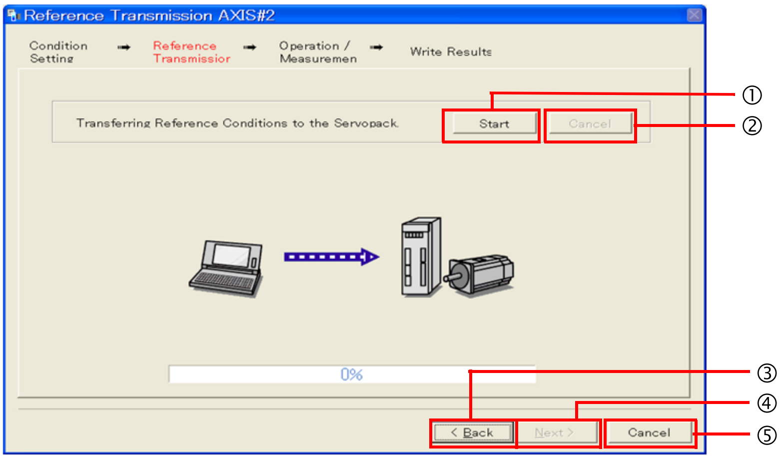
⚠ CAUTION

- 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.

Information **When Measurement Is Not Correct**
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.



Transferring Reference Conditions to the Servopack

① **Start** Button
The reference conditions will be transferred to the SERVOPACK. A progress bar will show the progress of the transfer.

② **Cancel** Button
The **Cancel** Button is enabled only while data is being transferred to the SERVOPACK. You cannot use it after the transfer has been completed.

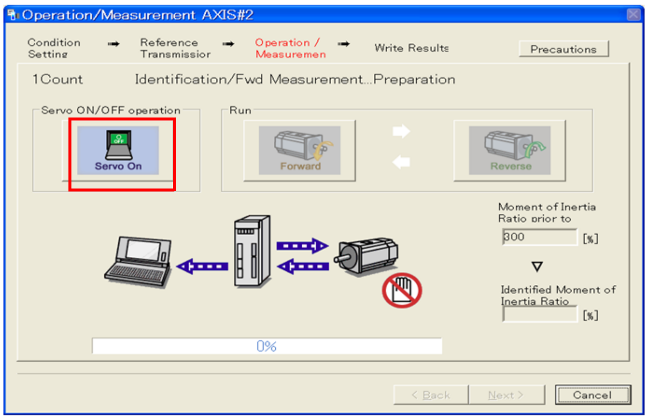
③ **Back** Button
This button returns you to the Condition Setting Dialog Box. It is disabled while data is being transferred.

④ **Next** Button
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** Button
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.



1Count Identification/Fwd Measurement...Preparation

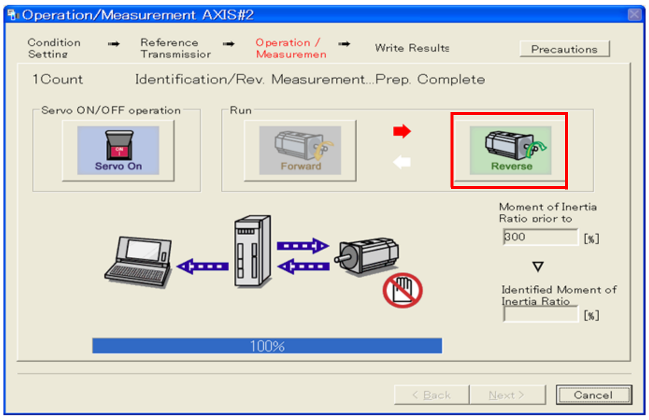
Moment of Inertia Ratio prior to: 300 [%]

Identified Moment of Inertia Ratio: [%]

9. Click the **Forward** Button.

The shaft will rotate in the forward direction and the measurement will start. After the measurement and data transfer have been completed, the **Reverse** Button will be displayed in color.

10. Click the **Reverse** Button.

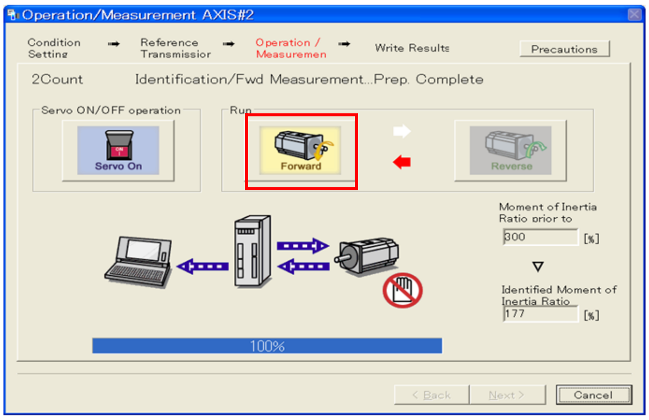


1Count Identification/Rev. Measurement...Prep. Complete

Moment of Inertia Ratio prior to 300 [%]

Identified Moment of Inertia Ratio [%]

The 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.



2Count Identification/Fwd Measurement...Prep. Complete

Moment of Inertia Ratio prior to 300 [%]

Identified Moment of Inertia Ratio 177 [%]

11. Repeat steps 8 to 9 until the **Next** Button is enabled.

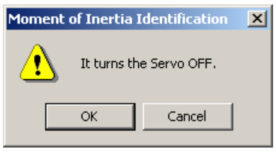
Measurements are performed from 2 to 7 times and then verified. The number of measurements is displayed in upper left corner of the dialog box. A progress bar at the bottom of the dialog box will show the progress of the transfer each time.

12. When the measurements have been completed, click the **Servo On** Button to turn OFF the servo.

13. Click the **Next** Button.

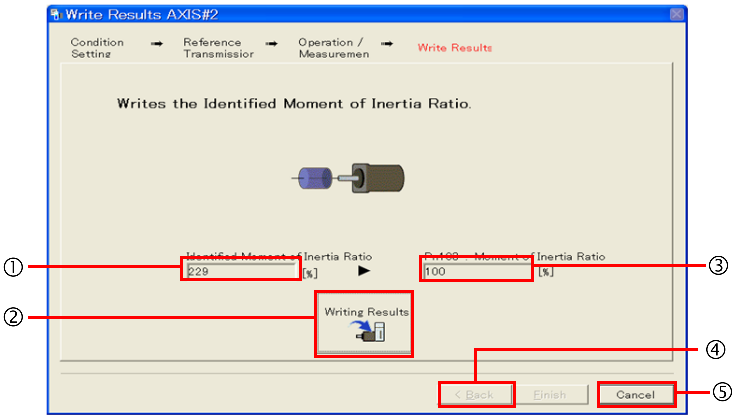
The Write Results Dialog Box will be displayed.

Information If you click the **Next** Button before you turn OFF the servo, the following Dialog Box will be displayed. Click the **OK** Button to turn OFF the servo.



It turns the Servo OFF.

14. Click the **Writing Results** Button.



Writes the Identified Moment of Inertia Ratio.

① **Identified Moment of Inertia Ratio** Box
The moment of inertia ratio that was found with operation and measurements is displayed here.

② **Writing Results** Button
If you click this button, Pn103 (Moment of Inertia Ratio) in the SERVOPACK is set to the value that is displayed for the identified moment of inertia ratio.

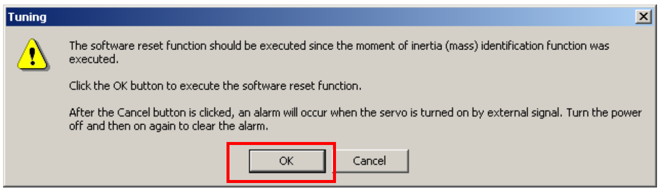
③ **Pn103: Moment of Inertia Ratio** Box
The value that is set for the parameter is displayed here.
After you click the **Writing Results** Button, the value that was found with operation and measurements will be displayed as the new setting.

④ **Back** Button
This button is disabled.

⑤ **Cancel** Button
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 **OK** Button.

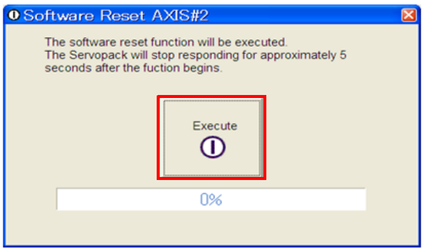


The software reset function should be executed since the moment of inertia (mass) identification function was executed.

Click the OK button to execute the software reset function.

After the Cancel button is clicked, an alarm will occur when the servo is turned on by external signal. Turn the power off and then on again to clear the alarm.

17. Click the **Execute** Button.



The software reset function will be executed.
The Servopack will stop responding for approximately 5 seconds after the fuction begins.

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.

This concludes the procedure.

8.6 Autotuning without Host Reference

This section describes autotuning without a host reference.

Important

- 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 damaged.
  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.

8.6.1 Outline

For autotuning without a host reference, operation is automatically performed by the SERVOPACK for round-trip (forward and reverse) operation to adjust for machine characteristics during operation. A reference from the host controller is not used.

The following items are adjusted automatically.

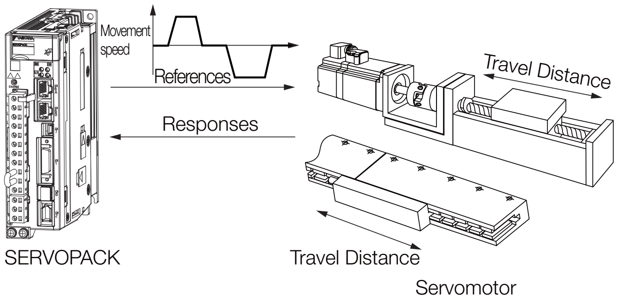
- Moment of inertia ratio
- Gains (e.g., speed loop gain and position loop gain)
- Filters (torque reference filter and notch filters)
- Friction compensation
- Anti-resonance control
- Vibration suppression (only for mode 2 or 3)

Refer to the following section for details on the parameters that are adjusted.

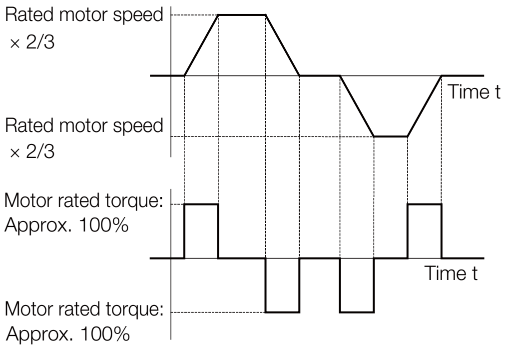
☞ *8.6.7 Related Parameters* on page 8-32

The motor is operated with the following specifications.

Maximum speed	Rated motor speed × $\frac{2}{3}$	
Acceleration Torque	Rated motor torque: Approx. 100% Note: The acceleration torque depends on the setting of the influence of the moment of inertia ratio (Pn103), 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 motor shaft rotations.
	Direct Drive Servomotors	You can set the desired travel distance. The default setting is for a value equivalent to 0.3 rotations.
	Linear Servomotors	You can set the desired travel distance in increments of 1,000 reference units. (The default setting is for 90 mm.)



Note: Execute autotuning without a host reference after jogging to a position that ensures a suitable range of motion.



Example of Automatic Operation Pattern

⚠ WARNING

- **Autotuning without a host reference requires operating the motor 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.

8.6.2 Restrictions

The following restrictions apply to autotuning without a host reference.

If you cannot use autotuning without a host reference because of these restrictions, use autotuning with a host reference or custom tuning. Refer to the following sections for details.

☞ *8.7 Autotuning with a Host Reference* on page 8-33

☞ *8.8 Custom Tuning* on page 8-41

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
- 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

Check the following settings 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.
- The test without a motor function must be disabled (Pn00C = n.□□□0).
- 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) and moment of inertia estimation must be specified.
- If you execute autotuning without a host reference during speed control, set the mode to 1.

Information

- If you start autotuning without a host reference while the SERVOPACK is in speed control for mode 2 or 3, the SERVOPACK will change to position control automatically to perform autotuning without a host reference. The SERVOPACK will return to speed control after autotuning has been completed.

8.6.3 Applicable Tools

The following table lists the tools that you can use to perform autotuning without a host reference and the applicable tool functions.

Tool	Function	Operating Procedure Reference
Digital Operator	Fn201	📖 Σ-7-Series Digital Operator Operating Manual (Manual No.: SIEP S800001 33)
SigmaWin+	***Tuning - Tuning***	☞ *8.6.4 Operating Procedure* on page 8-24

8.6.4 Operating Procedure

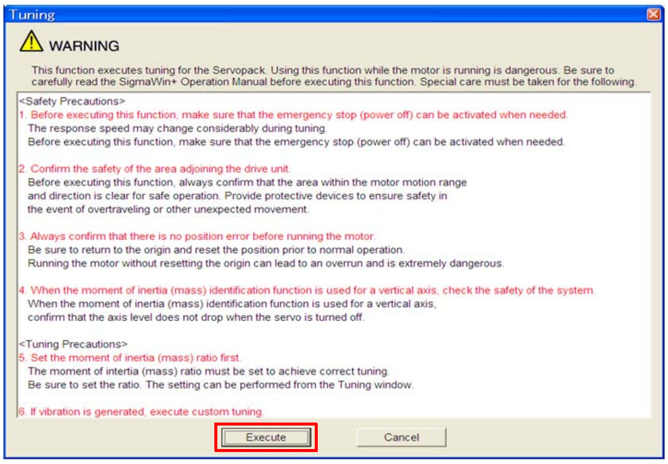
Use the following procedure to perform autotuning without a host reference.

⚠ 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.

1. Confirm that the moment of inertia ratio (Pn103) is set correctly.
2. Select ***Tuning - Tuning*** from the menu bar of the Main Window of the SigmaWin+.
   The Tuning Dialog Box will be displayed.
   Click the **Cancel** Button to cancel tuning.

3. Click the **Execute** Button.



This function executes tuning for the Servopack. Using this function while the motor is running is dangerous. Be sure to carefully read the SigmaWin+ Operation Manual before executing this function. Special care must be taken for the following.

<Safety Precautions>
1. Before executing this function, make sure that the emergency stop (power off) can be activated when needed.
The response speed may change considerably during tuning.
Before executing this function, make sure that the emergency stop (power off) can be activated when needed.

2. Confirm the safety of the area adjoining the drive unit.
Before executing this function, always confirm that the area within the motor motion range and direction is clear for safe operation. Provide protective devices to ensure safety in the event of overtraveling or other unexpected movement.

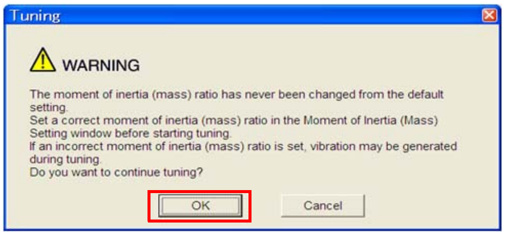
3. Always confirm that there is no position error before running the motor.
Be sure to return to the origin and reset the position prior to normal operation.
Running the motor without resetting the origin can lead to an overrun and is extremely dangerous.

4. When the moment of inertia (mass) identification function is used for a vertical axis, check the safety of the system.
When the moment of inertia (mass) identification function is used for a vertical axis, confirm that the axis level does not drop when the servo is turned off.

<Tuning Precautions>
5. Set the moment of inertia (mass) ratio first.
The moment of intertia (mass) ratio must be set to achieve correct tuning.
Be sure to set the ratio. The setting can be performed from the Tuning window.

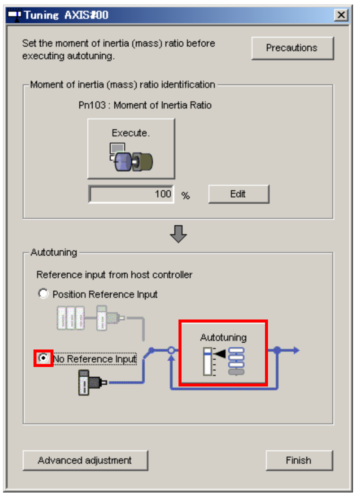
6. If vibration is generated, execute custom tuning.

4. Click the **OK** Button.



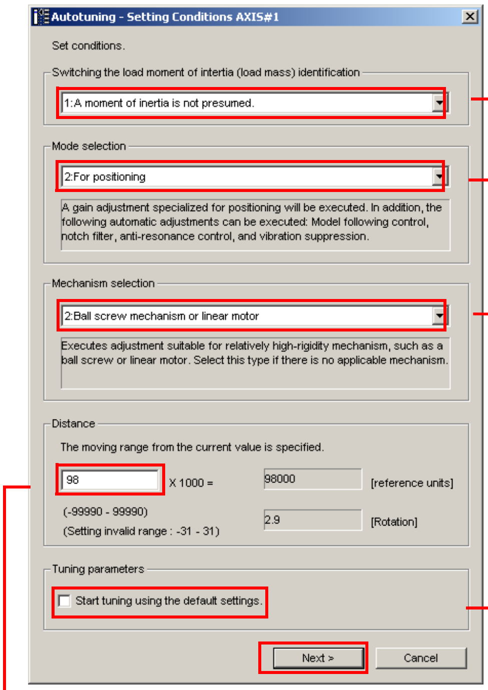
The moment of inertia (mass) ratio has never been changed from the default setting.
Set a correct moment of inertia (mass) ratio in the Moment of Inertia (Mass) Setting window before starting tuning.
If an incorrect moment of inertia (mass) ratio is set, vibration may be generated during tuning.
Do you want to continue tuning?

5. Select the **No Reference Input** Option in the **Autotuning** Area and then click the **Autotuning** Button.



Set the moment of inertia (mass) ratio before executing autotuning.

6. Set the conditions in the **Switching the load moment of inertia (load mass) identification** Box, the **Mode selection** Box, the **Mechanism selection** Box, and the **Distance Box**, and then click the **Next** Button.



Autotuning - Setting Conditions AXIS#1

Set conditions.

Switching the load moment of intertia (load mass) identification: 1:A moment of inertia is not presumed.

Mode selection: 2:For positioning

A gain adjustment specialized for positioning will be executed. In addition, the following automatic adjustments can be executed: Model following control, notch filter, anti-resonance control, and vibration suppression.

Mechanism selection: 2:Ball screw mechanism or linear motor

Executes adjustment suitable for relatively high-rigidity mechanism, such as a ball screw or linear motor. Select this type if there is no applicable mechanism.

Distance

The moving range from the current value is specified.

98 X 1000 = 98000 [reference units]

(-99990 - 99990)

(Setting invalid range : -31 - 31)

2.9 [Rotation]

Tuning parameters

☐ Start tuning using the default settings.

- **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.

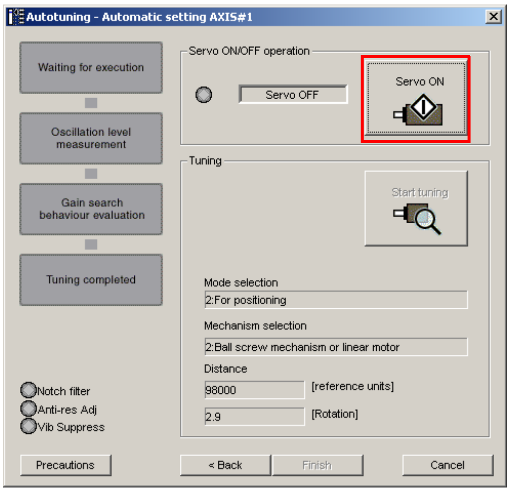
- **Mechanism selection** Box
  Select the type according to the machine element to drive.
  If there is noise or if the gain does not increase, better results may be obtained by changing the rigidity type.
  Select the type according to the following guidelines.

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.

- **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

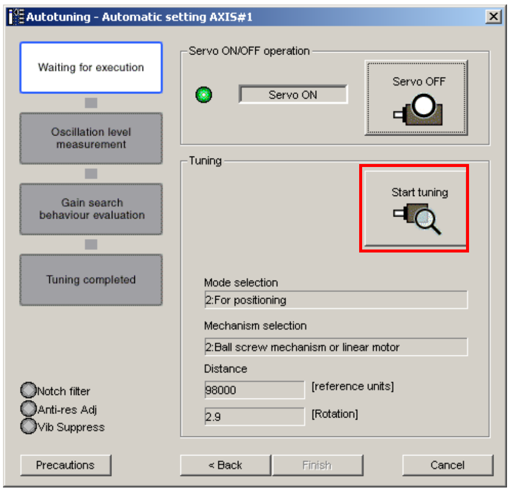
- **Tuning parameters** Box
  Specify the parameters to use for tuning.
  If you select the **Start tuning using the default settings** Check Box, the tuning parameters will be returned to the default settings before tuning is started.

7. Click the **Servo ON** Button.



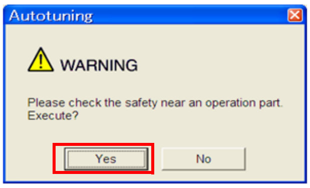
Mode selection: 2:For positioning
Mechanism selection: 2:Ball screw mechanism or linear motor
Distance: 98000 [reference units]
2.9 [Rotation]

8. Click the **Start tuning** Button.



Mode selection: 2:For positioning
Mechanism selection: 2:Ball screw mechanism or linear motor
Distance: 98000 [reference units]
2.9 [Rotation]

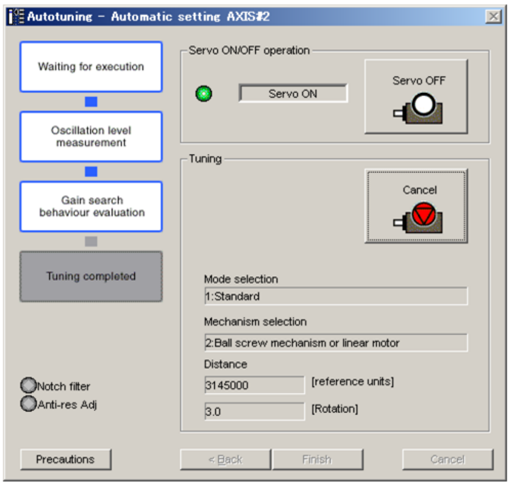
9. Confirm safety around moving parts and click the **Yes** Button.



WARNING

Please check the safety near an operation part.
Execute?

The motor will start operating and 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.



Mode selection
1:Standard

Mechanism selection
2:Ball screw mechanism or linear motor

Distance
3145000 [reference units]
3.0 [Rotation]

10. 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.

8.6.5 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 function 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* on page 8-29	
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).

◆ When an Error Occurs during Calculation of Moment of Inertia

Possible Cause	Corrective Action
The SERVOPACK 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).
Speed control changed to proportional control during calculation of the moment of inertia.	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 position reference unit (Position User Unit (2701 hex)).

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 (2561 hex)	Overshoot Detection Level			Speed Position Torque	
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 to 100	1%	100	Immediately	Setup

8.6.6 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 (2460 hex)	n.☐☐☐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.	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 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 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 (2160 hex)	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 (2140 hex)	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 (2408 hex)	n. 0□□□ (default setting)	Disable friction compensation.	Immediately	Setup
	n. 1□□□	Enable friction compensation.		

* Refer to the following section for details.
☞ *Required Parameter Settings* on page 8-68

◆ 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 (VFF), and the torque feedforward input (TFF) will be disabled.

To use the speed feedforward input (VFF), the torque feedforward input (TFF), 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 (2140 hex)	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.		

Important

When model following control is used with the feedforward function, it is used to make optimum feedforward settings in the SERVOPACK. Therefore, model following control is not normally used together with either the speed feedforward input (VFF) or torque feedforward input (TFF) from the host controller. However, model following control can be used with the speed feedforward input (VFF) or torque feedforward input (TFF) if required. An unsuitable feedforward input may result in overshooting.

8.6.7 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 (2100 hex)	Speed Loop Gain	Yes
Pn101 (2101 hex)	Speed Loop Integral Time Constant	Yes
Pn102 (2102 hex)	Position Loop Gain	Yes
Pn103 (2103 hex)	Moment of Inertia Ratio	Yes
Pn121 (2121 hex)	Friction Compensation Gain	Yes
Pn123 (2123 hex)	Friction Compensation Coefficient	Yes
Pn124 (2124 hex)	Friction Compensation Frequency Correction	No
Pn125 (2125 hex)	Friction Compensation Gain Correction	Yes
Pn401 (2401 hex)	First Stage First Torque Reference Filter Time Constant	Yes
Pn408 (2408 hex)	Torque-Related Function Selections	Yes
Pn409 (2409 hex)	First Stage Notch Filter Frequency	Yes
Pn40A (240A hex)	First Stage Notch Filter Q Value	Yes
Pn40C (240C hex)	Second Stage Notch Filter Frequency	Yes
Pn40D (240D hex)	Second Stage Notch Filter Q Value	Yes
Pn140 (2140 hex)	Model Following Control-Related Selections	Yes
Pn141 (2141 hex)	Model Following Control Gain	Yes
Pn142 (2142 hex)	Model Following Control Gain Correction	Yes
Pn143 (2143 hex)	Model Following Control Bias in the Forward Direction	Yes
Pn144 (2144 hex)	Model Following Control Bias in the Reverse Direction	Yes
Pn145 (2145 hex)	Vibration Suppression 1 Frequency A	Yes
Pn146 (2146 hex)	Vibration Suppression 1 Frequency B	Yes
Pn147 (2147 hex)	Model Following Control Speed Feedforward Compensation	Yes
Pn160 (2160 hex)	Anti-Resonance Control-Related Selections	Yes
Pn161 (2161 hex)	Anti-Resonance Frequency	Yes
Pn163 (2163 hex)	Anti-Resonance Damping Gain	Yes
Pn531 (2531 hex)	Program Jogging Travel Distance	No
Pn533 (2533 hex)	Program Jogging Movement Speed for Rotary Servomotor	No
Pn585 (2585 hex)	Program Jogging Movement Speed for Linear Servomotor	No
Pn534 (2534 hex)	Program Jogging Acceleration/Deceleration Time	No
Pn535 (2535 hex)	Program Jogging Waiting Time	No
Pn536 (2536 hex)	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.

8.7 Autotuning with a Host Reference

This section describes autotuning with a host reference.

Important 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.

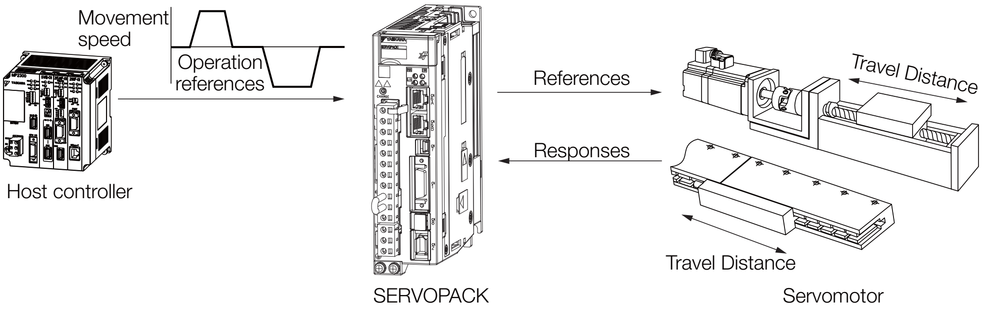
8.7.1 Outline

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.

☞ *8.7.7 Related Parameters* on page 8-40



⚠ 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.

8.7.2 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

Refer to the following sections for details on custom tuning.

☞ *8.8 Custom Tuning* on page 8-41

Preparations

Check the following settings 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.
- The test without a motor function must be disabled (Pn00C = n.□□□0).
- There must be no warnings.
- The tuning-less function must be disabled (Pn170 = n.□□□0).
- The parameters must not be write prohibited.

8.7.3 Applicable Tools

The following table lists the tools that you can use to perform autotuning with a host reference and the applicable tool functions.

Tool	Function	Operating Procedure Reference
Digital Operator	Fn202	📖 Σ-7-Series Digital Operator Operating Manual (Manual No.: SIEP S800001 33)
SigmaWin+	***Tuning - Tuning***	☞ *8.7.4 Operating Procedure* on page 8-35

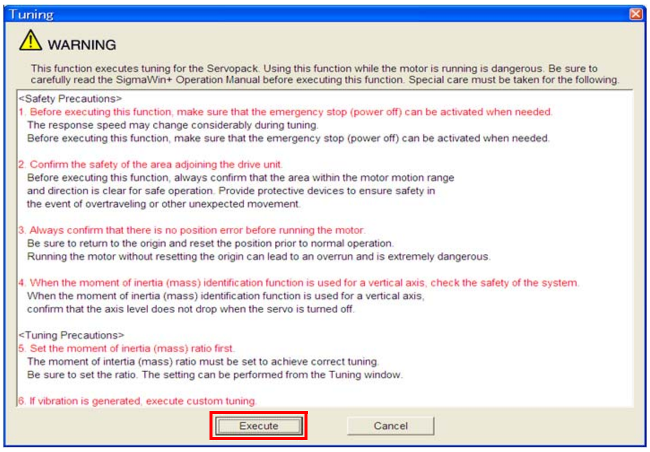
8.7.4 Operating Procedure

Use the following procedure to perform autotuning with a host reference.

1. Confirm that the moment of inertia ratio (Pn103) is set correctly.

2. Select ***Tuning - Tuning*** from the menu bar of the Main Window of the SigmaWin+.
   The Tuning Dialog Box will be displayed.
   Click the **Cancel** Button to cancel tuning.

3. Click the **Execute** Button.



This function executes tuning for the Servopack. Using this function while the motor is running is dangerous. Be sure to carefully read the SigmaWin+ Operation Manual before executing this function. Special care must be taken for the following.

<Safety Precautions>
1. Before executing this function, make sure that the emergency stop (power off) can be activated when needed.
The response speed may change considerably during tuning.
Before executing this function, make sure that the emergency stop (power off) can be activated when needed.

2. Confirm the safety of the area adjoining the drive unit.
Before executing this function, always confirm that the area within the motor motion range
and direction is clear for safe operation. Provide protective devices to ensure safety in
the event of overtraveling or other unexpected movement.

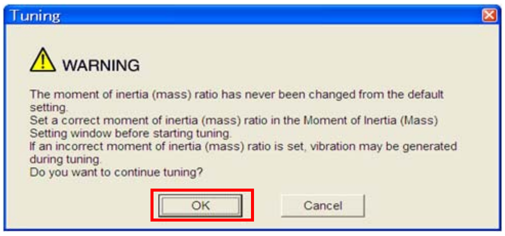
3. Always confirm that there is no position error before running the motor.
Be sure to return to the origin and reset the position prior to normal operation.
Running the motor without resetting the origin can lead to an overrun and is extremely dangerous.

4. When the moment of inertia (mass) identification function is used for a vertical axis, check the safety of the system.
When the moment of inertia (mass) identification function is used for a vertical axis,
confirm that the axis level does not drop when the servo is turned off.

<Tuning Precautions>
5. Set the moment of inertia (mass) ratio first.
The moment of intertia (mass) ratio must be set to achieve correct tuning.
Be sure to set the ratio. The setting can be performed from the Tuning window.

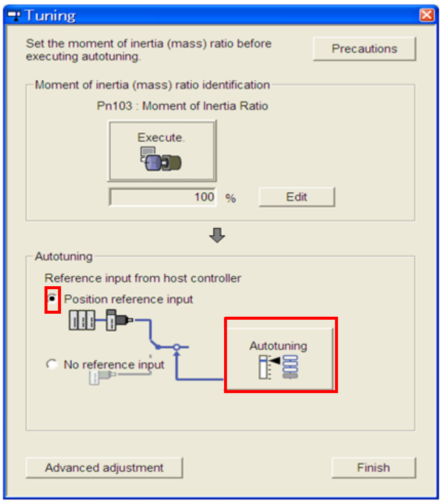
6. If vibration is generated, execute custom tuning.

4. Click the **OK** Button.



The moment of inertia (mass) ratio has never been changed from the default setting.
Set a correct moment of inertia (mass) ratio in the Moment of Inertia (Mass) Setting window before starting tuning.
If an incorrect moment of inertia (mass) ratio is set, vibration may be generated during tuning.
Do you want to continue tuning?

5. Select the **Position reference input** Option in the **Autotuning** Area and then click the **Autotuning** Button.

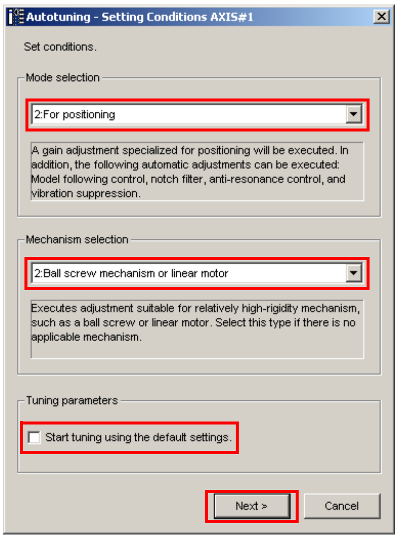


Set the moment of inertia (mass) ratio before executing autotuning.

Pn103 : Moment of Inertia Ratio
100 %

● Position reference input
○ No reference input

6. 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.



Set conditions.

Mode selection: 2:For positioning

A gain adjustment specialized for positioning will be executed. In addition, the following automatic adjustments can be executed: Model following control, notch filter, anti-resonance control, and vibration suppression.

Mechanism selection: 2:Ball screw mechanism or linear motor

Executes adjustment suitable for relatively high-rigidity mechanism, such as a ball screw or linear motor. Select this type if there is no applicable mechanism.

☐ Start tuning using the default settings.

- **Mode selection** Box
  Set the mode.

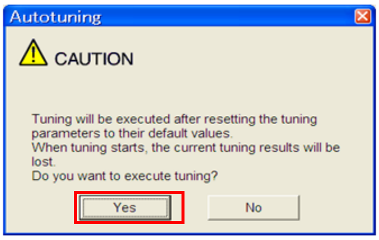
Mode Selection	Description
1: Standard	Standard gain adjustment is performed. In addition to gain adjustment, notch filters and anti-resonance control are automatically adjusted.
2: For positioning	Tuning is performed for positioning applications. In addition to gain adjustment, model following control, 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.

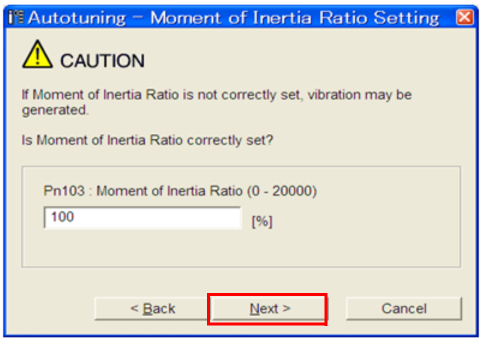
7. Click the **Yes** Button.



CAUTION

Tuning will be executed after resetting the tuning parameters to their default values.
When tuning starts, the current tuning results will be lost.
Do you want to execute tuning?

8. Input the correct moment of inertia ratio and click the **Next** Button.



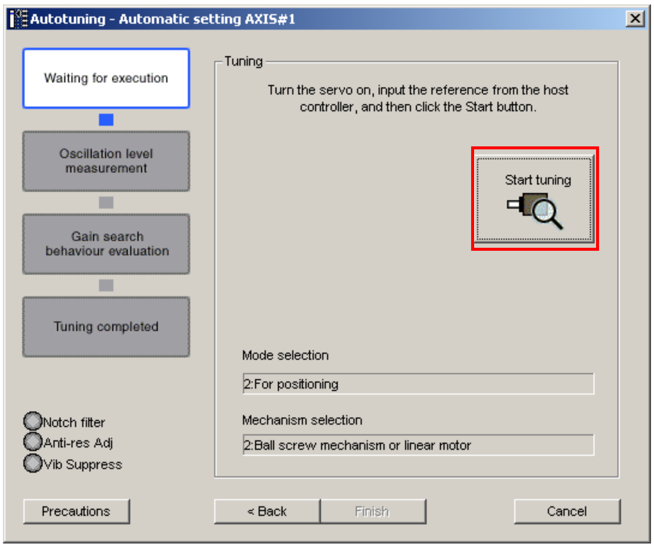
CAUTION

If Moment of Inertia Ratio is not correctly set, vibration may be generated.

Is Moment of Inertia Ratio correctly set?

Pn103 : Moment of Inertia Ratio (0 - 20000)
100 [%]

9. Turn ON the servo, enter a reference from the host controller, and then click the **Start tuning** Button.



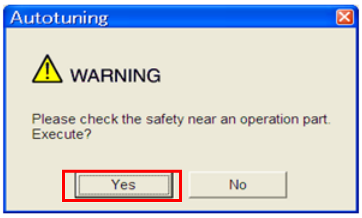
Tuning

Turn the servo on, input the reference from the host controller, and then click the Start button.

Mode selection
2:For positioning

Mechanism selection
2:Ball screw mechanism or linear motor

10. Confirm safety around moving parts and click the **Yes** Button.

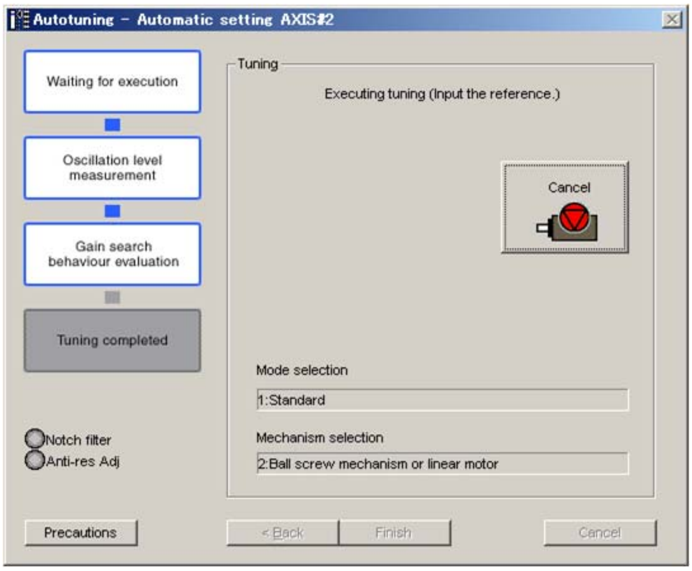


Autotuning

WARNING

Please check the safety near an operation part.
Execute?

The motor will start operating and 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.



Autotuning − Automatic setting AXIS#2

Tuning

Executing tuning (Input the reference.)

Mode selection
1:Standard

Mechanism selection
2:Ball screw mechanism or linear motor

11. 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.

8.7.5 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 Pn522 (2522 hex) (Positioning Completed Width). • Change the mode from 2 to 3. • If machine vibration occurs, suppress the vibration with the anti-resonance control function 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 Pn522 (2522 hex) (Positioning Completed Width).

◆ 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 position reference unit (*position user unit* (2701 hex)).

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 (2561 hex)	Overshoot Detection Level			Speed Position Torque	
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 to 100	1%	100	Immediately	Setup

8.7.6 Automatically Adjusted Function Settings

These function settings are the same as for autotuning without a host reference. Refer to the following section.

☞ *8.6.6 Automatically Adjusted Function Settings* on page 8-30

8.7.7 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 (2100 hex)	Speed Loop Gain	Yes
Pn101 (2101 hex)	Speed Loop Integral Time Constant	Yes
Pn102 (2102 hex)	Position Loop Gain	Yes
Pn103 (2103 hex)	Moment of Inertia Ratio	No
Pn121 (2121 hex)	Friction Compensation Gain	Yes
Pn123 (2123 hex)	Friction Compensation Coefficient	Yes
Pn124 (2124 hex)	Friction Compensation Frequency Correction	No
Pn125 (2125 hex)	Friction Compensation Gain Correction	Yes
Pn401 (2401 hex)	First Stage First Torque Reference Filter Time Constant	Yes
Pn408 (2408 hex)	Torque-Related Function Selections	Yes
Pn409 (2409 hex)	First Stage Notch Filter Frequency	Yes
Pn40A (240A hex)	First Stage Notch Filter Q Value	Yes
Pn40C (240C hex)	Second Stage Notch Filter Frequency	Yes
Pn40D (240D hex)	Second Stage Notch Filter Q Value	Yes
Pn140 (2140 hex)	Model Following Control-Related Selections	Yes
Pn141 (2141 hex)	Model Following Control Gain	Yes
Pn142 (2142 hex)	Model Following Control Gain Correction	Yes
Pn143 (2143 hex)	Model Following Control Bias in the Forward Direction	Yes
Pn144 (2144 hex)	Model Following Control Bias in the Reverse Direction	Yes
Pn145 (2145 hex)	Vibration Suppression 1 Frequency A	Yes
Pn146 (2146 hex)	Vibration Suppression 1 Frequency B	Yes
Pn147 (2147 hex)	Model Following Control Speed Feedforward Compensation	Yes
Pn160 (2160 hex)	Anti-Resonance Control-Related Selections	Yes
Pn161 (2161 hex)	Anti-Resonance Frequency	Yes
Pn163 (2163 hex)	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.

8.8 Custom Tuning

This section describes custom tuning.

8.8.1 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.

☞ *8.8.7 Related Parameters* on page 8-49

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.

8.8.2 Preparations

Check the following settings before you execute custom tuning.

- The test without a motor function must be disabled (Pn00C = n.□□□0).
- 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.

8.8.3 Applicable Tools

The following table lists the tools that you can use to perform custom tuning and the applicable tool functions.

Tool	Function	Operating Procedure Reference
Digital Operator	Fn203	📖 Σ-7-Series Digital Operator Operating Manual (Manual No.: SIEP S800001 33)
SigmaWin+	***Tuning*** – ***Tuning***	☞ *8.8.4 Operating Procedure* on page 8-42

8.8.4 Operating Procedure

Use the following procedure to perform custom tuning.

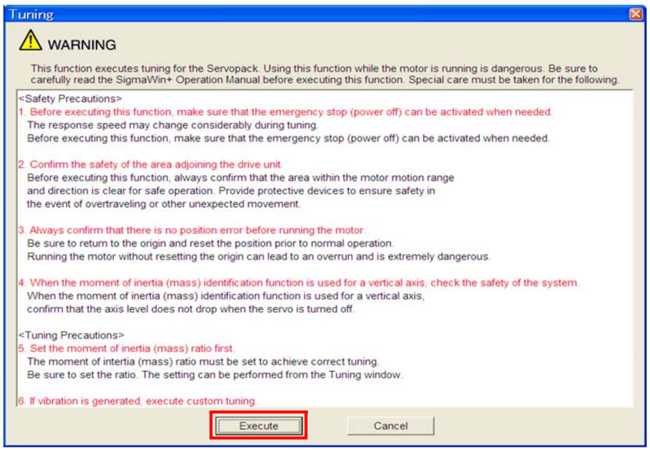
⚠ WARNING

- **Before you execute custom tuning, check the information provided in the SigmaWin+ 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.

1. Confirm that the moment of inertia ratio (Pn103) is set correctly.

2. Select ***Tuning*** **-** ***Tuning*** from the menu bar of the Main Window of the SigmaWin+.
   Click the **Cancel** Button to cancel tuning.

3. Click the **Execute** Button.



WARNING

This function executes tuning for the Servopack. Using this function while the motor is running is dangerous. Be sure to carefully read the SigmaWin+ Operation Manual before executing this function. Special care must be taken for the following.

<Safety Precautions>

1. Before executing this function, make sure that the emergency stop (power off) can be activated when needed.
The response speed may change considerably during tuning.
Before executing this function, make sure that the emergency stop (power off) can be activated when needed.

2. Confirm the safety of the area adjoining the drive unit.
Before executing this function, always confirm that the area within the motor motion range and direction is clear for safe operation. Provide protective devices to ensure safety in the event of overtraveling or other unexpected movement.

3. Always confirm that there is no position error before running the motor.
Be sure to return to the origin and reset the position prior to normal operation.
Running the motor without resetting the origin can lead to an overrun and is extremely dangerous.

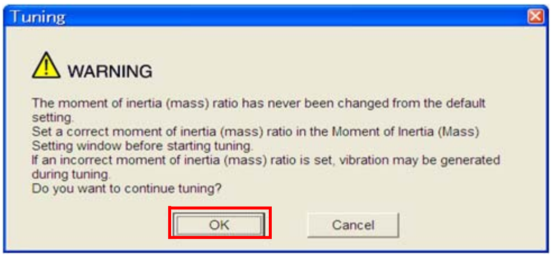
4. When the moment of inertia (mass) identification function is used for a vertical axis, check the safety of the system.
When the moment of inertia (mass) identification function is used for a vertical axis, confirm that the axis level does not drop when the servo is turned off.

<Tuning Precautions>

5. Set the moment of inertia (mass) ratio first.
The moment of intertia (mass) ratio must be set to achieve correct tuning.
Be sure to set the ratio. The setting can be performed from the Tuning window.

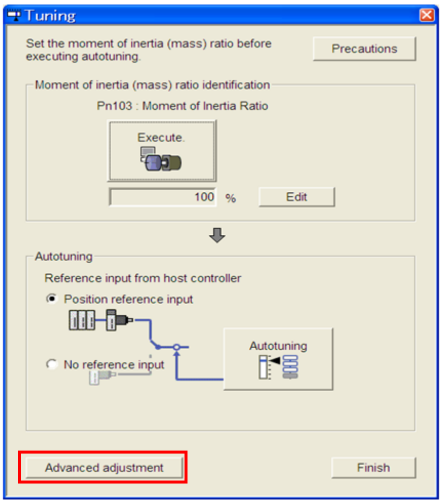
6. If vibration is generated, execute custom tuning.

Information When the following dialog box is displayed, click the **OK** Button and then confirm that the correct moment of inertia ratio is set in Pn103 (Moment of Inertia Ratio).



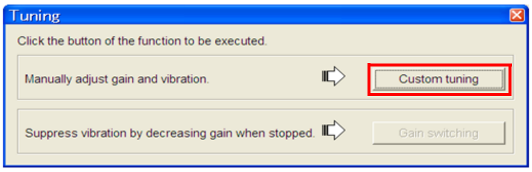
The moment of inertia (mass) ratio has never been changed from the default setting.
Set a correct moment of inertia (mass) ratio in the Moment of Inertia (Mass) Setting window before starting tuning.
If an incorrect moment of inertia (mass) ratio is set, vibration may be generated during tuning.
Do you want to continue tuning?

4. Click the **Advanced adjustment** Button.



Set the moment of inertia (mass) ratio before executing autotuning.

5. Click the **Custom tuning** Button.

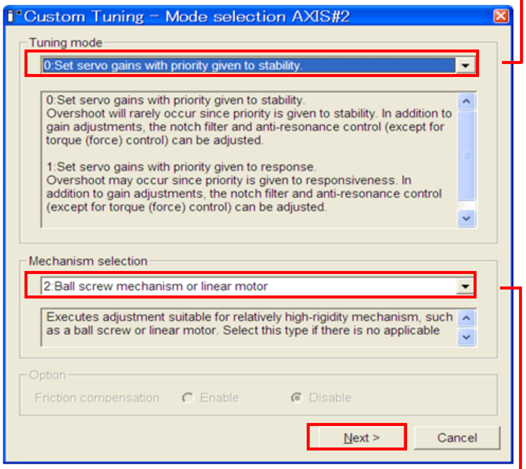


Click the button of the function to be executed.

Manually adjust gain and vibration.

Suppress vibration by decreasing gain when stopped.

6. Set the **Tuning mode** Box and **Mechanism selection** Box, and then click the **Next** Button.



Tuning mode

0:Set servo gains with priority given to stability.

0:Set servo gains with priority given to stability.
Overshoot will rarely occur since priority is given to stability. In addition to gain adjustments, the notch filter and anti-resonance control (except for torque (force) control) can be adjusted.

1:Set servo gains with priority given to response.
Overshoot may occur since priority is given to responsiveness. In addition to gain adjustments, the notch filter and anti-resonance control (except for torque (force) control) can be adjusted.

Mechanism selection

2:Ball screw mechanism or linear motor

Executes adjustment suitable for relatively high-rigidity mechanism, such as a ball screw or linear motor. Select this type if there is no applicable

Option

Friction compensation ○ Enable ● Disable

Tuning mode Box

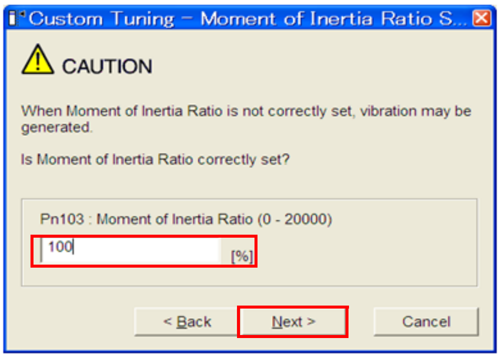
Mode Selection	Description
0: Set servo gains with priority given to stability.	This setting gives priority to stability and preventing overshooting. In addition to gain adjustment, notch filters and anti-resonance control (except during torque control) are automatically adjusted.
1: Set servo gains 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.

Information The tuning modes that you can select depend on the SERVOPACK setting.

7. If the moment of inertia ratio is not set correctly, correct the setting and then click the **Next** Button.



CAUTION

When Moment of Inertia Ratio is not correctly set, vibration may be generated.

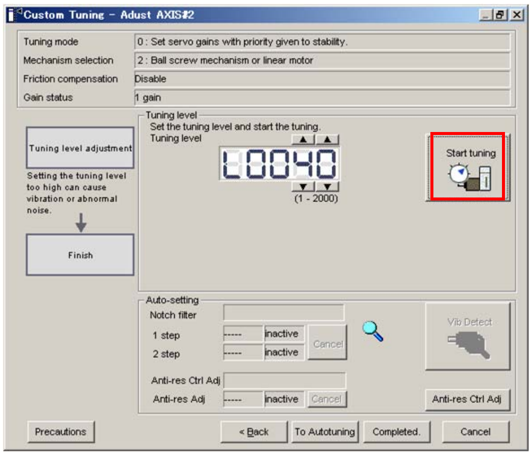
Is Moment of Inertia Ratio correctly set?

Pn103 : Moment of Inertia Ratio (0 - 20000)

100 [%]

8. Turn ON the servo, enter a reference from the host controller, and then click the **Start tuning** Button.

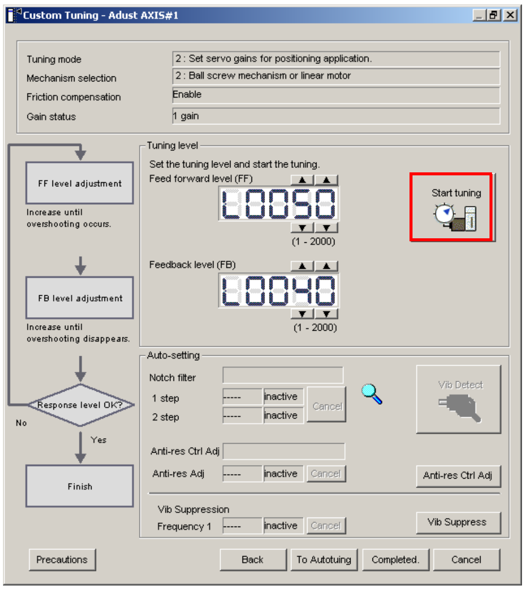
Tuning Mode 0 or 1


Custom Tuning - Adjust AXIS#2

Tuning mode: 0 : Set servo gains with priority given to stability.
Mechanism selection: 2 : Ball screw mechanism or linear motor
Friction compensation: Disable
Gain status: 1 gain

Tuning level
Set the tuning level and start the tuning.
Tuning level: 0040 (1 - 2000)

Tuning Mode 2 to 3


Custom Tuning - Adjust AXIS#1

Tuning mode: 2 : Set servo gains for positioning application.
Mechanism selection: 2 : Ball screw mechanism or linear motor
Friction compensation: Enable
Gain status: 1 gain

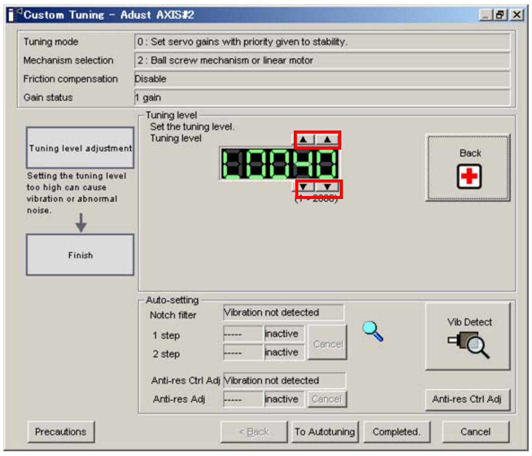
Tuning level
Set the tuning level and start the tuning.
Feed forward level (FF): 0050 (1 - 2000)
Feedback level (FB): 0040 (1 - 2000)

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.


Custom Tuning - Adjust AXIS#2

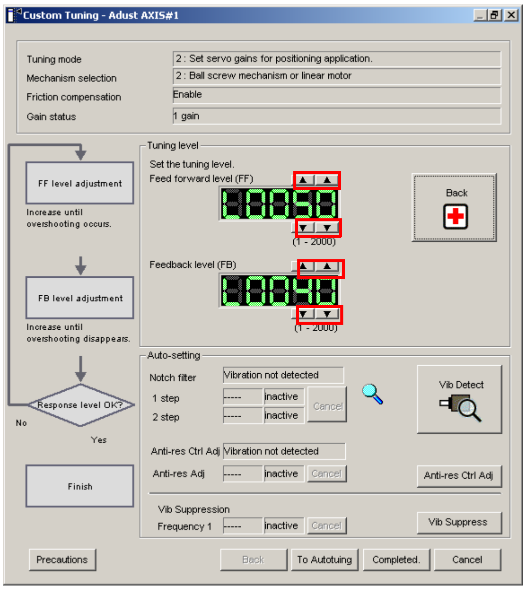
Tuning mode: 0 : Set servo gains with priority given to stability.
Mechanism selection: 2 : Ball screw mechanism or linear motor
Friction compensation: Disable
Gain status: 1 gain

Tuning level
Set the tuning level.
Tuning level: 0040 (1 - 2000)

Notch filter: Vibration not detected
Anti-res Ctrl Adj: Vibration not detected

Tuning Mode 2 to 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.


Custom Tuning - Adjust AXIS#1

Tuning mode: 2 : Set servo gains for positioning application.
Mechanism selection: 2 : Ball screw mechanism or linear motor
Friction compensation: Enable
Gain status: 1 gain

Tuning level
Set the tuning level.
Feed forward level (FF): 0050 (1 - 2000)
Feedback level (FB): 0040 (1 - 2000)

Notch filter: Vibration not detected
Anti-res Ctrl Adj: Vibration not detected

Information The new feedforward level will not be used until the positioning completed signal is output.

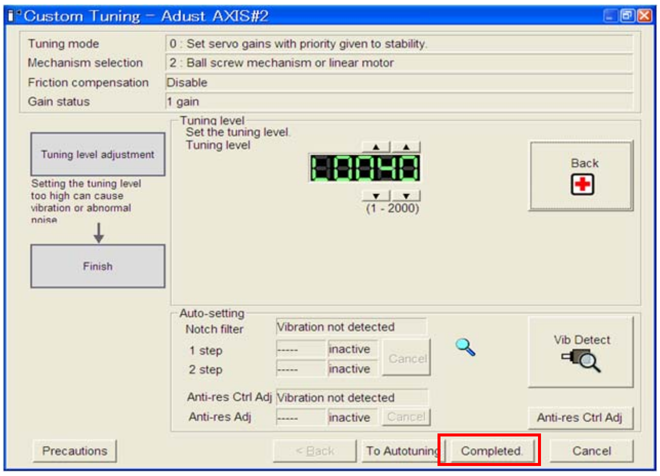
10. **You can set the functions to suppress vibration (notch filters, automatic anti-resonance setting, vibration suppression, and autotuning with a host reference) as required.**

Refer to the following section for details.

☞ *Vibration Suppression Functions* on page 8-46

11. **When tuning has been completed, click the Completed Button.**

The values that were changed will be saved in the SERVOPACK and you will return to the Tuning Dialog Box.



Tuning mode: 0 : Set servo gains with priority given to stability.
Mechanism selection: 2 : Ball screw mechanism or linear motor
Friction compensation: Disable
Gain status: 1 gain

Tuning level
Tuning level: 00040 (1 - 2000)

Auto-setting
Notch filter: Vibration not detected
1 step: ----- inactive
2 step: ----- inactive
Anti-res Ctrl Adj: Vibration not detected
Anti-res Adj: ----- inactive

This concludes the procedure.

Vibration Suppression Functions

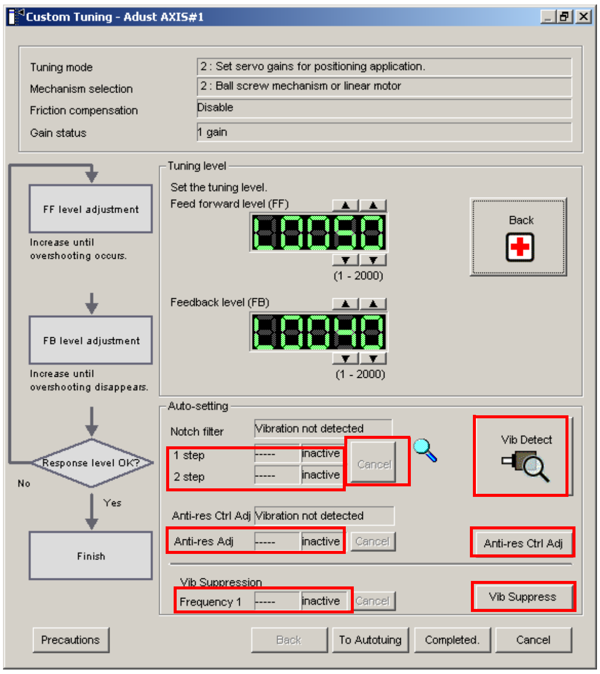
◆ Notch Filters and Automatic Anti-resonance Setting

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.



Custom Tuning - Adust AXIS#1

Tuning mode: 2 : Set servo gains for positioning application.
Mechanism selection: 2 : Ball screw mechanism or linear motor
Friction compensation: Disable
Gain status: 1 gain

Tuning level
Set the tuning level.
Feed forward level (FF): 0050 (1 - 2000)
Feedback level (FB): 0040 (1 - 2000)

Auto-setting
Notch filter: Vibration not detected
1 step: ----- inactive
2 step: ----- inactive
Anti-res Ctrl Adj: Vibration not detected
Anti-res Adj: ----- inactive
Vib Suppression
Frequency 1: ----- inactive

- **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 anti-resonance control adjustment automatic setting function is enabled, you can click the **Vib Detect** Button to manually detect vibration. When you click the **Vib Detect** Button, the SERVOPACK 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 SERVOPACK does not detect vibration.
- **Anti-res Ctrl Adj** Button
  You can use the **Anti-res Ctrl Adj** Button to execute the anti-resonance control function if fine-tuning is required. Refer to the following section.
  ☞ *8.9 Anti-Resonance Control Adjustment* on page 8-50
- **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.
  ☞ *8.10 Vibration Suppression* on page 8-55

◆ Autotuning with a Host Reference

You can perform autotuning with a host reference. Refer to the following section for details.

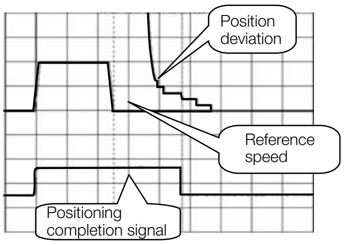
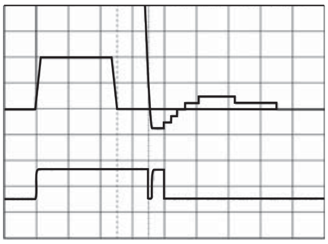
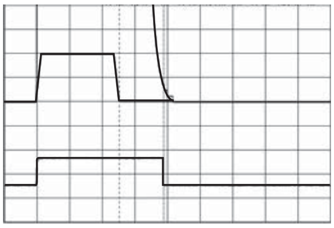
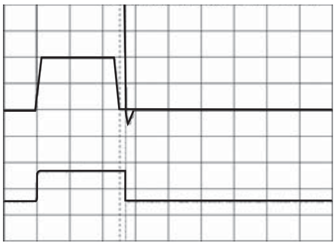
☞ *8.7 Autotuning with a Host Reference* on page 8-33

8.8.5 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.

☞ *8.6.6 Automatically Adjusted Function Settings* on page 8-30

8.8.6 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 SERVOPACK.
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 SERVOPACK. 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 SERVOPACK. 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 SERVOPACK.

8.8.7 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 (2100 hex)	Speed Loop Gain	Yes
Pn101 (2101 hex)	Speed Loop Integral Time Constant	Yes
Pn102 (2102 hex)	Position Loop Gain	Yes
Pn103 (2103 hex)	Moment of Inertia Ratio	No
Pn121 (2121 hex)	Friction Compensation Gain	Yes
Pn123 (2123 hex)	Friction Compensation Coefficient	Yes
Pn124 (2124 hex)	Friction Compensation Frequency Correction	No
Pn125 (2125 hex)	Friction Compensation Gain Correction	Yes
Pn401 (2401 hex)	First Stage First Torque Reference Filter Time Constant	Yes
Pn408 (2408 hex)	Torque-Related Function Selections	Yes
Pn409 (2409 hex)	First Stage Notch Filter Frequency	Yes
Pn40A (240A hex)	First Stage Notch Filter Q Value	Yes
Pn40C (240C hex)	Second Stage Notch Filter Frequency	Yes
Pn40D (240D hex)	Second Stage Notch Filter Q Value	Yes
Pn140 (2140 hex)	Model Following Control-Related Selections	Yes
Pn141 (2141 hex)	Model Following Control Gain	Yes
Pn142 (2142 hex)	Model Following Control Gain Correction	Yes
Pn143 (2143 hex)	Model Following Control Bias in the Forward Direction	Yes
Pn144 (2144 hex)	Model Following Control Bias in the Reverse Direction	Yes
Pn145 (2145 hex)	Vibration Suppression 1 Frequency A	No
Pn146 (2146 hex)	Vibration Suppression 1 Frequency B	No
Pn147 (2147 hex)	Model Following Control Speed Feedforward Compensation	Yes
Pn160 (2160 hex)	Anti-Resonance Control-Related Selections	Yes
Pn161 (2161 hex)	Anti-Resonance Frequency	Yes
Pn163 (2163 hex)	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.

8.9 Anti-Resonance Control Adjustment

This section describes anti-resonance control.

8.9.1 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 adjustment 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.**

Important

- 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.

8.9.2 Preparations

Check the following settings before you execute anti-resonance control adjustment.

- The tuning-less function must be disabled (Pn170 = n.□□□0).
- The test without a motor function must be disabled (Pn00C = n.□□□0).
- The control method must not be set to torque control.
- The parameters must not be write prohibited.

8.9.3 Applicable Tools

The following table lists the tools that you can use to perform anti-resonance control adjustment and the applicable tool functions.

Tool	Function	Operating Procedure Reference
Digital Operator	Fn204	🕮 Σ-7-Series Digital Operator Operating Manual (Manual No.: SIEP S800001 33)
SigmaWin+	***Tuning - Tuning***	☞ *8.9.4 Operating Procedure* on page 8-51

8.9.4 Operating Procedure

To execute anti-resonance control adjustment, an operation reference is input, and the adjustment is executed while vibration is occurring.

The following methods can be used to execute anti-resonance control adjustment.
- To automatically detect the vibration frequency
- To manually set the vibration frequency

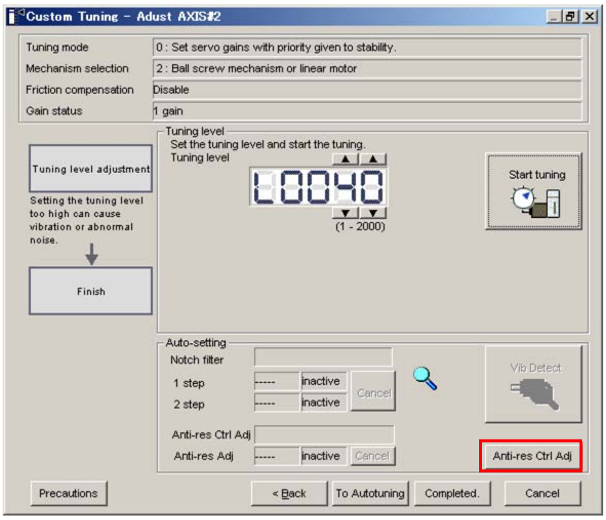
Use the following procedure.

⚠ CAUTION

- **Before you execute anti-resonance control adjustment, check the information provided in the SigmaWin+ 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 7 of the procedure for custom tuning. Refer to the following section for details.
   ☞ *8.8.4 Operating Procedure* on page 8-42

2. **Click the Anti-res Ctrl Adj Button.**
The rest of the procedure depends on whether you know the vibration frequency.



Tuning mode: 0 : Set servo gains with priority given to stability.
Mechanism selection: 2 : Ball screw mechanism or linear motor
Friction compensation: Disable
Gain status: 1 gain

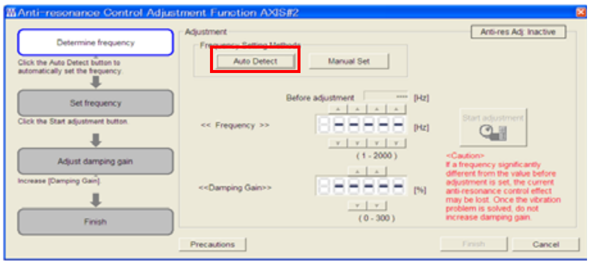
Set the tuning level and start the tuning.

Setting the tuning level too high can cause vibration or abnormal noise.

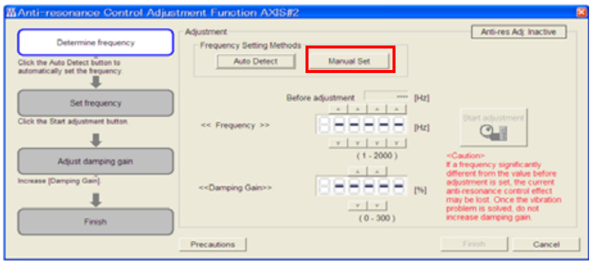
3. **If you do not know the vibration frequency, click the Auto Detect Button. If you know the vibration frequency, click the Manual Set Button.**

To Automatically Detect the Vibration Frequency

The frequency will be set.



To Manually Set the Vibration Frequency

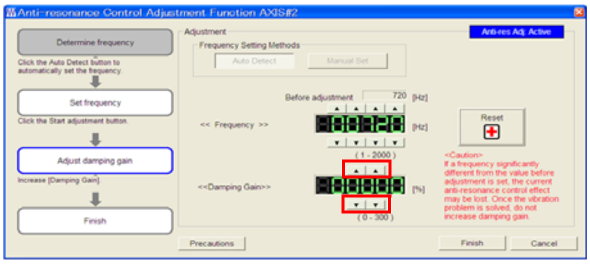


4. **Click the Start adjustment Button.**

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.

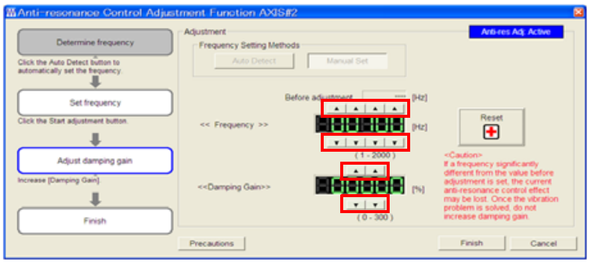
To Automatically Detect the Vibration Frequency

Change the setting of the damping gain.

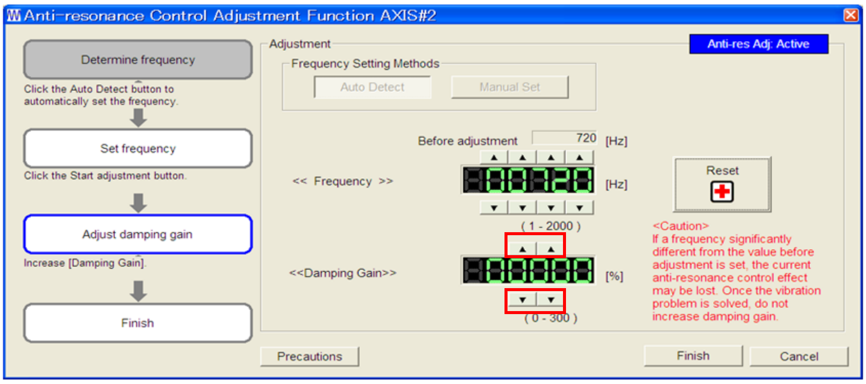


To Manually Set the Vibration Frequency

Change the settings of the frequency and damping gain.



6. **When the adjustment has been completed, click the Finish Button.**
The values that were changed will be saved in the SERVOPACK and you will return to the Tuning Dialog Box.



Click the Auto Detect button to automatically set the frequency.

Click the Start adjustment button.

Increase [Damping Gain].

<Caution>
If a frequency significantly different from the value before adjustment is set, the current anti-resonance control effect may be lost. Once the vibration problem is solved, do not increase damping gain.

This concludes the procedure.

8.9.5 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 (2160 hex)	Anti-Resonance Control-Related Selections	Yes
Pn161 (2161 hex)	Anti-Resonance Frequency	Yes
Pn162 (2162 hex)	Anti-Resonance Gain Correction	No
Pn163 (2163 hex)	Anti-Resonance Damping Gain	Yes
Pn164 (2164 hex)	Anti-Resonance Filter Time Constant 1 Correction	No
Pn165 (2165 hex)	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.

8.9.6 Suppressing Different Vibration Frequencies with Anti-resonance Control

When you use anti-resonance control and increase the control gain, for some mechanism, vibration can occur at a higher frequency than the frequency for which vibration was suppressed. If this occurs, you can suppress vibration for more than one frequency by adjusting Pn166 (Anti-Resonance Damping Gain 2).

Information Guidelines for Vibration That Can Be Suppressed
Anti-resonance frequency (Pn161): fa [Hz], Another vibration frequency that occurs when the control gain is increased: fb [Hz]

- Vibration frequencies: 100 Hz to 1,000 Hz
- Range of different vibration frequencies: $1 < (fb/fa) \leq 3$ to 4

Required Parameter Settings

The following parameter settings are required to use anti-resonance control for more than one vibration frequency.

Parameter		Description	When Enabled	Classification
Pn160 (2160 hex)	n.□□□0 (default setting)	Do not use anti-resonance control.	After restart	Setup
	n.□□□1	Use anti-resonance control.		

Pn161 (2161 hex)	Anti-Resonance Frequency			Speed Position Torque	
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	10 to 20,000	0.1 Hz	1000	Immediately	Tuning
Pn162 (2162 hex)	Anti-Resonance Gain Correction			Speed Position Torque	
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	1 to 1,000	1%	100	Immediately	Tuning
Pn163 (2163 hex)	Anti-Resonance Damping Gain			Speed Position Torque	
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 to 300	1%	0	Immediately	Tuning
Pn164 (2164 hex)	Anti-Resonance Filter Time Constant 1 Correction			Speed Position Torque	
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	-1,000 to 1,000	0.01 ms	0	Immediately	Tuning
Pn165 (2165 hex)	Anti-Resonance Filter Time Constant 2 Correction			Speed Position Torque	
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	-1,000 to 1,000	0.01 ms	0	Immediately	Tuning
Pn166 (2166 hex)	Anti-Resonance Damping Gain 2			Speed Position Torque	
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 to 1,000	1%	0	Immediately	Tuning

Adjustment Procedure for Suppressing Different Vibration Frequencies with Anti-resonance Control

Use the following procedure to make adjustments to suppress different vibration frequencies with anti-resonance control.

Step	Operation
1	Use the gain adjustment and anti-resonance control. Refer to the following section for details. ☞ *8.9.4 Operating Procedure* on page 8-51
2	If there is vibration at a higher frequency than the vibration suppressed with anti-resonance control in step 1, adjust Pn166 (Anti-Resonance Damping Gain 2).
3	Adjust Pn166 (Anti-Resonance Damping Gain 2) while checking to see if vibration reduction is effective. To adjust Pn166 (Anti-Resonance Damping Gain 2), increase the setting by 10% at a time starting from the value that resulted in Pn163 (Anti-Resonance Damping Gain) from the adjustment in step 1.
4	If the vibration disappears, the adjustment is completed. However, if the vibration does not disappear even when you adjust Pn166 (Anti-Resonance Damping Gain 2), reduce the tuning level or feedback level until vibration does not occur.

8.10 Vibration Suppression

This section describes vibration suppression.

8.10.1 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.**

Important

- 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 (2560 hex)	Residual Vibration Detection Width				Position
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	1 to 3,000	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.

Information 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.

8.10.2 Preparations

Check the following settings before you execute vibration suppression.

- Position control must be used.
- The tuning-less function must be disabled (Pn170 = n.☐☐☐0).
- The test without a motor function must be disabled (Pn00C = n.☐☐☐0).
- The parameters must not be write prohibited.

8.10.3 Applicable Tools

The following table lists the tools that you can use to perform vibration suppression and the applicable tool functions.

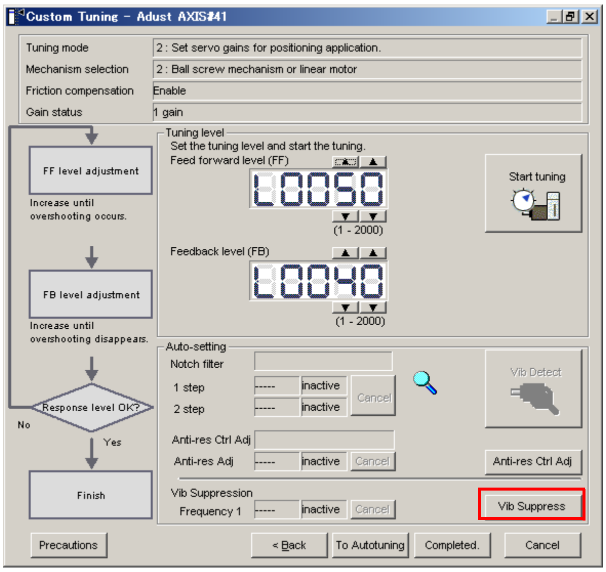
Tool	Function	Operating Procedure Reference
Digital Operator	Fn205	Σ-7-Series Digital Operator Operating Manual (Manual No.: SIEP S800001 33)
SigmaWin+	***Tuning - Tuning***	*8.10.4 Operating Procedure* on page 8-56

8.10.4 Operating Procedure

Use the following procedure to perform vibration suppression.

1. Perform steps 1 to 7 of the procedure for custom tuning. Refer to the following section for details.
   8.8.4 Operating Procedure on page 8-42

2. Click the **Vib Suppress** Button.

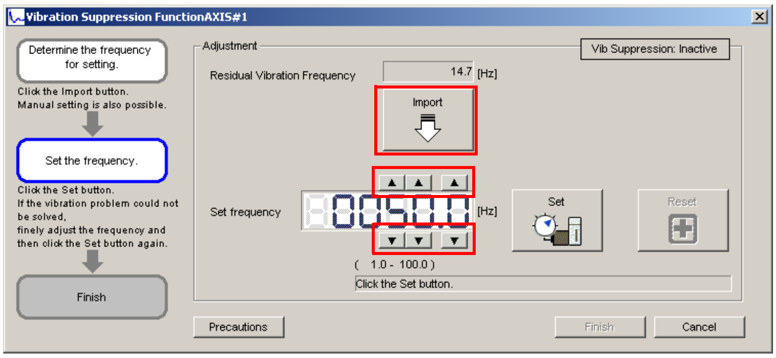


Custom Tuning - Adust AXIS#41

Tuning mode: 2 : Set servo gains for positioning application.
Mechanism selection: 2 : Ball screw mechanism or linear motor
Friction compensation: Enable
Gain status: 1 gain

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 motor is read as the set frequency. (The frequency can be read only when the residual vibration frequency is between 1.0 and 100.0.)

> Important
>
> 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.



Click the Import button.
Manual setting is also possible.

Click the Set button.
If the vibration problem could not be solved,
finely adjust the frequency and
then click the Set button again.

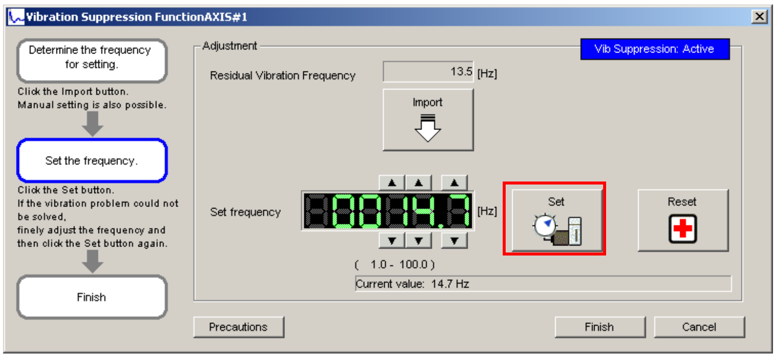
(1.0 - 100.0)

Click the Set button.

4. Click the **Set** Button.

Important

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.



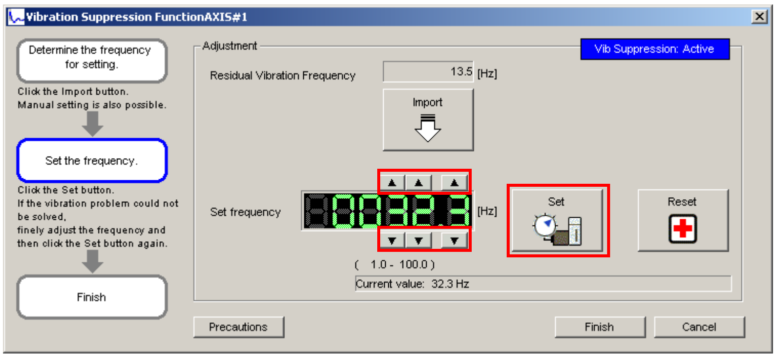
Click the Import button.
Manual setting is also possible.

Click the Set button.
If the vibration problem could not be solved,
finely adjust the frequency and
then click the Set button again.

(1.0 - 100.0)

Current value: 14.7 Hz

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 Import button.
Manual setting is also possible.

Click the Set button.
If the vibration problem could not be solved,
finely adjust the frequency and
then click the Set button again.

(1.0 - 100.0)

Current value: 32.3 Hz

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 SERVOPACK.

Important

Vibration suppression will be enabled in step 5. The motor response, however, will change when the Servomotor comes to a stop with no reference input.

This concludes the procedure.

8.10.5 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 (VFF), and the torque feedforward input (TFF) are disabled.

To use the speed feedforward input (VFF), the torque feedforward input (TFF), 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 (2140 hex)	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.		

Important

When model following control is used with the feedforward function, it is used to make optimum feedforward settings in the SERVOPACK. Therefore, model following control is not normally used together with either the speed feedforward input (VFF) or torque feedforward input (TFF) from the host controller. However, model following control can be used with the speed feedforward input (VFF) or torque feedforward input (TFF) if required. An unsuitable feedforward input may result in overshooting.

8.10.6 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 (2140 hex)	Model Following Control-Related Selections	Yes
Pn141 (2141 hex)	Model Following Control Gain	Yes
Pn142 (2142 hex)	Model Following Control Correction	No
Pn143 (2143 hex)	Model Following Control Bias in the Forward Direction	No
Pn144 (2144 hex)	Model Following Control Bias in the Reverse Direction	No
Pn145 (2145 hex)	Vibration Suppression 1 Frequency A	Yes
Pn146 (2146 hex)	Vibration Suppression 1 Frequency B	Yes
Pn147 (2147 hex)	Model Following Control Speed Feedforward Compensation	No
Pn14A (214A hex)	Vibration Suppression 2 Frequency	No
Pn14B (214B hex)	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.

8.11 Speed Ripple Compensation

This section describes speed ripple compensation.

8.11.1 Outline

Speed ripple compensation reduces the amount of ripple in the motor speed due to torque ripple or cogging torque. You can enable speed ripple compensation to achieve smoother operation. To enable it, you must set up ripple compensation on the SigmaWin+.

⚠ WARNING

- **Speed ripple compensation requires operating the motor and therefore presents hazards. Observe the following precaution.**
  Confirm safety around moving parts.
  This function involves automatic operation. Make sure that you can perform an emergency stop (to turn OFF the power supply) at any time.

Important

Execute speed ripple compensation only after adjusting the gains.
- Reset speed ripple compensation after you replace the Servomotor or SERVOPACK.
- Execute speed ripple compensation after jogging to a position that ensures a suitable range of motion.

8.11.2 Setting Up Speed Ripple Compensation

Restrictions

The following restrictions apply to the setup for speed ripple compensation.

◆ Systems for Which Execution Cannot Be Performed

There are no restrictions.

◆ Systems for Which Adjustments Cannot Be Made Accurately

Systems for which there is not a suitable range of motion

◆ Preparations

Check the following items before you set up speed ripple compensation.
- The main circuit power supply must be ON.
- The servo must be OFF.
- There must be no alarms or warnings.
- There must be no hard wire base block (HWBB).
- The parameters must not be write prohibited.

Applicable Tools

The following table lists the tools that you can use to set up speed ripple compensation and the applicable tool functions.

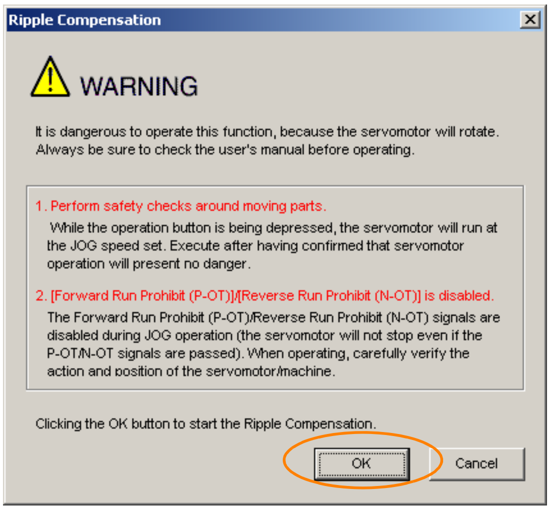
Tool	Function	Reference
Digital Operator	You cannot set up speed ripple compensation from the Digital Operator.	
SigmaWin+	***Solutions*** – ***Ripple Compensation***	☞ *Operating Procedure* on page 8-60

Operating Procedure

Use the following procedure to set up speed ripple compensation.

1. Select ***Solutions - Ripple Compensation*** from the menu bar of the Main Window of the SigmaWin+.

2. Click the **OK** Button.



WARNING

It is dangerous to operate this function, because the servomotor will rotate.
Always be sure to check the user's manual before operating.

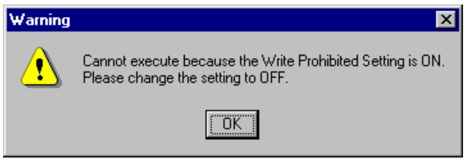
1. Perform safety checks around moving parts.
While the operation button is being depressed, the servomotor will run at the JOG speed set. Execute after having confirmed that servomotor operation will present no danger.

2. [Forward Run Prohibit (P-OT)]/[Reverse Run Prohibit (N-OT)] is disabled.
The Forward Run Prohibit (P-OT)/Reverse Run Prohibit (N-OT) signals are disabled during JOG operation (the servomotor will not stop even if the P-OT/N-OT signals are passed). When operating, carefully verify the action and position of the servomotor/machine.

Clicking the OK button to start the Ripple Compensation.

Information

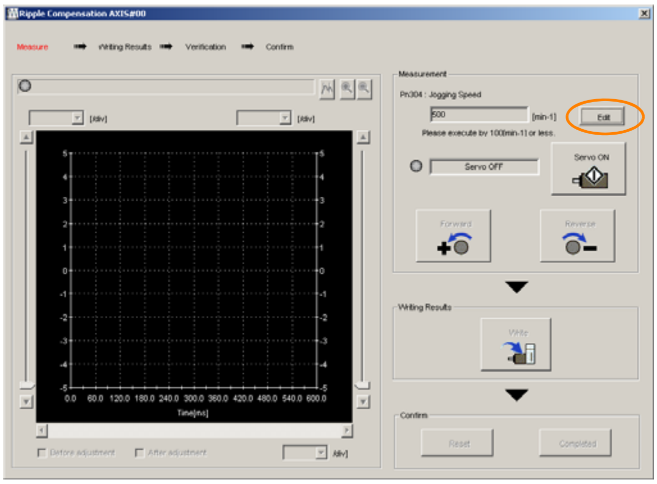
1. Click the **Cancel** Button to cancel ripple compensation. The Main Window will return.
2. If write protection is set, the following dialog box will be displayed.



Cannot execute because the Write Prohibited Setting is ON.
Please change the setting to OFF.

Click the **OK** Button to cancel write prohibition.

3. Click the **Edit** Button.

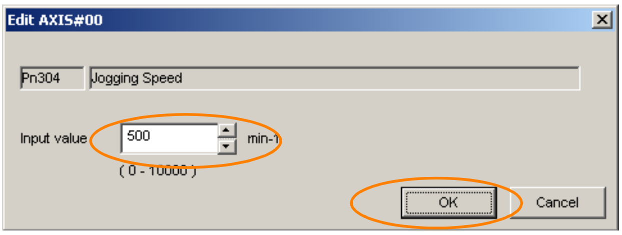


Pn304 : Jogging Speed

500 [min-1]

Please execute by 100[min-1] or less.

4. Enter the jogging speed in the **Input Value** Box and click the **OK** Button.

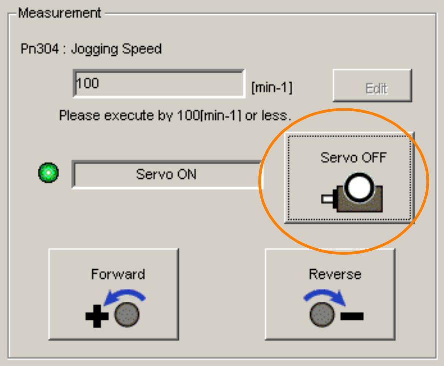


Pn304 Jogging Speed

Input value 500 min-1

(0 - 10000)

5. Click the **Servo ON** Button.

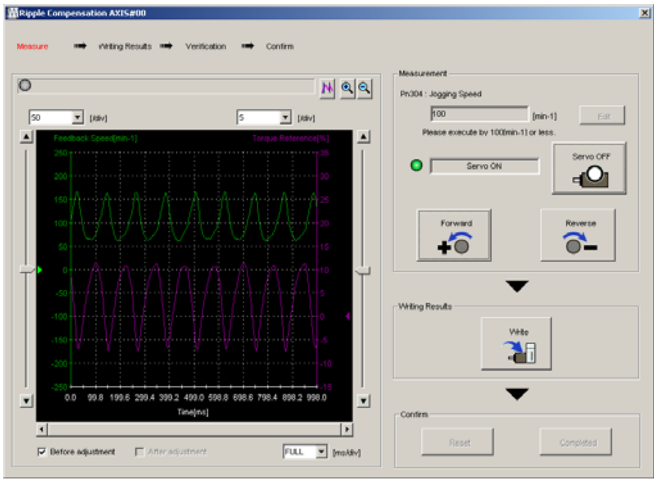


Pn304 : Jogging Speed

100 [min-1]

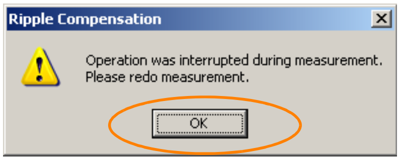
Please execute by 100[min-1] or less.

6. Click the **Forward** Button or the **Reverse** Button.
Measurement operation is started.
The motor will rotate at the preset jogging speed while you hold down the **Forward** or **Reverse** Button and the speed ripple will be measured.
The feedback speed and torque reference graph will be displayed in the Tracing Dialog Box during jogging.



Important

If the measurement time (i.e., the jogging time) for the speed ripple is too short, speed ripple measurement will not be completed. The following dialog box will be displayed if speed ripple measurement was not completed.
Click the **OK** Button and repeat the measurement.



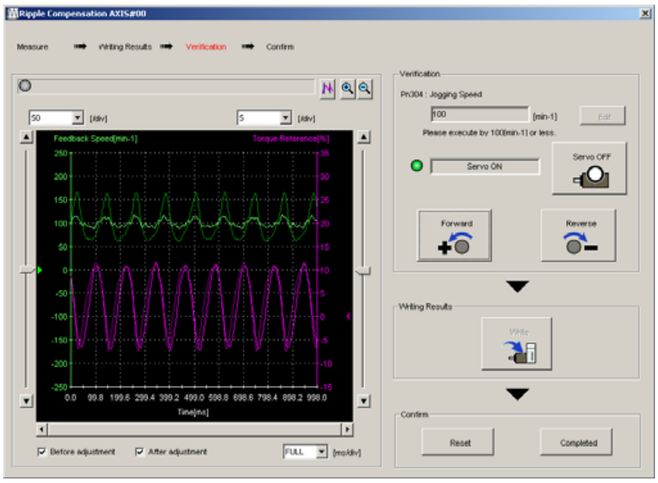
Operation was interrupted during measurement.
Please redo measurement.

7. After speed ripple measurement has been completed, click the **Write** Button.
The ripple compensation value will be written to the SERVOPACK.

8. After writing has been completed, click the **OK** Button.

The Ripple Compensation value was written in.
Please measure again and verify.
If a verification result is good, please click the "Completed" button.

9. Click the **Forward** Button or the **Reverse** Button.
Verification operation is started.
The motor will rotate at the preset jogging speed while you hold down the **Forward** or **Reverse** Button.
The waveform with speed ripple compensation applied to it will be displayed.


Pn304 : Jogging Speed 100 [min-1]
Please execute by 100[min-1] or less.

10. If the verification results are OK, click the **Finish** Button.

Information To discard the setup results, click the **Reset** Button.

This concludes the procedure.

8.11.3 Setting Parameters

The function is enabled when you perform the operating procedure on *Operating Procedure* on page 8-60. To cancel speed ripple compensation, use Pn423 = n.□□□0 (Disable speed ripple compensation) to disable it.

Parameter		Description	When Enabled	Classification
Pn423 (2423 hex)	n.□□□0 (default setting)	Disable speed ripple compensation.	After restart	Setup
	n.□□□1	Enable speed ripple compensation.		

If you enable speed ripple compensation, a compensation reference will be applied to reduce ripple even when stopped at a 0 speed reference. In speed control mode, this may result in the motor moving slightly. To prevent this, set Pn423 = n.□X□□ (Speed Ripple Compensation Selections) and Pn427 or Pn49F (Speed Ripple Compensation Enable Speed).

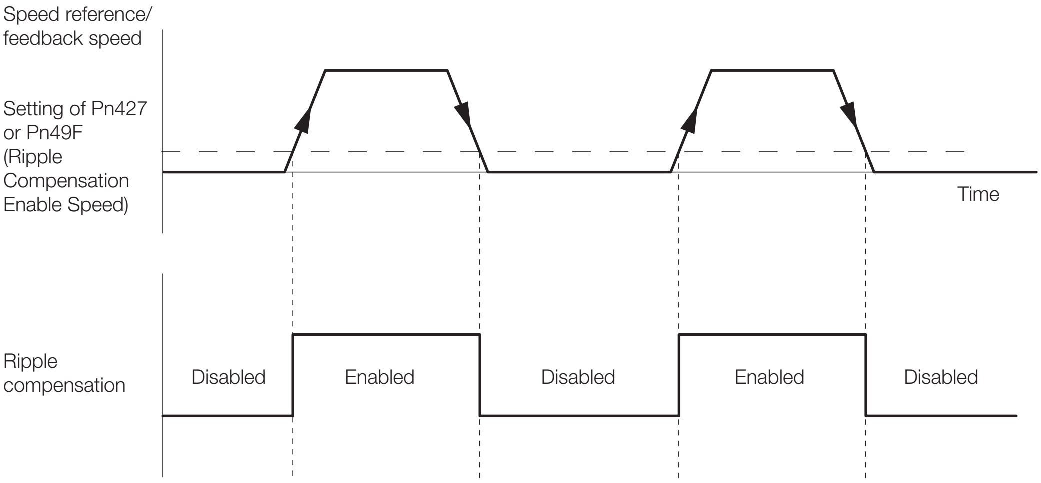
Parameter		Description	When Enabled	Classification
Pn423 (2423 hex)	n.□0□□ (default setting)	Speed reference	After restart	Setup
	n.□1□□	Motor Speed		

- For Rotary Servomotors

Pn427 (2427 hex)	Speed Ripple Compensation Enable Speed		Speed	Position	Torque
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 to 10,000	1 min^{-1}	0	Immediately	Tuning

- For Linear Servomotors

Pn49F (249F hex)	Speed Ripple Compensation Enable Speed		Speed	Position	Torque
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 to 10,000	1 mm/s	0	Immediately	Tuning



Speed Ripple Compensation Warnings

The speed ripple compensation value is specific to each Servomotor. If you replace the Servomotor while speed ripple compensation is enabled, an A.942 warning (Speed Ripple Compensation Information Disagreement) will occur to warn you.
You can use any of the following methods to clear A.942.

- Reset the speed ripple compensation value on the SigmaWin+.
- Disable speed ripple compensation (Pn423 = n.☐☐☐0).
- Disable detection of A.942 (Pn423 = n.☐☐1☐).

Parameter		Description	When Enabled	Classification
Pn423 (2423 hex)	n.☐☐0☐ (default setting)	Detect A.942 alarms.	After restart	Setup
	n.☐☐1☐	Do not detect A.942 alarms.		

8.12 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	Reference
Gain Switching	Position control, speed control, or torque control*	page 8-65
Friction Compensation	Position control or speed control	page 8-68
Current Control Mode Selection	Position control, speed control, or torque control	page 8-69
Current Gain Level Setting	Position control or speed control	page 8-70
Speed Detection Method Selection	Position control, speed control, or torque control	page 8-70
Backlash Compensation	Position Control	page 8-71

* Automatic gain switching is enabled only for position control.

8.12.1 Gain Switching

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 (2139 hex)	n.□□□0 (default setting)	Disable automatic gain switching.	Immediately	Tuning
	n.□□□2	Enable automatic gain switching.		

Note: Pn139 = n.□□□1 is a reserved setting. Do not use this setting.

Refer to the following section for gain switching combinations.

☞ *Gain Switching Combinations* on page 8-65

Gain Switching Combinations

Selected Gains	Speed Loop Gain	Speed Loop Integral Time Constant	Position Loop Gain	Torque Reference Filter	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)	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 Friction Compensation Gain (Pn122)

Note: Automatic gain switching is not supported for Model Following Control Gain and Model Following Control Correction.

Automatic Gain Switching

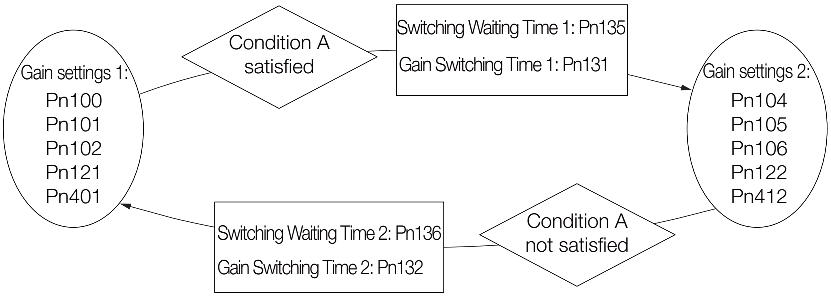
Automatic gain switching is enabled only for position control. The switching conditions are specified by using the following settings.

Parameter		Switching Condition	Selected Gains	Switching Waiting Time	Switching Time
Pn139 (2139 hex)	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.

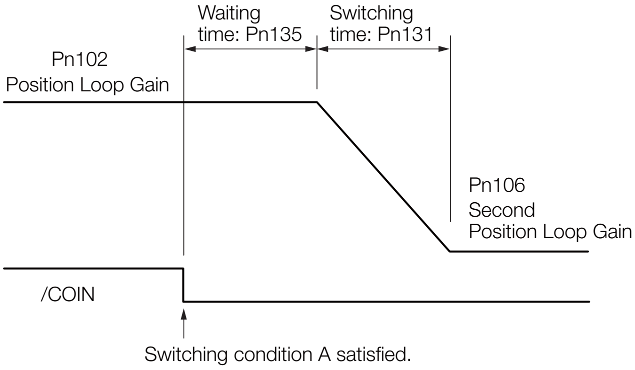
Parameter		Position Control Gain Switching Condition A	For Control Methods Other Than Position Control (No Switching)	When Enabled	Classification
Pn139 (2139 hex)	n.☐☐0☐ (default setting)	/COIN (Positioning Completion) signal ON	Gain settings 1 used.	Immediately	Tuning
	n.☐☐1☐	/COIN (Positioning Completion) 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 position reference input is OFF.	Gain settings 1 used.		
	n.☐☐5☐	Position reference 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).



Information You can use gain switching for either PI control or I-P control (Pn10B = n.☐☐0☐ or ☐☐1☐).

Related Parameters

Pn100 (2100 hex)	Speed Loop Gain			Speed	Position
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	10 to 20,000	0.1 Hz	400	Immediately	Tuning
Pn101 (2101 hex)	Speed Loop Integral Time Constant			Speed	Position
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	15 to 51,200	0.01 ms	2,000	Immediately	Tuning
Pn102 (2102 hex)	Position Loop Gain				Position
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	10 to 20,000	0.1/s	400	Immediately	Tuning
Pn401 (2401 hex)	First Stage First Torque Reference Filter Time Constant			Speed	Position Torque
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 to 65,535	0.01 ms	100	Immediately	Tuning
Pn121 (2121 hex)	Friction Compensation Gain			Speed	Position
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	10 to 1,000	1%	100	Immediately	Tuning
Pn104 (2104 hex)	Second Speed Loop Gain			Speed	Position
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	10 to 20,000	0.1 Hz	400	Immediately	Tuning
Pn105 (2105 hex)	Second Speed Loop Integral Time Constant			Speed	Position
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	15 to 51,200	0.01 ms	2,000	Immediately	Tuning
Pn106 (2106 hex)	Second Position Loop Gain				Position
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	10 to 20,000	0.1/s	400	Immediately	Tuning
Pn412 (2412 hex)	First Stage Second Torque Reference Filter Time Constant			Speed	Position Torque
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 to 65,535	0.01 ms	100	Immediately	Tuning
Pn122 (2122 hex)	Second Friction Compensation Gain			Speed	Position
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	10 to 1,000	1%	100	Immediately	Tuning

Parameters Related to Automatic Gain Switching

Pn131 (2131 hex)	Gain Switching Time 1				Position
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 to 65,535	1 ms	0	Immediately	Tuning
Pn132 (2132 hex)	Gain Switching Time 2				Position
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 to 65,535	1 ms	0	Immediately	Tuning
Pn135 (2135 hex)	Gain Switching Waiting Time 1				Position
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 to 65,535	1 ms	0	Immediately	Tuning
Pn136 (2136 hex)	Gain Switching Waiting Time 2				Position
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 to 65,535	1 ms	0	Immediately	Tuning

Related Monitoring

- SigmaWin+
  You can monitor gain switching with the status monitor or with tracing.
- Analog Monitors

Parameter	Analog Monitor	Monitor Name	Output Value	Description
Pn006 (2006 hex) Pn007 (2007 hex)	n.□□0B	Active Gain Monitor	1 V	Gain settings 1 are enabled.
			2 V	Gain settings 2 are enabled.

8.12.2 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 (2408 hex)	n.0□□□ (default setting)	Disable friction compensation.	Immediately	Setup
	n.1□□□	Enable friction compensation.		

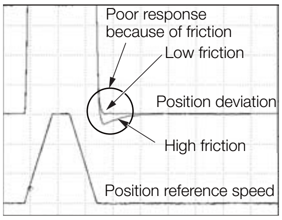
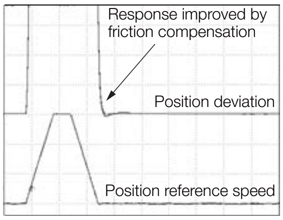
Pn121 (2121 hex)	Friction Compensation Gain			Speed	Position
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	10 to 1,000	1%	100	Immediately	Tuning
Pn122 (2122 hex)	Second Friction Compensation Gain			Speed	Position
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	10 to 1,000	1%	100	Immediately	Tuning
Pn123 (2123 hex)	Friction Compensation Coefficient			Speed	Position
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 to 100	1%	0	Immediately	Tuning
Pn124 (2124 hex)	Friction Compensation Frequency Correction			Speed	Position
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	-10,000 to 10,000	0.1 Hz	0	Immediately	Tuning
Pn125 (2125 hex)	Friction Compensation Gain Correction			Speed	Position
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	1 to 1,000	1%	100	Immediately	Tuning

Operating Procedure for Friction Compensation

Use the following procedure to perform 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

8.12.3 Current Control Mode Selection

Current control mode selection reduces high-frequency noise while the Servomotor is being stopped. Current control mode selection can be used for the following SERVOPACKs. To use current control mode selection, set Pn009 to n.□□1□ (Use current control mode 2). This will set effective conditions for many situations.

Input Voltage	SERVOPACK Model
200 V	SGD7S-120A, -180A, -200A, -330A, -470A, -550A, -590A, or -780A

Parameter		Meaning	When Enabled	Classification
Pn009 (2009 hex)	n. □□0□	Use current control mode 1.	After restart	Tuning
	n. □□1□ (default setting)	Use current control mode 2 (low noise).		

Important

If current control mode 2 is selected, the load ratio may increase while the Servomotor is being stopped.

8.12.4 Current Gain Level Setting

You can set the current gain level to reduce noise by adjusting the parameter for current control inside the SERVOPACK 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 SERVOPACK will also be reduced. Adjust the current gain level within the range that maintains the SERVOPACK response characteristic.

Pn13D (213D hex)	Current Gain Level			Speed	Position
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	100 to 2,000	1%	2,000	Immediately	Tuning

Important

If the current gain level is changed, the response characteristic of the speed loop will also change. Servo tuning must therefore be performed again.

8.12.5 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 (2009 hex)	n. □0□□ (default setting)	Use speed detection 1.	After restart	Tuning
	n. □1□□	Use speed detection 2.		

Important

If the speed detection method is changed, the response characteristic of the speed loop will also change. Servo tuning must therefore be performed again.

8.12.6 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.

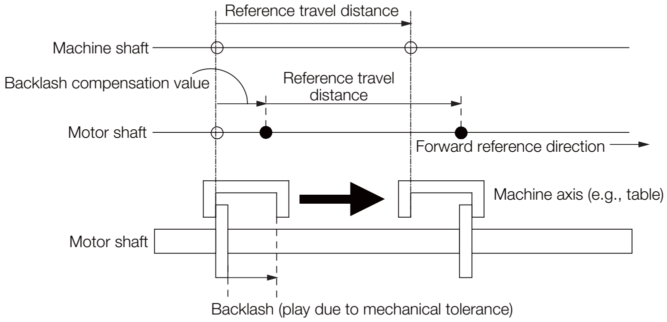
Pn308 (2308 hex)	Speed Feedback Filter Time Constant			Speed	Position
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 to 65,535 (0.00 ms to 655.35 ms)	0.01 ms	0 (0.00 ms)	Immediately	**Setup**

8.12.7 Backlash Compensation

Outline

If you drive a machine that has backlash, there will be deviation between the travel distance in the position reference that is managed by the host controller and the travel distance of the actual machine. Use backlash compensation to add the backlash compensation value to the position reference and use the result to drive the Servomotor. This will ensure that the travel distance of the actual machine will be the same as the travel distance in the host controller.

Note: 1. Backlash compensation can be used only with a Rotary Servomotor.
2. Backlash compensation can be used only for position control.



Related Parameters

Set the following parameters to use backlash compensation.

◆ Backlash Compensation Direction

Set the direction in which to apply backlash compensation.

Parameter		Meaning	When Enabled	Classification
Pn230 (2230 hex)	n.□□□0 (default setting)	Compensate forward references.	After restart	Setup
	n.□□□1	Compensate reverse references.		

◆ Backlash Compensation Value

Set the amount of backlash compensation to add to the position reference.
The amount is set in increments of 0.1 reference unit. However, when the amount is converted to encoder pulses, it is rounded off at the decimal point.

Example

When Pn231 = 6553.6 [reference units] and position reference unit (Numerator/Denominator) = 1/1:
6,553.6 × 1 = 6,553.6 [pulses]
⇒ The backlash compensation will be 6,553 encoder pulses.

Pn231 (2231 hex)	Backlash Compensation			Position	
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	-500,000 to 500,000	0.1 reference units	0	Immediately	Setup

Important

- The backlash compensation value is restricted by the following formula. Backlash compensation is not performed if this condition is not met.

$$\text{Pn231} \leq \frac{\text{Denominator}}{\text{Numerator}} \times \frac{\text{Maximum motor speed [min}^{-1}\text{]}}{60} \times \text{Encoder resolution*} \times 0.00025$$

*Refer to the following section for the encoder resolution.
☞ *5.14 Setting Unit Systems* on page 5-42

With fully-closed loop control, substitute the number of external encoder pulses per motor rotation for the encoder resolution in the above formula.

Example 1:
Denominator = 1, Numerator = 1, Maximum motor speed = 6,000 [min^{-1}], and Encoder resolution = 16,777,216 (24 bits)
1/4 × 6,000/60 × 16,777,216 × 0.00025 = 104,857.6 [reference units]
⇒ The backlash compensation will be limited to 104,857.6 reference units.

Example 2:
Denominator = 1, Numerator = 1, Maximum motor speed = 6,000 [min^{-1}], Number of External Encoder Pitches (Pn20A) = 500, and Use of the JZDP-H00□-000 (signal resolution: 1/256):
1/4 × 6,000/60 × (500 × 256) × 0.00025 = 800.0 [reference units]
⇒ The backlash compensation will be limited to 800.0 reference units.

- Do not exceed the upper limit of the backlash compensation value. You can check the upper limit on the operation monitor of the SigmaWin+.

◆ Backlash Compensation Time Constant

You can set a time constant for a first order lag filter for the backlash compensation value (Pn231) that is added to the position reference.
If you set Pn233 (Backlash Compensation Time Constant) to 0, the first order lag filter is disabled.

Pn233 (2233 hex)	Backlash Compensation Time Constant			Position	
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 to 65,535	0.01 ms	0	Immediately	Setup

Note: Changes to the settings are applied when there is no reference pulse input and the Servomotor is stopped. The current operation is not affected if the setting is changed during motor operation.

Related Monitoring

You can monitor the following values on the operation monitor of the SigmaWin+.

Displayed Value	Setting Unit
Current Backlash Compensation Value	0.1 reference units
Backlash Compensation Value Setting Limit	0.1 reference units

Compensation Operation

This section describes the operation that is performed for backlash compensation.

Note: The following figures are for when backlash compensation is applied to references in the forward direction (Pn230 = n.□□□0). The following monitor information is provided in the figures: *target position* (607A hex) (target position in the reference coordinate system), *position demand value* (6062 hex) (reference position in the reference coordinate system), and *position actual value* (6064 hex) (feedback position in the machine coordinate system). The monitor information includes the feedback position in machine coordinate system (*position actual value*) and other feedback information. The backlash compensation value is subtracted from the feedback positions in the monitor information, so it is not necessary for the host controller to consider the backlash compensation value.

⚠ CAUTION

- The encoder divided pulse output will output the number of encoder pulses for which driving was actually performed, including the backlash compensation value. If you use the encoder output pulses for position feedback at the host controller, you must consider the backlash compensation value.

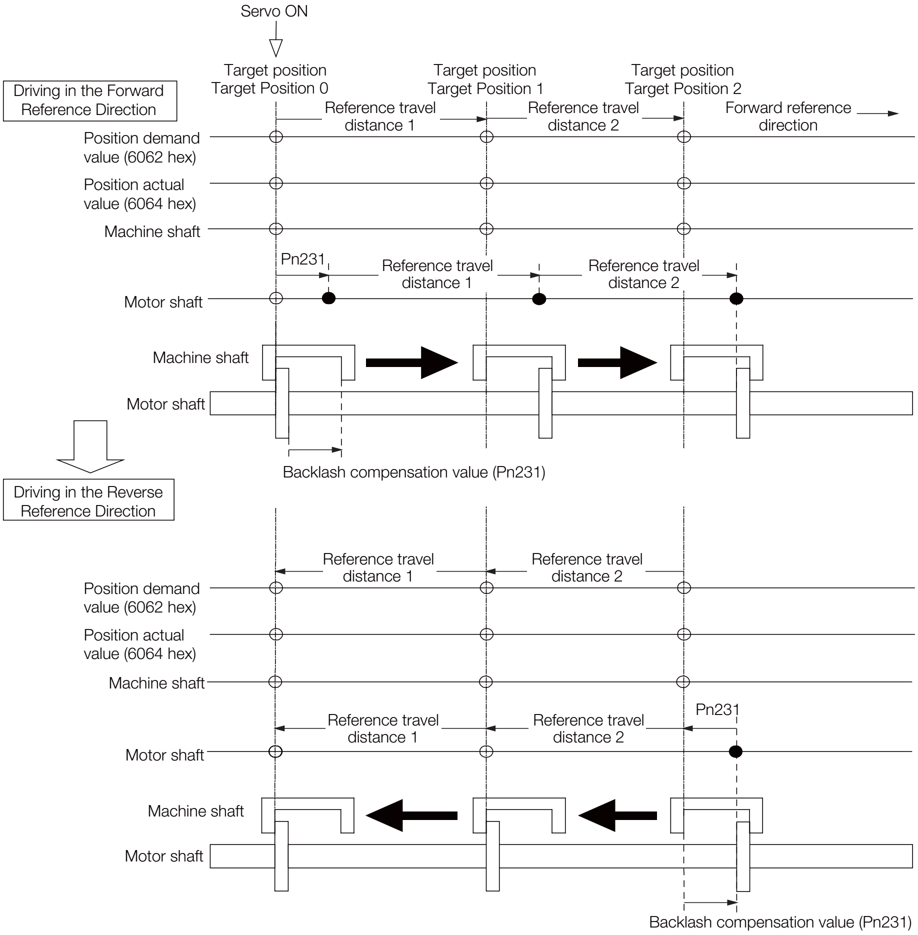
◆ Operation When the Servo Is ON

The backlash compensation value (Pn231) is added in the backlash compensation direction when the servo is ON (i.e.,while power is supplied to the motor) and a reference is input in the same direction as the backlash compensation direction (Pn230.0 = n.□□□X). When there is a reference input in the direction opposite to the backlash compensation direction, the backlash compensation value is not added (i.e., backlash compensation is not performed).

The relationship between *position actual value* (6064 hex) and the motor shaft position is as follows:

- If a reference is input in the compensation direction: Position actual value (6064 hex) = Motor shaft position - Pn231
- If a reference is input in the direction opposite to the compensation direction: Position actual value (6064 hex) = Motor shaft position

The following figure shows driving the Servomotor in the forward direction from Target Position 0 (*target position*: 607A hex) to Target Position 1 and then to Target Position 2, and then returning from Target Position 2 to Target Position 1 and then to Target Position 0.
Backlash compensation is applied when moving from Target Position 0 to Target Position 1, but not when moving from Target Position 2 to Target Position 1.

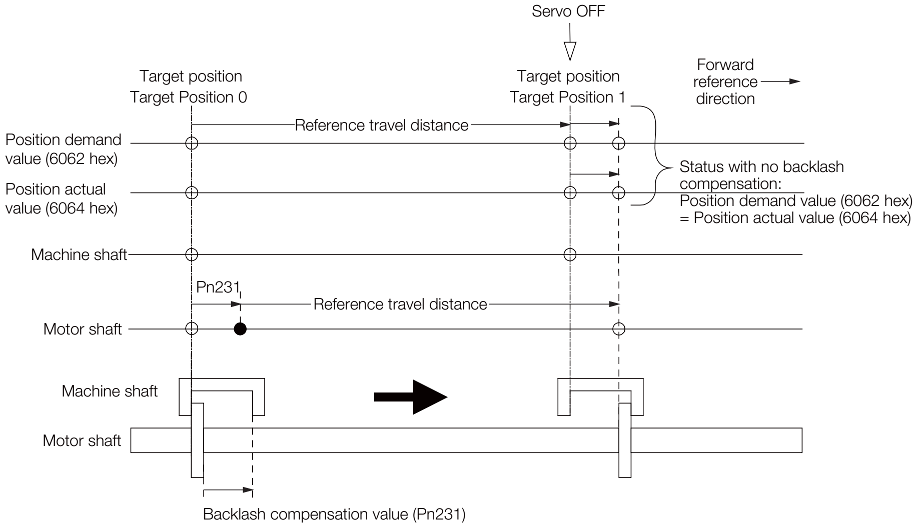


◆ Operation When the Servo Is OFF

Backlash compensation is not applied when the servo is OFF (i.e., when power is not supplied to motor). Therefore, the reference position (*position demand value* (6062 hex)) is moved by only the backlash compensation value.
The relationship between *position actual value* (6064 hex) and the motor shaft position is as follows:

- When servo is OFF: Position actual value (6064 hex) = Servomotor shaft position

The following figure shows what happens when the servo is turned OFF after driving the Servomotor in the forward direction from target position Target Position 0 to Target Position 1. Backlash compensation is not applied when the servo is OFF. (The SERVOPACK manages the position data so that *position actual value* (6064 hex) and *position demand value* (6062 hex) are the same.)



◆ Operation When There Is Overtravel

When there is overtravel (i.e., when driving is prohibited due to an overtravel signal or software limit), the operation is the same as for when the servo is OFF (◆ *Operation When the Servo Is OFF* on page 8-74), i.e., backlash compensation is not applied.

◆ Operation When Control Is Changed

Backlash compensation is performed only for position control.
Backlash compensation is not applied when position control is changed to any other control method.
Backlash compensation is applied in the same way as when the servo is ON (◆ *Operation When the Servo Is ON* on page 8-73) if any other control method is changed to position control.

Related Monitoring

You can monitor the following values on the operation monitor of the SigmaWin+.

Displayed Value	Unit	Specification
Input Reference Pulse Speed	min^{-1}	Displays the input reference pulse speed before backlash compensation.
Position Deviation	Reference units	Displays the position deviation for the position reference after backlash compensation.
Input Reference Pulse Counter	Reference units	Displays the input reference pulse counter before backlash compensation.
Feedback Pulse Counter	Encoder pulses	Displays the number of pulses from the actually driven motor encoder.
Fully-Closed Feedback Pulse Counter	External encoder resolution	Displays the number of pulses of the actually driven external encoder.
Feedback Pulse Counter	Reference units	Displays the number of pulses from the actually driven encoder in reference units.

◆ Related Monitoring Diagrams

The following symbols are used in the related monitoring diagrams.

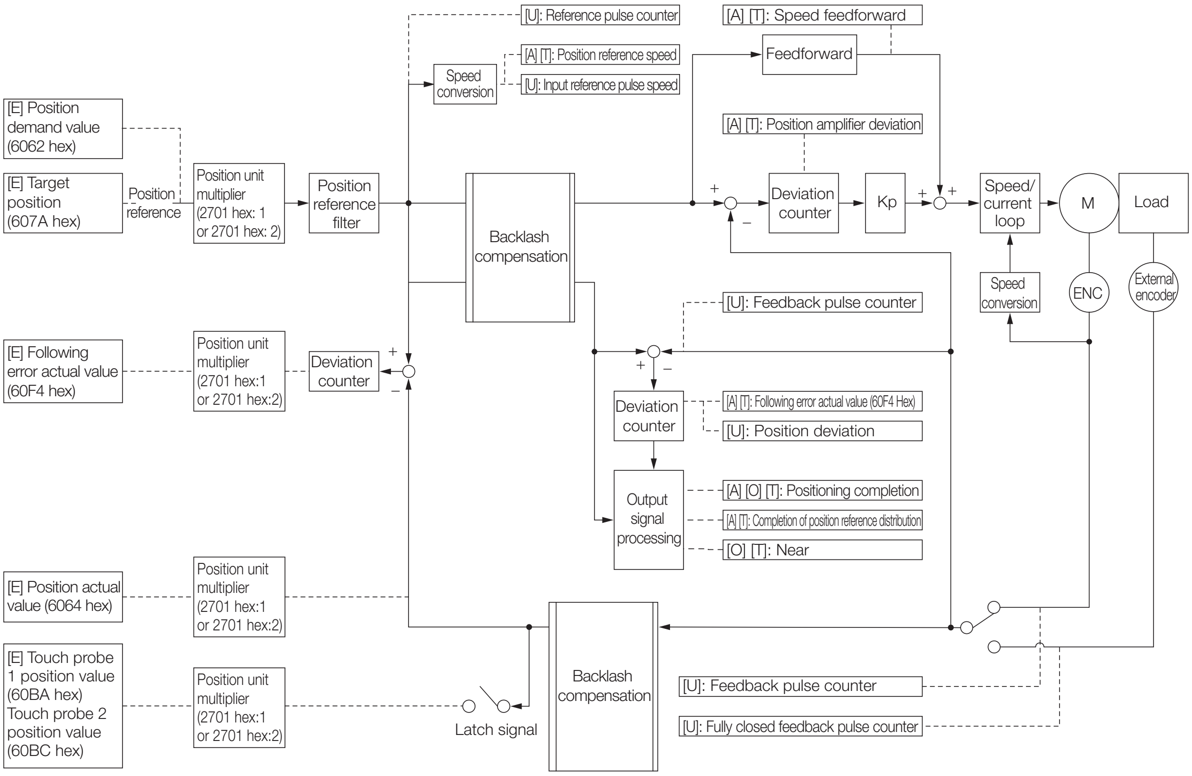
[A]: Analog monitor

[E]: EtherCAT monitor Information

[U]: Monitor mode (Un monitor)

[O]: Output signal

[T]: Trace data

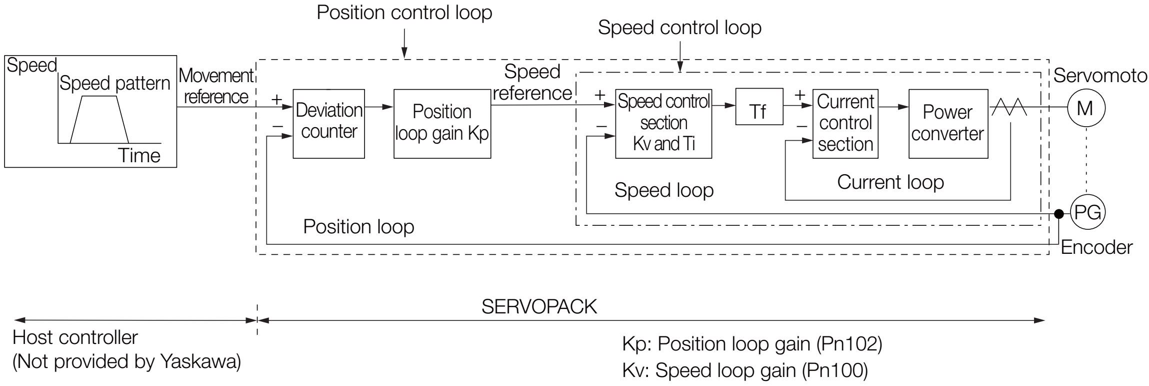


8.13 Manual Tuning

This section describes manual tuning.

8.13.1 Tuning the Servo Gains

Servo Gains



Kp: Position loop gain (Pn102)
Kv: Speed loop gain (Pn100)
Ti: Speed loop integral time constant (Pn101)
Tf: First stage first torque reference filter time constant (Pn401)

Figure 8.1 Simplified Block Diagram for Position Control

In order to manually tune the servo gains, you must understand the configuration and characteristic of the SERVOPACK 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 SERVOPACK 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 SERVOPACK to increase the response characteristic of the SERVOPACK. 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 SigmaWin+ 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.

☞ *6.11 Initializing the Vibration Detection Level* on page 6-45

Vibration alarms are not detected for all vibration. Also, an emergency stop method is necessary to stop the machine safely when an alarm occurs. You must provide an emergency stop device and activate it immediately whenever vibration occurs.

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 position 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.

Information 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 SERVOPACK.

- 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 SERVOPACK. 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 (2102 hex)	Position Loop Gain				Position
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	10 to 20,000	0.1/s	400	Immediately	Tuning

Information 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.

$$\text{Pn520} \geq \frac{\text{Maximum feed speed [reference units/s]}}{\text{Pn102} \div 10\ (1/\text{s})} \times 2.0$$

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 (2520 hex)	Position Deviation Overflow Alarm Level				Position
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	1 to 1,073,741,823	1 reference unit	5,242,880	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 (2100 hex)	Speed Loop Gain			Speed Position	Torque
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	10 to 20,000	0.1 Hz	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 (2103 hex)	Moment of Inertia Ratio			Speed Position	Torque
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 to 20,000	1%	100	Immediately	Tuning

◆ Speed Loop Integral Time Constant

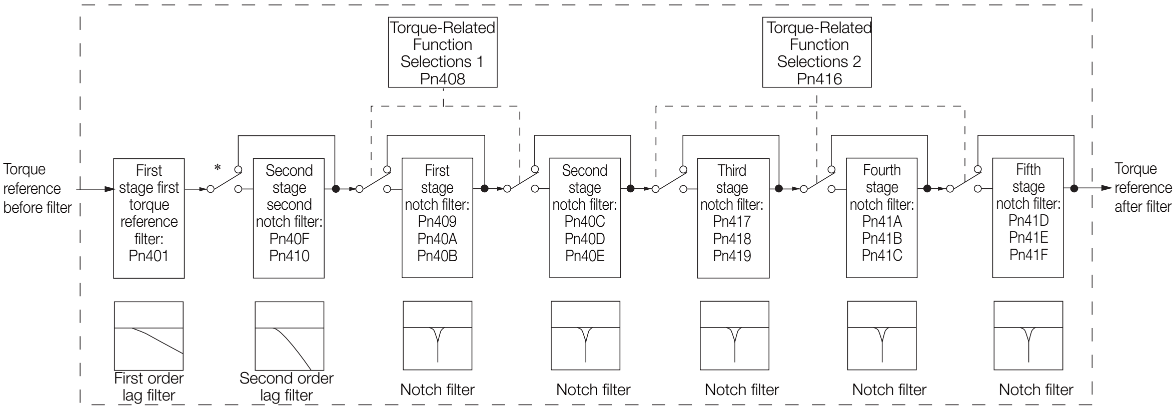
To enable response to even small inputs, the speed loop has an integral element. The integral element becomes a delay factor in the servo system. If the time constant is set too high, overshooting will occur, positioning settling time will increase, and the response characteristic will suffer.

Pn101 (2101 hex)	Speed Loop Integral Time Constant			Speed Position	
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	15 to 51,200	0.01 ms	2,000	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 (2401 hex)	First Stage First Torque Reference Filter Time Constant				Speed Position Torque
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 to 65,535	0.01 ms	100	Immediately	Tuning
Pn40F (240F hex)	Second Stage Second Torque Reference Filter Frequency				Speed Position Torque
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	100 to 5,000	1 Hz	5000*	Immediately	Tuning
Pn410 (2410 hex)	Second Stage Second Notch Filter Q Value				Speed Position Torque
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	50 to 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.

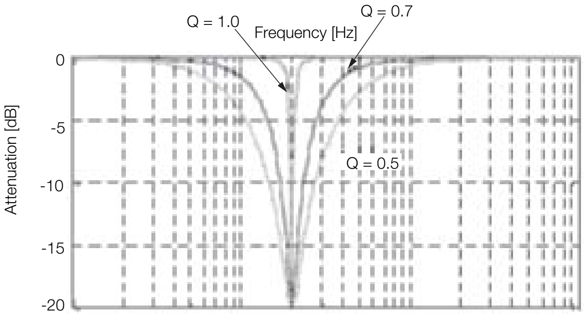
The notch filter puts a notch in the gain curve at the specific vibration frequency (called the notch frequency). The frequency components near the notch frequency can be reduced or removed with a notch filter.

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.



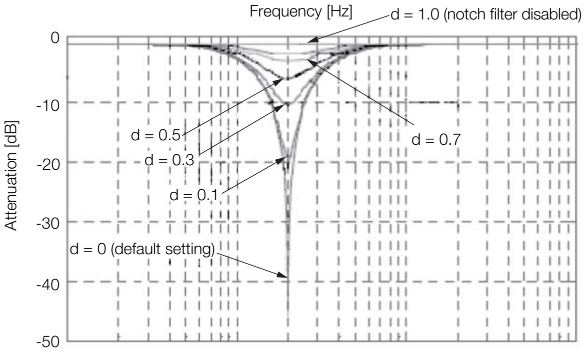
Note: The above notch filter frequency characteristics are based on calculated values and may be different from actual characteristics.

- 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.



Note: The above notch filter frequency characteristics are based on calculated values and may be different from actual characteristics.

You can enable or disable the notch filter with Pn408.

Parameter		Meaning	When Enabled	Classification
Pn408 (2408 hex)	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.		
Pn416 (2416 hex)	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.

<table>
<tr><td rowspan="3">Pn409
(2409
hex)</td><td colspan="3">First Stage Notch Filter Frequency</td><td colspan="2">Speed Position Torque</td></tr>
<tr><td>Setting Range</td><td>Setting Unit</td><td>Default Setting</td><td>When Enabled</td><td>Classification</td></tr>
<tr><td>50 to 5,000</td><td>1 Hz</td><td>5,000</td><td>Immediately</td><td>Tuning</td></tr>
<tr><td rowspan="3">Pn40A
(240A
hex)</td><td colspan="3">First Stage Notch Filter Q Value</td><td colspan="2">Speed Position Torque</td></tr>
<tr><td>Setting Range</td><td>Setting Unit</td><td>Default Setting</td><td>When Enabled</td><td>Classification</td></tr>
<tr><td>50 to 1,000</td><td>0.01</td><td>70</td><td>Immediately</td><td>Tuning</td></tr>
<tr><td rowspan="3">Pn40B
(240B
hex)</td><td colspan="3">First Stage Notch Filter Depth</td><td colspan="2">Speed Position Torque</td></tr>
<tr><td>Setting Range</td><td>Setting Unit</td><td>Default Setting</td><td>When Enabled</td><td>Classification</td></tr>
<tr><td>0 to 1,000</td><td>0.001</td><td>0</td><td>Immediately</td><td>Tuning</td></tr>
<tr><td rowspan="3">Pn40C
(240C
hex)</td><td colspan="3">Second Stage Notch Filter Frequency</td><td colspan="2">Speed Position Torque</td></tr>
<tr><td>Setting Range</td><td>Setting Unit</td><td>Default Setting</td><td>When Enabled</td><td>Classification</td></tr>
<tr><td>50 to 5,000</td><td>1 Hz</td><td>5,000</td><td>Immediately</td><td>Tuning</td></tr>
<tr><td rowspan="3">Pn40D
(240D
hex)</td><td colspan="3">Second Stage Notch Filter Q Value</td><td colspan="2">Speed Position Torque</td></tr>
<tr><td>Setting Range</td><td>Setting Unit</td><td>Default Setting</td><td>When Enabled</td><td>Classification</td></tr>
<tr><td>50 to 1,000</td><td>0.01</td><td>70</td><td>Immediately</td><td>Tuning</td></tr>
<tr><td rowspan="3">Pn40E
(240E
hex)</td><td colspan="3">Second Stage Notch Filter Depth</td><td colspan="2">Speed Position Torque</td></tr>
<tr><td>Setting Range</td><td>Setting Unit</td><td>Default Setting</td><td>When Enabled</td><td>Classification</td></tr>
<tr><td>0 to 1,000</td><td>0.001</td><td>0</td><td>Immediately</td><td>Tuning</td></tr>
<tr><td rowspan="3">Pn417
(2417
hex)</td><td colspan="3">Third Stage Notch Filter Frequency</td><td colspan="2">Speed Position Torque</td></tr>
<tr><td>Setting Range</td><td>Setting Unit</td><td>Default Setting</td><td>When Enabled</td><td>Classification</td></tr>
<tr><td>50 to 5,000</td><td>1 Hz</td><td>5,000</td><td>Immediately</td><td>Tuning</td></tr>
<tr><td rowspan="3">Pn418
(2418
hex)</td><td colspan="3">Third Stage Notch Filter Q Value</td><td colspan="2">Speed Position Torque</td></tr>
<tr><td>Setting Range</td><td>Setting Unit</td><td>Default Setting</td><td>When Enabled</td><td>Classification</td></tr>
<tr><td>50 to 1,000</td><td>0.01</td><td>70</td><td>Immediately</td><td>Tuning</td></tr>
<tr><td rowspan="3">Pn419
(2419
hex)</td><td colspan="3">Third Stage Notch Filter Depth</td><td colspan="2">Speed Position Torque</td></tr>
<tr><td>Setting Range</td><td>Setting Unit</td><td>Default Setting</td><td>When Enabled</td><td>Classification</td></tr>
<tr><td>0 to 1,000</td><td>0.001</td><td>0</td><td>Immediately</td><td>Tuning</td></tr>
<tr><td rowspan="3">Pn41A
(241A
hex)</td><td colspan="3">Fourth Stage Notch Filter Frequency</td><td colspan="2">Speed Position Torque</td></tr>
<tr><td>Setting Range</td><td>Setting Unit</td><td>Default Setting</td><td>When Enabled</td><td>Classification</td></tr>
<tr><td>50 to 5,000</td><td>1 Hz</td><td>5,000</td><td>Immediately</td><td>Tuning</td></tr>
<tr><td rowspan="3">Pn41B
(241B
hex)</td><td colspan="3">Fourth Stage Notch Filter Q Value</td><td colspan="2">Speed Position Torque</td></tr>
<tr><td>Setting Range</td><td>Setting Unit</td><td>Default Setting</td><td>When Enabled</td><td>Classification</td></tr>
<tr><td>50 to 1,000</td><td>0.01</td><td>70</td><td>Immediately</td><td>Tuning</td></tr>
<tr><td rowspan="3">Pn41C
(241C
hex)</td><td colspan="3">Fourth Stage Notch Filter Depth</td><td colspan="2">Speed Position Torque</td></tr>
<tr><td>Setting Range</td><td>Setting Unit</td><td>Default Setting</td><td>When Enabled</td><td>Classification</td></tr>
<tr><td>0 to 1,000</td><td>0.001</td><td>0</td><td>Immediately</td><td>Tuning</td></tr>
<tr><td rowspan="3">Pn41D
(241D
hex)</td><td colspan="3">Fifth Stage Notch Filter Frequency</td><td colspan="2">Speed Position Torque</td></tr>
<tr><td>Setting Range</td><td>Setting Unit</td><td>Default Setting</td><td>When Enabled</td><td>Classification</td></tr>
<tr><td>50 to 5,000</td><td>1 Hz</td><td>5,000</td><td>Immediately</td><td>Tuning</td></tr>
<tr><td rowspan="3">Pn41E
(241E
hex)</td><td colspan="3">Fifth Stage Notch Filter Q Value</td><td colspan="2">Speed Position Torque</td></tr>
<tr><td>Setting Range</td><td>Setting Unit</td><td>Default Setting</td><td>When Enabled</td><td>Classification</td></tr>
<tr><td>50 to 1,000</td><td>0.01</td><td>70</td><td>Immediately</td><td>Tuning</td></tr>
<tr><td rowspan="3">Pn41F
(241F
hex)</td><td colspan="3">Fifth Stage Notch Filter Depth</td><td colspan="2">Speed Position Torque</td></tr>
<tr><td>Setting Range</td><td>Setting Unit</td><td>Default Setting</td><td>When Enabled</td><td>Classification</td></tr>
<tr><td>0 to 1,000</td><td>0.001</td><td>0</td><td>Immediately</td><td>Tuning</td></tr>
</table>

Important

- 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 to an appropriate value.) 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 user's 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 SigmaWin+ or analog monitor to monitor operating conditions. Even if the status is stable while the motor 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 motor.

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.

Important

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] $\leq 2\pi \times$ Pn100/4 [Hz]
  Critical gain: Pn102 [/s] $< 2\pi \times$ Pn100 [Hz]

- Speed Loop Gain (Pn100 [Hz]) and Speed Loop Integral Time Constant (Pn101 [ms])
  Stable gain: Pn101 [ms] $\geq$ 4,000/($2\pi \times$ Pn100 [Hz])
  Critical gain: Pn101 [ms] > 1,000/($2\pi \times$ Pn100 [Hz])

- Speed Loop Gain (Pn100 [Hz]) and First Stage First Torque Reference Filter Time Constant (Pn401 [ms])
  Stable gain: Pn401 [ms] $\leq$ 1,000/($2\pi \times$ Pn100 [Hz] $\times$ 4)
  Critical gain: Pn401 [ms] < 1,000/($2\pi \times$ Pn100 [Hz] $\times$ 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 notch 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]

Information

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 SGD7S SERVOPACKs, decimal places are given for the settings of parameters on the Digital Operator, Panel Operator, and in the manual. For example with Speed Loop Gain (Pn100), 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.

Example

- 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].

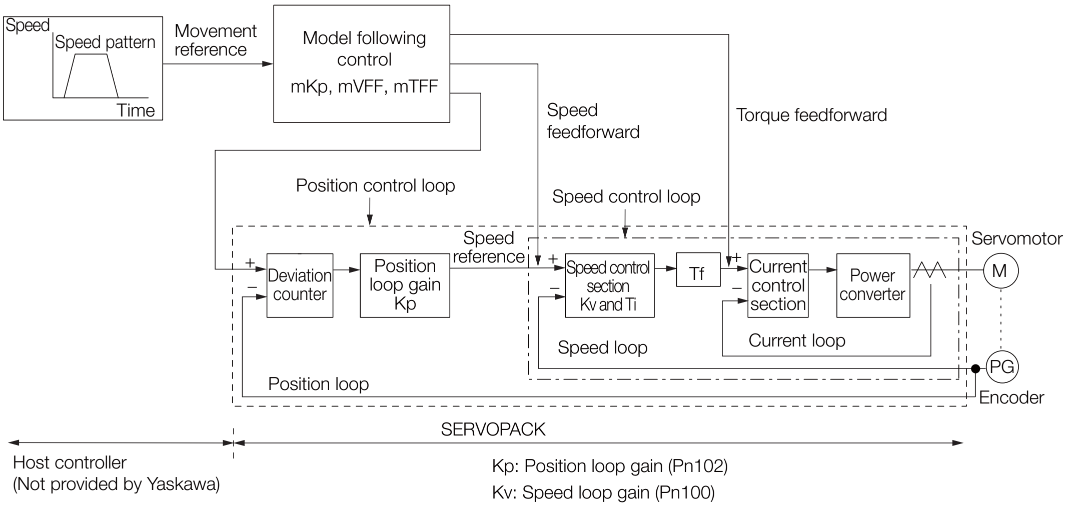
Model Following Control

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.



Kp: Position loop gain (Pn102)
Kv: Speed loop gain (Pn100)
Ti: Speed loop integral time constant (Pn101)
Tf: First stage first torque reference filter time constant (Pn401)
mKp: Model following control gain (Pn141)
mTFF: Model following control bias in the forward direction (Pn143)
Model following control bias in the reverse direction (Pn144)
mVFF: Model following control speed feedforward compensation (Pn147)

◆ 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. ☞ *8.12.2 Friction Compensation* on page 8-68
2	Adjust the servo gains. Refer to the following section for an example procedure. ☞ *Tuning Procedure Example (for Position Control or Speed Control)* on page 8-77 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). ☞ *Guidelines for Manually Tuning Servo Gains* on page 8-82
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 (2140 hex)	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 (2141 hex)	Model Following Control Gain			Position	
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	10 to 20,000	0.1/s	500	Immediately	Tuning

Information 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.

$$Pn\ 520 \geq \frac{\text{Maximum feed speed [reference units/s]}}{Pn\ 141/10\ [1/s]} \times 2.0$$

Pn520 (2520 hex)	Position Deviation Overflow Alarm Level			Position	
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	1 to 1,073,741,823	1 reference unit	5,242,880	Immediately	Setup

■ 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 (2143 hex)	Model Following Control Bias in the Forward Direction			Position	
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 to 10,000	0.1%	1,000	Immediately	Tuning
Pn144 (2144 hex)	Model Following Control Bias in the Reverse Direction			Position	
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 to 10,000	0.1%	1,000	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 (2147 hex)	Model Following Control Speed Feedforward Compensation				Position
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 to 10,000	0.1%	1,000	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).

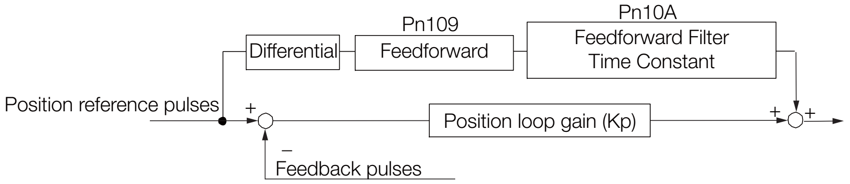
Parameter		Meaning	When Enabled	Classification
Pn14F (214F hex)	n.□□□0	Use model following control type 1.	After restart	Tuning
	n.□□□0 (default setting)	Use model following control type 2.		

8.13.2 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 Σ-III-Series SERVOPACKs to adjust Σ-7-Series SERVOPACKs.

Feedforward

The feedforward function applies feedforward compensation to position control to shorten the positioning time.

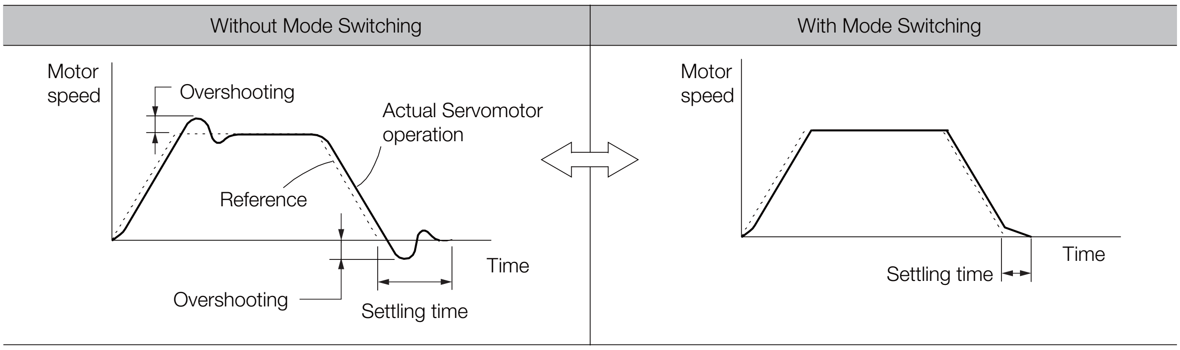


Pn109 (2109 hex)	Feedforward				Position
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 to 100	1%	0	Immediately	Tuning
Pn10A (210A hex)	Feedforward Filter Time Constant				Position
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 to 6,400	0.01 ms	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.

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 (210B hex)	n.□□□0 (default setting)	Use the internal torque reference as the condition.	Pn10C (210C hex)		Immediately	Setup
	n.□□□1	Use the speed reference as the condition.	Pn10D (210D hex)	Pn181 (2181 hex)		
	n.□□□2	Use the acceleration reference as the condition.	Pn10E (210E hex)	Pn182 (2182 hex)		
	n.□□□3	Use the position deviation as the condition.	Pn10F (210F hex)			
	n.□□□4	Do not use mode switching.	–			

■ Parameters That Set the Switching Levels

- Rotary Servomotors

Pn10C (210C hex)	Mode Switching Level for Torque Reference			Speed	Position
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 to 800	1%	200	Immediately	Tuning

Pn10D (210D hex)	Mode Switching Level for Speed Reference			Speed	Position
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 to 10,000	1 min^{-1}	0	Immediately	Tuning

Pn10E (210E hex)	Mode Switching Level for Acceleration			Speed	Position
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 to 30,000	1 min^{-1}/s	0	Immediately	Tuning

Pn10F (210F hex)	Mode Switching Level for Position Deviation				Position
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 to 10,000	1 reference unit	0	Immediately	Tuning

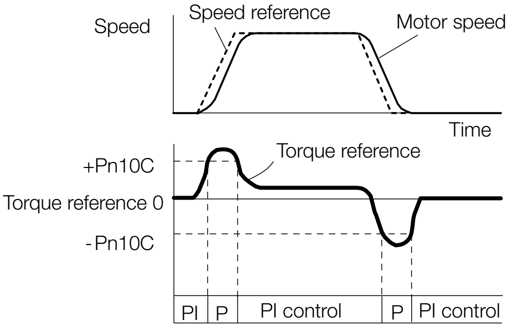
- Linear Servomotors

Pn10C (210C hex)	Mode Switching Level for Force Reference			Speed	Position
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 to 800	1%	200	Immediately	Tuning
Pn181 (2181 hex)	Mode Switching Level for Speed Reference			Speed	Position
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 to 10,000	1 mm/s	0	Immediately	Tuning
Pn182 (2182 hex)	Mode Switching Level for Acceleration			Speed	Position
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 to 30,000	1 mm/s^2	0	Immediately	Tuning
Pn10F (210F hex)	Mode Switching Level for Position Deviation				Position
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 to 10,000	1 reference unit	0	Immediately	Tuning

■ Using the Torque Reference as the Mode Switching Condition (Default Setting)

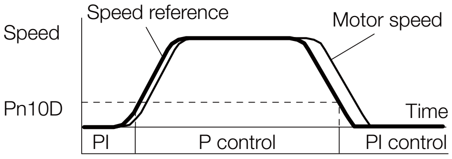
When the torque reference equals or exceeds the torque set for the mode switching level for torque reference (Pn10C), the speed loop is changed to P control.

The default setting for the torque reference level is 200%.

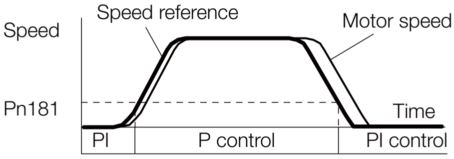


■ Using the Speed Reference as the Mode Switching Condition

- 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.

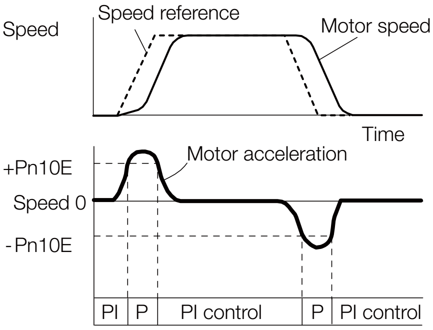


- Linear Servomotors
  When the speed reference equals or exceeds the speed set for the mode switching level for a speed reference (Pn181), the speed loop is changed to P control.

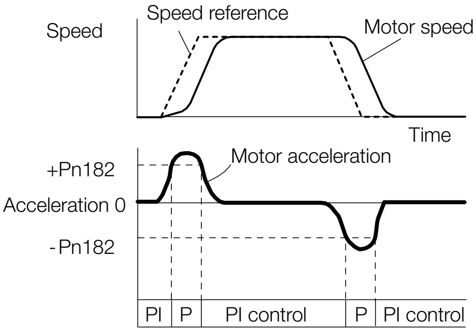


■ Using the Acceleration as the Mode Switching Condition

- 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.



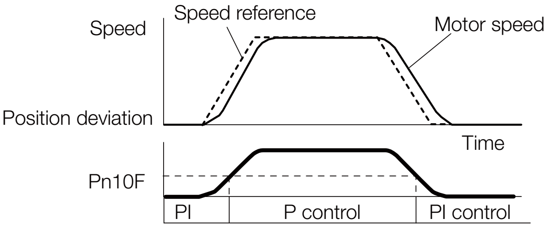
- Linear Servomotors
  When the speed reference equals or exceeds the acceleration rate set for the mode switching level for acceleration (Pn182), the speed loop is changed to P control.



◆ 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. This parameter is effective for electronic cams and electronic shafts.

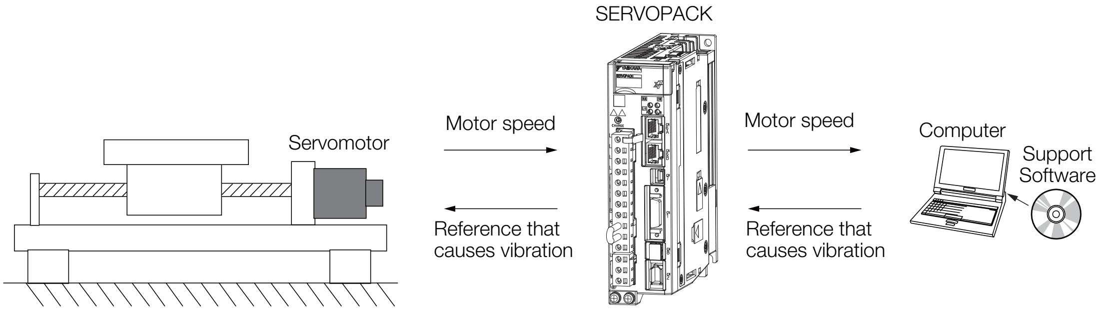
Pn11F (211F hex)	Position Integral Time Constant			Position	
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 to 50,000	0.1 ms	0	Immediately	Tuning

8.14 Diagnostic Tools

8.14.1 Mechanical Analysis

Overview

You can connect the SERVOPACK to a computer to measure the frequency characteristics of the machine. This allows you to measure the frequency characteristics of the machine without using a measuring instrument.



The motor is used to cause machine vibration and then the speed frequency characteristics for the motor torque are measured. The measured frequency characteristics can be used to determine the machine resonance.

You determine the machine resonance for use in servo tuning and as reference for considering changes to the machine. The performance of the servo cannot be completely utilized depending on the rigidity of the machine. You may need to consider making changes to the machine. The information can also be used as reference for servo tuning to help you adjust parameters, such as the servo rigidity and torque filter time constant.

You can also use the information to set parameters, such as the notch filters.

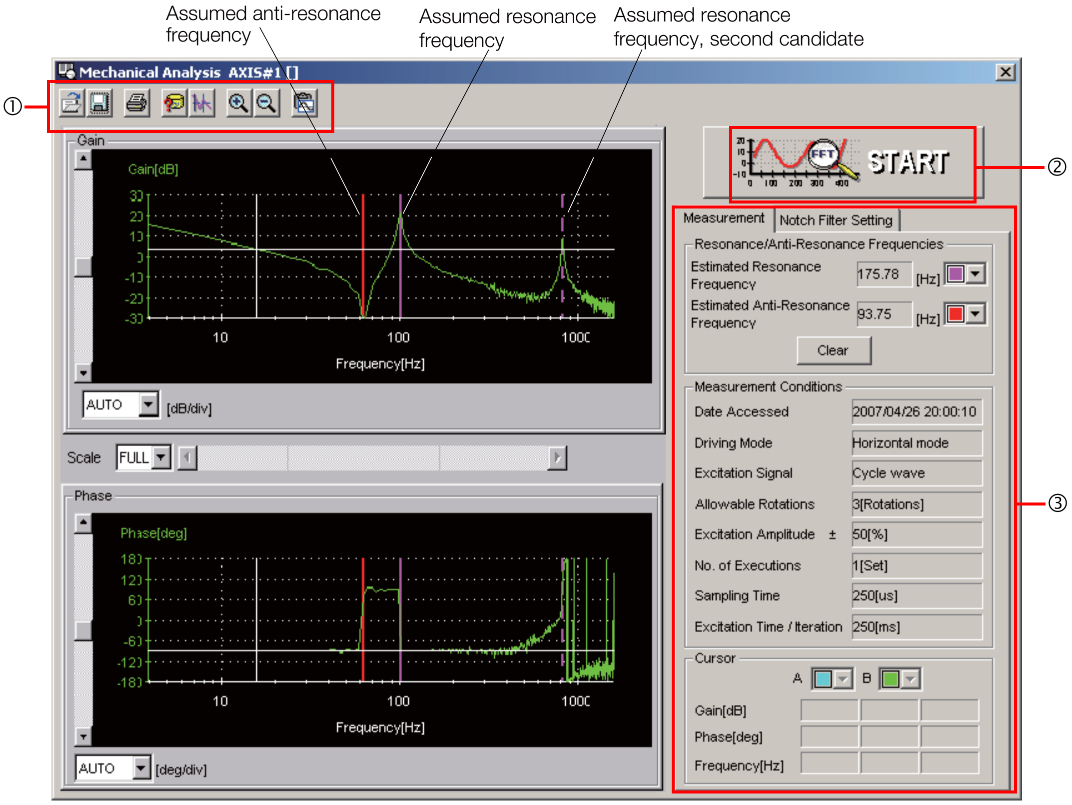
⚠ WARNING

- Mechanical analysis requires operating the motor and therefore presents hazards.
  Before you execute mechanical analysis, check the information provided in the SigmaWin+ operating manual.

Frequency Characteristics

The motor is used to cause the machine to vibrate and the frequency characteristics from the torque to the motor speed are measured to determine the machine characteristics. For a normal machine, the resonance frequencies are clear when the frequency characteristics are plotted on graphs with the gain and phase (Bode plots). The Bode plots show the size (gain) of the response of the machine to which the torque is applied, and the phase delay (phase) in the response for each frequency. Also, the machine resonance frequency can be determined from the maximum frequency of the valleys (anti-resonance) and peaks (resonance) of the gain and the phase delay.

For a motor without a load or for a rigid mechanism, the gain and phase change gradually in the Bode plots.



Estimated Resonance Frequency: 175.78 [Hz]
Estimated Anti-Resonance Frequency: 93.75 [Hz]

Date Accessed: 2007/04/26 20:00:10
Driving Mode: Horizontal mode
Excitation Signal: Cycle wave
Allowable Rotations: 3[Rotations]
Excitation Amplitude ±: 50[%]
No. of Executions: 1[Set]
Sampling Time: 250[us]
Excitation Time / Iteration: 250[ms]

① Toolbar

② **START** Button

Click the **START** Button to start analysis.

③ **Measurement** and **Notch Filter Setting** Tab Pages

Measurement Tab Page: Displays detailed information on the results of analysis.

Notch Filter Setting Tab Page: Displays the notch filter frequencies. You can set these values in the parameters.

8.14.2 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 SERVOPACK to the Servomotor to automatically cause the shaft to rotate multiple times within 1/4th of a rotation, thus causing the machine to vibrate.

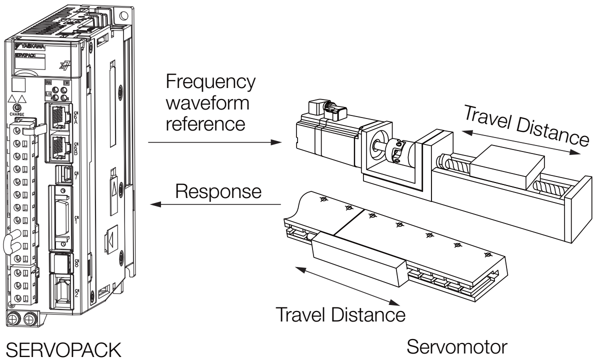
Execute Easy FFT after the servo is turned OFF if operation of the SERVOPACK results in high-frequency noise and vibration.

⚠ 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 SERVOPACK for compatibility with previous products. Normally use autotuning without a host reference for tuning.

Preparations

Check the following settings before you execute Easy FFT.

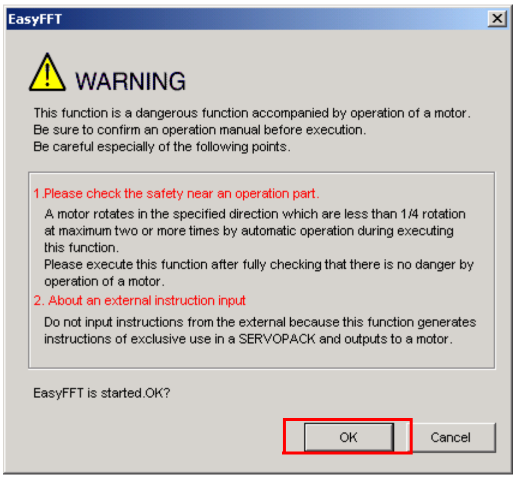
- The parameters must not be write prohibited.
- The main circuit power supply must be ON.
- The test without a motor function must be disabled (Pn00C = n.☐☐☐0).
- There must be no alarms.
- There must be no hard wire base block (HWBB).
- The servo must be OFF.
- There must be no overtravel.
- An external reference must not be input.

Operating Procedure

Use the following procedure.

1. Select ***Setup - EasyFFT*** from the menu bar of the Main Window of the SigmaWin+.
   The EasyFFT Dialog Box will be displayed.
   Click the **Cancel** Button to cancel Easy FFT. You will return to the main window.

2. Click the **OK** Button.



WARNING

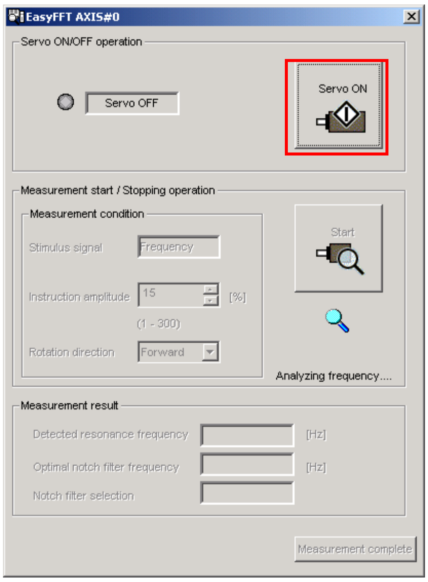
This function is a dangerous function accompanied by operation of a motor.
Be sure to confirm an operation manual before execution.
Be careful especially of the following points.

1.Please check the safety near an operation part.
A motor rotates in the specified direction which are less than 1/4 rotation at maximum two or more times by automatic operation during executing this function.
Please execute this function after fully checking that there is no danger by operation of a motor.
2. About an external instruction input
Do not input instructions from the external because this function generates instructions of exclusive use in a SERVOPACK and outputs to a motor.

EasyFFT is started.OK?

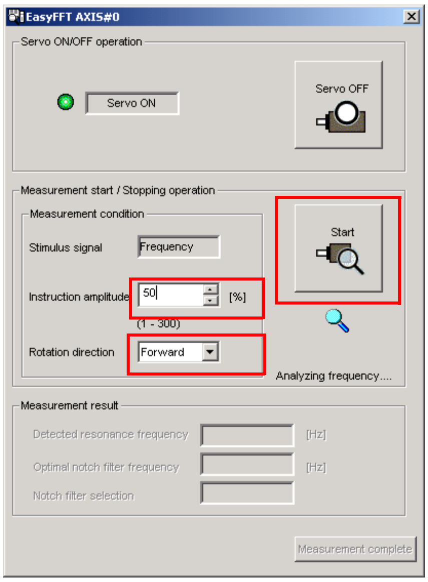
Another EasyFFT Dialog Box will be displayed.

3. Click the **Servo ON** Button.



Stimulus signal: Frequency
Instruction amplitude: 15 [%] (1 - 300)
Rotation direction: Forward

4. Select the instruction (reference) amplitude and the rotation direction in the **Measurement condition** Area, and then click the **Start** Button.
   The motor shaft will rotate and measurements will start.



Servo ON

Stimulus signal: Frequency

Instruction amplitude: 50 [%] (1 - 300)

Rotation direction: Forward

Analyzing frequency....

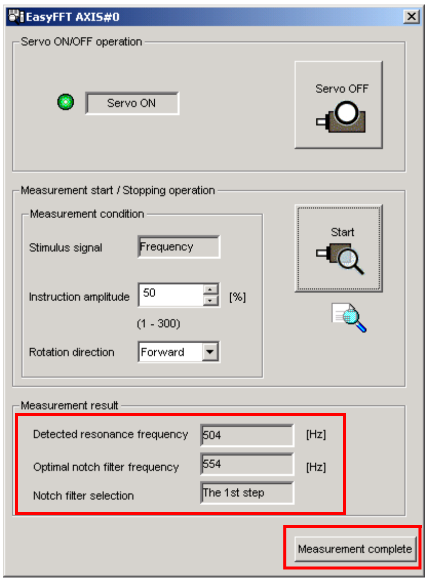
Detected resonance frequency: [Hz]

Optimal notch filter frequency: [Hz]

Notch filter selection:

   When measurements have been completed, the measurement results will be displayed.

5. Check the results in the **Measurement result** Area and then click the **Measurement complete** Button.



Servo ON

Stimulus signal: Frequency

Instruction amplitude: 50 [%] (1 - 300)

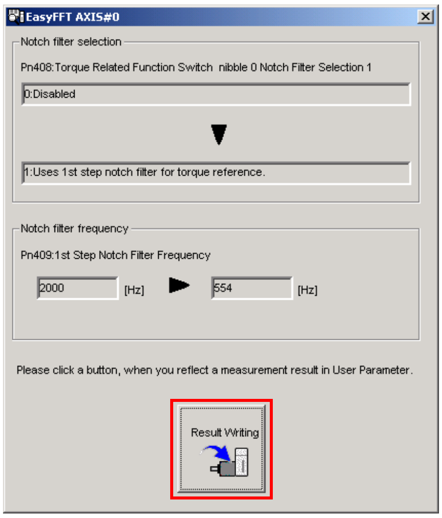
Rotation direction: Forward

Detected resonance frequency: 504 [Hz]

Optimal notch filter frequency: 554 [Hz]

Notch filter selection: The 1st step

6. Click the **Result Writing** Button if you want to set the measurement results in the parameters.



Notch filter selection

Pn408:Torque Related Function Switch nibble 0 Notch Filter Selection 1

0:Disabled

1:Uses 1st step notch filter for torque reference.

Notch filter frequency

Pn409:1st Step Notch Filter Frequency

2000 [Hz] 554 [Hz]

Please click a button, when you reflect a measurement result in User Parameter.

This concludes the procedure.

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 (2408 hex)	Torque-Related Function Selections	Yes
Pn409 (2409 hex)	First Stage Notch Filter Frequency	Yes
Pn40A (240A hex)	First Stage Notch Filter Q Value	No
Pn40C (240C hex)	Second Stage Notch Filter Frequency	Yes
Pn40D (240D hex)	Second Stage Notch Filter Q Value	No
Pn456 (2456 hex)	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.

Monitoring

9

This chapter provides information on monitoring SERVOPACK product information and SERVOPACK status.

9.1 Monitoring Product Information

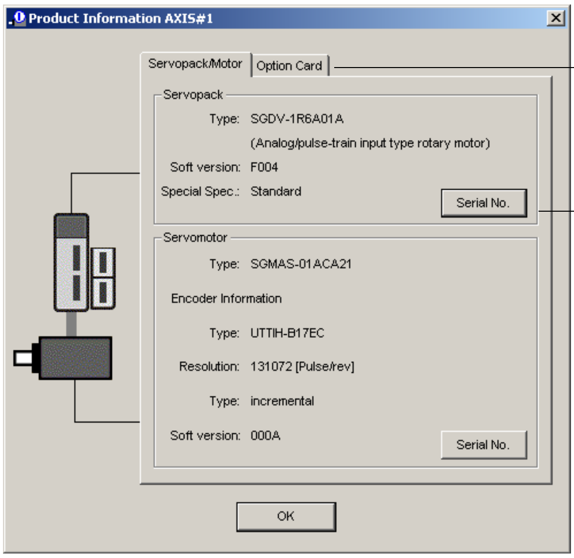
9.1.1 Items That You Can Monitor

Monitor Items	
Information on SERVOPACKs	• SERVOPACK model • SERVOPACK software version • SERVOPACK special specifications • SERVOPACK serial number • SERVOPACK manufacturing date
Information on Servomotors	• Servomotor model • Servomotor serial number • Servomotor manufacturing date
Information on Encoders	• Encoder model • Rotary encoder resolution and linear encoder pitch resolution • Encoder type • Encoder software version • Encoder serial number • Encoder manufacturing date
Information on Option Modules	• Option Module model • Option Module software version • Option Module special specifications • Option Module serial number • Option Module manufacturing date

9.1.2 Operating Procedures

Use the following procedure to display the product information monitor dialog box.

- Select ***Monitor - Read Product Information*** from the menu bar of the Main Window of the SigmaWin+.



Servopack
Type: SGDV-1R6A01A
(Analog/pulse-train input type rotary motor)
Soft version: F004
Special Spec.: Standard

Servomotor
Type: SGMAS-01ACA21
Encoder Information
Type: UTTIH-B17EC
Resolution: 131072 [Pulse/rev]
Type: incremental
Soft version: 000A

Change the tab page as necessary.

Click the **Serial No.** Buttons to display the serial numbers and manufacturing dates of the Servomotor and SERVOPACK.

Information

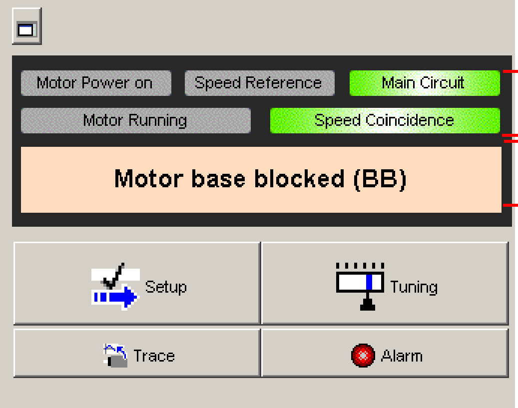
- With the Digital Operator, you can use Fn011, Fn012, and Fn01E to monitor this information.
  Refer to the following manual for the differences in the monitor items compared with the SigmaWin+.
  📖 Σ-7-Series Digital Operator Operating Manual (Manual No.: SIEP S800001 33)

9.2 Monitoring SERVOPACK Status

9.2.1 System Monitor

Use one of the following methods to display the System Monitor Window.

- Start the SigmaWin+. The System Monitor Window will be automatically displayed.
- Select ***Monitor - Monitor - System Monitor*** from the menu bar of the Main Window of the SigmaWin+.



☑ Displays the System Monitor window at SigmaWin+startup

The current signal status of the SERVOPACK is displayed. (This information is the same as the information that is displayed for the bit data on the panel display on the front of the SERVOPACK and the information that is displayed on the Digital Operator display.)

The current status of the SERVOPACK is displayed. (The information that is displayed is the same as the information that is displayed on the panel display on the front of the SERVOPACK.)

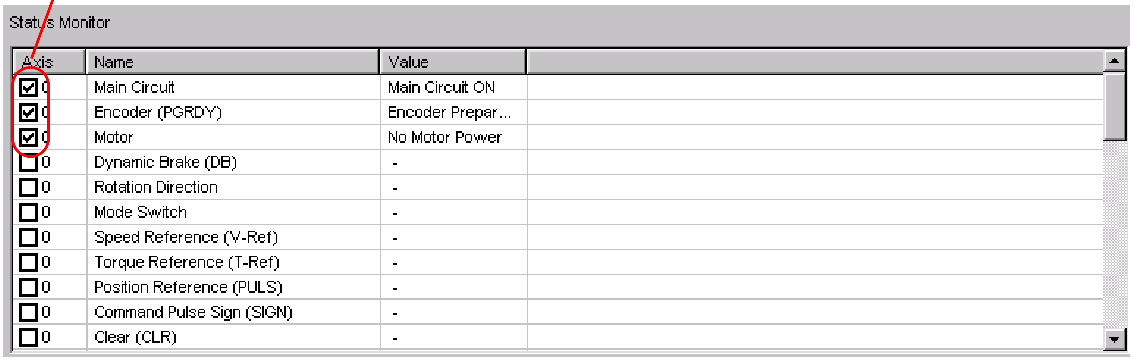
If this check box is selected, this window will be displayed automatically when the SigmaWin+ starts.

9.2.2 Monitoring Status and Operations

Use the following method to display the SERVOPACK's Status Monitor Window or Motion Monitor Window.

- Select ***Monitor - Monitor - Status Monitor*** or ***Monitor - Monitor - Motion Monitor*** from the menu bar of the Main Window of the SigmaWin+.

If these check boxes are selected, the current values are displayed in the *Value* column.



Status Monitor

Axis	Name	Value
☑ 0	Main Circuit	Main Circuit ON
☑ 0	Encoder (PGRDY)	Encoder Prepar...
☑ 0	Motor	No Motor Power
☐ 0	Dynamic Brake (DB)	-
☐ 0	Rotation Direction	-
☐ 0	Mode Switch	-
☐ 0	Speed Reference (V-Ref)	-
☐ 0	Torque Reference (T-Ref)	-
☐ 0	Position Reference (PULS)	-
☐ 0	Command Pulse Sign (SIGN)	-
☐ 0	Clear (CLR)	-

Monitor Items

The items that you can monitor on the Status Monitor Window and Motion Monitor Window are listed below.

- Status Monitor Window

Monitor Items					
Internal Status	• Polarity Sensor Signal Monitor • Active Gain Monitor • Main Circuit • Encoder (PGRDY) • Motor Power (Request) • Motor Power ON • Dynamic Brake (DB) • Rotation (Movement) Direction • Mode Switch • Speed Reference (V-Ref) • Torque Reference (T-Ref) • Position Reference (PULS) • CLR (Position Deviation Clear Input Signal) • Position Reference Direction • Surge Current Limiting Resistor Short Relay • Regenerative Transistor • Regenerative Error Detection • AC Power ON • Overcurrent • Origin Not Passed • Moment of Inertia Identification • Polarity Detection in Progress • Completion of Polarity Detection • Ripple Compensation in Progress	Input Signal Status	• /S-ON (Servo ON Input Signal) • /P-CON (Proportional Control Input Signal) • P-OT (Forward Drive Prohibit Input Signal) • N-OT (Reverse Drive Prohibit Input Signal) • /P-CL (Forward External Torque Limit Signal) • /N-CL (Reverse External Torque Limit Signal) • /ALM-RST (Alarm Reset Input Signal) • SEN (Absolute Data Request Input Signal) • /SPD-D (Motor Direction Input) Signal • /SPD-A (Internal Set Speed Selection Input Signal) • /SPD-B (Internal Set Speed Selection Input Signal) • /C-SEL (Control Selection Input Signal) • /ZCLAMP (Zero Clamping Input Signal) • /INHIBIT (Reference Pulse Inhibit Input Signal) • /G-SEL (Gain Selection Input Signal) • /P-DET (Polarity Detection Input Signal) • /DEC (Origin Return Deceleration Switch Input Signal) • /EXT1 (External Latch Input 1 Signal) • /EXT2 (External Latch Input 2 Signal) • /EXT3 (External Latch Input 3 Signal) • FSTP (Forced Stop Input Signal)	Output Signal Status	• ALM (Servo Alarm Output Signal) • /COIN (Positioning Completion Output Signal) • /V-CMP (Speed Coincidence Detection Output Signal) • /TGON (Rotation Detection Output Signal) • /S-RDY (Servo Ready Output Signal) • /CLT (Torque Limit Detection Output Signal) • /VLT (Speed Limit Detection Output Signal) • /BK (Brake Output Signal) • /WARN (Warning Output Signal) • /NEAR (Near Output Signal) • PAO (Encoder Divided Pulse Output Phase A Signal) • PBO (Encoder Divided Pulse Output Phase B Signal) • PCO (Encoder Divided Pulse Output Phase C Signal) • /PM (Preventative Maintenance Output Signal)

- Motion Monitor Window

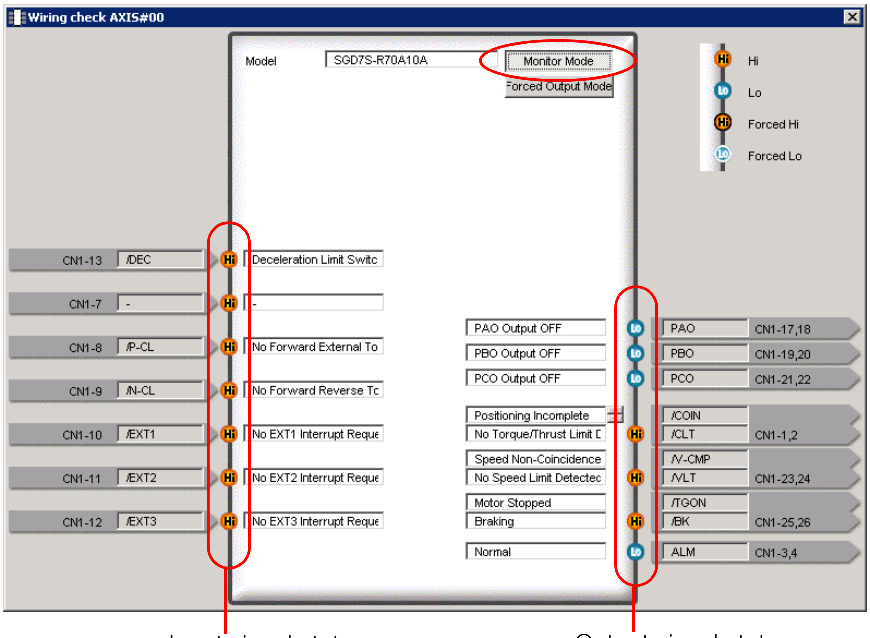
Monitor Items	
• Current Alarm State • Motor Speed • Speed Reference • Internal Torque Reference • Angle of Rotation 1 (number of encoder pulses from origin within one encoder rotation) • Angle of Rotation 2 (angle from origin within one encoder rotation) • Input Reference Pulse Speed • Deviation Counter (Position Deviation) • Cumulative Load • Regenerative Load • DB Resistor Consumption Power • Absolute Encoder Multiturn Data • Absolute Encoder Position within One Rotation • Lower Bits of Absolute Encoder Position • Upper Bits of Absolute Encoder Position • Reference Pulse Counter	• Feedback Pulse Counter • Fully Closed Feedback Pulse Counter • Total Operating Time • Current Backlash Compensation Value • Backlash Compensation Value Setting Limit • Position Amplifier Deviation • Feedback Position (APOS) • Current Reference Position (CPOS) • Position Deviation (PERR) • Target Position (TPOS) • Latched Position 1 (LPOS1) • Latched Position 2 (LPOS2) • Latched Position 3 (LPOS3) • Target Speed (TSPD) • Feedback Speed (FSPD) • Current Position Command Speed (CSPD) • Torque Limit (TRQ_LIM) • Speed Limit (SPD_LIM)

9.2.3 I/O Signal Monitor

Use the following procedure to check I/O signals.

1. Select ***Monitor - Check Wiring*** from the menu bar of the Main Window of the SigmaWin+.

2. Click the **Monitor Mode** Button.



Input signal status

Output signal status

Information

You can also use the above window to check wiring.

- Checking Input Signal Wiring
  Change the signal status at the host controller. If the input signal status on the window changes accordingly, then the wiring is correct.
- Checking Output Signal Wiring
  Click the **Force Output Mode** Button. This will force the output signal status to change. If the signal status at the host controller changes accordingly, then the wiring is correct.
  You cannot use the **Force Output Mode** Button while the servo is ON.

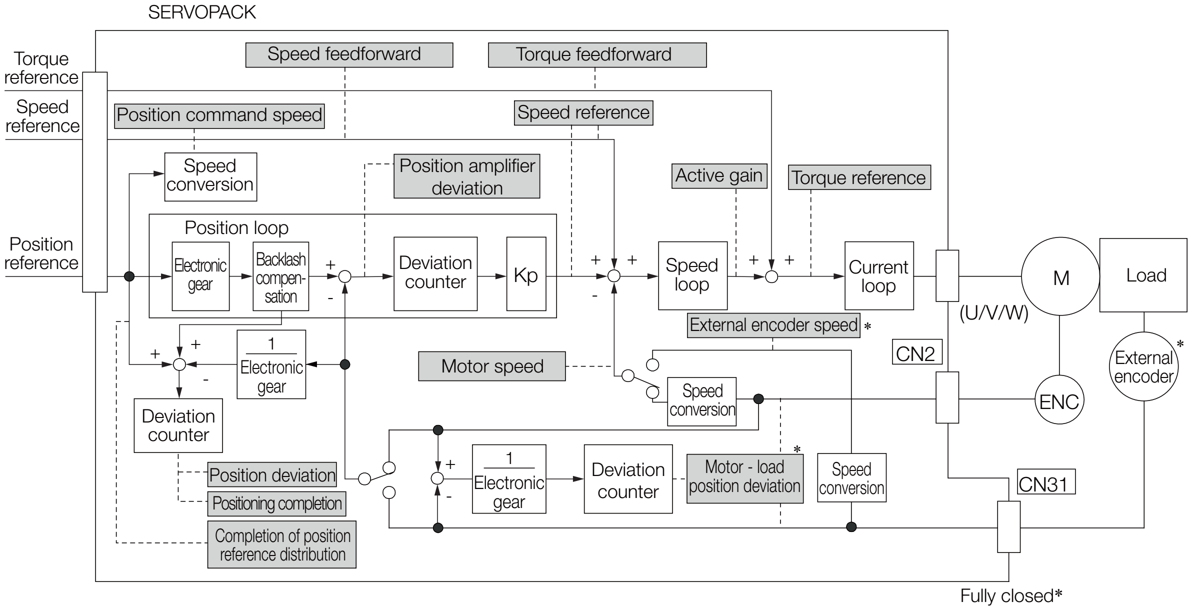
9.3 Monitoring Machine Operation Status and Signal Waveforms

To monitor waveforms, use the SigmaWin+ trace function or a measuring instrument, such as a memory recorder.

9.3.1 Items That You Can Monitor

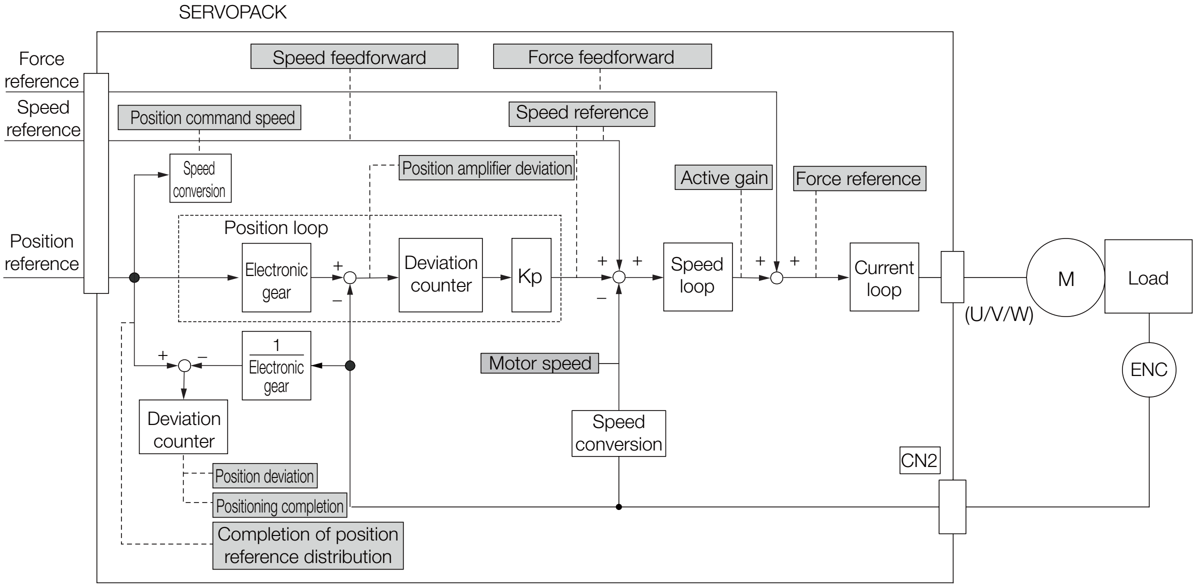
You can use the SigmaWin+ or a measuring instrument to monitor the shaded items in the following block diagram.

- Rotary Servomotors



* This speed is available when fully-closed loop control is being used.

- Linear Servomotors



9.3.2 Using the SigmaWin+

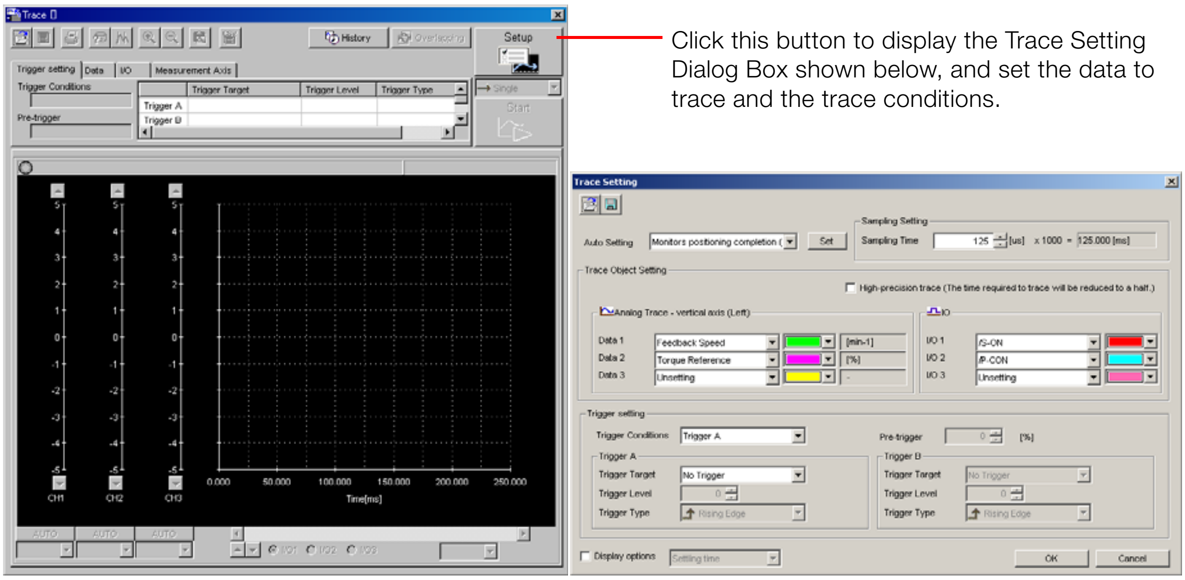
This section describes how to trace data and I/O with the SigmaWin+.

Refer to the following manual for detailed operating procedures for the SigmaWin+.

📖 AC Servo Drives Engineering Tool SigmaWin+ Online Manual Σ-7 Component (Manual No.: SIEP S800001 48)

Operating Procedure

Select ***Trace - Trace*** from the menu bar of the Main Window of the SigmaWin+.



Trace Setting

Sampling Setting: Auto Setting: Monitors positioning completion (| Set | Sampling Time 125 [us] x 1000 = 125.000 [ms]

Trace Object Setting: ☐ High-precision trace (The time required to trace will be reduced to a half.)

Analog Trace - vertical axis (Left)
Data 1: Feedback Speed [min-1]
Data 2: Torque Reference [%]
Data 3: Unsetting

I/O
I/O 1: /S-ON
I/O 2: /P-CON
I/O 3: Unsetting

Trigger setting: Trigger Conditions: Trigger A | Pre-trigger: 0 [%]

Trigger A: Trigger Target: No Trigger | Trigger Level: 0 | Trigger Type: Rising Edge

Trigger B: Trigger Target: No Trigger | Trigger Level: 0 | Trigger Type: Rising Edge

☐ Display options: Setting time | OK | Cancel

Click this button to display the Trace Setting Dialog Box shown below, and set the data to trace and the trace conditions.

Trace Objects

You can trace the following items.

- Data Tracing

Trace Objects	
• Torque Reference • Feedback Speed • Reference Speed • Position Reference Speed • Position Error (Deviation) • Position Amplifier Error (Deviation)	• Motor - Load Position Deviation • Speed Feedforward • Torque Feedforward • Effective (Active) Gain • Main Circuit DC Voltage

- I/O Tracing

Trace Objects			
Input Signals	• /S-ON (Servo ON Input Signal) • /P-CON (Proportional Control Input Signal) • P-OT (Forward Drive Prohibit Input Signal) • N-OT (Reverse Drive Prohibit Input Signal) • /ALM-RST (Alarm Reset Input Signal) • /P-CL (Forward External Torque/Force Limit Input Signal) • /N-CL (Reverse External Torque/Force Limit Input Signal) • /G-SEL (Gain Selection Input Signal) • /P-DET (Polarity Detection Input Signal) • /DEC (Origin Return Deceleration Switch Input Signal) • /EXT1 (External Latch Input 1 Signal) • /EXT2 (External Latch Input 2 Signal) • /EXT3 (External Latch Input 3 Signal) • FSTP (Forced Stop Input Signal) • /HWBB1 (Hard Wire Base Block Input 1 Signal) • /HWBB2 (Hard Wire Base Block Input 2 Signal)	Output Signals	• ALM (Servo Alarm Output Signal) • /COIN (Positioning Completion Output Signal) • /V-CMP (Speed Coincidence Detection Output Signal) • /TGON (Rotation Detection Output Signal) • /S-RDY (Servo Ready Output Signal) • /CLT (Torque Limit Detection Output Signal) • /VLT (Speed Limit Detection Output Signal) • /BK (Brake Output Signal) • /WARN (Warning Output Signal) • /NEAR (Near Output Signal) • ALO1 (Alarm Code Output Signal) • ALO2 (Alarm Code Output Signal) • ALO3 (Alarm Code Output Signal) • PAO (Encoder Divided Pulse Output Phase A Signal) • PBO (Encoder Divided Pulse Output Phase B Signal) • PCO (Encoder Divided Pulse Output Phase C Signal)
		Internal Status	• ACON (Main Circuit ON Signal) • PDETCMP (Polarity Detection Completed Signal) • DEN (Position Reference Distribution Completed Signal)

9.3.3 Using a Measuring Instrument

Connect a measuring instrument, such as a memory recorder, to the analog monitor connector (CN5) on the SERVOPACK to monitor analog signal waveforms. The measuring instrument is not provided by Yaskawa.

Refer to the following section for details on the connection.

☞ *4.8.3 Analog Monitor Connector (CN5)* on page 4-41

Setting the Monitor Object

Use Pn006 = n.□□XX and Pn007 = n.□□XX (Analog Monitor 1 and 2 Signal Selections) to set the items to monitor.

Line Color	Signal	Parameter Setting
White	Analog monitor 1	Pn006 (2006 hex) = n.□□XX
Red	Analog monitor 2	Pn007 (2007 hex) = n.□□XX
Black (2 lines)	GND	–

Parameter		Description		
		Monitor Signal	Output Unit	Remarks
Pn006 (2006 hex) or Pn007 (2007 hex)	n.□□00 (default setting of Pn007 (2007 hex))	Motor Speed	• Rotary Servomotor: 1 V/1,000 min^{-1} • Linear Servomotor: 1 V/1,000 mm/s	–
	n.□□01	Speed Reference	• Rotary Servomotor:1 V/1,000 min^{-1} • Linear Servomotor:1 V/1,000 mm/s	–
	n.□□02 (default setting of Pn006 (2006 hex))	Torque Reference	1 V/100% rated torque	–
	n.□□03	Position Deviation	0.05 V/Reference unit	0 V for speed or torque control
	n.□□04	Position Amplifier Deviation	0.05 V/encoder pulse unit	Position deviation after electronic gear conversion
	n.□□05	Position Command Speed	• Rotary Servomotor:1 V/1,000 min^{-1} • Linear Servomotor:1 V/1,000 mm/s	–
	n.□□06	Reserved parameter (Do not change.)	–	–
	n.□□07	Motor - Load Position Deviation	0.01 V/Reference unit	–
	n.□□08	Positioning Completion	Positioning completed: 5 V Positioning not completed: 0 V	Completion is indicated by the output voltage.
	n.□□09	Speed Feedforward	• Rotary Servomotor:1 V/1,000 min^{-1} • Linear Servomotor:1 V/1,000 mm/s	–
	n.□□0A	Torque Feedforward	1 V/100% rated torque	–
	n.□□0B	Active Gain*	1st gain: 1 V 2nd gain: 2 V	The gain that is active is indicated by the output voltage.
	n.□□0C	Completion of Position Reference Distribution	Distribution completed: 5 V Distribution not completed: 0 V	Completion is indicated by the output voltage.
	n.□□0D	External Encoder Speed	1 V/1,000 min^{-1}	Value calculated at the motor shaft

* Refer to the following section for details.

☞ *8.12.1 Gain Switching* on page 8-65

Changing the Monitor Factor and Offset

You can change the monitor factors and offsets for the output voltages for analog monitor 1 and analog monitor 2. The relationships to the output voltages are as follows:

$$\begin{array}{c}\text{Analog monitor 1}\\\text{output voltage}\end{array} = (-1) \times \left\{ \begin{array}{c}\text{Analog Monitor 1 Signal}\\\text{Selection (Pn006 = n.□□XX)}\end{array} \times \begin{array}{c}\text{Analog Monitor 1}\\\text{Magnification (Pn552)}\end{array} + \begin{array}{c}\text{Analog Monitor 1}\\\text{Offset Voltage (Pn550)}\end{array} \right\}$$

$$\begin{array}{c}\text{Analog monitor 2}\\\text{output voltage}\end{array} = (-1) \times \left\{ \begin{array}{c}\text{Analog Monitor 2 Signal}\\\text{Selection (Pn007 = n.□□XX)}\end{array} \times \begin{array}{c}\text{Analog Monitor 2}\\\text{Magnification (Pn553)}\end{array} + \begin{array}{c}\text{Analog Monitor 2}\\\text{Offset Voltage (Pn551)}\end{array} \right\}$$

The following parameters are set.

Pn550 (2550 hex)	Analog Monitor 1 Offset Voltage				Speed Position Torque
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	-10,000 to 10,000	0.1 V	0	Immediately	Setup

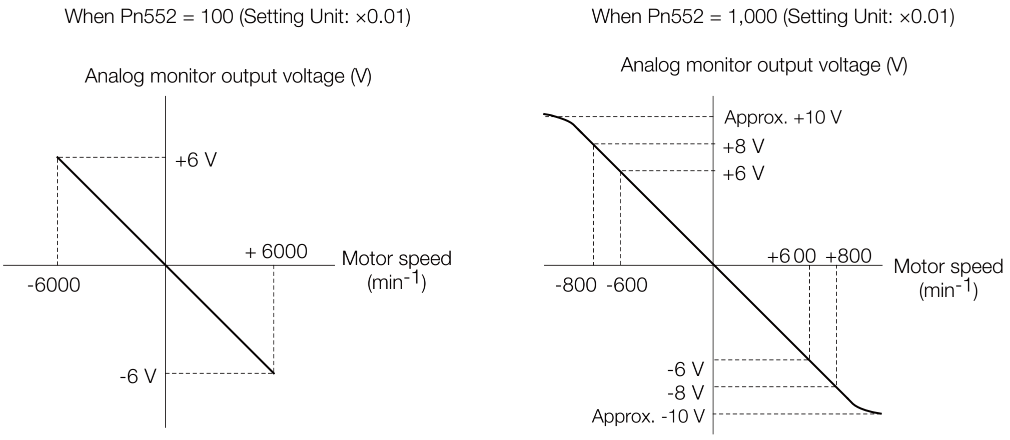
Pn551 (2551 hex)	Analog Monitor 2 Offset Voltage				Speed Position Torque
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	-10,000 to 10,000	0.1 V	0	Immediately	Setup

Pn552 (2552 hex)	Analog Monitor 1 Magnification				Speed Position Torque
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	-10,000 to 10,000	×0.01	100	Immediately	Setup

Pn553 (2553 hex)	Analog Monitor 2 Magnification				Speed Position Torque
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	-10,000 to 10,000	×0.01	100	Immediately	Setup

Example

- Example for Setting the Item to Monitor to the Motor Speed (Pn006 = n.□□00)


When Pn552 = 100 (Setting Unit: ×0.01)

When Pn552 = 1,000 (Setting Unit: ×0.01)

Note: The effective linearity range is ±8 V.
The resolution is 16 bits.

Adjusting the Analog Monitor Output

You can manually adjust the offset and gain for the analog monitor outputs for the torque reference monitor and motor speed monitor.

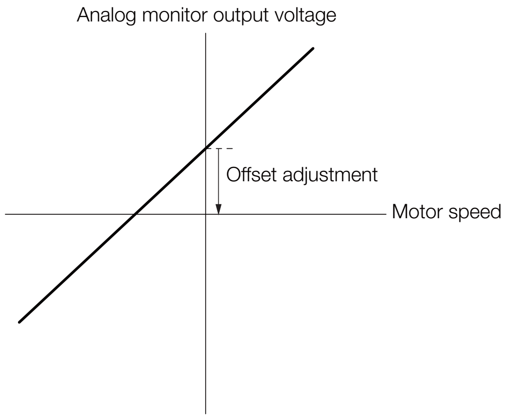
The offset is adjusted to compensate for offset in the zero point caused by output voltage drift or noise in the monitoring system.

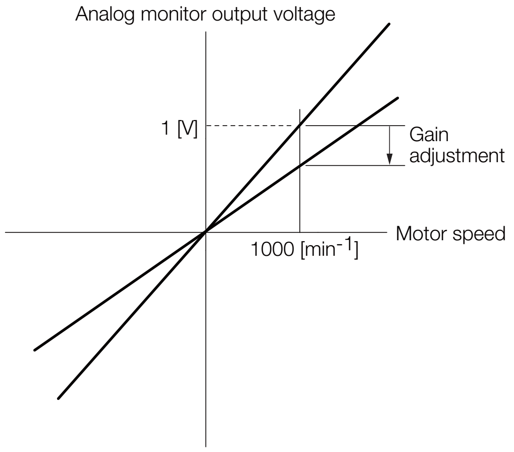
The gain is adjusted to match the sensitivity of the measuring system.

The offset and gain are adjusted at the factory. You normally do not need to adjust them.

◆ Adjustment Example

An example of adjusting the output of the motor speed monitor is provided below.

<table>
<tr><th>Offset Adjustment</th><th>Gain Adjustment</th></tr>
<tr>
<td>


<table>
<tr><th>Item</th><th>Specification</th></tr>
<tr><td>Offset Adjustment Range</td><td>-2.4 V to 2.4 V</td></tr>
<tr><td>Adjustment Unit</td><td>18.9 mV/LSB</td></tr>
</table>
</td>
<td>


<table>
<tr><th>Item</th><th>Specification</th></tr>
<tr><td>Gain Adjustment Range</td><td>100 ±50%</td></tr>
<tr><td>Adjustment Unit</td><td>0.4%/LSB</td></tr>
</table>
The gain adjustment range is made using a 100% output value (gain adjustment of 0) as the reference value with an adjustment range of 50% to 150%.
A setting example is given below.
• Setting the Adjustment Value to -125
100 + (-125 × 0.4) = 50 [%]
Therefore, the monitor output voltage goes to 50% of the original value.
• Setting the Adjustment Value to 125
100 + (125 × 0.4) = 150 [%]
Therefore, the monitor output voltage goes to 150% of the original value.
</td>
</tr>
</table>

Information
- The adjustment values do not use parameters, so they will not change even if the parameter settings are initialized.
- Adjust the offset with the measuring instrument connected so that the analog monitor output value goes to zero. The following setting example achieves a zero output.
  - While power is not supplied to the Servomotor, set the monitor signal to the torque reference.
  - In speed control, set the monitor signal to the position deviation.

◆ Preparations

Confirm the following condition before you adjust the analog monitor output.

- The parameters must not be write prohibited.

◆ Applicable Tools

You can use the following tools to adjust analog monitor outputs. The function that is used is given for each tool.

- Offset Adjustment

Tool	Function	Operating Procedure Reference
Digital Operator	Fn00C	📖 Σ-7-Series Digital Operator Operating Manual (Manual No.: SIEP S800001 33)
SigmaWin+	*Setup - Adjust Offset*	☞ ◆ *Operating Procedure* on page 9-12

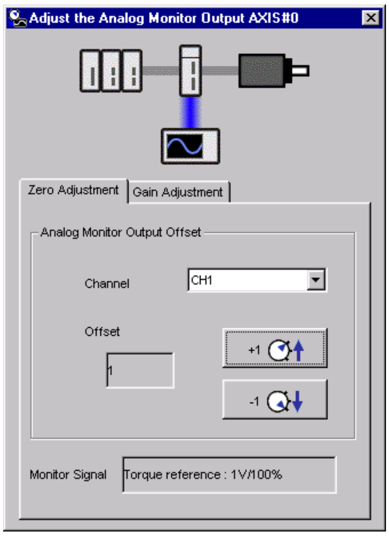
- Gain Adjustment

Tool	Function	Operating Procedure Reference
Digital Operator	Fn00D	📖 Σ-7-Series Digital Operator Operating Manual (Manual No.: SIEP S800001 33)
SigmaWin+	***Setup - Adjust Offset***	☞ ◆ *Operating Procedure* on page 9-12

◆ Operating Procedure

Use the following procedure.

1. Select ***Setup - Adjust Offset*** from the menu bar of the Main Window of the SigmaWin+.
   The Adjust the Analog Monitor Output Dialog Box will be displayed.



Adjust the Analog Monitor Output AXIS#0

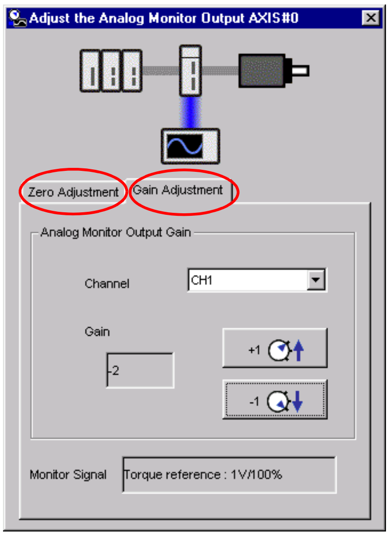
Analog Monitor Output Offset

Channel: CH1

Offset: 1

Monitor Signal: Torque reference : 1V/100%

2. Click the **Zero Adjustment** or **Gain Adjustment** Tab.



Adjust the Analog Monitor Output AXIS#0

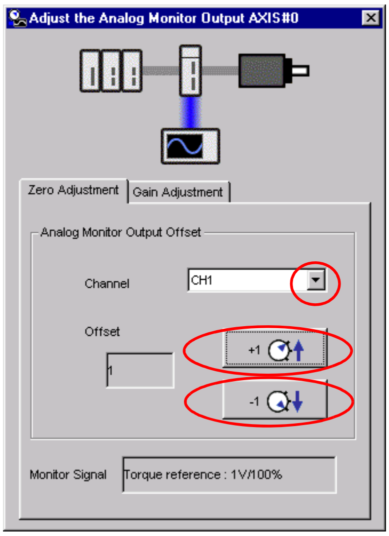
Analog Monitor Output Gain

Channel: CH1

Gain: -2

Monitor Signal: Torque reference : 1V/100%

3. While watching the analog monitor, use the **+1** and **-1** Buttons to adjust the offset.
There are two channels: CH1 and CH2. If necessary, click the down arrow on the **Channel** Box and select the channel.



Channel CH1

Offset 1

Monitor Signal Torque reference : 1V/100%

This concludes adjusting the analog monitor output.

9.4 Monitoring Product Life

9.4.1 Items That You Can Monitor

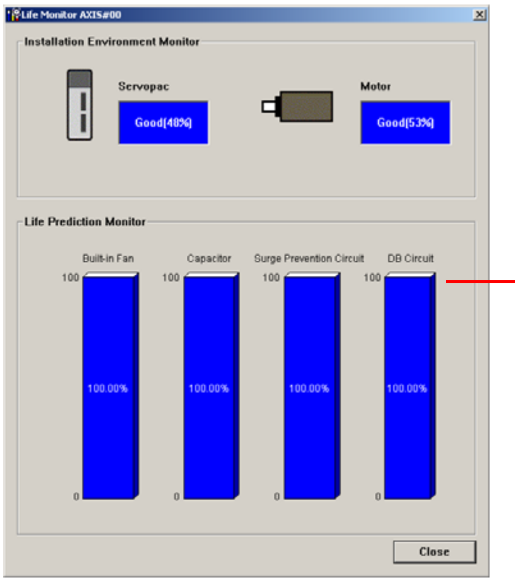
Monitor Items
• SERVOPACK Installation Environment • Servomotor Installation Environment • Built-in Fan Service Life Prediction • Capacitor Service Life Prediction • Surge Prevention Circuit Service Life Prediction • Dynamic Brake Circuit Service Life Prediction

9.4.2 Operating Procedure

Use the following procedure to display the installation environment and service life prediction monitor dialog boxes.

- Select ***Life Monitor* – *Installation Environment Monitor*** or ***Life Monitor* – *Service Life Prediction Monitor*** from the menu bar of the Main Window of the SigmaWin+.

Information With the Digital Operator, you can use Un025 to Un02A to monitor this information.



A value of 100% indicates that the SERVOPACK has not yet been used. The percentage decreases as the SERVOPACK is used and reaches 0% when it is time to replace the SERVOPACK.

9.4.3 Preventative Maintenance

You can use the following functions for preventative maintenance.

- Preventative maintenance warnings
- /PM (Preventative Maintenance Output) signal

The SERVOPACK can notify the host controller when it is time to replace any of the main parts.

Preventative Maintenance Warning

An A.9b0 warning (Preventative Maintenance Warning) is detected when any of the following service life prediction values drops to 10% or less: SERVOPACK built-in fan life, capacitor life, inrush current limiting circuit life, and dynamic brake circuit life. You can change the setting of Pn00F = n.□□□X to enable or disable these warnings.

Parameter		Description	When Enabled	Classification
Pn00F (200F hex)	n.□□□0 (default setting)	Do not detect preventative maintenance warnings.	After restart	Setup
	n.□□□1	Detect preventative maintenance warnings.		

/PM (Preventative Maintenance Output) Signal

The /PM (Preventative Maintenance Output) signal is output when any of the following service life prediction values reaches 10% or less: SERVOPACK built-in fan life, capacitor life, inrush current limiting circuit life, and dynamic brake circuit life. The /PM (Preventative Maintenance Output) signal must be allocated.

Even if detection of preventive maintenance warnings is disabled (Pn00F = n.□□□0), the /PM signal will still be output as long as it is allocated.

Classification	Signal	Connector Pin No.	Signal Status	Description
Output	/PM	Must be allocated.	ON (closed)	One of the following service life prediction values reached 10% or less: SERVOPACK built-in fan life, capacitor life, inrush current limiting circuit life, and dynamic brake circuit life.
			OFF (open)	All of the following service life prediction values are greater than 10%: SERVOPACK built-in fan life, capacitor life, inrush current limiting circuit life, and dynamic brake circuit life.

Note: You must allocate the /PM signal to use it. Use Pn514 = n.□□□X (/PM (Preventative Maintenance Output) Signal Allocation) to allocate the signal to connector pins. Refer to the following section for details.
☞ *6.1.2 Output Signal Allocations* on page 6-4

Fully-Closed Loop Control

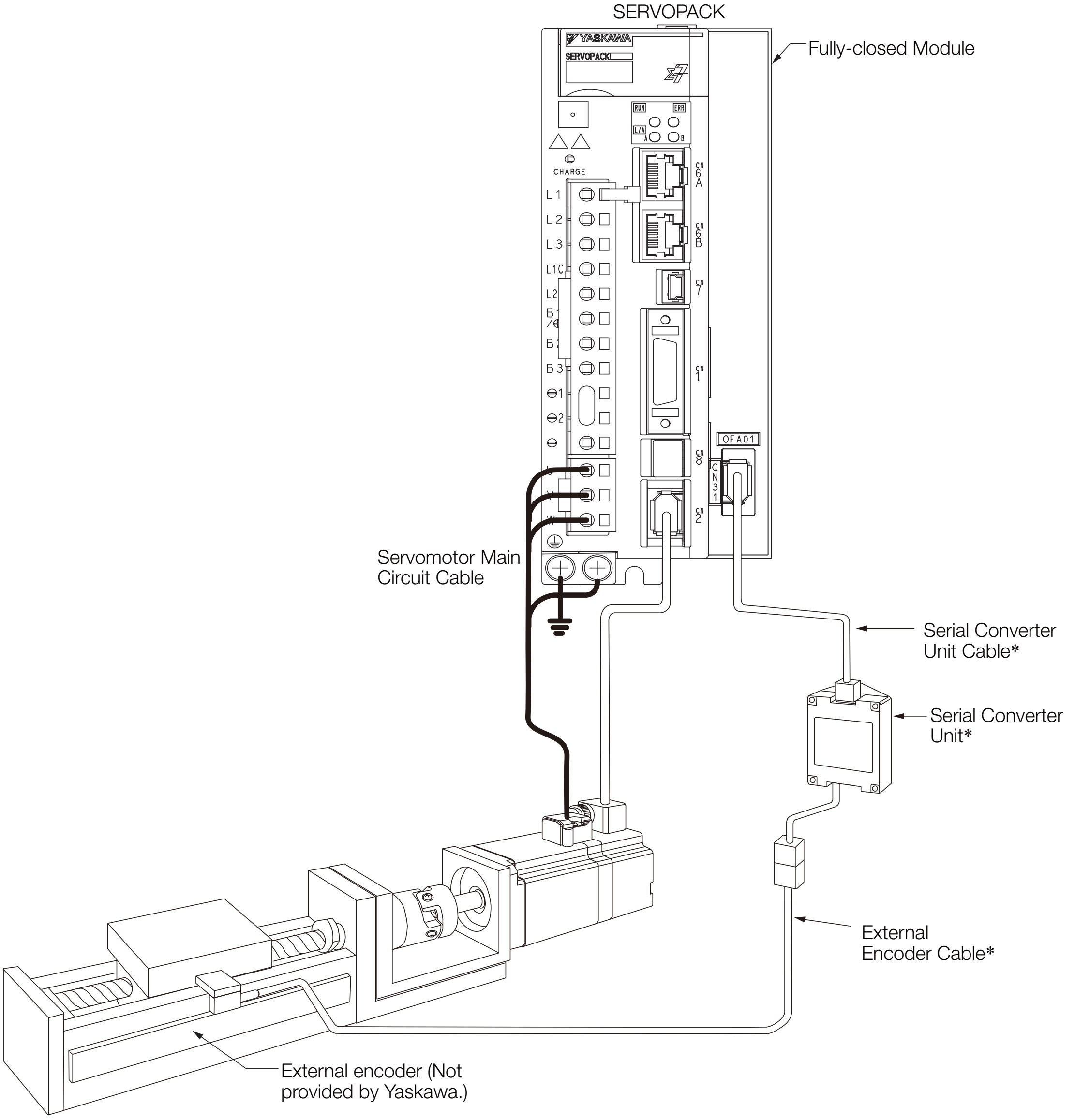
10

This chapter provides detailed information on performing fully-closed loop control with the SERVOPACK.

10.1 Fully-Closed System

With a fully-closed system, an externally installed encoder is used to detect the position of the controlled machine and the machine's position information is fed back to the SERVOPACK. High-precision positioning is possible because the actual machine position is fed back directly. With a fully-closed system, looseness or twisting of mechanical parts may cause vibration or oscillation, resulting in unstable positioning.

The following figure shows an example of the system configuration.



* The connected devices and cables depend on the type of external linear encoder that is used.

Note: Refer to the following section for details on connections that are not shown above, such as connections to power supplies and peripheral devices.

☞ *2.4 Examples of Standard Connections between SERVOPACKs and Peripheral Devices* on page 2-21

10.2 SERVOPACK Commissioning Procedure

First, confirm that the SERVOPACK operates correctly with semi-closed loop control, and then confirm that it operates correctly with fully-closed loop control.
The commissioning procedure for the SERVOPACK for fully-closed loop control is given below.

Step	Description	Operation	Required Parameter and Object Settings	Controlling Device
1	Check operation of the entire sequence with semi-closed loop control and without a load. Items to Check • Power supply circuit wiring • Servomotor wiring • Encoder wiring • Wiring of I/O signal lines from the host controller • Servomotor rotation direction, motor speed, and multiturn data • Operation of safety mechanisms, such as the brakes and the overtravel mechanisms	Set the parameters so that the SERVOPACK operates correctly in semi-closed loop control without a load and check the following points. Set Pn002 to n.0□□□ to specify semi-closed loop control. • Are there any errors in the SERVOPACK? • Does jogging function correctly when you operate the SERVOPACK without a load? • Do the I/O signals turn ON and OFF correctly? • Is power supplied to the Servomotor when the Servo ON command (Enable Operation command) is sent from the host controller? • Does the Servomotor operate correctly when a position reference is input by the host controller?	• Pn000 (Basic Function Select Switch 0) • Pn001 (Basic Function Select Switch 1) • Pn002 = n.X□□□ (External Encoder Usage) • Position reference unit (*position user unit* (2701 hex)) • Pn50A, Pn50B, Pn511, and Pn516 (Input Signal Selections) • Pn50E, Pn50F, Pn510, and Pn514 (Output Signal Selections)	SERVOPACK or host controller
2	Check operation with the Servomotor connected to the machine with semi-closed loop control. Items to Check • Initial response of the system connected to the machine • Movement direction, travel distance, and movement speed as specified by the references from the host controller	Connect the Servomotor to the machine. Set the moment of inertia ratio in Pn103 using autotuning without a host reference. Check that the machine's movement direction, travel distance, and movement speed agree with the references from the host controller.	• Pn103 (Moment of Inertia Ratio)	Host controller
3	Check the external encoder. Items to Check • Is the signal from the external encoder received correctly?	Set the parameters related to fully-closed loop control and move the machine with your hand without turning ON the power supply to the Servomotor. Check the following status with the Digital Operator or SigmaWin+. • Does the fully-closed feedback pulse counter count up when the Servomotor moves in the forward direction? • Is the travel distance of the machine visually about the same as the amount counted by the fully-closed feedback pulse counter? Note: The unit for the fully-closed feedback pulse counter is pulses, which is equivalent to the external encoder sine wave pitch.	• Pn002 = n.X□□□ (External Encoder Usage) • Pn20A (Number of External Scale Pitches) • Position reference unit (*position user unit* (2701 hex)) • Pn281 (Encoder Output Resolution) • Pn51B (Excessive Error Level between Servomotor and Load Positions) • Pn522 (Positioning Completed Width) • Pn52A (Multiplier per One Fully-closed Rotation)	–

Continued from previous page.

Step	Description	Operation	Required Parameter and Object Settings	Controlling Device
4	Perform a program jogging operation. Items to Check Does the fully-closed system operate correctly for the SERVOPACK without a load?	Perform a program jogging operation and confirm that the travel distance is the same as the reference value in Pn531. When you perform program jogging, start from a low speed and gradually increase the speed.	• Pn530 to Pn536 (program jogging-related parameters)	SERVOPACK
5	Operate the SERVOPACK. Items to Check Does the fully-closed system operate correctly, including the host controller?	Input a position reference and confirm that the SERVOPACK operates correctly. Start from a low speed and gradually increase the speed.	–	Host controller

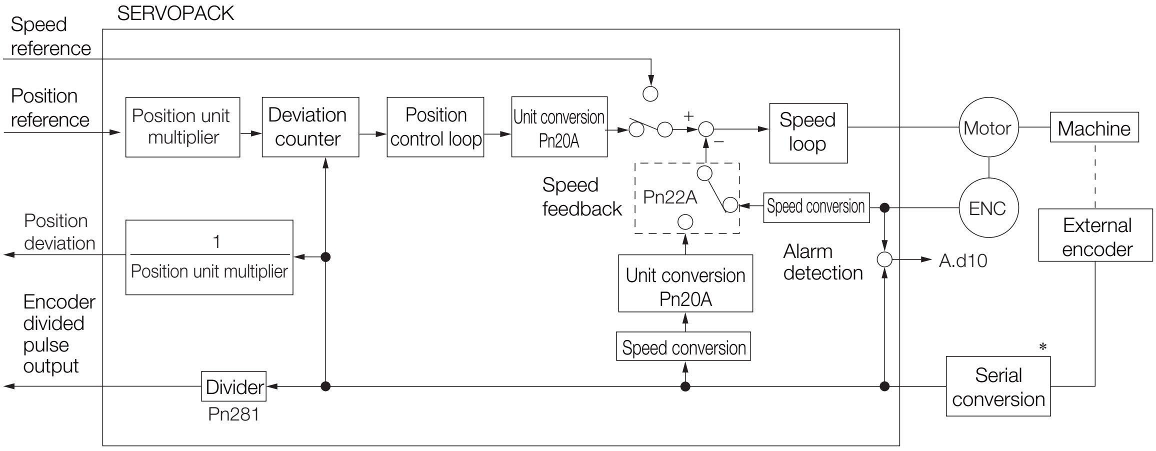
10.3 Parameter and Object Settings for Fully-closed Loop Control

This section describes the parameter settings that are related to fully-closed loop control.

Parameter and Object to Set	Setting	Position Control	Speed Control	Torque Control	Reference
Pn000 (2000 hex) = n.□□□X	Motor direction	√	√	√	page 10-6
Pn002 (2002 hex) = n.X□□□	External encoder usage method	√	√	√	
Pn20A (220A hex)	Number of external scale pitches	√	√	√	page 10-7
Pn281 (2281 hex)	Encoder divided pulse output signals (PAO, PBO, and PCO) from the SERVOPACK	√	√	√	page 10-7
–	External absolute encoder data reception sequence	√	√	√	page 6-41
Position User Unit (2701 hex)	Electronic gear ratio	√	–	–	page 5-42
Pn51B (251B hex)	Excessive deviation level between Servomotor and load positions	√	–	–	page 10-8
Pn52A (252A hex)	Multiplier for one fully-closed rotation	√	–	–	
Pn006 (2006 hex)/ Pn007 (2007 hex)	Analog monitor signal	√	√	√	page 10-9
Pn22A (222A hex) = n.X□□□	Speed feedback method during fully-closed loop control	√	–	–	page 10-9

10.3.1 Control Block Diagram for Fully-Closed Loop Control

The control block diagram for fully-closed loop control is provided below.



* The connected device depends on the type of external encoder.

Note: You can use either an incremental or an absolute encoder. If you use an absolute encoder, set Pn002 to n.□1□□ (Use the absolute encoder as an incremental encoder).

10.3.2 Setting the Motor Direction and the Machine Movement Direction

You must set the motor direction and the machine movement direction. To perform fully-closed loop control, you must set both Pn000 = n.□□□X (Direction Selection) and Pn002 = n.X□□□ (External Encoder Usage).

Parameter			Pn002 (2002 hex) = n.X□□□ (External Encoder Usage)			
			n.1□□□		n.3□□□	
Pn000 (2000 hex) =n.□□□X (Direction Selection)	n.□□□0	Reference direction	Forward reference	Reverse reference	Forward reference	Reverse reference
		Motor direction	CCW	CW	CCW	CW
		External encoder	Forward movement	Reverse movement	Reverse movement	Forward movement
	n.□□□1	Reference direction	Forward reference	Reverse reference	Forward reference	Reverse reference
		Motor direction	CW	CCW	CW	CCW
		External encoder	Reverse movement	Forward movement	Forward movement	Reverse movement

- Phase B leads in the divided pulses for a forward reference regardless of the setting of Pn000 = n.□□□X.
- Forward direction: The direction in which the pulses are counted up.
- Reverse direction: The direction in which the pulses are counted down.

Related Parameters

◆ Pn000 = n.□□□X

Refer to the following section for details.

☞ *5.4 Motor Direction Setting* on page 5-15

◆ Pn002 = n.X□□□

When you perform fully-closed loop control, set Pn002 to n.1□□□ or n.3□□□.

Parameter		Name	Meaning	When Enabled	Classification
Pn002 (2002 hex)	n.0□□□ (default setting)	External Encoder Usage	Do not use an external encoder.	After restart	Setup
	n.1□□□		External encoder moves in forward direction for CCW motor rotation.		
	n.2□□□		Reserved parameter (Do not change.)		
	n.3□□□		External encoder moves in reverse direction for CCW motor rotation.		
	n.4□□□		Reserved parameter (Do not change.)		

Information

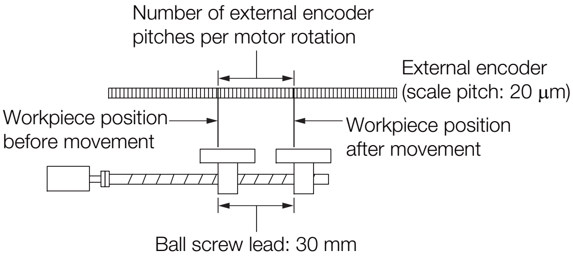
Determine the setting of Pn002 = n.X□□□ as described below.
- Set Pn000 to n.□□□0 (Use the direction in which the linear encoder counts up as the forward direction) and set Pn002 to n.1□□□ (The external encoder moves in the forward direction for CCW motor rotation).
- Manually rotate the motor shaft counterclockwise.
- If the fully-closed feedback pulse counter counts up, do not change the setting of Pn002 (Pn002 = n.1□□□).
- If the fully-closed feedback pulse counter counts down, set Pn002 to n.3□□□.

10.3.3 Setting the Number of External Encoder Scale Pitches

Set the number of external encoder scale pitches per motor rotation in Pn20A.

Setting Example

Specifications
External encoder scale pitch: 20 μm
Ball screw lead: 30 mm



If the external encoder is connected directly to the motor, the setting will be 1,500 (30 mm/0.02 mm = 1,500).

Note: 1. If there is a fraction, round off the digits below the decimal point.
2. If the number of external encoder scale pitches per motor rotation is not an integer, there will be deviation in the position loop gain (Kp), feedforward, and position reference speed monitor. This is not relevant for the position loop and it therefore does not interfere with the position accuracy.

Related Parameters

Pn20A (220A hex)	Number of External Scale Pitches				Position
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	4 to 1,048,576	1 scale pitch/revolution	32,768	After restart	Setup

10.3.4 Setting the PAO, PBO, and PCO (Encoder Divided Pulse Output) Signals

Set the position resolution in Pn281 (Encoder Output Resolution).

Enter the number of phase A and phase B edges for the setting.

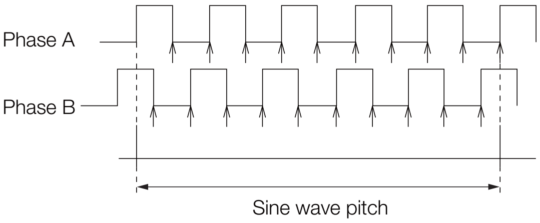
Setting Example

Specifications
External encoder scale pitch: 20 μm
Ball screw lead: 30 mm
Speed:1,600 mm/s

If a single pulse (multiplied by 4) is output for 1 μm, the setting would be 20.

If a single pulse (multiplied by 4) is output for 0.5 μm, the setting would be 40.

The encoder divided pulse output would have the following waveform if the setting is 20.



"↑" indicates the edge positions. In this example, the set value is 20 and therefore the number of edges is 20.

Note: The upper limit of the encoder signal output frequency (multiplied by 4) is 6.4 Mpps. Do not set a value that would cause the output to exceed 6.4 Mpps.
If the output exceeds the upper limit, an A.511 alarm (Overspeed of Encoder Output Pulse Rate) will be output.

Example If the setting is 20 and the speed is 1,600 mm/s, the output frequency would be 1.6 Mpps

$$\frac{1600\text{ mm/s}}{0.001\text{ mm}} = 1{,}600{,}000 = 1.6\text{ Mpps}$$

Because 1.6 Mpps is less than 6.4 Mpps, this setting can be used.

Related Parameters

Pn281 (2281 hex)	Encoder Output Resolution			Position	
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	1 to 4,096	1 edge/pitch	20	After restart	Setup

Note: The maximum setting for the encoder output resolution is 4,096.
If the resolution of the external encoder exceeds 4,096, pulse output will no longer be possible at the resolution given in ■ *Feedback Resolution of Linear Encoder* on page 5-45.

10.3.5 External Absolute Encoder Data Reception Sequence

Refer to the following section for details.

☞ *6.9.4 Reading the Position Data from the Absolute Linear Encoder* on page 6-41

With fully-closed loop control, the same sequence as for a Linear Servomotor is used.

10.3.6 Setting Unit Systems

Refer to the following section for details.

☞ *5.14 Setting Unit Systems* on page 5-42

With fully-closed loop control, the same setting as for a Linear Servomotor is used.

10.3.7 Alarm Detection Settings

This section describes the alarm detection settings (Pn51B and Pn52A).

Pn51B (Excessive Error Level between Servomotor and Load Positions)

This setting is used to detect the difference between the feedback position of the motor encoder and the feedback load position of the external encoder for fully-closed loop control. If the detected difference exceeds the setting, an A.d10 alarm (Motor-Load Position Error Overflow) will be output.

Pn51B (251B hex)	Excessive Error Level between Servomotor and Load Positions			Position	
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 to 1,073,741,824	1 reference unit	1000	Immediately	Setup

Note: An A.d10 alarm will not be output if this parameter is set to 0.

Pn52A (Multiplier per One Fully-closed Rotation)

Set the coefficient of the deviation between the motor and the external encoder per motor rotation.

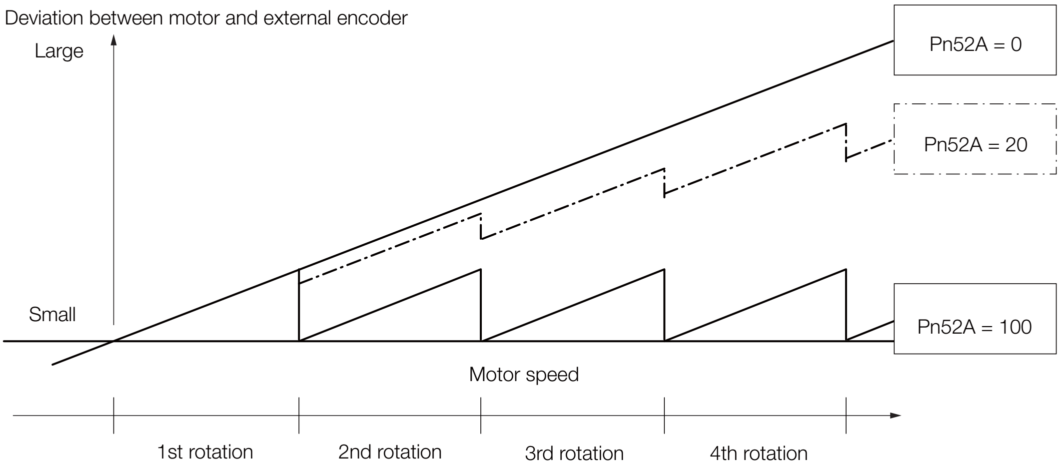
This setting can be used to prevent the motor from running out of control due to damage to the external encoder or to detect belt slippage.

◆ Setting Example

Increase the value if the belt slips or is twisted excessively.

If this parameter is set to 0, the external encoder value will be read as it is.

If you use the default setting of 20, the second rotation will start with the deviation for the first motor rotation multiplied by 0.8.



◆ Related Parameters

Pn52A (252A hex)	Multiplier per One Fully-closed Rotation				Position
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 to 100	1%	20	Immediately	Setup

10.3.8 Analog Monitor Signal Settings

You can monitor the position deviation between the Servomotor and load with an analog monitor.

Parameter		Name	Meaning	When Enabled	Classification
Pn006 (2006 hex)	n.□□07	Analog Monitor 1 Signal Selection	Position deviation between motor and load (output unit: 0.01 V/reference unit).	Immediately	Setup
Pn007 (2007 hex)	n.□□07	Analog Monitor 2 Signal Selection	Position deviation between motor and load (output unit: 0.01 V/reference unit).		

10.3.9 Setting to Use an External Encoder for Speed Feedback

For fully-closed loop control, you normally set a parameter to specify using the motor encoder speed (Pn22A = n.0□□□).

If you will use a Direct Drive Servomotor and a high-resolution external encoder, set the parameter to specify using the speed of the external encoder (Pn22A = n.1□□□).

Parameter		Meaning	When Enabled	Classification
Pn22A (222A hex)	n.0□□□ (default setting)	Use motor encoder speed.	After restart	Setup
	n.1□□□	Use external encoder speed.		

Note: This parameter cannot be used if Pn002 is set to n.0□□□ (Do not use external encoder).

10.4 Monitoring an External Encoder

You can monitor the current value of an external encoder attached to a machine without creating a fully-closed loop.

A dual encoder system with an encoder in the Rotary Servomotor and an external encoder attached to the machine is used, but only the encoder in the Rotary Servomotor is used in the control loop.

The external encoder is used only to monitor the current position of the machine. You can also use a touch probe to latch the current position of an external encoder.

10.4.1 Option Module Required for Monitoring

A Fully-closed Module (SGDV-OFA01A) is required to use this function.

Refer to the following manual for detailed information on installation.

📖 Σ-V-Series/Σ-V-Series for Large-Capacity Models/Σ-7-Series Installation Guide Fully-closed Module (Manual No.: TOBP C720829 03)

Note: You cannot use a Safety Module (SGDV-OSA01A) if you install a Fully-closed Module.

10.4.2 Related Parameters

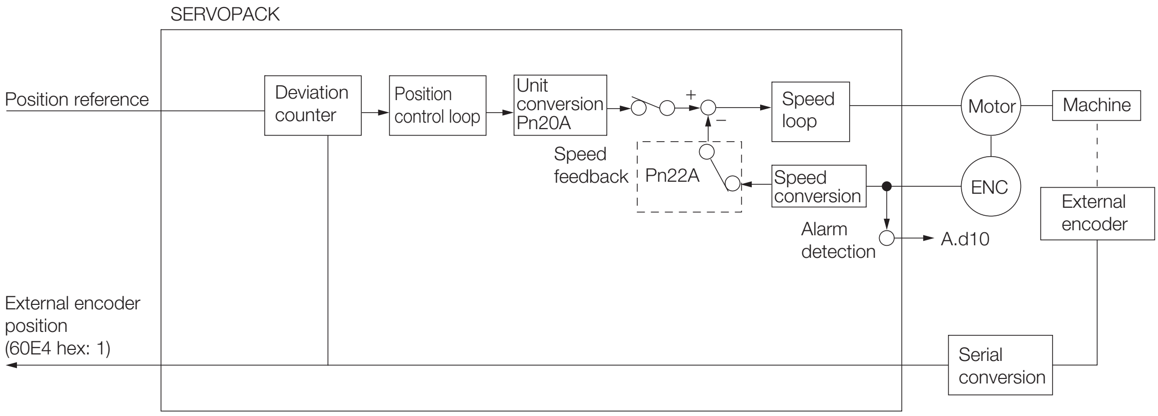
The parameter that is used to monitor the external encoder as the current value of the machine is given below.

Parameter		Meaning	When Enabled	Classification
Pn00E	n.0□□□ (default setting)	Do not use the external encoder monitor.	After startup	Setup
	n.1□□□	Use CCW as the forward direction.		
	n.2□□□	Reserved setting (Do not use.)		
	n.3□□□	Use CW as the forward direction. (Reverse Rotation Mode)		
	n.4□□□	Reserved setting (Do not use.)		

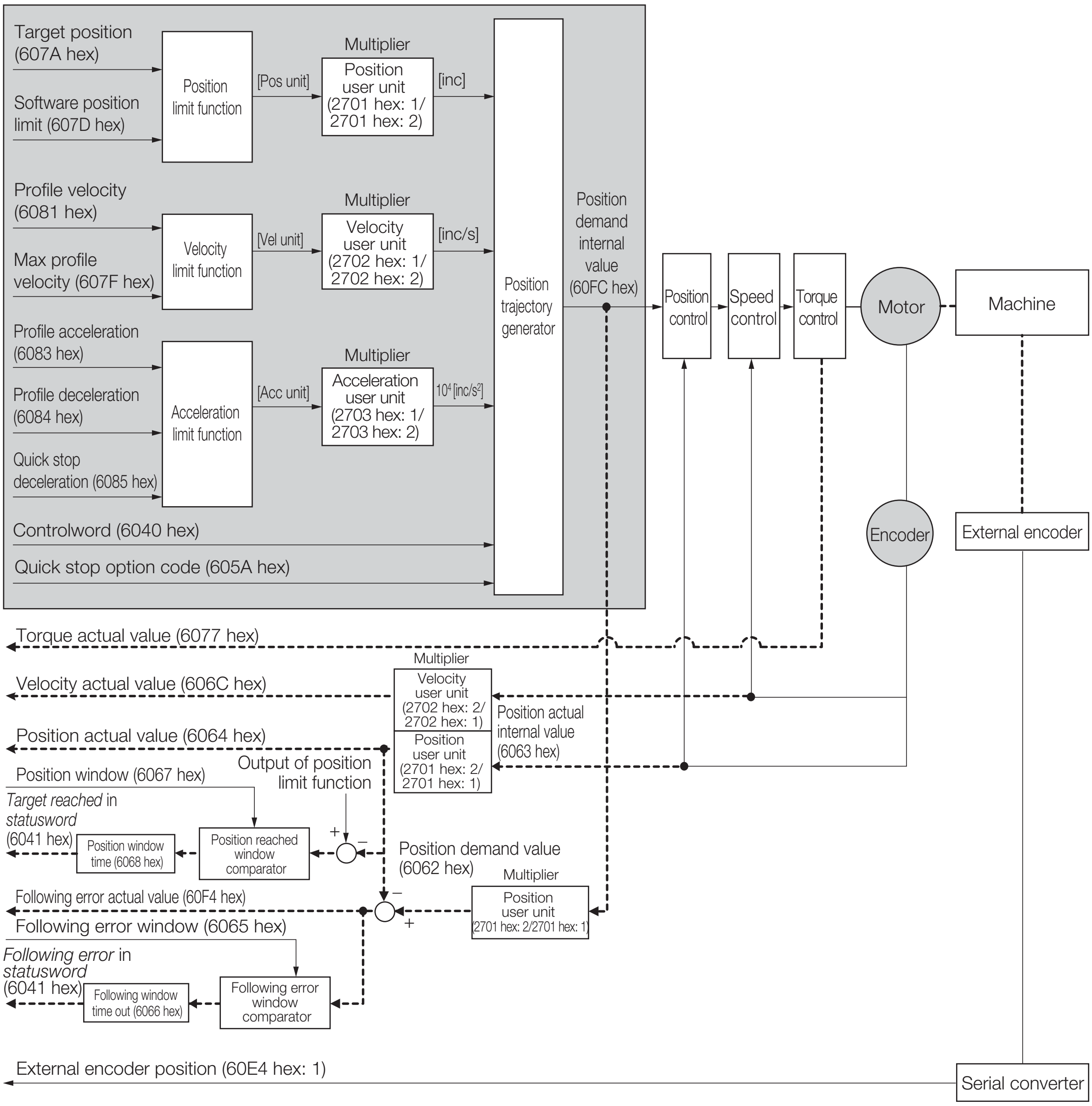
Set Pn002 to n.0□□□ (Do not use external encoder) if you will not use fully-closed loop control.

10.4.3 Block Diagrams

A simple block diagram is given below to provide an overall image of monitoring an external encoder.



The following block diagram shows monitoring an external encoder in the Profile Position Mode.



Safety Functions

11

This chapter provides detailed information on the safety functions of the SERVOPACK.

11.1 Introduction to the Safety Functions

11.1.1 Safety Functions

Safety functions are built into the SERVOPACK to reduce the risks associated with using the machine by protecting workers from the hazards of moving machine parts and otherwise increasing the safety of machine operation.
Especially when working in hazardous areas inside guards, such as for machine maintenance, the safety function can be used to avoid hazardous moving machine parts.

The SERVOPACK provides the following four safety functions for functional safety standards.

Function	Description	SERVO-PACK Built-in Function	Safety Module Function	
				Active Mode Function[*1]
Hard Wire Base Block (HWBB and SBB)	This safety function is equivalent to the Safety Torque OFF function defined in IEC 61800-5-2.	Yes (HWBB)	Yes (SBB[*2])	–
Safety Base Block with Delay (SBB-D)[*2]	This safety function is equivalent to the Safety Stop 1 function defined in IEC 61800-5-2.	–	Yes	Yes
Safe Position Monitor with Delay (SPM-D)[*2]	This safety function is equivalent to the Safety Stop 2 function defined in IEC 61800-5-2.	–	Yes	Yes
Safe Speed Limit with Delay (SLS-D)[*2]	This safety function is equivalent to the Safely-Limited Speed function defined in IEC 61800-5-2.	–	Yes	–

*1. The Active Mode Function stops the motor according to the speed reference that is preset in a parameter in the SERVOPACK when the safety request input signal turns OFF during SBB-D or SPM-D.
The Active Mode Function is not a safety function in the applicable standards. Keep this in mind when you design the system.
Refer to the following section for details.
11.7.4 Active Mode Function on page 11-19

*2. A Safety Module (optional) must be connected to use this function. Refer to the following manual for application procedures.
Σ-V-Series/Σ-V-Series for Large-Capacity Models/Σ-7-Series Installation Guide Safety Module (Manual No.: SIEP C720829 06)

Refer to the following section for information on the safety function and safety parameters.
Compliance with UL Standards, EU Directives, and Other Safety Standards on page xxiii

Important

Products that display the TÜV mark on the nameplate have met the safety standards.

11.1.2 Precautions for Safety Functions

⚠ **WARNING**

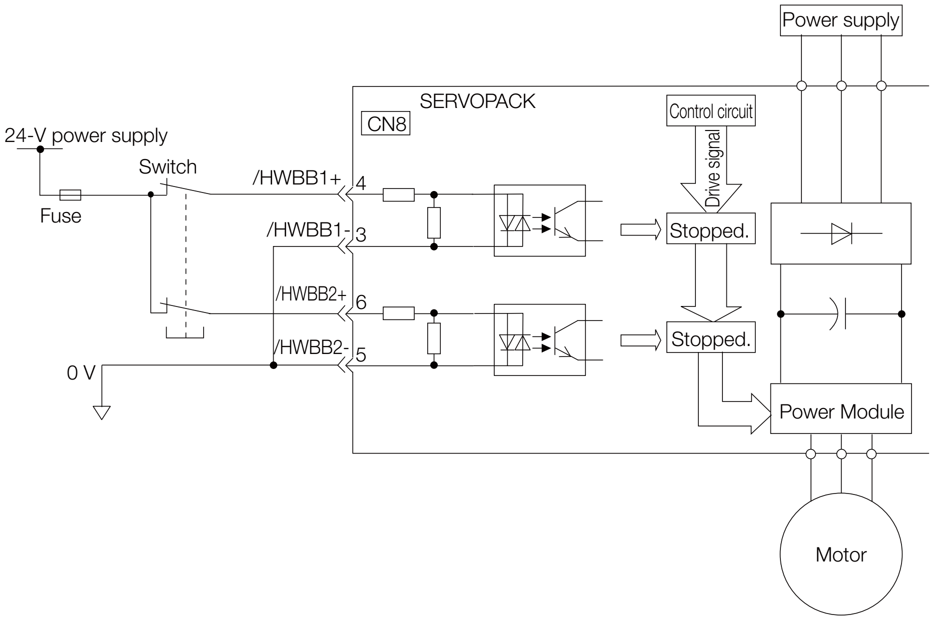
- To confirm that the HWBB function satisfies the safety requirements of the system, you must conduct a risk assessment of the system.
  Incorrect use of the safety function may cause injury.
- The Servomotor will move if there is an external force (e.g., gravity on a vertical axis) even when the HWBB function is operating. Use a separate means, such as a mechanical brake, that satisfies the safety requirements.
  Incorrect use of the safety function may cause injury.
- While the HWBB function is operating, the motor may move within an electric angle of 180° or less as a result of a SERVOPACK failure. Use the HWBB function for an application only after confirming that movement of the motor will not result in a hazardous condition.
  Incorrect use of the safety function may cause injury.
- The dynamic brake and the brake signal are not safety-related elements. You must design the system so that SERVOPACK failures will not cause a hazardous condition while the HWBB function is operating.
  Incorrect use of the safety function may cause injury.
- Connect devices that satisfy the safety standards for the signals for safety functions.
  Incorrect use of the safety function may cause injury.
- If the HWBB function is used for an emergency stop, shut OFF the power supply to the Servomotor with an independent electric or mechanical component.
  Incorrect use of the safety function may cause injury.
- The HWBB function does not shut OFF the power to the SERVOPACK or electrically isolate it. Implement measures to shut OFF the power supply to the SERVOPACK before you perform maintenance on it.
  There is a risk of electric shock.

11.2 Hard Wire Base Block (HWBB and SBB)

A hard wire base block (abbreviated as HWBB) is a safety function that is designed to shut OFF the current to the motor with a hardwired circuit.
The drive signals to the Power Module that controls the motor current are controlled by the circuits that are independently connected to the two input signal channels to turn OFF the Power Module and shut OFF the motor current.

> **Important**
> For safety function signal connections, the input signal is the 0-V common and the output signal is a source output.
> This is opposite to other signals described in this manual.
> To avoid confusion, the ON and OFF status of signals for the safety function are defined as follows:
> ON: The state in which the relay contacts are closed or the transistor is ON and current flows into the signal line.
> OFF: The state in which the relay contacts are open or the transistor is OFF and no current flows into the signal line.

The input signal uses the 0-V common. The following figure shows a connection example.



11.2.1 Risk Assessment

When using the HWBB, you must perform a risk assessment of the servo system in advance to confirm that the safety level of the standards is satisfied. Refer to the following section for details on the standards.

☞ *Compliance with UL Standards, EU Directives, and Other Safety Standards* on page xxiii

Note: To meet performance level e (PLe) in EN ISO 13849-1, the EDM signal must be monitored by the host controller. If the EDM signal is not monitored by the host controller, the level will be safety performance level d (PLd).

The following hazards exist even when the HWBB is operating. These hazards must be included in the risk assessment.

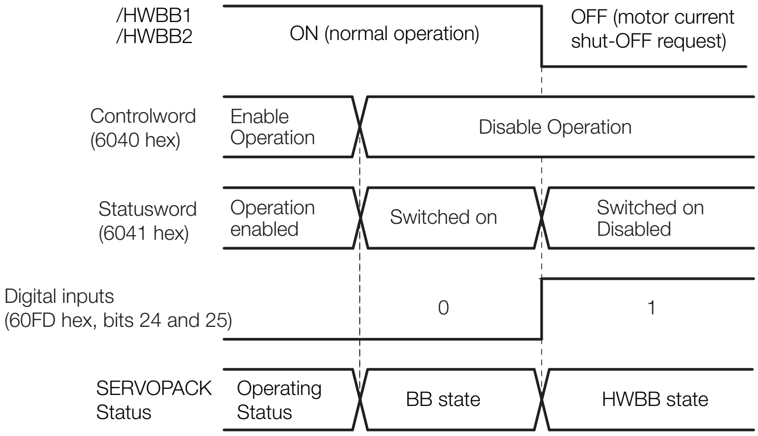
- The Servomotor will move if an external force is applied to it (for example, gravity on a vertical axis). Implement measures to hold the Servomotor, such as installing a separate mechanical brake.

- If a failure occurs such as a Power Module failure, the Servomotor may move within an electric angle of 180°. Ensure safety even if the Servomotor moves.
  The rotational angle or travel distance depends on the type of Servomotor as follows:
  - Rotary Servomotor: 1/6 rotation max. (rotational angle calculated at the motor shaft)
  - Direct Drive Servomotor: 1/20 rotation max. (rotational angle calculated at the motor shaft)
  - Linear Servomotor: 50 mm max.
- The HWBB does not shut OFF the power to the SERVOPACK or electrically isolate it. Implement measures to shut OFF the power supply to the SERVOPACK before you perform maintenance on it.

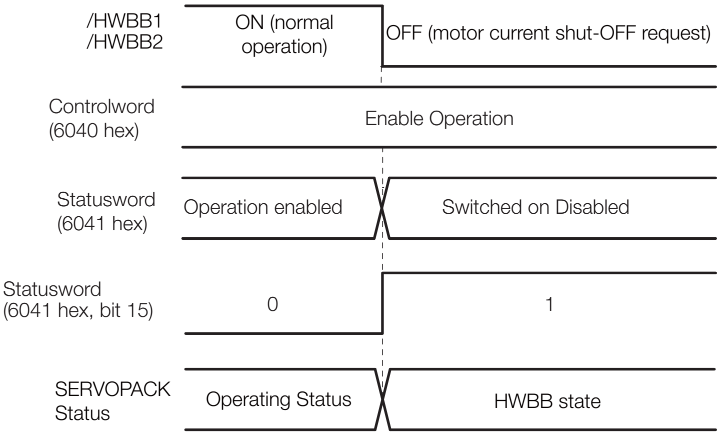
11.2.2 Hard Wire Base Block (HWBB) State

The SERVOPACK will be in the following state if the HWBB operates. If the /HWBB1 or /HWBB2 signal turns OFF, the HWBB will operate and the SERVOPACK will enter a HWBB state.

- **When HWBB Operates after Servo OFF (Power Not Supplied to Motor)**

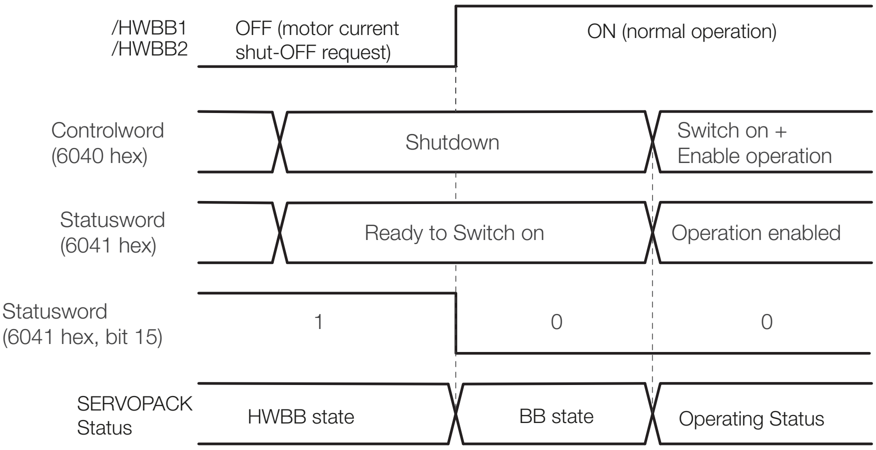


- **When HWBB Operates While Power Is Supplied to Servomotor**



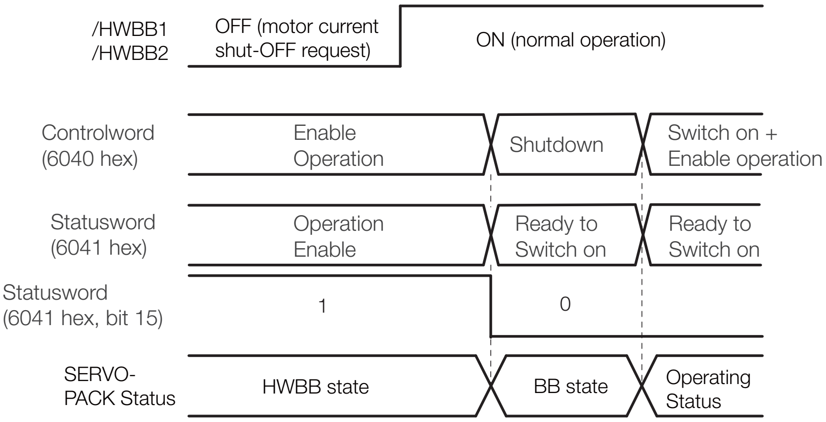
11.2.3 Resetting the HWBB State

Normally, after the Shutdown command is received and power is no longer supplied to the Servomotor, the /HWBB1 and /HWBB2 signals will turn OFF and the SERVOPACK will enter the HWBB state. If you turn ON the /HWBB1 and /HWBB2 signals in this state, the SERVOPACK will enter a base block (BB) state and will be ready to acknowledge the Servo ON command (Enable Operation command).



If the /HWBB1 and /HWBB2 signals are OFF and the Servo ON command (Enable Operation command) is received, the HWBB state will be maintained even after the /HWBB1 and /HWBB2 signals are turned ON.

Send the Shutdown command to place the SERVOPACK in the BB state and then send the Servo ON command (Enable Operation command).



Note: If the SERVOPACK is placed in the BB state while the main circuit power supply is OFF, the HWBB state will be maintained until the Shutdown command is received.

11.2.4 Recovery Method

■ Recovery Conditions

All of the following conditions must be met.

- All safety request inputs are ON.
- The Servo ON command (Enable Operation command) was not sent.
- None of the following utility functions have been executed. (These functions execute the Servo ON command (Enable Operation command).)

The following utility functions execute the Servo ON command (Enable Operation command).

Utility Function No.	Function Name
Fn002	Jog
Fn003	Origin Search
Fn004	Jog Program
Fn00E	Autotune Motor Current Detection Signal Offset
Fn080	Polarity Detection
Fn201	Advanced Autotuning without Reference
Fn206	Easy FFT

Note: If any of the above utility functions was executed, the utility function must be ended. Perform the operation to return to the Main Menu for the utility functions on the Digital Operator. Refer to the following manual for operating procedures.
📖 Σ-7-Series AC Servo Drive Digital Operator Operating Manual (Manual No.: SIEP S800001 33)

■ Recovery Procedure

1. **Specify Shutdown in *controlword* (6040 hex, bits 0 to 3) to reset the Servo Drive.**
2. **Specify Switch ON and the Servo ON command (Enable Operation command) in *controlword* (6040 hex, bits 0 to 3).**

Power will be supplied to the motor.

11.2.5 Detecting Errors in HWBB Signal

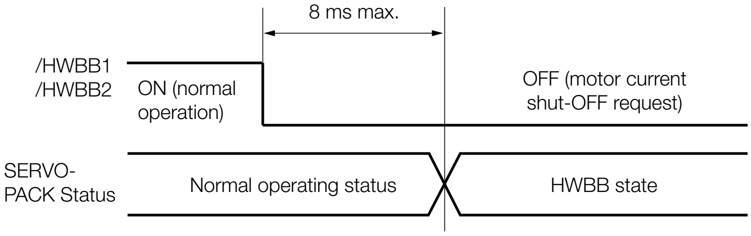
If only the /HWBB1 or the /HWBB2 signal is input, an A.Eb1 alarm (Safety Function Signal Input Timing Error) will occur unless the other signal is input within 10 seconds. This makes it possible to detect failures, such as disconnection of an HWBB signal.

⚠ CAUTION

- The A.Eb1 alarm (Safety Function Signal Input Timing Error) is not a safety-related element. Keep this in mind when you design the system.

11.2.6 HWBB Input Signal Specifications

If an HWBB is requested by turning OFF the two HWBB input signal channels (/HWBB1 and /HWBB2), the power supply to the Servomotor will be turned OFF within 8 ms.

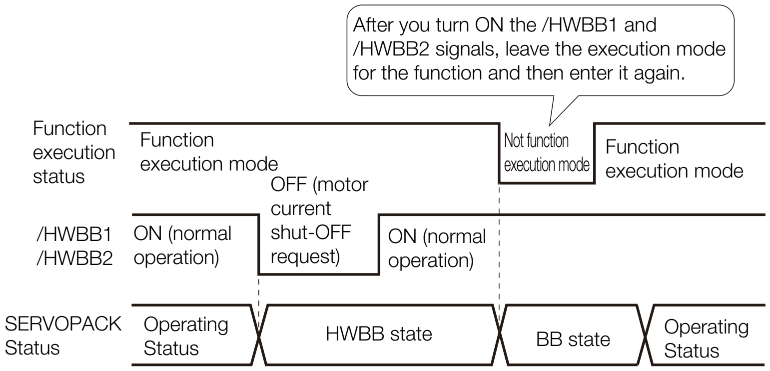


Note: 1. The OFF status is not recognized if the OFF interval of the /HWBB1 or /HWBB2 signal is 0.5 ms or shorter.
2. You can check the status of the input signals by using monitor displays. Refer to the following section for details.
☞ *9.2.3 I/O Signal Monitor* on page 9-5

11.2.7 Operation without a Host Controller

The HWBB will operate even for operation without a host controller.

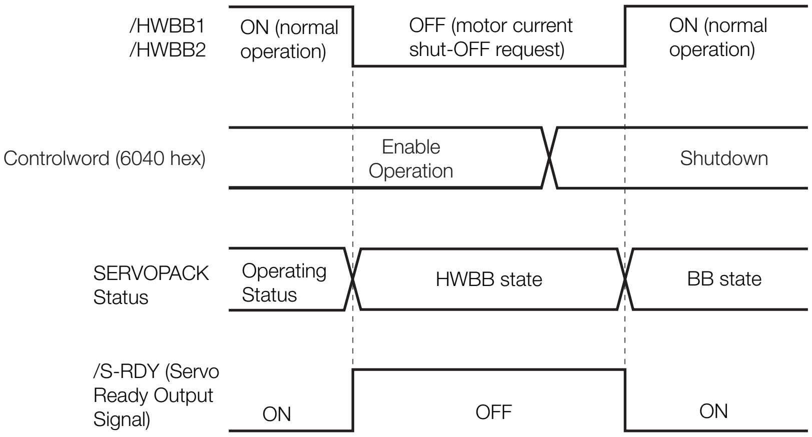
However, if the HWBB operates during execution of the following functions, leave the execution mode for the function and then enter it again to restart operation. Operation will not be restarted simply by turning OFF the /HWBB1 and /HWBB2 signals.

Applicable Functions	Resetting the HWBB State
• Jogging • Origin search • Program jogging • Automatic adjustment without host reference • Easy FFT • Adjustment of motor current detection signal offset	

11.2.8 /S-RDY (Servo Ready Output) Signal

The Servo ON command (Enable Operation command) will not be acknowledged in the HWBB state. Therefore, the Servo Ready Output Signal will turn OFF. The Servo Ready Output Signal will turn ON if both the /HWBB1 and /HWBB2 signals are ON and the servo is turned OFF (BB state).

An example is provided below for when the main circuit power supply is ON when there is no servo alarm.



11.2.9 /BK (Brake Output) Signal

If the HWBB operates when the /HWBB1 or /HWBB2 signal is OFF, the /BK (Brake) signal will turn OFF. At that time, the setting in Pn506 (Brake Reference - Servo OFF Delay Time) will be disabled. Therefore, the Servomotor may be moved by external force until the actual brake becomes effective after the /BK signal turns OFF.

⚠ CAUTION

- The brake signal is not a safety-related element. You must design the system so that a hazardous condition does not occur even if the brake signal fails in the HWBB state. Also, if a Servomotor with a Brake is used, keep in mind that the brake in the Servomotor is used only to prevent the moving part from being moved by gravity or an external force and it cannot be used to stop the Servomotor.

11.2.10 Stopping Methods

If the /HWBB1 or /HWBB2 signal turns OFF and the HWBB operates, the Servomotor will stop according to the stop mode that is set for stopping the Servomotor when the servo turns OFF (Pn001 = n.□□□X). However, if the dynamic brake is enabled (Pn001 = n.□□□0 or n.□□□1), observe the following precautions.

⚠ CAUTION

- The dynamic brake is not a safety-related element. You must design the system so that a hazardous condition does not occur even if the Servomotor coasts to a stop in the HWBB state. Normally, we recommend that you use a sequence that returns to the HWBB state after stopping for a reference.
- If the application frequently uses the HWBB, stopping with the dynamic brake may result in the deterioration of elements in the SERVOPACK. To prevent internal elements from deteriorating, use a sequence in which the HWBB state is returned to after the Servomotor has come to a stop.

11.2.11 ALM (Servo Alarm) Signal

The ALM (Servo Alarm) signal is not output in the HWBB state.

11.3 EDM1 (External Device Monitor)

The EDM1 (External Device Monitor) signal is used to monitor failures in the HWBB. Connect the monitor signal as a feedback signal, e.g., to the Safety Unit.

Note: To meet performance level e (PLe) in EN ISO 13849-1, the EDM signal must be monitored by the host controller. If the EDM signal is not monitored by the host controller, the level will be safety performance level d (PLd).

Information **Safety Module Monitor (2720 Hex)**
You can also use *safety module monitor* (2720 hex) in the EtherCAT communications object dictionary to monitor the Safety Module. Refer to the following sections for details on monitoring the Safety Module.
☞ *Safety Module Monitor (2720 Hex)* on page 14-21

- Failure Detection Signal for EDM1 Signal

The relationship between the EDM1, /HWBB1, and /HWBB2 signals is shown below.

Detection of failures in the EDM1 signal circuit can be achieved by using the four status of the EDM1 signal in the following table. A failure can be detected by checking the failure status, e.g., when the power supply is turned ON.

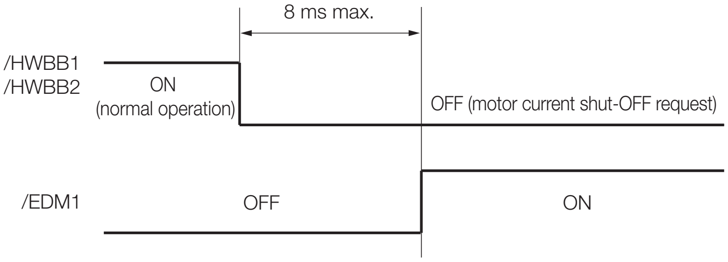
Signal	Logic			
/HWBB1	ON	ON	OFF	OFF
/HWBB2	ON	OFF	ON	OFF
EDM1	OFF	OFF	OFF	ON

⚠ WARNING

- The EDM1 signal is not a safety output. Use it only for monitoring for failures.

11.3.1 EDM1 Output Signal Specifications

If an HWBB is requested by turning OFF the two HWBB input signal channels (/HWBB1 and /HWBB2) when the safety function is operating normally, the EDM1 output signal will be turned ON within 8 ms.

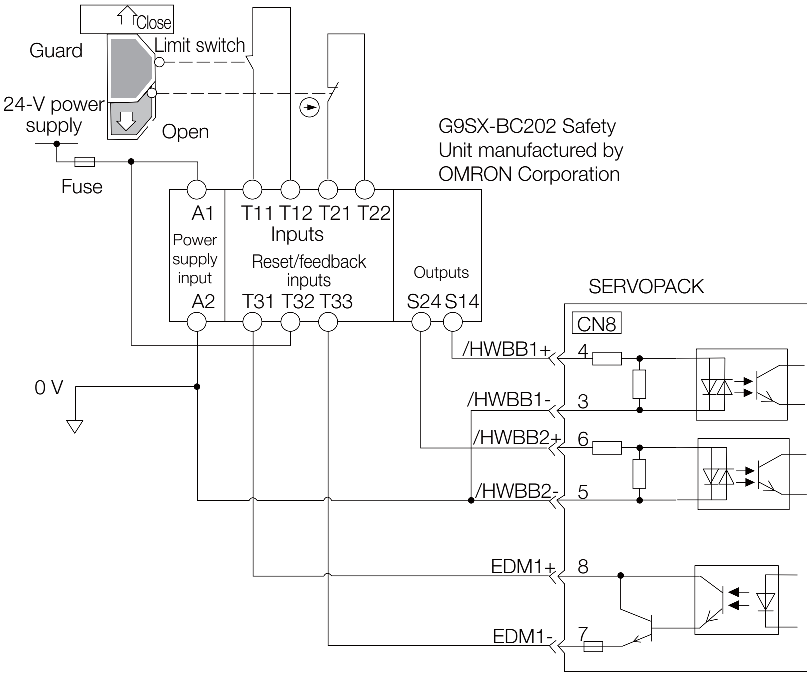


11.4 Applications Examples for Safety Functions

This section provides examples of using the safety functions.

11.4.1 Connection Example

In the following example, a Safety Unit is used and the HWBB operates when the guard is opened.



When the guard is opened, both the /HWBB1 and the /HWBB2 signals turn OFF, and the EDM1 signal turns ON. Because the feedback circuit is ON while the guard is closed, the Safety Unit is reset, the /HWBB1 and the / HWBB2 signals turn ON, and the operation is enabled.

Note: The EDM1 signal is used as a source output. Connect the EDM1 so that the current flows from EMD1+ to EMD1-.

11.4.2 Failure Detection Method

If a failure occurs (e.g., the /HWBB1 or the /HWBB2 signal remains ON), the Safety Unit is not reset when the guard is closed because the EDM1 signal remains OFF. Therefore starting is not possible and a failure is detected.
In this case the following must be considered: an error in the external device, disconnection of the external wiring, short-circuiting in the external wiring, or a failure in the SERVOPACK. Find the cause and correct the problem.

11.4.3 Procedure

1	Request is received to open the guard.
2	If the motor is operating, a stop command is received from the host controller, the motor stops, and the servo is turned OFF.
3	The guard is opened.
4	The /HWBB1 and /HWBB2 signals turn OFF and the HWBB operates. (Working inside the guard is enabled.)
5	The worker leaves the guarded area after completing work.
6	The guard is closed.
7	Send the Servo ON command (Enable Operation command) from the host controller.

11.5 Validating Safety Functions

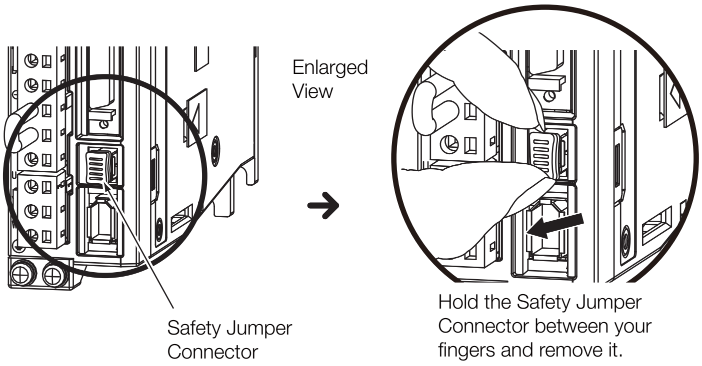
When you commission the system or perform maintenance or SERVOPACK replacement, you must always perform the following validation test on the HWBB after completing the wiring. (It is recommended that you keep the confirmation results as a record.)

- When the /HWBB1 and /HWBB2 signals turn OFF, confirm that the Digital Operator displays **Hbb** and that the Servomotor does not operate.
- Monitor the ON/OFF status of the /HWBB1 and /HWBB2 signals.
  If the ON/OFF status of the signals do not coincide with the display, the following must be considered: an error in the external device, disconnection of the external wiring, short-circuiting in the external wiring, or a failure in the SERVOPACK. Find the cause and correct the problem.
  Refer to the following sections for details on the monitor.
  ☞ *9.2.3 I/O Signal Monitor* on page 9-5
- Confirm that the EDM1 signal is OFF while in normal operation by using the feedback circuit input display of the connected device.

11.6 Connecting a Safety Function Device

Use the following procedure to connect a safety function device.

1. Remove the Safety Jumper Connector from the connector for the safety function device (CN8).



2. Connect the safety function device to the connector for the safety function device (CN8).

Note: If you do not connect a safety function device, leave the Safety Jumper Connector connected to the connector for the safety function device (CN8). If the SERVOPACK is used without the Safety Jumper Connector connected to CN8, no current will be supplied to the Servomotor and no motor torque will be output. In this case, **Hbb** will be displayed on the Digital Operator.

11.7 Safety Module Safety Functions

This section describes the safety functions provided by the Safety Module.

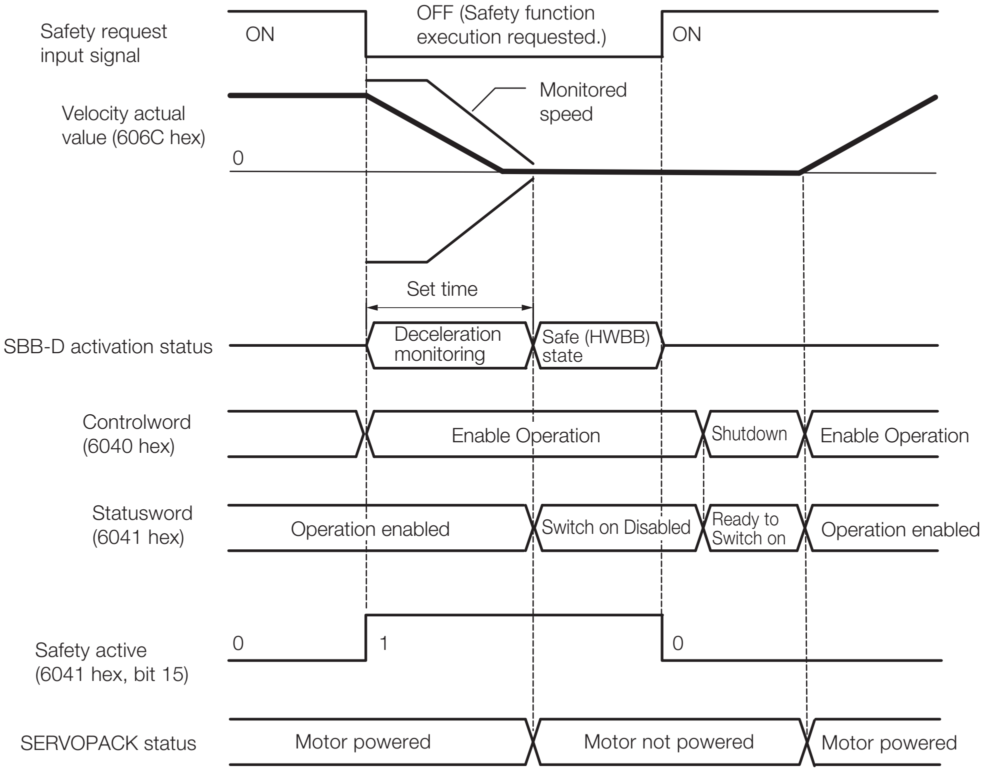
11.7.1 Safety Base Block with Delay (SBB-D)

The Safety Base Block with Delay (SBB-D) function operates according to the Safe Stop 1 (SS1) function defined in IEC 61800-5-2. The deceleration operation of the motor is monitored (deceleration monitoring) until the time set in a parameter elapses in response to the safety request input status. The HWBB in the SERVOPACK is then executed to shut OFF the power supply to the motor.

Note: Refer to the following manual for the application procedures for the SBB-D function.
📖 Σ-V-Series/Σ-V-Series for Large-Capacity Models/Σ-7-Series Installation Guide Safety Module (Manual No.: SIEP C720829 06)

Operation Example for SBB-D

When the safety monitor time expires, the safe state (HWBB) is entered and then the power supply to the motor is shut OFF. The Drive enters the Switch ON Disabled state (*statusword* (6041 hex)).



Recovery Method

When the safety request input signal turns ON, normal operation will be enabled.

The recovery method after deceleration monitoring is completed and the safe (HWBB) state is entered in the same as for the HWBB function. Refer to the following section for details.
☞ *11.2.4 Recovery Method* on page 11-8

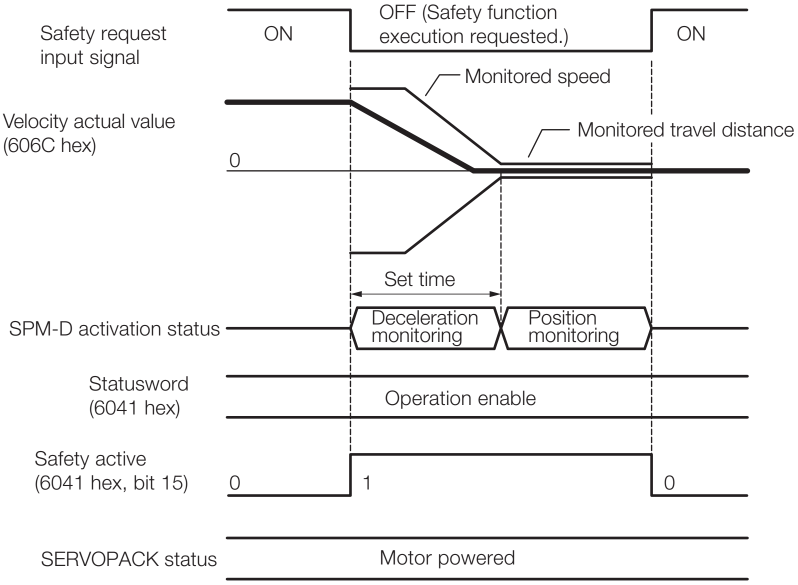
11.7.2 Safe Position Monitor with Delay (SPM-D)

The Safe Position Monitor with Delay (SPM-D) function operates according to the Safe Stop 2 (SS2) function defined in IEC 61800-5-2. The deceleration operation of the motor is monitored (deceleration monitoring) until the time set in a parameter elapses in response to the safety request input status. Position monitoring is then performed to see if the motor travel distance is within the allowable range.

Note: Refer to the following manual for the application procedures for the SPM-D function.

📖 Σ-V-Series/Σ-V-Series for Large-Capacity Models/S-7-Series Installation Guide Safety Module (Manual No.: SIEP C720829 06)

Operation Example for SPM-D



Recovery Method

When the safety request input signal turns ON, normal operation will be enabled.

The recovery method after deceleration monitoring is completed and the safe (HWBB) state is entered in the same as for the HWBB function. Refer to the following section for details.

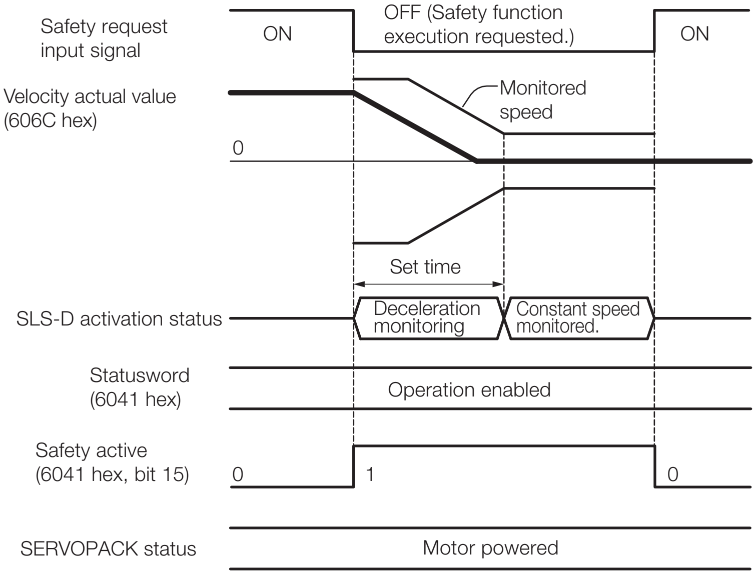
☞ *11.2.4 Recovery Method* on page 11-8

11.7.3 Safe Speed Limit with Delay (SLS-D)

The Safe Speed Limit with Delay (SLS-D) function operates according to the Safely-Limited Speed (SLS) function defined in IEC 61800-5-2. The deceleration operation of the motor is monitored (deceleration monitoring) until the time set in a parameter elapses in response to the safety request input status. The motor speed is then monitored to see if it is within the allowable range (within range for a constant speed).

Note: Refer to the following manual for the application procedures for the SLS-D function.
📖 **Σ-V-Series/Σ-V-Series for Large-Capacity Models/S-7-Series Installation Guide Safety Module (Manual No.: SIEP C720829 06)**

Operation Example for SLS-D



Recovery Method

When the safety request input signal turns ON, normal operation will be enabled.

The recovery method after deceleration monitoring is completed and the safe (HWBB) state is entered in the same as for the HWBB function. Refer to the following section for details.
☞ *11.2.4 Recovery Method* on page 11-8

11.7.4 Active Mode Function

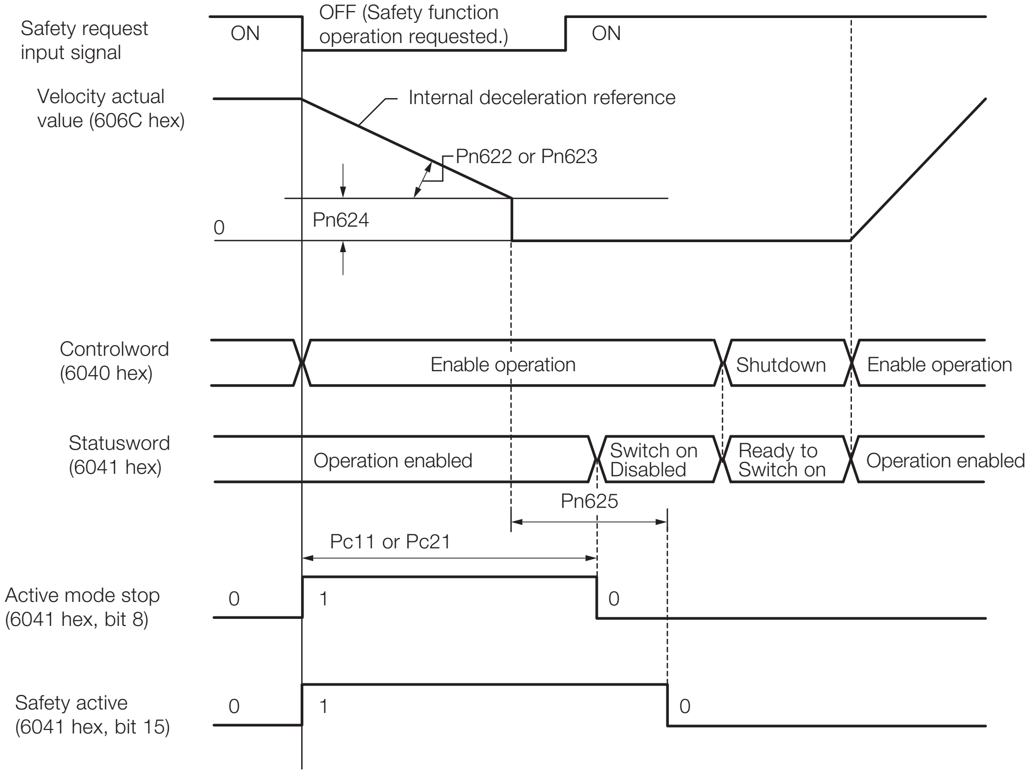
The Active Mode Function stops the motor according to the deceleration reference that is preset in a parameter in the SERVOPACK when the safety request input signal turns OFF during SBB-D or SPM-D.

Active Mode Function Operation Example

If Profile Torque Mode or Cyclic Synchronous Torque Mode is set in *controlword* (6040 hex, bits 4 to 9), the servo will be turned OFF and the motor will be stopped as soon as the safety request input signal turns OFF.

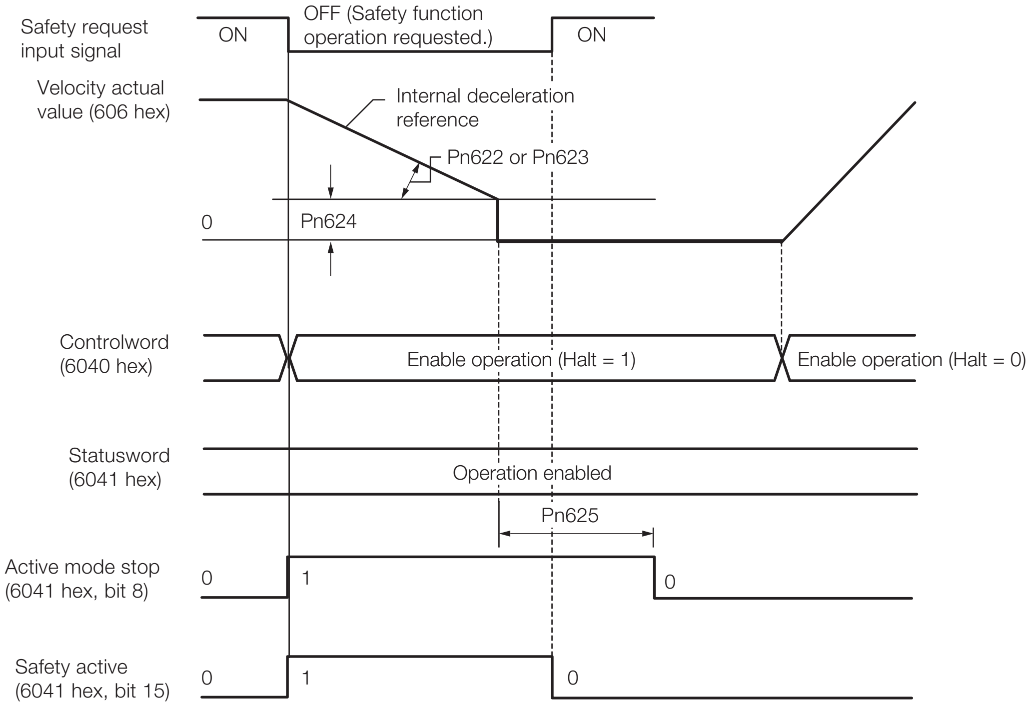
◆ When Using the SBB-D Function (Position or Speed Control)

The motor is stopped at the set deceleration rate (Pn622 or Pn623). After the deceleration monitor time (Pc11 or Pc21) elapses, the servo is turned OFF (Switch ON Disable state is entered).



◆ When Using the SPM-D Function (Position or Speed Control)

The motor is stopped at the set deceleration rate (Pn622 or Pn623) and then the servo is locked (Operation Enabled state).



◆ Operation by Operation Mode When Stopped for the Active Mode Function

Operation Mode	Operation
Profile position mode	Profile position operation is canceled and *statusword* (6041 hex) changes as given below. Bit 08 = 1: Active Mode Function operating. Bit 12 = 0: Previous set-point already processed, waiting for new set-point. Bit 15 = 1: Safety function operating.
Homing mode	Homing operation is canceled and *statusword* (6041 hex) changes as given below. Bit 08 = 1: Active Mode Function operating. Bit 13 = 1: Homing error. Bit 15 = 1: Safety function operating.
Cyclic synchronous position/velocity/torque mode	Cyclic synchronous position, velocity, or torque operation is canceled and *statusword* (6041 hex) changes as given below. Bit 08 = 1: Active Mode Function operating. Bit 12 = 0: Target value (position/velocity/torque) ignored. Bit 15 = 1: Safety function operating.
Interpolated position mode	Interpolated position operation is canceled and *statusword* (6041 hex) changes as given below. Bit 08 = 1: Active Mode Function operating. Bit 12 = 0: Interpolation operation disabled. Bit 15 = 1: Safety function operating.
Profile velocity/torque mode	Profile velocity or torque operation is canceled and *statusword* (6041 hex) changes as given below. Bit 08 = 1: Active Mode Function operating. Bit 15 = 1: Safety function operating.

Recovery Method

◆ Recovery Conditions

If the Active Mode Function operates and the motor is stopped, the Active Mode Function will be reset and normal operation will be enabled when all of the following conditions are met.

- All relevant safety request input signals must be ON.
- A period of time equal to or greater than the value set as the Active Mode Hold Time (Pn625) must have elapsed.
- The following command must have been sent from the Controller.
- Interpolated Position Mode: Bit 8 in *controlword* (6040 hex) = 1 (stop axis according to *halt option code* (605D hex)) or bit 4 = 0 (disable interpolation).
- Cyclic Synchronous Position/Velocity Mode or Profile Velocity Mode: Bit 8 in *controlword* (6040 hex) = 1 (Halt).
- Profile Torque or Cyclic Synchronous Torque Mode: Bits 1 and 2 in *controlword* (6040 hex) = 1 (Shutdown).
- Homing Mode or Profile Position Mode: No condition.

Note: If the HWBB function has turned OFF the servo, normal operation will be enabled when the corresponding safety request input signal turns ON.

◆ Recovery Procedure

1. After detecting that bit 8 in *statusword* (6041 hex) is 1 (Active Mode Function operating) or that bit 15 is 1 (safety function operating), set bit 8 in *controlword* (6040 hex) to 1 (stop axis according to *halt option code* (605D hex)).
2. After detecting that the safety request input signal turned ON, confirm that bit 8 in *statusword* (6041 hex) is 0 (Active Mode Function operation completed) and that bit 15 is 0 (safety function operation completed), and then specify the Servo ON command (Enable Operation command) in *controlword* (6040 hex).
3. Specify a new motion command.

EtherCAT Communications

12

This chapter provides basic information on EtherCAT communications.

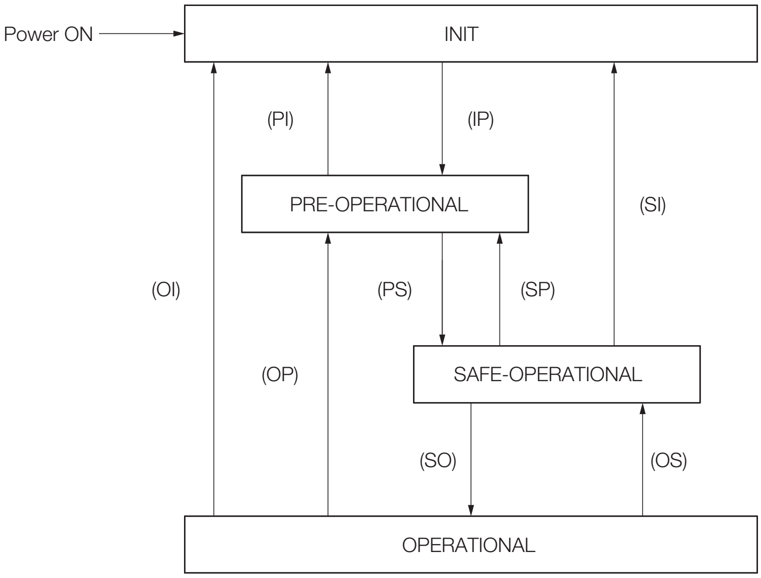
12.1 EtherCAT Slave Information

You can use an EtherCAT slave information file (ESI) to configure the EtherCAT master.
The ESI file contains general information on EtherCAT communications settings that are related to the SERVOPACK settings.
The following file is provided for the SERVOPACK.

SERVOPACK	File Name
SGD7S-□□□□E0□	Yaskawa_SGD7S-xxxxA0x_CoE_rev□□□□.□□.esi

12.2 EtherCAT State Machine

The EtherCAT state machine is used to manage the communications states between the master and slave applications when EtherCAT communications are started and during operation, as shown in the following figure. Normally, the state changes for requests from the master.



State	Description
INIT	• Mailbox communications are not possible. • Process data communications are not possible.
INIT => PRE-OP	• The master sets the DL address and Sync Manager channels for mailbox communications. • The master initializes DC clock synchronization. • The master requests the Pre-Operational state. • The master sets the AL control register. • The slaves check whether the mailbox was initialized correctly.
PRE-OPERATIONAL (PREOP)	• Mailbox communications are possible. • Process data communications are not possible.
PREOP => SAFEOP	• The master sets the Sync Manager channels and FMMU channels for process data. • The master uses SDOs to set the PDO mappings and the Sync Manager PDO Assignment parameters. • The master requests the Safe-Operational state. • The slaves check whether the Sync Manager channels for process data communications and, if required, the distributed clock settings are correct.
SAFE-OPERATIONAL (SAFEOP)	• Mailbox communications are possible. • Process data communications are possible. However, only the input data is valid. The output data is still not valid.
SAFEOP => OP	• The master sends valid output data. • The master requests the Operational state.
OPERATIONAL (OP)	• Mailbox communications are possible. • Process data communications are possible.

Information

1. The SERVOPACK does not support EtherCAT Read/Write commands (APRW, FPRW, BRW, and LRW).
2. For SDO and PDO communications through the EtherCAT data link layer, the FMMUs and Sync Managers must be set as follows:

- Sync Manager Settings

Sync Manager	Assignment (Fixed)	Size	Start Address (Fixed)
Sync Manager 0	Assigned to Receive Mailbox	128 bytes (fixed)	0x1000
Sync Manager 1	Assigned to Transmit Mailbox	128 bytes (fixed)	0x1080
Sync Manager 2	Assigned to Receive PDOs	0 to 256 bytes (0 to 200 bytes*)	0x1100
Sync Manager 3	Assigned to Transmit PDOs	0 to 256 bytes (0 to 200 bytes*)	0x1400 (0x1358*)

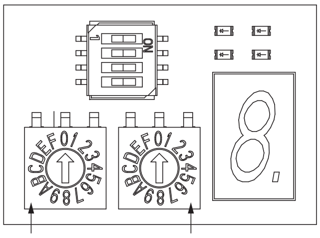
* This is the size and first address for a SERVOPACK with a revision number (object 1018 hex: 03 hex) of 0x00020000 or lower. This setting can also be used with a revision number (object 1018 hex: 03 hex) of 0x00030001 or higher.

- FMMU Settings

FMMU	Setting
FMMU 0	Mapped in receive PDO (RxPDO) area.
FMMU 1	Mapped in transmit PDO (TxPDO) area.
FMMU 2	Mapped to the mailbox status.

12.3 EtherCAT (CoE) Communications Settings

You can use EtherCAT secondary addresses (station aliases) to identify devices or to specify addresses.



12.3.1 Normal Device Recognition Process at Startup

When communications are started, the master uses auto-increment addressing to detect the slaves. The Identity objects read from the slaves are compared with the master configuration information (set in advance with an EtherCAT configuration tool). Therefore, the slaves must normally be connected in the network in the same order as they appear in the master configuration. However, you can define station aliases to enable using other network topologies.

12.3.2 Application Example

With a machining center, there may be two identical drives for operation in the X and Y directions. When a device is replaced, there is a chance that the cable may be connected in the wrong order. To prevent the drives from receiving incorrect process data, you can use station aliases to use explicit addresses for the drives.

12.3.3 Device Recognition with Station Aliases

The master uses auto-increment addressing to read the station aliases. It then compares the detected station aliases with the master configuration to get the topology that was set as the network topology.

Station Alias Register (0x0012)

The station alias is set in the ESC Configured Station Alias register when the power supply is turned ON.

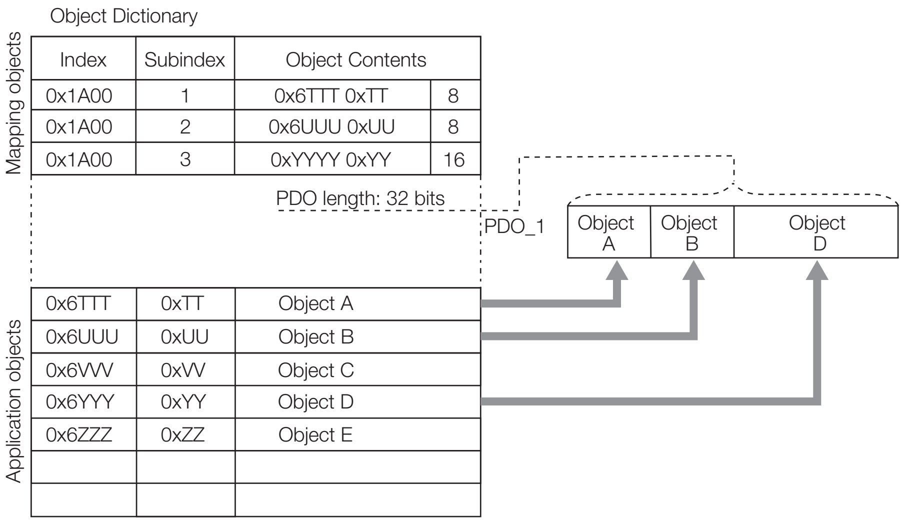
The value of the register can be read as follows:

Configured station alias = (S1 set value) × 16 + (S2 set value)

12.4 PDO Mappings

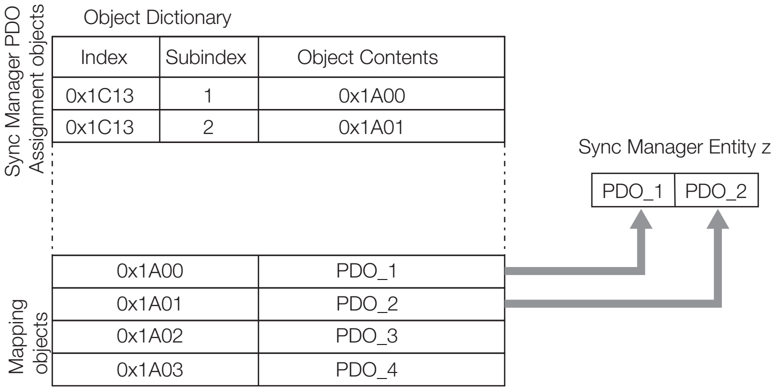
The process data that is used in process data communications is defined in the PDO mappings. POD mappings are definitions of the applications objects that are sent with PDOs. The PDO mapping tables are in indexes 1600 hex to 1603 hex for the RxPDOs and indexes 1A00 hex to 1A03 hex for the TxPDOs in the object dictionary.

The following figure shows an example of PDO mappings.



In addition to the above PDO mappings, PDOs have to be assigned to the Sync Managers to exchange EtherCAT process data.
The Sync Manager PDO assignment objects (1C12 hex and 1C13 hex) establish the relationship between these PDOs and the Sync Managers.

The following figure shows an example of a Sync Manager and the PDO mappings.



⚠ CAUTION

- The PDO mapping objects (indexes 1600 hex to 1603 hex and 1A00 hex to 1A03 hex) and the Sync Manager PDO assignment objects (index 1C12 hex and 1C13 hex) can be written only in Pre-Operation state.

12.4.1 Setting Procedure for PDO Mappings

1. Disable the assignments between the Sync Manager and PDOs.
(Set subindex 0 of objects 1C12 hex to 1C13 hex to 0.)
2. Set all of the mapping entries for the PDO mapping objects.
(Set objects 1600 hex to 1603 hex and 1A00 hex to 1A03 hex.)
3. Set the number of mapping entries for the PDO mapping objects.
(Set subindex 0 of objects 1600 hex to 1603 hex and 1A00 hex to 1A03 hex.)
4. Set the assignments between the Sync Manager and PDOs.
(Set subindex 1 of objects 1C12 hex to 1C13 hex.)
5. Enable the assignments between the Sync Manager and PDOs.
(Set subindex 0 of objects 1C12 hex to 1C13 hex to 1.)

12.4.2 Default PDO Mappings

The following table shows the default PDO mappings for the SERVOPACK.
The defaults are defined in the EtherCAT slave information file (ESI).

- 1st PDO Mapping (Position, Velocity, Torque, Torque Limit, and Touch Probe)

RxPDO (1600 hex)	Controlword (6040 hex)	Target position (607A hex)	Target velocity (60FF hex)	Target torque (6071 hex)	Max torque (6072 hex)	Mode of operation (6060 hex)	Padding (8 bits)	Touch probe function (60B8 hex)

TxPDO (1A00 hex)	Statusword (6041 hex)	Position actual value (6064 hex)	Torque actual value (6077 hex)	Following error actual value (60F4 hex)	Modes of operation display (6061 hex)	Padding (8 bits)	Touch probe status (60B9 hex)	Touch probe value (60BA hex)

- 2nd PDO Mapping (Cyclic Synchronous Position): Default PDO Assignments

RxPDO (1601 hex)	Controlword (6040 hex)	Target position (607A hex)

TxPDO (1A01 hex)	Statusword (6041 hex)	Position actual value (6064 hex)

- 3rd PDO Mapping (Cyclic Synchronous Velocity)

RxPDO (1602 hex)	Controlword (6040 hex)	Target velocity (60FF hex)

TxPDO (1A02 hex)	Statusword (6041 hex)	Position actual value (6064 hex)

- 4th PDO Mapping (Cyclic Synchronous Torque)

RxPDO (1603 hex)	Controlword (6040 hex)	Target torque (6071 hex)

TxPDO (1A03 hex)	Statusword (6041 hex)	Position actual value (6064 hex)	Torque actual value (6077 hex)

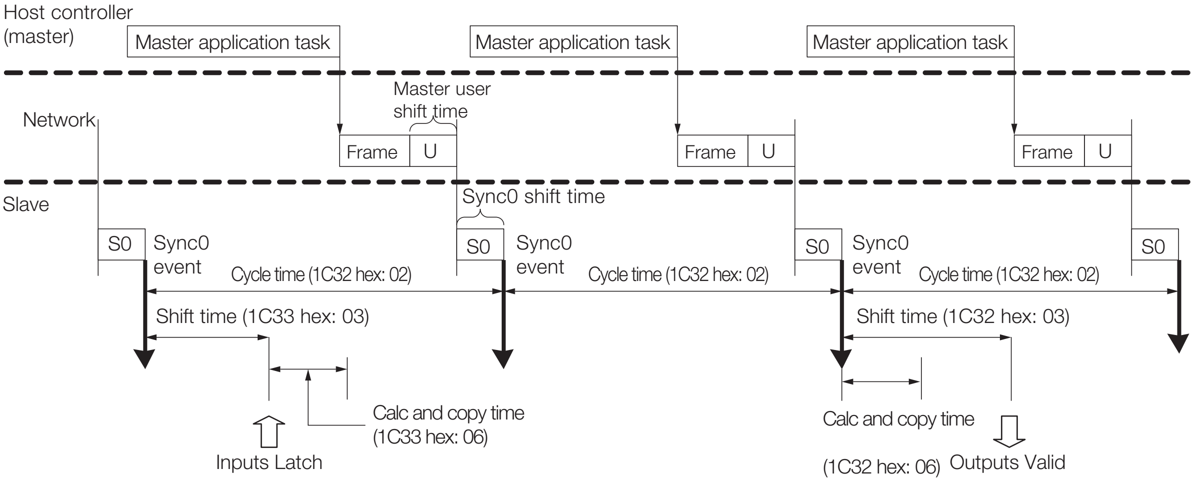
12.5 Synchronization with Distributed Clocks

The synchronization of EtherCAT communications is based on a mechanism called a distributed clock. With the distributed clock, all devices are synchronized with each other by sharing the same reference clock. The slave devices synchronize the internal applications to the Sync0 events that are generated according to the reference clock.

You can use the following synchronization modes with EtherCAT (CoE). You can change the synchronization mode in the Sync Control registers (ESC registers 0x980 and 0x981).

- Free-Run (ESC register 0x980 = 0x0000)
  In Free-Run mode, the local cycle is independent from the communications cycle and master cycle.
- DC Mode (ESC register 0x980 = 0x0300)
  In this mode, the SERVOPACK is synchronized with the host controller (master) on the Sync0 event.

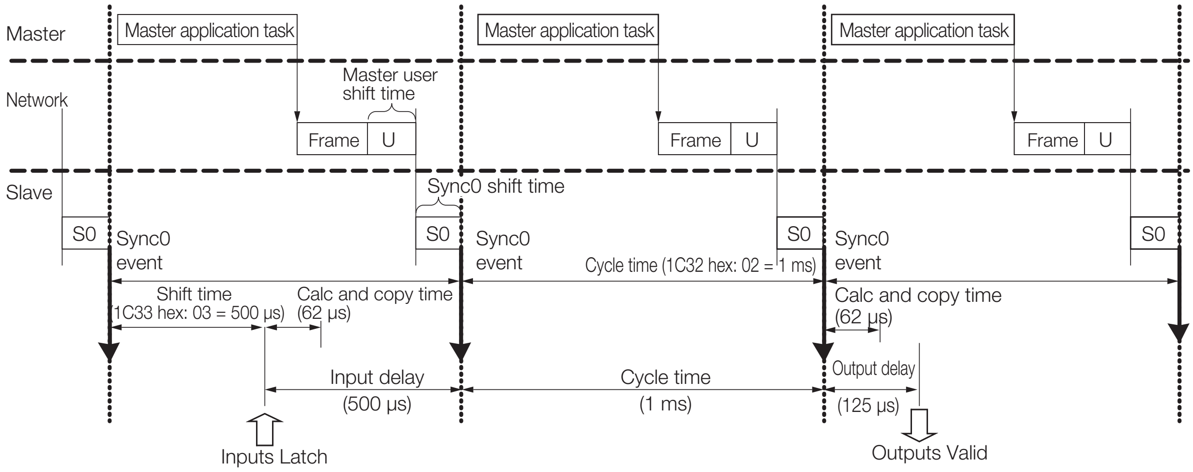
The following figure gives a timing chart for DC synchronization.



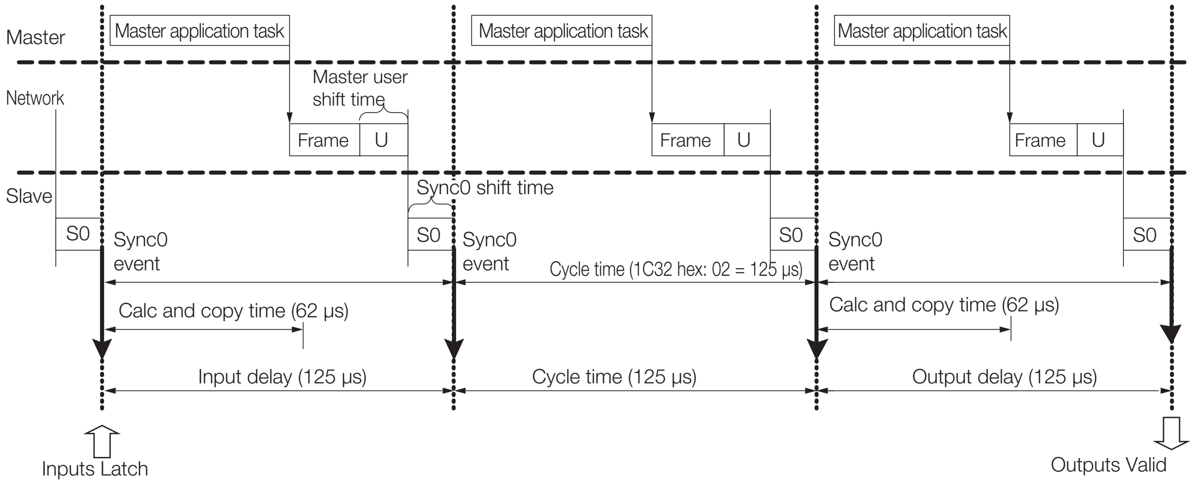
Index	Sub-index	Name	Access	PDO Mapping	Data Type	Description
1C32 hex	Sync Manager channel 2 (process data output) synchronization					
	1	Synchronization type	RO	No	UINT	Current status of DC mode 0: Free-run 2: DC mode (synchronous with Sync0)
	2	Cycle time	RO	No	UDINT	Sync0 event cycle [ns] (The value is set by the master via an ESC register.) Range: 125,000 × n (n = 1 to 32) [ns]
	3	Shift time	RO	No	UDINT	125,000 [ns] (fixed) The time between the Sync0 event and Outputs Valid (i.e., the time from Sync0 until the output data is input to the SERVOPACK).
	6	Calc and copy time	RO	No	UDINT	62,500 [ns] (fixed) The time from the Sync0 event until the output data from Sync Manager 2 is read.
1C33 hex	Sync Manager channel 3 (process data input) synchronization					
	3	Shift time	RW	No	UDINT	125,000 × n (n = 1 to 32) [ns] Range: 0 to (Sync0 event cycle - 125,000) [ns] The time between the Sync0 event and Inputs Latch (i.e., when the input data is obtained from the SERVOPACK).
	6	Calc and copy time	RO	No	UDINT	62,500 [ns] (fixed) The time for copying the input process data to the Sync Manager 3 area.

Example of PDO Data Exchange Timing in DC Mode

- DC Cycle Time = 1 ms, Input Shift Time = 500 µs



- DC Cycle Time = 125 µs, Input Shift Time = 0 µs



12.6 Emergency Messages

Emergency messages are triggered by alarms and warnings detected within the SERVOPACK. They are sent via the mailbox interface.

An emergency message consists of eight bytes of data as shown in the following table.

Byte	0	1	2	3	4	5	6	7
Description	Emergency error code (FF00 hex)*1		Error register (object 1001 hex)	Reserved.	Manufacturer-specific error field			
					SERVOPACK alarm/ warning code*2		Reserved.	

*1. The manufacturer-specific error code is always FF00 hex.

*2. For details on SERVOPACK alarms and warnings, refer to the following sections.

☞ *15.2.2 Troubleshooting Alarms* on page 15-10

☞ *15.3.2 Troubleshooting Warnings* on page 15-44

CiA402 Drive Profile

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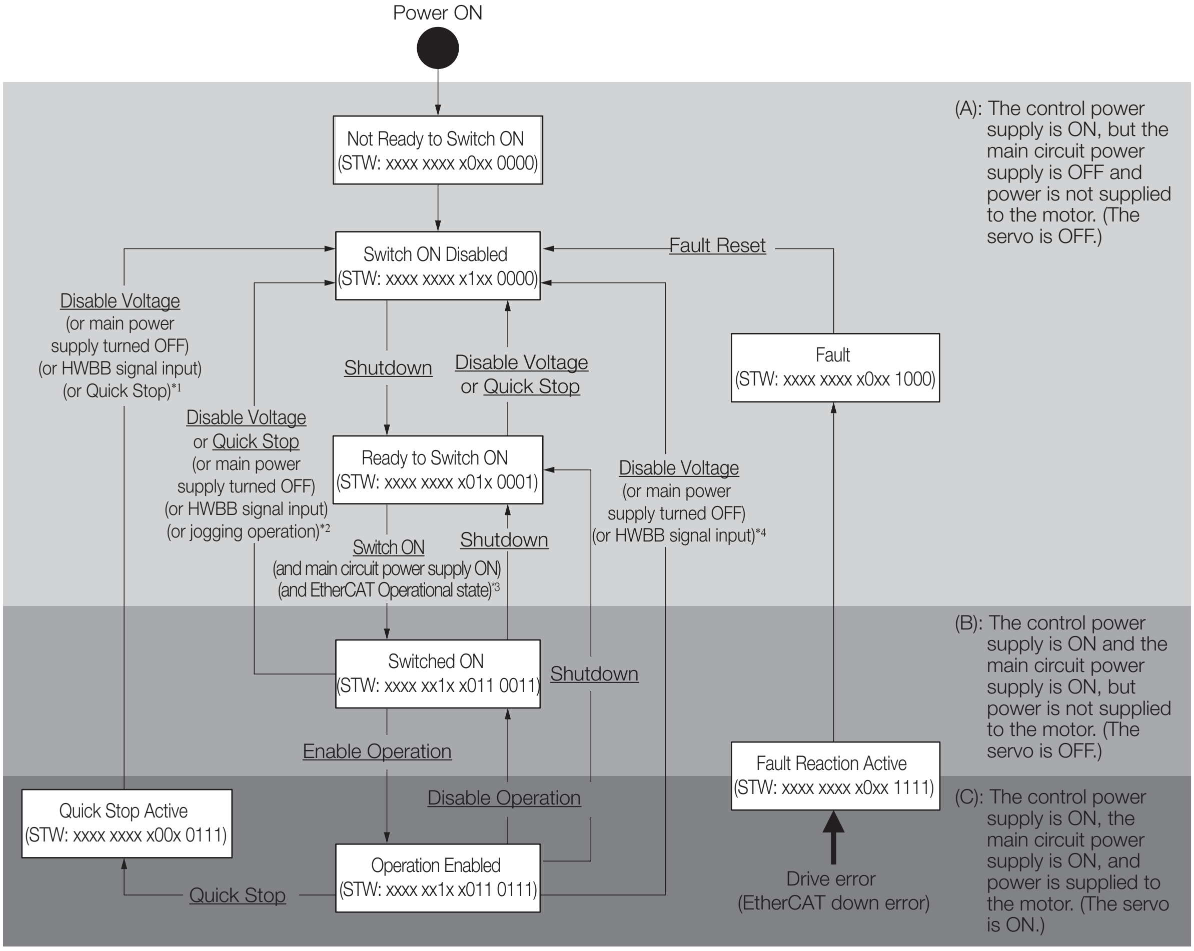
13.1 Device Control

You use the *controlword* (6040 hex) to execute device control for the Servo Drive according to the following state transitions. You can use the *statusword* (6041 hex) to monitor the device status of the Servo Drive.



[1] In the Quick Stop Active state, the SERVOPACK automatically moves to the Switch ON Disabled state in the following cases:
- The main power supply was turned OFF.
- The HWBB signal was input.
- The motor was stopped.

[2] In the Switched ON state, the SERVOPACK automatically moves to the Switch ON Disabled state in the following cases:
- The main power supply was turned OFF.
- The HWBB signal was input.
- Motor operation was already enabled by the Digital Operator or the SigmaWin+.

[3] In the Ready to Switch ON state, the SERVOPACK moves to the next state in the following cases:
- The main circuit power supply is ON.
- The EtherCAT state machine (ESM) is in the Operational state.
- The Servomotor is not being operated by the Digital Operator or the SigmaWin+.

[4] In the Operation Enabled state, the SERVOPACK automatically moves to the Switch ON Disabled state in the following cases:
- The main power supply was turned OFF.
- The HWBB signal was input.

Note: 1. ☐ : The states are shown in white boxes.
2. STW indicates the *statusword* (6041 hex).
3. ___________: Underlines indicate control commands in the *controlword* (6040 hex).

13.1.1 State Machine Control Commands

Command	Bits in Controlword (6040 Hex)				
	Bit 7	Bit 3	Bit 2	Bit 1	Bit 0
Shutdown	0	–	1	1	0
Switch ON	0	0	1	1	1
Switch ON + Enable Operation	0	1	1	1	1
Disable Voltage	0	–	–	0	–
Quick Stop	0	–	0	1	–
Disable Operation	0	0	1	1	1
Enable Operation	0	1	1	1	1
Fault Reset	0 → 1	–	–	–	–

13.1.2 Bits in Statusword (6041 Hex)

Bit	Data Description	Remarks
0	Ready to Switch ON	Refer to the following section for details. ☞ *14.6 Device Control* on page 14-22
1	Switched ON	
2	Operation Enabled	
3	Fault	
4	Voltage Enabled	
5	Quick Stop	
6	Switch ON Disabled	
7	Warning	
8	Active Mode Stop	
9	Remote	
10	Target Reached	
11	Internal Limit Active	
12	Operation Mode Specific	
13		
14	Torque Limit Active	
15	Safety Active	

13.1.3 Related Objects

Index	Subindex	Name	Access	PDO Mapping	Unit	Data Type
6040 hex	0	Controlword	RW	Yes	–	UINT
6041 hex	0	Statusword	RO	Yes	–	UINT
605A hex	0	Quick stop option code	RW	No	–	INT
605B hex	0	Shutdown option code	RW	No	–	INT
605C hex	0	Disable operation option code	RW	No	–	INT
605D hex	0	Halt option code	RW	No	–	INT
605E hex	0	Fault reaction option code	RW	No	–	INT

13.2 Modes of Operation

The SERVOPACK supports the following modes of operation.

- Profile Position Mode
- Homing Mode
- Interpolated Position Mode
- Profile Velocity Mode
- Torque Profile Velocity Mode
- Cyclic Sync Position Mode
- Cyclic Sync Velocity Mode
- Cyclic Sync Torque Mode

13.2.1 Related Objects

Index	Subindex	Name	Access	PDO Mapping	Unit	Data Type
6060 hex	0	Modes of operation	RW	Yes	–	SINT
6061 hex	0	Modes of operation display	RO	Yes	–	SINT
6502 hex	0	Supported drive modes	RO	No	–	UDINT

13.2.2 Dynamic Mode Changes

You can change the operation mode with *modes of operation* (6060 hex). The master must update all operation mode-specific process data objects at the same time when it changes the operation mode during motor operation. If the master selects a new operation mode, the SERVOPACK will change to the new operation mode immediately. The following table describes operation when the operation mode is changed to a new mode.

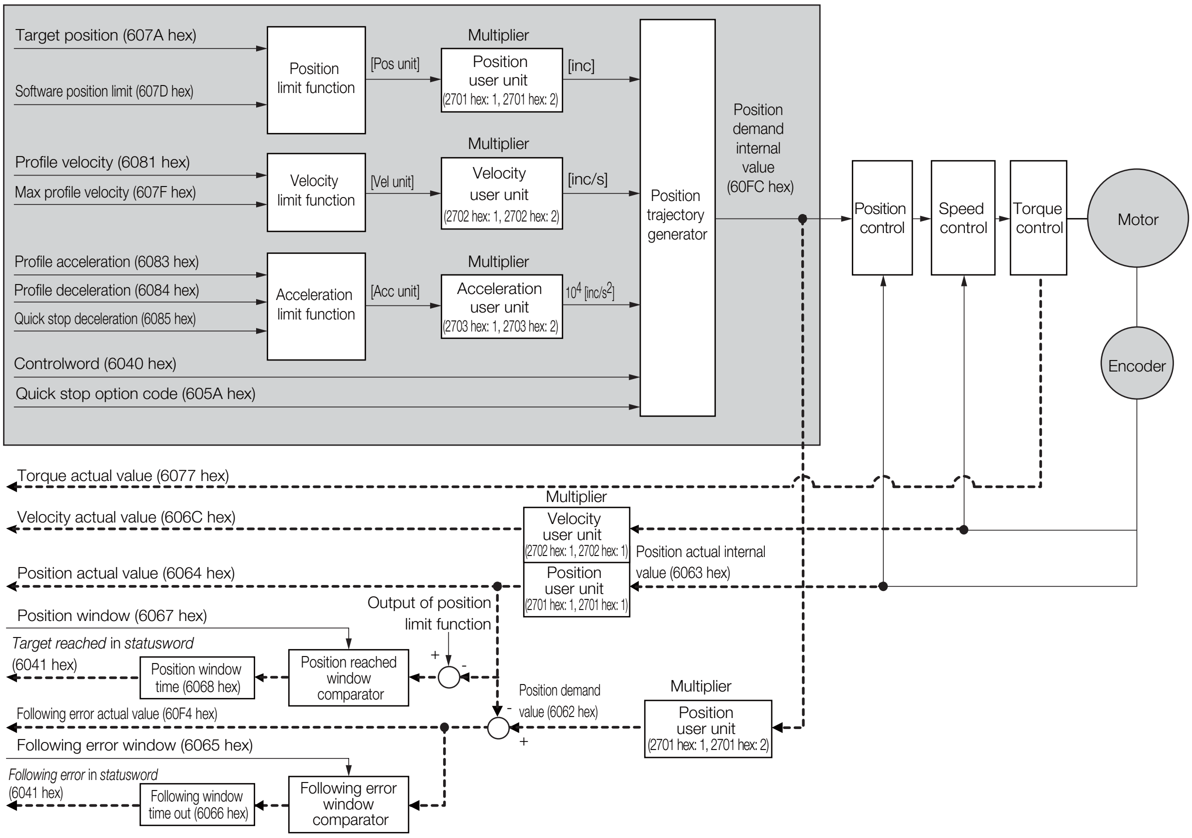
New Operation Mode	Operation When Operation Mode Is Changed
Profile Position Mode	Controlword bit 4 = 0: The motor is stopped in the current position control mode. Controlword bit 4 = 1: A new positioning operation is started immediately.
Homing Mode	Controlword bit 4 = 0: The motor is stopped in the current position control mode. Controlword bit 4 = 1: Homing is started immediately.
Interpolated Position Mode	Controlword bit 4 = 0: The motor is stopped in the current position control mode. Controlword bit 4 = 1: A new positioning operation is started immediately.
Profile Velocity Mode	The new operation mode is started immediately.
Torque Profile Velocity Mode	The new operation mode is started immediately.
Cyclic Sync Position Mode	The new operation mode is started immediately.
Cyclic Sync Velocity Mode	The new operation mode is started immediately.
Cyclic Sync Torque Mode	The new operation mode is started immediately.

13.3 Position Control Modes

13.3.1 Profile Position Mode

The Profile Position Mode is used to position to the Target Position at the Profile Velocity and the Profile Acceleration.

The following figure shows the block diagram for the Profile Position Mode.



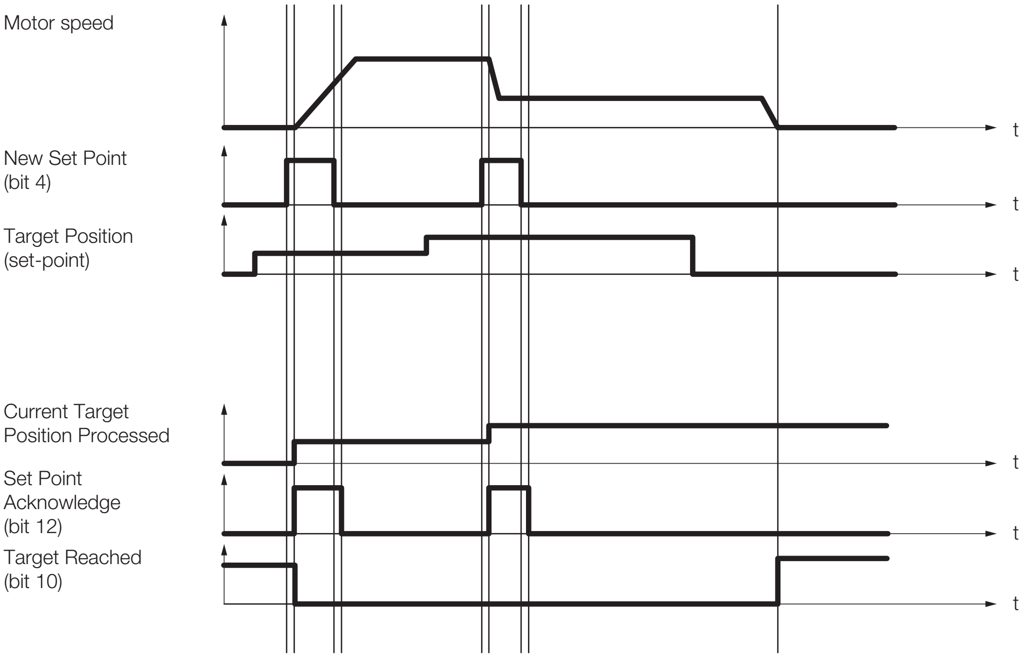
Related Objects

Index	Subindex	Name	Access	PDO Mapping	Unit	Data Type
6040 hex	0	Controlword	RW	Yes	–	UINT
6041 hex	0	Statusword	RO	Yes	–	UINT
607A hex	0	Target position	RW	Yes	Pos unit	DINT
607D hex	Software position limit					
	1	Min position limit	RW	No	Pos unit	DINT
	2	Max position limit	RW	No	Pos unit	DINT
607F hex	0	Max profile velocity	RW	Yes	Vel unit	UDINT
6081 hex	0	Profile velocity	RW	Yes	Vel unit	UDINT
6083 hex	0	Profile acceleration	RW	Yes	Acc unit	UDINT
6084 hex	0	Profile deceleration	RW	Yes	Acc unit	UDINT
6085 hex	0	Quick stop deceleration	RW	Yes	Acc unit	UDINT

In the Profile Position Mode, the following two methods can be used to start positioning.

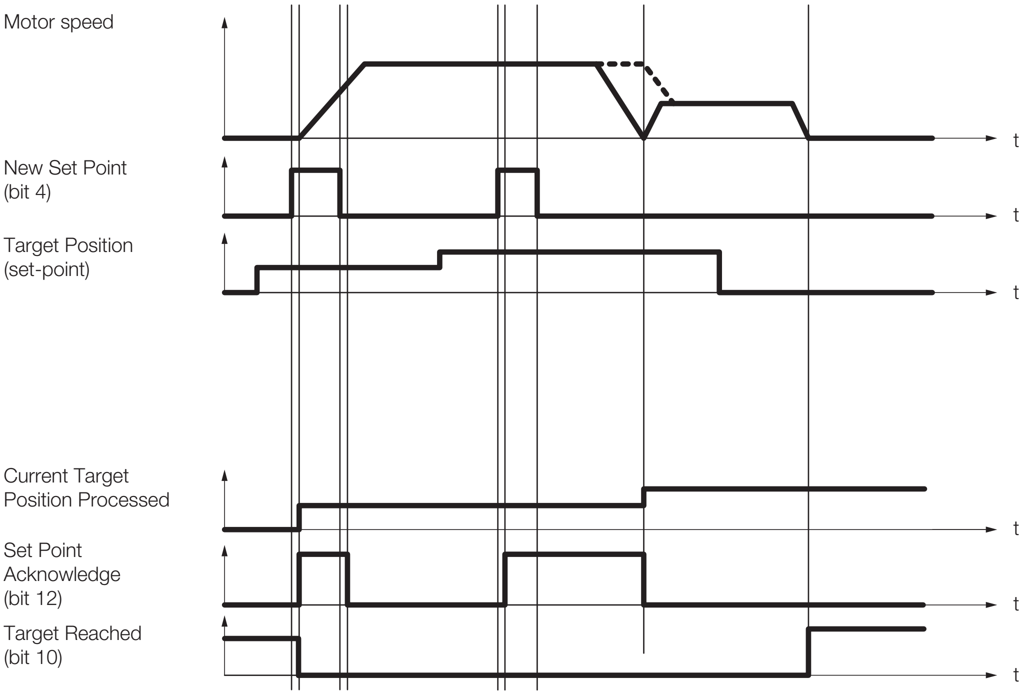
◆ Single Set Point (When Change Set Immediately Bit in *Controlword* Is 1)

When a new command is input to the New Set Point Bit (bit 4) in *controlword* during positioning, positioning for the new command is started immediately.



◆ Set of Set Points (When Change Set Immediately Bit in *Controlword* Is 0)

When a new command is input in the New Set Point Bit (bit 4) in *controlword* during positioning, positioning for the new command is started as soon as the current positioning operation is completed. The dotted line in the following figure shows the actual speed if the Change of Set Point Bit (bit 9) is set to 1.



13.3.2 Interpolated Position Mode

The Interpolated Position Mode is used to control multiple coordinated axes or to control a single axis that requires time interpolation of the set point data. There are the following two submodes for the Interpolated Position Mode.

Interpolation submode select (60C0 hex) is used to change the submode. Refer to the following section for details.

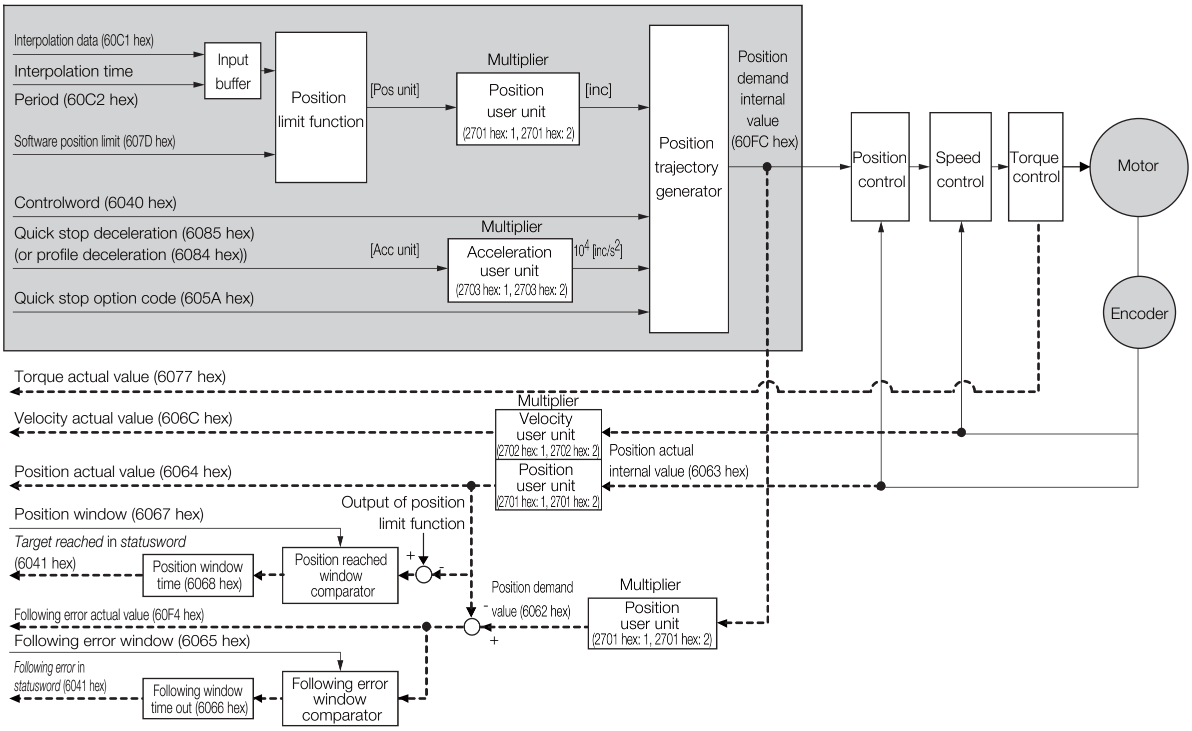
☞ *14.10 Interpolated Position Mode* on page 14-36

Interpolated Position Mode		Number of Data	Number of Profiles
Mode 1	No position reference filter	1	1
	Position reference filter		
Mode 2	No position reference filter	1 to 254	2
	Position reference filter		

Mode 1

This submode normally uses a time (communications) synchronization mechanism to synchronize the Servo Drives. The Interpolation Time Period defines the update cycle of the Interpolation Data (i.e., the interpolation position). The interpolation processing in the SERVOPACK is based on this setting. The Interpolation Data is interpreted as an absolute value.

The following figure shows the block diagram for mode 1.



◆ Related Objects

Index	Subindex	Name	Access	PDO Mapping	Unit	Data Type
6040 hex	0	Controlword	RW	Yes	–	UINT
6041 hex	0	Statusword	RO	Yes	–	UINT
60C1 hex	1	Interpolation data record	RW	Yes	Pos unit	DINT

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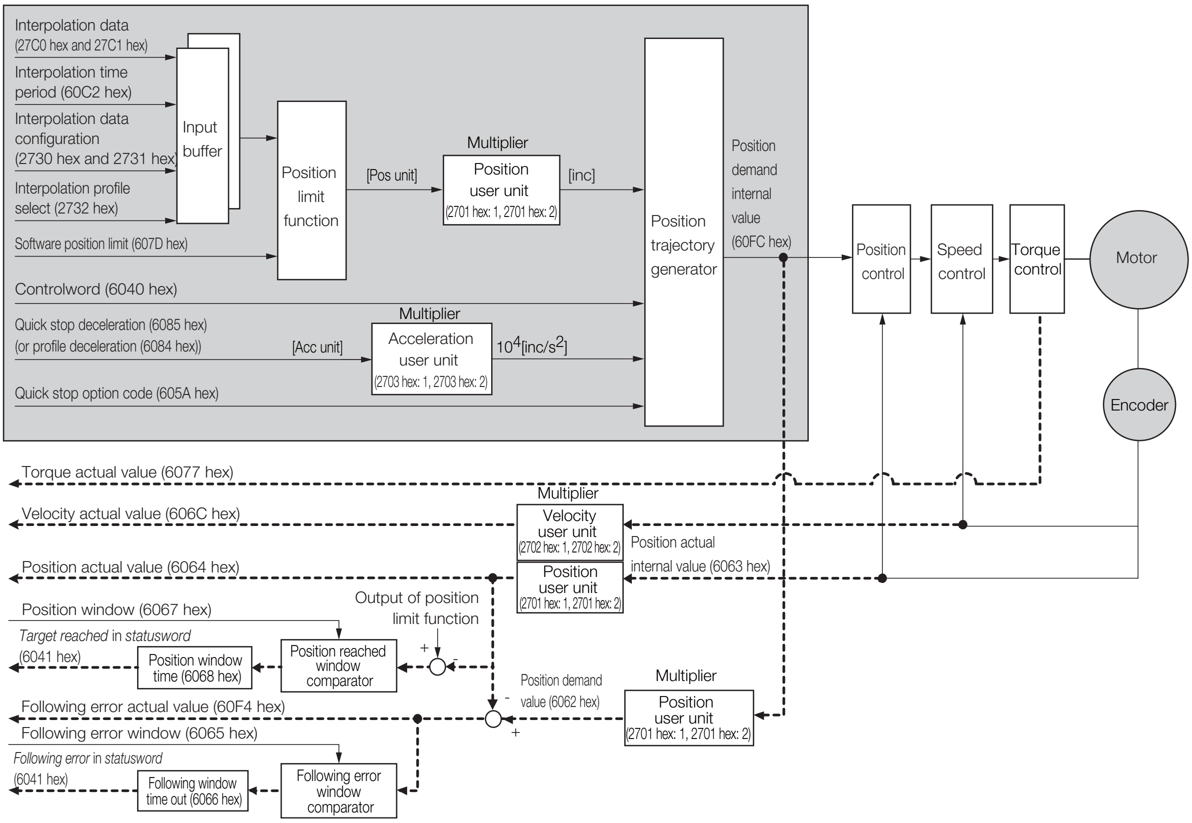
Index	Subindex	Name	Access	PDO Mapping	Unit	Data Type
60C2 hex	Interpolation time period					
	1	Interpolation time period value	RO	No	–	USINT
	2	Interpolation time index	RO	No	–	SINT
607D hex	Software position limit					
	1	Min position limit	RW	No	Pos unit	DINT
	2	Max position limit	RW	No	Pos unit	DINT
6084 hex	0	Profile deceleration	RW	Yes	Acc unit	UDINT
6085 hex	0	Quick stop deceleration	RW	Yes	Acc unit	UDINT

Mode 2

This submode is used to perform interpolation feeding control for an individual axis. Unlike mode 1, mode 2 has reference input buffers (*interpolation data record for 1st profile* and *interpolation data record for 2nd profile*) that you can set to different interpolation positions (*interpolation data record*). The interpolation positions that are set in the reference input buffers are read each *interpolation time period* to perform interpolation processing.

The following figure shows the block diagram for mode 2.



◆ Related Objects

Index	Subindex	Name	Access	PDO Mapping	Unit	Data Type
6040 hex	0	Controlword	RW	Yes	–	UINT
6041 hex	0	Statusword	RO	Yes	–	UINT
60C2 hex	Interpolation time period					
	1	Interpolation time period value	RW	No	–	USINT
	2	Interpolation time index	RW	No	–	SINT

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Index	Subindex	Name	Access	PDO Mapping	Unit	Data Type
2730 hex	Interpolation data configuration for 1st profile					
	1	Maximum buffer size	RO	No	–	UDINT
	2	Actual buffer size	RW	No	–	UDINT
	3	Buffer organization	RW	No	–	USINT
	4	Buffer position	RW	Yes	–	UINT
	5	Size of data record	WO	No	–	USINT
	6	Buffer clear	WO	No	–	USINT
	7	Position data definition	RW	Yes	–	USINT
	8	Position data polarity	RW	Yes	–	USINT
	9	Behavior after reaching buffer position	RW	Yes	–	USINT
2731 hex	Interpolation data configuration for 2nd profile					
	1	Maximum buffer size	RO	No	–	UDINT
	2	Actual buffer size	RW	No	–	UDINT
	3	Buffer organization	RW	No	–	USINT
	4	Buffer position	RW	Yes	–	UINT
	5	Size of data record	WO	No	–	USINT
	6	Buffer clear	WO	No	–	USINT
	7	Position data definition	RW	Yes	–	USINT
	8	Position data polarity	RW	Yes	–	USINT
	9	Behavior after reaching buffer position	RW	Yes	–	USINT
2732 hex	0	Interpolation profile select	RW	Yes	–	USINT
27C0 hex	1-254	Interpolation data record for 1st profile	RW	No	Pos unit	DINT
27C1 hex	1-254	Interpolation data record for 2nd profile	RW	No	Pos unit	DINT
2741 hex	Interpolation data read/write pointer position monitor					
	1	Interpolation data read pointer position	RO	Yes	–	UINT
	2	Interpolation data write pointer position	RO	Yes	–	UINT
607D hex	Software position limit					
	1	Min position limit	RW	No	Pos unit	DINT
	2	Max position limit	RW	No	Pos unit	DINT
6084 hex	0	Profile deceleration	RW	Yes	Acc unit	UDINT
6085 hex	0	Quick stop deceleration	RW	Yes	Acc unit	UDINT

◆ Object Setting Procedure

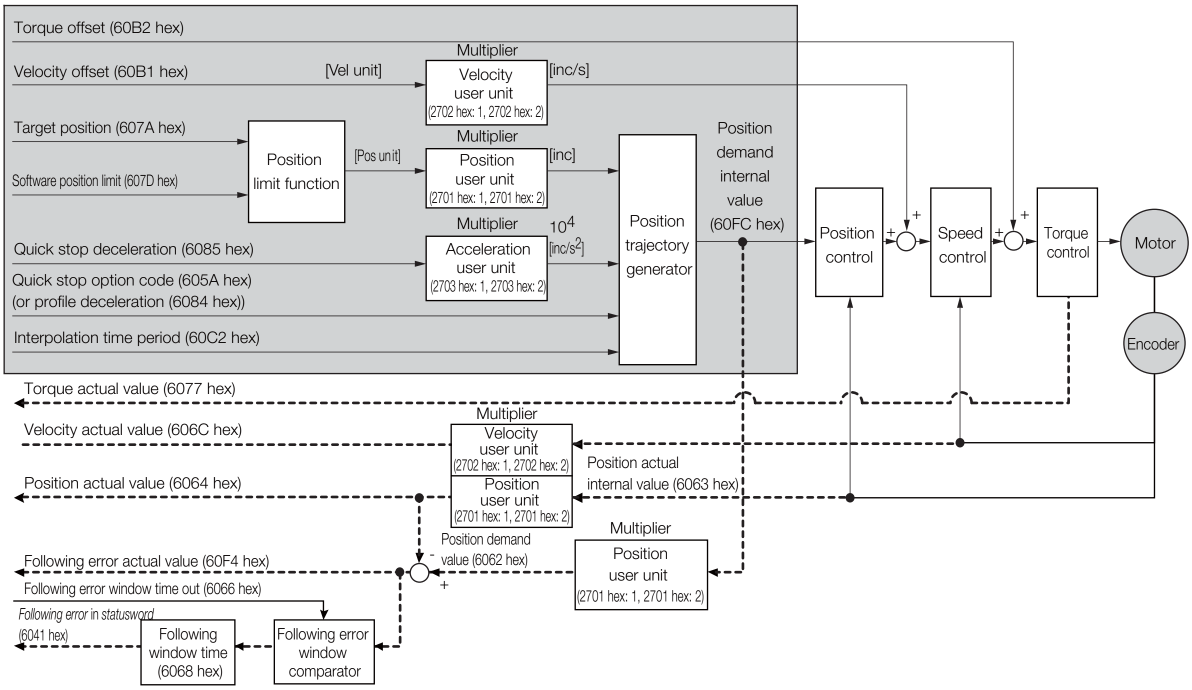
The recommended object setting procedure to use mode 2 is given in the following table.

Step	Description
1	Set *interpolation submode select* (60C0 hex).
2	Set *interpolation profile select* (2732 hex).
3	Set *interpolation data configuration for 1st profile* (2730 hex) and *interpolation data configuration for 2nd profile* (2731 hex).
4	Set *interpolation data record for 1st profile* (27C0 hex) and *interpolation data record for 2nd profile* (27C1 hex).
5	Set *mode of operation* (6060 hex).
6	Set *enable interpolation* (6060 hex bit 4).

13.3.3 Cyclic Synchronous Position Mode

The Cyclic Synchronous Position Mode is used for the interpolated positioning in the same way as the Interpolated Position Mode. In this mode, speed and torque compensations can be specified by the master to enable speed and torque feedforward.
The *interpolation time period* defines the interval at which the Target Position is updated. Interpolation is performed in the SERVOPACK according to this setting. The target position is interpreted as an absolute value.

The following figure shows the block diagram for the Cyclic Synchronous Position Mode.



◆ Related Objects

Index	Subindex	Name	Access	PDO Mapping	Unit	Data Type
607A hex	0	Target position	RW	Yes	Pos unit	DINT
607D hex	Software position limit					
	1	Min position limit	RW	No	Pos unit	DINT
	2	Max position limit	RW	No	Pos unit	DINT
6084 hex	0	Profile deceleration	RW	Yes	Acc unit	UDINT
6085 hex	0	Quick stop deceleration	RW	Yes	Acc unit	UDINT

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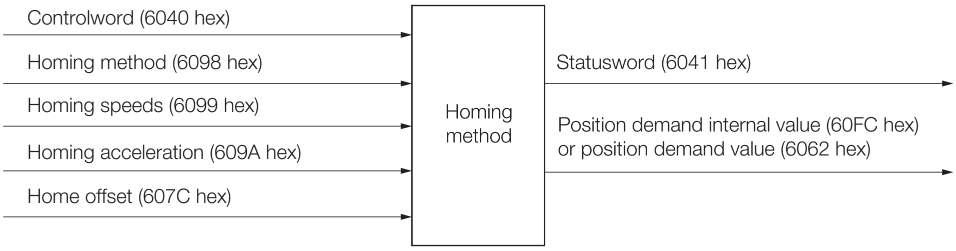
Index	Subindex	Name	Access	PDO Mapping	Unit	Data Type
60B1 hex	0	Velocity offset	RW	Yes	Vel unit	DINT
60B2 hex	0	Torque offset	RW	Yes	0.1% *	INT
60C2 hex	Interpolation time period					
	1	Interpolation time period value	RO	No	–	USINT
	2	Interpolation time index	RO	No	–	SINT

* The rated motor torque is 100%.

13.4 Homing

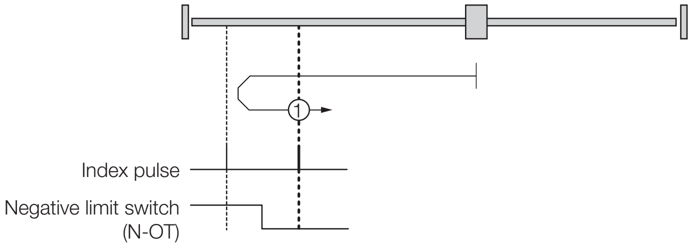
The following figure shows the relationship between the input objects and the output objects in the Homing Mode. You can specify the speeds, acceleration rate, and homing method. You can also use *home offset* to offset zero in the user coordinate system from the home position.



13.4.1 Related Objects

Index	Subindex	Name	Access	PDO Mapping	Unit	Data Type
6040 hex	0	Controlword	RW	Yes	–	UINT
6041 hex	0	Statusword	RO	Yes	–	UINT
607C hex	0	Home offset	RW	No	Pos unit	DINT
6098 hex	0	Homing method	RW	Yes	–	SINT
6099 hex	Homing speeds					
	1	Speed during search for switch	RW	Yes	Vel unit	UDINT
	2	Speed during search for zero	RW	Yes	Vel unit	UDINT
609A hex	0	Homing acceleration	RW	Yes	Acc unit	UDINT

13.4.2 Homing Method (6098 Hex)

Value	Definition	Description
0	–	No homing (default setting)
1	Homing with the negative limit switch and index pulse	With this method, homing starts in the negative direction if the negative limit switch is inactive. The home position is the first index pulse that is detected after the negative limit switch becomes inactive. 

Note: The index pulse is the encoder's zero signal (phase C).

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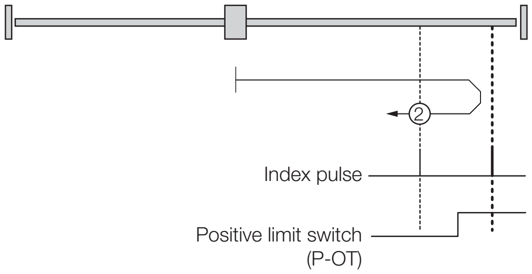
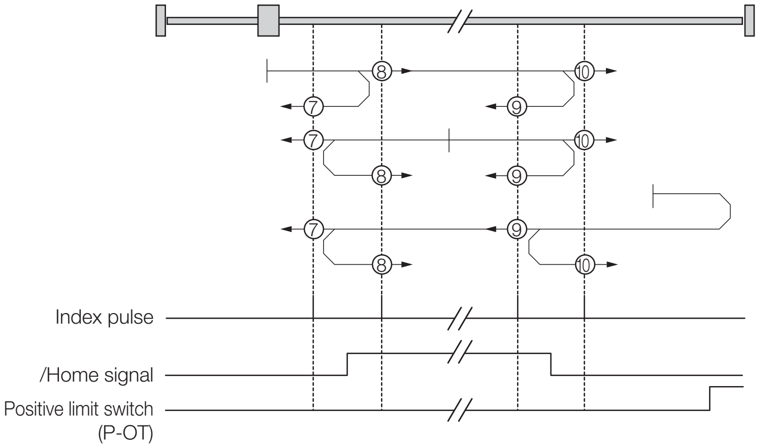
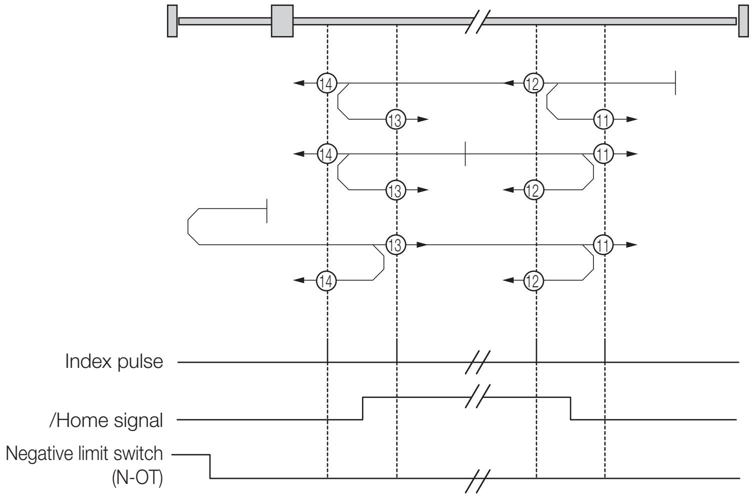
Value	Definition	Description
2	Homing with the positive limit switch and index pulse	With this method, homing starts in the positive direction if the positive limit switch is inactive. The home position is the first index pulse that is detected after the positive limit switch becomes inactive. 
7 to 10	Homing with the home switch input (/Home) signal and index pulse and starting in the positive direction	With methods 7 to 10, homing starts in the positive direction. However, if the /Home signal is already active when homing is started, the initial homing direction depends on the required edge. The home position will be the index pulse on either the rising or falling edge side of the /Home signal. If the initial movement direction is away from the /Home signal, the motor will reverse direction when the limit switch in the movement direction is input. 
11 to 14	Homing with the home switch input (/Home) signal and index pulse and starting in the negative direction	These methods are similar to methods 7 to 10 except that homing starts in the negative direction. 

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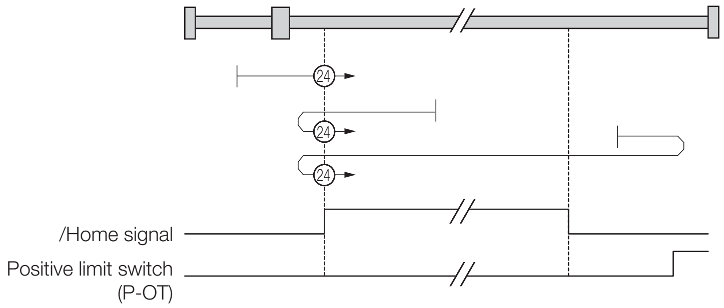
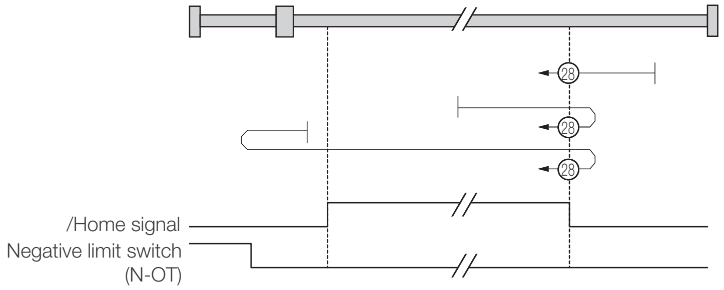
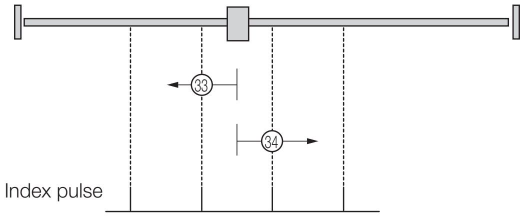
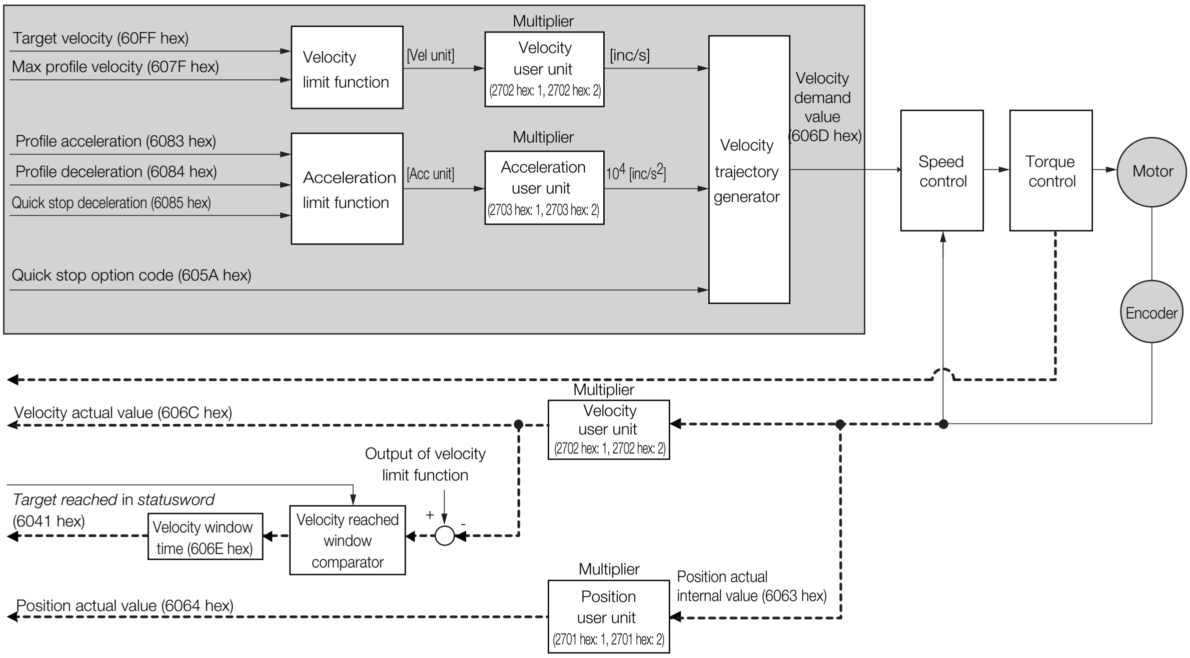
Value	Definition	Description
24	Homing with the home switch input (/Home) signal and starting in the positive direction	This method is same as method 8 except that the home position does not depend on the index pulse. Here, it depends only on changes in the relevant /Home signal or limit switch. 
28	Homing with the home switch input (/Home) signal and starting in the negative direction	This method is same as method 12 except that the home position does not depend on the index pulse. Here, it depends only on changes in the relevant /Home signal or limit switch. 
33, 34	Homing with the index pulse	
35	Homing with the current position	With this method, the current position is defined as the home position. You can execute this method even if the Servo Drive is not in the Operation Enabled state.

13.5 Velocity Control Modes

13.5.1 Profile Velocity Mode

In the Profile Velocity Mode, the speed is output according to the *profile acceleration* and *profile deceleration* until it reaches the *target velocity*.

The following figure shows the block diagram for the Profile Velocity Mode.



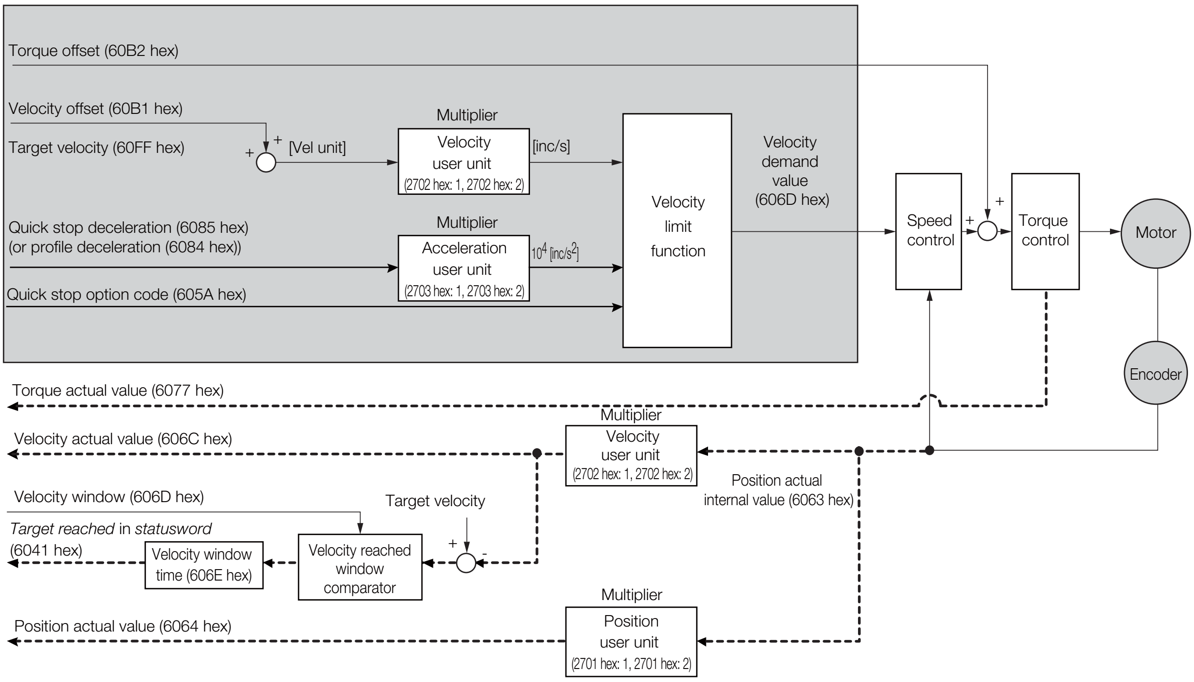
Related Objects

Index	Subindex	Name	Access	PDO Mapping	Unit	Data Type
60FF hex	0	Target velocity	RW	Yes	Vel unit	DINT
607F hex	0	Max profile velocity	RW	Yes	Vel unit	UDINT
6083 hex	0	Profile acceleration	RW	Yes	Acc unit	UDINT
6084 hex	0	Profile deceleration	RW	Yes	Acc unit	UDINT
6085 hex	0	Quick stop deceleration	RW	Yes	Acc unit	UDINT
606B hex	0	Velocity demand value	RO	Yes	Vel unit	DINT
606C hex	0	Velocity actual value	RO	Yes	Vel unit	DINT
606D hex	0	Velocity window	RW	No	Vel unit	UINT
606E hex	0	Velocity window time	RW	No	ms	UINT

13.5.2 Cyclic Synchronous Velocity Mode

In the Cyclic Synchronous Velocity Mode, the master provides the target speed to the Servo Drive, which performs speed control. In this mode, a torque compensation can be specified by the master to enable torque feedforward.

The following figure shows the block diagram for the Cyclic Synchronous Velocity Mode.



Related Objects

Index	Subindex	Name	Access	PDO Mapping	Unit	Data Type
60FF hex	0	Target velocity	RW	Yes	Vel unit	DINT
60B1 hex	0	Velocity offset	RW	Yes	Vel unit	DINT
60B2 hex	0	Torque offset	RW	Yes	0.1% *	INT
6084 hex	0	Profile deceleration	RW	Yes	Acc unit	UDINT
6085 hex	0	Quick stop deceleration	RW	Yes	Acc unit	UDINT
606B hex	0	Velocity demand value	RO	Yes	Vel unit	DINT
606C hex	0	Velocity actual value	RO	Yes	Vel unit	DINT
606D hex	0	Velocity window	RW	No	Vel unit	UINT
606E hex	0	Velocity window time	RW	No	ms	UINT

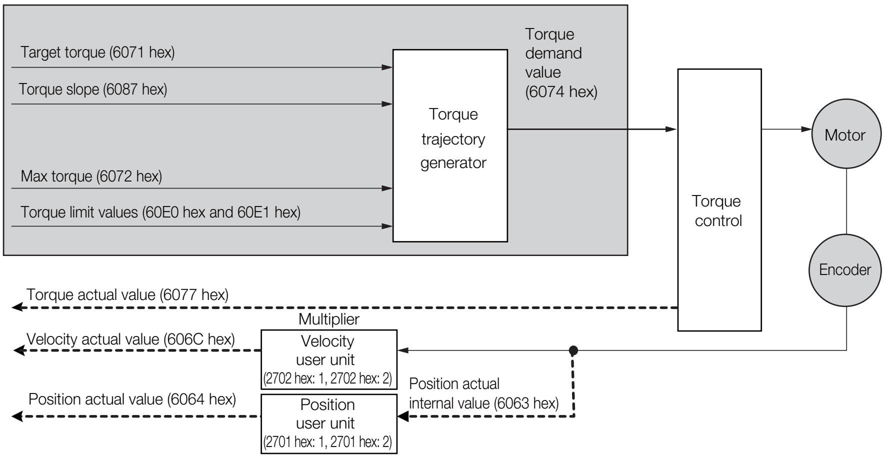
* The rated motor torque is 100%.

13.6 Torque Control Modes

13.6.1 Profile Torque Mode

In the Profile Torque Mode, the torque is output up to the *target torque* according to the *torque slope* setting.

The following figure shows the block diagram for the Profile Torque Mode.



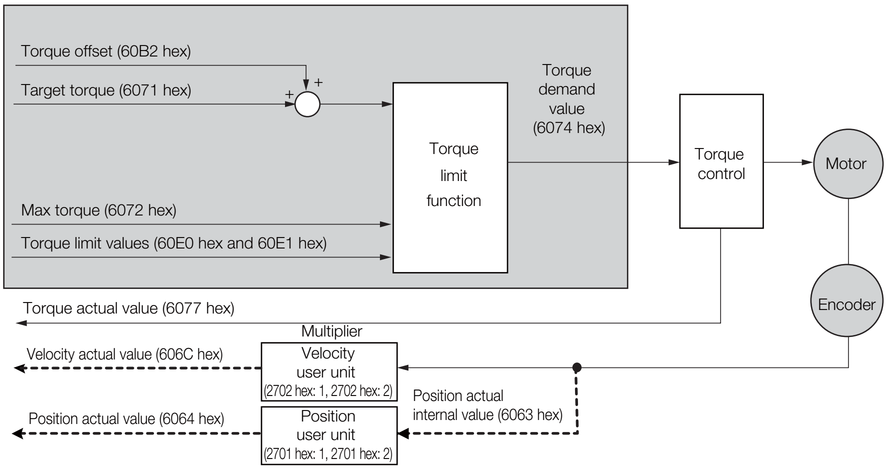
Related Objects

Index	Subindex	Name	Access	PDO Mapping	Unit	Data Type
6071 hex	0	Target torque	RW	Yes	0.1% *	INT
6087 hex	0	Torque slope	RW	Yes	0.1%/s *	UDINT
6074 hex	0	Torque demand value	RO	Yes	0.1% *	INT
6077 hex	0	Torque actual value	RO	Yes	0.1% *	INT
6072 hex	0	Max torque	RW	Yes	0.1% *	UINT
60E0 hex	0	Positive torque limit value	RW	Yes	0.1% *	UINT
60E1 hex	0	Negative torque limit value	RW	Yes	0.1% *	UINT

* The rated motor torque is 100%.

13.6.2 Cyclic Sync Torque Mode

In the Cyclic Synchronous Torque Mode, the master provides the *target torque* to the Servo Drive, which performs torque control.



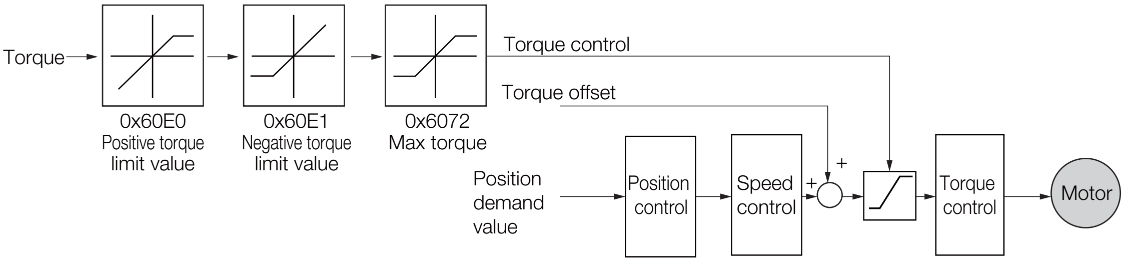
Related Objects

Index	Subindex	Name	Access	PDO Mapping	Unit	Data Type
6071 hex	0	Target torque	RW	Yes	0.1% *	INT
6074 hex	0	Torque demand value	RO	Yes	0.1% *	INT
6077 hex	0	Torque actual value	RO	Yes	0.1% *	INT
60B2 hex	0	Torque offset	RW	Yes	0.1% *	INT
6072 hex	0	Max torque	RW	Yes	0.1% *	UINT
60E0 hex	0	Positive torque limit value	RW	Yes	0.1% *	UINT
60E1 hex	0	Negative torque limit value	RW	Yes	0.1% *	UINT

* The rated motor torque is 100%.

13.7 Torque Limits

The following figure shows the block diagram for the torque limits. The torque is limited by the lowest limit value.



Related Objects

Index	Subindex	Name	Access	PDO Mapping	Unit	Data Type
6072 hex	0	Max torque	RW	Yes	0.1% *	UINT
60E0 hex	0	Positive torque limit value	RW	Yes	0.1% *	UINT
60E1 hex	0	Negative torque limit value	RW	Yes	0.1% *	UINT

* The rated motor torque is 100%.

13.8 Digital I/O Signals

The *digital inputs* and *digital outputs* are used to control the I/O signals of the CN1 connector on the SERVOPACK.

Index	Subindex	Name	Access	PDO Mapping	Unit	Data Type
60FD hex	0	Digital inputs	RO	Yes	–	UDINT
60FE hex	Digital outputs					
	1	Physical outputs	RW	Yes	–	UDINT
	2	Bit mask	RW	No	–	UDINT

13.9 Touch Probe

You can latch the feedback position with the following trigger events.
- Trigger with probe 1 input (Probe 1 Latch Input (/Probe1) signal)
- Trigger with probe 2 input (Probe 2 Latch Input (/Probe2) signal)
- Trigger with encoder zero signal (phase C)

The following two touch probe latches can be used at the same time.

■ Touch Probe 1 Latch

- Latch control object: 60B8 hex (bits 0 to 7)
- Latch status object: 60B9 hex (bits 0 to 7)
- The latched position is always stored in *touch probe 1 position value* (60BA hex).
- Trigger signal: Encoder zero signal or /Probe1 signal

■ Touch Probe 2 Latch

- Latch control object: 60B8 hex (bits 8 to 15)
- Latch status object: 60B9 hex (bits 8 to 15)
- The latched position is always stored in *touch probe 2 position value* (60BC hex).
- Trigger signal: /Probe2 signal

You can change the connector pin assignments and the /Probe1 and /Probe2 signal logic in the Probe 1 Latch Input Signal parameter (Pn511 = □□X□) and the Probe 2 Latch Input Signal parameter (Pn511 = □X□□).

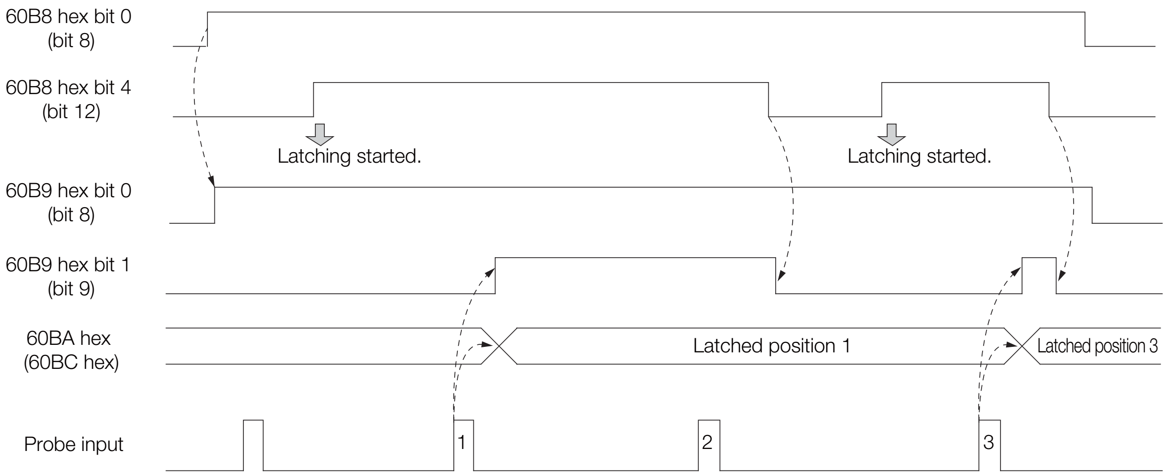
Note: Touch probe 1 cannot be used during homing. If touch probe 1 was already active, it will be switched OFF.

13.9.1 Related Objects

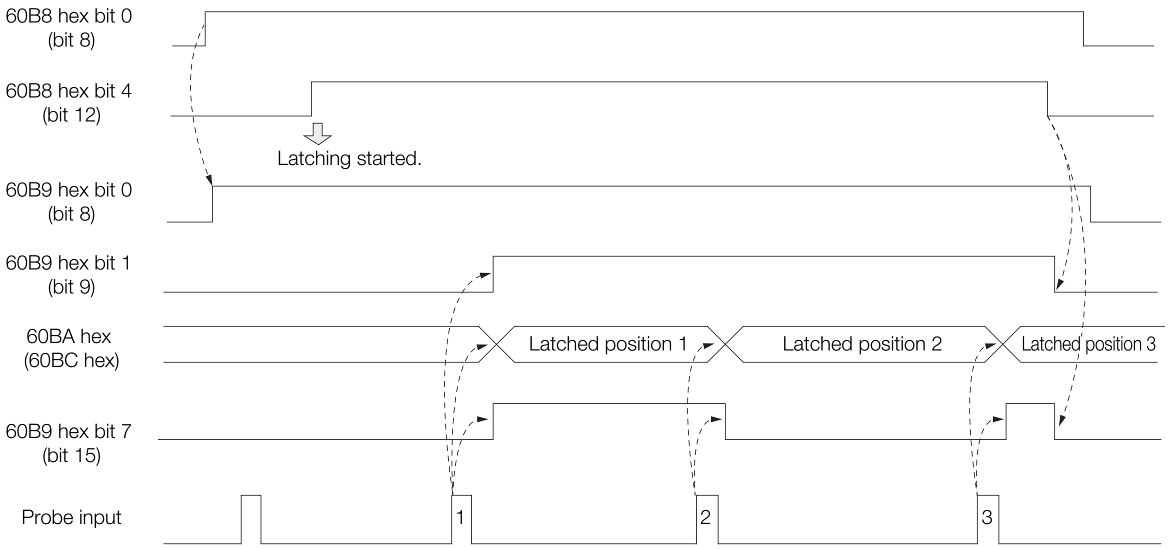
Index	Subindex	Name	Access	PDO Mapping	Unit	Data Type
60B8 hex	0	Touch probe function	RW	Yes	–	UINT
60B9 hex	0	Touch probe status	RO	Yes	–	UINT
60BA hex	0	Touch probe 1 position value	RO	Yes	Pos unit	DINT
60BC hex	0	Touch probe 2 position value	RO	Yes	Pos unit	DINT

13.9.2 Example of Execution Procedure for a Touch Probe

- Single Trigger Mode (60B8 hex bit 1 = 0 or bit 9 = 0)

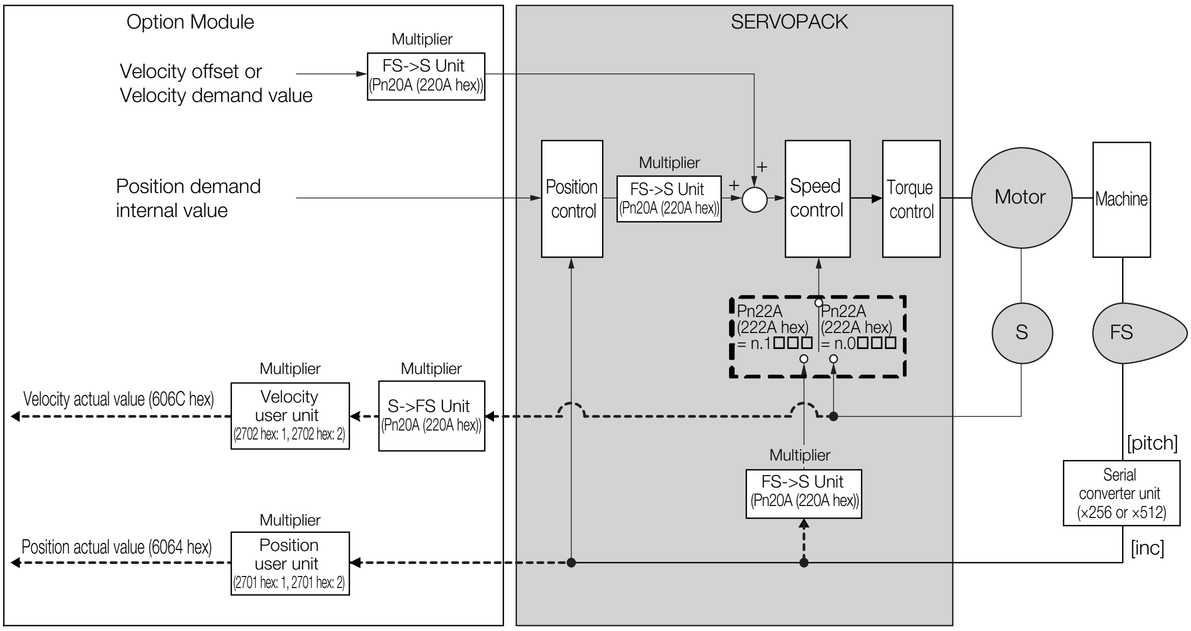


- Continuous Trigger Mode (60B8 hex bit 1 = 1 or bit 9 = 1)



13.10 Fully-Closed Loop Control

The following figure shows the block diagram for the fully-closed loop control.



The basic setting procedure for the related parameters is given in the following table.

Step	Description	Parameter Setting
1	Set the speed feedback method to use during fully-closed loop control.	Fully-closed Control Selections (Pn22A (222A hex))
2	Set the motor rotation direction.	Rotation Direction Selection (Pn000 (2000 hex) = n.□□□X) External Encoder Usage (Pn002 (2002 hex) = n.X□□□)
3	Set the number of pitches (cycles) of the sine wave for the external encoder.	Number of External Scale Pitches (Pn20A (220A hex))
4	Set the position reference unit (electronic gear).	Position user unit (2701 hex)
5	Set the alarm detection level for the external encoder.	Motor-Load Position Deviation Overflow Detection Level (Pn51B (251B hex)) Multiplier per Fully-closed Rotation (Pn52A (252A hex))

Object Dictionary

14

This chapter provides tables of the objects that are supported by an EtherCAT SERVOPACK.
Each object is described.

14.1 Object Dictionary List

The following table lists the dictionary objects.

Functional Classification	Object Name	Index	Refer to
General Objects	Device type	(1000 hex)	14.2
	Error register	(1001 hex)	14.2
	Manufacturer device name	(1008 hex)	14.2
	Manufacturer software version	(100A hex)	14.2
	Store parameters	(1010 hex)	14.2
	Restore default parameters	(1011 hex)	14.2
	Identity object	(1018 hex)	14.2
PDO Mapping Objects	Receive PDO mapping	(1600 hex to 1603 hex)	14.3
	Transmit PDO mapping	(1A00 hex to 1A03 hex)	14.3
Sync Manager Communication Objects	Sync manager communication type	(1C00 hex)	14.4
	Sync manager PDO assignment	(1C12 hex and 1C13 hex)	14.4
	Sync manager synchronization	(1C32 hex and 1C33 hex)	14.4
	Sync error setting	(10F1 hex)	14.4
Manufacturer Specific Objects	SERVOPACK parameters	(2000 hex to 26FF hex)	14.5
	User parameter configuration	(2700 hex)	14.5
	Position user unit	(2701 hex)	14.5
	Velocity user unit	(2702 hex)	14.5
	Acceleration user unit	(2703 hex)	14.5
	SERVOPACK adjusting command object	(2710 hex)	14.5
	Safety module monitor	(2720 hex)	14.5
Device Control	Error code	(603F hex)	14.6
	Controlword	(6040 hex)	14.6
	Statusword	(6041 hex)	14.6
	Quick stop option code	(605A hex)	14.6
	Shutdown option code	(605B hex)	14.6
	Disable operation option code	(605C hex)	14.6
	Halt option code	(605D hex)	14.6
	Fault reaction option code	(605E hex)	14.6
	Modes of operation	(6060 hex)	14.6
	Modes of operation display	(6061 hex)	14.6
	Supported drive modes	(6502 hex)	14.6
Profile Position Mode	Target position	(607A hex)	14.7
	Software position limit	(607D hex)	14.7
	Max profile velocity	(607F hex)	14.7
	Profile velocity	(6081 hex)	14.7
	Profile acceleration	(6083 hex)	14.7
	Profile deceleration	(6084 hex)	14.7
	Quick stop deceleration	(6085 hex)	14.7
Homing Mode	Home offset	(607C hex)	14.8
	Homing method	(6098 hex)	14.8
	Homing speeds	(6099 hex)	14.8
	Homing acceleration	(609A hex)	14.8

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Functional Classification	Object Name	Index	Refer to
Position Control Function	Position demand value	(6062 hex)	14.9
	Position actual internal value	(6063 hex)	14.9
	Position actual value	(6064 hex)	14.9
	Position demand internal value	(60FC hex)	14.9
	Following error window	(6065 hex)	14.9
	Following error time out	(6066 hex)	14.9
	Following error actual value	(60F4 hex)	14.9
	Position window	(6067 hex)	14.9
	Position window time	(6068 hex)	14.9
Interpolated Position Mode	Interpolation sub mode select	(60C0 hex)	14.10
	Interpolation data record	(60C1 hex)	14.10
	Interpolation time period	(60C2 hex)	14.10
	Manufacturer interpolation data configuration for 1st profile	(2730 hex)	14.10
	Manufacturer interpolation data configuration for 2nd profile	(2731 hex)	14.10
	Interpolation profile select	(2732 hex)	14.10
	Interpolation data record for 1st profile	(27C0 hex)	14.10
	Interpolation data record for 2nd profile	(27C1 hex)	14.10
	Interpolation data read/write pointer position	(2741 hex)	14.10
Cyclic Synchronous Position Mode	Velocity offset	(60B1 hex)	14.11
	Torque offset	(60B2 hex)	14.11
Profile Velocity/Cyclic Synchronous Velocity Mode	Velocity demand value	(606B hex)	14.12
	Velocity actual value	(606C hex)	14.12
	Velocity window	(606D hex)	14.12
	Velocity window time	(606E hex)	14.12
	Target velocity	(60FF hex)	14.12
Profile Torque/Cyclic Synchronous Velocity Mode	Target torque	(6071 hex)	14.13
	Torque demand value	(6074 hex)	14.13
	Torque slope	(6087 hex)	14.13
	Motor rated torque	(6076 hex)	14.13
	Torque actual value	(6077 hex)	14.13
Torque Limit Function	Max torque	(6072 hex)	14.14
	Positive torque limit value	(60E0 hex)	14.14
	Negative torque limit value	(60E1 hex)	14.14
Touch Probe Function	Touch probe function	(60B8 hex)	14.15
	Touch probe status	(60B9 hex)	14.15
	Touch probe 1 position value	(60BA hex)	14.15
	Touch probe 2 position value	(60BC hex)	14.15
Digital Inputs/Outputs	Digital inputs	(60FD hex)	14.16
	Digital outputs	(60FE hex)	14.16

14.2 General Objects

Device Type (1000 Hex)

This object contains the device type and functionality.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value	Saving to EEPROM
1000 hex	0	Device type	UDINT	RO	No	0x00020192	No

◆ Data Description

Bit 31 16	15 0
Additional Information	Device profile number

Additional information: 0002 (Servo Drive)
Device profile number: 0192 (DS402)

Error Register (1001 Hex)

This object contains the error status of the device. The value of this object is stored as part of an emergency message.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value	Saving to EEPROM
1001 hex	0	Error register	USINT	RO	No	0x00	No

◆ Data Description

Bit	Data	Description
0	Generic error	0: No error, 1: Error
1 to 7	Reserved.	0: Always 0

Manufacturer Device Name (1008 Hex)

This object contains the SERVOPACK model name, such as SGDV-1R6AE1A.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value	Saving to EEPROM
1008 hex	0	Manufacturer device name	STRING	RO	No	–	No

Manufacturer Software Version (100A Hex)

This object contains the software version of the SERVOPACK.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value	Saving to EEPROM
100A hex	0	Manufacturer software version	STRING	RO	No	–	No

◆ Data Description

The following string is saved.
"xxxx.**** (D:oooo)"

xxxx.****: Software version of EtherCAT (CoE)
oooo: Software version of the SERVOPACK

Store Parameters (1010 Hex)

You can use this object to save the parameter settings in non-volatile memory.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value	Saving to EEPROM
1010 hex	0	Largest subindex supported	USINT	RO	No	4	No
	1	Save all parameters	UDINT	RW	No	0x00000000 to 0xFFFFFFFF (default: 0x00000001)	No
	2	Save communication parameters	UDINT	RW	No	0x00000000 to 0xFFFFFFFF (default: 0x00000001)	No
	3	Save application parameters	UDINT	RW	No	0x00000000 to 0xFFFFFFFF (default: 0x00000001)	No
	4	Save manufacturer defined parameters	UDINT	RW	No	0x00000000 to 0xFFFFFFFF (default: 0x00000001)	No

If you read the object entry data, a value will be returned that tells whether the SERVOPACK can save the parameters.

Bit	Value	Meaning
1	0	The SERVOPACK does not save the parameters autonomously.
0	0 1	The SERVOPACK does not save the parameters for a command. The SERVOPACK saves the parameters for a command.

To prevent saving parameters by mistake, they are saved only when a specific signature is written to the appropriate subindex. The signature is “save.”

Signature	MSB			LSB
ASCII	e	v	a	s
hex	65 hex	76 hex	61 hex	73 hex

If you write “save” to subindex 1, all parameters are saved.

If you write “save” to subindex 2, the communications parameters (objects 1000 hex to 1FFF hex) are saved.

If you write “save” to subindex 3, the application parameters (objects 27□□ hex and 6□□□ hex) are saved.

If you write “save” to subindex 4, the SERVOPACK parameters (objects 2000 hex to 26FF hex) are saved.

Note: 1. If an incorrect signature is written, the SERVOPACK refuses to save the parameters and returns an SDO abort code.
2. If you read the object entry data while parameters are being saved, 0 will be returned.
3. Subindex 1 and subindex 4 can be written only in the Switch ON Disabled state (servo OFF).
4. After storing parameters with subindex 1 or subindex 4, you must turn the power supply OFF and ON again or execute *parameter configuration* (2700 hex) to move to the Operation Enabled state.

Restore Default Parameters (1011 Hex)

You can use this object to restore the parameters to the default values.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value	Saving to EEPROM
1011 hex	0	Largest subindex supported	USINT	RO	No	4	No
	1	Restore all default parameters	UDINT	RW	No	0x00000000 to 0xFFFFFFFF (default: 0x00000001)	No
	2	Restore communication default parameters	UDINT	RW	No	0x00000000 to 0xFFFFFFFF (default: 0x00000001)	No
	3	Restore application default parameters	UDINT	RW	No	0x00000000 to 0xFFFFFFFF (default: 0x00000001)	No
	4	Restore manufacturer defined default parameters	UDINT	RW	No	0x00000000 to 0xFFFFFFFF (default: 0x00000001)	No

If you read the object entry data, a value will be returned that tells whether the SERVOPACK can initialize the parameters.

Bit	Value	Description
0	0 1	The SERVOPACK does not restore the parameters to the default values. The SERVOPACK restores the parameters to the default values.

To prevent restoring the parameters to the default values by mistake, the parameters are restored to the default values only when a specific signature is written to the appropriate subindex. The signature is “load.”

Signature	MSB			LSB
ASCII	d	a	o	l
hex	64 hex	61 hex	6F hex	6C hex

If you write “load” to subindex 1, all parameters are restored to the default values.

If you write “load” to subindex 2, the communications parameters (objects 1□□□ hex) are restored to the default values.

If you write “load” to subindex 3, the application parameters (objects 27□□ hex and 6□□□ hex) are restored to the default values.

If you write “load” to subindex 4, the SERVOPACK parameters (objects 2000 hex to 26FF hex) are restored to the default values.

Note: 1. If an incorrect signature is written, the SERVOPACK refuses to restore the default values and returns an SDO abort code.
2. Subindex 1 and subindex 4 can be written only in the Switch ON Disabled state (servo OFF).
3. If you read this object while the default values are being restored, 0 will be returned.
4. The default values are enabled after the SERVOPACK is reset or after the power supply to the SERVOPACK is turned OFF and ON again.

Identity Object (1018 Hex)

This object contains general information on the device.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value	Saving to EEPROM
1018 hex	0	Number of entries	USINT	RO	No	4	No
	1	Vendor ID	UDINT	RO	No	0x00000539	No
	2	Product code	UDINT	RO	No	0x0220000[*1]	No
	3	Revision number [*2]	UDINT	RO	No	–	No
	4	Serial number [*3]	UDINT	RO	No	0x00000000	No

*1. For SGD7S-□□□□A0□: 0x02200001

*2. The revision number is saved as follows:

Bit 31 16	15 0
Major version	Minor version

The major version identifies the operating specifications of EtherCAT (CoE). If the CoE functionality is expanded, the major version has to be increased. The minor version number identifies different versions with the same operating specifications.

*3. Serial Number is not used. (It is always 0.)

14.3 PDO Mapping Objects

The CANopen over EtherCAT protocol allows the user to map objects to process data objects (PDOs) in order to use the PDOs for realtime data transfer.

The PDO mappings define which objects will be included in the PDOs.

A mapping entry (subindexes 1 to 8) is defined as shown below.

Bit 31 16	15 8	7 0
Object index	Subindex	Length

Bits 0 to 7: The length of the mapped object in bits. (If there is a gap in the PDOs, the bit length of the gap is given.)

Bits 8 to 15: The subindex of the mapped object (0 if there is a gap in the PDOs).

Bits 16 to 31: The index of the mapped object (0 if there is a gap in the PDOs).

Information The objects mapped to PDOs can be changed only when the EtherCAT (CoE) Network Module is in the Pre-Operational state.
Set the mapping entries (subindexes 1 to 8) only after you write 0 to subindex 0.

Receive PDO Mapping (1600 Hex to 1603 Hex)

◆ 1st Receive PDO Mapping

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value	Saving to EEPROM
1600 hex	0	Number of objects in this PDO	USINT	RW	No	0 to 8 (default: 8)	Yes
	1	Mapping entry 1	UDINT	RW	No	0 to 0xFFFFFFFF (default: 0x60400010)	Yes
	2	Mapping entry 2	UDINT	RW	No	0 to 0xFFFFFFFF (default: 0x607A0020)	Yes
	3	Mapping entry 3	UDINT	RW	No	0 to 0xFFFFFFFF (default: 0x60FF0020)	Yes
	4	Mapping entry 4	UDINT	RW	No	0 to 0xFFFFFFFF (default: 0x60710010)	Yes
	5	Mapping entry 5	UDINT	RW	No	0 to 0xFFFFFFFF (default: 0x60720010)	Yes
	6	Mapping entry 6	UDINT	RW	No	0 0xFFFFFFFF (default: 0x60600008)	Yes
	7	Mapping entry 7	UDINT	RW	No	0 to 0xFFFFFFFF (default: 0x00000008)	Yes
	8	Mapping entry 8	UDINT	RW	No	0 to 0xFFFFFFFF (default: 0x60B80010)	Yes

◆ 2nd Receive PDO Mapping

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value	Saving to EEPROM
1601 hex	0	Number of objects in this PDO	USINT	RW	No	0 to 8 (default: 2)	Yes
	1	Mapping entry 1	UDINT	RW	No	0 to 0xFFFFFFFF (default: 0x60400010)	Yes
	2	Mapping entry 2	UDINT	RW	No	0 to 0xFFFFFFFF (default: 0x607A0020)	Yes
	3 to 8	Mapping entry 3 to Mapping entry 8	UDINT	RW	No	0 to 0xFFFFFFFF (default: 0)	Yes

◆ 3rd Receive PDO Mapping

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value	Saving to EEPROM
1602 hex	0	Number of objects in this PDO	USINT	RW	No	0 to 8 (default: 2)	Yes
	1	Mapping entry 1	UDINT	RW	No	0 to 0xFFFFFFFF (default: 0x60400010)	Yes
	2	Mapping entry 2	UDINT	RW	No	0 to 0xFFFFFFFF (default: 0x60FF0020)	Yes
	3 to 8	Mapping entry 3 to Mapping entry 8	UDINT	RW	No	0 to 0xFFFFFFFF (default: 0)	Yes

◆ 4th Receive PDO Mapping

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value	Saving to EEPROM
1603 hex	0	Number of objects in this PDO	USINT	RW	No	0 to 8 (default: 2)	Yes
	1	Mapping entry 1	UDINT	RW	No	0 to 0xFFFFFFFF (default: 0x60400010)	Yes
	2	Mapping entry 2	UDINT	RW	No	0 to 0xFFFFFFFF (default: 0x60710010)	Yes
	3 to 8	Mapping entry 3 to Mapping entry 8	UDINT	RW	No	0 to 0xFFFFFFFF (default: 0)	Yes

Transmit PDO Mapping (1A00 Hex to 1A03 Hex)

◆ 1st Transmit PDO Mapping

Index	Subin-dex	Name	Data Type	Access	PDO Mapping	Value	Saving to EEPROM
1A00 hex	0	Number of objects in this PDO	USINT	RW	No	0 to 8 (default: 8)	Yes
	1	Mapping entry 1	UDINT	RW	No	0 to 0xFFFFFFFF (default: 0x60410010)	Yes
	2	Mapping entry 2	UDINT	RW	No	0 to 0xFFFFFFFF (default: 0x60640020)	Yes
	3	Mapping entry 3	UDINT	RW	No	0 to 0xFFFFFFFF (default: 0x60770010)	Yes
	4	Mapping entry 4	UDINT	RW	No	0 to 0xFFFFFFFF (default: 0x60F40020)	Yes
	5	Mapping entry 5	UDINT	RW	No	0 to 0xFFFFFFFF (default: 0x60610008)	Yes
	6	Mapping entry 6	UDINT	RW	No	0 to 0xFFFFFFFF (default: 0x00000008)	Yes
	7	Mapping entry 7	UDINT	RW	No	0 to 0xFFFFFFFF (default: 0x60B90010)	Yes
	8	Mapping entry 8	UDINT	RW	No	0 to 0xFFFFFFFF (default: 0x60BA0020)	Yes

◆ 2nd Transmit PDO Mapping

Index	Subin-dex	Name	Data Type	Access	PDO Mapping	Value	Saving to EEPROM
1A01 hex	0	Number of objects in this PDO	USINT	RW	No	0 to 8 (default: 2)	Yes
	1	Mapping entry 1	UDINT	RW	No	0 to 0xFFFFFFFF (default: 0x60410010)	Yes
	2	Mapping entry 2	UDINT	RW	No	0 to 0xFFFFFFFF (default: 0x60640020)	Yes
	3 to 8	Mapping entry 3 to Mapping entry 8	UDINT	RW	No	0 to 0xFFFFFFFF (default: 0)	Yes

◆ 3rd Transmit PDO Mapping

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value	Saving to EEPROM
1A02 hex	0	Number of objects in this PDO	USINT	RW	No	0 to 8 (default: 2)	Yes
	1	Mapping entry 1	UDINT	RW	No	0 to 0xFFFFFFFF (default: 0x60410010)	Yes
	2	Mapping entry 2	UDINT	RW	No	0 to 0xFFFFFFFF (default: 0x60640020)	Yes
	3 to 8	Mapping entry 3 to Mapping entry 8	UDINT	RW	No	0 to 0xFFFFFFFF (default: 0)	Yes

◆ 4th Transmit PDO Mapping

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value	Saving to EEPROM
1A03 hex	0	Number of objects in this PDO	USINT	RW	No	0 to 8 (default: 3)	Yes
	1	Mapping entry 1	UDINT	RW	No	0 to 0xFFFFFFFF (default: 0x60410010)	Yes
	2	Mapping entry 2	UDINT	RW	No	0 to 0xFFFFFFFF (default: 0x60640020)	Yes
	3	Mapping entry 3	UDINT	RW	No	0 to 0xFFFFFFFF (default: 0x60770010)	Yes
	4 to 8	Mapping entry 4 to Mapping entry 8	UDINT	RW	No	0 to 0xFFFFFFFF (default: 0)	Yes

14.4 Sync Manager Communications Objects

Sync Manager Communications Type (1C00 Hex)

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value	Saving to EEPROM
1C00 hex	0	Number of used Sync Manager channels	USINT	RO	No	4	No
	1	Communication type sync manager 0	USINT	RO	No	1: Mailbox reception (master to slave)	No
	2	Communication type sync manager 1	USINT	RO	No	2: Mailbox send (slave to master)	No
	3	Communication type sync manager 2	USINT	RO	No	3: Process data output (master to slave)	No
	4	Communication type sync manager 3	USINT	RO	No	4: Process data input (slave to master)	No

Sync Manager PDO Assignment (1C10 Hex to 1C13 Hex)

This object defines which PDOs will be transferred in the process data communications.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value	Saving to EEPROM
1C10 hex	0	Sync manager PDO assignment 0	USINT	RO	No	0	No
1C11 hex	0	Sync manager PDO assignment 1	USINT	RO	No	0	No
1C12 hex	0	Number of assigned PDOs	USINT	RW	No	0 to 2 (default: 1)	Yes
	1	Index of assigned RxPDO 1	UINT	RW	No	1600 hex to 1603 hex (default: 1601 hex)	Yes
	2	Index of assigned RxPDO 2	UINT	RW	No	1600 hex to 1603 hex (default: 1600 hex)	Yes
1C13 hex	0	Number of assigned PDOs	USINT	RW	No	0 to 2 (default: 1)	Yes
	1	Index of assigned TxPDO 1	UINT	RW	No	1A00 hex to 1A03 hex (default: 1A01 hex)	Yes
	2	Index of assigned TxPDO 2	UINT	RW	No	1A00 hex to 1A03 hex (default: 1A00 hex)	Yes

Objects 1C12 hex and 1C13 hex can be changed when the EtherCAT (CoE) Network Module is in the Pre-Operational state. Set subindex 1 or 2 only after you write 0 to subindex 0.

Sync Manager Synchronization (1C32 Hex and 1C33 Hex)

◆ Sync Manager 2 (Process Data Output) Synchronization

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value	Saving to EEPROM
1C32 hex	0	Number of synchronization parameters	USINT	RO	No	10	No
	1	Synchronization type	UINT	RO	No	0: Free-Run (DC not used) 2: DC Sync0 (DC used)	No
	2	Cycle time	UDINT	RO	No	Sync0 event cycle [ns]	No
	3	Shift time	UDINT	RO	No	125,000 [ns]	No
	4	Synchronization types supported	UINT	RO	No	Bit 0 = 1: Free-Run supported Bits 2 to 4 = 001: DC Sync0 supported Bits 5 and 6 = 00: Output shift not supported.	No
	5	Minimum cycle time	UDINT	RO	No	62,500 [ns]	No
	6	Calc and copy time	UDINT	RO	No	62,500 [ns]	No
	7	Reserved	UDINT	RO	No	–	No
	8	Reserved	UINT	RO	No	–	No
	9	Delay time	UDINT	RO	No	0 [ns]	No
	10	Sync0 cycle time	UDINT	RO	No	Same as 1C32 hex: 02.	No
	11	Reserved	UDINT	RO	No	–	No
	12	SM2 event miss count	UDINT	RO	No		No

◆ Sync Manager 3 (Process Data Input) Synchronization

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value	Saving to EEPROM
1C33 hex	0	Number of synchronization parameters	USINT	RO	No	10	No
	1	Synchronization type	UINT	RO	No	Same as 1C32 hex: 01.	No
	2	Cycle time	UDINT	RO	No	Same as 1C32 hex: 02.	No
	3	Shift time	UDINT	RW	No	125,000 × n [ns] (n = 1, 2, 3…) Range: 0 to (Sync0 event cycle -125,000)	Yes
	4	Synchronization types supported	UINT	RO	No	Bit 0 = 1: Free-Run supported. Bits 2 to 4 = 001: DC Sync0 supported Bits 5 and 6 = 01: Input shift with local timer supported.	No
	5	Minimum cycle time	UDINT	RO	No	Same as 1C32 hex: 05.	No
	6	Calc and copy time	UDINT	RO	No	62,500 [ns]	No
	7	Reserved	UDINT	RO	No	–	No
	8	Reserved	UINT	RO	No	–	No
	9	Delay time	UDINT	RO	No	0	No
	10	Sync0 cycle time	UDINT	RO	No	Same as 1C32 hex: 10.	No

Sync Error Settings (10F1 Hex)

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value	Saving to EEPROM
10F1 hex	0	Number of entries	USINT	RO	No	2	No
	1	Reserved	UDINT	RO	No	0	No
	2	Sync error count limit	UDINT	RW	No	0 to 15 (default: 9)	Yes

◆ 0x10F1 Hex: 2 Sync Error Counter Limit

This object defines the allowable number of failures when receiving process data. If the value of the internal error counter in the SERVOPACK exceeds the value of this object, the SERVOPACK will detect an alarm (A12 hex) and change the ESM state to SAFEOP.

The SERVOPACK increments the internal error counter by 3 if the process output data is not updated (i.e., if a reception event does not occur) when the synchronization event (Sync0) occurs. When the process output data is updated normally, the internal error counter is decremented by 1. The internal error counter is reset when the EtherCAT communications state changes from SAFEOP to OP.

An example of internal error counter operation is shown below.

Reception (SM2) event	1	0	1	0	1	0	1	0	1	0	1
SERVOPACK internal error counter (Error Counter Limit = 9)	0	3	2	5	4	7	6	9 (Error)	9	9	9

In this example, a failure in receiving the process data occurs every other DC (Sync0) cycle. After eight DC cycles, the internal error count reaches the Sync Error Count Limit, and an error occurs.

No alarm will be detected if the DC mode is disabled or when the Sync Error Count Limit is set to 0.

Important

1. Set a suitable cycle time for updating the process data according to the requirements of the application.
2. Determine if the default setting of the Sync Error Counter Limit is suitable for the requirements of the application. With the default value of 9, network frames will be lost (SM2 reception events will not occur) three times consecutively before an alarm occurs in the SERVOPACK. If the setting of the Sync Error Counter Limit is too small, alarms will occur even when there is no problem in the application.
3. Noise may cause communications errors. Check the wiring of the SERVOPACK to minimize the affects of noise. Refer to the following sections for details on countermeasures.

   ☞ *4.1.2 Countermeasures against Noise* on page 4-5

14.5 Manufacturer-Specific Objects

SERVOPACK Parameters (2000 Hex to 26FF Hex)

Objects 2000 hex to 26FF hex are mapped to SERVOPACK parameters (Pn□□□).

Object index 2□□□ hex corresponds to Pn□□□ in the SERVOPACK parameters (e.g., object 2100 hex is the same as Pn100).

User Parameter Configuration (2700 Hex)

This object enables all user parameter settings and initializes all of the position data.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value	Saving to EEPROM
2700 hex	0	User parameter configuration	UDINT	RW	No	0 to 0xFFFFFFFF (default: 0)	No

If you change any of the following objects and restart operation without turning the power supply OFF and then ON again, you must execute this object to enable the new settings.

- Objects 2701 hex, 2702 hex, and 2703 hex
- SERVOPACK parameters that require that the power supply be turned OFF and ON again to enable changes to the parameter settings

◆ Procedure

1. **Change the SERVOPACK to the Switch ON Disabled state.**
2. **Set the new parameter settings.**
3. **Set *user parameter configuration* (2700 hex) to 1. The parameter settings will be enabled.**
   After execution, object 2700 hex will automatically be reset to 0.

Position User Unit (2701 Hex)

This object sets the user-defined position reference unit (Pos unit).

The user-defined position reference unit is calculated with the following formula.
1 [Pos unit] = (Numerator/Denominator) [inc]

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value	Saving to EEPROM
2701 hex	0	Number of entries	USINT	RO	No	2	No
	1	Numerator	UDINT	RW	No	1 to 1,073,741,823 (default: 1)	Yes
	2	Denominator	UDINT	RW	No	1 to 1,073,741,823 (default: 1)	Yes

Setting range: 1/4,096 < Numerator/Denominator < 65,536
(Alarm A.A20 will be detected if the setting exceeds the setting range.)

Velocity User Unit (2702 Hex)

This object sets the user-defined speed reference unit (Vel unit).

The user-defined speed reference unit is calculated with the following formula.
1 [Vel unit] = (Numerator/Denominator) [inc/sec]

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value	Saving to EEPROM
2702 hex	0	Number of entries	USINT	RO	No	2	No
	1	Numerator	UDINT	RW	No	1 to 1,073,741,823 (default: 1)	Yes
	2	Denominator	UDINT	RW	No	1 to 1,073,741,823 (default: 1)	Yes

Setting range: 1/128 ≤ Numerator/Denominator ≤ 8,388,608
(Alarm A.A20 will be detected if the setting exceeds the setting range.)

Acceleration User Unit (2703 Hex)

This object sets the user-defined acceleration reference unit (Acc unit).

The user-defined acceleration reference unit is calculated with the following formula.
1 [Acc unit] = (Numerator/Denominator) × 10^4 [inc/sec^2]

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value	Saving to EEPROM
2703 hex	0	Number of entries	USINT	RO	No	2	No
	1	Numerator	UDINT	RW	No	1 to 1,073,741,823 (default: 1)	Yes
	2	Denominator	UDINT	RW	No	1 to 1,073,741,823 (default: 1)	Yes

Setting range: 1/128 ≤ Numerator/Denominator ≤ 262,144
(Alarm A.A20 will be detected if the setting exceeds the setting range.)

Torque User Unit (2704 Hex)

This object sets the user-defined torque reference unit (Torque unit).

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value	Saving to EEPROM
2704 hex	0	Number of entries	USINT	RO	No	2	No
	1	Numerator	UDINT	RW	No	1 to 1,073,741,823 (default: 1)	Yes
	2	Denominator	UDINT	RW	No	1 to 1,073,741,823 (default: 1)	Yes

Setting range: 1/128 ≤ Numerator/Denominator ≤ 262,144
(Alarm A.A20 will be detected if the setting exceeds the setting range.)

The setting unit for torque references is 0.1%. The objects that are related to torque references are given in the following table.

EtherCAT(CoE) Communications Object	Data Type	Default Unit	Setting Range	Default Value
Target torque (6071 hex)	INT	0.1%	-3,276.8% to 3,267.7%	0%
Torque demand (6074 hex)	INT	0.1%	-3,276.8% to 3,267.7%	0%
Torque slope (6087 hex)	UDINT	0.1%/s	0%/s to 429,496,729%/s	100%/s
Torque actual value (6077 hex)	INT	0.1%	-3,276.8% to 3,267.7%	0%
Max torque (6072 hex)	UINT	0.1%	0% to 6,553.5%	800.0%
Positive torque limit (60E0 hex)	UINT	0.1%	0% to 6,553.5%	800.0%
Negative torque limit (60E1 hex)	UINT	0.1%	0% to 6,553.5%	800.0%
Torque offset (60B2 hex)	INT	0.1%	-3,276.8% to 3,267.7%	0%

SERVOPACK Adjusting Command (2710 Hex)

This object is used for SERVOPACK adjustment services (e.g., encoder setup or multiturn reset). Write data to subindex 1 to start command execution. Also, read the subindex 3 to obtain the response. If you cannot obtain the response by reading subindex 3, the first byte of the response data will give information about the progress of execution.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value	Saving to EEPROM
2710 hex	0	Number of entries	USINT	RO	No	3	No
	1	Command	STRING	RW	No	Bytes 0 to n: Service Request Data The command is executed when command data is written.	No
	2	Status	USINT	RO	No	0: Command completed, no errors, and no response data 1: Command completed, no errors, and response data provided 2: Command completed, error, and no response data 3: Command completed, error, response data provided 255: Command is being executed	No
	3	Reply	STRING	RO	No	Byte 0: Subindex 2 Byte 1: Not used 2 to n: Service response data	No

◆ Command/Response Data Format

Command Data (Service Request Data)	
Byte	Description
0	Reserved.
1	Reserved.
2	CCMD (command code) 00: Read request 01: Write request
3	CSIZE (CDATA data byte size)
4 to 7	CADDRESS (address)
8 to 15	CDATA (writing data)

Response Data (Service Response Data)	
Byte	Description
0	Status (Same data as subindex 2)
1	Reserved.
2	RCMD (echoback of CCMD)
3	RSIZE (R_DATA data byte size)
4 to 7	RADDRESS (echoback of CADDRESS)
8 to 15	RDATA (read data)/ERROCODE

◆ Executable Adjustment Services

Adjustment Service	Request Code	Preparation before Execution	Processing Time	Execution Conditions
Absolute Encoder Reset	1008 hex	Required	5 s max.	If an incremental encoder is used, it is not possible to reset the encoder while the servo is ON.
Autotune Motor Current Detection Signal Offset	100E hex	Not required	5 s max.	Adjustment is disabled in the following cases. • While the main circuit power supply is OFF • While the servo is ON • While the Servomotor is running
Multiturn Limit Setting	1013 hex	Required	5 s max.	If an incremental encoder is used, the setting is disabled unless a Multiturn Limit Disagreement alarm has occurred.

◆ How to Send a Command for Adjustment

1. **Send the following data and set the request code for the adjustment service to execute.**
   CCMD = 0001 hex
   CADDRESS = 2000 hex
   CSIZE = 0002 hex
   CDATA = Request code of the adjustment service to execute
   If the slave station receives the command normally, the status field will be set to 1.
   If an error occurs, perform step 4 to stop execution.

2. **For an adjustment that requires preparations, send the following data.**
   If preparations before execution are not required, perform step 3.
   CCMD = 0001 hex
   CADDRESS = 2001 hex
   CSIZE = 0002 hex
   CDATA = 0002 hex
   If the slave station receives the command normally, the status field will be set to 1.
   If an error occurs, perform step 4 to stop execution.

3. **Send the following data to execute the adjustment service.**
   CCMD = 0001 hex
   CADDRESS = 2001 hex
   CSIZE = 0002 hex
   CDATA = 0001 hex
   If the slave station receives the command normally, the status field will be set to 1.
   If an error occurs, perform step 4 to stop execution.

4. **Send the following data to stop execution.**
   CCMD = 0001 hex
   CADDRESS = 2000 hex
   CSIZE = 0002 hex
   CDATA = 0000 hex
   If the slave station receives the command normally, the status field will be set to 1.

   Note: If no command is received within 10 seconds after step 1, the adjustment service will be automatically stopped.

Safety Module Monitor (2720 Hex)

This object shows the operating status of the Safety Module.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value	Saving to EEPROM
2720 hex	0	Safety module monitor	UDINT	RO	Yes	–	No

◆ Details

Bit	Signal	Description
0	Safety Request Input Signal A1	0: Safety Request Input Signal A1 is ON. (Operation is normal.)
		1: Safety Request Input Signal A1 is OFF. (Safety Function A is active.)
1	Safety Request Input Signal A2	0: Safety Request Input Signal A2 is ON. (Operation is normal.)
		1: Safety Request Input Signal A2 is OFF. (Safety Function A is active.)
2	Safety Request Input Signal B1	0: Safety Request Input Signal B1 is ON. (Operation is normal.)
		1: Safety Request Input Signal B1 is OFF. (Safety Function B is active.)
3	Safety Request Input Signal B2	0: Safety Request Input Signal B2 is ON. (Operation is normal.)
		1: Safety Request Input Signal B2 is OFF. (Safety Function B is active.)
4	External Device Monitor Signal A	0: External Device Monitor Output Signal A is OFF. (Operation is normal or a malfunction occurred in Safety Function A.)
		1: External Device Monitor Output Signal A is ON. (Safety Function A is active.)
5	External Device Monitor Signal B	0: External Device Monitor Output Signal B is OFF. (Operation is normal or a malfunction occurred in Safety Function B.)
		1: External Device Monitor Output Signal B is ON. (Safety Function B is active.)
6 and 7	Reserved.	–
8	Safety Function Monitoring	0: –
		1: Monitoring is in progress.
9	Safety Function Safe	0: –
		1: Safe state
10	Safety Function HWBB	0: –
		1: Safety BB is active.
12 to 15	Reserved.	–
16	Active Mode State	0: Standby or not selected.
		1: Operating
17 to 31	Reserved.	–

14.6 Device Control

Error Code (603F Hex)

This object provides the SERVOPACK alarm/warning code of the last error that occurred.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value	Saving to EEPROM
603F hex	0	Error code	UINT	RO	Yes	0	No

Controlword (6040 Hex)

This object controls the device and operation mode.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value	Saving to EEPROM
6040 hex	0	Controlword	UINT	RW	Yes	0 to 0xFFFF (default: 0)	No

◆ Controlword Bits

Bit	Function	Description
0	Switch on	Refer to ■ *Details on Bits 0 to 3*.
1	Enable voltage	
2	Quick stop	
3	Enable operation	
4 to 6	Operation mode specific	Refer to ■ *Details on Bits 4 to 9*.
7	Fault reset	0 → 1: Alarm/warning reset.
8	Halt	Refer to ■ *Details on Bits 4 to 9*.
9	Operation mode specific	
10	– (Reserved)	–
11	Positive torque limit	0: Disables *torque limit parameter* (object 2404 hex). 1: Enables *torque limit parameter* (object 2404 hex).
12	Negative torque limit	0: Disables *torque limit parameter* (object 2405 hex). 1: Enables *torque limit parameter* (object 2405 hex).
13 to 15	– (Reserved)	–

■ Details on Bits 0 to 3

- Bits 0 to 3: These bits function as the control command for the Servo Drive's state.

Command	Controlword Bits				
	Bit 7	Bit 3	Bit 2	Bit 1	Bit 0
Shutdown	0	X	1	1	0
Switch on	0	0	1	1	1
Switch on + Enable operation	0	1	1	1	1
Disable voltage	0	X	X	0	X
Quick stop	0	X	0	1	X
Disable operation	0	0	1	1	1
Enable operation	0	1	1	1	1

■ Details on Bits 4 to 9

- Bits 4, 5, and 9: Profile Position Mode

Bit 9	Bit 5	Bit 4	Description
0	0	0 → 1	Starts the next positioning operation after the current positioning operation is completed (i.e., after the target is reached).
X	1	0 → 1	Starts the next positioning operation immediately.
1	0	0 → 1	Continues positioning with the current profile speed up to the current target position and then start the next positioning operation.

- Bits 6 and 8: Profile Position Mode

Bit	Function	Value	Description
6	Abs/rel	0	Treats the target position as an absolute value.
		1	Treats the target position as a relative value. (Treats it as the movement distance from the current target position.)
8	Halt	0	Executes or continues positioning.
		1	Stops axis according to *halt option code* (605D hex).

- Bits 4, 5, 6, 8, and 9: Homing Mode

Bit	Function	Value	Description
4	Homing operation start	0	Does not start homing.
		1	Starts or continues homing.
5	–	0	Reserved.
6	–	0	Reserved.
8	Halt	0	Enables bit 4.
		1	Stops the axis according to *halt option code* (605D hex).
9	–	0	Reserved.

- Bits 4, 5, 6, 8, and 9: Cyclic Synchronous Position, Velocity, or Torque Mode

Bit	Function	Value	Description
4	–	0	Reserved.
5	–	0	Reserved.
6	–	0	Reserved.
8	Halt	0	Executes or continues operation.
		1	Stops axis according to *halt option code* (605D hex).
9	–	0	Reserved.

- Bits 4, 5, 6, 8, and 9: Interpolated Position Mode

Bit	Function	Value	Description
4	Enable interpolation	0	Disables interpolation.
		1	Enables interpolation.
5	–	0	Reserved.
6	–	0	Reserved.
8	Halt	0	Executes specification for bit 4.
		1	Stops the axis according to *halt option code* (605D hex).
9	–	0	Reserved.

- Bits 4, 5, 6, 8, and 9: Profile Velocity/Torque Mode

Bit	Function	Value	Description
4	–	0	Reserved.
5	–	0	Reserved.
6	–	0	Reserved.
8	Halt	0	Executes or continues operation.
		1	Stops the axis according to *halt option code* (605D hex).
9	–	0	Reserved.

Statusword (6041 Hex)

Statusword contains the bits that give the current state of the Servo Drive and the operating state of the operation mode.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value	Saving to EEPROM
6041 hex	0	Statusword	UINT	RO	Yes	0	No

◆ Statusword Bits

Bit	State	Description
0	Ready to switch on	Refer to ■ *Details on Bits 0 to 7*.
1	Switched on	
2	Operation enabled	
3	Fault	
4	Voltage enabled	
5	Quick stop	
6	Switch on disabled	
7	Warning	
8	Active mode stop	1: Active mode function execution is in progress.
9	Remote	*Controlword* (6040 hex) is being processed
10	Operation mode specific	Refer to ■ *Details on Bits 10, 12, and 13*.
11	Internal limit active	Refer to ■ *Details on Bit 11*.
12, 13	Operation mode specific	Refer to ■ *Details on Bits 10, 12, and 13*.
14	Torque limit active	0: Torque limit is disabled. 1: Torque limit is enabled.
15	Safety active	1: Safety function is active.

■ Details on Bits 0 to 7

- Bits 0 to 7: Current State of Servo Drive

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Servo Drive State
X	0	X	X	0	0	0	0	Not ready to switch on
X	1	X	X	0	0	0	0	Switch on disabled
X	0	1	X	0	0	0	1	Ready to switch on
X	0	1	X	0	0	1	1	Switched on
X	0	1	X	0	1	1	1	Operation enabled
X	0	0	X	0	1	1	1	Quick stop active
X	0	X	X	1	1	1	1	Fault reaction active
X	0	X	X	1	0	0	0	Fault
X	X	X	1	X	X	X	X	Main power on
1	X	X	X	X	X	X	X	Warning occurred

■ Details on Bit 11

- Bit 11: Internal limit active

The internal limit is activated in the following cases:

- The target position was limited by a software limit.
- The N-OT or P-OT signal was activated.
- The interpolation speed was exceeded in Interpolated Position Mode or Cyclic Position Mode.

If the interpolated reference speed exceeds the following speed range, the target position will be ignored.

$$\frac{\text{(Target position – position demand value)} \times \text{(2701 hex: 01)/(2701 hex: 02)}}{\text{Interpolation time period}} < 4{,}194{,}304\ \text{[inc/ms]}$$

■ Details on Bits 10, 12, and 13

• Bits 10, 12, and 13: Profile Position Mode

Bit	Meaning	Value	Description
10	Target reached	0	*Halt* (bit 8 in *controlword*) = 0: The target position has not been reached. *Halt* (bit 8 in *controlword*) = 1: The axis is decelerating.
		1	*Halt* (bit 8 in *controlword*) = 0: The target position was reached. *Halt* (bit 8 in *controlword*) = 1: The axis is stopped.
12	Set-point acknowledge	0	Processing of previous set point (reference) was completed and Servo Drive is waiting for a new set point.
		1	Processing the previous set point is still in process or a set point was acknowledged.
13	Following error	0	No following error has occurred.
		1	A following error occurred.

• Bits 10, 12, and 13: Homing Mode

Bit 13	Bit 12	Bit 10	Description
Homing error	Homing attained	Target reached	
0	0	0	Homing is in progress.
0	0	1	Homing was interrupted or has not yet started.
0	1	0	Home has been defined, but the operation is still in progress.
0	1	1	Homing was completed normally.
1	0	0	A homing error occurred and the speed is not 0.
1	0	1	A homing error occurred and the speed is 0.

• Bits 10, 12, and 13: Cyclic Synchronous Position, Velocity, or Torque Mode

Bit	State	Value	Description
10	Target reached	0	The target (position, speed, or torque) has not been reached.
		1	The target (position, speed, or torque) was reached.
12	Target value ignored	0	The target value (position, speed, or torque) was disabled.
		1	Target value (position, speed, or torque) was enabled.
13	Following error	0	There is no following error (always 0 in Cyclic Velocity or Torque Mode).
		1	A following error occurred.

• Bits 10, 12, and 13: Interpolated Position Mode

Bit	State	Value	Description
10	Target reached	0	*Halt* (bit 8 in *controlword*) = 0: The target position has not been reached. *Halt* (bit 8 in *controlword*) = 1: The axis is decelerating.
		1	*Halt* (bit 8 in *controlword*) = 0: The target position was reached. *Halt* (bit 8 in *controlword*) = 1: The axis is stopped.
12	Ip mode active	0	Interpolation is disabled.
		1	Interpolation is enabled.
13	–	0	Reserved.

- Bits 10, 12, and 13: Profile Velocity Mode

Bit	State	Value	Description
10	Target reached	0	*Halt* (bit 8 in *controlword*) = 0: The target speed has not been reached. *Halt* (bit 8 in *controlword*) = 1: The axis is decelerating.
		1	*Halt* (bit 8 in *controlword*) = 0: The target speed was reached. *Halt* (bit 8 in *controlword*) = 1: The axis is stopped.
12	Speed	0	The speed is not 0.
		1	The speed is 0.
13	–	0	Reserved.

- Bits 10, 12, and 13: Profile Torque Mode

Bit	State	Value	Description
10	Target reached	0	*Halt* (bit 8 in *controlword*) = 0: The target torque has not been reached. *Halt* (bit 8 in *controlword*) = 1: The axis is decelerating.
		1	*Halt* (bit 8 in *controlword*) = 0: The target torque was reached. *Halt* (bit 8 in *controlword*) = 1: The axis is stopped.
12	–	0	Reserved.
13	–	0	Reserved.

Quick Stop Option Code (605A Hex)

This object determines what operation will be performed if a Quick Stop is executed.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value	Saving to EEPROM
605A hex	0	Quick stop option code	INT	RW	No	0 to 4 (default: 2)	Yes

◆ Data Description

Value	Description
0	Disables the Servo Drive (moves to the Switch ON Disabled state).
1	Decelerates at the deceleration rate for decelerating to a stop and moves to the Switch ON Disabled state.*1, *2
2	Decelerates at the deceleration rate for a quick stop and moves to the Switch ON Disabled state.*1, *3
3	Decelerates at the torque limit and moves to the Switch ON Disabled state.*1

*1. The motor is always stopped according to option code 0 (servo OFF stop) in Profile Torque Mode or Cyclic Torque Mode.

*2. The deceleration rate for decelerating to a stop is defined in the following object.
- Profile Position, Interpolated Position, Cyclic Position, or Cyclic Velocity Mode: 6084 Hex
- Homing Mode: 609A Hex

*3. *Quick stop deceleration* (6085 hex) is the deceleration rate for a quick stop.

Shutdown Option Code (605B Hex)

This object defines the operation that is performed if there is a move from Operation Enable state to Ready to Switch ON state.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value	Saving to EEPROM
605B hex	0	Shutdown option code	INT	RW	No	0 to 1 (default: 0)	Yes

◆ Data Description

Value	Description
0	Disables the Servo Drive (moves to the Switch ON Disabled state).
1	Decelerates at the deceleration rate for decelerating to a stop and moves to the Switch ON Disabled state.[*1, *2]

[*1] The motor is always stopped according to option code 0 (servo OFF stop) in Profile Torque Mode or Cyclic Torque Mode.

[*2] The deceleration rate for decelerating to a stop is defined in the following object.
- Profile Position, Interpolated Position, Cyclic Position, or Cyclic Velocity Mode: 6084 Hex
- Homing Mode: 609A Hex

Disable Operation Option Code (605C Hex)

This object defines the operation that is performed if there is a move from Operation Enable state to Switched ON state.

Index	Subin-dex	Name	Data Type	Access	PDO Mapping	Value	Saving to EEPROM
605C hex	0	Disable operation option code	INT	RW	No	0 to 1 (default: 1)	Yes

◆ Data Description

Value	Description
0	Disables the Servo Drive (moves to the Switch ON Disabled state).
1	Decelerates at the deceleration rate for decelerating to a stop and moves to the Switch ON Disabled state.[*1, *2]

[*1] The motor is always stopped according to option code 0 (servo OFF stop) in Profile Torque Mode or Cyclic Torque Mode.

[*2] The deceleration rate for decelerating to a stop is defined in the following object.
- Profile Position, Interpolated Position, Cyclic Position, or Cyclic Velocity Mode: 6084 Hex
- Homing Mode: 609A Hex

Halt Option Code (605D Hex)

This object defines the operation that is performed if bit 8 (Halt) in *controlword* is active.

Index	Subin-dex	Name	Data Type	Access	PDO Mapping	Value	Saving to EEPROM
605D hex	0	Halt option code	INT	RW	No	0 to 4 (default: 1)	Yes

◆ Data Description

Value	Description
1	Decelerates at the deceleration rate for decelerating to a stop and moves to the Operation Enabled state.[*1, *2]
2	Decelerates at the deceleration rate for a quick stop and moves to the Operation Enabled state.[*1, *3]
3	Decelerates at the torque limit and moves to the Operation Enabled state.[*1]

[*1] If bit 8 (Halt) is 1 in Profile Torque Mode or Cyclic Torque Mode, the torque reference value is reduced to zero.

[*2] The deceleration rate for decelerating to a stop is defined in the following object.
- Profile Position, Interpolated Position, Cyclic Position, or Cyclic Velocity Mode: 6084 Hex
- Homing Mode: 609A Hex

[*3] *Quick stop deceleration* (6085 hex) is the deceleration rate for a quick stop.

Fault Reaction Option Code (605E Hex)

This object defines the operation that is performed when an alarm is detected in the Servo Drive system.

Index	Subin-dex	Name	Data Type	Access	PDO Mapping	Value	Saving to EEPROM
605E hex	0	Fault reaction option code	INT	RW	No	0	Yes

◆ Data Description

Value	Description
0	Disables the Servo Drive. (Turns OFF the servo.)

Modes of Operation (6060 Hex)

This object is used to select the operation mode. The Servo Drive gives the actual operation mode in the *modes of operation display* object.

Index	Subin-dex	Name	Data Type	Access	PDO Mapping	Value	Saving to EEPROM
6060 hex	0	Modes of operation	SINT	RW	Yes	0 to 10 (default: 0)	Yes

◆ Data Description

Value	Description
0	There is no mode change or no mode assigned.
1	Profile Position Mode
2	Reserved (continue previous mode).
3	Profile Velocity Mode
4	Torque Profile mode
6	Homing Mode
7	Interpolated Position Mode
8	Cyclic Sync Position Mode
9	Cyclic Sync Velocity Mode
10	Cyclic Sync Torque Mode
Other value	Reserved (continue previous mode).

Modes of Operation Display (6061 Hex)

This object gives the current mode of operation.

The values that are returned are the same as the object codes for *modes of operation* (6060 hex).

Index	Subin-dex	Name	Data Type	Access	PDO Mapping	Value	Saving to EEPROM
6061 hex	0	Modes of operation display	SINT	RO	Yes	0	No

Supported Drive Modes (6502 Hex)

This object gives the operation modes that are supported by the device.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value	Saving to EEPROM
6502 hex	0	Supported drive modes	UDINT	RO	No	03ED hex	No

◆ Data Description

Bit	Applicable Mode	Definition
0	Pp (Profile position mode)	1: Supported.
1	Vl (Velocity mode)	0: Not supported.
2	Pv (Profile velocity mode)	1: Supported.
3	Tq (Torque profile mode)	1: Supported.
4	Reserved.	0
5	Hm (Homing mode)	1: Supported.
6	Ip (Interpolated position mode)	1: Supported.
7	Csp (Cyclic sync position mode)	1: Supported.
8	Csv (Cyclic sync velocity mode)	1: Supported.
9	Cst (Cyclic sync torque mode)	1: Supported.
10 to 31	Reserved.	0

14.7 Profile Position Mode

Target Position (607A Hex)

This object contains the target position for the Profile Position Mode or Cyclic Synchronous Position Mode.

In Profile Position Mode, the value of this object is interpreted as either an absolute or relative value depending on the Abs/Rel Flag in *controlword*. In Cyclic Synchronous Position Mode, the value is always interpreted as an absolute value.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value	Saving to EEPROM
607A hex	0	Target position	DINT	RW	Yes	–2,147,483,648 to 2,147,483,647 (default: 0) [Pos. unit]	No

Software Position Limits (607D Hex)

This object defines the absolute positions of the limits to the target position (*position demand value*). Every target position is checked against these limits.

The limit positions are specified in user-defined position reference units, the same as for target positions, and are always relative to the machine home position.

The limit values are corrected internally for the *home offset* as given below. The target positions are compared with the corrected values.

- Corrected minimum position limit = Min position limit – Home offset (607C hex)
- Corrected maximum position limit = Max position limit – Home offset (607C hex)

The software position limits are enabled at the following times:

- When homing is completed
- When an absolute encoder is connected

The software limits are disabled if they are set as follows:

- Min position limit ≥ Max position limit

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value	Saving to EEPROM
607D hex	0	Number of entries	USINT	RO	No	2	No
	1	Min position limit	DINT	RW	No	–536,870,912 to 536,870,911 (default: 0) [Pos. unit]	Yes
	2	Max position limit	DINT	RW	No	–536,870,912 to 536,870,911 (default: 0) [Pos. unit]	Yes

Max Profile Velocity (607F Hex)

This object contains the maximum speed during a Profile Mode operation.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value	Saving to EEPROM
607F hex	0	Max profile velocity	UDINT	RW	Yes	0 to 4,294,967,295 (default: 2,147,483,647) [Vel. unit]	Yes

Profile Velocity (6081 Hex)

This object contains the final movement speed at the end of acceleration for a Profile Mode operation.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value	Saving to EEPROM
6081 hex	0	Profile velocity	UDINT	RW	Yes	0 to 4,294,967,295 (default: 0) [Vel. unit]	Yes

Profile Acceleration (6083 Hex)

This object specifies the acceleration rate for Profile Mode operations.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value	Saving to EEPROM
6083 hex	0	Profile acceleration	UDINT	RW	Yes	0 to 4,294,967,295 (default: 1,000) [Acc. unit]	Yes

Profile Deceleration (6084 Hex)

This object specifies the deceleration rate for Profile Mode operations.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value	Saving to EEPROM
6084 hex	0	Profile deceleration	UDINT	RW	Yes	0 to 4,294,967,295 (default: 1,000) [Acc. unit]	Yes

Quick Stop Deceleration (6085 Hex)

This object contains the deceleration rate that is used to stop the motor if the *quick stop option code* (605A hex) is set to 2 and the Quick Stop command is given.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value	Saving to EEPROM
6085 hex	0	Quick stop deceleration	UDINT	RW	Yes	0 to 4,294,967,295 (default: 1,000) [Acc. unit]	Yes

14.8 Homing Mode

Home Offset (607C Hex)

This object contains the offset between the zero position for the application and the machine home position (found during homing).

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value	Saving to EEPROM
607C hex	0	Home offset	DINT	RW	No	–536,870,912 to 536,870,911 (default: 0) [Pos. unit]	Yes

- Incremental Encoder

The machine home position is found during homing. After homing is completed, the zero position is offset from the home position by adding the home offset to the home position.

- Absolute Encoder

If an absolute encoder is connected to the SERVOPACK, the home offset is added to the encoder absolute position when the power supply to the SERVOPACK is turned ON.

Homing Method (6098 Hex)

This object specifies the homing method. Refer to the following section for details on the operations that are performed.

☞ *13.4 **Homing*** on page 13-13

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value	Saving to EEPROM
6098 hex	0	Homing method	SINT	RW	Yes	0 to 35 (default: 35)	No

◆ Data Description

Value (Method)	Description
0	Homing is disabled.
1	Homing with the negative limit switch and index pulse
2	Homing with the positive limit switch and index pulse
7 to 14	Homing with the home switch and index pulse
24	Homing with the home switch
28	Homing with the home switch
33 or 34	Homing with the index pulse
35	Homing with the current position

Homing Speeds (6099 Hex)

This object defines the speeds that are used during homing. The speeds are given in user speed reference units.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value	Saving to EEPROM
6099 hex	0	Number of entries	USINT	RO	No	2	No
	1	Speed during search for switch	UDINT	RW	Yes	0 to 4,294,967,295 (default: 500,000) [Vel. unit]	Yes
	2	Speed during search for zero	UDINT	RW	Yes	0 to 4,294,967,295 (default: 100,000) [Vel. unit]	Yes

Homing Acceleration (609A Hex)

This object defines the acceleration that is used during homing. The rate is given in user acceleration reference units.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value	Saving to EEPROM
609A hex	0	Homing acceleration	UDINT	RW	Yes	0 to 4,294,967,295 (default: 1,000) [Acc. unit]	Yes

14.9 Position Control Function

Position Demand Value (6062 Hex)

This object specifies the current reference position in user position reference units.

Index	Subin-dex	Name	Data Type	Access	PDO Mapping	Value	Saving to EEPROM
6062 hex	0	Position demand value	DINT	RO	Yes	– [Pos. unit]	No

Position Actual Internal Value (6063 Hex)

This object gives the current feedback position in encoder pulse units.

Index	Subin-dex	Name	Data Type	Access	PDO Mapping	Value	Saving to EEPROM
6063 hex	0	Position actual internal value	DINT	RO	Yes	– [inc]	No

Position Actual Value (6064 Hex)

This object gives the current feedback position in user position reference units.

Index	Subin-dex	Name	Data Type	Access	PDO Mapping	Value	Saving to EEPROM
6064 hex	0	Position actual value	DINT	RO	Yes	– [Pos. unit]	No

Position Demand Internal Value (60FC Hex)

This object gives the output of the trajectory generator during position control (the position that is input to the position loop). The value is given in encoder pulses.

Index	Subin-dex	Name	Data Type	Access	PDO Mapping	Value	Saving to EEPROM
60FC hex	0	Position demand internal value	DINT	RO	Yes	– [inc]	No

Following Error Window (6065 Hex)

This object defines the detection range for the following error (bit 13 of *statusword*).

If the position deviation exceeds the *following error window* for the *following error time out* (6066 hex), bit 13 in *statusword* changes to 1 to indicate following error. A following error can occur when the Servo Drive is blocked, when the profile speed is too high, or when the gain settings are not correct.

Index	Subin-dex	Name	Data Type	Access	PDO Mapping	Value	Saving to EEPROM
6065 hex	0	Following error window	UDINT	RW	No	0 to 1,073,741,823 (default: 5,242,880) [Pos. unit]	Yes

Following Error Time Out (6066 Hex)

If the position deviation exceeds the *following error window* for the time specified in this object, bit 13 in *statusword* changes to 1 to indicate following error.

Index	Subin-dex	Name	Data Type	Access	PDO Mapping	Value	Saving to EEPROM
6066 hex	0	Following error time out	UINT	RW	No	0 to 65,535 (default: 0) [ms]	Yes

Following Error Actual Value (60F4 Hex)

This object provides the current following error.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value	Saving to EEPROM
60F4 hex	0	Following error actual value	DINT	RO	Yes	– [Pos. unit]	No

Position Window (6067 Hex)

This object defines the positioning completed width for the target position. When the Servo Drive has completed outputting the reference to the target position and the time specified in *position window time* (6068 hex) has passed after the distance between the target position and the *position actual value* is within the value of this object, bit 10 (*target reached*) in *statusword* changes to 1.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value	Saving to EEPROM
6067 hex	0	Position window	UDINT	RW	No	0 to 1,073,741,823 (default: 30) [Pos. unit]	Yes

Position Window Time (6068 Hex)

When the Servo Drive has completed outputting the reference to the target position and the time specified in this object has passed after the distance between the target position and the *position actual value* is within the *position window* (6067 hex), bit 10 (*target reached*) in *statusword* changes to 1.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value	Saving to EEPROM
6068 hex	0	Position window time	UINT	RW	No	0 to 65,535 (default: 0) [ms]	Yes

14.10 Interpolated Position Mode

Interpolation Submode Select (60C0 Hex) (Object Shared by Mode 1 and Mode 2)

This object is used to select the submode for the Interpolated Position Mode.
To use Interpolated Position Mode, set this object first.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value	Saving to EEPROM
60C0 hex	0	Interpolation sub mode select	INT	RW	No	-3 to 0 (default: 0)	No

◆ Data Description

Value (Method)	Description	
0	Selects mode 1 with no position reference filter.	*Interpolation data record* (60C1 hex) is used as the interpolation position reference.
-1	Selects mode 1 with a position reference filter.*	
-2	Selects mode 2 with no position reference filter.	*Interpolation data record for 1st profile* (27C0 hex) and *interpolation data record for 2nd profile* (27C1 hex) are used as the interpolation position references.
-3	Selects mode 2 with a position reference filter.*	

* If a reference filter is used, the moving average of the interpolation position over the *interpolation time period* (60C2 hex) is used.

Interpolation Data Record (60C1 Hex) (Object Shared by Mode 1 and Mode 2)

This object gives the interpolation position reference for Interpolated Position Mode.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value	Saving to EEPROM
60C1 hex	0	Number of entries	USINT	RO	No	1	No
	1	Interpolation data record	DINT	RW	Yes	–2,147,483,648 to 2,147,483,647 (default: 0) [Pos. unit]	No

Interpolation Time Period (60C2 hex) (Object Shared by Mode 1 and Mode 2)

This object defines the interpolated position reference period for Interpolation Position Mode.

If DC Sync0 Mode is selected, the interpolation time period is automatically stored as the Sync0 Cycle Time. If DC Free-Run Mode is selected, set the object manually.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value	Saving to EEPROM
60C2 hex	0	Number of entries	USINT	RO	No	2	No
	1	Interpolation time period	USINT	RW	No	1 to 250 (default:125)	No
	2	Interpolation time index	SINT	RW	No	–6 to –3 (default: –3)	No

Interpolation time = (Interpolation time period (60C2 hex: 01)) × $10^{\text{Interpolation time index (60C2 hex: 02)}}$ [s]

Note: You can change this object only under the following conditions.
- When DC Sync0 Mode Is Selected:
  EtherCAT (CoE) is in the Switch ON Disable state.
- When DC Free-run Mode Is Selected:
  EtherCAT (CoE) is in the Switch ON Disable state.
  Or, EtherCAT (CoE) is in Interpolated Position Mode and *enable interpolation* equals 0.

Manufacturer Interpolation Data Configuration for 1st Profile (2730 hex) (Mode 2 Object)

This object sets how to use the interpolation position reference in *interpolation data record for 1st profile* (27C0 hex).

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value	Saving to EEPROM
2730 hex	0	Number of entries	USINT	RO	No	9	No
	1	Maximum buffer size	UDINT	RO	No	254	No
	2	Actual buffer size	UDINT	RW	No	254	No
	3	Buffer organization	USINT	RW	No	0 or 1 (default: 0)	No
	4	Buffer position	UINT	RW	Yes	1 to 255 (default: 1)	No
	5	Size of data record	USINT	WO	No	1	No
	6	Buffer clear	USINT	WO	No	0 or 1 (default: 0)	No
	7	Position data definition	USINT	RW	Yes	0 or 1 (default: 1)	No
	8	Position data polarity	USINT	RW	Yes	0 or 1 (default: 0)	No
	9	Behavior after reaching buffer position	USINT	RW	Yes	0 or 1 (default: 0)	No

◆ 2730 Hex: 3 Buffer Organization

Value (Method)	Description
0	Uses the reference input buffer as a FIFO buffer.
1	Uses the reference input buffer is as a ring buffer.

Note: Do not change this value while *enable interpolation* (6040 hex bit 4) is 1.

◆ 2730 Hex: 4 Buffer Position

The object contains the entry point for the available area in the reference input buffer.

Note: Do not change this value while *enable interpolation* (6040 hex bit 4) is 1.

◆ 2730 Hex: 6 Buffer Clear

Value (Method)	Description
0	Disables the reference input buffer.
1	Enables the reference input buffer.

◆ 2730 Hex: 7 Position Data Definition

Value (Method)	Description
0	Uses the value in the reference input buffer as an absolute value.
1	Uses the value in the reference input buffer as a relative value.

To enable changing this value, set the write pointer (2741 hex: 2) and the read pointer (2741 hex: 1) to the same value.

◆ 2730 Hex: 8 Position Data Polarity

Value (Method)	Description
0	Multiplies the value in the reference input buffer by 1.
1	Multiplies the value in the reference input buffer by -1.

This value is valid when *position data definition* (2730 hex: 7) is 1.
To enable changing this value, set the write pointer (2741 hex: 2) and the read pointer (2741 hex: 1) to the same value.

◆ 2730 Hex: 9 Behavior after Reaching Buffer Position

Value (Method)	Description
0	Holds the value of the read pointer (2741 hex: 1) when the read pointer (2741 hex: 1) equals the write pointer (2741 hex: 2) and *enable interpolation* is 0.
1	Initializes the value of the read pointer (2741 hex: 1) when the read pointer (2741 hex: 1) equals the write pointer (2741 hex: 2) and *enable interpolation* is 0.

This value is valid when *buffer organization* (2731 hex: 3) is 0.

Manufacturer Interpolation Data Configuration for 2nd Profile (2731 Hex) (Mode 2 Object)

This object sets how to use the interpolation position reference in *interpolation data record for 2nd profile* (27C1 hex).

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value	Saving to EEPROM
2731 hex	0	Number of entries	USINT	RO	No	9	No
	1	Maximum buffer size	UDINT	RO	No	254	No
	2	Actual buffer size	UDINT	RW	No	254	No
	3	Buffer organization	USINT	RW	No	0 or 1 (default: 0)	No
	4	Buffer position	UINT	RW	Yes	1 to 255 (default: 1)	No
	5	Size of data record	USINT	WO	No	1	No
	6	Buffer clear	USINT	WO	No	0 or 1 (default: 0)	No
	7	Position data definition	USINT	RW	Yes	0 or 1 (default: 0)	No
	8	Position data polarity	USINT	RW	Yes	0 or 1 (default: 0)	No
	9	Behavior after reaching buffer position	USINT	RW	Yes	0 or 1 (default: 0)	No

◆ 2731 Hex: 3 Buffer Organization

Value (Method)	Description
0	Uses the reference input buffer as a FIFO buffer.
1	Uses the reference input buffer is as a ring buffer.

Note: Do not change this value while *enable interpolation* (6040 hex bit 4) is 1.

◆ 2731 Hex: 4 Buffer Position

This object contains the entry point for the available area in the reference input buffer.

Note: Do not change this value while *enable interpolation* (6040 hex bit 4) is 1.

◆ 2731 Hex: 6 Buffer Clear

Value (Method)	Description
0	Disables the reference input buffer.
1	Enables the reference input buffer.

◆ 2731 Hex: 7 Position Data Definition

Value (Method)	Description
0	Uses the value in the reference input buffer as an absolute value.
1	Uses the value in the reference input buffer as a relative value.

To enable changing this value, set the write pointer (2741 hex: 2) and the read pointer (2741 hex: 1) to the same value.

◆ 2731 Hex: 8 Position Data Polarity

Value (Method)	Description
0	Multiplies the value in the reference input buffer by 1.
1	Multiplies the value in the reference input buffer by -1.

This value is valid when *position data definition* (2731 hex: 7) is 1.
To enable changing this value, set the write pointer (2741 hex: 2) and the read pointer (2741 hex: 1) to the same value.

◆ 2731 Hex: 9 Behavior after Reaching Buffer Position

Value (Method)	Description
0	Holds the value of the read pointer (2741 hex: 1) when the read pointer (2741 hex: 1) equals the write pointer (2741 hex: 2) and *enable interpolation* is 0.
1	Initializes the value of the read pointer (2741 hex: 1) when the read pointer (2741 hex: 1) equals the write pointer (2741 hex: 2) and *enable interpolation* is 0.

This value is valid when *buffer organization* (2731 hex: 3) is 0.

Interpolation Profile Select (2732 Hex) (Mode 2 Object)

This object is used to select the type of interpolation profile to use.
Change the interpolation profile only after execution of the current profile has been completed.
You can change the object when *enable interpolation* (6040 hex bit 4) is 0.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value	Saving to EEPROM
2732 hex	0	Interpolation profile select	USINT	RW	Yes	0 or 1 (default: 0)	No

◆ Data Description

Value (Method)	Description
0	Uses the 1st profile. (*interpolation data record for 1st profile* (27C0 hex) and *manufacturer interpolation data configuration for 1st profile* (2730 hex) are enabled.)
1	Uses the 2nd profile. (*interpolation data record for 2nd profile* (27C1 hex) and *manufacturer interpolation data configuration for 2nd profile* (2731 hex) are enabled.)

Note: Do not change this value while *enable interpolation* (6040 hex bit 4) is 1.

Interpolation Data Record for 1st Profile (27C0 Hex) (Mode 2 Object)

This object is used to set the interpolation position reference for the 1st profile in Buffer Strategies for the Interpolated Position Mode.
Set this object only after setting all of the items in *manufacturer interpolation data configuration for 1st profile* (2730 hex).
After you set this object, set *enable interpolation* (6040 hex bit 4) to 1.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value	Saving to EEPROM
27C0 hex	0	Number of entries	DINT	RO	No	254	No
	1 to 254	1st set point to 254th set point	DINT	RW	No	-2,147,483,648 to 2,147,483,647 (default:0)	No

Interpolation Data Record for 2nd Profile (27C1 Hex) (Mode 2 Object)

This object is used to set the interpolation position reference for the 2nd profile in Buffer Strategies for the Interpolated Position Mode.

Set this object only after setting all of the items in *manufacturer interpolation data configuration for 2nd profile* (2731 hex).

After you set this object, set *enable interpolation* (6040 hex bit 4) to 1.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value	Saving to EEPROM
27C1 hex	0	Number of entries	DINT	RO	No	254	No
	1 to 254	1st set point to 254th set point	DINT	RW	No	-2,147,483,648 to 2,147,483,647 (default:0)	No

Interpolation Data Read/Write Pointer Position Monitor (2741 Hex) (Mode 2 Object)

This object gives the current values of the read and write pointers for the reference input buffers in the EtherCAT (CoE) Network Module.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value	Saving to EEPROM
2741 hex	0	Number of entries	UINT	RO	No	2	No
	1	Interpolation data read pointer position	UINT	RO	Yes	1 to 254	No
	2	Interpolation data write pointer position	UINT	RO	Yes	1 to 254	No

◆ 2741 Hex: 1 Interpolation Data Read Pointer Position

This object gives the current value of the read pointer for the reference input buffer in the EtherCAT (CoE) Network Module.

◆ 2741 Hex: 2 Interpolation Data Write Pointer Position

This object gives the current value of the write pointer for the reference input buffer in the EtherCAT (CoE) Network Module.

14.11 Cyclic Synchronous Position Mode

Velocity Offset (60B1 Hex)

In Cyclic Synchronous Position Mode, this object contains the speed feedforward value.

In Cyclic Synchronous Velocity Mode, this object contains the offset value to add to the speed reference.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value	Saving to EEPROM
60B1 hex	0	Velocity offset	DINT	RW	Yes	–2,147,483,648 to 2,147,483,647 (default: 0) [Vel. unit]	No

Torque Offset (60B2 Hex)

In Cyclic Synchronous Position Mode or Cyclic Synchronous Velocity Mode, this object contains the torque feedforward value. In Cyclic Synchronous Torque Mode, this object contains the offset value to add to the torque reference.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value	Saving to EEPROM
60B2 hex	0	Torque offset	INT	RW	Yes	–32,768 to 32,767 (default: 0) [0.1%]	No

14.12 Profile Velocity/Cyclic Synchronous Velocity Mode

Velocity Demand Value (606B Hex)

This object contains the output value from the velocity trajectory generator or the output value from the position control function (i.e., the input reference for the speed loop).

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value	Saving to EEPROM
606B hex	0	Velocity demand value	DINT	RO	Yes	– [Vel. unit]	No

Velocity Actual Value (606C Hex)

This object contains the motor speed.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value	Saving to EEPROM
606C hex	0	Velocity actual value	DINT	RO	Yes	– [Vel. unit]	No

Velocity Window (606D Hex)

This object sets the speed coincidence detection width.

When the time specified in *velocity window time* (606E hex) has passed after the difference between the target speed (*target velocity*) and the *velocity actual value* is within the setting of the *velocity window*, bit 10 (*target reached*) in *statusword* is set to 1.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value	Saving to EEPROM
606D hex	0	Velocity window	UINT	RW	No	0 to 65,535 (default: 20,000) [Vel. unit]	Yes

Velocity Window Time (606E Hex)

When the time specified in *velocity window time* (606E hex) has passed after the difference between the target speed (*target velocity*) and the *velocity actual value* is within the setting of the *velocity window*, bit 10 (*target reached*) in *statusword* is set to 1.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value	Saving to EEPROM
606E hex	0	Velocity window time	UINT	RW	No	0 to 65,535 (default: 0) [ms]	Yes

Target Velocity (60FF Hex)

This object specifies the target speed for Profile Velocity Mode or Cyclic Synchronous Velocity Mode in user defined speed reference units.

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value	Saving to EEPROM
60FF hex	0	Target velocity	DINT	RW	Yes	–2,147,483,648 to 2,147,483,647 (default: 0) [Vel. unit]	No

14.13 Profile Torque/Cyclic Synchronous Torque Mode

Target Torque (6071 Hex)

This object specifies the input torque reference value for Torque Control Mode. Set the value in units of 0.1% of the motor rated torque.

Index	Subin-dex	Name	Data Type	Access	PDO Mapping	Value	Saving to EEPROM
6071 hex	0	Target torque	INT	RW	Yes	–32,768 to 32,767 (default: 0) [0.1%]	No

Torque Demand Value (6074 Hex)

This object gives the currently output torque reference value. The value is given in units of 0.1% of the motor rated torque.

Index	Subin-dex	Name	Data Type	Access	PDO Mapping	Value	Saving to EEPROM
6074 hex	0	Torque demand value	INT	RO	Yes	– [0.1%]	No

Torque Slope (6087 Hex)

This object sets the torque output slope to use in Profile Torque Mode. Set the value as the rate of change per second (0.1%/s) in respect to the motor rated torque.

Index	Subin-dex	Name	Data Type	Access	PDO Mapping	Value	Saving to EEPROM
6087 hex	0	Torque slope	UDINT	RW	Yes	0 to 4,294,967,295 (default:1,000) [0.1%/s]	Yes

Motor Rated Torque (6076 Hex)

This object gives the motor rated torque (rated force for a Linear Servomotor). The value is given in m·Nm for a Rotary Servomotor, and in m·N for a Linear Servomotor.

Index	Subin-dex	Name	Data Type	Access	PDO Mapping	Value	Saving to EEPROM
6076 hex	0	Motor rated torque	UDINT	RO	No	–[mNm] or [mN]	No

Torque Actual Value (6077 Hex)

For a SERVOPACK, this object contains the same value as the torque reference output value.

Index	Subin-dex	Name	Data Type	Access	PDO Mapping	Value	Saving to EEPROM
6077 hex	0	Torque actual value	INT	RO	Yes	– [0.1%]	No

14.14 Torque Limit Function

Max Torque (6072 Hex)

This object sets the maximum output torque for the motor. Set the value in units of 0.1% of the motor rated torque.

The maximum motor torque is automatically set in this object when the power is turned ON.

Index	Subin-dex	Name	Data Type	Access	PDO Mapping	Value	Saving to EEPROM
6072 hex	0	Max torque	UINT	RW	Yes	0 to 65,535 (default: maximum motor torque) [0.1%]	No

Positive Torque Limit Value (60E0 Hex)

This object sets the positive torque limit. Set the value in units of 0.1% of the motor rated torque.

Index	Subin-dex	Name	Data Type	Access	PDO Mapping	Value	Saving to EEPROM
60E0 hex	0	Positive torque limit value	UINT	RW	Yes	0 to 65,535 (default: 8,000) [0.1%]	Yes

Negative Torque Limit Value (60E1 Hex)

This object sets the negative torque limit. Set the value in units of 0.1% of the motor rated torque.

Index	Subin-dex	Name	Data Type	Access	PDO Mapping	Value	EEPROM
60E1 hex	0	Negative torque limit value	UINT	RW	Yes	0 to 65,535 (default: 8,000) [0.1%]	Yes

14.15 Touch Probe Function

Touch Probe Function (60B8 Hex)

This object sets the touch probes.

Index	Subin-dex	Name	Data Type	Access	PDO Mapping	Value	Saving to EEPROM
60B8 hex	0	Touch probe function	UINT	RW	Yes	0 to 0xFFFF (default: 0)	No

◆ Data Description

Bit	Value	Description
0	0	Disables touch probe 1.
	1	Enables touch probe 1.
1	0	Single Trigger Mode (Latches the position at the first trigger event.)
	1	Continuous Trigger Mode (Latches the position every trigger event.)
2	0	Triggers on probe 1 input (SERVOPACK CN1/Probe 1 (SI4) signal).
	1	Triggers on encoder zero signal (phase C).
3	–	Reserved.
4	0	Stops sampling at touch probe 1.
	1	Starts sampling at touch probe 1
5 to 7	–	Reserved.
8	0	Disables touch probe 2.
	1	Enables touch probe 2.
9	0	Single Trigger Mode (Latches the position at the first trigger event.)
	1	Continuous Trigger Mode (Latches the position every trigger event.)
10	0	Triggers on probe 2 input (SERVOPACK CN1/Probe 2 (SI5) signal).
	1	Reserved.
11	–	Reserved.
12	0	Stops sampling at touch probe 2.
	1	Starts sampling at touch probe 2
13 to 15	–	Reserved.

Note: 1. Bits 0 to 7: For touch probe 1.
Bits 8 to 15: For touch probe 2.
2. Touch probe 1 cannot be used during execution of homing. If touch probe 1 was already enabled, it will be disabled when homing is started.
3. If 1 is specified for bit 1 (i.e., if Continuous Trigger Mode is set), the setting of bit 2 (Trigger Selection Signal) will be read each time the latch is started. To continuously latch with the same trigger signal, do not change the status of bit 2.

Touch Probe Status (60B9 Hex)

This object gives the status of the touch probes.

Index	Subin-dex	Name	Data Type	Access	PDO Mapping	Value	Saving to EEPROM
60B9 hex	0	Touch probe status	UINT	RO	Yes	–	No

◆ Data Description

Bit	Value	Description
0	0	Touch probe 1 is disabled.
	1	Touch probe 1 is enabled.
1	0	No latched position is stored for touch probe 1.
	1	A latch position is stored for touch probe 1.
2 to 6	–	Reserved.
7	0 or 1	Saving the latched position for Continuous Trigger Mode for touch probe 1 was completed. * (Status toggles every time a position is latched.)
8	0	Touch probe 2 is disabled.
	1	Touch probe 2 is enabled.
9	0	No latched position is stored for touch probe 2.
	1	A latch position is stored for touch probe 2.
10 to 14	–	Reserved.
15	1	Saving the latched position for Continuous Trigger Mode for touch probe 2 was completed.* (Status toggles every time a position is latched.)

* If the continuous latch is enabled (60B8 hex bit 1 = 1 or bit 9 = 1), bit 7 or bit 15 of object 60B9 hex is toggled every time the latched position is updated.

Touch Probe 1 Position Value (60BA Hex)

This object gives the latched position for touch probe 1. The value is given in user position units (Pos. unit).

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value	Saving to EEPROM
60BA hex	0	Touch probe 1 position value	DINT	RO	Yes	– [Pos. unit]	No

Touch Probe 2 Position Value (60BC Hex)

This object gives the latched position for touch probe 2. The value is given in user position units (Pos. unit).

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value	Saving to EEPROM
60BC hex	0	Touch probe 2 position value	DINT	RO	Yes	– [Pos. unit]	No

14.16 Digital Inputs/Outputs

Digital Inputs (60FD Hex)

This object gives the status of the *digital inputs* to CN1 on the SERVOPACK.

Index	Subin-dex	Name	Data Type	Access	PDO Mapping	Value	Saving to EEPROM
60FD hex	0	Digital inputs	UDINT	RO	Yes	–	No

◆ Data Description

Bit	Signal	Description
0	N-OT: Negative limit switch	0: OFF, 1: ON
1	P-OT: Positive limit switch	0: OFF, 1: ON
2	Home switch	0: OFF, 1: ON
3 to 15	–	Reserved.
16	SI0	0: OFF (open), 1: ON (closed)
17	SI1	0: OFF (open), 1: ON (closed)
18	SI2	0: OFF (open), 1: ON (closed)
19	SI3	0: OFF (open), 1: ON (closed)
20	SI4	0: OFF (open), 1: ON (closed)
21	SI5	0: OFF (open), 1: ON (closed)
22	SI6	0: OFF (open), 1: ON (closed)
23	–	Reserved.
24	HWBB1	Hardwired base block signal input 1 (0: Open, 1: Closed)
25	HWBB2	Hardwired base block signal input 2 (0: Open, 1: Closed)
26 to 31	–	Reserved.

Digital Outputs (60FE Hex)

This object controls the status of the general-purpose output signals (SO1 to SO3) from CN1 on the SERVOPACK.

Subindex 1 is used to control the status of the output signals. Subindex 2 determines which output signals in subindex 1 are enabled.

If SERVOPACK status outputs are assigned in objects 250E hex, 250F hex, and 2510 hex, the status will be output using ORs with the settings in this object. If any of these signals (SO1 to SO3) are assigned to functions that are enabled with objects 250E hex, 250F hex, or 2510 hex, use the Bit Masks in subindex 2 to disable the corresponding signals so that the signals are not duplicated.

Index	Subin-dex	Name	Data Type	Access	PDO Mapping	Value	Saving to EEPROM
60FE hex	0	Number of entries	USINT	RO	No	2	No
	1	Physical outputs[*1]	UDINT	RW	Yes	0 to 0xFFFFFFFF (default: 0)	No
	2	Bit mask[*2]	UDINT	RW	No	0 to 0xFFFFFFFF (default: 0x000C0000)	Yes

*1. Data Description of Physical Outputs:

Bit	Signal	Description
0 to 16	–	Reserved.
17	SO1	0: OFF, 1: ON
18	SO2	0: OFF, 1: ON
19	SO3	0: OFF, 1: ON
20 to 31	–	Reserved.

*2. Data Description of Bit Masks:

Bit	Signal	Description
0 to 16	–	Reserved.
17	SO1	0: Disables physical output. 1: Enables physical output.
18	SO2	0: Disables physical output. 1: Enables physical output.
19	SO3	0: Disables physical output. 1: Enables physical output.
20 to 31	–	Reserved.

14.17 Dual Encoder Feedback

You can monitor the position of the external encoder in *dual encoder feedback* (60E4 hex).

Index	Subindex	Name	Data Type	Access	PDO Mapping	Value	Saving to EEPROM
60E4 hex	0	Number of entries	UINT8	RO	No	1	No
	1	External encoder position	INT32	RO	Yes	(Default: 0)	Yes

Maintenance

15

This chapter provides information on the meaning of, causes of, and corrections for alarms and warnings.
In this chapter, the object index number (2□□□ hex) for EtherCAT communications is given after the SERVOPACK parameter number (Pn□□□)

15.1 Inspections and Part Replacement

This section describes inspections and part replacement for SERVOPACKs.

15.1.1 Inspections

Perform the inspections given in the following table at least once every year for the SERVOPACK. 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.

15.1.2 Guidelines for Part Replacement

The following electric or electronic parts are subject to mechanical wear or deterioration over time. Use one of the following methods to check the standard replacement period.

- Use the service life prediction function of the SERVOPACK.
  Refer to the following section for information on service life predictions.
  ☞ *9.4 Monitoring Product Life* on page 9-14
- Use the following table.

Part	Standard Replacement Period	Remarks
Cooling Fan	4 to 5 years	The standard replacement periods given on the left are for the following operating conditions. • Surrounding air temperature: Annual average of 30°C • Load factor: 80% max. • Operation rate: 20 hours/day max.
Electrolytic Capacitor	10 years	
Relays	100,000 power ON operations	Power ON frequency: Once an hour
Battery	3 years without power supplied	Surrounding temperature without power supplied: 20°C

When any standard replacement period is close to expiring, contact your Yaskawa representative. After an examination of the part in question, we will determine whether the part should be replaced.

Important

The parameters of any SERVOPACKs that are sent to Yaskawa for part replacement are reset to the factory settings before they are returned to you. Always keep a record of the parameter settings. And, always confirm that the parameters are properly set before starting operation.

15.1.3 Replacing the Battery

If the battery voltage drops to approximately 2.7 V or less, an A.830 alarm (Encoder Battery Alarm) or an A.930 warning (Encoder Battery Warning) will be displayed.

If this alarm or warning is displayed, the battery must be replaced.
Refer to the following section for the battery replacement procedure.

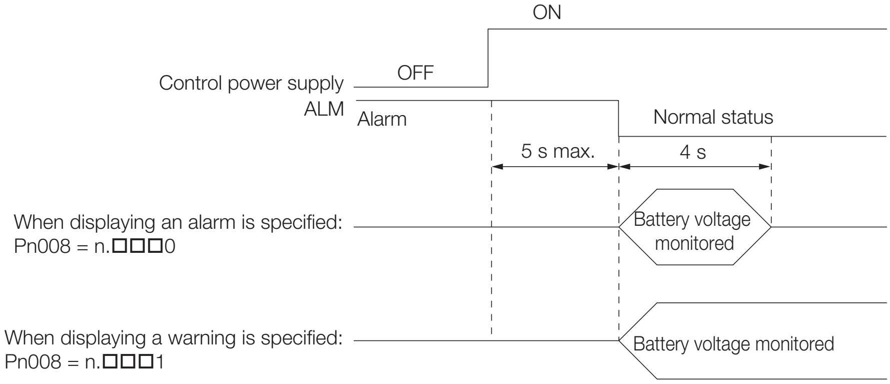
☞ *Battery Replacement Procedure* on page 15-3

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		Meaning	When Enabled	Classification
Pn008 (2008 hex)	n.☐☐☐0 (default setting)	Output alarm (A.830) for low battery voltage.	After restart	Setup
	n.☐☐☐1	Output warning (A.930) for low battery voltage.		

- 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.



Battery Replacement Procedure

◆ When Installing a Battery on the Host Controller

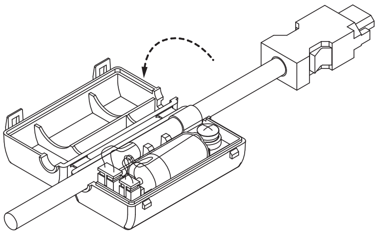
1. Turn ON only the control power supply to the SERVOPACK.
2. Remove the old battery and mount a new battery.
3. Turn OFF the control power supply to the SERVOPACK to clear the A.830 alarm (Absolute Encoder Battery Error).
4. Turn ON the control power supply to the SERVOPACK again.
5. Make sure that the alarm has been cleared and that the SERVOPACK operates normally.

◆ When Using an Encoder Cable with a Battery Case

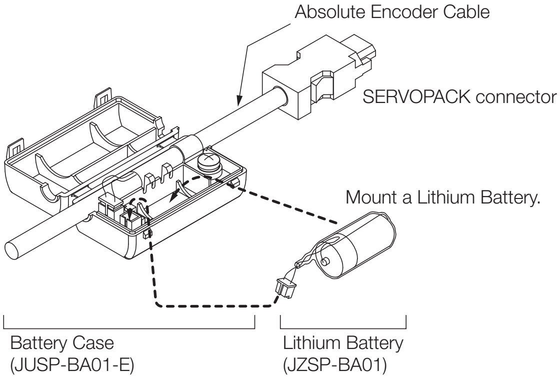
1. Turn ON only the control power supply to the SERVOPACK.

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

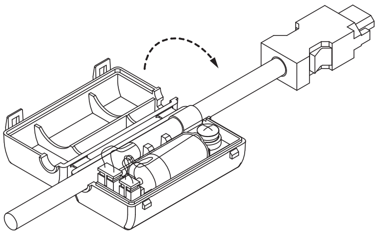
2. Open the cover of the Battery Case.



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



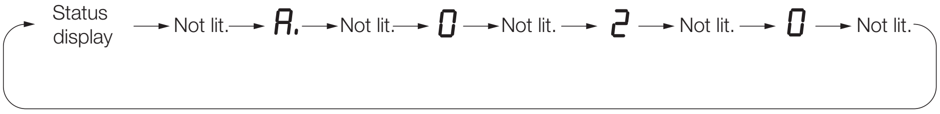
4. Close the cover of the Battery Case.



5. Turn OFF the power supply to the SERVOPACK to clear the A.830 alarm (Absolute Encoder Battery Error).
6. Turn ON the power supply to the SERVOPACK.
7. Make sure that the alarm has been cleared and that the SERVOPACK operates normally.

15.2 Alarm Displays

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

Panel display on SERVOPACK	If there is an alarm, the code will be displayed one character at a time, as shown below. Example: Alarm A.E60 
Digital Operator	The alarm code will be displayed.
Statusword (6041 hex)	Bit 3 (*fault*) in the *statusword* will change to 1. (Bit 3 is 0 during normal operation.)
Error Code (603F hex)	A current alarm code is stored in object 603F hex.
Emergency message	The Controller is notified of any alarm that occurs. (Notification may not be possible if EtherCAT communications are unstable.)

This section provides a list of the alarms that may occur and the causes of and corrections for those alarms.

15.2.1 List of Alarms

The following alarm tables gives the alarm name, alarm meaning, alarm stopping method, and alarm reset possibility in order of the alarm codes.

Servomotor Stopping Method for Alarms

Refer to the following section for information on the stopping method for alarms.

☞ *5.12.2 Servomotor Stopping Method for Alarms* on page 5-38

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 Code	Alarm Name	Alarm Meaning	Servo-motor Stop-ping Method	Alarm Reset Possi-ble?
020 hex	Parameter Checksum Error	There is an error in the parameter data in the SERVOPACK.	Gr.1	No
021 hex	Parameter Format Error	There is an error in the parameter data format in the SERVOPACK.	Gr.1	No
022 hex	System Checksum Error	There is an error in the parameter data in the SERVOPACK.	Gr.1	No
024 hex	System Alarm	An internal program error occurred in the SERVOPACK.	Gr.1	No
025 hex	System Alarm	An internal program error occurred in the SERVOPACK.	Gr.1	No
030 hex	Main Circuit Detector Error	There is an error in the detection data for the main circuit.	Gr.1	Yes

Continued from previous page.

Alarm Code	Alarm Name	Alarm Meaning	Servomotor Stopping Method	Alarm Reset Possible?
040 hex	Parameter Setting Error	A parameter setting is outside of the setting range.	Gr.1	No
041 hex	Encoder Output Pulse Setting Error	The setting of Pn212 (2212 hex) (Encoder Output Pulses) or Pn281 (2281 hex) (Encoder Output Resolution) is outside of the setting range or does not satisfy the setting conditions.	Gr.1	No
042 hex	Parameter Combination Error	The combination of some parameters exceeds the setting range.	Gr.1	No
044 hex	Semi-Closed/Fully-Closed Loop Control Parameter Setting Error	The settings of the Option Module and Pn002 = n.X□□□ (External Encoder Usage) do not match.	Gr.1	No
050 hex	Combination Error	The capacities of the SERVOPACK and Servomotor do not match.	Gr.1	Yes
051 hex	Unsupported Device Alarm	An unsupported device was connected.	Gr.1	No
070 hex	Motor Type Change Detected	The connected motor is a different type of motor from the previously connected motor.	Gr.1	No
080 hex	Linear Encoder Pitch Setting Error	The setting of Pn282 (2282 hex) (Linear Encoder Pitch) has not been changed from the default setting.	Gr.1	No
0b0 hex	Invalid Servo ON Command Alarm	The Servo ON command (Enable Operation command) was sent from the host controller after a utility function that turns ON the Servomotor was executed.	Gr.1	Yes
100 hex	Overcurrent Detected	An overcurrent flowed through the power transformer or the heat sink overheated.	Gr.1	No
101 hex	Motor Overcurrent Detected	The current to the motor exceeded the allowable current.	Gr.1	No
300 hex	Regeneration Error	There is an error related to regeneration.	Gr.1	Yes
320 hex	Regenerative Overload	A regenerative overload occurred.	Gr.2	Yes
330 hex	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
400 hex	Overvoltage	The main circuit DC voltage is too high.	Gr.1	Yes
410 hex	Undervoltage	The main circuit DC voltage is too low.	Gr.2	Yes
510 hex	Overspeed	The motor exceeded the maximum speed.	Gr.1	Yes
511 hex	Encoder Output Pulse Overspeed	• Rotary Servomotor: The pulse output speed for the setting of Pn212 (2212 hex) (Encoder Output Pulses) was exceeded. • Linear Servomotor: The motor speed upper limit for the setting of Pn281 (2281 hex) (Encoder Output Resolution) was exceeded.	Gr.1	Yes
520 hex	Vibration Alarm	Abnormal oscillation was detected in the motor speed.	Gr.1	Yes
521 hex	Autotuning Alarm	Vibration was detected during autotuning for the tuning-less function.	Gr.1	Yes
550 hex	Maximum Speed Setting Error	The setting of Pn385 (2385 hex) (Maximum Motor Speed) is greater than the maximum motor speed.	Gr.1	Yes
710 hex	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
720 hex	Continuous Overload	The Servomotor was operating continuously under a torque that exceeded the rating.	Gr.1	Yes

Continued from previous page.

Alarm Code	Alarm Name	Alarm Meaning	Servomotor Stopping Method	Alarm Reset Possible?
730 hex 731 hex	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
740 hex	Inrush Current Limiting Resistor Overload	The main circuit power supply was frequently turned ON and OFF.	Gr.1	Yes
7A1 hex	Internal Temperature Error 1 (Control Board Temperature Error)	The surrounding temperature of the control PCB is abnormal.	Gr.2	Yes
7A2 hex	Internal Temperature Error 2 (Power Board Temperature Error)	The surrounding temperature of the power PCB is abnormal.	Gr.2	Yes
7A3 hex	Internal Temperature Sensor Error	An error occurred in the temperature sensor circuit.	Gr.2	No
7Ab hex	SERVOPACK Built-in Fan Stopped	The fan inside the SERVOPACK stopped.	Gr.1	Yes
810 hex	Encoder Backup Alarm	The power supplies to the encoder all failed and the position data was lost.	Gr.1	No
820 hex	Encoder Checksum Alarm	There is an error in the checksum results for encoder memory.	Gr.1	No
830 hex	Encoder Battery Alarm	The battery voltage was lower than the specified level after the control power supply was turned ON.	Gr.1	Yes
840 hex	Encoder Data Alarm	There is an internal data error in the encoder.	Gr.1	No
850 hex	Encoder Overspeed	The encoder was operating at high speed when the power was turned ON.	Gr.1	No
860 hex	Encoder Overheated	The internal temperature of encoder is too high.	Gr.1	No
861 hex	Motor Overheated	The internal temperature of motor is too high.	Gr.1	No
890 hex	Encoder Scale Error	A failure occurred in the linear encoder.	Gr.1	No
891 hex	Encoder Module Error	An error occurred in the linear encoder.	Gr.1	No
8A0 hex	External Encoder Error	An error occurred in the external encoder.	Gr.1	Yes
8A1 hex	External Encoder Module Error	An error occurred in the Serial Converter Unit.	Gr.1	Yes
8A2 hex	External Incremental Encoder Sensor Error	An error occurred in the external encoder.	Gr.1	Yes
8A3 hex	External Absolute Encoder Position Error	An error occurred in the position data of the external encoder.	Gr.1	Yes
8A5 hex	External Encoder Overspeed	An overspeed error occurred in the external encoder.	Gr.1	Yes
8A6 hex	External Encoder Overheated	An overheating error occurred in the external encoder.	Gr.1	Yes
A10 hex	EtherCAT DC Synchronization Error [*2]	The SERVOPACK and Sync0 events cannot be synchronized.	Gr.2[*3]	Yes
A11 hex	EtherCAT State Error	The EtherCAT AL does not move to the Operational state when the DS402 drive is in Operation Enabled state.	Gr.2[*3]	Yes
A12 hex	EtherCAT Outputs Data Synchronization Error [*2]	The process data reception events and Sync0 events cannot be synchronized. (Process data communications failed.)	Gr.2[*3]	Yes
A20 hex	Parameter Setting Error	A parameter setting exceeds the setting range.	Gr.1	No
A40 hex	System Initialization Error	Initialization failed when the power supply was turned ON.	Gr.1	No
A41 hex	Communication Device Initialization Error	An error occurred during ESC initialization.	Gr.1	No

Continued from previous page.

Alarm Code	Alarm Name	Alarm Meaning	Servomotor Stopping Method	Alarm Reset Possible?
A47 hex	Loading Servo Information Error	Loading SERVOPACK information failed.	Gr.1	No
A48 hex	EEPROM Parameter Data Error	A checksum error occurred in the EEPROM.	Gr.1	No
b33 hex	Current Detection Error 3	An error occurred in the current detection circuit.	Gr.1	No
bF0 hex	System Alarm 0	Internal program error 0 occurred in the SERVOPACK.	Gr.1	No
bF1 hex	System Alarm 1	Internal program error 1 occurred in the SERVOPACK.	Gr.1	No
bF2 hex	System Alarm 2	Internal program error 2 occurred in the SERVOPACK.	Gr.1	No
bF3 hex	System Alarm 3	Internal program error 3 occurred in the SERVOPACK.	Gr.1	No
bF4 hex	System Alarm 4	Internal program error 4 occurred in the SERVOPACK.	Gr.1	No
C10 hex	Servomotor Out of Control	The Servomotor ran out of control.	Gr.1	Yes
C20 hex	Phase Detection Error	The detection of the phase is not correct.	Gr.1	No
C21 hex	Polarity Sensor Error	An error occurred in the polarity sensor.	Gr.1	No
C22 hex	Phase Information Disagreement	The phase information does not match.	Gr.1	No
C50 hex	Polarity Detection Failure	The polarity detection failed.	Gr.1	No
C51 hex	Overtravel Detected during Polarity Detection	The overtravel signal was detected during polarity detection.	Gr.1	Yes
C52 hex	Polarity Detection Not Completed	The servo was turned ON before the polarity was detected.	Gr.1	Yes
C53 hex	Out of Range of Motion for Polarity Detection	The travel distance exceeded the setting of Pn48E (248E hex) (Polarity Detection Range).	Gr.1	No
C54 hex	Polarity Detection Failure 2	The polarity detection failed.	Gr.1	No
C80 hex	Encoder Clear Error or Multiturn Limit Setting Error	The multiturn data for the absolute encoder was not correctly cleared or set.	Gr.1	No
C90 hex	Encoder Communications Error	Communications between the encoder and SERVOPACK is not possible.	Gr.1	No
C91 hex	Encoder Communications Position Data Acceleration Rate Error	An error occurred in calculating the position data of the encoder.	Gr.1	No
C92 hex	Encoder Communications Timer Error	An error occurred in the communications timer between the encoder and SERVOPACK.	Gr.1	No
CA0 hex	Encoder Parameter Error	The parameters in the encoder are corrupted.	Gr.1	No
Cb0 hex	Encoder Echoback Error	The contents of communications with the encoder are incorrect.	Gr.1	No
CC0 hex	Multiturn Limit Disagreement	Different multiturn limits have been set in the encoder and the SERVOPACK.	Gr.1	No
CF1 hex	Reception Failed Error in Feedback Option Module Communications	Receiving data from the Feedback Option Module failed.	Gr.1	No
CF2 hex	Timer Stopped Error in Feedback Option Module Communications	An error occurred in the timer for communications with the Feedback Option Module.	Gr.1	No
d00 hex	Position Deviation Overflow	The setting of Pn520 (2520 hex) (Excessive Position Deviation Alarm Level) was exceeded by the position deviation while the servo was ON.	Gr.1	Yes

Continued from previous page.

Alarm Code	Alarm Name	Alarm Meaning	Servomotor Stopping Method	Alarm Reset Possible?
d01 hex	Position Deviation Overflow Alarm at Servo ON	The servo was turned ON after the position deviation exceeded the setting of Pn526 (2526 hex) (Excessive Position Deviation Alarm Level at Servo ON) while the servo was OFF.	Gr.1	Yes
d02 hex	Position Deviation Overflow Alarm for Speed Limit at Servo ON	If position deviation remains in the deviation counter, the setting of Pn529 (2529 hex) or Pn584 (2584 hex) (Speed Limit Level at Servo ON) will limit the speed when the servo is turned ON. This alarm occurs if a position reference is input and the setting of Pn520 (2520 hex) (Excessive Position Deviation Alarm Level) is exceeded before the limit is cleared.	Gr.2	Yes
d10 hex	Motor-Load Position Deviation Overflow	There was too much position deviation between the motor and load during fully-closed loop control.	Gr.2	Yes
d30 hex	Position Data Overflow	The position feedback data exceeded ±1,879,048,192.	Gr.1	No
E00 hex	EtherCAT Module Interface Initialization Timeout Error	Communications initialization failed between the SERVOPACK and the EtherCAT Module.	Gr.2	Yes
E02 hex	EtherCAT Internal Synchronization Error 1	A synchronization error occurred during EtherCAT communications with the SERVOPACK.	Gr.1	Yes
E03 hex	EtherCAT Module Interface Communications Data Error	There is an error in the communications data between the SERVOPACK and the EtherCAT Module.	Gr.1	Yes
E72 hex	Feedback Option Module Detection Failure	Detection of the Feedback Option Module failed.	Gr.1	No
E74 hex	Unsupported Safety Option Module Alarm	An unsupported Safety Option Module was connected.	Gr.1	No
E75 hex[*3]	Unsupported Feedback Option Module Alarm	An unsupported Feedback Option Module was connected.	Gr.1	No
EA0 hex	Command-Option IF Servo Unit Initial Error	Communications could not be initialized between the SERVOPACK and EtherCAT (CoE) Network Module within 10 seconds.	Gr.1	No
EA1 hex	Command-Option IF Memory Check Error	An error occurred in communications memory between the SERVOPACK and EtherCAT (CoE) Network Module.	Gr.1	No
EA2 hex	Command-Option IF Servo Synchronization Error [*2]	Communications could not be synchronized between the SERVOPACK and EtherCAT (CoE) Network Module.	Gr.1	Yes
EA3 hex	Command-Option IF Servo Data Error [*2]	An error occurred in communications data between the SERVOPACK and EtherCAT (CoE) Network Module.	Gr.1	Yes
Eb1 hex	Safety Function Signal Input Timing Error	An error occurred in the input timing of the safety function signal.	Gr.1	No
Ed1 hex	Command Execution Timeout	A timeout error occurred for a EtherCAT command.	Gr.2	Yes
F10 hex	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
F50 hex	Servomotor Main Circuit Cable Disconnection	The Servomotor did not operate or power was not supplied to the Servomotor even though the Servo ON command (Enable Operation command) was input when the Servomotor was ready to receive it.	Gr.1	Yes

Continued from previous page.

Alarm Code	Alarm Name	Alarm Meaning	Servomotor Stopping Method	Alarm Reset Possible?
FL-1*1	System Alarm	An internal program error occurred in the SERVOPACK.	–	No
FL-2*1				
FL-3*1				
FL-4*1				
FL-5*1				
CPF00	Digital Operator Communications Error 1	Communications were not possible between the Digital Operator (model: JUSP-OP05A-1-E) and the SERVOPACK (e.g., a CPU error occurred).	–	No
CPF01	Digital Operator Communications Error 2			

*1. These alarms are not stored in the alarm history. They are only displayed on the panel display.
*2. The EtherCAT communications state moved to SAFEOP after an alarm was detected.
*3. This alarm can occur when a Fully-Close Option Module is mounted.

15.2.2 Troubleshooting Alarms

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

Alarm Code: Alarm Name	Possible Cause	Confirmation	Correction	Reference
020 hex: Parameter Checksum Error (There is an error in the parameter data in the SERVOPACK.)	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.	page 5-9
	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 SERVOPACK may be faulty. Replace the SERVOPACK. 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 SERVOPACK OFF and ON again. If the alarm still occurs, noise may be the cause.	Implement countermeasures against noise.	page 4-5
	Gas, water drops, or cutting oil entered the SERVOPACK and caused failure of the internal components.	Check the installation conditions.	The SERVOPACK may be faulty. Replace the SERVOPACK.	–
	A failure occurred in the SERVOPACK.	Turn the power supply to the SERVOPACK OFF and ON again. If the alarm still occurs, the SERVOPACK may have failed.	The SERVOPACK may be faulty. Replace the SERVOPACK.	–

Continued from previous page.

Alarm Code: Alarm Name	Possible Cause	Confirmation	Correction	Reference
021 hex: Parameter Format Error (There is an error in the parameter data format in the SERVOPACK.)	The software version of the SERVOPACK 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 SERVOPACK with the same model and the same software version, and then turn the power OFF and ON again.	page 9-2
	A failure occurred in the SERVOPACK.	–	The SERVOPACK may be faulty. Replace the SERVOPACK.	–
022 hex: System Checksum Error (There is an error in the parameter data in the SERVOPACK.)	The power supply voltage suddenly dropped.	Measure the power supply voltage.	The SERVOPACK may be faulty. Replace the SERVOPACK.	–
	The power supply was shut OFF while setting a utility function.	Check the timing of shutting OFF the power supply.	The SERVOPACK may be faulty. Replace the SERVOPACK.	–
	A failure occurred in the SERVOPACK.	Turn the power supply to the SERVOPACK OFF and ON again. If the alarm still occurs, the SERVOPACK may have failed.	The SERVOPACK may be faulty. Replace the SERVOPACK.	–
024 hex: System Alarm (An internal program error occurred in the SERVOPACK.)	A failure occurred in the SERVOPACK.	–	The SERVOPACK may be faulty. Replace the SERVOPACK.	–
025 hex: System Alarm (An internal program error occurred in the SERVOPACK.)	A failure occurred in the SERVOPACK.	–	The SERVOPACK may be faulty. Replace the SERVOPACK.	–
030 hex: Main Circuit Detector Error	A failure occurred in the SERVOPACK.	–	The SERVOPACK may be faulty. Replace the SERVOPACK.	–
040 hex: Parameter Setting Error (A parameter setting is outside of the setting range.)	The SERVOPACK and Servomotor capacities do not match each other.	Check the combination of the SERVOPACK and Servomotor capacities.	Select a proper combination of SERVOPACK and Servomotor capacities.	–
	A failure occurred in the SERVOPACK.	–	The SERVOPACK may be faulty. Replace the SERVOPACK.	–
	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.	–
041 hex: Encoder Output Pulse Setting Error	The setting of Pn212 (2212 hex) (Encoder Output Pulses) or Pn281 (2281 hex) (Encoder Output Resolution) is outside of the setting range or does not satisfy the setting conditions.	Check the setting of Pn212 (2212 hex) or Pn281 (2281 hex).	Set Pn212 (2212 hex) or Pn281 (2281 hex) to an appropriate value.	page 6-17

Continued from previous page.

Alarm Code: Alarm Name	Possible Cause	Confirmation	Correction	Reference
042 hex: Parameter Combination Error	The speed of program jogging went below the setting range when Pn533 (2533 hex) or Pn585 (2585 hex) (Program Jogging Speed) was changed.	Check to see if the detection conditions[*1] are satisfied.	Increase the setting of Pn533 (2533 hex) or Pn585 (2585 hex).	page 7-13
044 hex: Semi-Closed/ Fully-Closed Loop Control Parameter Setting Error	The setting of the Fully-Closed Module does not match the setting of Pn002 (2002 hex) = n.X□□□ (External Encoder Usage).	Check the setting of Pn002 (2002 hex) = n.X□□□.	Make sure that the setting of the Fully-closed Module agrees with the setting of Pn002 (2002 hex) = n.X□□□.	page 10-6
050 hex: Combination Error (The capacities of the SERVOPACK and Servomotor do not match.)	The SERVOPACK and Servomotor capacities do not match each other.	Check the capacities to see if they satisfy the following condition: $1/4 \le \frac{\text{Servomotor capacity}}{\text{SERVOPACK capacity}} \le 4$	Select a proper combination of the SERVOPACK and Servomotor capacities.	–
	A failure occurred in the encoder.	Replace the encoder and check to see if the alarm still occurs.	Replace the Servomotor or encoder.	–
	A failure occurred in the SERVOPACK.	–	The SERVOPACK may be faulty. Replace the SERVOPACK.	–
051 hex: 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.	page 5-17
	An unsupported Serial Converter Unit or encoder (e.g., an external encoder) is connected to the SERVOPACK.	Check the product combination specifications.	Change to a correct combination of models.	–
070 hex: Motor Type Change Detected (The connected motor is a different type of motor from the previously connected motor.)	A Rotary Servomotor was removed and a Linear Servomotor was connected.	–	Set the parameters for a Linear Servomotor and reset the motor type alarm. Then, turn the power supply to the SERVOPACK OFF and ON again.	page 15-42
	A Linear Servomotor was removed and a Rotary Servomotor was connected.	–	Set the parameters for a Rotary Servomotor and reset the motor type alarm. Then, turn the power supply to the SERVOPACK OFF and ON again.	page 15-42
080 hex: Linear Encoder Pitch Setting Error	The setting of Pn282 (2282 hex) (Linear Encoder Pitch) has not been changed from the default setting.	Check the setting of Pn282 (2282 hex).	Correct the setting of Pn282 (2282 hex).	page 5-16

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Alarm Code: Alarm Name	Possible Cause	Confirmation	Correction	Reference
0b0 hex: Invalid Servo ON Command Alarm	The Servo ON command (Enable Operation command) was sent from the host controller after a utility function that turns ON the Servomotor was executed.	–	Turn the power supply to the SERVOPACK OFF and ON again. Or, execute a software reset.	page 6-43
100 hex: Overcurrent Detected (An overcurrent flowed through the power transformer or the heat sink overheated.)	The Main Circuit Cable is not wired correctly or there is faulty contact.	Check the wiring.	Correct the wiring.	page 4-23
	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 short-circuited. 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 SERVOPACK.	Check for short-circuits across the Servomotor connection terminals U, V, and W on the SERVOPACK, or between the ground and terminals U, V, or W.	The SERVOPACK may be faulty. Replace the SERVOPACK.	
	The regenerative resistor is not wired correctly or there is faulty contact.	Check the wiring.	Correct the wiring.	page 4-19
	The dynamic brake (DB, emergency stop executed from the SERVOPACK) 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 SERVOPACK model, operating methods, or the mechanisms so that the dynamic brake does not need to be used so frequently.	–
	The regenerative resistor value exceeded the SERVOPACK regenerative processing capacity.	Check the regenerative load ratio in the SigmaWin+ Motion Monitor Tab Page to see how frequently the regenerative resistor is being used.	Select a regenerative resistance value that is appropriate for the operating conditions and load.	–
	The SERVOPACK regenerative resistance is too small.	Check the regenerative load ratio in the SigmaWin+ Motion Monitor Tab Page to see how frequently the regenerative resistor is being used.	Change the regenerative resistance to a value larger than the SERVOPACK 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.	–

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Alarm Code: Alarm Name	Possible Cause	Confirmation	Correction	Reference
100 hex: Overcurrent Detected (An overcurrent flowed through the power transformer or the heat sink overheated.)	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 SERVOPACK's main circuit wire size.	–
	A failure occurred in the SERVOPACK.	–	Turn the power supply to the SERVOPACK OFF and ON again. If an alarm still occurs, the SERVOPACK may be faulty. Replace the SERVOPACK.	–
101 hex: 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.	page 4-23
	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 short-circuited. 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 SERVOPACK.	Check for short-circuits across the Servomotor connection terminals U, V, and W on the SERVOPACK, or between the ground and terminals U, V, or W.	The SERVOPACK may be faulty. Replace the SERVOPACK.	
	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 SERVOPACK's main circuit wire size.	–
	A failure occurred in the SERVOPACK.	–	Turn the power supply to the SERVOPACK OFF and ON again. If an alarm still occurs, the SERVOPACK may be faulty. Replace the SERVOPACK.	–

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Alarm Code: Alarm Name	Possible Cause	Confirmation	Correction	Reference
300 hex: Regeneration Error	Pn600 (2600 hex)) (Regenerative Resistor Capacity) is set to a value other than 0 (setting unit: 10 W) even though a Regenerative Resistor is not connected to one of the following SERVOPACKs: SGD7S-R70A, -R90A, -1R6A, -2R8A, or -330A.	Check it see if an External Regenerative Resistor is connected and check the setting of Pn600 (2600 hex).	Connect an External Regenerative Resistor, or if a Regenerative Resistor is not required, set Pn600 (2600 hex) to 0.	page 5-55
	An External Regenerative Resistor is not connected to one of the following SERVOPACKs: SGD7S-470A, -550A, -590A, or -780A.	Check to see if an External Regenerative Resistor or a Regenerative Resistor Unit is connected and check the setting of Pn600 (2600 hex) (Regenerative Resistor Capacity).	Connect an External Regenerative Resistor and set Pn600 (2600 hex) to an appropriate value, or connect a Regenerative Resistor Unit and set Pn600 (2600 hex) to 0 (setting unit: 10 W).	
	The jumper between the regenerative resistor terminals (B2 and B3) was removed from one of the following SERVOPACKs: SGD7S-3R8A, SGD7S-5R5A, SGD7S-7R6A, SGD7S-120A, SGD7S-180A, or SGD7S-200A.	Check to see if the jumper is connected between power supply terminals B2 and B3.	Correctly connect a jumper.	page 4-19
	The External Regenerative Resistor is not wired correctly, or was removed or disconnected.	Check the wiring of the External Regenerative Resistor.	Correct the wiring of the External Regenerative Resistor.	
	A failure occurred in the SERVOPACK.	–	While the main circuit power supply is OFF, turn the control power supply to the SERVOPACK OFF and ON again. If an alarm still occurs, the SERVOPACK may be faulty. Replace the SERVOPACK.	–

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Alarm Code: Alarm Name	Possible Cause	Confirmation	Correction	Reference
320 hex: 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.	Check the operating conditions or the capacity using the SigmaJunmaSize+ Capacity Selection Software or other means.	Change the regenerative resistance value or capacity. Reconsider the operating conditions using the SigmaJunmaSize+ Capacity Selection Software or other means.	–
	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.	–
	The setting of Pn600 (2600 hex) (Regenerative Resistor Capacity) is smaller than the capacity of the External Regenerative Resistor.	Check it see if a Regenerative Resistor is connected and check the setting of Pn600 (2600 hex).	Correct the setting of Pn600 (2600 hex).	page 5-55
	The setting of Pn603 (2603 hex) (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 (2603 hex).	Correct the setting of Pn603 (2603 hex).	page 5-55
	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 SERVOPACK.	–	The SERVOPACK may be faulty. Replace the SERVOPACK.	–

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Alarm Code: Alarm Name	Possible Cause	Confirmation	Correction	Reference
330 hex: Main Circuit Power Supply Wiring Error (Detected when the main circuit power supply is turned ON.)	The regenerative resistor was disconnected when the SERVOPACK 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 SERVOPACK, replace the SERVOPACK. 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.	page 5-12
	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.	
	Pn600 (2600 hex) (Regenerative Resistor Capacity) (setting unit: 10 W) is not set to 0 and an External Regenerative Resistor is not connected to one of the following SERVOPACKs: SGD7S-R70A, SGD7S-R90A, SGD7S-1R6A, or SGD7S-2R8A.	Check it see if an External Regenerative Resistor is connected and check the setting of Pn600 (2600 hex).	Connect an External Regenerative Resistor, or if an External Regenerative Resistor is not required, set Pn600 (2600 hex) to 0.	page 4-19, page 5-55
	A failure occurred in the SERVOPACK.	–	The SERVOPACK may be faulty. Replace the SERVOPACK.	–

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Alarm Code: Alarm Name	Possible Cause	Confirmation	Correction	Reference
400 hex: Overvoltage (Detected in the main circuit power supply section of the SERVOPACK.)	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 an alarm still occurs, the SERVOPACK may be faulty. Replace the SERVOPACK.	–
	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.	Select a regenerative resistance value that is appropriate for the operating conditions and load.	–
	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 the SERVOPACK.	–	While the main circuit power supply is OFF, turn the control power supply to the SERVOPACK OFF and ON again. If an alarm still occurs, the SERVOPACK may be faulty. Replace the SERVOPACK.	–
410 hex: Undervoltage (Detected in the main circuit power supply section of the SERVOPACK.)	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 (2509 hex) (Momentary Power Interruption Hold Time), decrease the setting.	page 6-13
	The SERVOPACK fuse is blown out.	–	Replace the SERVOPACK and connect a reactor to the DC reactor terminals (⊖1 and ⊖2) on the SERVOPACK.	–
	A failure occurred in the SERVOPACK.	–	The SERVOPACK may be faulty. Replace the SERVOPACK.	–

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Alarm Code: Alarm Name	Possible Cause	Confirmation	Correction	Reference
510 hex: 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 SERVOPACK.	–	The SERVOPACK may be faulty. Replace the SERVOPACK.	–
511 hex: Encoder Output Pulse Overspeed	The encoder output pulse frequency exceeded the limit.	Check the encoder output pulse setting.	Decrease the setting of Pn212 (2212 hex) (Encoder Output Pulses) or Pn281 (2281 hex) (Encoder Output Resolution).	page 6-22
	The encoder output pulse frequency exceeded the limit because the motor speed was too high.	Check the encoder output pulse setting and the motor speed.	Reduce the motor speed.	–
520 hex: 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 (2100 hex) (Speed Loop Gain).	–
	The setting of Pn103 (2103 hex) (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.	Correct the setting of Pn103 (2103 hex).	–
521 hex: 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 tuning-less level settings.	page 8-12
	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.	page 8-41, page 8-92
550 hex: Maximum Speed Setting Error	The setting of Pn385 (2385 hex) (Maximum Motor Speed) is greater than the maximum speed.	Check the setting of Pn385 (2385 hex), and the upper limits of the maximum motor speed setting and the encoder output resolution setting.	Set Pn385 (2385 hex) to a value that does not exceed the maximum motor speed.	page 6-16

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Alarm Code: Alarm Name	Possible Cause	Confirmation	Correction	Reference
710 hex: Instantaneous Overload **720 hex:** Continuous Overload	The wiring is not correct or there is a faulty contact in the motor or encoder wiring.	Check the wiring.	Make sure that the Servomotor and encoder are correctly wired.	page 4-23
	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 due to mechanical problems.	Check the operation reference and motor speed.	Correct the mechanical problem.	–
	There is an error in the setting of Pn282 (2282 hex) (Linear Encoder Pitch).	Check the setting of Pn282 (2282 hex).	Correct the setting of Pn282 (2282 hex).	page 5-16
	There is an error in the setting of Pn080 (2080 hex) = n.□□X□ (Motor Phase Selection).	Check the setting of Pn080 (2080 hex) = n.□□X□.	Set Pn080 (2080 hex) = n.□□X□ to an appropriate value.	page 5-21
	A failure occurred in the SERVOPACK.	–	The SERVOPACK may be faulty. Replace the SERVOPACK.	–
730 hex and 731 hex: 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 SERVOPACK.	–	The SERVOPACK may be faulty. Replace the SERVOPACK.	–
740 hex: 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 SERVOPACK.	–	The SERVOPACK may be faulty. Replace the SERVOPACK.	–

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Alarm Code: Alarm Name	Possible Cause	Confirmation	Correction	Reference
7A1 hex: Internal Temperature Error 1 (Control Board Temperature Error)	The surrounding temperature is too high.	Check the surrounding temperature using a thermostat. Or, check the operating status with the SERVOPACK installation environment monitor.	Decrease the surrounding temperature by improving the SERVOPACK installation conditions.	–
	An overload alarm was reset by turning OFF the power supply too many times.	Check the alarm display to see if there is an overload alarm.	Change the method for resetting the alarm.	–
	There was an excessive load or operation was performed that exceeded the regenerative processing capacity.	Use the accumulated load ratio to check the load during operation, and use the regenerative load ratio to check the regenerative processing capacity.	Reconsider the load and operating conditions.	–
	The SERVOPACK installation orientation is not correct or there is insufficient space around the SERVOPACK.	Check the SERVOPACK installation conditions.	Install the SERVOPACK according to specifications.	page 3-3, page 3-5
	A failure occurred in the SERVOPACK.	–	The SERVOPACK may be faulty. Replace the SERVOPACK.	–
7A2 hex: Internal Temperature Error 2 (Power Board Temperature Error)	The surrounding temperature is too high.	Check the surrounding temperature using a thermostat. Or, check the operating status with the SERVOPACK installation environment monitor.	Decrease the surrounding temperature by improving the SERVOPACK installation conditions.	–
	An overload alarm was reset by turning OFF the power supply too many times.	Check the alarm display to see if there is an overload alarm.	Change the method for resetting the alarm.	–
	There was an excessive load or operation was performed that exceeded the regenerative processing capacity.	Use the accumulated load ratio to check the load during operation, and use the regenerative load ratio to check the regenerative processing capacity.	Reconsider the load and operating conditions.	–
	The SERVOPACK installation orientation is not correct or there is insufficient space around the SERVOPACK.	Check the SERVOPACK installation conditions.	Install the SERVOPACK according to specifications.	page 3-3, page 3-5
	A failure occurred in the SERVOPACK.	–	The SERVOPACK may be faulty. Replace the SERVOPACK.	–
7A3 hex: Internal Temperature Sensor Error (An error occurred in the temperature sensor circuit.)	A failure occurred in the SERVOPACK.	–	The SERVOPACK may be faulty. Replace the SERVOPACK.	–

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Alarm Code: Alarm Name	Possible Cause	Confirmation	Correction	Reference
7Ab hex: SERVOPACK Built-in Fan Stopped	The fan inside the SERVOPACK stopped.	Check for foreign matter inside the SERVOPACK.	Remove foreign matter from the SERVOPACK. If an alarm still occurs, the SERVOPACK may be faulty. Replace the SERVOPACK.	–
810 hex: Encoder Backup Alarm (Detected at the encoder, but only when an absolute encoder is used.)	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.	page 5-49
	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 SERVOPACK 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 SERVOPACK.	–	The SERVOPACK may be faulty. Replace the SERVOPACK.	–
820 hex: 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 Single-turn Absolute Encoder or Incremental Encoder • The Servomotor may be faulty. Replace the Servomotor. • The linear encoder may be faulty. Replace the linear encoder.	page 5-49
	A failure occurred in the SERVOPACK.	–	The SERVOPACK may be faulty. Replace the SERVOPACK.	–
830 hex: 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.	page 4-24
	The battery voltage is lower than the specified value (2.7 V).	Measure the battery voltage.	Replace the battery.	page 15-3
	A failure occurred in the SERVOPACK.	–	The SERVOPACK may be faulty. Replace the SERVOPACK.	–

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Alarm Code: Alarm Name	Possible Cause	Confirmation	Correction	Reference
840 hex: Encoder Data Alarm (Detected at the encoder.)	The encoder malfunctioned.	–	Turn the power supply to the SERVOPACK OFF and ON again. If an alarm still occurs, the Servomotor or linear encoder may be faulty. Replace the Servomotor or linear encoder.	–
	An error occurred in reading data from the linear encoder.	–	The linear encoder is not mounted within an appropriate tolerance. Correct the mounting of the linear encoder.	–
	Excessive speed occurred in the linear encoder.	–	Control the motor speed within the range specified by the linear encoder manufacturer and then turn ON the control power supply.	–
	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.	–
	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.	–
850 hex: 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.	–
	Linear Servomotor: The Servomotor exceeded the specified speed when the control power supply was turned ON.	Check the motor speed when the power supply is turned ON.	Control the motor speed within the range specified by the linear encoder manufacturer and then turn ON the control power supply.	–
	A failure occurred in the encoder.	–	Turn the power supply to the SERVOPACK OFF and ON again. If an alarm still occurs, the Servomotor or linear encoder may be faulty. Replace the Servomotor or linear encoder.	–
	A failure occurred in the SERVOPACK.	–	Turn the power supply to the SERVOPACK OFF and ON again. If an alarm still occurs, the SERVOPACK may be faulty. Replace the SERVOPACK.	–

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Alarm Code: Alarm Name	Possible Cause	Confirmation	Correction	Reference
860 hex: Encoder Overheated (Detected at the encoder, but only when an absolute encoder is used.)	The surrounding air temperature around the Servomotor is too high.	Measure the surrounding air temperature around the Servomotor.	Reduce the surrounding air temperature of the Servomotor to 40°C or less.	–
	The Servomotor load is greater than the rated load.	Use the accumulated load ratio to check the load.	Operate the Servo Drive so that the motor load remains within the specified range.	–
	A failure occurred in the encoder.	–	Turn the power supply to the SERVOPACK OFF and ON again. If an alarm still occurs, the Servomotor or absolute linear encoder may be faulty. Replace the Servomotor or absolute linear encoder.	–
	A failure occurred in the SERVOPACK.	–	Turn the power supply to the SERVOPACK OFF and ON again. If an alarm still occurs, the SERVOPACK may be faulty. Replace the SERVOPACK.	–
861 hex: Motor Overheated	The surrounding temperature around the Servomotor is too high.	Measure the surrounding temperature around the Servomotor.	Reduce the surrounding air temperature of the Servomotor to 40° or less.	–
	The motor load is greater than the rated load.	Check the load with the accumulated load ratio on the Motion Monitor Tab Page on the SigmaWin+.	Operate the Servo Drive so that the motor load remains within the specified range.	–
	A failure occurred in the Serial Converter Unit.	–	Turn the power supply to the SERVOPACK OFF and ON again. If an alarm still occurs, the Serial Converter Unit may be faulty. Replace the Serial Converter Unit.	–
	A failure occurred in the SERVOPACK.	–	Turn the power supply to the SERVOPACK OFF and ON again. If an alarm still occurs, the SERVOPACK may be faulty. Replace the SERVOPACK.	–
890 hex: Encoder Scale Error	A failure occurred in the linear encoder.	–	The linear encoder may be faulty. Replace the linear encoder.	–
891 hex: Encoder Module Error	A failure occurred in the linear encoder.	–	Turn the power supply to the SERVOPACK OFF and ON again. If an alarm still occurs, the linear encoder may be faulty. Replace the linear encoder.	–
8A0 hex: External Encoder Error	Setting the origin of the absolute linear encoder failed because the motor moved.	Before you set the origin, use the fully-closed feedback pulse counter to confirm that the motor is not moving.	The motor must be stopped while setting the origin position.	page 5-52
	A failure occurred in the external encoder.	–	Replace the external encoder.	–

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Alarm Code: Alarm Name	Possible Cause	Confirmation	Correction	Reference
8A1 hex: External Encoder Module Error	A failure occurred in the external encoder.	–	Replace the external encoder.	–
	A failure occurred in the Serial Converter Unit.	–	Replace the Serial Converter Unit.	–
8A2 hex: External Incremental Encoder Sensor Error	A failure occurred in the external encoder.	–	Replace the external encoder.	–
8A3 hex: External Absolute Encoder Position Error	A failure occurred in the external absolute encoder.	–	The external absolute encoder may be faulty. Refer to the encoder manufacturer's instruction manual for corrections.	–
8A5 hex: External Encoder Overspeed	An overspeed error was detected in the external encoder.	Check the maximum speed of the external encoder.	Keep the external encoder below its maximum speed.	–
8A6 hex: External Encoder Overheated	An overheating error was detected in the external encoder.	–	Replace the external encoder.	–
A10 hex: EtherCAT DC Synchronization Error	The synchronization timing (Sync0) for EtherCAT communications fluctuated.	–	Turn the power supply OFF and ON again and re-establish communications.	–
A11 hex: EtherCAT State Error	The EtherCAT communications state left the Operational state during motor operation.	–	Reset the alarm and then re-establish communications.	–
A12 hex: EtherCAT Output Data Synchronization Error	Noise caused an error in EtherCAT communications.	–	Check the EtherCAT wiring and implement noise countermeasures.	–
	The controller did not update the process data during the fixed period.	Check the process data specified by the controller.	Correct the controller so that the process data is updated during the fixed period.	–
	The EtherCAT Communications Cable or connector wiring is faulty.	Check the EtherCAT Communications Cable and connector wiring.	Wire the connections correctly.	–
A20 hex: Parameter Setting Error	The position unit is outside of the setting range.	Make sure it is within the following range. 1/4,096 < Numerator (2701 hex: 1)/Denominator (2701 hex: 2) < 65,536	Correct the setting of *position user unit* (2701 hex).	–
	The speed unit is outside of the setting range.	Make sure it is within the following range. 1/128 ≤ Numerator (2702 hex: 1)/Denominator (2702 hex: 2) ≤ 8,388,608	Correct the setting of *velocity user unit* (2702 hex).	–
	The acceleration unit is outside of the setting range.	Make sure it is within the following range. 1/128 ≤ Numerator (2703 hex: 1)/Denominator (2703 hex: 2) ≤ 262,144	Correct the setting of *acceleration user unit* (2703 hex).	–
A40 hex: System Initialization Error	A failure occurred in the SERVOPACK.	–	Replace the SERVOPACK.	–

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Alarm Code: Alarm Name	Possible Cause	Confirmation	Correction	Reference
A41 hex: Communications Device Initialization Error	A failure occurred in the SERVOPACK.	–	Replace the SERVOPACK.	–
A47 hex: Loading Servo Information Error	*User parameter configuration* (2700 hex) was executed while a utility function (Fn□□□) was being executed from the Digital Operator or SigmaWin+.	–	Turn the power supply OFF and ON again.	–
	The power supply was turned ON or *user parameter configuration* (2700 hex) was executed when an encoder was not connected.	Check the wiring of the encoder.	Turn OFF the power supply, correct the encoder connection, and then turn the power supply back ON.	–
	The power supply was turned ON or *user parameter configuration* (2700 hex) was executed when there was a Parameter Setting Error (alarm 040 hex).	Check the parameter settings.	Correct the parameter settings and turn the power supply OFF and ON again.	–
	A failure occurred in the SERVOPACK.	–	Replace the SERVOPACK.	–
A48 hex: EEPROM Parameter Data Error	The power supply was shut OFF while writing parameter settings.	Check the timing of shutting OFF the power supply.	Initialize the parameter settings (*restore default parameters* (1011 hex)) and then set the parameters again.	–
	The number of times that parameters were written exceeded the limit.	–	Repair or replace the SERVOPACK. Reconsider the method for writing the parameters.	–
	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 (*restore default parameters* (1011 hex)).	–
	A failure occurred in the SERVOPACK.	–	Replace the SERVOPACK.	–
b33 hex: Current Detection Error 3	A failure occurred in the current detection circuit.	–	Turn the power supply to the SERVOPACK OFF and ON again. If an alarm still occurs, the SERVOPACK may be faulty. Replace the SERVOPACK.	–
	The Servomotor Main Circuit Cable is disconnected.	Check for a disconnection in the Servomotor's Main Circuit Cables.	Correct the Servomotor wiring.	–
bF0 hex: System Alarm 0	A failure occurred in the SERVOPACK.	–	Turn the power supply to the SERVOPACK OFF and ON again. If an alarm still occurs, the SERVOPACK may be faulty. Replace the SERVOPACK.	–

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Alarm Code: Alarm Name	Possible Cause	Confirmation	Correction	Reference
bF1 hex: System Alarm 1	A failure occurred in the SERVOPACK.	–	Turn the power supply to the SERVOPACK OFF and ON again. If an alarm still occurs, the SERVOPACK may be faulty. Replace the SERVOPACK.	–
bF2 hex: System Alarm 2	A failure occurred in the SERVOPACK.	–	Turn the power supply to the SERVOPACK OFF and ON again. If an alarm still occurs, the SERVOPACK may be faulty. Replace the SERVOPACK.	–
bF3 hex: System Alarm 3	A failure occurred in the SERVOPACK.	–	Turn the power supply to the SERVOPACK OFF and ON again. If an alarm still occurs, the SERVOPACK may be faulty. Replace the SERVOPACK.	–
bF4 hex: System Alarm 4	A failure occurred in the SERVOPACK.	–	Turn the power supply to the SERVOPACK OFF and ON again. If an alarm still occurs, the SERVOPACK may be faulty. Replace the SERVOPACK.	–
C10 hex: 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.	–
	There is an error in the setting of Pn080 (2080 hex) = n.□□X□ (Motor Phase Selection).	Check the setting of Pn080 (2080 hex) = n.□□X□.	Set Pn080 (2080 hex) = n.□□X□ to an appropriate value.	page 5-21
	A failure occurred in the encoder.	–	If the motor wiring is correct and an 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 SERVOPACK.	–	Turn the power supply to the SERVOPACK OFF and ON again. If an alarm still occurs, the SERVOPACK may be faulty. Replace the SERVOPACK.	–
C20 hex: Phase Detection Error	The linear encoder signal level is too low.	Check the voltage of the linear encoder signal.	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 (2080 hex) = n.□□X□ (Motor Phase Selection). Check the installation orientation for the linear encoder and Moving Coil.	Change the setting of Pn080 (2080 hex) = n.□□X□. Correctly reinstall the linear encoder or Moving Coil.	page 5-21
	The polarity sensor signal is being affected by noise.	–	Correct the FG wiring. Implement countermeasures against noise for the polarity sensor wiring.	–

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Alarm Code: Alarm Name	Possible Cause	Confirmation	Correction	Reference
C21 hex: Polarity Sensor Error	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 setting of Pn282 (2282 hex) (Linear Encoder Pitch) is not correct.	Check the setting of Pn282 (2282 hex) (Linear Encoder Pitch).	Check the specifications of the linear encoder and set a correct value.	page 5-16
	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.	–
C22 hex: Phase Information Disagreement	The SERVOPACK phase information is different from the linear encoder phase information.	–	Perform polarity detection.	page 5-26
C50 hex: Polarity Detection Failure	The parameter settings are not correct.	Check the linear encoder specifications and feedback signal status.	The settings of Pn282 (2282 hex) (Linear Encoder Pitch) and Pn080 (2080 hex) = n.□□X□ (Motor Phase Selection) may not match the installation. Set the parameters to correct values.	page 5-16, page 5-21
	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 SERVOPACK and that the FG terminal on the SERVOPACK 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 (2481 hex) (Polarity Detection Speed Loop Gain).	–

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Alarm Code: Alarm Name	Possible Cause	Confirmation	Correction	Reference
C50 hex: Polarity Detection Failure	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 SERVOPACK 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 (2485 hex) (Polarity Detection Reference Speed). However, increasing the setting of Pn485 (2485 hex) will increase the Servomotor movement range that is required for polarity detection.	–
C51 hex: 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.	page 4-32
C52 hex: Polarity Detection Not Completed	The servo was turned ON when using an absolute linear encoder, Pn587 (2587 hex) was set to n.□□□0 (Do not detect polarity), and the polarity had not been detected.	–	When using an absolute linear encoder, set Pn587 (2587 hex) to n.□□□1 (Detect polarity)	–
C53 hex: Out of Range of Motion for Polarity Detection	The travel distance exceeded the setting of Pn48E (248E hex) (Polarity Detection Range) in the middle of detection.	–	Increase the setting of Pn48E (248E hex) (Polarity Detection Range). Or, increase the setting of Pn481 (2481 hex) (Polarity Detection Speed Loop Gain).	–
C54 hex: Polarity Detection Failure 2	An external force was applied to the Servomotor.	–	Increase the setting of Pn495 (2495 hex) (Polarity Detection Confirmation Force Reference). Increase the setting of Pn498 (2498 hex) (Polarity Detection Allowable Error Range). Increasing the allowable error will also increase the motor temperature.	–
C80 hex: Encoder Clear Error or Multiturn Limit Setting Error	A failure occurred in the encoder.	–	Turn the power supply to the SERVOPACK OFF and ON again. If an alarm still occurs, the Servomotor or linear encoder may be faulty. Replace the Servomotor or linear encoder.	–
	A failure occurred in the SERVOPACK.	–	Turn the power supply to the SERVOPACK OFF and ON again. If an alarm still occurs, the SERVOPACK may be faulty. Replace the SERVOPACK.	–

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Alarm Code: Alarm Name	Possible Cause	Confirmation	Correction	Reference
C90 hex: 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.	page 4-23
	There is a cable disconnection or short-circuit 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 environmental, and replace the cable. If the alarm still occurs, replace the SERVOPACK.	page 3-2
	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.	page 4-5
	A failure occurred in the SERVOPACK.	–	Connect the Servomotor to another SERVOPACK, and turn ON the control power supply. If no alarm occurs, the SERVOPACK may be faulty. Replace the SERVOPACK.	–
C91 hex: 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.	page 4-8
	The Encoder Cable is bundled with a high-current line or installed near a high-current 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.	–

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Alarm Code: Alarm Name	Possible Cause	Confirmation	Correction	Reference
C92 hex: Encoder Communications Timer Error	Noise entered on the signal line from the encoder.	–	Implement countermeasures against noise for the encoder wiring.	page 4-5
	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 SERVOPACK OFF and ON again. If an alarm still occurs, the Servomotor or linear encoder may be faulty. Replace the Servomotor or linear encoder.	–
	A failure occurred in the SERVOPACK.	–	Turn the power supply to the SERVOPACK OFF and ON again. If an alarm still occurs, the SERVOPACK may be faulty. Replace the SERVOPACK.	–
CA0 hex: Encoder Parameter Error	A failure occurred in the encoder.	–	Turn the power supply to the SERVOPACK OFF and ON again. If an alarm still occurs, the Servomotor or linear encoder may be faulty. Replace the Servomotor or linear encoder.	–
	A failure occurred in the SERVOPACK.	–	Turn the power supply to the SERVOPACK OFF and ON again. If an alarm still occurs, the SERVOPACK may be faulty. Replace the SERVOPACK.	–

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Alarm Code: Alarm Name	Possible Cause	Confirmation	Correction	Reference
Cb0 hex: 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.	page 4-23
	The specifications of the Encoder Cable are not correct and noise entered on it.	–	Use a shielded twisted-pair 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 SERVOPACK OFF and ON again. If an alarm still occurs, the Servomotor or linear encoder may be faulty. Replace the Servomotor or linear encoder.	–
	A failure occurred in the SERVOPACK.	–	Turn the power supply to the SERVOPACK OFF and ON again. If an alarm still occurs, the SERVOPACK may be faulty. Replace the SERVOPACK.	–
CC0 hex: Multiturn Limit Disagreement	When using a Direct Drive Servomotor, the setting of Pn205 (2205 hex) (Multiturn Limit) does not agree with the encoder.	Check the setting of Pn205 (2205 hex).	Correct the setting of Pn205 (2205 hex) (0 to 65,535).	page 6-36
	The multiturn limit of the encoder is different from that of the SERVOPACK. Or, the multiturn limit of the SERVOPACK has been changed.	Check the setting of Pn205 (2205 hex) (Multiturn Limit).	Change the setting if the alarm occurs.	–
	A failure occurred in the SERVOPACK.	–	Turn the power supply to the SERVOPACK OFF and ON again. If an alarm still occurs, the SERVOPACK may be faulty. Replace the SERVOPACK.	–

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Alarm Code: Alarm Name	Possible Cause	Confirmation	Correction	Reference
CF1 hex: Reception Failed Error in Feedback Option Module Communications	The cable between the Serial Converter Unit and SERVOPACK is not wired correctly or there is a faulty contact.	Check the wiring of the external encoder.	Correctly wire the cable between the Serial Converter Unit and SERVOPACK.	page 4-25
	A specified cable is not being used between Serial Converter Unit and SERVOPACK.	Check the wiring specifications of the external encoder.	Use a specified cable.	–
	The cable between the Serial Converter Unit and SERVOPACK is too long.	Measure the length of the cable that connects the Serial Converter Unit.	The length of the cable between the Serial Converter Unit and SERVOPACK must be 20 m or less.	–
	The sheath on cable between the Serial Converter Unit and SERVOPACK is broken.	Check the cable that connects the Serial Converter Unit.	Replace the cable between the Serial Converter Unit and SERVOPACK.	–
CF2 hex: Timer Stopped Error in Feedback Option Module Communications	Noise entered the cable between the Serial Converter Unit and SERVOPACK.	–	Correct the wiring around the Serial Converter Unit, e.g., separate I/O signal lines from the Main Circuit Cables or ground.	–
	A failure occurred in the Serial Converter Unit.	–	Replace the Serial Converter Unit.	–
	A failure occurred in the SERVOPACK.	–	Replace the SERVOPACK.	–
d00 hex: Position Deviation Overflow (The setting of Pn520 (2520 hex) (Excessive Position Error 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 position command speed is too fast.	Reduce the position command speed and try operating the SERVOPACK.	Reduce the position reference speed or the reference acceleration rate, or reconsider the electronic gear ratio.	page 5-43
	The acceleration of the position reference is too high.	Reduce the reference acceleration and try operating the SERVOPACK.	Reduce the acceleration of the position reference using an EtherCAT command.	–
	The setting of Pn520 (2520 hex) (Excessive Position Deviation Alarm Level) is too low for the operating conditions.	Check the setting of Pn520 (2520 hex) to see if it is appropriate.	Optimize the setting of Pn520 (2520 hex).	page 8-8
	A failure occurred in the SERVOPACK.	–	Turn the power supply to the SERVOPACK OFF and ON again. If an alarm still occurs, the SERVOPACK may be faulty. Replace the SERVOPACK.	–

Continued from previous page.

Alarm Code: Alarm Name	Possible Cause	Confirmation	Correction	Reference
d01 hex: Position Deviation Overflow Alarm at Servo ON	The servo was turned ON after the position deviation exceeded the setting of Pn526 (2526 hex) (Excessive Position Deviation Alarm Level at Servo ON) while the servo was OFF.	Check the position deviation while the servo is OFF.	Optimize the setting of Pn526 (2526 hex).	page 8-8
d02 hex: Position Deviation Overflow Alarm for Speed Limit at Servo ON	If position deviation remains in the deviation counter, the setting of Pn529 (2529 hex) or Pn584 (2584 hex) (Speed Limit Level at Servo ON) will limit the speed when the servo is turned ON. This alarm occurs if a position reference is input and the setting of Pn520 (2520 hex) (Excessive Position Deviation Alarm Level) is exceeded.	–	Optimize the setting of Pn520 (2520 hex). Or, set Pn529 (2529 hex) or Pn584 (2584 hex) to an appropriate value.	
d10 hex: 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 (2002 hex) = n.X□□□ (External Encoder Usage) to reverse the direction.	page 10-6
	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.	–
d30 hex: Position Data Overflow	The position data exceeded ±1,879,048,192.	Check the input reference pulse counter.	Reconsider the operating specifications.	–
E00 hex: EtherCAT Module Interface Initialization Timeout Error	A failure occurred in the SERVOPACK.	–	Replace the SERVOPACK.	–
E02 hex: EtherCAT Internal Synchronization Error 1	The EtherCAT transmission cycle fluctuated.	–	Remove the cause of transmission cycle fluctuation at the host controller.	–
	A failure occurred in the SERVOPACK.	–	Turn the power supply to the SERVOPACK OFF and ON again. If an alarm still occurs, the SERVOPACK may be faulty. Replace the SERVOPACK.	–
E03 hex: EtherCAT Module Interface Communications Data Error	Noise caused an error in communications between the SERVOPACK and EtherCAT Network Module.	–	Implement countermeasures against noise.	–
	A failure occurred in the SERVOPACK.	–	Replace the SERVOPACK.	

Continued from previous page.

Alarm Code: Alarm Name	Possible Cause	Confirmation	Correction	Reference
E72 hex: Feedback Option Module Detection Failure	There is a faulty connection between the SERVOPACK and the Feedback Option Module.	Check the connection between the SERVOPACK and the Feedback Option Module.	Correctly connect the Feedback Option Module.	–
	The Feedback Option Module was disconnected.	–	Reset the Option Module configuration error and turn the power supply to the SERVOPACK OFF and ON again.	page 15-40
	A failure occurred in the Feedback Option Module.	–	Replace the Feedback Option Module.	–
	A failure occurred in the SERVOPACK.	–	Replace the SERVOPACK.	–
E74 hex: Unsupported Safety Option Module Alarm	A failure occurred in the Safety Option Module.	–	Replace the Safety Option Module.	–
	An unsupported Safety Option Module was connected.	Refer to the manual for the connected Safety Option Module.	Connect a supported Safety Option Module.	–
E75 hex: Unsupported Safety Option Module Alarm	A failure occurred in the Feedback Option Module.	–	Replace the Safety Option Module.	–
	An unsupported Feedback Option Module was connected.	Refer to the catalog for the connected Feedback Option Module or the SERVOPACK manual.	Connect a supported Feedback Option Module.	–
EA0 hex: Command-Option IF Servo Unit Initial Error	A failure occurred in the SERVOPACK.	–	Replace the SERVOPACK.	–
EA1 hex: Command-Option IF Memory Check Error	A failure occurred in the SERVOPACK.	–	Replace the SERVOPACK.	–
EA2 hex: Command-Option IF Servo Synchronization Error	Fluctuation in the EtherCAT communications synchronization timing (Sync0) caused the synchronization timing in the SERVOPACK to fluctuate.	–	Turn the power supply OFF and ON again and re-establish communications.	–
	A failure occurred in the SERVOPACK.	–	Repair or replace the SERVOPACK.	–
EA3 hex: Command-Option IF Servo Data Error	Noise caused an error in communications in the SERVOPACK.	–	Implement countermeasures against noise.	–
	A failure occurred in the SERVOPACK.	–	Replace the SERVOPACK.	–

Continued from previous page.

Alarm Code: Alarm Name	Possible Cause	Confirmation	Correction	Reference
Eb1 hex: Safety Function Signal Input Timing Error	The delay between activation of the /HWBB1 and /HWBB2 input signals for the HWBB was ten second or longer.	Measure the time delay between the /HWBB1 and /HWBB2 signals.	The output signal circuits or devices for /HWBB1 and /HWBB2 or the SERVOPACK input signal circuits may be faulty. Alternatively, the input signal cables may be disconnected. Check to see if any of these items are faulty or have been disconnected.	–
	A failure occurred in the SERVOPACK.	–	Replace the SERVOPACK.	–
EC8 hex: Gate Drive Error 1 (An error occurred in the gate drive circuit.)	A failure occurred in the SERVOPACK.	–	Turn the power supply to the SERVOPACK OFF and ON again. If an alarm still occurs, the SERVOPACK may be faulty. Replace the SERVOPACK.	–
EC9 hex: **Gate Drive Error 2 (An error occurred in the gate drive circuit.)**				
Ed1 hex: Command Execution Timeout	A timeout error occurred for an EtherCAT command.	Check the motor status when the command is executed.	Execute the Servo ON command (Enable Operation command) only when the motor is not operating.	–
F10 hex: 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.)	The three-phase power supply wiring is not correct.	Check the power supply wiring.	Make sure that the power supply is correctly wired.	page 4-11
	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 single-phase power supply was input without specifying a signal-phase AC power supply input (Pn00B (200B hex) = n.☐1☐☐).	Check the power supply and the parameter setting.	Match the parameter setting to the power supply.	page 4-11
	A failure occurred in the SERVOPACK.	–	Turn the power supply to the SERVOPACK OFF and ON again. If an alarm still occurs, the SERVOPACK may be faulty. Replace the SERVOPACK.	–

Continued from previous page.

Alarm Code: Alarm Name	Possible Cause	Confirmation	Correction	Reference
F50 hex: Servomotor Main Circuit Cable Disconnection (The Servomotor did not operate or power was not supplied to the Servomotor even though the Servo ON command (Enable Operation command) was input when the Servomotor was ready to receive it.)	A failure occurred in the SERVOPACK.	–	The SERVOPACK may be faulty. Replace the SERVOPACK.	–
	The wiring is not correct or there is a faulty contact in the motor wiring.	Check the wiring.	Make sure that the Servomotor is correctly wired.	page 4-23
FL-1[*2]: System Alarm	A failure occurred in the SERVOPACK.	–	Turn the power supply to the SERVOPACK OFF and ON again. If an alarm still occurs, the SERVOPACK may be faulty. Replace the SERVOPACK.	–
FL-2[*2]: System Alarm				
FL-3[*2]: System Alarm				
FL-4[*2]: System Alarm				
FL-5[*2]: System Alarm				
CPF00: Digital Operator Communications Error 1	There is a faulty contact between the Digital Operator and the SERVOPACK.	Check the connector contact.	Disconnect the connector and insert it again. Or, replace the cable.	–
	A malfunction was caused by noise.	–	Keep the Digital Operator or the cable away from sources of noise.	–
CPF01: Digital Operator Communications Error 2	A failure occurred in the Digital Operator.	–	Disconnect the Digital Operator and then connect it again. If an alarm still occurs, the Digital Operator may be faulty. Replace the Digital Operator.	–
	A failure occurred in the SERVOPACK.	–	Turn the power supply to the SERVOPACK OFF and ON again. If an alarm still occurs, the SERVOPACK may be faulty. Replace the SERVOPACK.	–

*1. Detection Conditions

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

$$\cdot\ \text{Pn533 [min}^{-1}\text{]} \times \frac{\text{Encoder resolution}}{6 \times 10^5} \leq 1$$

$$\cdot\ \text{Maximum motor speed [min}^{-1}\text{]} \times \frac{\text{Encoder resolution}}{\text{Approx. } 3.66 \times 10^{12}} \geq 1$$

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

$$\cdot\ \frac{\text{Pn585 [mm/s]}}{\text{Linear encoder pitch [}\mu\text{m]}} \times \frac{\text{Resolution of Serial Converter Unit}}{10} \leq 1$$

$$\cdot\ \frac{\text{Pn385 [100 mm/s]}}{\text{Linear encoder pitch [}\mu\text{m]}} \times \frac{\text{Resolution of Serial Converter Unit}}{\text{Approx. } 6.10 \times 10^5} \geq 1$$

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

15.2.3 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.

Important

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.

Clearing Alarms and Warnings with the Fault Reset Command

Execute the Fault Reset command to clear alarms or warnings.

Refer to the following section for details on the Fault Reset command.

◆ *Controlword Bits* on page 14-22

Resetting Alarms Using the Digital Operator

Press the **ALARM RESET** Key on the Digital Operator. Refer to the following manual for details on resetting alarms.

Σ-7-Series Digital Operator Operating Manual (Manual No.: SIEP S800001 33)

15.2.4 Displaying the Alarm History

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

Note: The following alarms are not displayed in the alarm history: A.E50 (EtherCAT Synchronization Error), A.E60 (Reception Error in EtherCAT Communications), and FL-1 to FL-5.

Preparations

No preparations are required.

Applicable Tools

The following table lists the tools that you can use to display the alarm history and the applicable tool functions.

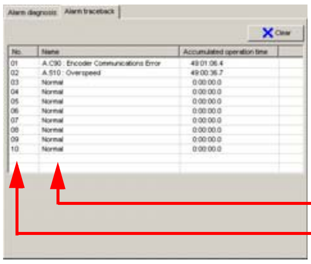
Tool	Function	Reference
Digital Operator	Fn000	Σ-7-Series Digital Operator Operating Manual (Manual No.: SIEP S800001 33)
SigmaWin+	***Alarm* – *Display Alarm***	☞ ***Operating Procedure*** on page 15-39

Operating Procedure

Use the following display procedure.

1. Select ***Alarm - Display Alarm*** from the menu bar of the Main Window of the SigmaWin+.
   The Alarm Display Dialog Box will be displayed.

2. Click the **Alarm History** Tab.
   The following display will appear and you can check the alarms that occurred in the past.



No.	Name	Accumulated operation time
01	A.C90 : Encoder Communications Error	49:01:06.4
02	A.510 : Overspeed	49:00:36.7
03	Normal	0:00:00.0
04	Normal	0:00:00.0
05	Normal	0:00:00.0
06	Normal	0:00:00.0
07	Normal	0:00:00.0
08	Normal	0:00:00.0
09	Normal	0:00:00.0
10	Normal	0:00:00.0

Alarm number: Alarm name

Alarms in order of occurrence (Older alarms have higher numbers.)

Information

1. If the same alarm occurs consecutively within one hour, it is not saved in the alarm history. If it occurs after an hour or more, it is saved.
2. You can clear the alarm history by clicking the **Clear** Button. The alarm history is not cleared when alarms are reset or when the SERVOPACK main circuit power is turned OFF.

15.2.5 Clearing the Alarm History

You can clear the alarm history that is recorded in the SERVOPACK.

The alarm history is not cleared when alarms are reset or when the SERVOPACK main circuit power is turned OFF. You must perform the following procedure.

Preparations

Check the following setting before you clear the alarm history.

- The parameters must not be write prohibited.

Applicable Tools

The following table lists the tools that you can use to clear the alarm history and the applicable tool functions.

Tool	Function	Reference
Digital Operator	Fn006	📖 Σ-7-Series Digital Operator Operating Manual (Manual No.: SIEP S800001 33)
SigmaWin+	***Alarm – Display Alarm***	☞ ***Operating Procedure*** on page 15-40

Maintenance

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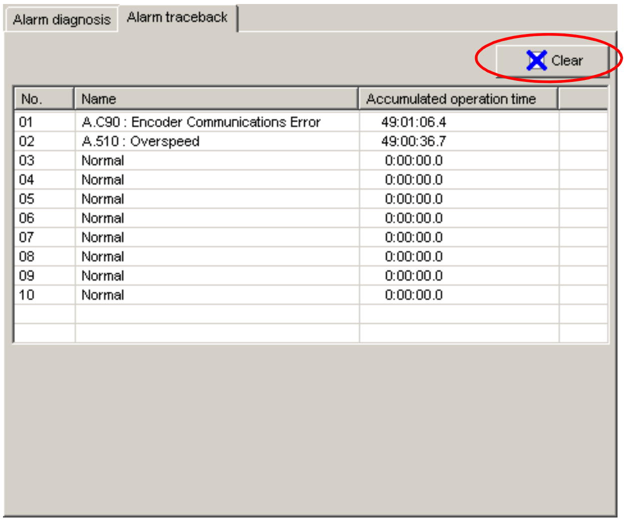
Operating Procedure

Use the following procedure.

1. Select ***Alarm - Display Alarm*** from the menu bar of the Main Window of the SigmaWin+.
   The Alarm Display Dialog Box will be displayed.
2. Click the **Alarm History** Tab.
3. Click the **Clear** Button.
   The alarm history will be cleared.



No.	Name	Accumulated operation time
01	A.C90 : Encoder Communications Error	49:01:06.4
02	A.510 : Overspeed	49:00:36.7
03	Normal	0:00:00.0
04	Normal	0:00:00.0
05	Normal	0:00:00.0
06	Normal	0:00:00.0
07	Normal	0:00:00.0
08	Normal	0:00:00.0
09	Normal	0:00:00.0
10	Normal	0:00:00.0

15.2.6 Resetting Alarms Detected in Option Modules

If any Option Modules are attached to the SERVOPACK, the SERVOPACK detects the presence and models of the connected Option Modules. If it finds any errors, it outputs alarms.

You can delete those alarms with this operation.

Information

- This operation is the only way to reset alarms for Option Modules. The alarms are not reset when you reset other alarms or when you turn OFF the power supply to the SERVOPACK.
- Always remove the cause of an alarm before you reset the alarm.

Preparations

Confirm the following condition before you clear alarms that were detected in Option Module.

- The parameters must not be write prohibited.

Applicable Tools

The following table lists the tools that you can use to reset Option Module configuration errors and the applicable tool functions.

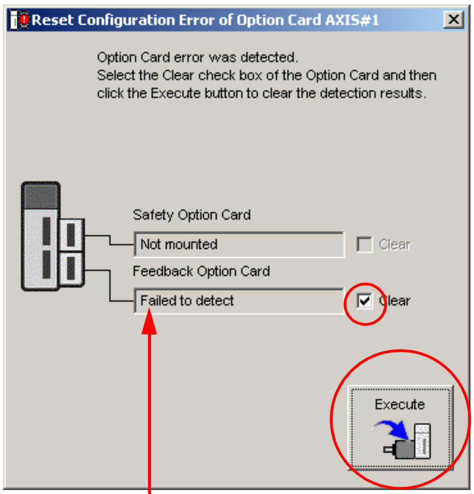
Tool	Function	Reference
Digital Operator	Fn014	📖 Σ-7-Series Digital Operator Operating Manual (Manual No.: SIEP S800001 33)
SigmaWin+	*Setup – Reset Configuration Error of Option Module*	☞ *Operating Procedure* on page 15-41

Operating Procedure

Use the following procedure.

1. Select *Setup* – *Reset Configuration Error of Option Module* from the menu bar of the Main Window of the SigmaWin+.
   The Reset Configuration Error of Option Module Dialog Box will be displayed.
   This dialog box will be displayed automatically when you start the SigmaWin+ if there is an error in an Option Module.

2. Select the **Clear** Check Box for the Option Modules from which to clear alarms and the click the **Execute** Button.



Reset Configuration Error of Option Card AXIS#1

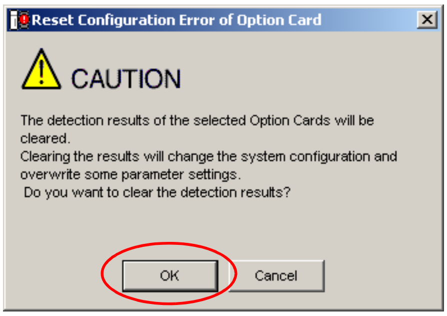
Option Card error was detected.
Select the Clear check box of the Option Card and then click the Execute button to clear the detection results.

Safety Option Card: Not mounted ☐ Clear

Feedback Option Card: Failed to detect ☑ Clear

You cannot clear the **Error detected** detection result. Remove the Option Module, or check to see if the Option Module is correctly mounted.

3. Click the **OK** Button.

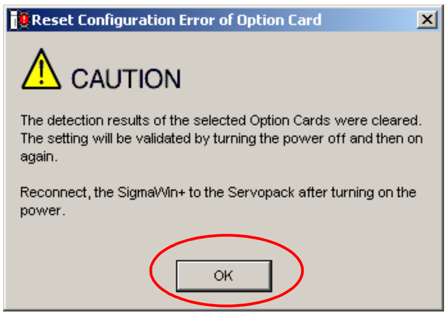


Reset Configuration Error of Option Card

CAUTION

The detection results of the selected Option Cards will be cleared.
Clearing the results will change the system configuration and overwrite some parameter settings.
Do you want to clear the detection results?

4. Click the **OK** Button.



The detection results of the selected Option Cards were cleared.
The setting will be validated by turning the power off and then on again.

Reconnect, the SigmaWin+ to the Servopack after turning on the power.

5. Turn the power supply to the SERVOPACK OFF and ON again.

15.2.7 Resetting Motor Type Alarms

The SERVOPACK automatically determines the type of motor that is connected to it. If the type of motor that is connected is changed, an A.070 alarm (Motor Type Change Detected) will occur the next time the SERVOPACK is started. If an A.070 alarm occurs, you must set the parameters to match the new type of motor.

An A.070 alarm is reset by executing the Reset Motor Type Alarm utility function.

Information
1. This utility function is the only way to reset an A.070 alarm (Motor Type Change Detected). The errors are not reset when you reset alarms or turn OFF the power supply to the SERVOPACK.
2. If an A.070 alarm occurs, first set the parameters according to the newly connected motor type and then execute the Reset Motor Type Alarm utility function.

Preparations

Check the following setting before you execute the Reset Motor Type Alarm utility function.

- The parameters must not be write prohibited.

Applicable Tools

The following table lists the tools that you can use to clear the motor type alarm and the applicable tool functions.

Tool	Function	Reference
Digital Operator	Fn021	📖 Σ-7-Series Digital Operator Operating Manual (Manual No.: SIEP S800001 33)
SigmaWin+	***Setup – Reset Motor Type Alarm***	☞ *Operating Procedure* on page 15-42

Operating Procedure

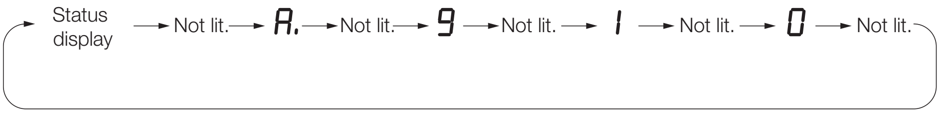
Use the following procedure.

1. Select ***Setup - Reset Motor Type Alarm*** from the menu bar of the Main Window of the SigmaWin+.
The Reset Motor Type Alarm Dialog Box will be displayed.

2. Click the **Clear** Button.
The alarm will be cleared.

15.3 Warning Displays

To check a warning that occurs in the SERVOPACK, use one of the following methods. Warnings are displayed to warn you before an alarm occurs.

Panel display on SERVOPACK	If there is a warning, the code will be displayed one character at a time, as shown below. Example: Alarm A.E60 
Digital Operator	The warning code is displayed.
Statusword (6041 hex)	Bit 7 (*warning*) in the *statusword* will change to 1. (Bit 7 is 0 during normal operation.)
Error code (603F hex)	A current warning code is stored in *error code* (603F hex).
Emergency message	The Controller is notified of any warning that occurs. (Notification may not be possible if EtherCAT communications are unstable.)

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

15.3.1 List of Warnings

The warning table gives the warning name and warning meaning in order of the warning codes.

Warning Code	Warning Name	Meaning
900 hex[*1]	Position Deviation Overflow	The position deviation exceeded the parameter settings (Pn520 (2520 hex) × Pn51E (251E hex)/100).
901 hex[*1]	Position Deviation Overflow Alarm at Servo ON	The position deviation exceeded the parameter settings (Pn526 (2526 hex) × Pn528 (2528 hex)/100) when the servo was turned ON.
910 hex[*1]	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.
911 hex[*1]	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 (2310 hex) (Vibration Detection Switch).
912 hex[*1]	Internal Temperature Warning 1 (Control Board Temperature Error)	The surrounding temperature of the control PCB is abnormal.
913 hex[*1]	Internal Temperature Warning 2 (Power Board Temperature Error)	The surrounding temperature of the power PCB is abnormal.
920 hex[*1]	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.
921 hex[*1]	Dynamic Brake Overload	This warning occurs before an A.731 alarm (Dynamic Brake Overload) occurs. If the warning is ignored and operation is continued, an alarm may occur.
923 hex[*1]	SERVOPACK Built-in Fan Stopped	The fan inside the SERVOPACK stopped.
930 hex[*3]	Absolute Encoder Battery Error	This warning occurs when the voltage of absolute encoder's battery is low.

Continued from previous page.

Warning Code	Warning Name	Meaning
942 hex[*1]	Speed Ripple Compensation Information Disagreement	The speed ripple compensation information stored in the encoder does not agree with the speed ripple compensation information stored in the SERVOPACK.
971 hex[*2]	Undervoltage	This warning occurs before an A.410 alarm (Undervoltage) occurs. If the warning is ignored and operation is continued, an alarm may occur.
9A0 hex[*1]	Overtravel	Overtravel was detected while the servo was ON.
9b0 hex[*1]	Preventative Maintenance Warning	One of the consumable parts has reached the end of its service life.

*1. Use Pn008 = n.□X□□ (Warning Detection Selection) to control warning detection.

*2. Use Pn008 (2008h) = n.□□X□ (Function Selection for Undervoltage) to select warning detection.

*3. Use Pn00D = n.X□□□ (Overtravel Warning Detection Selection) to select warning detection.

Note: A warning code is not output unless you set Pn001 (2001 hex) to n.1□□□ (Output both alarm codes and warning codes).

15.3.2 Troubleshooting Warnings

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

Warning Number: Warning Name	Possible Cause	Confirmation	Correction	Reference
900 hex: 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 SERVOPACK gain is too low.	Check the SERVOPACK gains.	Increase the servo gain, e.g., by using autotuning without a host reference.	page 8-22
	The acceleration of the position reference is too high.	Reduce the reference acceleration and try operating the SERVOPACK.	Reduce the acceleration of the position reference using an EtherCAT command.	–
	The setting of Pn520 (2520 hex) (Excessive Position Deviation Alarm Level) is too low for the operating conditions.	Check the setting of Pn520 (2520 hex) to see if it is appropriate.	Optimize the setting of Pn520 (2520 hex).	page 8-8
	A failure occurred in the SERVOPACK.	–	Turn the power supply to the SERVOPACK OFF and ON again. If an alarm still occurs, the SERVOPACK may be faulty. Replace the SERVOPACK.	–
901 hex: Position Deviation Overflow Alarm at Servo ON	The position deviation exceeded the parameter settings (Pn526 (2526 hex) × Pn528 (2528 hex)/ 100) when the servo was turned ON.	–	Optimize the setting of Pn528 (2528 hex) (Excessive Position Error Warning Level at Servo ON).	–

Continued from previous page.

Warning Number: Warning Name	Possible Cause	Confirmation	Correction	Reference
910 hex: Overload (warning before an A.710 or A.720 alarm occurs)	The wiring is not correct or there is a faulty contact 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.	–
	A failure occurred in the SERVOPACK.	–	The SERVOPACK may be faulty. Replace the SERVOPACK.	–
911 hex: 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.	page 8-41
	The setting of Pn103 (2103 hex) (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.	Correct the setting of Pn103 (2103 hex).	–
912 hex: Internal Temperature Warning 1 (Control Board Temperature Error)	The surrounding temperature is too high.	Check the surrounding temperature using a thermostat. Or, check the operating status with the SERVOPACK installation environment monitor.	Decrease the surrounding temperature by improving the SERVOPACK installation conditions.	–
	An overload alarm was reset by turning OFF the power supply too many times.	Check the alarm display to see if there is an overload alarm.	Change the method for resetting the alarm.	–
	There was an excessive load or operation was performed that exceeded the regenerative processing capacity.	Use the accumulated load ratio to check the load during operation, and use the regenerative load ratio to check the regenerative processing capacity.	Reconsider the load and operating conditions.	–
	The SERVOPACK installation orientation is not correct or there is insufficient space around the SERVOPACK.	Check the SERVOPACK installation conditions.	Install the SERVOPACK according to specifications.	page 3-3, page 3-5
	A failure occurred in the SERVOPACK.	–	The SERVOPACK may be faulty. Replace the SERVOPACK.	–

Continued from previous page.

Warning Number: Warning Name	Possible Cause	Confirmation	Correction	Reference
913 hex: Internal Temperature Warning 2 (Power Board Temperature Error)	The surrounding temperature is too high.	Check the surrounding temperature using a thermostat. Or, check the operating status with the SERVOPACK installation environment monitor.	Decrease the surrounding temperature by improving the SERVOPACK installation conditions.	–
	An overload alarm was reset by turning OFF the power supply too many times.	Check the alarm display to see if there is an overload alarm.	Change the method for resetting the alarm.	–
	There was an excessive load or operation was performed that exceeded the regenerative processing capacity.	Use the accumulated load ratio to check the load during operation, and use the regenerative load ratio to check the regenerative processing capacity.	Reconsider the load and operating conditions.	–
	The SERVOPACK installation orientation is not correct or there is insufficient space around the SERVOPACK.	Check the SERVOPACK installation conditions.	Install the SERVOPACK according to specifications.	page 3-3, page 3-5
	A failure occurred in the SERVOPACK.	–	The SERVOPACK may be faulty. Replace the SERVOPACK.	–
920 hex: Regenerative Overload (warning before an A.320 alarm occurs)	The power supply voltage exceeded the specified range.	Measure the power supply voltage.	Set the power supply voltage within the specified range.	–
	There is insufficient external regenerative resistance, regenerative resistor capacity, or SERVOPACK capacity, or there has been a continuous regeneration state.	Check the operating conditions or the capacity using the SigmaJunmaSize+ Capacity Selection Software or another means.	Change the regenerative resistance value, regenerative resistance capacity, or SERVOPACK capacity. Reconsider the operating conditions using the SigmaJunmaSize+ Capacity Selection Software or other means.	–
	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.	–

Continued from previous page.

Warning Number: Warning Name	Possible Cause	Confirmation	Correction	Reference
921 hex: 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 SERVOPACK.	–	The SERVOPACK may be faulty. Replace the SERVOPACK.	–
923 hex: SERVOPACK Built-in Fan Stopped	The fan inside the SERVOPACK stopped.	Check for foreign matter inside the SERVOPACK.	Remove foreign matter from the SERVOPACK. If an alarm still occurs, the SERVOPACK may be faulty. Replace the SERVOPACK.	–
930 hex: 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.	page 4-24
	The battery voltage is lower than the specified value (2.7 V).	Measure the battery voltage.	Replace the battery.	page 15-3
	A failure occurred in the SERVOPACK.	–	The SERVOPACK may be faulty. Replace the SERVOPACK.	–
942 hex: Speed Ripple Compensation Information Disagreement	The speed ripple compensation information stored in the encoder does not agree with the speed ripple compensation information stored in the SERVOPACK.	–	Reset the speed ripple compensation value on the SigmaWin+.	page 8-59
		–	Set Pn423 (2423 hex) to n.□□1□ (Do not detect A.942 alarms). However, changing the setting may increase the speed ripple.	–
		–	Set Pn423 (2423 hex) to n.□□□0 (Disable torque ripple compensation). However, changing the setting may increase the speed ripple.	–

Continued from previous page.

Warning Number: Warning Name	Possible Cause	Confirmation	Correction	Reference
971 hex: Undervoltage	For a 200-V SERVOPACK, the AC power supply voltage dropped below 140 V.	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 (2509 hex) (Momentary Power Interruption Hold Time), decrease the setting.	page 6-13
	The SERVOPACK fuse is blown out.	–	Replace the SERVOPACK and connect a reactor.	page 4-22
	A failure occurred in the SERVOPACK.	–	The SERVOPACK may be faulty. Replace the SERVOPACK.	–
9A0 hex: 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.	–
9b0 hex: Preventative Maintenance Warning	One of the consumable parts has reached the end of its service life.	–	Replace the part. Contact your Yaskawa representative for replacement.	–

15.4 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.

Turn OFF the Servo System before troubleshooting the items shown in bold lines in the table.

Problem	Possible Cause	Confirmation	Correction	Reference
Servomotor Does Not Start	The control power supply is not turned ON.	Measure the voltage between control power supply terminals.	Correct the wiring so that the control power supply is turned ON.	–
	The main circuit power supply is not turned ON.	Measure the voltage across the main circuit power input terminals.	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.	Check the wiring condition of the I/O signal connector (CN1) pins.	Correct the wiring of the I/O signal connector (CN1) pins.	page 4-29
	The wiring for the Servomotor Main Circuit Cables or Encoder Cable is disconnected.	Check the wiring conditions.	Wire the cable correctly.	–
	There is an overload on the Servomotor.	Operate the Servomotor with no load and check the load status.	Reduce the load or replace the Servomotor with a Servomotor with a larger capacity.	–
	The type of encoder that is being used does not agree with the setting of Pn002 (2002 hex) = n.□X□□ (Encoder Usage).	Check the type of the encoder that is being used and the setting of Pn002 (2002 hex) = n.□X□□.	Set Pn002 (2002 hex) = n.□X□□ according to the type of the encoder that is being used.	page 6-30
	There is a mistake in the input signal allocations (Pn50A (250A hex), Pn50B (250B hex), Pn511 (2511 hex), and Pn516 (2516 hex)).	Check the input signal allocations (Pn50A (250A hex), Pn50B (250B hex), Pn511 (2511 hex), Pn516 (2516 hex)).	Correctly allocate the input signals (Pn50A (250A hex), Pn50B (250B hex), Pn511 (2511 hex), Pn516 (2516 hex)).	page 6-3
	The Servo ON command (Enable Operation command) was not sent.	Make sure the Servo ON command (Enable Operation command) is set to Operation Enabled.	Set the correct value for the Servo ON command (Enable Operation command).	–
	The torque limit reference is too small.	Check the torque limit reference.	Increase the torque limit reference.	–
	The operation mode is not set.	Check to see if *modes of operation* (6060 hex) is set.	Set *modes of operation* (6060 hex) correctly.	–
	A software limit is active.	Check to see if the target position exceeds a software limit.	Specify a target position that is within the software limits.	–
	EtherCAT communications are not established.	Check to see if the EtherCAT indicator shows the Operational state.	Place the EtherCAT communications in the Operational state.	–
	The P-OT (Forward Drive Prohibit) or N-OT (Reverse Drive Prohibit) signal is still OFF.	Check the P-OT and N-OT signals.	Turn ON the P-OT and N-OT signals.	–
	The safety input signals (/HWBB1 or /HWBB2) were not turned ON.	Check the /HWBB1 and /HWBB2 input signals.	Turn ON the /HWBB1 and /HWBB2 input signals. If you are not using the safety function, connect the Safety Jumper Connector (provided as an accessory) to CN8.	–

Continued from previous page.

Problem	Possible Cause	Confirmation	Correction	Reference
Servomotor Does Not Start	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 (2516 hex) = n.□□□X (FSTP (Forced Stop Input) Signal Allocation) to disable the signal.	–
	A failure occurred in the SERVOPACK.	–	Replace the SERVOPACK.	–
	The polarity detection was not executed.	Check the setting of Pn080 (2080 hex) =n.□□□X (Polarity Sensor Selection).	Correct the parameter setting.	page 5-23
		Check the inputs to the Servo ON command (Enable Operation command).	• If you are using an incremental linear encoder, send the Servo ON command (Enable Operation command) from the host controller. • If you are using an absolute linear encoder, execute polarity detection.	page 5-24
Servomotor Moves Instantaneously, and Then Stops	There is a mistake in the Servomotor wiring.	Check the wiring.	Wire the Servomotor correctly.	–
	There is a mistake in the wiring of the encoder or Serial Converter Unit.	Check the wiring.	Wire the Serial Converter Unit correctly.	–
	There is a mistake in the linear encoder wiring.	Check the wiring.	Wire the cable correctly.	–
	The setting of Pn282 (2282 hex) (Linear Encoder Pitch) is not correct.	Check the setting of Pn282 (2282 hex).	Correct the setting of Pn282 (2282 hex).	page 5-16
	The count-up direction of the linear encoder does not match the forward direction of the Moving Coil in the motor.	Check the directions.	Change the setting of Pn080 (2080 hex) = n.□□X□ (Motor Phase Selection). Match the linear encoder direction and motor direction.	page 5-21
	Polarity detection was not performed correctly.	Check to see if electrical angle 2 (electrical angle from polarity origin) at any position is between ±10°.	Correct the settings for the polarity detection-related parameters.	–
Servomotor Speed 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. Check the wiring.	Tighten any loose terminals or connectors and correct the wiring.	–

Continued from previous page.

Problem	Possible Cause	Confirmation	Correction	Reference
Servomotor Moves without a Reference Input	A failure occurred in the SERVOPACK.	–	Replace the SERVOPACK.	–
	The count-up direction of the linear encoder does not match the forward direction of the Moving Coil in the motor.	Check the directions.	Change the setting of Pn080 (2080 hex) = n.□□X□ (Motor Phase Selection). Match the linear encoder direction and Servomotor direction.	page 5-21
	Polarity detection was not performed correctly.	Check to see if electrical angle 2 (electrical angle from polarity origin) at any position is between ±10°.	Correct the settings for the polarity detection-related parameters.	–
Dynamic Brake Does Not Operate	The setting of Pn001 (2001 hex) = n.□□□X (Servo OFF or Alarm Group 1 Stopping Method) is not suitable.	Check the setting of Pn001 (2001 hex) = n.□□□X.	Set Pn001 (2001 hex) = 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.	Replace the SERVOPACK. 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. Replace the SERVOPACK.	–

Continued from previous page.

Problem	Possible Cause	Confirmation	Correction	Reference
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.	page 8-11
	The machine mounting is not secure.	Check to see if there are any loose mounting screws.	Tighten the mounting screws.	–
	The machine mounting is not secure.	Check to see if there is misalignment in the coupling.	Align the coupling.	–
		Check to see if the coupling is balanced.	Balance the coupling.	–
	The bearings are defective.	Check for noise and vibration around the bearings.	Replace the Servomotor.	–
	There is a vibration source at the driven machine.	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.	Check the I/O signal cables to see if they satisfy specifications. Use shielded twisted-pair wire cables or screened twisted-pair cables with conductors of at least 0.12 mm^2.	Use cables that satisfy the specifications.	–
	Noise interference occurred because an I/O signal cable is too long.	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.	Make sure that the rotary or Linear Encoder Cable satisfies the specifications. Use a shielded twisted-pair wire cable or a screened twisted-pair cable with a conductors of at least 0.12 mm^2.	Use cables that satisfy the specifications.	–
	Noise interference occurred because the Encoder Cable is too long.	Check the length of the Encoder Cable.	• Rotary Servomotors: The Encoder Cable length must be 50 m max. • Linear Servomotors: Make sure that the Serial Converter Unit cable is no longer than 20 m and that the Linear Encoder Cable and the Sensor Cable are no longer than 15 m each.	–
	Noise interference occurred because the Encoder Cable is damaged.	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.	–

Continued from previous page.

Problem	Possible Cause	Confirmation	Correction	Reference
Abnormal Noise from Servomotor	The Encoder Cable was subjected to excessive noise interference.	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.	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 SERVOPACK pulse counting error due to noise.	Check to see if there is noise interference on the signal line from the encoder.	Implement countermeasures against noise for the encoder wiring.	–
	The encoder was subjected to excessive vibration or shock.	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.	–	Replace the Servomotor.	–
	A failure occurred in the Serial Converter Unit.	–	Replace the Serial Converter Unit.	–
	A failure occurred in the linear encoder.	–	Replace the linear encoder.	–
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.	page 8-22
	The setting of Pn100 (2100 hex) (Speed Loop Gain) is too high.	Check the setting of Pn100 (2100 hex). The default setting is Kv = 40.0 Hz.	Set Pn100 (2100 hex) to an appropriate value.	–
	The setting of Pn102 (2102 hex) (Position Loop Gain) is too high.	Check the setting of Pn102 (2102 hex). The default setting is Kp = 40.0/s.	Set Pn102 (2102 hex) to an appropriate value.	–
	The setting of Pn101 (2101 hex) (Speed Loop Integral Time Constant) is not appropriate.	Check the setting of Pn101 (2101 hex). The default setting is Ti = 20.0 ms.	Set Pn101 (2101 hex) to an appropriate value.	–
	The setting of Pn103 (2103 hex) (Moment of Inertia Ratio or Mass Ratio) is not appropriate.	Check the setting of Pn103 (2103 hex).	Set Pn103 (2103 hex) to an appropriate value.	–

Continued from previous page.

Problem	Possible Cause	Confirmation	Correction	Reference
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.	page 8-22
	The setting of Pn100 (2100 hex) (Speed Loop Gain) is too high.	Check the setting of Pn100 (2100 hex). The default setting is Kv = 40.0 Hz.	Set Pn100 (2100 hex) to an appropriate value.	–
	The setting of Pn102 (2102 hex) (Position Loop Gain) is too high.	Check the setting of Pn102 (2102 hex). The default setting is Kp = 40.0/s.	Set Pn102 (2102 hex) to an appropriate value.	–
	The setting of Pn101 (2101 hex) (Speed Loop Integral Time Constant) is not appropriate.	Check the setting of Pn101 (2101 hex). The default setting is Ti = 20.0 ms.	Set Pn101 (2101 hex) to an appropriate value.	–
	The setting of Pn103 (2103 hex) (Moment of Inertia Ratio or Mass Ratio) is not appropriate.	Check the setting of Pn103 (2103 hex).	Set Pn103 (2103 hex) to an appropriate value.	–
	The torque reference is saturated.	Check the waveform of the torque reference.	Use the mode switch.	–
	The force limits (Pn483 (2483 hex) and Pn484 (2484 hex)) are set to the default values.	The default values of the force limits and Pn483 (2483 hex) = 30% and Pn484 (2484 hex) = 30%.	Set Pn483 (2483 hex) and Pn484 (2484 hex) to appropriate values.	page 6-25

Continued from previous page.

Problem	Possible Cause	Confirmation	Correction	Reference
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.	Check the Encoder Cable to see if it satisfies specifications. Use a shielded twisted-pair wire cable or a screened twisted-pair cable with conductors of at least 0.12 mm^2.	Use cables that satisfy the specifications.	–
	Noise interference occurred because the Encoder Cable is too long.	Check the length of the Encoder Cable.	• Rotary Servomotors: The Encoder Cable length must be 50 m max. • Linear Servomotors: Make sure that the Serial Converter Unit cable is no longer than 20 m and that the Linear Encoder Cable and the Sensor Cable are no longer than 15 m each.	–
	Noise interference occurred because the Encoder Cable is damaged.	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.	–
	Replace the Encoder Cable and correct the cable installation environment.	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.	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 SERVOPACK pulse counting error due to noise.	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.	–

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Problem	Possible Cause	Confirmation	Correction	Reference
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.)	The encoder was subjected to excessive vibration or shock.	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.	–	Replace the Servomotor or linear encoder.	–
	A failure occurred in the SERVOPACK.	–	Replace the SERVOPACK.	–
	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 SERVOPACK and the host controller.	Implement countermeasures against noise and then perform parity checks again for the multiturn data or absolute encoder position data.	–

Continued from previous page.

Problem	Possible Cause	Confirmation	Correction	Reference
Overtravel Occurred	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.	page 5-27
		Check the settings of the overtravel input signal allocations (Pn50A/ Pn50B).	Set the parameters to correct values.	page 5-27
	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 (250A hex) = n.X□□□ or Pn50B (250B hex) = n.□□□X.	Check to see if the P-OT signal is allocated in Pn50A (250A hex) = n.X□□□.	If another signal is allocated in Pn50A (250A hex) =n.X□□□, allocate the P-OT signal instead.	page 5-27
		Check to see if the N-OT signal is allocated in Pn50B (250B hex) = n.□□□X.	If another signal is allocated in Pn50B (250B hex) =n.□□□X, allocate the N-OT signal instead.	
Overtravel Occurred	The selection of the Servomotor stopping method is not correct.	Check the servo OFF stopping method set in Pn001 (2001 hex) = n.□□□X or Pn001 (2001 hex) = n.□□X□.	Select a Servomotor stopping method other than coasting to a stop.	page 5-28
		Check the torque control stopping method set in Pn001 (2001 hex) = n.□□□X or Pn001 (2001 hex) = 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.	–

Continued from previous page.

Problem	Possible Cause	Confirmation	Correction	Reference
Position Deviation (without Alarm)	Noise interference occurred because of incorrect Encoder Cable specifications.	Check the Encoder Cable to see if is satisfies specifications. Use a shielded twisted-pair wire cable or a screened twisted-pair cable with conductors of at least 0.12 mm^2.	Use cables that satisfy the specifications.	–
	Noise interference occurred because the Encoder Cable is too long.	Check the length of the Encoder Cable.	• Rotary Servomotors: The Encoder Cable length must be 50 m max. • Linear Servomotors: Make sure that the Serial Converter Unit cable is no longer than 20 m and that the Linear Encoder Cable and the Sensor Cable are no longer than 15 m each.	–
	Noise interference occurred because the Encoder Cable is damaged.	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.	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.	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 SERVOPACK pulse counting error due to noise.	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.	–

Continued from previous page.

Problem	Possible Cause	Confirmation	Correction	Reference
Position Deviation (without Alarm)	The encoder was subjected to excessive vibration or shock.	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.	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.	Check the I/O signal cables to see if they satisfy specifications. Use a shielded twisted-pair wire cable or a screened twisted-pair cable with conductors of at least 0.12 mm^2.	Use cables that satisfy the specifications.	–
	Noise interference occurred because an I/O signal cable is too long.	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.)	–	Replace the Servomotor or linear encoder.	–
	A failure occurred in the SERVOPACK.	–	Replace the SERVOPACK.	–
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.	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 SERVOPACK and Servomotor with larger capacities.	–
	Polarity detection was not performed correctly.	Check to see if electrical angle 2 (electrical angle from polarity origin) at any position is between ±10°.	Correct the settings for the polarity detection-related parameters.	–

Parameter and Object Lists

16

This chapter provides information on parameters and objects.

16.1 List of Parameters

16.1.1 Interpreting the Parameter Lists

The types of motors to which the parameter applies.
- All: The parameter is used for both Rotary Servomotors and Linear Servomotors.
- Rotary: The parameter is used for only Rotary Servomotors.
- Linear: The parameter is used for only Linear Servomotors.

Rotary Servomotor terms are used for parameters that are applicable to all Servomotors. If you are using a Linear Servomotor, you need to interpret the terms accordingly. Refer to the following section for details.

☞ ◆ *Differences in Terms for Rotary Servomotors and Linear Servomotors* on page viii

Indicates when a change to the parameter will be effective.

Parameter No.	Size	Name	Setting Range	Setting Unit	Default Setting	Applicable Motors	When Enabled	Classification	Reference
Pn000 (2000 hex)	2	Basic Function Selections 0	0000 to 10B1	–	0000	All	After restart	Setup	–

There are the following two classifications.
- Setup
- Tuning

Refer to the following section for details.

☞ *5.1.1 Classifications of SERVOPACK Parameters* on page 5-3

If there are differences in the parameters for Rotary Servomotor and Linear Servomotor, information is provided for both.
- Top row: For Rotary Servomotors
- Bottom row: For Linear Servomotors

		Rotation Direction Selection Movement Direction Selection	Reference
n.□□□X	0	Use CCW as the forward direction. Use the direction in which the linear encoder counts up as the forward direction.	page 5-15
	1	Use CW as the forward direction. (Reverse Rotation Mode) Use the direction in which the linear encoder counts down as the forward direction. (Reverse Movement Mode)	

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

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

		Rotary/Linear Servomotor Startup Selection When Encoder Is Not Connected	Reference
n.X□□□	0	When an encoder is not connected, start as SERVOPACK for Rotary Servomotor.	page 5-14
	1	When an encoder is not connected, start as SERVOPACK for Linear Servomotor.	

16.1.2 List of Parameters

Parameter No.	Size	Name	Setting Range	Setting Unit	Default Setting	Applicable Motors	When Enabled	Classi-fication	Refer-ence
Pn000 (2000 hex)	2	Basic Function Selections 0	0000 to 10B1	–	0000	All	After restart	Setup	–

n.□□□X	Rotation Direction Selection		Reference
	Movement Direction Selection		
	0	Use CCW as the forward direction.	page 5-15
		Use the direction in which the linear encoder counts up as the forward direction.	
	1	Use CW as the forward direction. (Reverse Rotation Mode)	
		Use the direction in which the linear encoder counts down as the forward direction. (Reverse Movement Mode)	

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

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

n.X□□□	Rotary/Linear Servomotor Startup Selection When Encoder Is Not Connected		Reference
	0	When an encoder is not connected, start as SERVOPACK for Rotary Servomotor.	page 5-14
	1	When an encoder is not connected, start as SERVOPACK for Linear Servomotor.	

Pn001 (2001 hex)	2	Application Function Selections 1	0000 to 1142	–	0000	All	After restart	Setup	–

n.□□□X	Motor Stopping Method for Servo OFF and Group 1 Alarms		Reference
	0	Stop the motor by applying the dynamic brake.	page 5-37
	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		Reference
	0	Apply the dynamic brake or coast the motor to a stop (use the stopping method set in Pn001 (2001 hex) = n.□□□X).	page 5-28
	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		Reference
	0	Input AC power as the main circuit power supply using the L1, L2, and L3 terminals (do not use shared converter).	page 5-12
	1	Input DC power as the main circuit power supply using the B1/⊕ and ⊖ 2 terminals or the B1 and ⊖ 2 terminals (use an external converter or the shared converter).	

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

Continued from previous page.

Parameter No.	Size	Name	Setting Range	Setting Unit	Default Setting	Applicable Motors	When Enabled	Classi- fication	Refer- ence
Pn002 (2002 hex)	2	Application Function Selections 2	0000 to 4213	–	0000	–	After restart	Setup	–

n.□□□X	EtherCAT (CoE) Module Torque Limit Command Usage Selection		Applicable Motors	Reference
	0	Reserved setting (Do not use.)	All	–
	1	Enable torque limit commands from EtherCAT (CoE). (Automatically set by the EtherCAT (CoE) Module.)		
	2	Reserved setting (Do not use.)		
	3	Reserved setting (Do not use.)		

n.□□X□	EtherCAT (CoE) Module Speed Limit Command Usage Selection		Applicable Motors	Reference
	0	Disable speed limit commands from EtherCAT (CoE) during torque control.	All	–
	1	Reserved setting (Do not use.)		

n.□X□□	Encoder Usage		Applicable Motors	Reference
	0	Use the encoder according to encoder specifications.	All	page 6-30
	1	Use the encoder as an incremental encoder.		
	2	Use the encoder as a single-turn absolute encoder.	Rotary	

n.X□□□	External Encoder Usage		Applicable Motors	Reference
	0	Do not use an external encoder.	Rotary	page 10-6
	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.)		

Continued from previous page.

Parameter No.	Size	Name	Setting Range	Setting Unit	Default Setting	Applicable Motors	When Enabled	Classification	Reference
Pn006 (2006 hex)	2	Application Function Selections 6	0000 to 105F	–	0002	All	Immediately	Setup	page 9-6

n.□□XX	Analog Monitor 1 Signal Selection	
	00	Motor speed (1 V/1,000 min^{-1}) Motor speed (1 V/1,000 mm/s)
	01	Speed reference (1 V/1,000 min^{-1}) Speed reference (1 V/1,000 mm/s)
	02	Torque reference (1 V/100% rated torque) Force reference (1 V/100% rated force)
	03	Position deviation (0.05 V/reference unit)
	04	Position amplifier deviation (after electronic gear) (0.05 V/encoder pulse unit) Position amplifier deviation (after electronic gear) (0.05 V/linear encoder pulse unit)
	05	Position reference speed (1 V/1,000 min^{-1}) Position reference speed (1 V/1,000 mm/s)
	06	Reserved setting (Do not use.)
	07	Load-motor position deviation (0.01 V/reference unit)
	08	Positioning completion (positioning completed: 5 V, positioning not completed: 0 V)
	09	Speed feedforward (1 V/1,000 min^{-1}) Speed feedforward (1 V/1,000 mm/s)
	0A	Torque feedforward (1 V/100% rated torque) Force feedforward (1 V/100% rated force)
	0B	Active gain (1st gain: 1 V, 2nd gain: 2 V)
	0C	Completion of position reference distribution (completed: 5 V, not completed: 0 V)
	0D	External encoder speed (1 V/1,000 min^{-1}: value at the motor shaft)
	0E	Position amplifier deviation (0.05 V/reference unit)
	0F	Reserved setting (Do not use.)
	10	Main circuit DC voltage
	11 to 5F	Reserved settings (Do not use.)
n.□X□□	Reserved parameter (Do not change.)	
n.X□□□	Reserved parameter (Do not change.)	

Continued from previous page.

Parameter No.	Size	Name	Setting Range	Setting Unit	Default Setting	Applicable Motors	When Enabled	Classification	Reference
Pn007 (2007 hex)	2	Application Function Selections 7	0000 to 105F	–	0000	All	Immediately	Setup	page 9-6

n.□□XX	Analog Monitor 2 Signal Selection	
	00	Motor speed (1 V/1,000 min^{-1})
		Motor speed (1 V/1,000 mm/s)
	01	Speed reference (1 V/1,000 min^{-1})
		Speed reference (1 V/1,000 mm/s)
	02	Torque reference (1 V/100% rated torque)
		Force reference (1 V/100% rated force)
	03	Position deviation (0.05 V/reference unit)
	04	Position amplifier deviation (after electronic gear) (0.05 V/encoder pulse unit)
		Position amplifier deviation (after electronic gear) (0.05 V/linear encoder pulse unit)
	05	Position reference speed (1 V/1,000 min^{-1})
		Position reference speed (1 V/1,000 mm/s)
	06	Reserved setting (Do not use.)
	07	Load-motor position deviation (0.01 V/reference unit)
	08	Positioning completion (positioning completed: 5 V, positioning not completed: 0 V)
	09	Speed feedforward (1 V/1,000 min^{-1})
		Speed feedforward (1 V/1,000 mm/s)
	0A	Torque feedforward (1 V/100% rated torque)
		Force feedforward (1 V/100% rated force)
	0B	Active gain (1st gain: 1 V, 2nd gain: 2 V)
	0C	Completion of position reference distribution (completed: 5 V, not completed: 0 V)
	0D	External encoder speed (1 V/1,000 min^{-1}: value at the motor shaft)
	0E	Position amplifier deviation (0.05 V/reference unit)
	0F	Reserved setting (Do not use.)
	10	Main circuit DC voltage
	11 to 5F	Reserved settings (Do not use.)

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

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

Parameter No.	Size	Name	Setting Range	Setting Unit	Default Setting	Applicable Motors	When Enabled	Classification	Reference
Pn008 (2008 hex)	2	Application Function Selections 8	0000 to 7121	–	4000	Rotary	After restart	Setup	–

n.□□□X	Low Battery Voltage Alarm/Warning Selection		Reference
	0	Output alarm (A.830) for low battery voltage.	page 15-2
	1	Output warning (A.930) for low battery voltage.	

n.□□X□	Function Selection for Undervoltage		Reference
	0	Do not detect undervoltage.	page 6-14
	1	Detect undervoltage warning and limit torque at host controller.	
	2	Detect undervoltage warning and limit torque with Pn424 (2424 hex) and Pn425 (2425 hex) (i.e., only in the SERVOPACK).	

n.□X□□	Warning Detection Selection		Reference
	0	Detect warnings.	page 15-43
	1	Do not detect warnings except for A.971.	

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

Continued from previous page.

Parameter No.	Size	Name	Setting Range	Setting Unit	Default Setting	Applicable Motors	When Enabled	Classi-fication	Refer-ence
Pn009 (2009 hex)	2	Application Function Selections 9	0000 to 0111	–	0010	All	After restart	Tuning	–

n.□□□X	Reserved parameter (Do not change.)		
n.□□X□	Current Control Mode Selection		Reference
	0	Use current control mode 1.	page 8-69
	1	Use current control mode 2.	
n.□X□□	Speed Detection Method Selection		Reference
	0	Use speed detection 1.	page 8-70
	1	Use speed detection 2.	
n.X□□□	Reserved parameter (Do not change.)		

Parameter No.	Size	Name	Setting Range	Setting Unit	Default Setting	Applicable Motors	When Enabled	Classi-fication	Refer-ence
Pn00A (200A hex)	2	Application Function Selections A	0000 to 0044	–	0001	All	After restart	Tuning	–

n.□□□X	Motor Stopping Method for Group 2 Alarms		Reference
	0	Apply the dynamic brake or coast the motor to a stop (use the stopping method set in Pn001 (2001 hex) = n.□□□X)).	page 5-38
	1	Decelerate the motor to a stop using the torque set in Pn406 (2406 hex) as the maximum torque. Use the setting of Pn001 (2001 hex) = n.□□□X for the status after stopping.	
	2	Decelerate the motor to a stop using the torque set in Pn406 (2406 hex) as the maximum torque and then let the motor coast.	
	3	Decelerate the motor to a stop using the deceleration time set in Pn30A (230A hex). Use the setting of Pn001 (2001 hex) = n.□□□X for the status after stopping.	
	4	Decelerate the motor to a stop using the deceleration time set in Pn30A (230A hex) and then let the motor coast.	
n.□□X□	Stopping Method for Forced Stops		Reference
	0	Apply the dynamic brake or coast the motor to a stop (use the stopping method set in Pn001 (2001 hex) = n.□□□X).	–
	1	Decelerate the motor to a stop using the torque set in Pn406 (2406 hex) as the maximum torque. Use the setting of Pn001 (2001 hex) = n.□□□X for the status after stopping.	
	2	Decelerate the motor to a stop using the torque set in Pn406 (2406 hex) as the maximum torque and then let the motor coast.	
	3	Decelerate the motor to a stop using the deceleration time set in Pn30A (230A hex). Use the setting of Pn001 (2001 hex) = n.□□□X for the status after stopping.	
	4	Decelerate the motor to a stop using the deceleration time set in Pn30A (230A hex) and then let the motor coast.	
n.□X□□	Reserved parameter (Do not change.)		
n.X□□□	Reserved parameter (Do not change.)		

Continued from previous page.

Parameter No.	Size	Name	Setting Range	Setting Unit	Default Setting	Applicable Motors	When Enabled	Classi-fication	Refer-ence
Pn00B (200B hex)	2	Application Function Selections B	0000 to 1121	–	0000	All	After restart	Setup	–

n.□□□X	Operator Parameter Display Selection		Reference
	0	Display only setup parameters.	page 5-3
	1	Display all parameters.	

n.□□X□	Motor Stopping Method for Group 2 Alarms		Reference
	0	Stop the motor by setting the speed reference to 0.	page 5-38
	1	Apply the dynamic brake or coast the motor to a stop (use the stopping method set in Pn001 (2001 hex) = n.□□□X).	
	2	Set the stopping method with Pn00A (200A hex) = n.□□□X.	

n.□X□□	Power Input Selection for Three-phase SERVOPACK		Reference
	0	Use a three-phase power supply input.	page 5-12
	1	Use a three-phase power supply input and as a single-phase power supply input.	

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

Pn00C (200C hex)	2	Application Function Selections C	0000 to 0131	–	0000	–	After restart	Setup	page 7-21

n.□□□X	Function Selection for Test without a Motor		Applicable Motors
	0	Disable tests without a motor.	All
	1	Enable tests without a motor.	

n.□□X□	Encoder Resolution for Tests without a Motor		Applicable Motors
	0	Use 13 bits.	Rotary
	1	Use 20 bits.	
	2	Use 22 bits.	
	3	Use 24 bits.	

n.□X□□	Encoder Type Selection for Tests without a Motor		Applicable Motors
	0	Use an incremental encoder.	All
	1	Use an absolute encoder.	

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

Pn00D (200D hex)	2	Application Function Selections D	0000 to 1001	–	0000	All	After restart	Setup	page 5-30

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.

Continued from previous page.

Parameter No.	Size	Name	Setting Range	Setting Unit	Default Setting	Applicable Motors	When Enabled	Classi-fication	Refer-ence
Pn00F (200F hex)	2	Application Function Selections F	0000 to 2011	–	0000	All	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	Applicable Motors	When Enabled	Classi-fication	Refer-ence
Pn010 (2010 hex)	2	Axis Address Selection for UART/USB Communications	0000 to 0007	–	0001	–	After startup	Setup	–
Pn021 (2021 hex)	2	DC Bus Connection	0000 to 2010	–	0000	–	After startup	Setup	–

n.□□□X	Reserved parameter (Do not change.)
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	Applicable Motors	When Enabled	Classi-fication	Refer-ence
Pn040 (2040 hex)	2	Σ-V Compatible Function Switch	0000 to 2111	–	0000	–	After restart	Setup	–

n.□□□X	Communications Interface Compatibility Selection		Applicable Motors
	0	Perform Σ-7 communications.	All
	1	Perform Σ-V communications.	
n.□□X□	Encoder Resolution Compatibility Selection		Applicable Motors
	0	Use the encoder resolution of the connected motor.	Rotary
	1	Use a resolution of 20 bits when connected to an SGM7J, SGM7A, SGM7P, or SGM7G motor.	
n.□X□□	Reserved parameter (Do not change.)		
n.X□□□	Reserved parameter (Do not change.)		

Continued from previous page.

Parameter No.	Size	Name	Setting Range	Setting Unit	Default Setting	Applicable Motors	When Enabled	Classi-fication	Refer-ence
Pn080 (2080 hex)	2	Application Function Selections 80	0000 to 1111	–	0000	Linear	After restart	Setup	–

n.□□□X	Polarity Sensor Selection		Reference
	0	Use polarity sensor.	page 5-23
	1	Do not use polarity sensor.	

n.□□X□	Motor Phase Sequence Selection		Reference
	0	Set a phase-A lead as a phase sequence of U, V, and W.	page 5-21
	1	Set a phase-B lead as a phase sequence of U, V, and W.	

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

n.X□□□	Calculation Method for Maximum Speed or Encoder Output Pulses		Reference
	0	Calculate the encoder output pulse setting for a fixed maximum speed.	page 17-4
	1	Calculate the maximum speed for a fixed encoder output pulse setting.	

Pn081 (2081 hex)	2	Application Function Selections 81	0000 to 1111	–	0000	All	After restart	Setup	page 6-17

n.□□□X	Phase-C Pulse Output Selection	
	0	Output phase-C pulses only in the forward direction.
	1	Output phase-C pulses in both the forward and reverse directions.

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

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

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

Pn100 (2100 hex)	2	Speed Loop Gain	10 to 20,000	0.1 Hz	400	All	Immedi-ately	Tuning	page 8-65
Pn101 (2101 hex)	2	Speed Loop Integral Time Constant	15 to 51,200	0.01 ms	2000	All	Immedi-ately	Tuning	page 8-65
Pn102 (2102 hex)	2	Position Loop Gain	10 to 20,000	0.1/s	400	All	Immedi-ately	Tuning	page 8-65
Pn103 (2103 hex)	2	Moment of Inertia Ratio	0 to 20,000	1%	100	All	Immedi-ately	Tuning	page 8-65
Pn104 (2104 hex)	2	Second Speed Loop Gain	10 to 20,000	0.1 Hz	400	All	Immedi-ately	Tuning	page 8-65
Pn105 (2105 hex)	2	Second Speed Loop Integral Time Constant	15 to 51,200	0.01 ms	2000	All	Immedi-ately	Tuning	page 8-65
Pn106 (2106 hex)	2	Second Position Loop Gain	10 to 20,000	0.1/s	400	All	Immedi-ately	Tuning	page 8-65
Pn109 (2109 hex)	2	Feedforward	0 to 100	1%	0	All	Immedi-ately	Tuning	page 8-86
Pn10A (210A hex)	2	Feedforward Filter Time Constant	0 to 6,400	0.01 ms	0	All	Immedi-ately	Tuning	page 8-86

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<table>
<tr><th>Parameter No.</th><th>Size</th><th>Name</th><th>Setting Range</th><th>Setting Unit</th><th>Default Setting</th><th>Applicable Motors</th><th>When Enabled</th><th>Classi-fication</th><th>Refer-ence</th></tr>
<tr><td rowspan="2">Pn10B
(210B hex)</td><td>2</td><td>Gain Application Selections</td><td>0000 to 5334</td><td>–</td><td>0000</td><td>All</td><td>–</td><td>Setup</td><td>–</td></tr>
<tr><td colspan="9">
<table>
<tr><th rowspan="8">n.□□□X</th><th colspan="2">Mode Switching Selection</th><th>When Enabled</th><th>Reference</th></tr>
<tr><td>0</td><td>Use the internal torque reference as the condition (level setting: Pn10C (210C hex)).</td><td rowspan="7">Immediately</td><td rowspan="7">page 8-87</td></tr>
<tr><td rowspan="2">1</td><td>Use the speed reference as the condition (level setting: Pn10D (210D hex)).</td></tr>
<tr><td>Use the speed reference as the condition (level setting: Pn181 (2181 hex)).</td></tr>
<tr><td rowspan="2">2</td><td>Use the acceleration reference as the condition (level setting: Pn10E (210E hex)).</td></tr>
<tr><td>Use the acceleration reference as the condition (level setting: Pn182 (2182 hex)).</td></tr>
<tr><td>3</td><td>Use the position deviation as the condition (level setting: Pn10F (210F hex)).</td></tr>
<tr><td>4</td><td>Do not use mode switching.</td></tr>
</table>
<table>
<tr><th rowspan="4">n.□□X□</th><th colspan="2">Speed Loop Control Method</th><th>When Enabled</th><th>Reference</th></tr>
<tr><td>0</td><td>PI control</td><td rowspan="3">After restart</td><td rowspan="3">–</td></tr>
<tr><td>1</td><td>I-P control</td></tr>
<tr><td>2 to 3</td><td>Reserved settings (Do not use.)</td></tr>
</table>
<table>
<tr><td>n.□X□□</td><td>Reserved parameter (Do not change.)</td></tr>
</table>
<table>
<tr><td>n.X□□□</td><td>Reserved parameter (Do not change.)</td></tr>
</table>
</td></tr>
<tr><td>Pn10C
(210C hex)</td><td>2</td><td>Mode Switching Level for Torque Reference</td><td>0 to 800</td><td>1%</td><td>200</td><td>All</td><td>Immediately</td><td>Tuning</td><td>page 8-87</td></tr>
<tr><td>Pn10D
(210D hex)</td><td>2</td><td>Mode Switching Level for Speed Reference</td><td>0 to 10,000</td><td>1 min^{-1}</td><td>0</td><td>Rotary</td><td>Immediately</td><td>Tuning</td><td>page 8-87</td></tr>
<tr><td>Pn10E
(210E hex)</td><td>2</td><td>Mode Switching Level for Acceleration</td><td>0 to 30,000</td><td>1 min^{-1}/s</td><td>0</td><td>Rotary</td><td>Immediately</td><td>Tuning</td><td>page 8-87</td></tr>
<tr><td>Pn10F
(210F hex)</td><td>2</td><td>Mode Switching Level for Position Deviation</td><td>0 to 10,000</td><td>1 reference unit</td><td>0</td><td>All</td><td>Immediately</td><td>Tuning</td><td>page 8-87</td></tr>
<tr><td>Pn11F
(211F hex)</td><td>2</td><td>Position Integral Time Constant</td><td>0 to 50,000</td><td>0.1 ms</td><td>0</td><td>All</td><td>Immediately</td><td>Tuning</td><td>page 8-89</td></tr>
<tr><td>Pn121
(2121 hex)</td><td>2</td><td>Friction Compensation Gain</td><td>10 to 1,000</td><td>1%</td><td>100</td><td>All</td><td>Immediately</td><td>Tuning</td><td>page 8-65,
page 8-68</td></tr>
<tr><td>Pn122
(2122 hex)</td><td>2</td><td>Second Friction Compensation Gain</td><td>10 to 1,000</td><td>1%</td><td>100</td><td>All</td><td>Immediately</td><td>Tuning</td><td>page 8-65,
page 8-68</td></tr>
<tr><td>Pn123
(2123 hex)</td><td>2</td><td>Friction Compensation Coefficient</td><td>0 to 100</td><td>1%</td><td>0</td><td>All</td><td>Immediately</td><td>Tuning</td><td>page 8-68</td></tr>
<tr><td>Pn124
(2124 hex)</td><td>2</td><td>Friction Compensation Frequency Correction</td><td>-10,000 to 10,000</td><td>0.1 Hz</td><td>0</td><td>All</td><td>Immediately</td><td>Tuning</td><td>page 8-68</td></tr>
<tr><td>Pn125
(2125 hex)</td><td>2</td><td>Friction Compensation Gain Correction</td><td>1 to 1,000</td><td>1%</td><td>100</td><td>All</td><td>Immediately</td><td>Tuning</td><td>page 8-68</td></tr>
<tr><td>Pn131
(2131 hex)</td><td>2</td><td>Gain Switching Time 1</td><td>0 to 65,535</td><td>1 ms</td><td>0</td><td>All</td><td>Immediately</td><td>Tuning</td><td>page 8-65</td></tr>
<tr><td>Pn132
(2132 hex)</td><td>2</td><td>Gain Switching Time 2</td><td>0 to 65,535</td><td>1 ms</td><td>0</td><td>All</td><td>Immediately</td><td>Tuning</td><td>page 8-65</td></tr>
<tr><td>Pn135
(2135 hex)</td><td>2</td><td>Gain Switching Waiting Time 1</td><td>0 to 65,535</td><td>1 ms</td><td>0</td><td>All</td><td>Immediately</td><td>Tuning</td><td>page 8-65</td></tr>
<tr><td>Pn136
(2136 hex)</td><td>2</td><td>Gain Switching Waiting Time 2</td><td>0 to 65,535</td><td>1 ms</td><td>0</td><td>All</td><td>Immediately</td><td>Tuning</td><td>page 8-65</td></tr>
</table>

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Parameter No.	Size	Name	Setting Range	Setting Unit	Default Setting	Applicable Motors	When Enabled	Classi-fication	Refer-ence
Pn139 (2139 hex)	2	Automatic Gain Switching Selections 1	0000 to 0052	–	0000	All	Immediately	Tuning	page 8-65

n.□□□X	Gain Switching Selection	
	0	Disable automatic gain switching.
	1	Reserved setting (Do not use.)
	2	Use automatic gain switching pattern 1. The gain is switched automatically from the first gain to the second gain when switching condition A is satisfied. The gain is switched automatically from the second gain to the first gain 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 position reference input is OFF.
	5	Position reference input is ON.

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

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

Parameter No.	Size	Name	Setting Range	Setting Unit	Default Setting	Applicable Motors	When Enabled	Classi-fication	Refer-ence
Pn13D (213D hex)	2	Current Gain Level	100 to 2,000	1%	2000	All	Immediately	Tuning	page 8-70
Pn140 (2140 hex)	2	Model Following Control-Related Selections	0000 to 1121	–	0100	All	Immediately	Tuning	–

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

n.□□X□	Vibration Suppression Selection	
	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		Reference
	0	Do not adjust vibration suppression automatically during execution of autotuning without a host reference, autotuning with a host reference, and custom tuning.	page 8-29
	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 (TFF) Selection		Reference
	0	Do not use model following control and speed/torque feedforward together.	page 8-29
	1	Use model following control and speed/torque feedforward together.	

Parameter No.	Size	Name	Setting Range	Setting Unit	Default Setting	Applicable Motors	When Enabled	Classi-fication	Refer-ence
Pn141 (2141 hex)	2	Model Following Control Gain	10 to 20,000	0.1/s	500	All	Immediately	Tuning	–
Pn142 (2142 hex)	2	Model Following Control Gain Correction	500 to 2,000	0.1%	1000	All	Immediately	Tuning	–
Pn143 (2143 hex)	2	Model Following Control Bias in the Forward Direction	0 to 10,000	0.1%	1000	All	Immediately	Tuning	–

Continued from previous page.

Parameter No.	Size	Name	Setting Range	Setting Unit	Default Setting	Applicable Motors	When Enabled	Classi-fication	Refer-ence
Pn144 (2144 hex)	2	Model Following Control Bias in the Reverse Direction	0 to 10,000	0.1%	1000	All	Immediately	Tuning	–
Pn145 (2145 hex)	2	Vibration Suppression 1 Frequency A	10 to 2,500	0.1 Hz	500	All	Immediately	Tuning	–
Pn146 (2146 hex)	2	Vibration Suppression 1 Frequency B	10 to 2,500	0.1 Hz	700	All	Immediately	Tuning	–
Pn147 (2147 hex)	2	Model Following Control Speed Feedforward Compensation	0 to 10,000	0.1%	1000	All	Immediately	Tuning	–
Pn148 (2148 hex)	2	Second Model Following Control Gain	10 to 20,000	0.1/s	500	All	Immediately	Tuning	–
Pn149 (2149 hex)	2	Second Model Following Control Gain Correction	500 to 2,000	0.1%	1000	All	Immediately	Tuning	–
Pn14A (214A hex)	2	Vibration Suppression 2 Frequency	10 to 2,000	0.1 Hz	800	All	Immediately	Tuning	–
Pn14B (214B hex)	2	Vibration Suppression 2 Correction	10 to 1,000	1%	100	All	Immediately	Tuning	–
Pn14F (214F hex)	2	Control-Related Selections	0000 to 0021	–	0021	All	After restart	Tuning	–

	Model Following Control Type Selection		Reference
n.□□□X	0	Use model following control type 1.	page 8-86
	1	Use model following control type 2.	

	Tuning-less Type Selection		Reference
n.□□X□	0	Use tuning-less type 1.	page 8-12
	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.)

Parameter No.	Size	Name	Setting Range	Setting Unit	Default Setting	Applicable Motors	When Enabled	Classi-fication	Refer-ence
Pn160 (2160 hex)	2	Anti-Resonance Control-Related Selections	0000 to 0011	–	0010	All	Immediately	Tuning	–

	Anti-Resonance Control Selection	
n.□□□X	0	Do not use anti-resonance control.
	1	Use anti-resonance control.

	Anti-Resonance Control Adjustment Selection		Reference
n.□□X□	0	Do not adjust anti-resonance control automatically during execution of autotuning without a host reference, autotuning with a host reference, and custom tuning.	page 8-29
	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.)

Parameter No.	Size	Name	Setting Range	Setting Unit	Default Setting	Applicable Motors	When Enabled	Classi-fication	Refer-ence
Pn161 (2161 hex)	2	Anti-Resonance Frequency	10 to 20,000	0.1 Hz	1000	All	Immediately	Tuning	–
Pn162 (2162 hex)	2	Anti-Resonance Gain Correction	1 to 1,000	1%	100	All	Immediately	Tuning	–
Pn163 (2163 hex)	2	Anti-Resonance Damping Gain	0 to 300	1%	0	All	Immediately	Tuning	–

Continued from previous page.

Parameter No.	Size	Name	Setting Range	Setting Unit	Default Setting	Applicable Motors	When Enabled	Classi-fication	Refer-ence
Pn164 (2164 hex)	2	Anti-Resonance Filter Time Constant 1 Correction	-1,000 to 1,000	0.01 ms	0	All	Immediately	Tuning	–
Pn165 (2165 hex)	2	Anti-Resonance Filter Time Constant 2 Correction	-1,000 to 1,000	0.01 ms	0	All	Immediately	Tuning	–
Pn166 (2166 hex)	2	Anti-Resonance Damping Gain 2	0 to 1,000	1%	0	All	Immediately	Tuning	–
Pn170 (2170 hex)	2	Tuning-less Function-Related Selections	0000 to 2711	–	1401	All	–	Setup	page 8-11

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 to 7	Set the rigidity level.	Immediately

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

Parameter No.	Size	Name	Setting Range	Setting Unit	Default Setting	Applicable Motors	When Enabled	Classi-fication	Refer-ence
Pn181 (2181 hex)	2	Mode Switching Level for Speed Reference	0 to 10,000	1 mm/s	0	Linear	Immediately	Tuning	page 8-87
Pn182 (2182 hex)	2	Mode Switching Level for Acceleration	0 to 30,000	1 mm/s^2	0	Linear	Immediately	Tuning	page 8-87
Pn205 (2205 hex)	2	Multiturn Limit	0 to 65,535	1 rev	65535	Rotary	After restart	Setup	page 6-35
Pn207 (2207 hex)	2	Position Control Function Selections	0000 to 2210	–	0010	All	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□□□	/COIN (Positioning Completion Output) Signal Output Timing		Refer-ence
	0	Output when the absolute value of the position deviation is the same or less than the setting of Pn522 (2522 hex) (Positioning Completed Width).	page 6-9
	1	Output when the absolute value of the position error is the same or less than the setting of Pn522 (2522 hex) (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 (2522 hex) (Positioning Completed Width) and the reference input is 0.	

Parameter No.	Size	Name	Setting Range	Setting Unit	Default Setting	Applicable Motors	When Enabled	Classi-fication	Refer-ence
Pn20A (220A hex)	4	Number of External Encoder Scale Pitches	4 to 1,048,576	1 scale pitch/revolution	32768	Rotary	After restart	Setup	page 10-7

Continued from previous page.

Parameter No.	Size	Name	Setting Range	Setting Unit	Default Setting	Applicable Motors	When Enabled	Classi-fication	Refer-ence
Pn20E (220E hex)	4	Electronic Gear Ratio (Numerator)[*5]	1 to 1,073,741,824	1	64	All	After restart	Setup	page 5-42
Pn210 (2210 hex)	4	Electronic Gear Ratio (Denominator)[*5]	1 to 1,073,741,824	1	1	All	After restart	Setup	page 5-42
Pn212 (2212 hex)	4	Number of Encoder Output Pulses	16 to 1,073,741,824	1 P/Rev	2048	Rotary	After restart	Setup	page 6-22
Pn22A (222A hex)	2	Fully-closed Control Selections	0000 to 1003	–	0000	Rotary	After restart	Setup	page 10-9

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

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

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

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

Pn230 (2230 hex)	2	Position Control Expansion Function Selections	0000 to 0001	–	0000	All	After restart	Setup	page 8-71

n.□□□X	Backlash Compensation Direction	
	0	Compensate forward references.
	1	Compensate reverse references.

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

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

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

Pn231 (2231 hex)	4	Backlash Compensation	-500,000 to 500,000	0.1 reference units	0	All	Immediately	Setup	page 8-71
Pn233 (2233 hex)	2	Backlash Compensation Time Constant	0 to 65,535	0.01 ms	0	All	Immediately	Setup	page 8-71
Pn281 (2281 hex)	2	Encoder Output Resolution	1 to 4,096	1 edge/pitch	20	All	After restart	Setup	page 6-22
Pn282 (2282 hex)	4	Linear Encoder Scale Pitch	0 to 6,553,600	0.01 μm	0	Linear	After restart	Setup	page 5-16
Pn304 (2304 hex)	2	Jogging Speed	0 to 10,000	Rotary: 1 min^{-1} Direct Drive: 0.1 min^{-1}	500	Rotary	Immediately	Setup	page 7-7
Pn305 (2305 hex)	2	Soft Start Acceleration Time	0 to 10,000	1 ms	0	All	Immediately	Setup	*1
Pn306 (2306 hex)	2	Soft Start Deceleration Time	0 to 10,000	1 ms	0	All	Immediately	Setup	*1
Pn308 (2308 hex)	2	Speed Feedback Filter Time Constant	0 to 65,535	0.01 ms	0	All	Immediately	Setup	page 8-76
Pn30A (230A hex)	2	Deceleration Time for Servo OFF and Forced Stops	1 to 10,000	1 ms	0	All	Immediately	Setup	page 5-29
Pn30C (230C hex)	2	Speed Feedforward Average Movement Time	0 to 5,100	0.1 ms	0	All	Immediately	Setup	–

Continued from previous page.

<table>
<tr><th>Parameter No.</th><th>Size</th><th>Name</th><th>Setting Range</th><th>Setting Unit</th><th>Default Setting</th><th>Applicable Motors</th><th>When Enabled</th><th>Classi- fication</th><th>Refer- ence</th></tr>
<tr><td rowspan="2">Pn310
(2310 hex)</td><td>2</td><td>Vibration Detection Selections</td><td>0000 to 0002</td><td>–</td><td>0000</td><td>All</td><td>Immedi- ately</td><td>Setup</td><td>page 6-45</td></tr>
<tr><td colspan="9"><table>
<tr><td rowspan="4">n.□□□X</td><td colspan="2">Vibration Detection Selection</td></tr>
<tr><td>0</td><td>Do not detect vibration.</td></tr>
<tr><td>1</td><td>Output a warning (A.911) if vibration is detected.</td></tr>
<tr><td>2</td><td>Output an alarm (A.520) if vibration is detected.</td></tr>
</table>
<table><tr><td>n.□□X□</td><td>Reserved parameter (Do not change.)</td></tr></table>
<table><tr><td>n.□X□□</td><td>Reserved parameter (Do not change.)</td></tr></table>
<table><tr><td>n.X□□□</td><td>Reserved parameter (Do not change.)</td></tr></table></td></tr>
<tr><td>Pn311
(2311 hex)</td><td>2</td><td>Vibration Detection Sensitivity</td><td>50 to 500</td><td>1%</td><td>100</td><td>All</td><td>Immedi- ately</td><td>Tuning</td><td>page 6-45</td></tr>
<tr><td>Pn312
(2312 hex)</td><td>2</td><td>Vibration Detection Level</td><td>0 to 5,000</td><td>1 min^{-1}</td><td>50</td><td>Rotary</td><td>Immedi- ately</td><td>Tuning</td><td>page 6-45</td></tr>
<tr><td>Pn316
(2316 hex)</td><td>2</td><td>Maximum Motor Speed</td><td>0 to 65,535</td><td>1 min^{-1}</td><td>10000</td><td>Rotary</td><td>After restart</td><td>Setup</td><td>page 6-16</td></tr>
<tr><td>Pn324
(2324 hex)</td><td>2</td><td>Moment of Inertia Calculation Starting Level</td><td>0 to 20,000</td><td>1%</td><td>300</td><td>All</td><td>Immedi- ately</td><td>Setup</td><td>page 8-29</td></tr>
<tr><td>Pn383
(2383 hex)</td><td>2</td><td>Jogging Speed</td><td>0 to 10,000</td><td>1 mm/s</td><td>50</td><td>Linear</td><td>Immedi- ately</td><td>Setup</td><td>page 7-7</td></tr>
<tr><td>Pn384
(2384 hex)</td><td>2</td><td>Vibration Detection Level</td><td>0 to 5,000</td><td>1 mm/s</td><td>10</td><td>Linear</td><td>Immedi- ately</td><td>Tuning</td><td>page 6-45</td></tr>
<tr><td>Pn385
(2385 hex)</td><td>2</td><td>Maximum Motor Speed</td><td>1 to 100</td><td>100 mm/s</td><td>50</td><td>Linear</td><td>After restart</td><td>Setup</td><td>page 6-16</td></tr>
<tr><td>Pn401
(2401 hex)</td><td>2</td><td>First Stage First Torque Reference Filter Time Constant</td><td>0 to 65,535</td><td>0.01 ms</td><td>100</td><td>All</td><td>Immedi- ately</td><td>Tuning</td><td>page 8-79</td></tr>
<tr><td>Pn402
(2402 hex)</td><td>2</td><td>Forward Torque Limit</td><td>0 to 800</td><td>1%[*1]</td><td>800</td><td>Rotary</td><td>Immedi- ately</td><td>Setup</td><td>page 6-25</td></tr>
<tr><td>Pn403
(2403 hex)</td><td>2</td><td>Reverse Torque Limit</td><td>0 to 800</td><td>1%[*1]</td><td>800</td><td>Rotary</td><td>Immedi- ately</td><td>Setup</td><td>page 6-25</td></tr>
<tr><td>Pn404
(2404 hex)</td><td>2</td><td>Forward External Torque Limit</td><td>0 to 800</td><td>1%[*1]</td><td>100</td><td>All</td><td>Immedi- ately</td><td>Setup</td><td>page 6-26</td></tr>
<tr><td>Pn405
(2405 hex)</td><td>2</td><td>Reverse External Torque Limit</td><td>0 to 800</td><td>1%[*1]</td><td>100</td><td>All</td><td>Immedi- ately</td><td>Setup</td><td>page 6-26</td></tr>
<tr><td>Pn406
(2406 hex)</td><td>2</td><td>Emergency Stop Torque</td><td>0 to 800</td><td>1%[*1]</td><td>800</td><td>All</td><td>Immedi- ately</td><td>Setup</td><td>page 5-28</td></tr>
<tr><td>Pn407
(2407 hex)</td><td>2</td><td>Speed Limit during Torque Control</td><td>0 to 10,000</td><td>1 min^{-1}</td><td>10000</td><td>Rotary</td><td>Immedi- ately</td><td>Setup</td><td>page 6-11</td></tr>
</table>

Continued from previous page.

Parameter No.	Size	Name	Setting Range	Setting Unit	Default Setting	Applicable Motors	When Enabled	Classi-fication	Refer-ence
Pn408 (2408 hex)	2	Torque-Related Function Selections	0000 to 1111	–	0000	All	–	Setup	–

n.□□□X	Notch Filter Selection 1		When Enabled	Reference
	0	Disable first stage notch filter.	Immediately	page 8-79
	1	Enable first stage notch filter.		

n.□□X□	Speed Limit Selection		When Enabled	Reference
	0	Use the smaller of the maximum motor speed and the setting of Pn407 (2407 hex) as the speed limit.	After restart	page 6-11
		Use the smaller of the maximum motor speed and the setting of Pn480 (2480 hex) as the speed limit.		
	1	Use the smaller of the overspeed alarm detection speed and the setting of Pn407 (2407 hex) as the speed limit.		
		Use the smaller of the overspeed alarm detection speed and the setting of Pn480 (2480 hex) as the speed limit.		

n.□X□□	Notch Filter Selection 2		When Enabled	Reference
	0	Disable second stage notch filter.	Immediately	page 8-79
	1	Enable second stage notch filter.		

n.X□□□	Friction Compensation Function Selection		When Enabled	Reference
	0	Disable friction compensation.	Immediately	page 8-68
	1	Enable friction compensation.		

Parameter No.	Size	Name	Setting Range	Setting Unit	Default Setting	Applicable Motors	When Enabled	Classi-fication	Refer-ence
Pn409 (2409 hex)	2	First Stage Notch Filter Frequency	50 to 5,000	1 Hz	5000	All	Immediately	Tuning	page 8-79
Pn40A (240A hex)	2	First Stage Notch Filter Q Value	50 to 1,000	0.01	70	All	Immediately	Tuning	page 8-79
Pn40B (240B hex)	2	First Stage Notch Filter Depth	0 to 1,000	0.001	0	All	Immediately	Tuning	page 8-79
Pn40C (240C hex)	2	Second Stage Notch Filter Frequency	50 to 5,000	1 Hz	5000	All	Immediately	Tuning	page 8-79
Pn40D (240D hex)	2	Second Stage Notch Filter Q Value	50 to 1,000	0.01	70	All	Immediately	Tuning	page 8-79
Pn40E (240E hex)	2	Second Stage Notch Filter Depth	0 to 1,000	0.001	0	All	Immediately	Tuning	page 8-79
Pn40F (240F hex)	2	Second Stage Second Torque Reference Filter Frequency	100 to 5,000	1 Hz	5000	All	Immediately	Tuning	page 8-79
Pn410 (2410 hex)	2	Second Stage Second Notch Filter Q Value	50 to 100	0.01	50	All	Immediately	Tuning	page 8-79
Pn412 (2412 hex)	2	First Stage Second Torque Reference Filter Time Constant	0 to 65,535	0.01 ms	100	All	Immediately	Tuning	page 8-65

Continued from previous page.

Parameter No.	Size	Name	Setting Range	Setting Unit	Default Setting	Applicable Motors	When Enabled	Classi-fication	Refer-ence
Pn416 (2416 hex)	2	Torque-Related Function Selections 2	0000 to 1111	–	0000	All	Immediately	Setup	page 8-81

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.)

Parameter No.	Size	Name	Setting Range	Setting Unit	Default Setting	Applicable Motors	When Enabled	Classi-fication	Refer-ence
Pn417 (2417 hex)	2	Third Stage Notch Filter Frequency	50 to 5,000	1 Hz	5000	All	Immediately	Tuning	page 8-81
Pn418 (2418 hex)	2	Third Stage Notch Filter Q Value	50 to 1,000	0.01	70	All	Immediately	Tuning	page 8-81
Pn419 (2419 hex)	2	Third Stage Notch Filter Depth	0 to 1,000	0.001	0	All	Immediately	Tuning	page 8-81
Pn41A (241A hex)	2	Fourth Stage Notch Filter Frequency	50 to 5,000	1 Hz	5000	All	Immediately	Tuning	page 8-81
Pn41B (241B hex)	2	Fourth Stage Notch Filter Q Value	50 to 1,000	0.01	70	All	Immediately	Tuning	page 8-81
Pn41C (241C hex)	2	Fourth Stage Notch Filter Depth	0 to 1,000	0.001	0	All	Immediately	Tuning	page 8-81
Pn41D (241D hex)	2	Fifth Stage Notch Filter Frequency	50 to 5,000	1 Hz	5000	All	Immediately	Tuning	page 8-81
Pn41E (241E hex)	2	Fifth Stage Notch Filter Q Value	50 to 1,000	0.01	70	All	Immediately	Tuning	page 8-81
Pn41F (241F hex)	2	Fifth Stage Notch Filter Depth	0 to 1,000	0.001	0	All	Immediately	Tuning	page 8-80
Pn423 (2423 hex)	2	Speed Ripple Compensation Selections	0000 to 1111	–	0000	Rotary	–	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.)

Parameter No.	Size	Name	Setting Range	Setting Unit	Default Setting	Applicable Motors	When Enabled	Classi-fication	Refer-ence
Pn424 (2424 hex)	2	Torque Limit at Main Circuit Voltage Drop	0 to 100	1%[*1]	50	All	Immediately	Setup	page 6-14

Continued from previous page.

<table>
<tr><th>Parameter No.</th><th>Size</th><th>Name</th><th>Setting Range</th><th>Setting Unit</th><th>Default Setting</th><th>Applicable Motors</th><th>When Enabled</th><th>Classi-fication</th><th>Refer-ence</th></tr>
<tr><td>Pn425
(2425 hex)</td><td>2</td><td>Release Time for Torque Limit at Main Circuit Voltage Drop</td><td>0 to 1,000</td><td>1 ms</td><td>100</td><td>All</td><td>Immedi-ately</td><td>Setup</td><td>page 6-14</td></tr>
<tr><td>Pn426
(2426 hex)</td><td>2</td><td>Torque Feedforward Average Movement Time</td><td>0 to 5,100</td><td>0.1 ms</td><td>0</td><td>All</td><td>Immedi-ately</td><td>Setup</td><td>–</td></tr>
<tr><td>Pn427
(2427 hex)</td><td>2</td><td>Speed Ripple Compen-sation Enable Speed</td><td>0 to 10,000</td><td>1 min^{-1}</td><td>0</td><td>Rotary Ser-vomotor</td><td>Immedi-ately</td><td>Tuning</td><td>–</td></tr>
<tr><td>Pn456
(2456 hex)</td><td>2</td><td>Sweep Torque Refer-ence Amplitude</td><td>1 to 800</td><td>1%</td><td>15</td><td>All</td><td>Immedi-ately</td><td>Tuning</td><td>page 8-92</td></tr>
<tr><td rowspan="2">Pn460
(2460 hex)</td><td>2</td><td>Notch Filter Adjustment Selections 1</td><td>0000 to 0101</td><td>–</td><td>0101</td><td>All</td><td>Immedi-ately</td><td>Tuning</td><td>page 8-11,
page 8-22,
page 8-41</td></tr>
<tr><td colspan="9">
<table>
<tr><td rowspan="3">n.□□□X</td><td colspan="2">Notch Filter Adjustment Selection 1</td></tr>
<tr><td>0</td><td>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.</td></tr>
<tr><td>1</td><td>Adjust the first stage notch filter automatically during execution of autotuning without a host reference, autotuning with a host reference, and custom tuning.</td></tr>
<tr><td>n.□□X□</td><td colspan="2">Reserved parameter (Do not change.)</td></tr>
<tr><td rowspan="3">n.□X□□</td><td colspan="2">Notch Filter Adjustment Selection 2</td></tr>
<tr><td>0</td><td>Do not adjust the second stage notch filter automatically during execution of autotuning without a host reference, autotuning with a host reference, and custom tuning.</td></tr>
<tr><td>1</td><td>Adjust the second stage notch filter automatically during execution of autotuning without a host reference, autotuning with a host reference, and custom tuning.</td></tr>
<tr><td>n.X□□□</td><td colspan="2">Reserved parameter (Do not change.)</td></tr>
</table>
</td></tr>
<tr><td>Pn480
(2480 hex)</td><td>2</td><td>Speed Limit during Force Control</td><td>0 to 10,000</td><td>1 mm/s</td><td>10000</td><td>Linear</td><td>Immedi-ately</td><td>Setup</td><td>page 6-11</td></tr>
<tr><td>Pn481
(2481 hex)</td><td>2</td><td>Polarity Detection Speed Loop Gain</td><td>10 to 20,000</td><td>0.1 Hz</td><td>400</td><td>Linear</td><td>Immedi-ately</td><td>Tuning</td><td>–</td></tr>
<tr><td>Pn482
(2482 hex)</td><td>2</td><td>Polarity Detection Speed Loop Integral Time Constant</td><td>15 to 51,200</td><td>0.01 ms</td><td>3000</td><td>Linear</td><td>Immedi-ately</td><td>Tuning</td><td>–</td></tr>
<tr><td>Pn483
(2483 hex)</td><td>2</td><td>Forward Force Limit</td><td>0 to 800</td><td>1%[*1]</td><td>30</td><td>Linear</td><td>Immedi-ately</td><td>Setup</td><td>page 6-25</td></tr>
<tr><td>Pn484
(2484 hex)</td><td>2</td><td>Reverse Force Limit</td><td>0 to 800</td><td>1%[*1]</td><td>30</td><td>Linear</td><td>Immedi-ately</td><td>Setup</td><td>page 6-25</td></tr>
<tr><td>Pn485
(2485 hex)</td><td>2</td><td>Polarity Detection Refer-ence Speed</td><td>0 to 100</td><td>1 mm/s</td><td>20</td><td>Linear</td><td>Immedi-ately</td><td>Tuning</td><td>–</td></tr>
<tr><td>Pn486
(2486 hex)</td><td>2</td><td>Polarity Detection Refer-ence Acceleration/ Deceleration Time</td><td>0 to 100</td><td>1 ms</td><td>25</td><td>Linear</td><td>Immedi-ately</td><td>Tuning</td><td>–</td></tr>
<tr><td>Pn487
(2487 hex)</td><td>2</td><td>Polarity Detection Con-stant Speed Time</td><td>0 to 300</td><td>1 ms</td><td>0</td><td>Linear</td><td>Immedi-ately</td><td>Tuning</td><td>–</td></tr>
<tr><td>Pn488
(2488 hex)</td><td>2</td><td>Polarity Detection Refer-ence Waiting Time</td><td>50 to 500</td><td>1 ms</td><td>100</td><td>Linear</td><td>Immedi-ately</td><td>Tuning</td><td>–</td></tr>
<tr><td>Pn48E
(248E hex)</td><td>2</td><td>Polarity Detection Range</td><td>1 to 65,535</td><td>1 mm</td><td>10</td><td>Linear</td><td>Immedi-ately</td><td>Tuning</td><td>–</td></tr>
<tr><td>Pn490
(2490 hex)</td><td>2</td><td>Polarity Detection Load Level</td><td>0 to 20,000</td><td>1%</td><td>100</td><td>Linear</td><td>Immedi-ately</td><td>Tuning</td><td>–</td></tr>
<tr><td>Pn495
(2495 hex)</td><td>2</td><td>Polarity Detection Con-firmation Force Refer-ence</td><td>0 to 200</td><td>1%</td><td>100</td><td>Linear</td><td>Immedi-ately</td><td>Tuning</td><td>–</td></tr>
</table>

Continued from previous page.

Parameter No.	Size	Name	Setting Range	Setting Unit	Default Setting	Applicable Motors	When Enabled	Classi- fication	Refer- ence
Pn498 (2498 hex)	2	Polarity Detection Allowable Error Range	0 to 30	1 deg	10	Linear	Immediately	Tuning	–
Pn49F (249F hex)	2	Speed Ripple Compensation Enable Speed	0 to 10,000	1 mm/s	0	Linear	Immediately	Tuning	–
Pn502 (2502 hex)	2	Rotation Detection Level	1 to 10,000	1 min^{-1}	20	Rotary	Immediately	Setup	page 6-7
Pn503 (2503 hex)	2	Speed Coincidence Detection Signal Output Width	0 to 100	1 min^{-1}	10	Rotary	Immediately	Setup	page 6-8
Pn506 (2506 hex)	2	Brake Reference-Servo OFF Delay Time	0 to 50	10 ms	0	All	Immediately	Setup	page 5-32
Pn507 (2507 hex)	2	Brake Reference Output Speed Level	0 to 10,000	1 min^{-1}	100	Rotary	Immediately	Setup	page 5-32
Pn508 (2508 hex)	2	Servo OFF-Brake Command Waiting Time	10 to 100	10 ms	50	All	Immediately	Setup	page 5-32
Pn509 (2509 hex)	2	Momentary Power Interruption Hold Time	20 to 50,000	1 ms	20	All	Immediately	Setup	page 6-13
Pn50A (250A hex)	2	Input Signal Selections 1	0000 to FFF2	–	1881	All	After restart	Setup	–

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

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

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

		P-OT (Forward Drive Prohibit) Signal Allocation	Reference
n.X□□□	0	Enable forward drive when CN1-13 input signal is ON (closed).	page 5-27
	1	Enable forward drive when CN1-7 input signal is ON (closed).	
	2	Enable forward drive when CN1-8 input signal is ON (closed).	
	3	Enable forward drive when CN1-9 input signal is ON (closed).	
	4	Enable forward drive when CN1-10 input signal is ON (closed).	
	5	Enable forward drive when CN1-11 input signal is ON (closed).	
	6	Enable forward drive when CN1-12 input signal is ON (closed).	
	7	Set the signal to always prohibit forward drive.	
	8	Set the signal to always enable forward drive.	
	9	Enable forward drive when CN1-13 input signal is OFF (open).	
	A	Enable forward drive when CN1-7 input signal is OFF (open).	
	B	Enable forward drive when CN1-8 input signal is OFF (open).	
	C	Enable forward drive when CN1-9 input signal is OFF (open).	
	D	Enable forward drive when CN1-10 input signal is OFF (open).	
	E	Enable forward drive when CN1-11 input signal is OFF (open).	
	F	Enable forward drive when CN1-12 input signal is OFF (open).	

Continued from previous page.

Parameter No.	Size	Name	Setting Range	Setting Unit	Default Setting	Applicable Motors	When Enabled	Classi-fication	Refer-ence
Pn50B (250B hex)	2	Input Signal Selections 2	0000 to FFFF	–	8882	All	After restart	Setup	–

	N-OT (Reverse Drive Prohibit) Signal Allocation		Reference
n.□□□X	0	Enable reverse drive when CN1-13 input signal is ON (closed).	page 5-27
	1	Enable reverse drive when CN1-7 input signal is ON (closed).	
	2	Enable reverse drive when CN1-8 input signal is ON (closed).	
	3	Enable reverse drive when CN1-9 input signal is ON (closed).	
	4	Enable reverse drive when CN1-10 input signal is ON (closed).	
	5	Enable reverse drive when CN1-11 input signal is ON (closed).	
	6	Enable reverse drive when CN1-12 input signal is ON (closed).	
	7	Set the signal to always prohibit reverse drive.	
	8	Set the signal to always enable reverse drive.	
	9	Enable reverse drive when CN1-13 input signal is OFF (open).	
	A	Enable reverse drive when CN1-7 input signal is OFF (open).	
	B	Enable reverse drive when CN1-8 input signal is OFF (open).	
	C	Enable reverse drive when CN1-9 input signal is OFF (open).	
	D	Enable reverse drive when CN1-10 input signal is OFF (open).	
	E	Enable reverse drive when CN1-11 input signal is OFF (open).	
	F	Enable reverse drive when CN1-12 input signal is OFF (open).	

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

	/P-CL (Forward External Torque Limit Input) Signal Allocation		Reference
n.□X□□	0	Active when CN1-13 input signal is ON (closed).	page 6-26
	1	Active when CN1-7 input signal is ON (closed).	
	2	Active when CN1-8 input signal is ON (closed).	
	3	Active when CN1-9 input signal is ON (closed).	
	4	Active when CN1-10 input signal is ON (closed).	
	5	Active when CN1-11 input signal is ON (closed).	
	6	Active when CN1-12 input signal is ON (closed).	
	7	The signal is always active.	
	8	The signal is always inactive.	
	9	Active when CN1-13 input signal is OFF (open).	
	A	Active when CN1-7 input signal is OFF (open).	
	B	Active when CN1-8 input signal is OFF (open).	
	C	Active when CN1-9 input signal is OFF (open).	
	D	Active when CN1-10 input signal is OFF (open).	
	E	Active when CN1-11 input signal is OFF (open).	
	F	Active when CN1-12 input signal is OFF (open).	

	/N-CL (Reverse External Torque Limit Input) Signal Allocation		Reference
n.X□□□	0 to F	The allocations are the same as the /P-CL (Forward External Torque Limit Input) signal allocations.	page 6-26

Continued from previous page.

Parameter No.	Size	Name	Setting Range	Setting Unit	Default Setting	Applicable Motors	When Enabled	Classification	Reference
Pn50E (250E hex)	2	Output Signal Selections 1	0000 to 6666	–	0000	All	After restart	Setup	–

	/COIN (Positioning Completion Output) Signal Allocation		Reference
n.□□□X	0	Disabled (the above signal output is not used).	page 6-9
	1	Output the signal from the CN1-1 or CN1-2 output terminal.	
	2	Output the signal from the CN1-23 or CN1-24 output terminal.	
	3	Output the signal from the CN1-25 or CN1-26 output terminal.	
	4 to 6	Reserved setting (Do not use.)	

	/V-CMP (Speed Coincidence Detection Output) Signal Allocation		Reference
n.□□X□	0 to 6	The allocations are the same as the /COIN (Positioning Completion) signal allocations.	page 6-8

	/TGON (Rotation Detection Output) Signal Allocation		Reference
n.□X□□	0 to 6	The allocations are the same as the /COIN (Positioning Completion) signal allocations.	page 6-7

	/S-RDY (Servo Ready) Signal Allocation		Reference
n.X□□□	0 to 6	The allocations are the same as the /COIN (Positioning Completion) signal allocations.	page 6-7

Parameter No.	Size	Name	Setting Range	Setting Unit	Default Setting	Applicable Motors	When Enabled	Classification	Reference
Pn50F (250F hex)	2	Output Signal Selections 2	0000 to 6666	–	0100	All	After restart	Setup	–

	/CLT (Torque Limit Detection Output) Signal Allocation		Reference
n.□□□X	0	Disabled (the above signal output is not used).	page 6-29
	1	Output the signal from the CN1-1 or CN1-2 output terminal.	
	2	Output the signal from the CN1-23 or CN1-24 output terminal.	
	3	Output the signal from the CN1-25 or CN1-26 output terminal.	
	4 to 6	Reserved setting (Do not use.)	

	/VLT (Speed Limit Detection) Signal Allocation		Reference
n.□□X□	0 to 6	The allocations are the same as the /CLT (Torque Limit Detection Output) signal allocations.	page 6-11

	/BK (Brake Output) Signal Allocation		Reference
n.□X□□	0 to 6	The allocations are the same as the /CLT (Torque Limit Detection Output) signal allocations.	page 5-32

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

Continued from previous page.

Parameter No.	Size	Name	Setting Range	Setting Unit	Default Setting	Applicable Motors	When Enabled	Classi-fication	Refer-ence
Pn510 (2510 hex)	2	Output Signal Selections 3	0000 to 0666	–	0000	All	After restart	Setup	–

		/NEAR (Near Output) Signal Allocation	Reference
n.□□□X	0	Disabled (the above signal output is not used).	page 6-10
	1	Output the signal from the CN1-1 or CN1-2 output terminal.	
	2	Output the signal from the CN1-23 or CN1-24 output terminal.	
	3	Output the signal from the CN1-25 or CN1-26 output terminal.	
	4 to 6	Reserved setting (Do not use.)	

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	Applicable Motors	When Enabled	Classi-fication	Refer-ence
Pn511 (2511 hex)	2	Input Signal Selections 5	0000 to FFFF	–	6543	All	After restart	Setup	page 6-3

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

		/Probe1 (Probe 1 Latch Input) Signal Allocation
n.□□X□	4	Active when CN1-10 input signal is ON (closed).
	5	Active when CN1-11 input signal is ON (closed).
	6	Active when CN1-12 input signal is ON (closed).
	7	The signal is always inactive.
	8	The signal is always inactive.
	D	Active when CN1-10 input signal is OFF (open).
	E	Active when CN1-11 input signal is OFF (open).
	F	Active when CN1-12 input signal is OFF (open).

		/Probe2 (Probe 2 Latch Input) Signal Allocation
n.X□□□	0 to F	The allocations are the same as the /Probe1 (Probe 1 Latch Input) signal allocations.

		/Home (Home Switch Input) Signal Allocation
n.X□□□	0 to F	The allocations are the same as the /Probe1 (Probe 1 Latch Input) signal allocations.

Parameter No.	Size	Name	Setting Range	Setting Unit	Default Setting	Applicable Motors	When Enabled	Classi-fication	Refer-ence
Pn512 (2512 hex)	2	Output Signal Inverse Settings	0000 to 1111	–	0000	All	After restart	Setup	page 6-4

		Output Signal Inversion for CN1-1 and CN1-2 Terminals
n.□□□X	0	The signal is not inverted.
	1	The signal is inverted.

		Output Signal Inversion for CN1-23 and CN1-24 Terminals
n.□□X□	0	The signal is not inverted.
	1	The signal is inverted.

		Output Signal Inversion for CN1-25 and CN1-26 Terminals
n.□X□□	0	The signal is not inverted.
	1	The signal is inverted.

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

Continued from previous page.

Parameter No.	Size	Name	Setting Range	Setting Unit	Default Setting	Applicable Motors	When Enabled	Classi-fication	Refer-ence
Pn514 (2514 hex)	2	Output Signal Selections 4	0000 to 0666	–	0000	All	After restart	Setup	–

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

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

	/PM (Preventative Maintenance Output) Signal Allocation		Reference
n.□X□□	0	Disabled (the above signal output is not used).	–
	1	Output the signal from the CN1-1 or CN1-2 output terminal.	
	2	Output the signal from the CN1-23 or CN1-24 output terminal.	
	3	Output the signal from the CN1-25 or CN1-26 output terminal.	
	4 to 6	Reserved setting (Do not use.)	

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

Pn516 (2516 hex)	2	Input Signal Selections 7	0000 to FFFF	–	8888	All	After restart	Setup	–

	FSTP (Forced Stop Input) Signal Allocation	
n.□□□X	0	Enable drive when CN1-13 input signal is ON (closed).
	1	Enable drive when CN1-7 input signal is ON (closed).
	2	Enable drive when CN1-8 input signal is ON (closed).
	3	Enable drive when CN1-9 input signal is ON (closed).
	4	Enable drive when CN1-10 input signal is ON (closed).
	5	Enable drive when CN1-11 input signal is ON (closed).
	6	Enable drive when CN1-12 input signal is ON (closed).
	7	Set the signal to always prohibit drive (always force the motor to stop).
	8	Set the signal to always enable drive (always disable forcing the motor to stop).
	9	Enable drive when CN1-13 input signal is OFF (open).
	A	Enable drive when CN1-7 input signal is OFF (open).
	B	Enable drive when CN1-8 input signal is OFF (open).
	C	Enable drive when CN1-9 input signal is OFF (open).
	D	Enable drive when CN1-10 input signal is OFF (open).
	E	Enable drive when CN1-11 input signal is OFF (open).
	F	Enable drive when CN1-12 input signal is OFF (open).

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

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

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

Pn51B (251B hex)	4	Motor-Load Position Deviation Overflow Detection Level	0 to 1,073,741,824	1 reference unit	1000	Rotary	Immediately	Setup	page 10-8
Pn51E (251E hex)	2	Position Deviation Overflow Warning Level	10 to 100	1%	100	All	Immediately	Setup	page 15-43
Pn520 (2520 hex)	4	Position Deviation Overflow Alarm Level	1 to 1,073,741,823	1 reference unit	5242880	All	Immediately	Setup	page 8-8, page 15-5
Pn522 (2522 hex)	4	Positioning Completed Width	0 to 1,073,741,824	1 reference unit	7	All	Immediately	Setup	page 6-9
Pn524 (2524 hex)	4	Near Signal Width	1 to 1,073,741,824	1 reference unit	1073741824	All	Immediately	Setup	page 6-10

Continued from previous page.

<table>
<tr><th>Parameter No.</th><th>Size</th><th>Name</th><th>Setting Range</th><th>Setting Unit</th><th>Default Setting</th><th>Applicable Motors</th><th>When Enabled</th><th>Classification</th><th>Reference</th></tr>
<tr><td>Pn526 (2526 hex)</td><td>4</td><td>Position Deviation Overflow Alarm Level at Servo ON</td><td>1 to 1,073,741,823</td><td>1 reference unit</td><td>5242880</td><td>All</td><td>Immediately</td><td>Setup</td><td>page 8-8</td></tr>
<tr><td>Pn528 (2528 hex)</td><td>2</td><td>Position Deviation Overflow Warning Level at Servo ON</td><td>10 to 100</td><td>1%</td><td>100</td><td>All</td><td>Immediately</td><td>Setup</td><td>page 8-8</td></tr>
<tr><td>Pn529 (2529 hex)</td><td>2</td><td>Speed Limit Level at Servo ON</td><td>0 to 10,000</td><td>1 min^{-1}</td><td>10000</td><td>Rotary</td><td>Immediately</td><td>Setup</td><td>page 8-8</td></tr>
<tr><td>Pn52A (252A hex)</td><td>2</td><td>Multiplier per Fully-closed Rotation</td><td>0 to 100</td><td>1%</td><td>20</td><td>Rotary</td><td>Immediately</td><td>Tuning</td><td>page 10-8</td></tr>
<tr><td>Pn52B (252B hex)</td><td>2</td><td>Overload Warning Level</td><td>1 to 100</td><td>1%</td><td>20</td><td>All</td><td>Immediately</td><td>Setup</td><td>page 5-40</td></tr>
<tr><td>Pn52C (252C hex)</td><td>2</td><td>Base Current Derating at Motor Overload Detection</td><td>10 to 100</td><td>1%</td><td>100</td><td>All</td><td>After restart</td><td>Setup</td><td>page 5-40</td></tr>
<tr><td>Pn52D (252D hex)</td><td>2</td><td>Reserved parameter (Do not change.)</td><td>–</td><td>–</td><td>50</td><td>All</td><td>–</td><td>–</td><td>–</td></tr>
<tr><td rowspan="2">Pn530 (2530 hex)</td><td>2</td><td>Program Jogging-Related Selections</td><td>0000 to 0005</td><td>–</td><td>0000</td><td>All</td><td>Immediately</td><td>Setup</td><td>page 7-13</td></tr>
<tr><td colspan="9">
<table>
<tr><td rowspan="7">n.□□□X</td><td colspan="2">Program Jogging Operation Pattern</td></tr>
<tr><td>0</td><td>(Waiting time in Pn535 → Forward by travel distance in Pn531) × Number of movements in Pn536</td></tr>
<tr><td>1</td><td>(Waiting time in Pn535 → Reverse by travel distance in Pn531) × Number of movements in Pn536</td></tr>
<tr><td>2</td><td>(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</td></tr>
<tr><td>3</td><td>(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</td></tr>
<tr><td>4</td><td>(Waiting time in Pn535 → Forward by travel distance in Pn531 → Waiting time in Pn535 → Reserve by travel distance in Pn531) × Number of movements in Pn536</td></tr>
<tr><td>5</td><td>(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</td></tr>
<tr><td>n.□□X□</td><td colspan="2">Reserved parameter (Do not change.)</td></tr>
<tr><td>n.□X□□</td><td colspan="2">Reserved parameter (Do not change.)</td></tr>
<tr><td>n.X□□□</td><td colspan="2">Reserved parameter (Do not change.)</td></tr>
</table>
</td></tr>
<tr><td>Pn531 (2531 hex)</td><td>4</td><td>Program Jogging Travel Distance</td><td>1 to 1,073,741,824</td><td>1 reference unit</td><td>32768</td><td>All</td><td>Immediately</td><td>Setup</td><td>page 7-13</td></tr>
<tr><td>Pn533 (2533 hex)</td><td>2</td><td>Program Jogging Movement Speed</td><td>1 to 10,000</td><td>Rotary: 1 min^{-1}
Direct Drive: 0.1 min^{-1}</td><td>500</td><td>Rotary</td><td>Immediately</td><td>Setup</td><td>page 7-13</td></tr>
<tr><td>Pn534 (2534 hex)</td><td>2</td><td>Program Jogging Acceleration/Deceleration Time</td><td>2 to 10,000</td><td>1 ms</td><td>100</td><td>All</td><td>Immediately</td><td>Setup</td><td>page 7-13</td></tr>
<tr><td>Pn535 (2535 hex)</td><td>2</td><td>Program Jogging Waiting Time</td><td>0 to 10,000</td><td>1 ms</td><td>100</td><td>All</td><td>Immediately</td><td>Setup</td><td>page 7-13</td></tr>
<tr><td>Pn536 (2536 hex)</td><td>2</td><td>Program Jogging Number of Movements</td><td>0 to 1,000</td><td>Times</td><td>1</td><td>All</td><td>Immediately</td><td>Setup</td><td>page 7-13</td></tr>
<tr><td>Pn548 (2548 hex)</td><td>2</td><td>Specified Alarm Number for Tracing</td><td>0000 to FFFF</td><td>–</td><td>0000</td><td>All</td><td>Immediately</td><td>Setup</td><td>–</td></tr>
</table>

Continued from previous page.

Parameter No.	Size	Name	Setting Range	Setting Unit	Default Setting	Applicable Motors	When Enabled	Classi-fication	Refer-ence
Pn550 (2550 hex)	2	Analog Monitor 1 Offset Voltage	-10,000 to 10,000	0.1 V	0	All	Immedi-ately	Setup	page 9-6
Pn551 (2551 hex)	2	Analog Monitor 2 Offset Voltage	-10,000 to 10,000	0.1 V	0	All	Immedi-ately	Setup	page 9-6
Pn552 (2552 hex)	2	Analog Monitor 1 Magnification	-10,000 to 10,000	× 0.01	100	All	Immedi-ately	Setup	page 9-6
Pn553 (2553 hex)	2	Analog Monitor 2 Magnification	-10,000 to 10,000	× 0.01	100	All	Immedi-ately	Setup	page 9-6
Pn55A (255A hex)	2	Power Consumption Monitor Unit Time	1 to 1,440	1 min	1	All	Immedi-ately	Setup	–
Pn560 (2560 hex)	2	Residual Vibration Detection Width	1 to 3,000	0.1%	400	All	Immedi-ately	Setup	page 8-55
Pn561 (2561 hex)	2	Overshoot Detection Level	0 to 100	1%	100	All	Immedi-ately	Setup	page 8-22, page 8-33
Pn581 (2581 hex)	2	Zero Speed Level	1 to 10,000	1 mm/s	20	Linear	Immedi-ately	Setup	page 6-7
Pn582 (2582 hex)	2	Speed Coincidence Detection Signal Output Width	0 to 100	1 mm/s	10	Linear	Immedi-ately	Setup	page 6-8
Pn583 (2583 hex)	2	Brake Reference Output Speed Level	0 to 10,000	1 mm/s	10	Linear	Immedi-ately	Setup	page 5-32
Pn584 (2584 hex)	2	Speed Limit Level at Servo ON	0 to 10,000	1 mm/s	10000	Linear	Immedi-ately	Setup	page 8-8
Pn585 (2585 hex)	2	Program Jogging Movement Speed	1 to 10,000	1 mm/s	50	Linear	Immedi-ately	Setup	page 7-13
Pn586 (2586 hex)	2	Motor Running Cooling Ratio	0 to 100	1%/ Max. speed	0	Linear	Immedi-ately	Setup	–
Pn587 (2587 hex)	2	Polarity Detection Execution Selection for Absolute Linear Encoder	0000 to 0001	–	0000	Linear	Immedi-ately	Setup	–

n.□□□X	Polarity Detection Selection for Absolute Linear Encoder	
	0	Do not detect polarity.
	1	Detect polarity.

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	Applicable Motors	When Enabled	Classi-fication	Refer-ence
Pn600 (2600 hex)	2	Regenerative Resistor Capacity[*2]	Depends on model.[*3]	10 W	0	All	Immedi-ately	Setup	page 5-55
Pn601 (2601 hex)	2	Dynamic Brake Resistor Capacity	Depends on model.[*3]	10 W	0	All	Immedi-ately	Setup	–
Pn603 (2603 hex)	2	Regenerative Resistance	0 to 65,535	10 mΩ	0	All	Immedi-ately	Setup	page 5-55
Pn604 (2604 hex)	2	Dynamic Brake Resistance	0 to 65,535	10 mΩ	0	All	Immedi-ately	Setup	–
Pn621 (2621 hex) to Pn628 (2628 hex)[*4]	–	Safety Module-Related Parameters	–	–	–	All	–	–	–

*1. Set a percentage of the motor rated torque.

*2. Normally set this parameter to 0. If you use an External Regenerative Resistor, set the capacity (W) of the External Regenerative Resistor.

*3. The upper limit is the maximum output capacity (W) of the SERVOPACK.

*4. These parameters are for SERVOPACKs with a Safety Module.

*5. These parameters do not function for EtherCAT (CoE).

16.2 Object List

Index	Subindex	Name	Data Type	Access	PDO Mapping	Saving to EEPROM[*1]	Default Value	Lower Limit	Upper Limit	Unit	Parameter No.[*2]
1000 hex	0	Device type	UDINT	RO	No	No	0x00020192	–	–	–	–
1001 hex	0	Error register	USINT	RO	No	No	–	–	–	–	–
1008 hex	0	Manufacturer device name	STRING	RO	No	No	–	–	–	–	–
100A hex	0	Manufacturer software version	STRING	RO	No	No	–	–	–	–	–
1010 hex	Store parameters										
	0	Largest subindex supported	USINT	RO	No	No	4	–	–	–	–
	1	Save all parameters	UDINT	RW	No	No	0x00000001	0x00000000	0xFFFFFFFF	–	PnC00[*3]
	2	Save communication parameters	UDINT	RW	No	No	0x00000001	0x00000000	0xFFFFFFFF	–	PnC02[*3]
	3	Save application parameters	UDINT	RW	No	No	0x00000001	0x00000000	0xFFFFFFFF	–	PnC04[*3]
	4	Save manufacturer defined parameters	UDINT	RW	No	No	0x00000001	0x00000000	0xFFFFFFFF	–	PnC06[*3]
1011 hex	Restore default parameters										
	0	Largest subindex supported	USINT	RO	No	No	4	–	–	–	–
	1	Restore all default parameters	UDINT	RW	No	No	0x00000001	0x00000000	0xFFFFFFFF	–	PnC08[*3]
	2	Restore communication default parameters	UDINT	RW	No	No	0x00000001	0x00000000	0xFFFFFFFF	–	PnC0A[*3]
	3	Restore application default parameters	UDINT	RW	No	No	0x00000001	0x00000000	0xFFFFFFFF	–	PnC0C[*3]
	4	Restore manufacturer defined default parameters	UDINT	RW	No	No	0x00000001	0x00000000	0xFFFFFFFF	–	PnC0E[*3]
1018 hex	Identity object										
	0	Number of entries	USINT	RO	No	No	4	–	–	–	–
	1	Vendor ID	UDINT	RO	No	No	0x539	–	–	–	–
	2	Product code	UDINT	RO	No	No	0x0220000[*4]	–	–	–	–
	3	Revision number	UDINT	RO	No	No	–	–	–	–	–
	4	Serial number	UDINT	RO	No	No	0	–	–	–	–
10F1 hex	Sync error settings										
	0	Number of entries	USINT	RO	No	No	2	–	–	–	–
	1	Reserved	UDINT	RO	No	No	0	–	–	–	–
	2	Sync error count limit	UDINT	RW	No	No	9	0	15	–	PnCCC
1600 hex	1st receive PDO mapping										
	0	Number of objects in this PDO	USINT	RW	No	Yes	8	0	8	–	PnCA0
	1	Mapping entry 1	UDINT	RW	No	Yes	0x60400010	0	0xFFFFFFFF	–	PnC20
	2	Mapping entry 2	UDINT	RW	No	Yes	0x607A0020	0	0xFFFFFFFF	–	PnC22
	3	Mapping entry 3	UDINT	RW	No	Yes	0x60FF0020	0	0xFFFFFFFF	–	PnC24
	4	Mapping entry 4	UDINT	RW	No	Yes	0x60710010	0	0xFFFFFFFF	–	PnC26
	5	Mapping entry 5	UDINT	RW	No	Yes	0x60720010	0	0xFFFFFFFF	–	PnC28
	6	Mapping entry 6	UDINT	RW	No	Yes	0x60600008	0	0xFFFFFFFF	–	PnC2A
	7	Mapping entry 7	UDINT	RW	No	Yes	0x00000008	0	0xFFFFFFFF	–	PnC2C
	8	Mapping entry 8	UDINT	RW	No	Yes	0x60B80010	0	0xFFFFFFFF	–	PnC2E

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Index	Subindex	Name	Data Type	Access	PDO Mapping	Saving to EEPROM*1	Default Value	Lower Limit	Upper Limit	Unit	Parameter No.*2
1601 hex	2nd receive PDO mapping										
	0	Number of objects in this PDO	USINT	RW	No	Yes	2	0	8	–	PnCA1
	1	Mapping entry 1	UDINT	RW	No	Yes	0x60400010	0	0xFFFFFFFF	–	PnC30
	2	Mapping entry 2	UDINT	RW	No	Yes	0x607A0020	0	0xFFFFFFFF	–	PnC32
	3	Mapping entry 3	UDINT	RW	No	Yes	0	0	0xFFFFFFFF	–	PnC34
	4	Mapping entry 4	UDINT	RW	No	Yes	0	0	0xFFFFFFFF	–	PnC36
	5	Mapping entry 5	UDINT	RW	No	Yes	0	0	0xFFFFFFFF	–	PnC38
	6	Mapping entry 6	UDINT	RW	No	Yes	0	0	0xFFFFFFFF	–	PnC3A
	7	Mapping entry 7	UDINT	RW	No	Yes	0	0	0xFFFFFFFF	–	PnC3C
	8	Mapping entry 8	UDINT	RW	No	Yes	0	0	0xFFFFFFFF	–	PnC3E
1602 hex	3rd receive PDO mapping										
	0	Number of objects in this PDO	USINT	RW	No	Yes	2	0	8	–	PnCA2
	1	Mapping entry 1	UDINT	RW	No	Yes	0x60400010	0	0xFFFFFFFF	–	PnC40
	2	Mapping entry 2	UDINT	RW	No	Yes	0x60FF0020	0	0xFFFFFFFF	–	PnC42
	3	Mapping entry 3	UDINT	RW	No	Yes	0	0	0xFFFFFFFF	–	PnC44
	4	Mapping entry 4	UDINT	RW	No	Yes	0	0	0xFFFFFFFF	–	PnC46
	5	Mapping entry 5	UDINT	RW	No	Yes	0	0	0xFFFFFFFF	–	PnC48
	6	Mapping entry 6	UDINT	RW	No	Yes	0	0	0xFFFFFFFF	–	PnC4A
	7	Mapping entry 7	UDINT	RW	No	Yes	0	0	0xFFFFFFFF	–	PnC4C
	8	Mapping entry 8	UDINT	RW	No	Yes	0	0	0xFFFFFFFF	–	PnC4E
1603 hex	4th receive PDO mapping										
	0	Number of objects in this PDO	USINT	RW	No	Yes	2	0	8	–	PnCA3
	1	Mapping entry 1	UDINT	RW	No	Yes	0x60400010	0	0xFFFFFFFF	–	PnC50
	2	Mapping entry 2	UDINT	RW	No	Yes	0x60710010	0	0xFFFFFFFF	–	PnC52
	3	Mapping entry 3	UDINT	RW	No	Yes	0	0	0xFFFFFFFF	–	PnC54
	4	Mapping entry 4	UDINT	RW	No	Yes	0	0	0xFFFFFFFF	–	PnC56
	5	Mapping entry 5	UDINT	RW	No	Yes	0	0	0xFFFFFFFF	–	PnC58
	6	Mapping entry 6	UDINT	RW	No	Yes	0	0	0xFFFFFFFF	–	PnC5A
	7	Mapping entry 7	UDINT	RW	No	Yes	0	0	0xFFFFFFFF	–	PnC5C
	8	Mapping entry 8	UDINT	RW	No	Yes	0	0	0xFFFFFFFF	–	PnC5E
1A00 hex	1st transmit PDO mapping										
	0	Number of objects in this PDO	USINT	RW	No	Yes	8	0	8	–	PnCA4
	1	Mapping entry 1	UDINT	RW	No	Yes	0x60410010	0	0xFFFFFFFF	–	PnC60
	2	Mapping entry 2	UDINT	RW	No	Yes	0x60640020	0	0xFFFFFFFF	–	PnC62
	3	Mapping entry 3	UDINT	RW	No	Yes	0x60770010	0	0xFFFFFFFF	–	PnC64
	4	Mapping entry 4	UDINT	RW	No	Yes	0x60F40020	0	0xFFFFFFFF	–	PnC66
	5	Mapping entry 5	UDINT	RW	No	Yes	0x60610008	0	0xFFFFFFFF	–	PnC68
	6	Mapping entry 6	UDINT	RW	No	Yes	0x00000008	0	0xFFFFFFFF	–	PnC6A
	7	Mapping entry 7	UDINT	RW	No	Yes	0x60B90010	0	0xFFFFFFFF	–	PnC6C
	8	Mapping entry 8	UDINT	RW	No	Yes	0x60BA0020	0	0xFFFFFFFF	–	PnC6E
1A01 hex	2nd transmit PDO mapping										
	0	Number of objects in this PDO	USINT	RW	No	Yes	2	0	8	–	PnCA5
	1	Mapping entry 1	UDINT	RW	No	Yes	0x60410010	0	0xFFFFFFFF	–	PnC70
	2	Mapping entry 2	UDINT	RW	No	Yes	0x60640020	0	0xFFFFFFFF	–	PnC72
	3	Mapping entry 3	UDINT	RW	No	Yes	0	0	0xFFFFFFFF	–	PnC74
	4	Mapping entry 4	UDINT	RW	No	Yes	0	0	0xFFFFFFFF	–	PnC76
	5	Mapping entry 5	UDINT	RW	No	Yes	0	0	0xFFFFFFFF	–	PnC78
	6	Mapping entry 6	UDINT	RW	No	Yes	0	0	0xFFFFFFFF	–	PnC7A
	7	Mapping entry 7	UDINT	RW	No	Yes	0	0	0xFFFFFFFF	–	PnC7C
	8	Mapping entry 8	UDINT	RW	No	Yes	0	0	0xFFFFFFFF	–	PnC7E

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Index	Subindex	Name	Data Type	Access	PDO Mapping	Saving to EEPROM*1	Default Value	Lower Limit	Upper Limit	Unit	Parameter No.*2
1A02 hex	3rd transmit PDO mapping										
	0	Number of objects in this PDO	USINT	RW	No	Yes	2	0	8	–	PnCA6
	1	Mapping entry 1	UDINT	RW	No	Yes	0x60410010	0	0xFFFFFFFF	–	PnC80
	2	Mapping entry 2	UDINT	RW	No	Yes	0x60640020	0	0xFFFFFFFF	–	PnC82
	3	Mapping entry 3	UDINT	RW	No	Yes	0	0	0xFFFFFFFF	–	PnC84
	4	Mapping entry 4	UDINT	RW	No	Yes	0	0	0xFFFFFFFF	–	PnC86
	5	Mapping entry 5	UDINT	RW	No	Yes	0	0	0xFFFFFFFF	–	PnC88
	6	Mapping entry 6	UDINT	RW	No	Yes	0	0	0xFFFFFFFF	–	PnC8A
	7	Mapping entry 7	UDINT	RW	No	Yes	0	0	0xFFFFFFFF	–	PnC8C
	8	Mapping entry 8	UDINT	RW	No	Yes	0	0	0xFFFFFFFF	–	PnC8E
1A03 hex	4th transmit PDO mapping										
	0	Number of objects in this PDO	USINT	RW	No	Yes	3	0	8	–	PnCA7
	1	Mapping entry 1	UDINT	RW	No	Yes	0x60410010	0	0xFFFFFFFF	–	PnC90
	2	Mapping entry 2	UDINT	RW	No	Yes	0x60640020	0	0xFFFFFFFF	–	PnC92
	3	Mapping entry 3	UDINT	RW	No	Yes	0x60770010	0	0xFFFFFFFF	–	PnC94
	4	Mapping entry 4	UDINT	RW	No	Yes	0	0	0xFFFFFFFF	–	PnC96
	5	Mapping entry 5	UDINT	RW	No	Yes	0	0	0xFFFFFFFF	–	PnC98
	6	Mapping entry 6	UDINT	RW	No	Yes	0	0	0xFFFFFFFF	–	PnC9A
	7	Mapping entry 7	UDINT	RW	No	Yes	0	0	0xFFFFFFFF	–	PnC9C
	8	Mapping entry 8	UDINT	RW	No	Yes	0	0	0xFFFFFFFF	–	PnC9E
1C00 hex	Sync Manager communication type										
	0	Number of used Sync Manager channels	USINT	RO	No	No	4	–	–	–	–
	1	Communication type sync manager 0	USINT	RO	No	No	1	–	–	–	PnCB0
	2	Communication type sync manager 1	USINT	RO	No	No	2	–	–	–	PnCB1
	3	Communication type sync manager 2	USINT	RO	No	No	3	–	–	–	PnCB2
	4	Communication type sync manager 3	USINT	RO	No	No	4	–	–	–	PnCB3
1C10 hex	0	Sync Manager PDO assignment 0	USINT	RO	No	No	0	–	–	–	–
1C11 hex	0	Sync Manager PDO assignment 1	USINT	RO	No	No	0	–	–	–	–
1C12 hex	Sync Manager PDO assignment 2										
	0	Number of assigned PDOs	USINT	RW	No	Yes	1	0	2	–	PnCB5
	1	Index of assigned RxPDO 1	UINT	RW	No	Yes	0x1601	0x1600	0x1603	–	PnCB6
	2	Index of assigned RxPDO 2	UINT	RW	No	Yes	0x1600	0x1600	0x1603	–	PnCB7
1C13 hex	Sync Manager PDO assignment 3										
	0	Number of assigned PDOs	USINT	RW	No	Yes	1	0	2	–	PnCBB
	1	Index of assigned TxPDO 1	UINT	RW	No	Yes	0x1A01	0x1A00	0x1A03	–	PnCBC
	2	Index of assigned TxPDO 2	UINT	RW	No	Yes	0x1A00	0x1A00	0x1A03	–	PnCBD

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Index	Subindex	Name	Data Type	Access	PDO Mapping	Saving to EEPROM*1	Default Value	Lower Limit	Upper Limit	Unit	Parameter No.*2
1C32 hex	Sync Manager 2 (process data output) synchronization										
	0	Number of synchronization parameters	USINT	RO	No	No	10	–	–	–	–
	1	Synchronization type	UINT	RO	No	No	–	–	–	–	PnCC0
	2	Cycle time	UDINT	RO	No	No	–	–	–	–	PnCC2
	3	Shift time	UDINT	RO	No	No	125000	–	–	–	PnCC4
	4	Synchronization types supported	UINT	RO	No	No	0x0005	–	–	–	–
	5	Minimum cycle time	UDINT	RO	No	No	62500	–	–	–	–
	6	Calc and copy time	UDINT	RO	No	No	62500	–	–	–	–
	7	Reserved	UDINT	RO	No	No	0	–	–	–	–
	8	Reserved	UINT	RO	No	No	0	–	–	–	–
	9	Delay time	UDINT	RO	No	No	0	–	–	–	–
	10	Sync0 cycle time	UDINT	RO	No	No	–	–	–	–	PnCC6
	11	Reserved	UDINT	RO	No	No	0				–
	12	SM2 event miss count	UDINT	RO	No	No	–				PnCC8
1C33 hex	Sync Manager 3 (process data input) synchronization										
	0	Number of synchronization parameters	USINT	RO	No	No	10	–	–	–	–
	1	Synchronization type	UINT	RO	No	No	–	–	–	–	–
	2	Cycle time	UDINT	RO	No	No	–	–	–	–	–
	3	Shift time	UDINT	RW	No	Yes	0	0	Sync0 event cycle - 12,500	–	PnCCA
	4	Synchronization types supported	UINT	RO	No	No	0x0025	–	–	–	–
	5	Minimum cycle time	UDINT	RO	No	No	62500	–	–	–	–
	6	Calc and copy time	UDINT	RO	No	No	62500	–	–	–	–
	7	Reserved	UDINT	RO	No	No	0	–	–	–	–
	8	Reserved	UINT	RO	No	No	0	–	–	–	–
	9	Delay time	UDINT	RO	No	No	0	–	–	–	–
	10	Sync0 cycle time	UDINT	RO	No	No	–	–	–	–	–
2000 hex to 26FF hex	0	SERVOPACK parameters (Pn000 (2000 hex) to Pn6FF (26FF hex))	–	–	-	-	–	–	–	–	Pn000 – Pn6FF
2700 hex	0	User parameter Configuration	UDINT	RW	No	No	0	0	0xFFFFFFFF	–	PnB00
2701 hex	Position user unit										
	0	Number of entries	USINT	RO	No	No	2	–	–	–	–
	1	Numerator	UDINT	RW	No	Yes	1	1	1073741823	–	PnB02
	2	Denominator	UDINT	RW	No	Yes	1	1	1073741823	–	PnB04
2702 hex	Velocity user unit										
	0	Number of entries	USINT	RO	No	No	2	–	–	–	–
	1	Numerator	UDINT	RW	No	Yes	1	1	1073741823	–	PnB06
	2	Denominator	UDINT	RW	No	Yes	1	1	1073741823	–	PnB08
2703 hex	Acceleration user unit										
	0	Number of entries	USINT	RO	No	No	2	–	–	–	–
	1	Numerator	UDINT	RW	No	Yes	1	1	1073741823	–	PnB0A
	2	Denominator	UDINT	RW	No	Yes	1	1	1073741823	–	PnB0C
2704 hex	Torque user unit										
	0	Number of entries	USINT	RO	No	No	2	–	–	–	–
	1	Numerator	UDINT	RW	No	Yes	1	1	1073741823	–	PnB94
	2	Denominator	UDINT	RW	No	Yes	10	1	1073741823	–	PnB96

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Index	Subindex	Name	Data Type	Access	PDO Mapping	Saving to EEPROM[*1]	Default Value	Lower Limit	Upper Limit	Unit	Parameter No.[*2]
2710 hex	SERVOPACK adjusting command										
	0	Number of entries	USINT	RO	No	No	3	–	–	–	–
	1	Command	STRING	RW	No	No	0	0	0xFF	–	–
	2	Status	USINT	RO	No	No	–	–	–	–	–
	3	Reply	STRING	RO	No	No	–	–	–	–	–
2720 hex	0	Safety Module monitor	UDINT	RO	Yes	No	–	–	–	–	–
2730 hex	Interpolation data configuration for 1st profile										
	0	Number of entries	USINT	RO	No	No	9	–	–	–	–
	1	Maximum buffer size	UDINT	RO	No	No	254	–	–	–	–
	2	Actual buffer size	UDINT	RW	No	No	254	–	–	–	–
	3	Buffer organization	USINT	RW	No	No	0	0	1	–	PnCEC
	4	Buffer position	UINT	RW	Yes	No	1	1	255		PnCED
	5	Size of data record	USINT	WO	No	No	1	1	1		–
	6	Buffer clear	USINT	WO	No	No	0	0	1		–
	7	Position data definition	USINT	RW	Yes	No	1	0	1		PnCEE
	8	Position data polarity	USINT	RW	Yes	No	0	0	1		PnCEF
	9	Behavior after reaching buffer position	USINT	RW	Yes	No	0	0	1		PnCF0
2731 hex	Interpolation data configuration for 2nd profile										
	0	Number of entries	USINT	RO	No	No	9	–	–		–
	1	Maximum buffer size	UDINT	RO	No	No	254	–	–		–
	2	Actual buffer size	UDINT	RW	No	No	254	–	–		–
	3	Buffer organization	USINT	RW	No	No	0	0	1		PnCF1
	4	Buffer position	UINT	RW	Yes	No	1	1	255		PnCF2
	5	Size of data record	USINT	WO	No	No	1	1	1		–
	6	Buffer clear	USINT	WO	No	No	0	0	1		–
	7	Position data definition	USINT	RW	Yes	No	1	0	1		PnCF3
	8	Position data polarity	USINT	RW	Yes	No	0	0	1		PnCF4
	9	Behavior after reaching buffer position	USINT	RW	Yes	No	0	0	1		PnCF5
2732 hex	0	Interpolation profile select	USINT	RW	Yes	No	0	0	1	–	PnCF6
2741 hex	Interpolation data read/write pointer position monitor										
	0	Number of entries	UINT	RO	No	No	2	–	–	–	–
	1	Interpolation data read pointer position	UINT	RO	Yes	No	–	1	254	–	PnCF7
	2	Interpolation data write pointer position	UINT	RO	Yes	No	–	1	254	–	PnCF8
27C0 hex	Interpolation data record for 1st profile										
	0	Number of entries	DINT	RO	No	No	254	–	–	–	–
	1 to 254	1st set-point to 254 set-point	DINT	RW	No	No	0	-2147483648	2147483647	–	–
27C1 hex	Interpolation data record for 2nd profile										
	0	Number of entries	DINT	RO	No	No	254	–	–	–	–
	1 to 254	1st set-point to 254 set-point	DINT	RW	No	No	0	-2147483648	2147483647	–	–
27E0 hex	–	Diag.mode	UINT	RW	No	No	0	0	0xFFFF	–	PnCFE
603F hex	0	Error code	UINT	RO	Yes	No	–	–	–	–	PnB10
6040 hex	0	Controlword	UINT	RW	Yes	No	0	0	0xFFFF	–	PnB11
6041 hex	0	Statusword	UINT	RO	Yes	No	–	–	–	–	PnB12
605A hex	0	Quick stop option code	INT	RW	No	Yes	2	0	4	–	PnB13
605B hex	0	Shutdown option code	INT	RW	No	Yes	0	0	1	–	PnB14

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Index	Subindex	Name	Data Type	Access	PDO Mapping	Saving to EEPROM[*1]	Default Value	Lower Limit	Upper Limit	Unit	Parameter No.[*2]
605C hex	0	Disable operation option code	INT	RW	No	Yes	1	0	1	–	PnB15
605D hex	0	Halt option code	INT	RW	No	Yes	1	0	4	–	PnB16
605E hex	0	Fault reaction option code	INT	RW	No	Yes	0	0	0	–	PnB17
6060 hex	0	Modes of operation	SINT	RW	Yes	Yes	0	0	10	–	PnB18
6061 hex	0	Modes of operation display	SINT	RO	Yes	No	0	–	–	–	PnB19
6062 hex	0	Position demand value	DINT	RO	Yes	No	–	–	–	Pos. unit	PnB20
6063 hex	0	Position actual internal value	DINT	RO	Yes	No	–	–	–	Inc	PnB22
6064 hex	0	Position actual value	DINT	RO	Yes	No	–	–	–	Pos. unit	PnB24
6065 hex	0	Following error window	UDINT	RW	No	Yes	5242880	0	1073741823	Pos. unit	PnB26
6066 hex	0	Following error time out	UINT	RW	No	Yes	0	0	65535	ms	PnB28
6067 hex	0	Position window	UDINT	RW	No	Yes	30	0	1073741823	Pos. unit	PnB2A
6068 hex	0	Position window time	UINT	RW	No	Yes	0	0	65535	ms	PnB2C
606B hex	0	Velocity demand value	DINT	RO	Yes	No	–	–	–	Vel. Unit	PnB2E
606C hex	0	Velocity actual value	DINT	RO	Yes	No	–	–	–	Vel. Unit	PnB30
606D hex	0	Velocity window	UINT	RW	No	Yes	20000	0	65535	Vel. Unit	PnB32
606E hex	0	Velocity window time	UINT	RW	No	Yes	0	0	65535	ms	PnB34
6071 hex	0	Target torque	INT	RW	Yes	No	0	–32768	32767	0.1 %	PnB36
6072 hex	0	Max torque	UINT	RW	Yes	No	Motor max torque	0	65535	0.1 %	PnB38
6074 hex	0	Max current	INT	RO	Yes	No	–	–	–	0.1 %	PnB3A
6076 hex	0	Motor rated torque	UDINT	RO	No	No	–	–	–	mNm, mN	PnB3C
6077 hex	0	Torque actual value	INT	RO	Yes	No	–	–	–	0.1 %	PnB3E
607A hex	0	Target position	DINT	RW	Yes	No	0	–2147483648	2147483647	Pos. unit	PnB40
607C hex	–	Home offset	DINT	RW	No	Yes	0	–536870912	536870911	Pos. unit	PnB46
607D hex	Software position limit										
	0	Number of entries	USINT	RO	No	No	2	–	–	–	–
	1	Min position limit	DINT	RW	No	Yes	0	–536870912	536870911	Pos. unit	PnB48
	2	Max position limit	DINT	RW	No	Yes	0	–536870912	536870911	Pos. unit	PnB4A
607F hex	0	Max profile velocity	UDINT	RW	Yes	Yes	2147483647	0	4294967295	Vel. Unit	PnB4C
6081 hex	0	Profile velocity	UDINT	RW	Yes	Yes	0	0	4294967295	Vel. Unit	PnB4E
6083 hex	0	Profile acceleration	UDINT	RW	Yes	Yes	1000	0	4294967295	Acc. Unit	PnB50
6084 hex	0	Profile deceleration	UDINT	RW	Yes	Yes	1000	0	4294967295	Acc. Unit	PnB52
6085 hex	0	Quick stop deceleration	UDINT	RW	Yes	Yes	1000	0	4294967295	Acc. Unit	PnB54
6087 hex	0	Torque slope	UDINT	RW	Yes	Yes	1000	0	4294967295	0.1 %/s	PnB56
6098 hex	0	Homing method	SINT	RW	Yes	No	35	0	35	–	PnB58

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Index	Subindex	Name	Data Type	Access	PDO Mapping	Saving to EEPROM[*1]	Default Value	Lower Limit	Upper Limit	Unit	Parameter No.[*2]
6099 hex	Homing speeds										
	0	Number of entries	USINT	RO	No	No	2	–	–	–	–
	1	Speed during search for switch	UDINT	RW	Yes	Yes	500000	0	4294967295	Vel. Unit	PnB5A
	2	Speed during search for zero	UDINT	RW	Yes	Yes	100000	0	4294967295	Vel. Unit	PnB5C
609A hex	0	Homing acceleration	UDINT	RW	Yes	Yes	1000	0	4294967295	Acc. Unit	PnB5E
60B1 hex	0	Velocity offset	DINT	RW	Yes	No	0	–2147483648	2147483647	Vel. Unit	PnB60
60B2 hex	0	Torque offset	INT	RW	Yes	No	0	–32768	32767	0.1 %	PnB62
60B8 hex	0	Touch probe function	UINT	RW	Yes	No	0	0	0xFFFF	–	PnB64
60B9 hex	0	Touch probe status	UINT	RO	Yes	No	–	–	–	–	PnB66
60BA hex	0	Touch probe pos1 pos value	DINT	RO	Yes	No	–	–	–	Pos. unit	PnB68
60BC hex	0	Touch probe pos2 pos value	DINT	RO	Yes	No	–	–	–	Pos. unit	PnB6A
60C0 hex	0	Interpolation sub mode select	INT	RW	No	No	0	-3	0	–	PnB92
60C1 hex	Interpolation data record										
	0	Number of entries	USINT	RO	No	No	1	–	–	–	–
	1	Interpolation data record	DINT	RW	Yes	No	0	–2147483648	2147483647	Pos. unit	PnB70
60C2 hex	Interpolation time period										
	0	Number of entries	USINT	RO	No	No	2	–	–	–	–
	1	Interpolation time period	USINT	RW	No	No	125	1	250	–	PnB6E
	2	Interpolation time index	SINT	RW	No	No	–6	–6	–3	–	PnB6F
60E0 hex	0	Positive torque limit value	UINT	RW	Yes	Yes	8000	0	65535	0.1 %	PnB80
60E1 hex	0	Negative torque limit value	UINT	RW	Yes	Yes	8000	0	65535	0.1 %	PnB82
60E4 hex	0	Number of entries	UINT	RO	No	No	1	–	–	–	–
	1	External encoder position	INT	RO	Yes	Yes	0	–	–	–	–
60F4 hex	0	Following error actual value	DINT	RO	Yes	No	–	–	–	Pos. unit	PnB84
60FC hex	0	Position demand internal value	DINT	RO	Yes	No	–	–	–	Inc	PnB86
60FD hex	0	Digital inputs	UDINT	RO	Yes	No	–	–	–	–	PnB88
60FE hex	Digital outputs										
	0	Number of entries	USINT	RO	No	No	2	–	–	–	–
	1	Physical outputs	UDINT	RW	Yes	No	0	0	0xFFFFFFFF	–	PnB8A
	2	Bit mask	UDINT	RW	No	Yes	0x000C0000	0	0xFFFFFFFF	–	PnB8C
60FF hex	0	Target velocity	DINT	RW	Yes	No	0	–2147483648	2147483647	Vel. Unit	PnB8E
6502 hex	0	Supported drive modes	UDINT	RO	No	No	0x03ED	–	–	–	PnB90

[*1] Write “Save” to object 1010 hex to save all of the current parameter data to EEPROM.
If the objects are modified by the Digital Operator or SigmaWin+, the data will be directly saved in EEPROM.

[*2] The parameter numbers given in the table are the parameter numbers that are used with the Digital Operator and SigmaWin+.

[*3] These parameters cannot be written by the Digital Operator.

[*4] For SGD7S-□□□□E0: 0x02200001.

16.3 SDO Abort Code List

The following table gives the SDO abort codes for SDO communications errors.

Value	Meaning
0x05 03 00 00	Toggle bit did not change.
0x05 04 00 00	SDO protocol timeout
0x05 04 00 01	Client/server command specifier is not valid or is unknown.
0x05 04 00 05	Out of memory
0x06 01 00 00	Unsupported access to an object
0x06 01 00 01	Attempt to read to a write-only object
0x06 01 00 02	Attempt to write to a read-only object
0x06 02 00 00	The object does not exist in the object directory.
0x06 04 00 41	The object cannot be mapped to the PDO.
0x06 04 00 42	The number and length of the objects to be mapped would exceed the PDO length.
0x06 04 00 43	General parameter incompatibility
0x06 04 00 47	General internal incompatibility in the device
0x06 06 00 00	Access failed due to a hardware error.
0x06 07 00 10	Data type does not match: length of service parameter does not match.
0x06 07 00 12	Data type does not match: service parameter too long.
0x06 07 00 13	Data type does not match: service parameter too short.
0x06 09 00 11	Subindex does not exist.
0x06 09 00 30	Value range of parameter was exceeded (only for write access).
0x06 09 00 31	Value of parameter that was written is too high.
0x06 09 00 32	Value of parameter that was written is too low.
0x06 09 00 36	The maximum value is less than the minimum value.
0x08 00 00 00	General error
0x08 00 00 20	Data cannot be transferred or stored to the application.
0x08 00 00 21	Data cannot be transferred or stored to the application because of local control.
0x08 00 00 22	Data cannot be transferred or stored to the application because of the present device state.

16.4 Parameter Recording Table

Use the following table to record the settings of the parameters.

Parameter No.	Default Setting						Name	When Enabled
Pn000 (2000 hex)	0000						Basic Function Selections 0	After restart
Pn001 (2001 hex)	0000						Application Function Selections 1	After restart
Pn002 (2002 hex)	0000						Application Function Selections 2	After restart
Pn006 (2006 hex)	0002						Application Function Selections 6	Immediately
Pn007 (2007 hex)	0000						Application Function Selections 7	Immediately
Pn008 (2008 hex)	4000						Application Function Selections 8	After restart
Pn009 (2009 hex)	0010						Application Function Selections 9	After restart
Pn00A (200A hex)	0001						Application Function Selections A	After restart
Pn00B (200B hex)	0000						Application Function Selections B	After restart
Pn00C (200C hex)	0000						Application Function Selections C	After restart
Pn00D (200D hex)	0000						Application Function Selections D	After restart
Pn00F (200F hex)	0000						Application Function Selections F	After restart
Pn010 (2010 hex)	0001						Axis Address Selection for UART/USB Communications	After restart
Pn021 (2021 hex)	0000						DC Bus Connection	After restart
Pn080 (2080 hex)	0000						Application Function Selections 80	After restart
Pn081 (2081 hex)	0000						Application Function Selections 81	After restart
Pn100 (2100 hex)	400						Speed Loop Gain	Immediately
Pn101 (2101 hex)	2000						Speed Loop Integral Time Constant	Immediately
Pn102 (2102 hex)	400						Position Loop Gain	Immediately
Pn103 (2103 hex)	100						Moment of Inertia Ratio	Immediately
Pn104 (2104 hex)	400						Second Speed Loop Gain	Immediately
Pn105 (2105 hex)	2000						Second Speed Loop Integral Time Constant	Immediately
Pn106 (2106 hex)	400						Second Position Loop Gain	Immediately
Pn109 (2109 hex)	0						Feedforward	Immediately
Pn10A (210A hex)	0						Feedforward Filter Time Constant	Immediately
Pn10B (210B hex)	0000						Gain Application Selections	*1

Continued from previous page.

Parameter No.	Default Setting						Name	When Enabled
Pn10C (210C hex)	200						Mode Switching Level for Torque Reference	Immediately
Pn10D (210D hex)	0						Mode Switching Level for Speed Reference	Immediately
Pn10E (210E hex)	0						Mode Switching Level for Acceleration	Immediately
Pn10F (210F hex)	0						Mode Switching Level for Position Deviation	Immediately
Pn11F (211F hex)	0						Position Integral Time Constant	Immediately
Pn121 (2121 hex)	100						Friction Compensation Gain	Immediately
Pn122 (2122 hex)	100						Second Friction Compensation Gain	Immediately
Pn123 (2123 hex)	0						Friction Compensation Coefficient	Immediately
Pn124 (2124 hex)	0						Friction Compensation Frequency Correction	Immediately
Pn125 (2125 hex)	100						Friction Compensation Gain Correction	Immediately
Pn131 (2131 hex)	0						Gain Switching Time 1	Immediately
Pn132 (2132 hex)	0						Gain Switching Time 2	Immediately
Pn135 (2135 hex)	0						Gain Switching Waiting Time 1	Immediately
Pn136 (2136 hex)	0						Gain Switching Waiting Time 2	Immediately
Pn139 (2139 hex)	0000						Automatic Gain Switching Selections 1	Immediately
Pn13D (213D hex)	2000						Current Gain Level	Immediately
Pn140 (2140 hex)	0100						Model Following Control-Related Selections	Immediately
Pn141 (2141 hex)	500						Model Following Control Gain	Immediately
Pn142 (2142 hex)	1000						Model Following Control Gain Correction	Immediately
Pn143 (2143 hex)	1000						Model Following Control Bias in the Forward Direction	Immediately
Pn144 (2144 hex)	1000						Model Following Control Bias in the Reverse Direction	Immediately
Pn145 (2145 hex)	500						Vibration Suppression 1 Frequency A	Immediately
Pn146 (2146 hex)	700						Vibration Suppression 1 Frequency B	Immediately
Pn147 (2147 hex)	1000						Model Following Control Speed Feedforward Compensation	Immediately
Pn148 (2148 hex)	500						Second Model Following Control Gain	Immediately
Pn149 (2149 hex)	1000						Second Model Following Gain Control Correction	Immediately
Pn14A (214A hex)	800						Vibration Suppression 2 Frequency	Immediately

Continued from previous page.

Parameter No.	Default Setting						Name	When Enabled
Pn14B (214B hex)	100						Vibration Suppression 2 Correction	Immediately
Pn14F (214F hex)	0021						Control-Related Selections	After restart
Pn160 (2160 hex)	0010						Anti-Resonance Control-Related Selections	Immediately
Pn161 (2161 hex)	1000						Anti-Resonance Frequency	Immediately
Pn162 (2162 hex)	100						Anti-Resonance Gain Correction	Immediately
Pn163 (2163 hex)	0						Anti-Resonance Damping Gain	Immediately
Pn164 (2164 hex)	0						Anti-Resonance Filter Time Constant 1 Correction	Immediately
Pn165 (2165 hex)	0						Anti-Resonance Filter Time Constant 2 Correction	Immediately
Pn166 (2166 hex)	0						Anti-Resonance Damping Gain 2	Immediately
Pn170 (2170 hex)	1401						Tuning-less Function-Related Selections	*1
Pn181 (2181 hex)	0						Mode Switching Level for Speed Reference	Immediately
Pn182 (2182 hex)	0						Mode Switching Level for Acceleration	Immediately
Pn205 (2205 hex)	65535						Multiturn Limit	After restart
Pn207 (2207 hex)	0010						Position Control Function Selections	After restart
Pn20A (220A hex)	32768						Number of External Scale Pitches	After restart
Pn20E (220E hex)	64						Electronic Gear Ratio (Numerator)	After restart
Pn210 (2210 hex)	1						Electronic Gear Ratio (Denominator)	After restart
Pn212 (2212 hex)	2048						Number of Encoder Output Pulses	After restart
Pn22A (222A hex)	0000						Fully-closed Control Selections	After restart
Pn230 (2230 hex)	0000						Position Control Expansion Function Selections	After restart
Pn231 (2231 hex)	0						Backlash Compensation	Immediately
Pn233 (2233 hex)	0						Backlash Compensation Time Constant	Immediately
Pn281 (2281 hex)	20						Encoder Output Resolution	After restart
Pn282 (2282 hex)	0						Linear Encoder Pitch	After restart
Pn304 (2304 hex)	500						Jogging Speed	Immediately
Pn305 (2305 hex)	0						Soft Start Acceleration Time	Immediately
Pn306 (2306 hex)	0						Soft Start Deceleration Time	Immediately
Pn308 (2308 hex)	0						Speed Feedback Filter Time Constant	Immediately
Pn30A (230A hex)	0						Deceleration Time for Servo OFF and Forced Stops	Immediately

Continued from previous page.

Parameter No.	Default Setting						Name	When Enabled
Pn30C (230C hex)	0						Speed Feedforward Average Movement Time	Immediately
Pn310 (2310 hex)	0000						Vibration Detection Selections	Immediately
Pn311 (2311 hex)	100						Vibration Detection Sensitivity	Immediately
Pn312 (2312 hex)	50						Vibration Detection Level	Immediately
Pn316 (2316 hex)	10000						Maximum Motor Speed	After restart
Pn324 (2324 hex)	300						Moment of Inertia Calculation Starting Level	Immediately
Pn383 (2383 hex)	50						Jogging Speed	Immediately
Pn384 (2384 hex)	10						Vibration Detection Level	Immediately
Pn385 (2385 hex)	50						Maximum Motor Speed	After restart
Pn401 (2401 hex)	100						First Stage First Torque Reference Filter Time Constant	Immediately
Pn402 (2402 hex)	800						Forward Torque Limit	Immediately
Pn403 (2403 hex)	800						Reverse Torque Limit	Immediately
Pn404 (2404 hex)	100						Forward External Torque Limit	Immediately
Pn405 (2405 hex)	100						Reverse External Torque Limit	Immediately
Pn406 (2406 hex)	800						Emergency Stop Torque	Immediately
Pn407 (2407 hex)	10000						Speed Limit during Torque Control	Immediately
Pn408 (2408 hex)	0000						Torque-Related Function Selections	*1
Pn409 (2409 hex)	5000						First Stage Notch Filter Frequency	Immediately
Pn40A (240A hex)	70						First Stage Notch Filter Q Value	Immediately
Pn40B (240B hex)	0						First Stage Notch Filter Depth	Immediately
Pn40C (240C hex)	5000						Second Stage Notch Filter Frequency	Immediately
Pn40D (240D hex)	70						Second Stage Notch Filter Q Value	Immediately
Pn40E (240E hex)	0						Second Stage Notch Filter Depth	Immediately
Pn40F (240F hex)	5000						Second Stage Second Torque Reference Filter Frequency	Immediately
Pn410 (2410 hex)	50						Second Stage Second Notch Filter Q Value	Immediately
Pn412 (2412 hex)	100						First Stage Second Torque Reference Filter Time Constant	Immediately
Pn416 (2416 hex)	0000						Torque-Related Function Selections 2	Immediately

Continued from previous page.

Parameter No.	Default Setting						Name	When Enabled
Pn417 (2417 hex)	5000						Third Stage Notch Filter Frequency	Immediately
Pn418 (2418 hex)	70						Third Stage Notch Filter Q Value	Immediately
Pn419 (2419 hex)	0						Third Stage Notch Filter Depth	Immediately
Pn41A (241A hex)	5000						Fourth Stage Notch Filter Frequency	Immediately
Pn41B (241B hex)	70						Fourth Stage Notch Filter Q Value	Immediately
Pn41C (241C hex)	0						Fourth Stage Notch Filter Depth	Immediately
Pn41D (241D hex)	5000						Fifth Stage Notch Filter Frequency	Immediately
Pn41E (241E hex)	70						Fifth Stage Notch Filter Q Value	Immediately
Pn41F (241F hex)	0						Fifth Stage Notch Filter Depth	Immediately
Pn423 (2423 hex)	0000						Speed Ripple Compensation Selections	*1
Pn424 (2424 hex)	50						Torque Limit at Main Circuit Voltage Drop	Immediately
Pn425 (2425 hex)	100						Release Time for Torque Limit at Main Circuit Voltage Drop	Immediately
Pn426 (2426 hex)	0						Torque Feedforward Average Movement Time	Immediately
Pn427 (2427 hex)	0						Speed Ripple Compensation Enable Speed	Immediately
Pn456 (2456 hex)	15						Sweep Torque Reference Amplitude	Immediately
Pn460 (2460 hex)	0101						Notch Filter Adjustment Selections 1	Immediately
Pn480 (2480 hex)	10000						Speed Limit during Force Control	Immediately
Pn481 (2481 hex)	400						Polarity Detection Speed Loop Gain	Immediately
Pn482 (2482 hex)	3000						Polarity Detection Speed Loop Integral Time Constant	Immediately
Pn483 (2483 hex)	30						Forward Force Limit	Immediately
Pn484 (2484 hex)	30						Reverse Force Limit	Immediately
Pn485 (2485 hex)	20						Polarity Detection Reference Speed	Immediately
Pn486 (2486 hex)	25						Polarity Detection Reference Acceleration/Deceleration Time	Immediately
Pn487 (2487 hex)	0						Polarity Detection Constant Speed Time	Immediately
Pn488 (2488 hex)	100						Polarity Detection Reference Waiting Time	Immediately
Pn48E (248E hex)	10						Polarity Detection Range	Immediately
Pn490 (2490 hex)	100						Polarity Detection Load Level	Immediately

Continued from previous page.

Parameter No.	Default Setting						Name	When Enabled
Pn495 (2495 hex)	100						Polarity Detection Confirmation Force Reference	Immediately
Pn498 (2498 hex)	10						Polarity Detection Allowable Error Range	Immediately
Pn49F (249F hex)	0						Speed Ripple Compensation Enable Speed	Immediately
Pn502 (2502 hex)	20						Rotation Detection Level	Immediately
Pn503 (2503 hex)	10						Speed Coincidence Detection Signal Output Width	Immediately
Pn506 (2506 hex)	0						Brake Reference-Servo OFF Delay Time	Immediately
Pn507 (2507 hex)	100						Brake Reference Output Speed Level	Immediately
Pn508 (2508 hex)	50						Servo OFF-Brake Command Waiting Time	Immediately
Pn509 (2509 hex)	20						Momentary Power Interruption Hold Time	Immediately
Pn50A (250A hex)	1881						Input Signal Selections 1	After restart
Pn50B (250B hex)	8882						Input Signal Selections 2	After restart
Pn50E (250E hex)	0000						Output Signal Selections 1	After restart
Pn50F (250F hex)	0100						Output Signal Selections 2	After restart
Pn510 (2510 hex)	0000						Output Signal Selections 3	After restart
Pn511 (2511 hex)	6543						Input Signal Selections 5	After restart
Pn512 (2512 hex)	0000						Output Signal Inverse Settings	After restart
Pn514 (2514 hex)	0000						Output Signal Selections 4	After restart
Pn516 (2516 hex)	8888						Input Signal Selections 7	After restart
Pn51B (251B hex)	1000						Motor-Load Position Deviation Overflow Detection Level	Immediately
Pn51E (251E hex)	100						Position Deviation Overflow Warning Level	Immediately
Pn520 (2520 hex)	5242880						Position Deviation Overflow Alarm Level	Immediately
Pn522 (2522 hex)	7						Positioning Completed Width	Immediately
Pn524 (2524 hex)	1073741824						Near Signal Width	Immediately
Pn526 (2526 hex)	5242880						Position Deviation Overflow Alarm Level at Servo ON	Immediately
Pn528 (2528 hex)	100						Position Deviation Overflow Warning Level at Servo ON	Immediately
Pn529 (2529 hex)	10000						Speed Limit Level at Servo ON	Immediately
Pn52A (252A hex)	20						Multiplier per Fully-closed Rotation	Immediately
Pn52B (252B hex)	20						Overload Warning Level	Immediately

Continued from previous page.

Parameter No.	Default Setting						Name	When Enabled
Pn52C (252C hex)	100						Base Current Derating at Motor Overload Detection	After restart
Pn52D (252D hex)	50						Reserved parameter	–
Pn530 (2530 hex)	0000						Program Jogging-Related Selections	Immediately
Pn531 (2531 hex)	32768						Program Jogging Travel Distance	Immediately
Pn533 (2533 hex)	500						Program Jogging Movement Speed	Immediately
Pn534 (2534 hex)	100						Program Jogging Acceleration/Deceleration Time	Immediately
Pn535 (2535 hex)	100						Program Jogging Waiting Time	Immediately
Pn536 (2536 hex)	1						Program Jogging Number of Movements	Immediately
Pn548 (2548 hex)	0000						Specified Alarm Number for Tracing	Immediately
Pn550 (2550 hex)	0						Analog Monitor 1 Offset Voltage	Immediately
Pn551 (2551 hex)	0						Analog Monitor 2 Offset Voltage	Immediately
Pn552 (2552 hex)	100						Analog Monitor 1 Magnification	Immediately
Pn553 (2553 hex)	100						Analog Monitor 2 Magnification	Immediately
Pn55A (255A hex)	1						Power Consumption Monitor Unit Time	Immediately
Pn560 (2560 hex)	400						Residual Vibration Detection Width	Immediately
Pn561 (2561 hex)	100						Overshoot Detection Level	Immediately
Pn581 (2581 hex)	20						Zero Speed Level	Immediately
Pn582 (2582 hex)	10						Speed Coincidence Detection Signal Output Width	Immediately
Pn583 (2583 hex)	10						Brake Reference Output Speed Level	Immediately
Pn584 (2584 hex)	10000						Speed Limit Level at Servo ON	Immediately
Pn585 (2585 hex)	50						Program Jogging Movement Speed	Immediately
Pn586 (2586 hex)	0						Motor Running Cooling Ratio	Immediately
Pn587 (2587 hex)	0000						Polarity Detection Execution Selection for Absolute Linear Encoder	Immediately
Pn600 (2600 hex)	0						Regenerative Resistor Capacity	Immediately
Pn601 (2601 hex)	0						Dynamic Brake Resistor Capacity	Immediately
Pn603 (2603 hex)	0						Regenerative Resistance	Immediately
Pn604 (2604 hex)	0						Dynamic Brake Resistance	Immediately

Appendices

17

The appendix provides information on interpreting panel displays, and tables of corresponding SERVOPACK and SigmaWin+ function names.

17.1 Interpreting Panel Displays

You can check the Servo Drive status on the panel display of the SERVOPACK.
Also, if an alarm or warning occurs, the alarm or warning number will be displayed.

17.1.1 Interpreting Status Displays

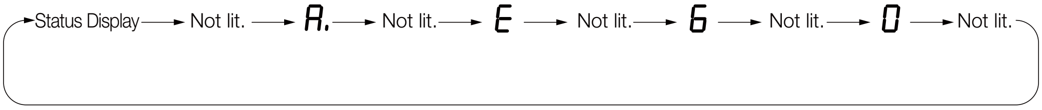
The status is displayed as described below.

Display	Meaning	Display	Meaning
	/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.)		Reference Input Display Lit while a reference is being input.
	Base Block Display Lit during the base block state (servo OFF). Not lit while the servo is ON.		Connected Display Lit while there is a connection.

17.1.2 Alarm and Warning Displays

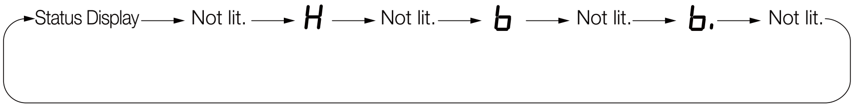
If there is an alarm or warning, the code will be displayed one character at a time, as shown below.

Example: Alarm A.E60



17.1.3 Hard Wire Base Block Active Display

If a hard wire base block (HWBB) is active, the display will change in the following order.

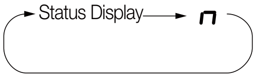


17.1.4 Overtravel Display

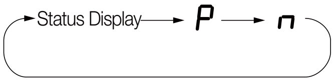
If overtravel has occurred, the display will change in the following order.

① Forward Overtravel (P-OT)

② Reverse Overtravel (N-OT)

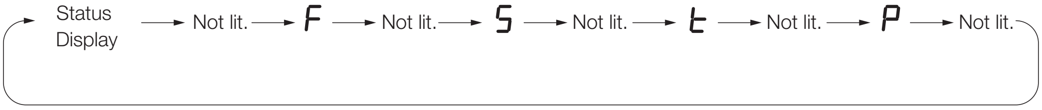


③ Forward and Reverse Overtravel



17.1.5 Forced Stop Display

During a forced stop, the following display will appear.



17.2 Corresponding SERVOPACK and SigmaWin+ Function Names

This section gives the names and numbers of the utility functions and monitor display functions used by the SERVOPACKs and the names used by the SigmaWin+.

17.2.1 Corresponding SERVOPACK Utility Function Names

SigmaWin+		SERVOPACK	
Menu Bar Button	Function Name	Fn No.	Function Name
Setup	Origin Search	Fn003	Origin Search
	Reset Absolute Encoder	Fn008	Reset Absolute Encoder
	Adjust the Analog Monitor Output	Fn00C	Adjust Analog Monitor Output Offset
		Fn00D	Adjust Analog Monitor Output Gain
	Adjust the Motor Current Detection Signal Offsets	Fn00E	Autotune Motor Current Detection Signal Offset
		Fn00F	Manually Adjust Motor Current Detection Signal Offset
	Multiturn Limit Setting	Fn013	Multiturn Limit Setting after Multiturn Limit Disagreement Alarm
	Reset Option Module Configuration Error	Fn014	Reset Option Module Configuration Error
	Initialize Vibration Detection Level	Fn01B	Initialize Vibration Detection Level
	Set Absolute Linear Encoder Origin	Fn020	Set Absolute Linear Encoder Origin
	Reset Motor Type Alarm	Fn021	Reset Motor Type Alarm
	Software Reset	Fn030	Software Reset
	Polarity Detection	Fn080	Polarity Detection
	Tuning-less Level Setting	Fn200	Tuning-less Level Setting
	Easy FFT	Fn206	Easy FFT
Parameters	Initialize Servo	Fn005	Initializing Parameters
	Write Prohibition Setting	Fn010	Write Prohibition Setting
	Setup Wizard	–	–
Tuning	Autotuning without Host Reference	Fn201	Advanced Autotuning without Reference
	Autotuning with Host Reference	Fn202	Advanced Autotuning with Reference
	Custom Tuning	Fn203	One-Parameter Tuning
	Adjust Anti-resonance Control	Fn204	Adjust Anti-resonance Control
	Vibration Suppression	Fn205	Vibration Suppression
	Moment of Inertia Estimation	–	–
Monitoring	Product Information	Fn011	Display Servomotor Model
		Fn012	Display Software Version
		Fn01E	Display SERVOPACK and Servomotor IDs
		Fn01F	Display Servomotor ID from Feedback Option Module
Test Operation	Jog	Fn002	Jog
	Jog Program	Fn004	Jog Program
Alarms	Display Alarm History	Fn000	Display Alarm History
	Clear Alarm History	Fn006	Clear Alarm History
Solutions	Mechanical Analysis	–	–

17.2.2 Corresponding SERVOPACK Monitor Display Function Names

SigmaWin+		SERVOPACK	
Menu Bar Button	Name [Unit]	Un No.	Name [Unit]
Motion Monitor	Motor Speed [min^{-1}]	Un000	Motor Speed [min^{-1}]
	Speed Reference [min^{-1}]	Un001	Speed Reference [min^{-1}]
	Torque Reference [%]	Un002	Torque Reference [%] (percentage of rated torque)
	• Rotary Servomotors: Rotational Angle 1 [encoder pulses] (number of encoder pulses from origin within one encoder rotation) • Linear Servomotors: Electrical Angle 1 [linear encoder pulses] (linear encoder pulses from the polarity origin)	Un003	• Rotary Servomotors: Rotational Angle 1 [encoder pulses] (number of encoder pulses from origin within one encoder rotation displayed in decimal) • Linear Servomotors: Electrical Angle 1 [linear encoder pulses] (linear encoder pulses from the polarity origin displayed in decimal)
	• Rotary Servomotors: Rotational Angle 2 [deg] (electrical angle from origin within one encoder rotation) • Linear Servomotors: Electrical Angle 2 [deg] (electrical angle from polarity origin)	Un004	• Rotary Servomotors: Rotational Angle 2 [deg] (electrical angle from polarity origin) • Linear Servomotors: Electrical Angle 2 [deg] (electrical angle from polarity origin)
	Input Reference Pulse Speed [min^{-1}]	Un007	Input Reference Pulse Speed [min^{-1}] (displayed only during position control)
	Position Deviation [reference units]	Un008	Position Error Amount [reference units] (displayed only during position control)
	Accumulated Load Ratio [%]	Un009	Accumulated Load Ratio [%] (percentage of rated torque: effective torque in cycles of 10 seconds)
	Regenerative Load Ratio [%]	Un00A	Regenerative Load Ratio [%] (percentage of processable regenerative power: regenerative power consumption in cycles of 10 seconds)
	Dynamic Brake Resistor Power Consumption [%]	Un00B	Power Consumed by DB Resistance [%] (percentage of processable power at DB activation: displayed in cycles of 10 seconds)
	Input Reference Pulse Counter [reference units]	Un00C	Input Reference Pulse Counter [reference units]
	Feedback Pulse Counter [encoder pulses]	Un00D	Feedback Pulse Counter [encoder pulses]

Continued on next page.

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SigmaWin+		SERVOPACK	
Menu Bar Button	Name [Unit]	Un No.	Name [Unit]
Motion Monitor	Fully-closed Loop Feedback Pulse Counter [external encoder resolution]	Un00E	Fully-closed Loop Feedback Pulse Counter [external encoder resolution]
	Upper Limit Setting of Motor Maximum Speed/Upper Limit Setting of Encoder Output Resolution	Un010*1	Upper Limit Setting of Motor Maximum Speed/ Upper Limit Setting of Encoder Output Resolution
	Total Operation Time [100 ms]	Un012	Total Operation Time [100 ms]
	Feedback Pulse Counter [reference units]	Un013	Feedback Pulse Counter [reference units]
	Current Backlash Compensation Value [0.1 reference units]	Un030	Current Backlash Compensation Value [0.1 reference units]
	Backlash Compensation Value Setting Limit [0.1 reference units]	Un031	Backlash Compensation Value Setting Limit [0.1 reference units]
	Power Consumption [W]	Un032	Power Consumption [W]
	Consumed Power [0.001 Wh]	Un033	Consumed Power [0.001 Wh]
	Cumulative Power Consumption [Wh]	Un034	Cumulative Power Consumption [Wh]
	Absolute Encoder Multiturn Data	Un040	Absolute Encoder Multiturn Data
	Position within One Rotation of Absolute Encoder [encoder pulses]	Un041	Position within One Rotation of Absolute Encoder [encoder pulses]
	Lower Bits of Absolute Encoder Position [encoder pulses]	Un042	Lower Bits of Absolute Encoder Position [encoder pulses]
	Upper Bits of Absolute Encoder Position [encoder pulses]	Un043	Upper Bits of Absolute Encoder Position [encoder pulses]
Status Monitor	Polarity Sensor Signal Monitor	Un011	Polarity Sensor Signal Monitor
	Active Gain Monitor	Un014	Effective Gain Monitor (gain settings 1 = 1, gain settings 2 = 2)
	Safety I/O Signal Monitor	Un015	Safety I/O Signal Monitor
Input Signal Monitor	Input Signal Monitor	Un005	Input Signal Monitor
Output Signal Monitor	Output Signal Monitor	Un006	Output Signal Monitor
Service Life Monitor	Installation Environment Monitor – SERVOPACK	Un025	SERVOPACK Installation Environment Monitor [%]
	Installation Environment Monitor – Servomotor*2	Un026*2	Servomotor Installation Environment Monitor [%]
	Service Life Prediction Monitor – Built-in Fan	Un027	Built-in Fan Remaining Life Ratio [%]
	Service Life Prediction Monitor – Capacitor	Un028	Capacitor Remaining Life Ratio [%]
	Service Life Prediction Monitor – Surge Prevention Circuit	Un029	Surge Prevention Circuit Remaining Life Ratio [%]
	Service Life Prediction Monitor – Dynamic Brake Circuit	Un02A	Dynamic Brake Circuit Remaining Life Ratio [%]
Product Information	Motor – Resolution	Un084	Linear Encoder Pitch (Scale pitch = Un084 × 10^{Un085} [pm])
		Un085	Linear Encoder Pitch Exponent (Scale pitch = Un084 × 10^{Un085} [pm])
–	–	Un020	Rated Motor Speed [min^{-1}]
	–	Un021	Maximum Motor Speed [min^{-1}]

*1. You can use Un010 to monitor the upper limit setting for the maximum motor speed or the upper limit setting for the encoder output resolution.
You can monitor the upper limit of the encoder output resolution setting (Pn281) for the current maximum motor speed setting (Pn385), or you can monitor the upper limit of the maximum motor speed setting for the current encoder output resolution setting.
Select which signal to monitor with Pn080 = n.X□□□ (Calculation Method for Maximum Speed or Divided Output Pulses).
- If Pn080 = n.0□□□, the encoder output resolution (Pn281) that can be set is displayed.
- If Pn080 = n.1□□□, the maximum motor speed (Pn385) that can be set is displayed in mm/s.

*2. This applies to the following motors. The display will show 0 for all other models.
SGM7J, SGM7A, SGM7P, SGM7G, and SGMCV

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Revision History

The revision dates and numbers of the revised manuals are given on the bottom of the back cover.

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Σ-7S SERVOPACK with EtherCAT (CoE) Communications References

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