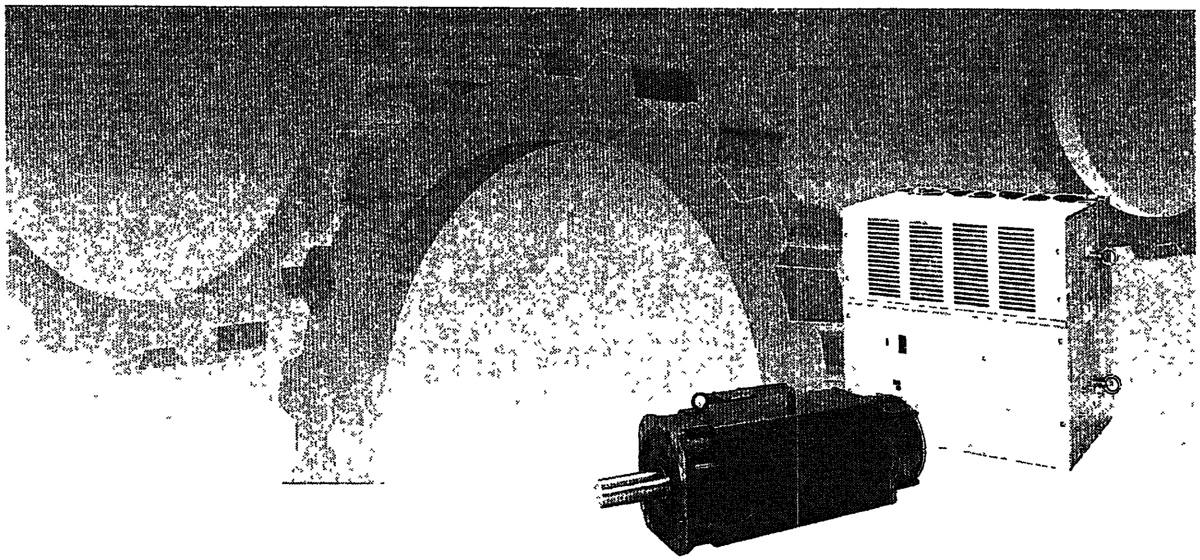
YASKAWA

Σ Series SGMB/SGDB

USER'S MANUAL

AC Servomotor and Driver (200V: 22 to 37kW, 400V: 22 to 55kW)

SGMB Servomotor
SGDB SERVOPACK



YASKAWA

MANUAL NO. SIEZ-S800-16.1

Safety Information

The following conventions are used to indicate precautions in this manual. Failure to heed precautions provided in this manual can result in serious or possibly even fatal injury or damage to the products or to related equipment and systems.

⚠ WARNING Indicates precautions that, if not heeded, could possibly result in loss of life or serious injury.

⚠ Caution Indicates precautions that, if not heeded, could result in relatively serious or minor injury, damage to the product, or faulty operation.

Visual Aids

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

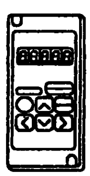
◀EXAMPLE▶ Indicates application examples.

INFO Indicates supplemental information.

IMPORTANT Indicates important information that should be memorized.

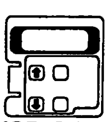
TERMS

Technical terms placed in bold in the text are briefly explained in a "TERMS" section at the bottom of the page The following kinds of technical terms are explained Technical terms that need to be explained to users who are not very familiar with servo systems or electronic devices and technical terms specific to Σ-Series Servos that need to be explained in descriptions of functions



JUSP-OP02A-1

The text indicated by this icon explains the operating procedure using Hand-held Type Digital Operator (Type: JUSP-OP02A-1).



JUSP-OP03A

The text indicated by this icon explains the operating procedure using Mount Type Digital Operator (Type: JUSP-OP03A).

OVERVIEW

TABLE OF CONTENTS

Overview

■ Manual Contents

This manual provides Σ-Series users with information on the following:

- An overview of servo systems for first-time users.
- Checking the product on delivery and basic applications of the servo.
- Servo applications.
- Selecting an appropriate servo for your needs and placing an order.
- Inspection and maintenance.

Using This Manual

■ Basic Terms

Unless otherwise specified, the following definitions are used:

Servomotor: Σ-Series SGMB servomotor

SERVOPACK: An amplifier (Trademark of Yaskawa servo amplifier "Σ-Series SGDB SERVOPACK")

Servodrive: A servomotor and an amplifier (SGDB SERVOPACK)

Servo system: A complete servo control system consisting of servodrive, host controller, and peripheral devices

Safety Precautions

The following precautions are for checking products on delivery, installation, wiring, operation, maintenance, and inspection.

■ Checking Products on Delivery

⚠ Caution

- **Use the specified combination of servomotor and SERVOPACK.**
  Failure to observe this caution may lead to fire or failure.

■ Installation

⚠ Caution

- **Never use the equipment where it may be exposed to splashes of water, corrosive or flammable gases, or near flammable materials.**
  Failure to observe this caution may lead to electric shock or fire.

■ Wiring

⚠ WARNING

- Grounding must be in accordance with the national code and consistent with sound local practices.

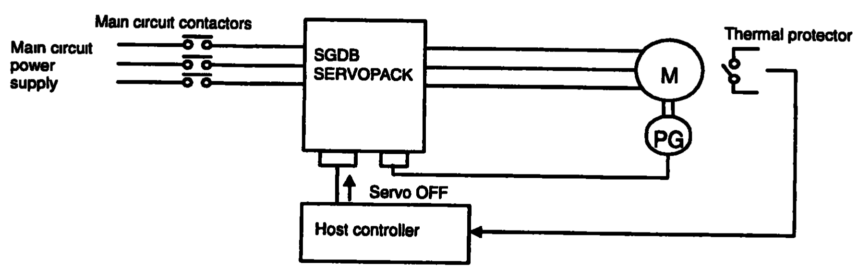
  Failure to observe this warning may result in electric shock or fire.

- Use the thermal protector built into the servomotor according to either of the two following methods.

  SGMB servomotors are cooled by a fan. If the fan is defective or power to the fan is disconnected, heat from the motor may result in burns or fire.

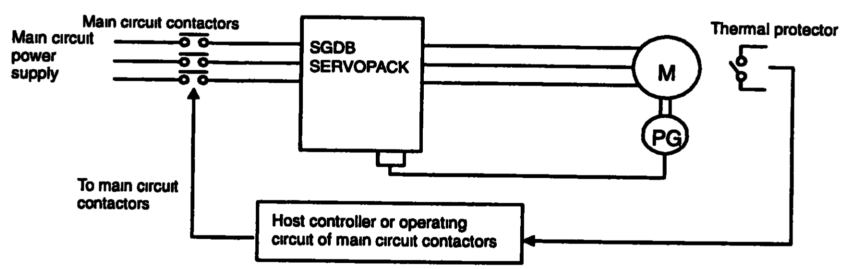
  - Method 1:

    Wire the output from the thermal protector to the host controller and turn OFF the servo when the thermal protector operates.



  - Method 2:

    Wire the thermal protector to the operating circuit of the main circuit contactors or the host controller and turn OFF the main circuit when the thermal protector operates.



⚠ Caution

- Do not connect three-phase power supply to output terminals Ⓤ Ⓥ and Ⓦ.

  Failure to observe this caution may result in personal injury or fire.

- Securely tighten screws on the power supply and motor output terminals.

  Failure to observe this caution may result in a fire.

■ Operation

⚠ WARNING

- **Never touch any rotating motor parts during operation.**
  Failure to observe this warning may result in personal injury.

⚠ Caution

- **To avoid inadvertent accidents, run the servomotor only in test run (without load).**
  Failure to observe this caution may result in personal injury.
- **Before starting operation with a load connected, set up parameters suitable for the machine.**
  Starting operation without setting up parameters may result in overrun failure.
- **Before starting operation with a load connected, make sure emergency-stop procedures are in place.**
  Failure to observe this caution may result in personal injury.
- **During operation, do not touch the heat sink.**
  Failure to observe this caution may result in burns.

■ Maintenance and Inspection

⚠ WARNING

- **Be sure to turn OFF power before inspection or maintenance.**
  Failure to observe this warning may result in electric shock.
- **Never open the terminal cover while power is ON, and never turn ON power when the terminal cover is open.**
  Failure to observe this warning may result in electric shock.
- **After turning OFF power, wait at least five minutes before servicing the product.**
  Failure to observe this warning may result in residual electric charges causing electric shock.

⚠ Caution

- **Do not disassemble the servomotor.**
  Failure to observe this caution may result in electric shock or personal injury.

⚠ Caution

- **Never change wiring while power is ON.**

  Failure to observe this caution may result in electric shock or personal injury.

■ General Precautions

Note the following to ensure safe application.
• Some drawings in this manual are shown with the protective cover or shields removed, in order to describe the detail with more clarity. Make sure all covers and shields are replaced before operating this product. • Some drawings in this manual are shown as typical example and may differ from the shipped product. • This manual may be modified when necessary because of improvement of the product, modification or changes in specifications. Such modification is made as a revision by renewing the manual No. • To order a copy of this manual, if your copy has been damaged or lost, contact your YASKAWA representative listed on the last page stating the manual No. on the front cover. • YASKAWA is not responsible for accidents or damages due to any modification of the product made by the user since that will void our guarantee.

1

FOR FIRST-TIME USERS OF AC SERVOS

This chapter is intended for first-time users of AC servos. It describes the basic configuration of a servo mechanism and basic technical terms relating to servos.
Users who already have experience in using a servo should also take a look at this chapter to understand the features of Σ-Series AC Servos.

1.1 Basic Understanding of AC Servos

This section describes the basic configuration of a servo mechanism and technical terms relating to servos and also explains the features of Σ-Series AC Servos.

1.1.1 Servo Mechanisms

You may be familiar with the following terms:

- Servo
- **Servo mechanism**
- Servo control system

In fact, these terms are synonymous. They have the following meaning:

A control mechanism that monitors physical quantities such as specified positions.

In short, a servo mechanism is like a servant who does tasks faithfully and quickly according to his master's instructions. In fact, "servo" originally derives from the word "servant."

TERMS

◆ Servo mechanism

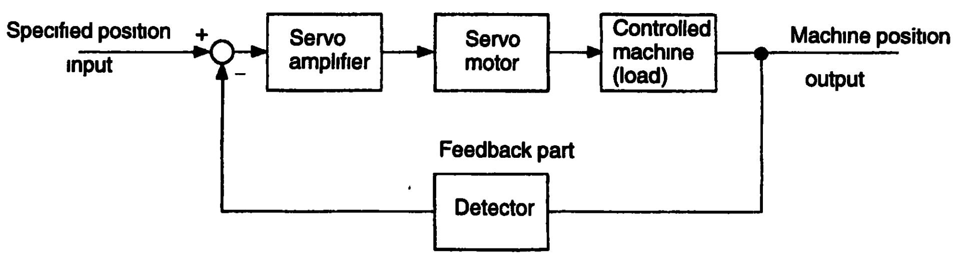
According to Japanese Industrial Standard (JIS) terminology, a "servo mechanism" is defined as a mechanism that uses the position, direction, or orientation of an object as a process variable to control a system to follow any changes in a target value (set point)
More simply, a servo mechanism is a control mechanism that monitors physical quantities such as specified positions Feedback control is normally performed by a servo mechanism (Source JIS B0181)

Servo system could be defined in more detail as a mechanism that:

- Moves at a specified speed and
- Locates an object in a specified position

To develop such a servo system, an automatic control system involving **feedback control** must be designed. This automatic control system can be illustrated in the following block diagram:

Configuration of Servo System



This servo system is an automatic control system that detects the machine position (output data), feeds back the data to the input side, compares it with the specified position (input data), and moves the machine by the difference between the compared data.

In other words, the servo system is a system to control the output data to match the specified input data.

If, for example, the specified position changes, the servo system will reflect the changes.

In the above example, input data is defined as a position, but input data can be any physical quantities such as orientation (angle), water pressure, or voltage.

Position, speed, force (torque), electric current, and so on are typical controlled values for a servo system.

TERMS

◆ Feedback control

A control method in which process variables are returned to the input side to form a closed loop It is also called closed-loop control

If a negative signal is returned to the input side, it is called negative feedback control Normally, negative feedback control is used to stabilize the system If feedback is not returned, the control method is called open-loop control

1.1.2 Technical Terms

The main technical terms used in this manual are as follows:

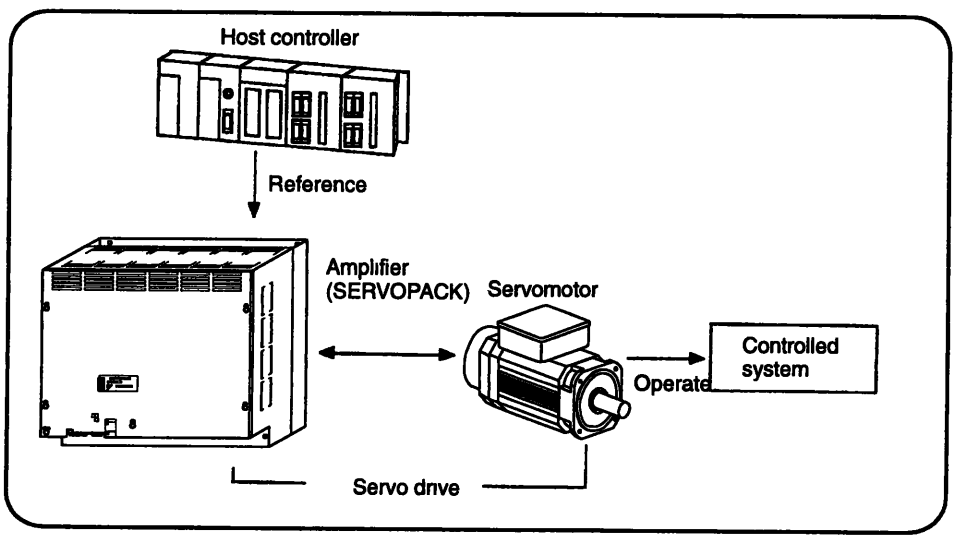
- Servo mechanism
- Servo

  Normally, servo is synonymous with servo mechanism. However, because "mechanism" is omitted, the meaning becomes somewhat ambiguous. Servo may refer to the entire servo mechanism but may also refer to an integral part of a servo mechanism such as a servomotor or a servo amplifier. This manual also follows this convention in the use of the term "servo".

- Servo control system

  Servo control system is almost synonymous with servo mechanism but places the focus on system control. In this manual, the term "servo system" is also used as a synonym of servo control system.

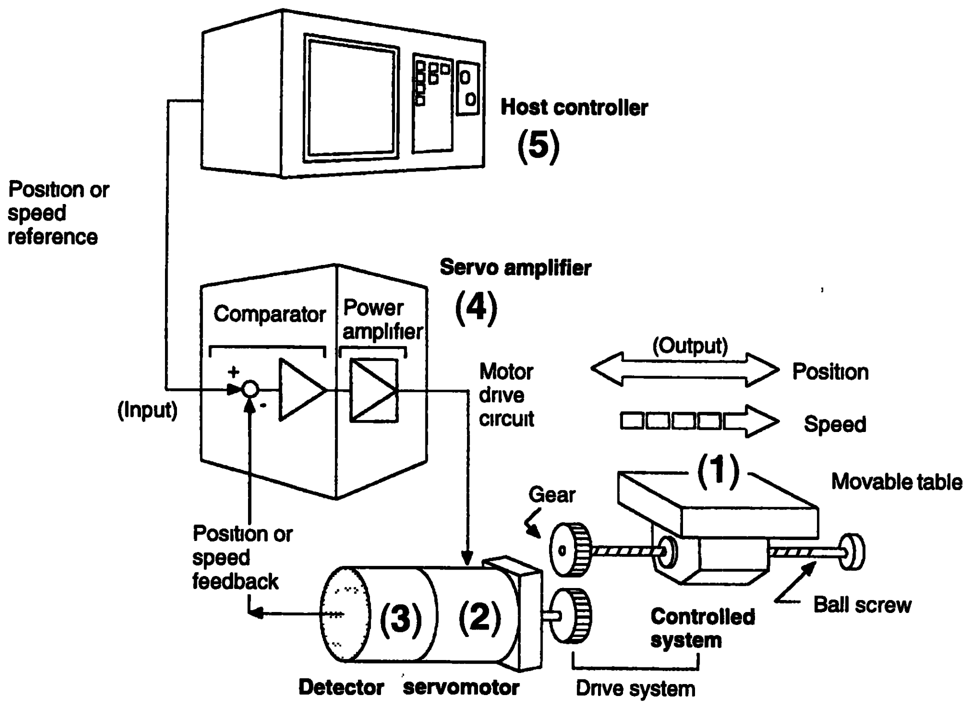
Related Terms	Meaning
Servomotor	General servomotors or Yaskawa SGMB servomotors. In some cases, a position detector (encoder) is included in a servomotor.
SERVOPACK	Trademark of Yaskawa servo amplifier "SGDB SERVOPACK."
Servo drive	A servomotor and amplifier pair. Also called "servo."
Servo system	A closed control system consisting of a host controller, servo drive and controlled system to form a servo mechanism



Servo system

1.2 Configuration of Servo System

The following diagram illustrates a servo system in detail:



(1) Controlled system: Mechanical system for which the position or speed is to be controlled. This includes a drive system that transmits torque from a servomotor.

(2) Servomotor: A main actuator that moves a controlled system. Two types are available: AC servomotor and DC servomotor.

(3) Detector: A position or speed detector. Normally, an encoder mounted on a motor is used as a position detector.

(4) Servo amplifier: An amplifier that processes an error signal to correct the difference between a reference and feedback data and operates the servomotor accordingly. A servo amplifier consists of a comparator, which processes error signals, and a power amplifier, which operates the servomotor.

(5) Host controller: A device that controls a servo amplifier by specifying a position or speed as a set point.

Servo components (1) to (5) are outlined below:

1. Controlled system

In the previous figure, the controlled system is a movable table for which the position or speed is controlled. The movable table is driven by a ball screw and is connected to the servomotor via gears.
So, the **drive system** consists of:

a) Gears + Ball Screw

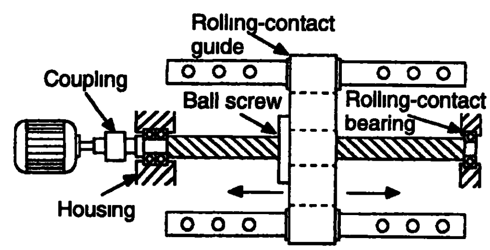
This drive system is most commonly used because the power transmission ratio (gear ratio) can be freely set to ensure high positioning accuracy. However, play in the gears must be minimized.

The following drive system is also possible when the controlled system is a movable table:

b) Coupling + Ball Screw

When the power transmission ratio is 1 : 1, a coupling is useful because it has no play.

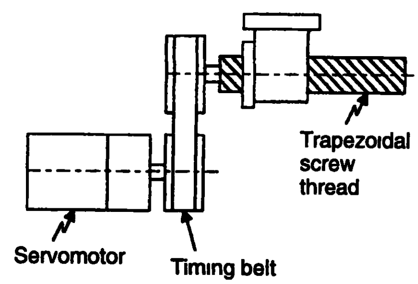
This drive system is widely used for machining tools.



c) Timing Belt + Trapezoidal Screw Thread

A timing belt is a coupling device that allows the power transmission ratio to be set freely and that has no play.

A trapezoidal screw thread does not provide excellent positioning accuracy, so can be treated as a minor coupling device.



To develop an excellent servo system, it is important to select a rigid drive system that has no play.

Configure the controlled system by using an appropriate drive system for the control purpose.

TERMS

◆ Drive system

Also called a drive mechanism
A drive system connects an actuator (such as a servomotor) to a controlled system and serves as a mechanical control component that transmits torque to the controlled system, orientates the controlled system, and converts motion from rotation to linear motion and vice versa

2. Servomotor

a) DC Servomotor and AC Servomotor

Servomotors are divided into two types: DC servomotors and AC servomotors.

DC servomotors are driven by direct current (DC). They have a long history. Up until the 1980s, the term "servomotor" used to imply a DC servomotor.

From 1984, AC servomotors were emerging as a result of rapid progress in microprocessor technology. Driven by alternating current (AC), AC servomotors are now widely used because of the following advantages:

- Easy maintenance: No brush
- High speed: No limitation in rectification rate

Note however that servomotors and SERVOPACKs use some parts that are subject to mechanical wear or aging. For preventive maintenance, inspect and replace parts at regular intervals.
For details, refer to *Chapter 6 Inspection, Maintenance, and Troubleshooting.*

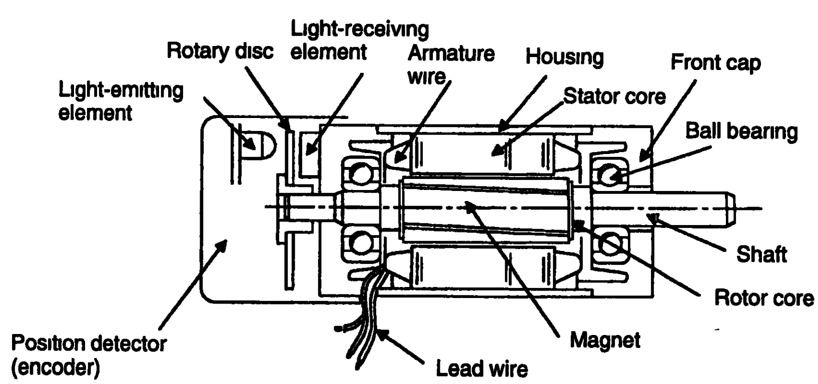
b) AC Servomotor

AC servomotors are divided into two types: Synchronous type and induction type. The synchronous type is more commonly used.

For a synchronous type servomotor, motor speed is controlled by changing the frequency of alternating current.

A synchronous type servomotor provides strong holding torque when stopped, so this type is ideal when precise positioning is required. Use this type for a servo mechanism for position control.

The following figure illustrates the structure of a synchronous type servomotor:



Yaskawa SGM□ servomotors are of the synchronous type.

c) Performance of Servomotor

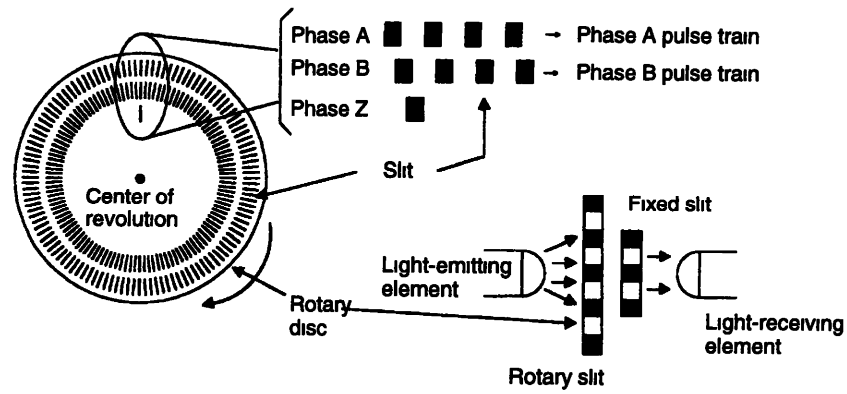
A servomotor must have "instantaneous power" so that it can start as soon as a start reference is received.
The term "power rating (kW/s)" is used to represent instantaneous power.
It refers to the electric power (kW) that a servomotor generates per second.
The greater the power rating, the more powerful the servomotor.

3. Detector

A servo system requires a position or speed detector. It uses an encoder mounted on a servomotor for this purpose.
Encoders are divided into the following two types:

a) Incremental Encoder

An incremental encoder is a pulse generator, which generates a certain number of pulses per revolution (e.g., 2,000 pulses per revolution). If this encoder is connected to the mechanical system and one pulse is defined as a certain length (e.g., 0.001 mm), it can be used as a position detector.
However, this encoder does not detect an absolute position and merely outputs a pulse train. Hence zero point return operation must be performed before positioning.
The following figure illustrates the operation principle of a pulse generator:



b) Absolute Encoder

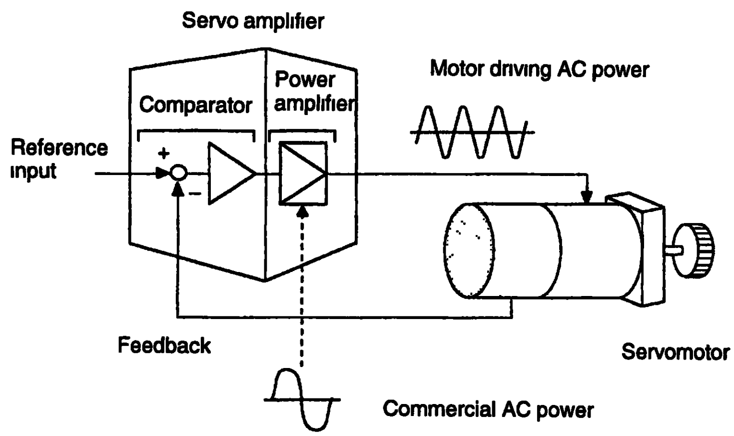
An absolute encoder is designed to detect an absolute angle of rotation as well as to perform the general functions of an incremental encoder. With an absolute encoder, therefore, it is possible to create a system that does not require zero point return operation at the beginning of each operation.

Difference between an absolute and incremental encoder:
An absolute encoder will keep track of the motor shaft position even if system power is lost and some motion occurs during that period of time. The incremental encoder is incapable of the above.

4. Servo amplifier

A servo amplifier is required to operate an AC servomotor.

The following figure illustrates the configuration of a servo amplifier:



A servo amplifier consists of the following two sections:

a) Comparator

A comparator consists of a comparison function and a control function. The comparison function compares reference input (position or speed) with a feedback signal and generates a differential signal.

The control function amplifies and transforms the differential signal. In other words, it performs proportional (P) control or **proportional/integral (PI) control.** (It is not important if you do not understand these control terms completely at this point.)

b) Power Amplifier

A power amplifier runs the servomotor at a speed or torque proportional to the output of the comparator. In other words, from the commercial power supply of 50/60 Hz, it generates alternating current with a frequency proportional to the reference speed and runs the servomotor with this current.

TERMS

◆ Proportional/integral (PI) control

PI control provides more accurate position or speed control than proportional control, which is more commonly used

5. Host Controller

A host controller controls a servo amplifier by specifying a position or speed as a set point.

For speed reference, a position control loop may be formed in the host controller when a position feedback signal is received. Yaskawa **PROGIC-8** is a typical host controller.

TERMS

◆ PROGIC-8

A programmable machine controller If combined with a servo amplifier for speed control (maximum eight axis control), the PROGIC-8 can provide position control
The PROGIC-8 also provides programmable controller functions

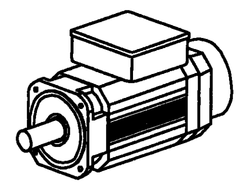
1.3 Features of Σ-Series Servos

A Σ-Series Servo consists of an SGMB servomotor and an SGDB SERVOPACK.

1.3.1 Outline

Σ-Series SGMB servomotors are synchronous type servomotors and have the following features:

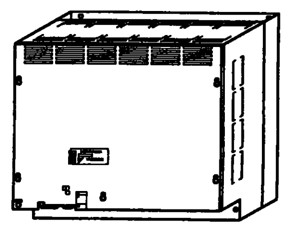
Rated rotation speed Maximum rotation speed	Voltage	Maximum torque	Rated output
1500 r/min 2000 r/min	200 V	200% 250%	22 to 37 kW (6 models)
	400 V		22 to 55 kW (10 models)



SGMB
Servomotor

SGDB model SERVOPACKs allow the control of speed, position and torque.

- Speed control (analog reference)
  Accepts an analog voltage speed reference.
- Position control (pulse reference)
  Accepts a pulse train position reference
- Torque control (analog reference)
  Accepts an analog voltage torque reference

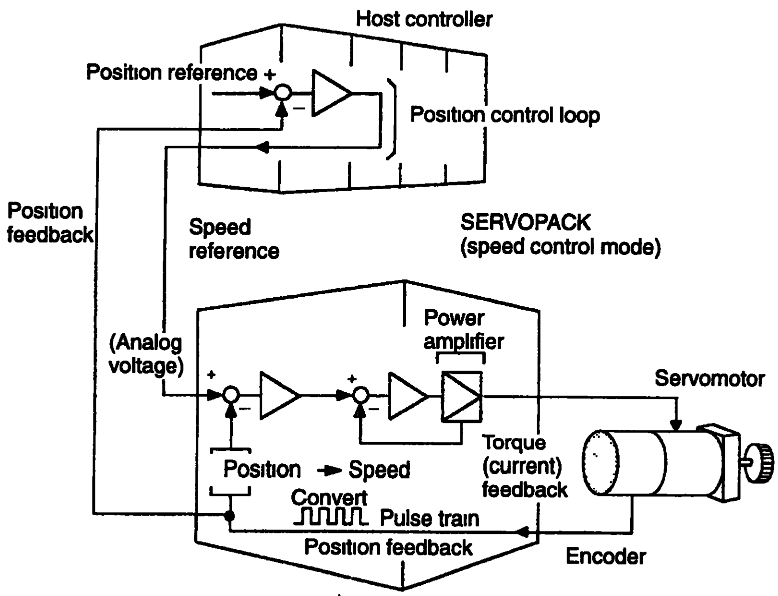


SGDB SERVOPACK

1.3.2 Using the SGDB SERVOPACK

The most common use of a SERVOPACK for speed control is shown below:

■ Using the SERVOPACK for Speed Control

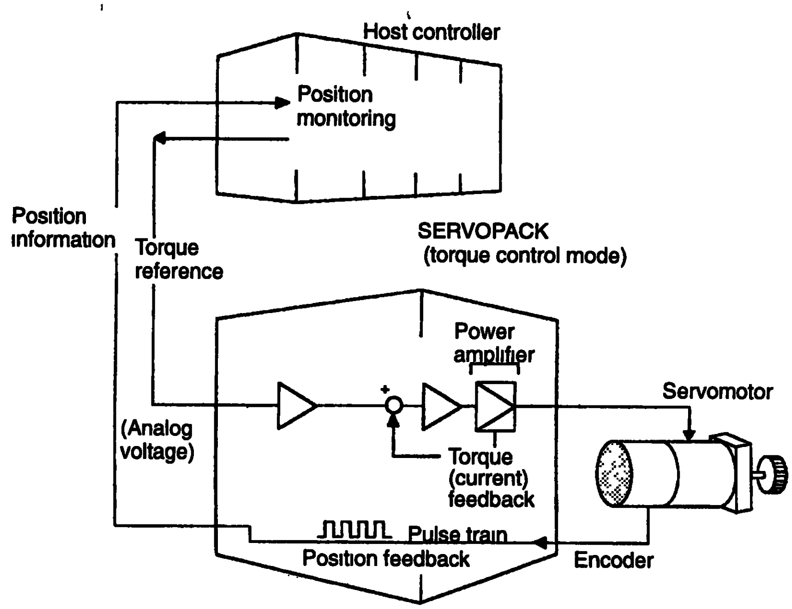


As shown in the above figure, a position control loop is formed in the host controller. The host controller compares a position reference with a position feedback signal and sends the processed result to the SERVOPACK as a speed reference.

In this way the host controller can be freed from performing the servo mechanism control. The SERVOPACK undertakes the speed control loop and subsequent control processing.

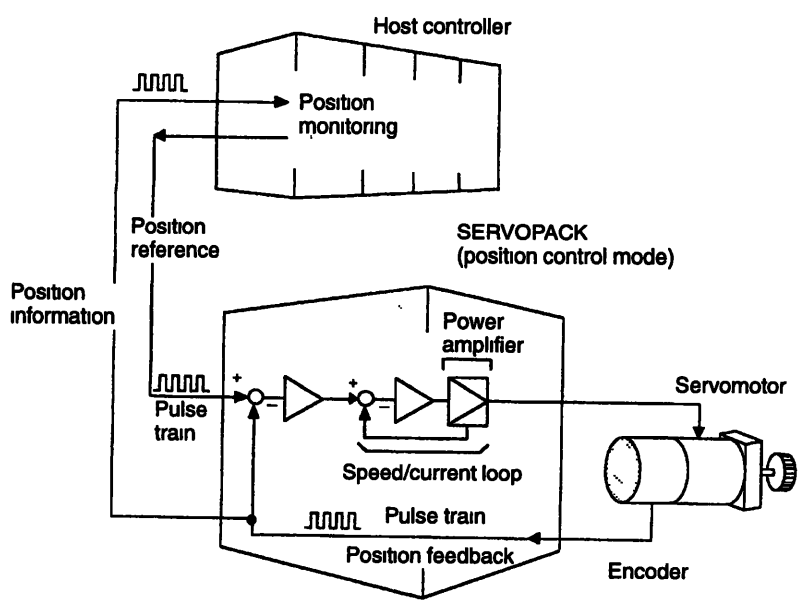
The Yaskawa programmable machine controller PROGIC-8 is used as a typical host controller.

■ Using the SERVOPACK for Torque Control



The host controller outputs a torque reference to control the SERVOPACK. It also receives a pulse train (position information) from the SERVOPACK and uses it to monitor the position.

■ Using the SERVOPACK for Position Control



The host controller can send a position reference (pulse train) to the SERVOPACK to perform positioning or interpolation.
This type of SERVOPACK contains a position control loop.

Parameters can be used to select either of the following pulse trains:

a) Code and pulse train

b) Two-phase pulse train with 90° phase difference

c) Forward and reverse pulse trains

The host controller receives a pulse train (position information) from the SERVOPACK and uses it to monitor the position.

■ Parameters

A Digital Operator can be used to set parameters for a SERVOPACK as follows:

a) Setting parameters to enable or disable each function

b) Setting parameters required for functions to be used

Set parameters according to the servo system to be set up.

2

BASIC USES OF Σ-SERIES PRODUCTS

This chapter describes the first things to do when Σ-Series products are delivered. It also explains the most fundamental ways of connecting and operating Σ-Series products. Both first-time and experienced servo users **must read** this chapter.

2.1 Precautions

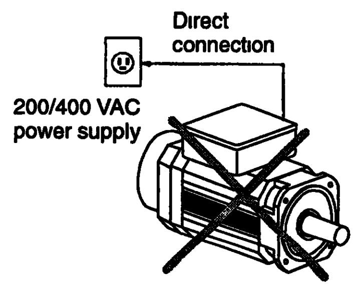
This section provides notes on using Σ-Series products.

INFO Always note the following to ensure safe use

Use 200/400-VAC power supply

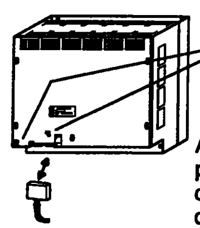
Use a 200-VAC or 400-VAC power supply according to the servomotor model.

Be sure to use the correct model. Do not plug the servomotor directly into the power frequency supply (Direct connection to the power frequency supply will damage the servomotor.)



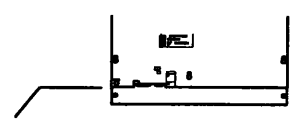
Do not change wiring when power is ON.

Always turn the power OFF before connecting or disconnecting a connector.
(Except for Digital Operator (Models: JUSP-OP02A-1, JUSP-OP03A))



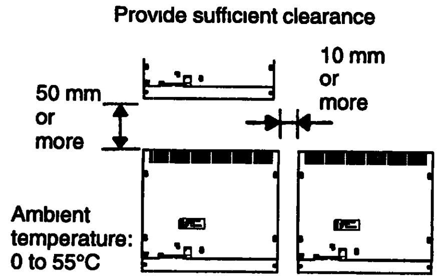
Note that residual voltage still remains in the SERVOPACK even after the power is turned OFF.

Even after the power is turned OFF, residual electric charge still remains in the capacitor inside the SERVOPACK. To prevent an electric shock, always wait for the CHARGE lamp to go OFF before starting inspection (if necessary)



Always follow the specified installation method.

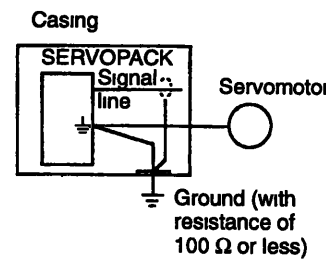
The SERVOPACK generates heat. Install the SERVOPACK so that it can radiate heat freely. Note also that the SERVOPACK must be in an environment free from condensation, vibration and shock.



Perform noise reduction and grounding properly.

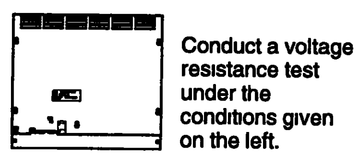
If the signal line is noisy, vibration or malfunction will result.

- Separate high-voltage cables from low-voltage cables.
- Use cables as short as possible.
- Perform the grounding with the ground resistance of 100Ω or less for the servomotor and SERVOPACK.
- Never use a line filter for the power supply in the motor circuit.



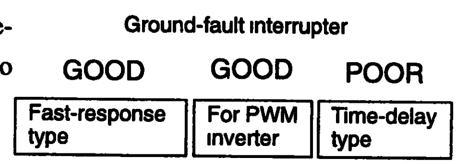
Conduct a voltage resistance test under the following conditions.

- Voltage: 1500 Vrms AC, one minute
- Current limit: 100 mA
- Frequency: 50/60 Hz
- Voltage application points: Between L1/Cr, L3C/t, L1/R, L2/S, L3/T terminals and frame ground (connect terminals securely).



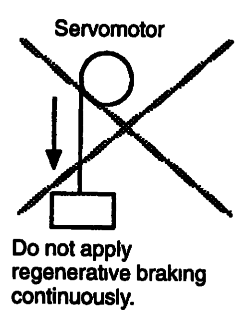
Use a fast-response type ground-fault interrupter.

For a ground-fault interrupter, always use a fast-response type or one designed for PWM inverters. Do not use a time-delay type.



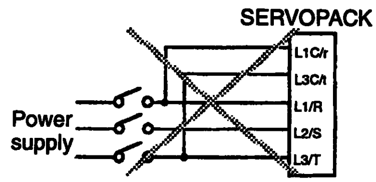
Do not perform continuous operation under overhanging load.

Continuous operation cannot be performed by rotating the motor from the load and applying regenerative braking. Regenerative braking by the SERVOPACK can be applied only for a short period, such as the motor deceleration time.



The servomotor cannot be operated by turning the power ON and OFF.

Frequently turning the power ON and OFF causes the internal circuit elements to deteriorate. Always start or stop the servomotor by using reference pulses.



Do not start or stop by turning power ON and OFF.

2.2 Installation

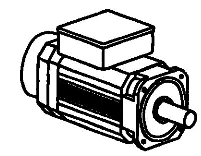
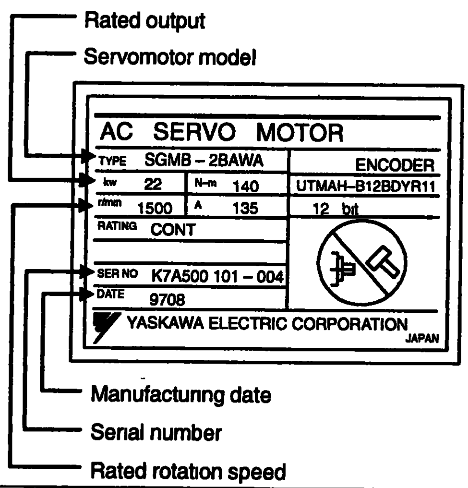
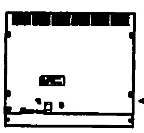
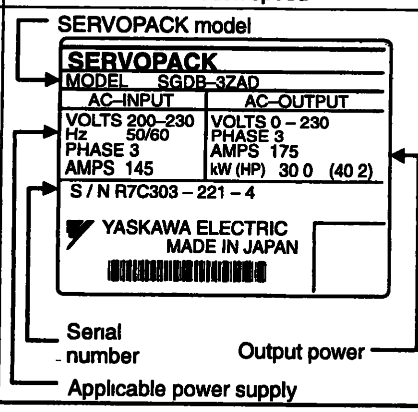
This section describes how to check Σ-Series products on delivery and how to install them.

2.2.1 Checking on Delivery

When Σ-Series products are delivered, check the following items:

Check Items	Remarks
Check if the delivered products are the ones you ordered.	Check the models marked on the nameplates of servomotor and SERVOPACK (see the following table)
Check if the motor shaft rotates smoothly	If the motor shaft is smoothly turned by hand, it is normal. However, if the motor has brakes, it cannot be turned manually
Check for damage.	Check the overall appearance, and check for damage or scratches resulting from transportation.
Check screws for looseness.	Check for looseness by using a screwdriver as necessary.

If any of the above items are faulty or incorrect, contact the dealer from which you purchased the products or your nearest local sales representative.

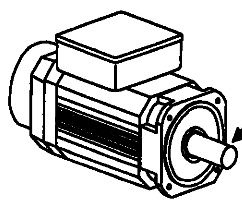
	Appearance	Nameplate	Model
Servo-motor	 Σ-Serıes servomotor	(Example) 	SGM B - 2B A 2 A □ □ Σ-Serıes servomotor Type B SGMB Motor capacıty 2B 22 kW 3Z 30 kW 3G 37 kW 4E 45 kW 5E 55 kW Standard A YASKAWA Standard Encoder specıfications 2 8192 P/R ıncremental (standard) 6 4096 P/R ıncremental (semı-standard) S 8192 P/R absolute (semı-standard) W 1024 P/R absolute (semı-standard) Options B 90VDC BRAKE C 24VDC BRAKE S Oıl seal F 90VDC BRAKE, Oıl seal G 24VDC Brake Oıl seal Shaft specıfications Blank Straıght, flange-type A Straıght flange-type (for use wıth optıon specıfıca-tıons) B Straıght, flange-type, wıth key and shaft-end tap K Straıght with foot L Straıght wıth foot, key, and shaft-end tap Rated rotatıon speed A, B 200 V, 1500 r/mın D, E 400 V, 1500 r/mın
SER-VO-PACK	 Name-plate Σ-Serıes SGDB SERVOPACK		SGDB - 2B A D Σ-Serıes SGDB SERVOPACK Motor capacıty 2B 22 kW 3Z 30 kW 3G 37 kW 4E 45 kW 5E 55 kW Voltage A 200 V D 400 V Model D torque, speed, posıtıon control

2.2.2 Installing the Servomotor

The SGMB servomotor can be installed either horizontally or vertically. However, if the servomotor is installed incorrectly or in an inappropriate location, the service life will be shortened or unexpected problems will occur. To prevent this, always observe the installation instructions described below.
When using the models with an oil seal, installing the motor with the output shaft up may cause oil to enter the motor depending on the operating conditions. Check the operating conditions.

Before installation:

Anticorrosive paint is coated on the edge of the motor shaft to prevent it from rusting during storage. Clean off the anticorrosive paint thoroughly using a cloth before installing the motor.



Storage:

When the servomotor is to be stored with the power cable disconnected, store it in the following temperature range:

Between –20°C and 60°C

Installation sites:

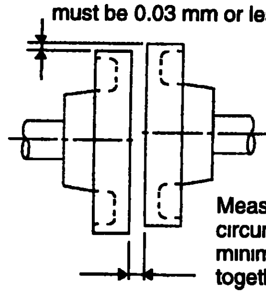
The SGMB servomotor is designed for indoor use.
Install servomotor in an environment which meets the following conditions:

1. Free from corrosive and explosive gases
2. Well-ventilated and free from dust and moisture
3. Ambient temperature of 0 to 40°C
4. Relative humidity of 20% to 80% (non-condensing)
5. Inspection and cleaning can be performed easily
6. Altitude of 1000 m max.

If the servomotor is used in a location subject to water or oil mist, the motor can be protected by taking necessary precautions on the motor side. However, if the **shaft opening** is to be sealed, specify the motor with oil seal. Install with the electrical connector facing downward.

Alignment:

Align the shaft of the servomotor with that of the equipment to be controlled, then connect the shafts with couplings. Install the servomotor so that alignment accuracy falls within the range shown below.



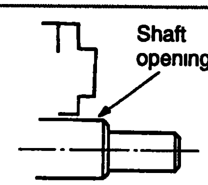
INFO

1. If the shafts are not aligned properly, vibration will occur, resulting in damage to the bearings.
2. A precision detector (encoder) is mounted on the opposite-drive end of the servomotor To mount a coupling, always protect the shaft from impacts that could damage the detector.
3. Before mounting the pinion gear directly to the motor output shaft, consult your Yaskawa sales representative.

TERMS

◆ Shaft opening

Refers to the space where the shaft comes out from the motor

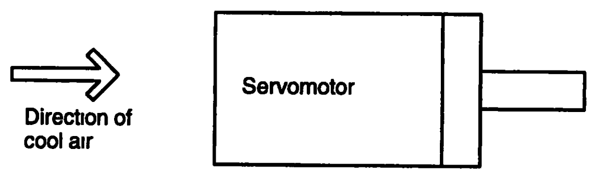


Wiring the Servomotor Power Lines

Connect the servomotor power lines (U, V, and W) to the servomotor terminal block (M10) in the servomotor terminal box. Connect the ground wire to the ground screw in the terminal box.

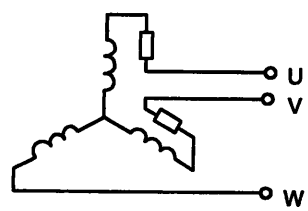
Wiring the Servomotor Fan

Wire the servomotor fan leads U(A), V(B), and W(C) so that the direction of air flows according to the following diagram. If the air flows in the opposite direction, change the wiring of any of the two phases U, V, and W.



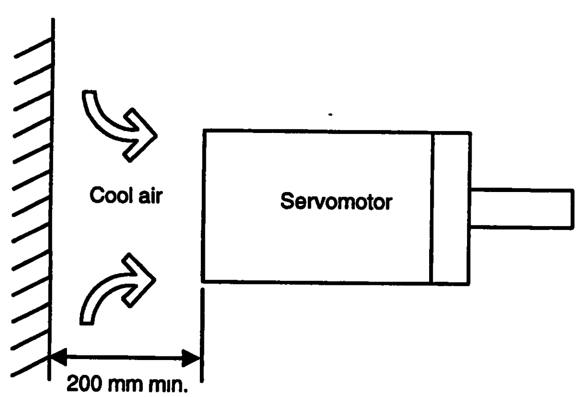
Protecting the Servomotor Fan

The servomotor fan has a built-in thermal protector, as shown in the following diagram, that operates at 140°C ± 5%. To protect the servomotor fan from overcurrent, use with a 2-A no-fuse breaker.



Installing the Servomotor Fan

To maximize the cooling capacity of the servomotor fan, install the fan at least 200 mm from the inlet side of the servomotor as shown in the following diagram.



Servomotor Connector Specifications

- Encoder Connector on Servomotor

The connector specifications for the encoder on the servomotor are as follows:

Encoder Connectors			
Plug		Cable Clamp	Receptacle*1
L-shaped	Straight		
JA08A-20-29S-JA-EB*2*3 or MS3108B20-29S	JA06A-20-29S-J1-EB*2*3 or MS3106B20-29S	JL04-2022CKE(**)*2*3 or MS3057-12A ** indicates the cable diameter	97F-3102E20-29P*3

← To be prepared by the customer →

* 1 Connector at servomotor is already provided
* 2 Manufactured by Japan Aviation Electronics Industry, Ltd
* 3 Waterproof

- Fan Connector on Servomotor

The connector specifications for the fan on the servomotor are as follows:

Fan Connectors			
Plug		Cable Clamp	Receptacle*1
L-shaped	Straight		
CE05-8A18-10SD-B-BAS*2*3 or MS3108B18-10S	CE05-6A18-10SD-B-BSS*2*3 or MS3106B18-10S	CE3057-10A-* (D265)*2*3 or MS3057-10A * indicates the cable diameter.	CE05-2A18-10PD-B*3

← To be prepared by the customer →

* 1 Connector at the servomotor is already provided
* 2 Manufactured by Daiichi Denshi Kogyo Co , Ltd
* 3 Waterproof

2.2.3 Allowable Thrust and Radial Shaft Loads

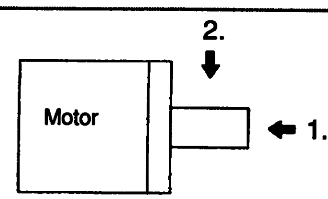
Design the mechanical system so that the **thrust load and radial load** applied to the servomotor shaft during operation fall within the ranges shown in the following table.

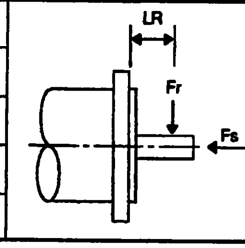
TERMS

◆ Thrust load and radial load

1 Thrust load
Shaft-end load applied parallel to the centerline of the shaft

2 Radial load
Shaft-end load applied perpendicular to the centerline of the shaft



Servomotor Model	Allowable Radial Load Fr [N(lbf)]	Allowable Thrust Load Fs [N(lbf)]	LR [mm(in.)]	Reference Drawing
SGMB-2BA□□	5880 (1322)	2156 (485)	100 (3.94)	
SGMB-3ZA□□	6272 (1410)	2156 (485)	100 (3.94)	
SGMB-3GA□□	7448 (1675)	2156 (485)	100 (3.94)	
SGMB-4EA□□	7840 (1763)	2156 (485)	100 (3.94)	
SGMB-5EA□□	8428 (1895)	2156 (485)	100 (3 94)	

Note Allowable radial and thrust loads shown above are the maximum values that could be applied to the shaft end

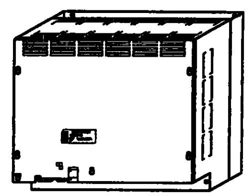
2.2.4 Installing the SERVOPACK

Σ-Series SGDB SERVOPACK is a base-mounting servo controller.
Incorrect installation will cause problems. Always observe the installation instructions described below.

Storage:

When the SERVOPACK is to be stored with the power cable disconnected, store it in the following temperature range:

Between −20°C and 85°C



SGDB SERVOPACK

Installation sites:

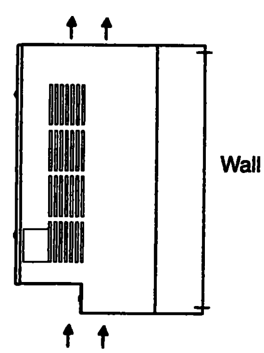
Situation	Notes on Installation
When installed in a control panel	Design the control panel size, unit layout, and cooling method so that the temperature around the periphery of the SERVOPACK does not exceed 55°C.
When installed near a heating unit	Suppress radiation heat from the heating unit and a temperature rise caused by convection so that the temperature around the periphery of the SERVOPACK does not exceed 55°C.
When installed near a source of vibration	Install a vibration isolator underneath the SERVOPACK to prevent it from receiving vibration
When installed in a place receiving corrosive gases	Corrosive gases do not immediately affect the SERVOPACK but will eventually cause contactor-related devices to malfunction. Take appropriate action to prevent corrosive gases.
Others	Avoid installation in a hot and humid place or where excessive dust or iron powder is present in the air

Orientation:

Install the SERVOPACK perpendicular to the wall as shown in the figure.

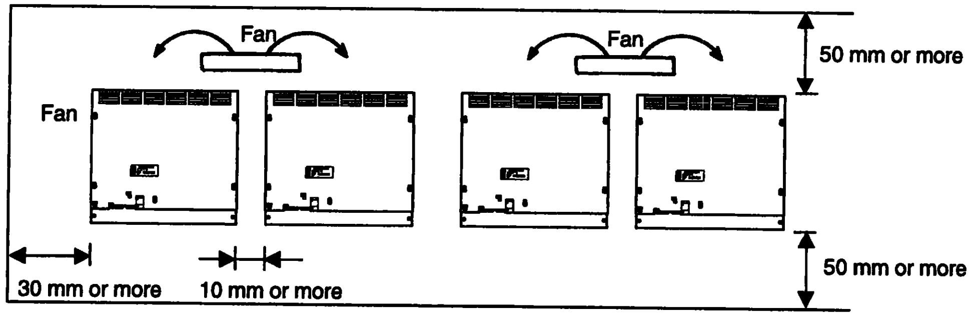
The SERVOPACK must be orientated as shown in the figure.

Firmly secure the SERVOPACK through three or four mounting holes.



Installation method:

When installing multiple SERVOPACKs side by side in a control panel, observe the following installation method:



1. Install SERVOPACK perpendicular to the wall so that the front panel (digital operator mounted face) faces outward.
2. Provide sufficient space around each SERVOPACK to allow cooling by fan and natural convection.
3. When installing SERVOPACKs side by side, provide at least 10 mm space between them and at least 50 mm space above and below them as shown in the figure above. Install cooling fans above the SERVOPACKs to prevent the temperature around each SERVOPACK from increasing excessively and also to maintain the temperature inside the control panel evenly.
4. Maintain the following conditions inside the control panel:
   - Ambient temperature for SERVOPACK: 0 to 55°C
   - Humidity: 90%RH or less
   - Vibration: 4.9 m/s^2
   - Condensation and freezing: None
   - Ambient temperature to ensure long-term reliability: 45°C or less

2.2.5 Power Loss

Power loss of SERVOPACK is given below:

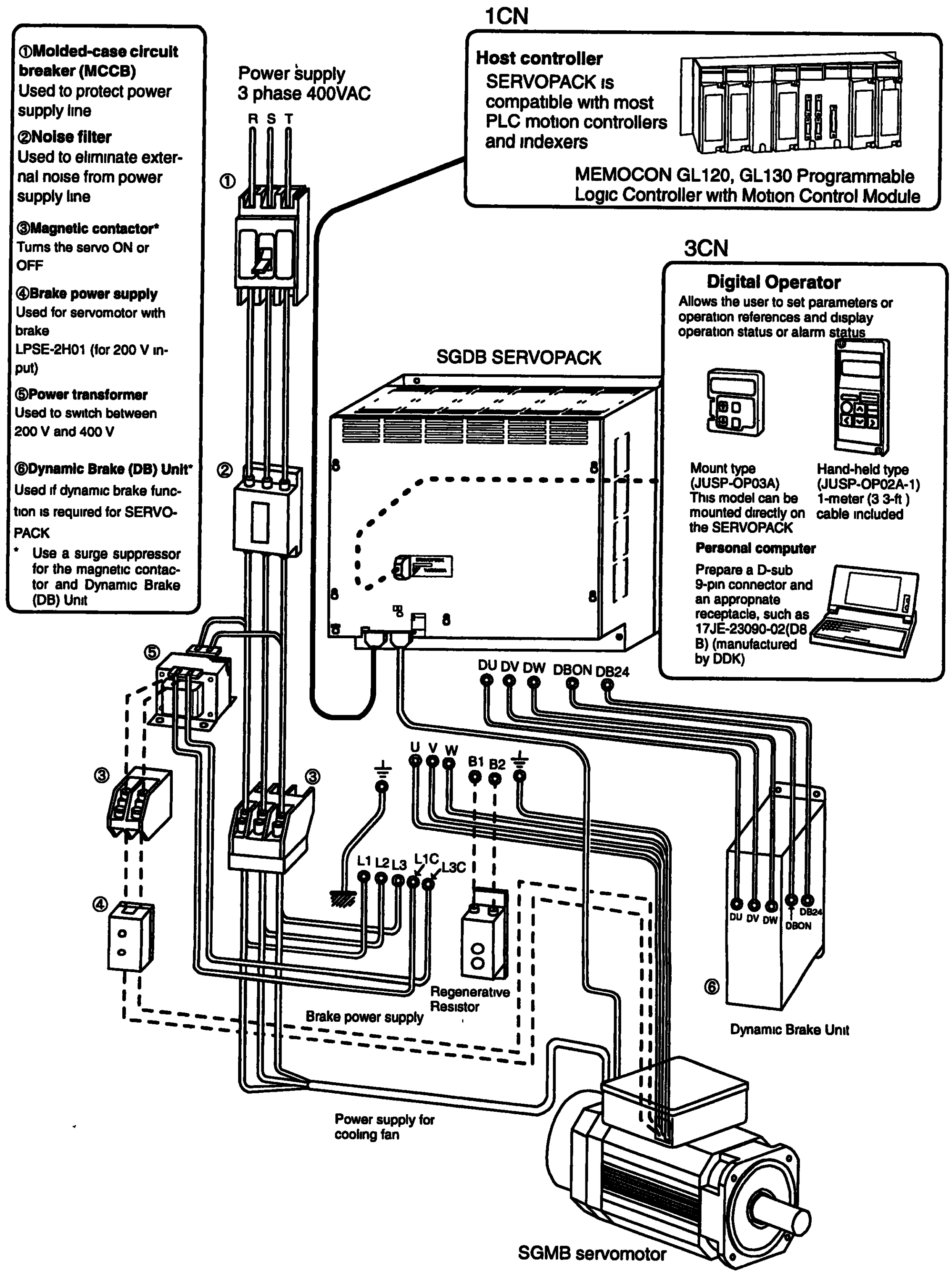
SERVOPACK Model	Output Current (RMS Value) A	Power Loss in Main Circuit W	Power Loss in Control Circuit W	Total Power Loss W
SGDB-2BAD	120	670	72	742
SGDB-3ZAD	175	980		1052
SGDB-3GAD	210	1700	120	1820
SGDB-2BDD	60	650		770
SGDB-3ZDD	88	970		1090
SGDB-3GDD	105	1140		1260
SGDB-4EDD	135	1440		1560
SGDB-5EDD	160	1720		1840

2.3 Connection and Wiring

This section describes how to connect Σ-Series products to peripheral devices and explains a typical example of wiring the main circuit. It also describes an example of connecting to main host controllers.

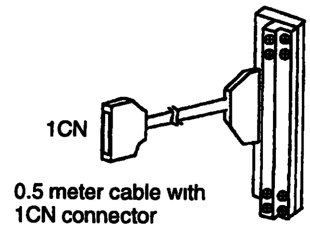
2.3.1 Connecting to Peripheral Devices

This section shows a standard example of connecting Σ-Series products to peripheral devices and briefly explains how to connect to each peripheral device.


①Molded-case circuit breaker (MCCB)
Used to protect power supply line
②Noise filter
Used to eliminate external noise from power supply line
③Magnetic contactor*
Turns the servo ON or OFF
④Brake power supply
Used for servomotor with brake
LPSE-2H01 (for 200 V input)
⑤Power transformer
Used to switch between 200 V and 400 V
⑥Dynamic Brake (DB) Unit*
Used if dynamic brake function is required for SERVOPACK
* Use a surge suppressor for the magnetic contactor and Dynamic Brake (DB) Unit
Power supply
3 phase 400VAC
R S T
①
②
③
③
④
⑤
1CN
Host controller
SERVOPACK is compatible with most PLC motion controllers and indexers
MEMOCON GL120, GL130 Programmable Logic Controller with Motion Control Module
3CN
Digital Operator
Allows the user to set parameters or operation references and display operation status or alarm status
Mount type
(JUSP-OP03A)
This model can be mounted directly on the SERVOPACK
Hand-held type
(JUSP-OP02A-1)
1-meter (3 3-ft) cable included
Personal computer
Prepare a D-sub 9-pin connector and an appropriate receptacle, such as 17JE-23090-02(D8B) (manufactured by DDK)
SGDB SERVOPACK
DU DV DW DBON DB24
U V W
B1 B2
L1 L2 L3 L1C L3C
Regenerative Resistor
Brake power supply
DU DV DW DBON DB24
⑥
Dynamic Brake Unit
Power supply for cooling fan
SGMB servomotor

Connector terminal block conversion unit (Model: JUSP-TA50P)

The terminal block allows connection to a host controller.

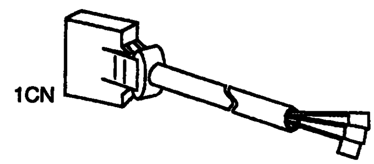


Cable with 1CN connector and one end without connector

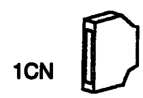
1m (3.3ft) DE9406969-1

2m (6.6ft) DE9406969-2

3m (9.8ft) DE9406969-3



1CN connector kit (Model: DP9406970)

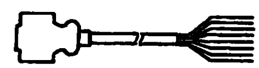


Cable for PG

This cable is used to connect the encoder of servomotor to the SERVOPACK.
The following three types of cables are available according to encoder types.

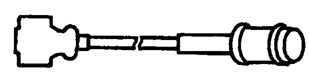
- Cable with a single connector (without connector on encoder end)

Length	Cable Model	
	Incremental	Absolute
3m (9.8ft)	JZSP-VBP00-03	JZSP-VBP10-03
5m (16.4ft)	JZSP-VBP00-05	JZSP-VBP10-05
10m (32.8ft)	JZSP-VBP00-10	JZSP-VBP10-10
15m (49.2ft)	JZSP-VBP00-15	JZSP-VBP10-15
20m (65.6ft)	JZSP-VBP00-20	JZSP-VBP10-20



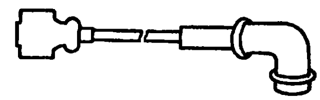
- Cable with connectors on both ends (straight plug on encoder end)

Length	Cable Model	
	Incremental	Absolute
3m (9.8ft)	JZSP-VBP01-03	JASP-VBP11-03
5m (16.4ft)	JZSP-VBP01-05	JASP-VBP11-05
10m (32.8ft)	JZSP-VBP01-10	JASP-VBP11-10
15m (49.2ft)	JZSP-VBP01-15	JASP-VBP11-15
20m (65.6ft)	JZSP-VBP01-20	JASP-VBP11-20



- Cable with connectors on both ends (L-shape plug on encoder end)

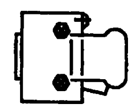
Length	Cable Model	
	Incremental	Absolute
3m (9.8ft)	JZSP-VBP02-03	JZSP-VBP12-03
5m (16.4ft)	JZSP-VBP02-05	JZSP-VBP12-05
10m (32.8ft)	JZSP-VBP02-10	JZSP-VBP12-10
15m (49.2ft)	JZSP-VBP02-15	JZSP-VBP12-15
20m (65.6ft)	JZSP-VBP02-20	JZSP-VBP12-20



Connector kit (DE9406973)for PG.
Connector on SERVOPACK end only

SERVOPACK end

2CN



2.3.2 Main Circuit Wiring and Power ON Sequence

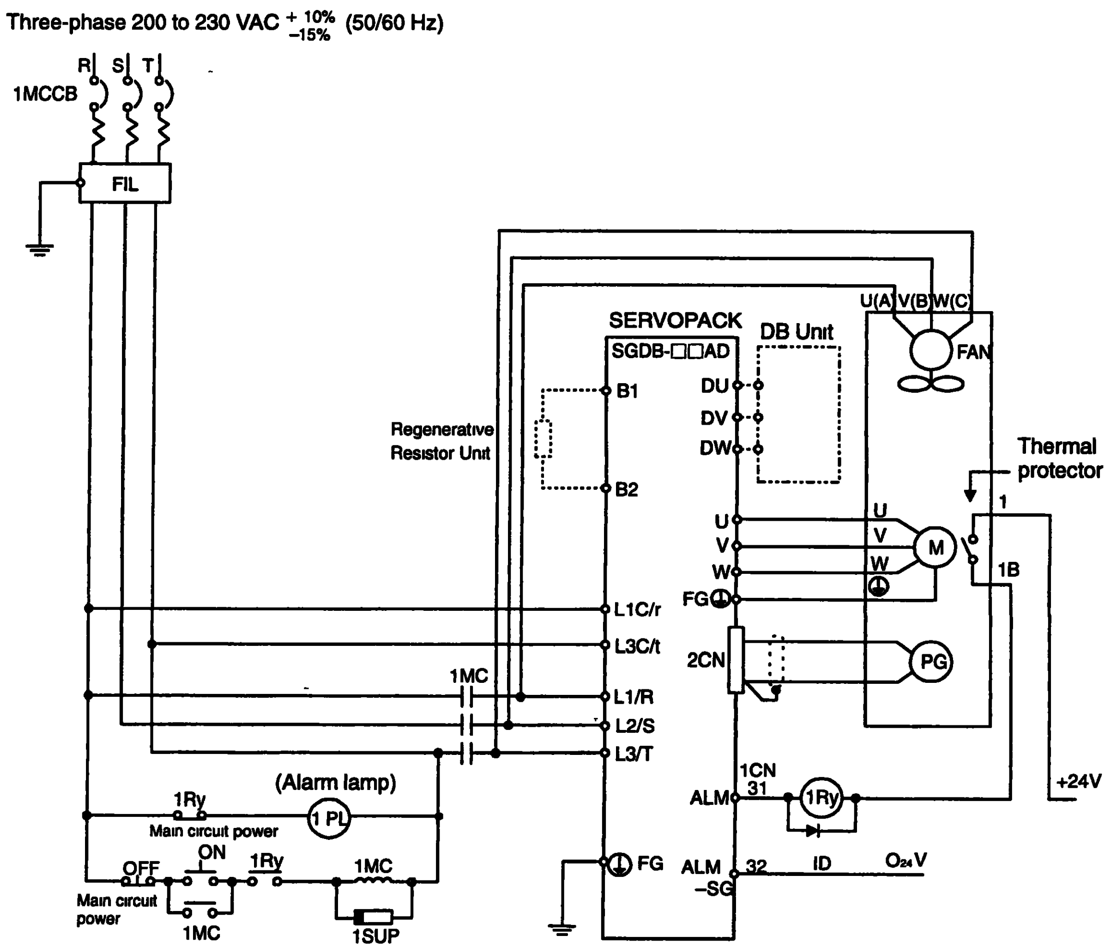
■ 200-V Power Supply

The following table shows the name and description of each main circuit terminal:

Terminal Symbol	Name	Description
L1/R, L2/S, L3/T	Main power input terminals	Three-phase 200 to 230 VAC$^{+10}_{-15}$% , 50/60Hz
U, V, W	Motor connection terminal	Used to connect motor
L1C/r, L3C/t	Control power input terminals	Single phase 200 to 220 VAC $^{+10}_{-15}$%, 50 Hz Single phase 200 to 230 VAC $^{+10}_{-15}$%, 60 Hz
⊕ ×2	Ground terminal	Connected to ground. (For power ground and motor ground).
+1, +2	DC reactor connection terminal	Used for power supply harmonic suppression (factory setting. short-circuited.)
B1, B2	Regenerative Resistor Unit connection terminal	Used to connect the regenerative resistor.
–	Main circuit negative terminal	Normally, external connection is not required.
DU, DV, DW	Dynamic Brake Unit connection terminal	Used to connect the Dynamic Brake Unit.
DBON, DB24	Dynamic Brake Unit connection terminal	Used to connect the Dynamic Brake Unit to the DBON and DB24 terminals (when using 37-kW SERVOPACKs only)

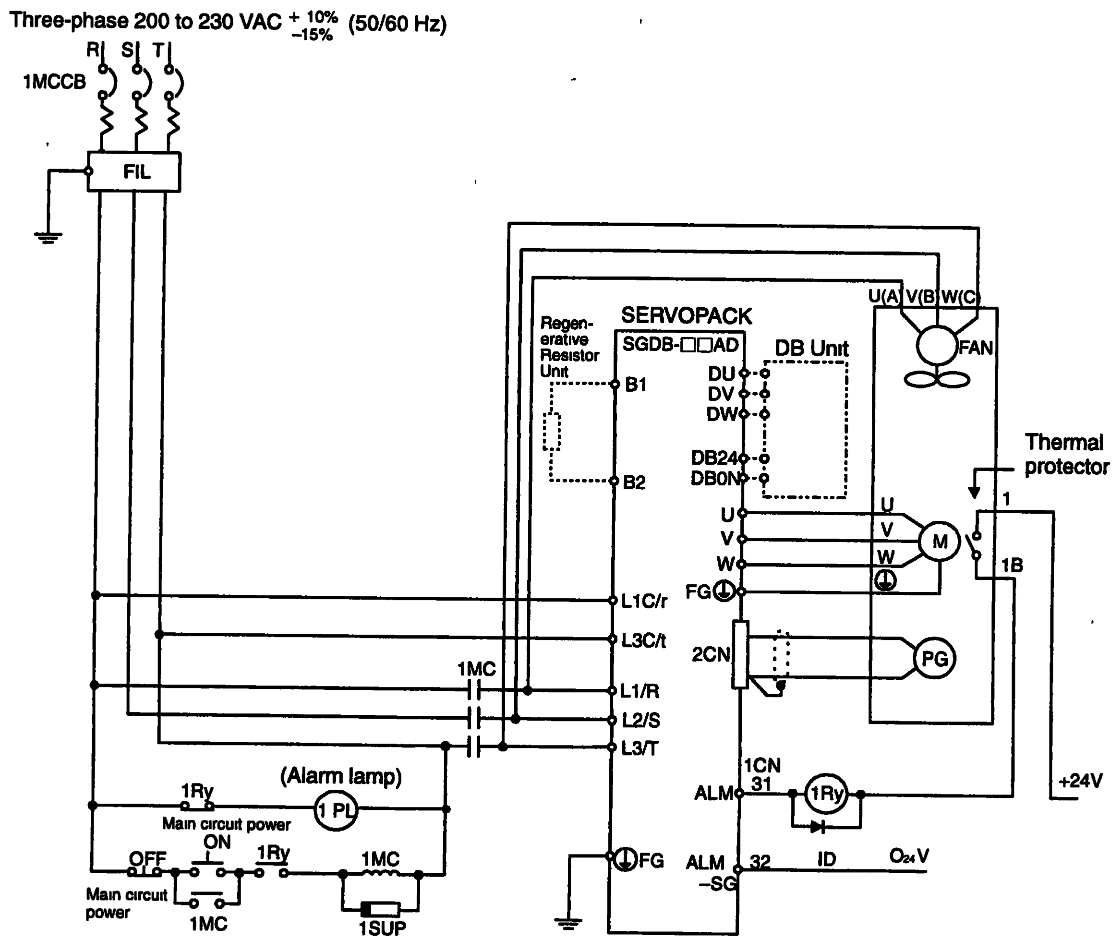
The following diagrams show typical examples of wiring the main circuit for Σ-Series products:

- Using 200 V, 22 kW or 30 kW



1MCCB:	Circuit breaker (for inverter type)
FIL	Noise filter
1MC.	Contactor
1Ry.	Relay
1PL:	Lamp for display
1SUP·	Surge suppressor
1D	Flywheel diode

- Using 200 V, 37 kW



1MCCB: Circuit breaker (for inverter type)
FIL: Noise filter
1MC: Contactor
1Ry: Relay
1PL: Lamp for display
1SUP: Surge suppressor
1D: Flywheel diode

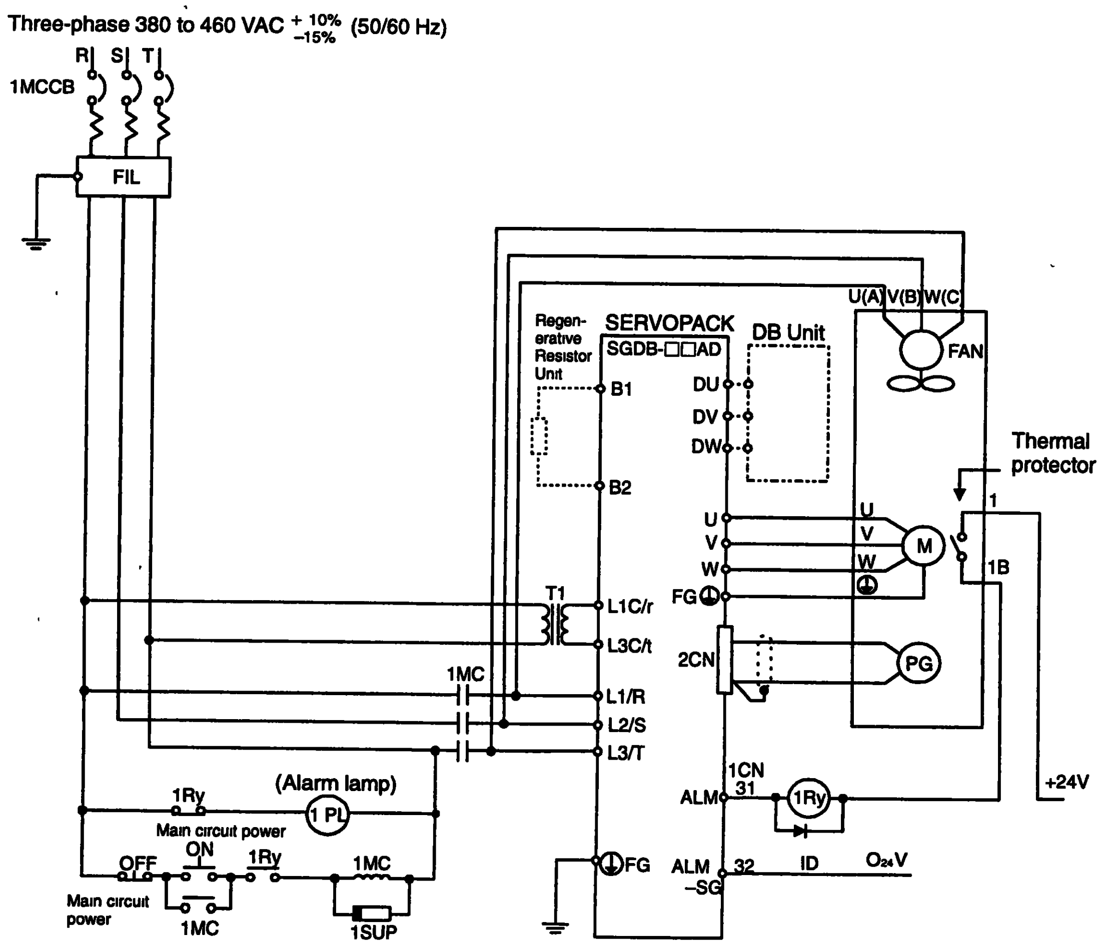
400-V Power Supply

The following table shows the name and description of each main circuit terminal:

Terminal Symbol	Name	Description
L1/R, L2/S, L3/T	Main power input terminals	Three-phase 380 to 460 VAC$^{+10}_{-15}$% , 50/60Hz
U, V, W	Motor connection terminal	Used to connect motor
L1C/r; L3C/t	Control power input terminals	Single phase 200 to 220 VAC $^{+10}_{-15}$%, 50 Hz Single phase 200 to 230 VAC $^{+10}_{-15}$%, 60 Hz
⊕ ×2	Ground terminal	Connected to ground. (For power ground and motor ground).
+1, +2	DC reactor connection terminal	Used to protect against harmonics (factory setting: short-circuited)
B1, B2	Regenerative Resistor Unit connection terminal	Used to connect the regenerative resistor.
–	Main circuit negative terminal	Normally, external connection is not required
DU, DV, DW	Dynamic Brake Unit connection terminal	Used to connect the Dynamic Brake Unit
DBON, DB24	Dynamic Brake Unit connection terminal	Used to connect the Dynamic Brake Unit to the DBON and DB24 terminals (when using 37-kW and 55-kW SERVOPACKs only).

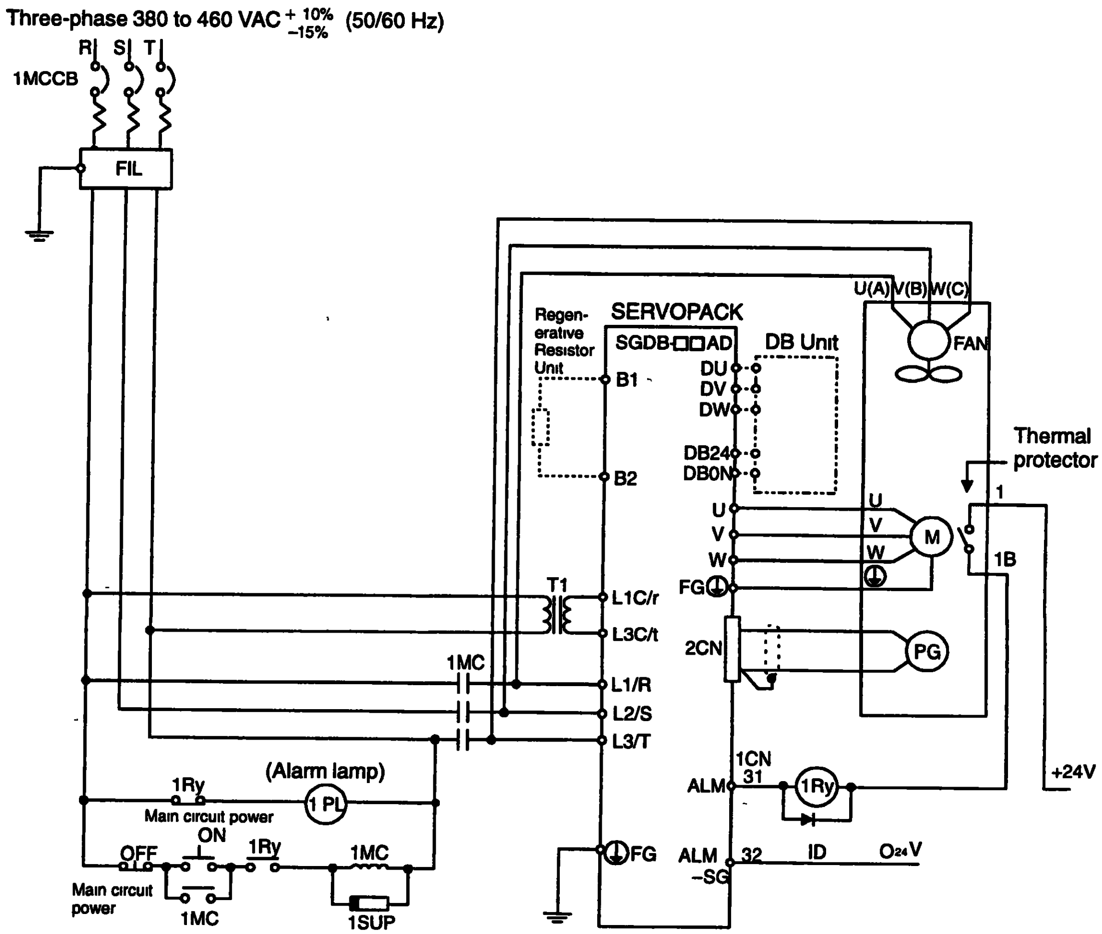
The following diagrams show typical examples of wiring the main circuit for Σ-Series products:

- Using 400 V, 22 kW or 30 kW



1MCCB	Circuit breaker (for inverter type)
FIL:	Noise filter
1MC.	Contactor
1Ry.	Relay
T1	Power transformer (400 V/200 V)
1PL:	Lamp for display
1SUP:	Surge suppressor
1D.	Flywheel diode

- Using 400 V, 37 kW to 55 kW



1MCCB: Circuit breaker (for inverter type)
FIL· Noise filter
1MC Contactor
1Ry. Relay
T1: Power transformer (400 V/200 V)
1PL Lamp for display
1SUP Surge suppressor
1D Flywheel diode

Note

- Do not wire power lines and signal lines in the same duct or bundle them together.
  Wire such that signal lines are kept apart from power lines by at least 30 cm.
- Twisted pair wire and multi-core twisted pair shielding wires should be used for signal lines, encoder (PG) feedback line.
  The length for wiring is 3 m maximum for the reference input line, 20 m maximum for the PG feedback line.
- Do not touch the power terminal even if power was turned OFF.
  High voltage may still remain in SERVOPACK
  Perform inspection only after the CHARGE lamp is OFF.
- Avoid frequently turning the power ON and OFF. Since the SERVOPACK has a capacitor in the power supply, a high charging current flows (for 0.2 second) when the power is turned

ON. Therefore, frequently turning the power ON and OFF causes the main circuit devices (such as capacitors and fuses) to deteriorate, resulting in unexpected problems.

2.3.3 Examples of Connecting I/O Signal Terminals

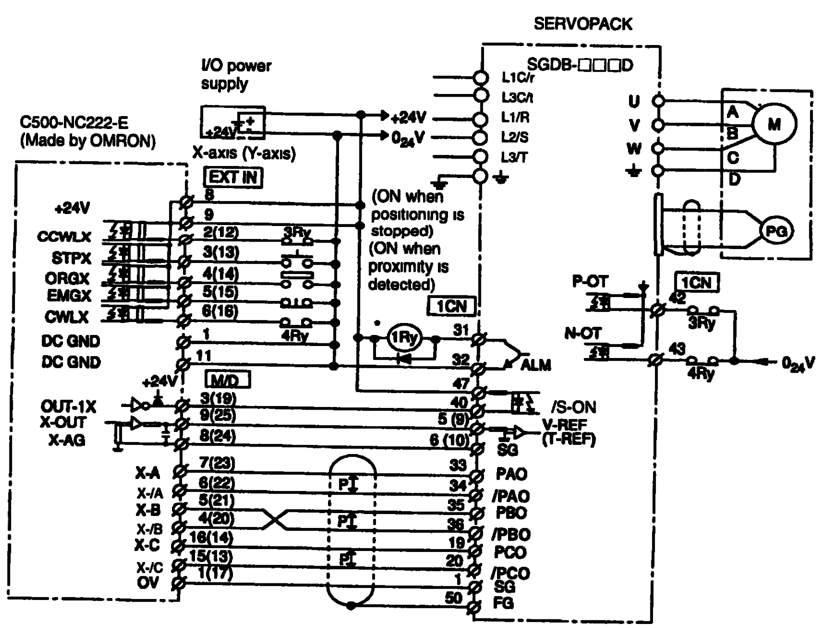
SGDB SERVOPACKs can be connected to the host controllers listed below. Connect the SERVOPACK to the host controller by referring to documentation for the host controller. Typical connection examples for the OMRON Position Control Unit and MITSUBISHI Positioning Unit are provided below.

- PROGIC-8
- GL-Series B2833 Positioning Module
- GL-Series B2813 Positioning Module
- OMRON C500-NC222-E and C500-NC112 Position Control Units
- MITSUBISHI AD72 and AD71 (B Type) Positioning Unit

■ Connection to OMRON C500-NC222-E Position Control Unit

Speed/Torque

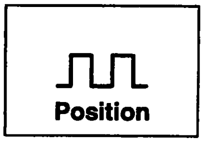
SERVOPACK for Speed/Torque Control



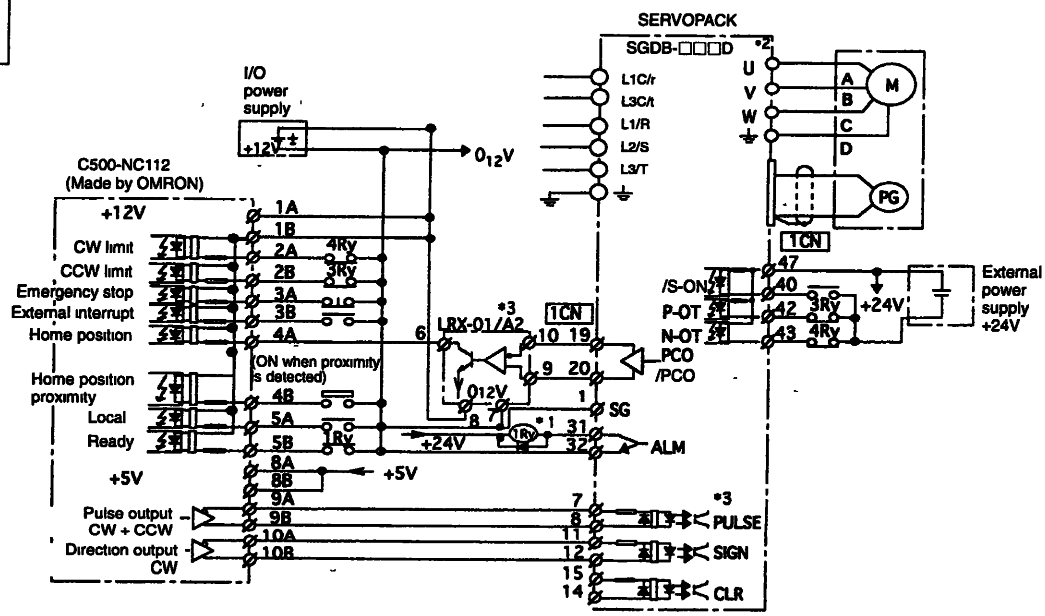
* These signals are output for approximately two seconds when the power is turned ON. Take this into consideration when designing a power ON sequence. Relay 1Ry is used to stop main circuit power supply to SERVOPACK.

Note The signals shown here are applicable only to OMRON C500-NC222-E Position Control Unit and Yaskawa SGDB-□□□D SERVOPACK.

■ Connection to OMRON C500-NC112 Position Control Unit



SERVOPACK for Position Control



* 1 These signals are output for approximately two seconds when the power is turned ON Take this into consideration when designing a power ON sequence. Relay 1Ry is used to stop main circuit power supply to SERVOPACK.

* 2 Change the Cn-02 setting as follows:
Bit No. 3 = 1
Bit No. 4 = 0
Bit No. 5 = 0

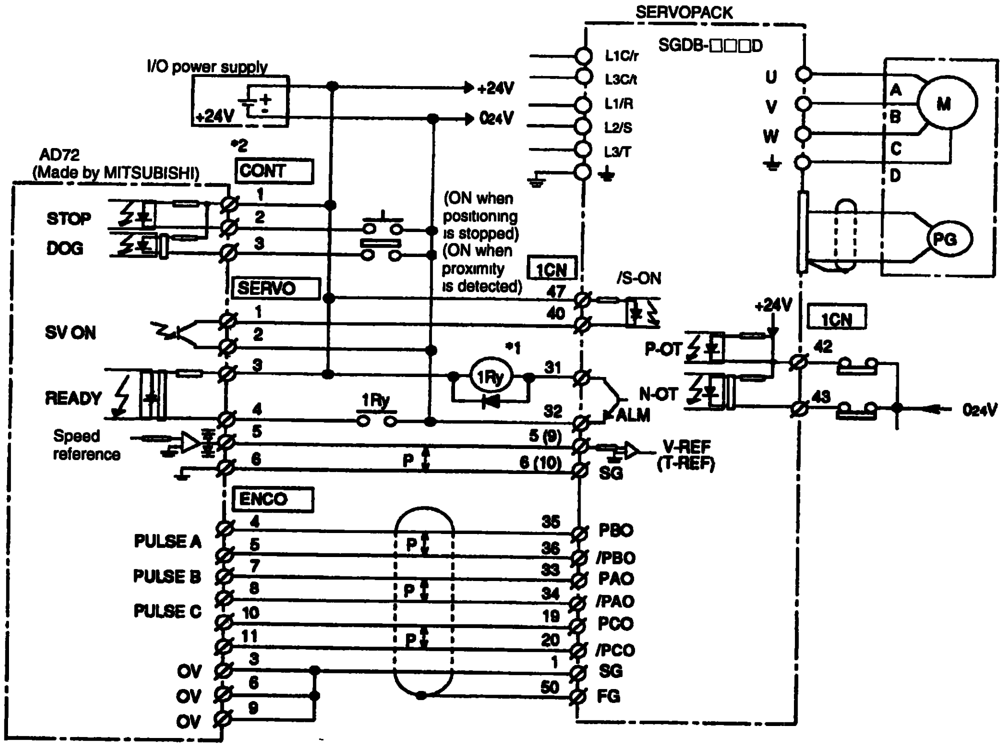
* 3 Manufactured by Yaskawa Controls Co , Ltd.

Note The signals shown here are applicable only to OMRON C500-NC112 Position Control Unit and Yaskawa SGDB-□□□D SERVOPACK.

Connection to MITSUBISHI AD72 Positioning Unit

Speed/Torque

SERVOPACK for Speed/Torque Control



* 1 These signals are output for approximately two seconds when the power is turned ON. Take this into consideration when designing a power ON sequence Relay 1Ry is used to stop main circuit power supply to SERVOPACK.

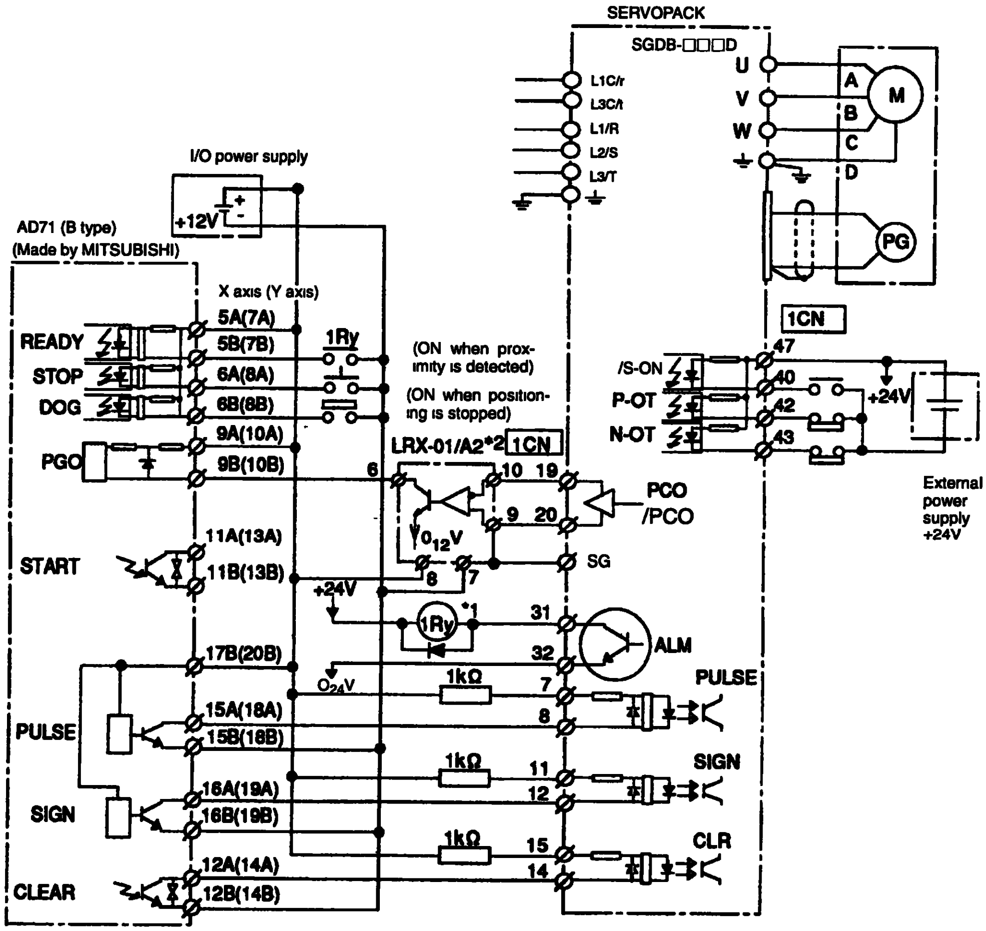
* 2 These pin numbers are the same for both X and Y axes

Note The signals shown here are applicable only to MITSUBISHI AD72 Positioning Unit and Yaskawa SGDB-□□□D SERVOPACK.

■ Connection to MITSUBISHI AD71 (B Type) Positioning Unit

Position

SERVOPACK for Position Control



* 1 These signals are output for approximately two seconds when the power is turned ON. Take this into consideration when designing a power ON sequence. Relay 1Ry is used to stop main circuit power supply to SERVOPACK.

* 2 Manufactured by Yaskawa Controls Co., Ltd.

Note The signals shown here are applicable only to MITSUBISHI AD71 (B Type) Positioning Unit and Yaskawa SGDB-□□□D SERVOPACK.

2.4 Conducting a Test Run

This section describes how to conduct a full test run. The test run is divided into two steps. Complete a test run in step 1 first, then proceed to step 2.

2.4.1 Test Run in Two Steps

Conduct the test run when wiring is complete.

Generally, conducting a test run for servo drives can be difficult. However, by following the two steps described below, the test run can be performed safely and correctly.

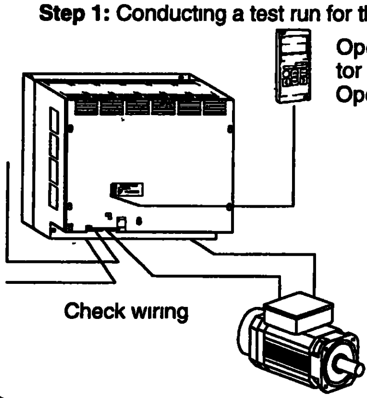
IMPORTANT

To prevent accidents, initially conduct a test run only for a servomotor under no load (i.e., with all couplings and belts disconnected). Do not run the servomotor while it is connected to a machine.

The test run is divided here into steps 1 and 2.

Complete the test run in step 1 first, then proceed to step 2. The purposes of each step are described on the next page.

Step 1: Conducting a test run for the motor without load .... Check that the motor is wired correctly

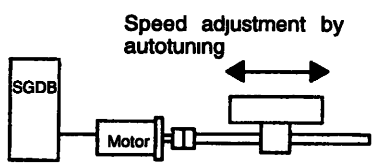


Conduct a test run with the motor shaft disconnected from the machine For wiring details, refer to *2.3.1 Connecting to Peripheral Devices.*

Purpose:
- To check power supply circuit wiring
- To check motor wiring
- To check I/O signal (1CN) wiring

Outline:
- Turn the power ON
- Operate the motor with a digital operator
- Check I/O signals (1CN)
- Conduct a test run using I/O signals

Step 2: Conducting a test run with the motor and machine connected .... Adjust SERVOPACK according to machine characteristics.



Connect to the machine.

Connect to the machine and conduct a test run.

Purpose:
- To perform autotuning to adjust the motor according to machine characteristics
- To match the speed and direction of rotation with the machine specifications
- To check the final control mode

Outline:
- Perform autotuning
- Adjust parameter settings
- Record parameter settings

End of test run

For servomotors with a brake, refer to *Section 2.4.4 Supplementary Information on Test Run* before starting a test run.

The following pages describe the test run procedure in detail.

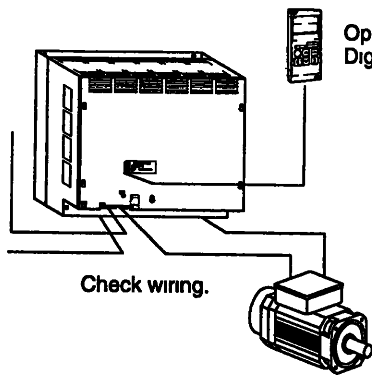
2.4.2 Step 1: Conducting a Test Run for Motor without Load

Check that the motor is wired correctly.

If the motor fails to rotate properly during a servo drive test run, the cause most frequently lies with incorrect wiring.

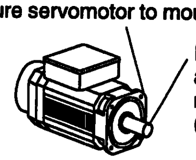
Conduct a test run for the motor without load according to the procedure described below.

For customers who use a servomotor with brake, refer to *Section 2.4.4 Supplementary Information on Test Run* before starting a test run.

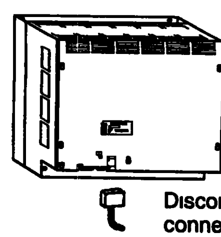


1. Secure the servomotor.
   Secure the servomotor to mounting holes to prevent it from moving during operation. Alternatively, install the servomotor on the machine and disconnect couplings and belts.

Secure servomotor to mounting holes.



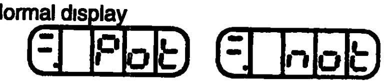
2. Disconnect connector 1CN, then check the motor wiring in the power supply circuit.
   I/O signals (1CN) are not to be used so leave connector 1CN disconnected.



3. Turn the power ON.
   Turn the SERVOPACK power ON. If the SERVOPACK is turned ON normally, the LED on the Digital Operator lights up as shown in the figure. Power is not supplied to the servomotor because the servo is OFF.

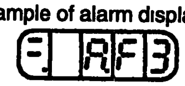
   If an alarm display appears on the LED as shown in the figure above, the power supply circuit, motor wiring or encoder wiring is incorrect. In this case, turn the power OFF, then correct the problem.

Normal display



Alternately displayed

Example of alarm display



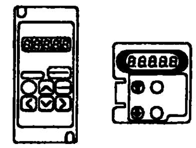
Refer to *Appendix E List of Alarm Displays.*

4. **Operate using the Digital Operator**

   Operate the motor with the Digital Operator. Check that the motor runs normally.

   Refer to *Section 4.2.2 Operation Using the Digital Operator.*

Operation by Digital Operator



If an alarm occurs, the power supply circuit, motor wiring, or encoder wiring is incorrect.

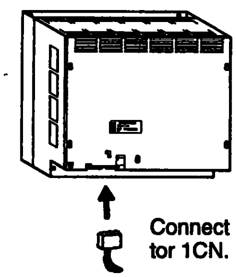
5. **Connect signal lines.**

   Connect connector 1CN as follows:

   a) Turn the power OFF.

   b) Connect connector 1CN.

   c) Turn the power ON again.

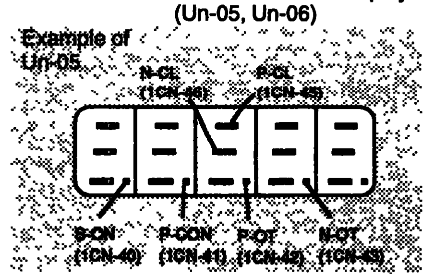


Connect connector 1CN.

6. **Check input signals.**

   Check the input signal wiring in monitor mode. For the checking method, refer to *Section 4.1.7 Operation in Monitor Mode.*

Internal status bit display (Un-05, Un-06)



- Checking method
  Turn each connected signal line ON and OFF to check that the monitor bit display changes accordingly.

The memory switch can be used to eliminate the need for external short-circuits in wiring (see pages 3 -7 and 3 -73).

Input Signal	ON/OFF	Monitor Bit Display
High level or open	OFF	Not lit
0 V level	ON	Lit

If the signal lines below are not wired correctly, the motor fails to rotate. Always wire them correctly. (If signal lines are not to be used, short them as necessary.)

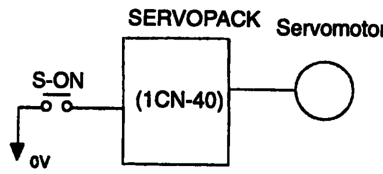
A memory switch can be used to eliminate the need for external short-circuit wiring (see pages 3 -4 and 3 -64).

P-OT	1CN-42	Motor can rotate in forward direction when this input signal is at 0 V.
N-OT	1CN-43	Motor can reverse when this input signal is at 0 V.
S-ON	1CN-40	Servo is turned ON when this input signal is at 0 V. However, leave the servo in OFF status.

7. Turn servo (motor) ON.

   Turn the servo ON as follows:

   a) Check that no reference has been input.
      For speed/torque control:
      V-REF (1CN-5) and T-REF (1CN-9) are at 0 V.
      For position control:
      PULS (1CN-7) and SIGN (1CN-11) are fixed.



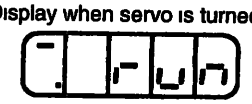
Turn the servo ON

INFO The parameter Cn-2B is used to set control modes (refer to *Section 3.2 Setting Parameters According to Host Controller*).

---

   b) Turn the servo ON signal ON.
      Set /S-ON (1CN-40) to 0 V. If normal, the motor starts and the Digital Operator displays the data as shown in the figure. If an alarm display appears, take appropriate action as described in *Appendix E List of Alarm Displays*.

Display when servo is turned ON



8. Operate by reference input.

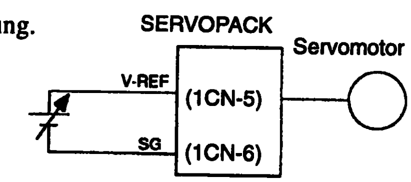
   The operating procedure varies according to the setting of parameter "Control mode selection (Cn-2B)."

Speed/Torque

SERVOPACK for Speed/Torque

This section describes the standard speed control setting.

1. Gradually increase the speed reference input (V-REF, 1CN-5) voltage. The motor will rotate.



Servomotor rotates at a speed proportional to the reference voltage.

   When a host controller such as a programmable controller performs position control, it may be difficult to directly input the speed reference voltage. In this case, constant voltage reference should be input once to ensure correct operation.

2. Check the following items in monitor mode (see page 4-14):

   a) Has a reference speed been input?

   b) Is the rotation speed the same value as the setting one?

   c) Does the reference speed match the actual motor speed?

   d) Does the motor stop when no reference is input?

Un-00	Actual motor speed
Un-01	Reference speed

3. If the motor rotates at an extremely slow speed when 0 V is specified as the reference voltage, correct the reference offset value as described in *Section 4.2.4 Reference Offset Automatic Adjustment*.

4. To change motor speed or the direction of rotation, reset the parameters shown below.

Cn-03	Speed reference gain (see page 3 -16)
Cn-02 bit 0	Reverse rotation mode (see page 3 -5)

Position

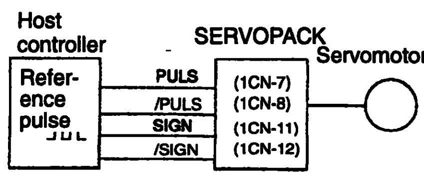
SERVOPACK for Position Control

1. Set parameter Cn-02 so that the reference pulse form matches the host controller output form. (See page 4 -9 for details on how to set parameters.)

Selecting reference pulse form (See page 3 -18)

Cn-02	Bit 3
	Bit 4
	Bit 5

2. Input slow speed pulses from the host controller and execute low-speed operation.



3. Check the following items in monitor mode (see page 4 -14):

   a) Has a reference pulse been input?

   b) Is the motor speed as designed?

   c) Does the reference speed match the actual motor speed?

   d) Does the motor stop when no reference is input?

Un-00	Actual motor speed
Un-07	Reference pulse speed display
Un-08	Position error

4. To change motor speed or the direction of rotation, reset the parameters shown below.

Cn-24,Cn-25	Electronic gear ratio (see page 3 -30)
Cn-02 bit 0	Reverse rotation mode (see page 3 -5)

If an alarm occurs or the motor fails to rotate during the above operation, connector 1CN wiring is incorrect or the parameter settings do not match the host controller specifications. In this case, check the wiring and review the parameter settings, then repeat step 1.

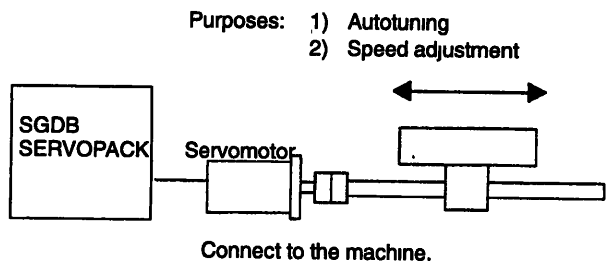
Refer to *Appendix D List of Parameters* and *Appendix E List of Alarm Displays.*

This is all that is required to complete step 1 (conducting a test run for motor without load). Whenever possible, perform tuning associated with the host controller and other necessary adjustments in step 1 (before installing the motor on the machine).

2.4.3 Step 2: Conducting a Test Run with the Motor Connected to the Machine

After step 1 is complete, proceed to step 2 in which a test run is conducted with the motor connected to the machine. The purpose of step 2 is to adjust the SERVOPACK according to the machine characteristics.

Conduct a test run according to the procedure described below.



IMPORTANT

Before proceeding to step 2, repeat step 1 (conducting a test run for the motor without load) until you are fully satisfied that the test has been completed successfully. Operation faults that arise after the motor is connected to the machine not only damage the machine but may also cause an accident resulting in injury or death. Therefore, all items including parameters setting and wiring should be tested as conclusively as possible before step 1 is complete.

1. Check that power is OFF.
   Turn the SERVOPACK power OFF.
2. Connect the servomotor to the machine.
   Refer to *Section 2.2.2 Installing the Servomotor.*
3. Perform autotuning.
   Tune the SERVOPACK according to the machine characteristics. Refer to *Section 4.2.3 Autotuning.*
4. Operate by reference input.
   As in step 1 (conducting a test run for motor without load), perform (8) *Operate by reference input* on page 2 -31. Perform tuning associated with the host controller.
5. Set parameters and record the settings.
   Set parameters as necessary. Record all the parameter settings for maintenance purposes.

   This is all that is required to conduct the test run.

   Normally, the machine may cause much friction because of an insufficient running-in period. After a test run is complete, perform adequate running-in.

2.4.4 Supplementary Information on Test Run

In the following cases, always refer to the information described below before starting a test run:

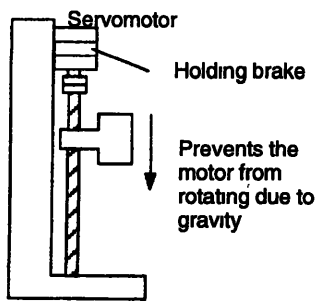
- When using a servomotor with a brake
- When performing position control from the host controller

■ When Using a Servomotor with Brake

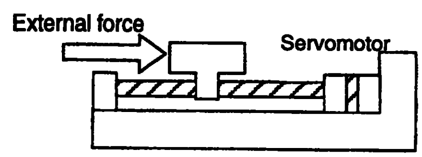
The brake prevents the motor shaft from rotating due to a backdriving torque. Such a torque may be created by an external force or the force of gravity acting on the load and may result in undesired motion or the load, should motor power be lost.

SERVOPACK uses the brake interlock output (BK) signal to control holding brake operation for a servomotor with brake.

- Vertical axis



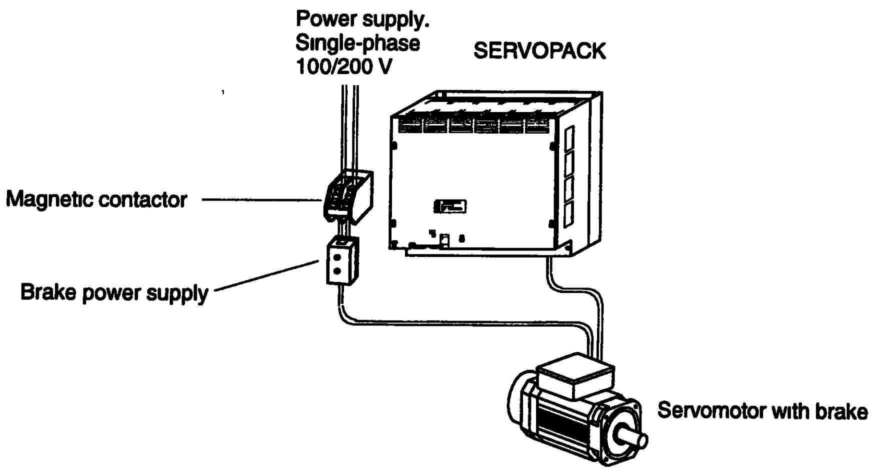
- Axis to which external force is applied



INFO

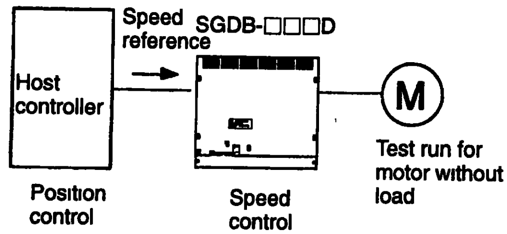
To prevent faulty operation caused by gravity (or external force), first check that the motor and holding brake operate normally with the motor disconnected from the machine Then, connect the motor to the machine and conduct a test run.

For wiring of a servomotor with a brake, refer to *Section 3.4.4 Using Holding Brake.*



When Performing the Position Control from the Host Controller

Check motor operation first and then conduct a test run as described in the table below.



IMPORTANT

Check the motor operation with the motor disconnected from the machine. If the host controller does not perform position control correctly, the motor may run out of control.

Reference from Host Controller	Check Items	Check Method	Review Items
Jogging (constant-speed reference input from host controller)	Motor speed	Check the motor speed as follows: • Use the speed monitor (Un-00) of the digital operator. • Run the motor at low speed. For example, input a speed reference of 60 r/min and check that the motor makes one revolution per one second.	Check whether the speed reference gain value (parameter Cn-03) is correct.
Simple positioning	Number of motor revolutions	Input a reference equivalent to one motor revolution and visually check that the motor shaft makes one revolution.	Check whether the dividing ratio count (parameter Cn-0A) is correct.
Overtravel (when P-OT and N-OT signals are used)	Whether the motor stops rotating when P-OT and N-OT signals are input	Check that the motor stops when P-OT and N-OT signals are input during continuous motor operation.	If the motor does not stop, review the P-OT and N-OT wiring.

2.4.5 Minimum Parameters Required and Input Signals

This section describes the minimum parameters that must be set to conduct a test run. For details on how to set each parameter, refer to *Section 4.1.6 Operation in Parameter Setting Mode.*

- Basic parameters (common to speed, torque, position control)

Cn-11	Number of encoder pulses
Cn-01, bit E	Encoder selection
Cn-2A	Motor selection (check only in substance).
Cn-2C	PG power supply voltage change

- For speed/torque control

Cn-03	Speed reference gain (see page 3 -16)
Cn-0A	Dividing ratio setting

- For position control

Cn-02 bits 3, 4 and 5	Reference pulse form selection (see page 3 -18)
Cn-24	Electronic gear ratio (numerator) (see page 3 -30)
Cn-25	Electronic gear ratio (denominator) (see page 3 -30)

When these parameters (except for Cn-03) are changed, always turn the power OFF, then back ON. This makes the new setting valid.

If the specified direction of rotation differs from the actual direction of rotation, the wiring may be incorrect. In this case, recheck the wiring and correct it accordingly. Then, if the direction of rotation is to be reversed, set the following parameter:

Cn-02 (bit 0)	Reverse rotation mode (see page 3 -5)

After changing the Cn-02 setting, always turn the power OFF, then ON, to make the new setting valid.

The following table lists the minimum input signals required to conduct a test run. For details of each input signal, refer to the relevant page.

Signal Name		Pin Number	Function
/S-ON	(servo ON)	1CN-40	Switching between motor ON and OFF status. The memory switch can be used to eliminate the need for external short-circuit wiring (see page 3 -7).
P-OT	(forward rotation prohibited)	1CN-42	Overtravel limit switch The memory switch can be used to eliminate the need for external short-circuit wiring (see page 3 -7).
N-OT	(reverse rotation prohibited)	1CN-43	

3

APPLICATIONS OF Σ-SERIES PRODUCTS

This chapter is prepared for readers who wish to learn more about the applications of Σ-series products after fully understanding *Chapter 2 Basic Uses of Σ-series Products*. It explains how to set parameters for each purpose and how to use each function. Read the applicable sections according to your requirements.

3

Before Reading this Chapter

This chapter describes how to use each 1CN connector I/O signal for the SGDB SERVOPACK and how to set the corresponding parameter.

- For a list of I/O signals of 1CN connector, refer to *Appendix C List of I/O Signals.*
- For terminal arrangement for I/O signals of 1CN connector, refer to *Section 3.8.6 Connector Terminal Layouts.*
- For a list of parameters, refer to *Appendix D List of Parameters.*

Parameters are divided into the following two types.

Memory switch Cn-01 and Cn-02	Set each bit to ON or OFF to select a function.
Constant setting Cn-03 and later	Set a numerical value such as a torque limit value or speed loop gain.

- For details on how to set parameters, refer to *Section 4.1.6 Operation in Parameter Setting Mode.*

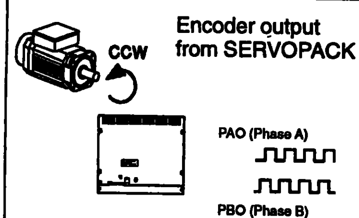
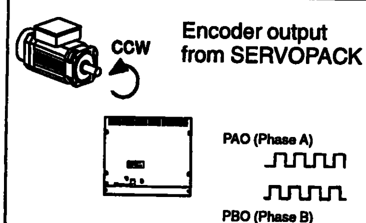
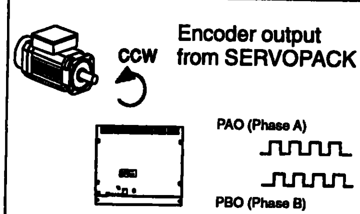
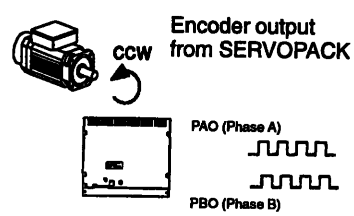
3.1 Setting the Parameters According to Machine Characteristics

This section describes how to set parameters according to the dimensions and performance of the machine to be used.

3.1.1 Changing the Direction of Motor Rotation

This SERVOPACK provides a reverse rotation mode in which the direction of rotation can be reversed without altering the servomotor wiring. With the standard setting, forward rotation is defined as counterclockwise (ccw) rotation viewed from the drive end.

If reverse rotation mode is used, the direction of motor rotation can be reversed without other items being changed. The direction (+/–) of axial motion is reversed.

	Standard Setting	Reverse Rotation Mode
Forward Run Reference		
Reverse Run Reference		

■ Setting the Reverse Rotation Mode

Reverse rotation mode can be set in either of the following two ways. Normally, method 1 is easier to use.

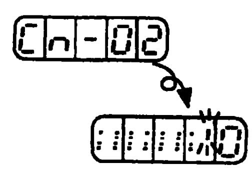
- **Method 1: Setting the Memory Switch**

Set bit 0 of memory switch Cn-02 to select reverse rotation mode.

Cn-02 Bit 0	Rotation Direction Selection	Factory Setting: 0	For Speed/Torque Control and Position Control

Set the direction of rotation.

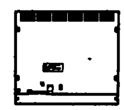
Setting	Meaning	
0	Forward rotation is defined as counterclockwise rotation when viewed from the drive end	(Standard setting)
1	Forward rotation is defined as clockwise rotation when viewed from the drive end.	(Reverse rotation mode)

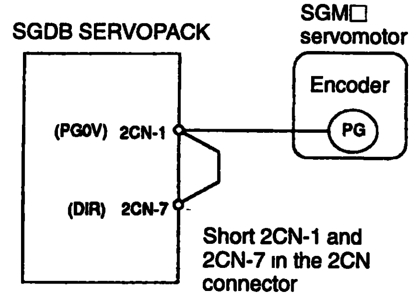


- **Method 2: Shorting the Wiring in the 2CN Connector**

Reverse rotation mode can be set for the 2CN connector for the encoder. This method is used to standardize parameter settings without using the memory switch.

In this case, reverse rotation mode is set regardless of the memory switch setting.





IMPORTANT Be sure to short 2CN-1 and 2CN-7 in the 2CN connector. Do not wire this connection externally.

3.1.2 Setting the Overtravel Limit Function

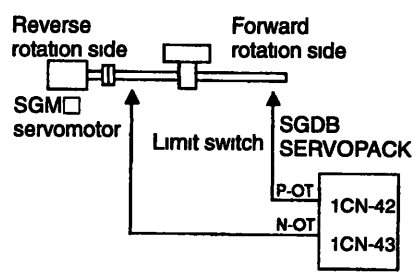
The overtravel limit function forces the moving part of the machine to stop when it exceeds the movable range.

To use the overtravel limit function, connect the following input signal terminals correctly.

→ Input P-OT 1CN-42	Forward Rotation Prohibited (Forward Overtravel)	For Speed/Torque Control and Position Control
→ Input N-OT 1CN-43	Reverse Rotation Prohibited (Reverse Overtravel)	For Speed/Torque Control and Position Control

Input terminals for overtravel limit switch.

For linear motion, connect a limit switch to prevent damage to the machine.



P-OT	ON: 1CN-42 is at low level	Forward rotation allowed. Normal operation status.
	OFF: 1CN-42 is at high level.	Forward rotation prohibited (reverse rotation allowed)
N-OT	ON. 1CN-43 is at low level.	Reverse rotation allowed. Normal operation status.
	OFF· 1CN-43 is at high level.	Reverse rotation prohibited (forward rotation allowed).

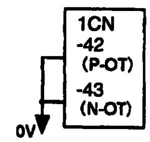
Use the following parameters (memory switch) to specify whether input signals for overtravel are to be used.

Cn-01 Bit 2	Use of P-OT Input Signal	Factory Setting: 0	For Speed/Torque Control and Position Control
Cn-01 Bit 3	Use of N-OT Input Signal	Factory Setting: 0	For Speed/Torque Control and Position Control

Specifies whether the P-OT input signal for prohibiting forward rotation at overtravel (1CN-42) is to be used and whether the N-OT input signal for prohibiting reverse rotation at overtravel (1CN-43) is to be used.

Specifies "1" when external short-circuit wiring is to be omitted.

SGDB SERVOPACK



The short-circuit wiring shown in the figure can be omitted when P-OT and N-OT are not used.

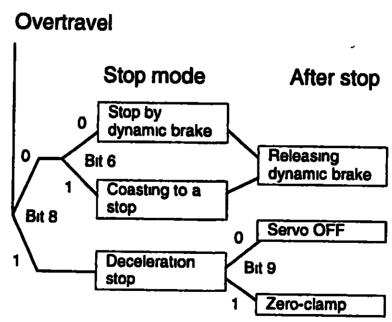
Bit	Setting	Meaning
Cn-01 bit 2	0	Uses the P-OT input signal for prohibiting forward rotation. (Forward rotation is allowed when 1CN-42 is at 0 V.)
	1	Does not use the P-OT input signal for prohibiting forward rotation. (Forward rotation is always allowed. This has the same effect as shorting 1CN-42 to 0 V.)
Cn-01 bit 3	0	Uses the N-OT input signal for prohibiting reverse rotation. (Reverse rotation is prohibited when 1CN-43 is open. Reverse rotation is allowed when 1CN-43 is at 0 V.)
	1	Does not use the N-OT input signal for prohibiting reverse rotation. (Reverse rotation is always allowed This has the same effect as shorting 1CN-43 to 0 V.)

If the P-OT and N-OT input signals are used, set the following parameters to specify how to stop the motor.

Cn-01 Bit 8	How to Stop Motor at Overtravel	Factory Setting: 0	Invalid for Torque Control
Cn-01 Bit 9	Operation to be Performed when Motor Stops after Overtravel	Factory Setting: 0	Invalid for Torque Control

- Inputs signal for prohibiting forward rotation (P-OT, 1CN-42)
- Inputs signal for prohibiting reverse rotation (N-OT, 1CN-43)

Specify how to stop the motor when either of the above signals is input.



	Setting	Meaning
Cn-01 bit 8	0	Stop the motor in the same way as when the servo is turned OFF. The motor is stopped by dynamic brake or coasts to a stop. Either of these stop modes is selected by setting bit 6 of Cn-01.
	1	Stop the motor by decelerating it with the preset torque. Preset value: Cn-06 (EMGTRQ) emergency stop torque

If deceleration stop mode is selected, specify the operation to be done after the motor stops.

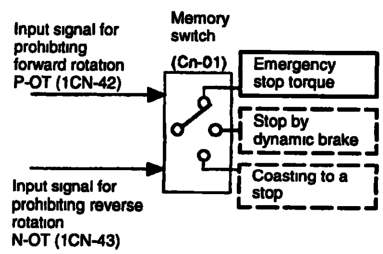
	Setting	Meaning
Cn-01 bit 9	0	Turns the servo OFF when the motor stops in deceleration stop mode
	1	Causes the motor to enter zero-clamp status after it stops in deceleration stop mode.

In torque control mode, the motor stops in the same way as when the servo is turned OFF, regardless of the bit 8 setting.

Cn-06	EMGTRQ Emergency Stop Torque	Unit: %	Setting Range. 0 to Maximum Torque	Factory Setting: Maximum Torque	Valid when Cn-01 bit 8 = 1

Specifies the stop torque to be applied at overtravel when the input signal for prohibiting forward or reverse rotation is to be used.

Specifies a torque value in terms of a percentage of the rated torque.

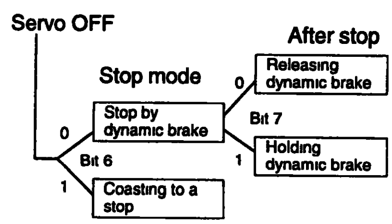


Cn-01 Bit 6	How to Stop Motor at Servo OFF	Factory Setting: 0	
Cn-01 Bit 7	Operation to Be Performed when Motor Stops after Servo OFF	Factory Setting 1	Invalid for 2.0 kW or more

The SERVOPACK enters servo OFF status when:

- Servo ON input signal (/S-ON, 1CN-40) is turned OFF.
- Servo alarm arises.
- Power is turned OFF.

Specify how to stop the motor when one of the above events occurs during operation.



Dynamic brake is a function that electrically applies brakes by using a resistor to consume motor rotation energy.

	Setting	Meaning
Cn-01 bit 6	0	Stops the motor by dynamic brake.
	1	Causes the motor to coast to a stop. The motor power is OFF and stops due to machine friction.

If dynamic brake stop mode is selected, specify the operation to be performed when the motor stops.

	Setting	Meaning
Cn-01 bit 7	0	Releases dynamic brake after the motor stops
	1	Does not release dynamic brake even after the motor stops.

Note For SERVOPACKs of 2.0 kW or more, bit 7 of Cn-01 can be set to 0 only.

3.1.3 Restricting Torque

The SERVOPACK can provide the following torque control:

- Torque restriction
  - Level 1: To restrict the maximum output torque to protect the machine or workpiece
  - Level 2: To restrict torque after the motor moves the machine to a specified position
- Torque control
  - Level 3: To always control output torque, not speed
  - Level 4. To alternately use speed control and torque control

This section describes how to use levels 1 and 2 of the torque restriction function.

■ How to Set Level 1: Internal Torque Limit

The maximum torque is restricted to the values set in the following parameters.

Cn-08	TLMTF Forward Rotation Torque Limit	Unit: %	Setting Range. 0 to 800	Factory Setting. 800	For Speed/Torque Control and Position Control
Cn-09	TLMTR Reverse Rotation Torque Limit	Unit. %	Setting Range: 0 to 800	Factory Setting: 800	For Speed/Torque Control and Position Control

Sets the maximum torque values for forward rotation and reverse rotation, respectively.

Sets these parameters when torque must be restricted according to machine conditions.

This torque restriction function always monitors torque, and outputs the signal shown on the right when the limit value is reached.

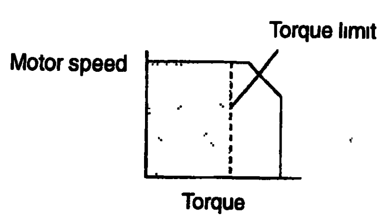
Specifies a torque limit value in terms of a percentage of the rated torque.

If a value higher than the maximum torque is set, the maximum torque value is used.

Output Signal for Torque Restriction Function

• /CLT • Monitor mode (Un-06) bit 4
Parameter Setting: (Cn-2D) = □□3, □3□, 3□□

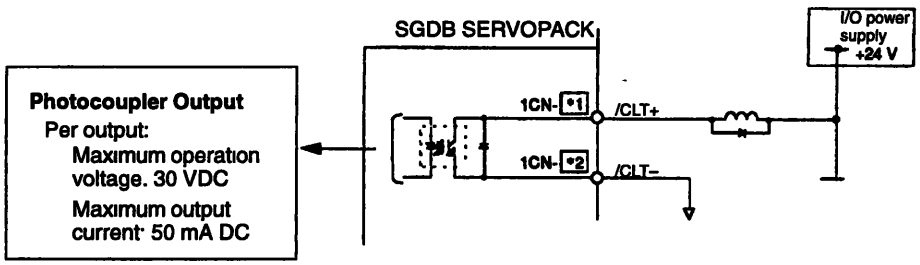
Example of Use: Machine Protection



Note that too small a torque limit value will result in torque shortage at acceleration or deceleration.

- Using the /CLT Signal

This section describes how to use contact output signal /CLT as a torque limit output signal.



Output → /CLT 1CN-*1	Torque Limit Output	For Speed/Torque Control and Position Control

This signal indicates whether motor output torque (current) is being restricted.

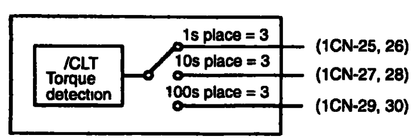
ON status The circuit between 1CN-*1 and 1CN-*2 is closed. 1CN-*1 is at low level.	Motor output torque is being restricted (Internal torque reference is greater than the preset value.)
OFF status: The circuit between 1CN-*1 and 1CN-*2 is open. 1CN-*1 is at high level.	Motor output torque is not being restricted. (Internal torque reference is equal to or below the preset value)

Preset Value: Cn-08 (TLMTF)
Cn-09 (TLMTR)
Cn-18 (CLMIF) : P-CL input only
Cn-19 (CLMIR) : N-CL input only

Cn-2D	Output Signal Selection	Factory Setting: 210	For Speed/Torque Control and Position Control

Specifies the terminal to which /CLT is to be output.

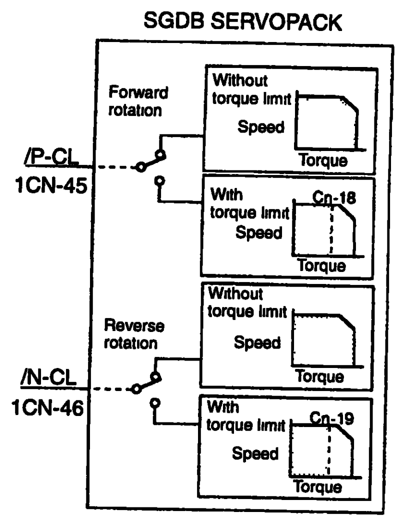
Setting	Output terminals (1CN-)	
	*1	*2
1s place = 3	25	26
10s place = 3	27	28
100s place = 3	29	30



How to Set Level 2: External Torque Limit

First, use a contact input signal to make the torque (current) limit value set in the parameter valid. Torque limit can be set separately for forward and reverse rotation.

To use this function, always set bit 2 of memory switch Cn-02 to 0 (standard setting). The contact input speed control function cannot be used.



P-CL	ON: 1CN-45 is at low level.	Torque restriction applies during forward rotation.	Limit value. Cn-18
	OFF. 1CN-45 is at high level	Torque restriction does not apply during forward rotation	
N-CL	ON: 1CN-46 is at low level.	Torque restriction applies during reverse rotation.	Limit value: Cn-19
	OFF: 1CN-46 is at high level.	Torque restriction does not apply during reverse rotation.	

This torque restriction function outputs the signal shown on the right.

Output Signal for Torque Restriction Function

• /CLT • Status indication mode bit data • Monitor mode Un-05 bit 4
Parameter Setting: Cn-2D = □□3, □3□, 3□□

Examples of Use:

- Forced stopping
- Holding workpiece by robot

Cn-18	CLMIF Forward External Torque Limit	Unit: %	Setting Range: 0 to 800	Factory Setting: 100	For Speed/Torque Control and Position Control
Cn-19	CLMIR Reverse External Torque Limit	Unit: %	Setting Range: 0 to 800	Factory Setting: 100	For Speed/Torque Control and Position Control

Sets a torque limit value when torque is restricted by external contact input.

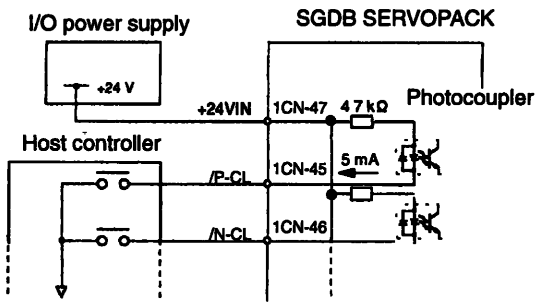
This function is valid when Cn-2B is set to 0, 1, 2, 7, 8, 9, 10, 11.

When /P-CL (1CN-45) is input	Applies torque restriction as specified in Cn-18
When /N-CL (1CN-46) is input	Applies torque restriction as specified in Cn-19

For torque restriction by analog voltage reference, refer to *Section 3.2.8 Using Torque Restriction by Analog Voltage Reference.*

- Using the /P-CL and /N-CL Signals

  This section describes how to use input signals /P-CL and /N-CL as torque limit input signals.



→ Input /P-CL 1CN-45	Forward External Torque Limit Input	For Speed/Torque Control and Position Control
→ Input /N-CL 1CN-46	Reverse External Torque Limit Input	For Speed/Torque Control and Position Control

These signals are for forward and reverse external torque (current) limit input.

This function is useful in forced stopping.

Output Signal for Torque Restriction Function

• /CLT • Status indication mode bit data • Monitor mode Un-06 bit 4
• Parameter Setting Cn-2D = □□3, □3□, 3□□

P-CL	ON. 1CN-45 is at low level.	Torque restriction applies during forward rotation.	Limit value: Cn-18
	OFF: 1CN-45 is at high level	Torque restriction does not apply during forward rotation. Normal operation status.	
N-CL	ON: 1CN-46 is at low level.	Torque restriction applies during reverse rotation.	Limit value. Cn-19
	OFF: 1CN-46 is at high level	Torque restriction does not apply during reverse rotation Normal operation status.	

The signal shown on the above are output while torque is being restricted.

INFO

This function is changed to another function depending on the setting of bit 2 of memory switch Cn-2B (see below).

To use /P-CL and /N-CL as torque limit input signals, set the following constant.

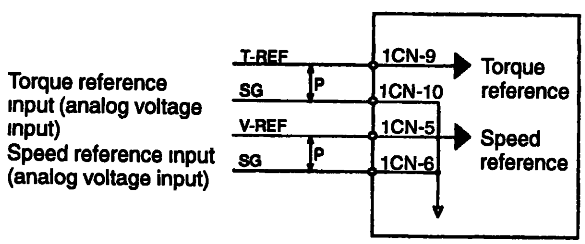
Cn-2B	Control Mode Selection	Factory Setting: 0	For Speed/Torque Control and Position Control

3.2 Setting Parameters According to Host Controller

This section describes how to connect a Σ-series Servo to a host controller and how to set parameters.

3.2.1 Inputting the Speed Reference

Input a speed reference by using the following input signal “speed reference input.” Since this signal can be used in different ways, set the optimum reference input for the system to be created.



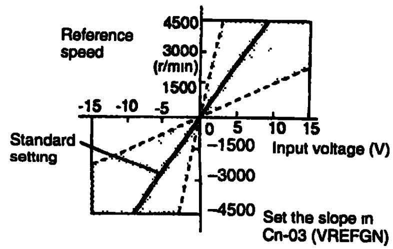
‡P. Represents twisted-pair cables

→ Input V-REF	1CN-5	Speed Reference Input	For Speed Control Only
→ Input SG	1CN-6	Signal Ground for Speed Reference Input	For Speed Control Only

Use these signals when speed control (analog reference) mode is selected (Cn-2B is set to 0, 4, 7, 9, or 10).

For ordinary speed control, always wire the V-REF and SG terminals.

Motor speed is controlled in proportion to the input voltage between V-REF and SG.



- Standard Example:

  Cn-03 = 500: This setting means that 6 V is 3000 r/min

  Examples:

  +6 V input → 3000 r/min in forward direction

  +1 V input → 500 r/min in forward direction

  –3 V input → 1500 r/min in reverse direction

Parameter Cn-03 can be used to change the voltage input range.

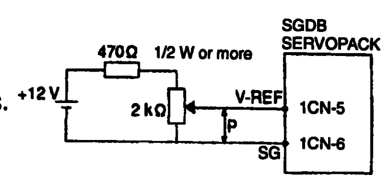
- Example of Input Circuit

  (See the figure on the right)

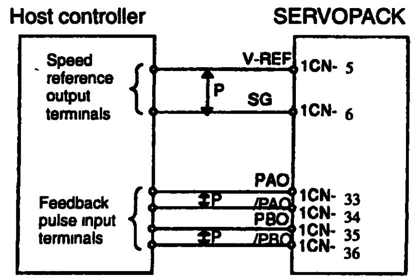
  For noise control, always use twisted-pair cables.

  Recommended Variable Resistor for Speed Setting:

  Model 25HP-10B manufactured by Sakae Tsushin Kogyo Co., Ltd.



When position control is performed by a host controller such as a programmable controller, connect V-REF and SG-V to speed reference output terminals on the host controller. In this case, adjust Cn-03 according to output voltage specifications.



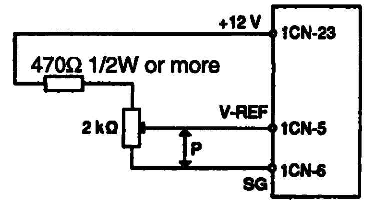
↕P. Represents twisted-pair cables

The internal ±12 V power supply can be used.

+12V	1CN-23
−12V	1CN-24

Maximum output current 30 mA

Voltage. 12 V±2 V



Set constant Cn-2B to select one of the following control modes.

Cn-2B	Control Mode Selection	Factory Setting: 0	For Speed/Torque Control and Position Control

<table>
<tr><th>Cn-2B Setting</th><th colspan="2">Control Method</th></tr>
<tr><td>0</td><td>

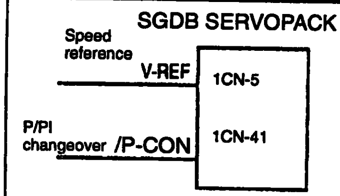
Speed Control

This is normal speed control.

- Speed reference is input from V-REF (1CN-5).
- /P-CON (1CN-41) signal is used to switch between P control and PI control.

<table><tr><td>1CN-41 is open</td><td>PI control</td></tr><tr><td>1CN-41 is at 0 V</td><td>P control</td></tr></table>

</td><td>



</td></tr>
<tr><td>7, 9</td><td>

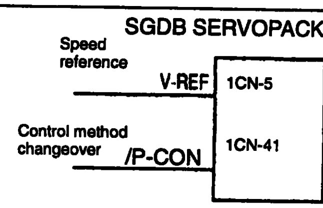
Position/Torque Control ↔ Speed Control

This control mode can be switched between position/torque control and speed control.

- Speed reference is input from V-REF (1CN-5).
- /P-CON (1CN-41) is used to switch the control mode between position/torque control and speed control.

<table><tr><td>1CN-41 is open</td><td>Position/Torque control</td></tr><tr><td>1CN-41 is at 0 V</td><td>Speed control</td></tr></table>

</td><td>



</td></tr>
<tr><td>10</td><td>

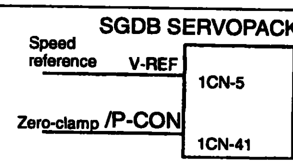
Zero-clamp Speed Control

This speed control allows the **zero-clamp function** to be set when the motor stops.

- Speed reference is input from V-REF (1CN-5).
- /P-CON (1CN-41) signal is used to turn the zero-clamp function ON or OFF.

<table><tr><td>1CN-41 is open</td><td>Turns zero-clamp function OFF</td></tr><tr><td>1CN-41 is at 0 V</td><td>Turns zero-clamp function ON</td></tr></table>

</td><td>



Zero-clamp is performed when the following two conditions are met

Condition 1: /P-CON is turned ON.

Condition 2: Motor speed drops below the preset value

Preset value: Cn-0F (ZCLVL)

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

TERMS

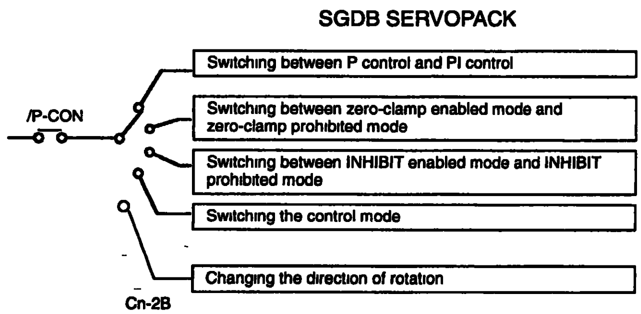
◆ Zero-clamp function

This function is used for a system in which the host controller does not form a position loop. In this case, the stopping position may shift even if a speed reference is set to 0. If the zero-clamp function is turned ON, a position loop is internally formed so that the stopping position is firmly "clamped."

- Using the /P-CON Signal:

→ Input /P-CON 1CN-41	Proportional Control, etc.	For Speed Control and Position Control

The function of input signal /P-CON changes with Cn-2B setting.

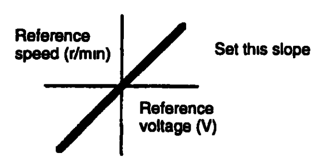


Cn-2B Setting	Meaning of /P-CON Signal
0, 1	Switching between proportional (P) control and proportional/integral (PI) control
2	Not used
7, 8, 9	Switching the control mode
10	Switching between zero-clamp enabled and zero-clamp prohibited modes
11	Switching between INHIBIT enabled and INHIBIT prohibited modes

Adjust the speed reference gain using the following parameter.

Cn-03	VREFGN Speed Reference Gain	Unit: (r/min)/V	Setting Range. 10 to 2000		For Speed Control Only

Sets the voltage range for speed reference input V-REF (1CN-5). Sets this parameter according to the output form of the host controller or external circuit.



The factory setting is as follows:
Rated speed ±1%/6 V

Motor Series	Factory Setting
SGMB (1500 r/min)	250

3.2.2 Inputting the Position Reference

Input a position reference by using the following input signal "reference pulse input." Since there are several specifications for input signal, select reference input for the system to be created.

To use position control, set the following constant.

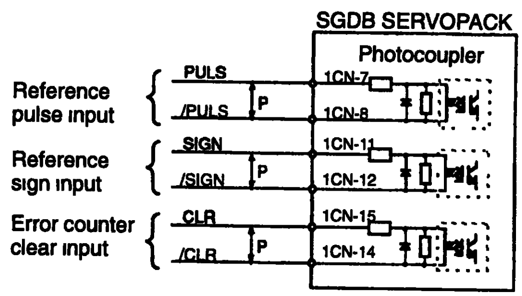
Cn-2B	Control Mode Selection	Factory setting: 1	For Speed / Torque Control and Position Control

Pulse Input Reference

Inputs a move reference by pulse input.

Position reference can correspond to the following three types of output form:

- Line driver output
- +12V Open collector output
- +5V Open collector output

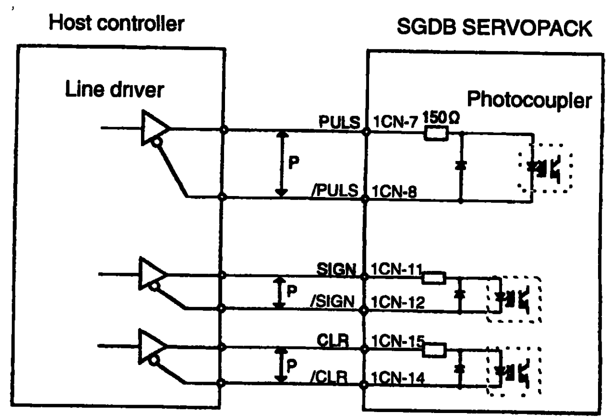


↕P: Represents twisted-pair cables

Connection Example 1: Line Driver Output

Line Driver Used.

SN75174 manufactured by Texas Instruments Inc., or MC3487 or equivalent.



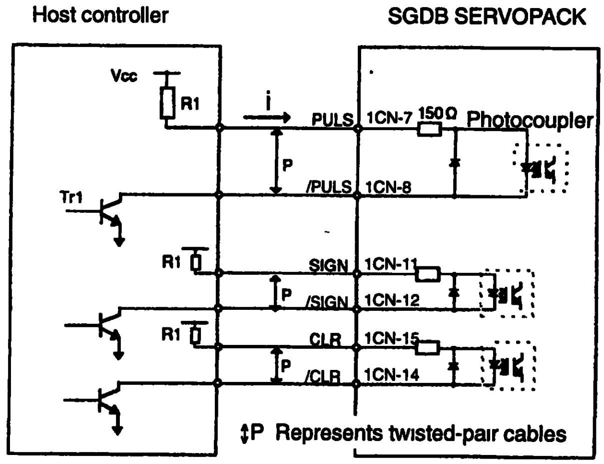
Connection Example 2: Open Collector Output

Sets the value of limiting resistor R1 so that input current i falls within the following range:

Input Current i: 7 to 15 mA

Examples:

- When Vcc is 12 V, R1 = 1 kΩ
- When Vcc is 5 V, R1 = 180 Ω

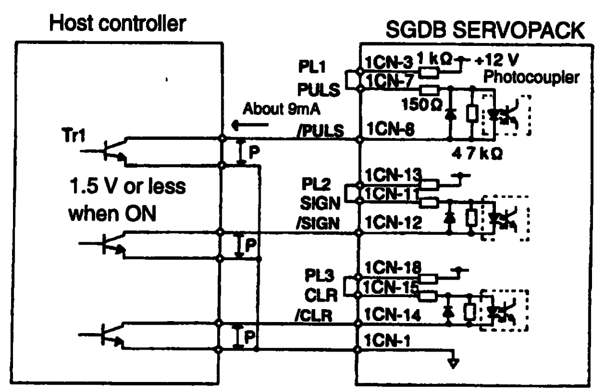


INFO The signal logic for open collector output is as follows.

When Tr1 is ON	Equivalent to high level input
When Tr1 is OFF	Equivalent to low level input

The power supply inside the SERVOPACK can be used.

If this power supply is used, it will not be isolated from 0 V in the SERVOPACK.



■ Selecting the Reference Pulse Form

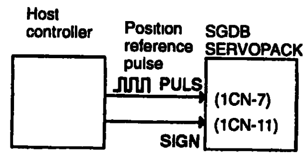
Use the following memory switch to select the reference pulse form to be used:

→ Input PULS	1CN-7	Reference Pulse Input	For Position Control Only
→ Input /PULS	1CN-8	Reference Pulse Input	For Position Control Only
→ Input SIGN	1CN-11	Reference Sign Input	For Position Control Only
→ Input /SIGN	1CN-12	Reference Sign Input	For Position Control Only

The motor only rotates at an angle proportional to the input pulse.

Cn-02 Bit 3	Reference Pulse Form Selection	Factory Setting: 0	For Position Control Only
Cn-02 Bit 4	Reference Pulse Form Selection	Factory Setting. 0	For Position Control Only
Cn-02 Bit 5	Reference Pulse Form Selection	Factory Setting. 0	For Position Control Only

Sets the form of a reference pulse that is externally output to the SERVOPACK.



Sets the pulse form according to the host controller specifications.

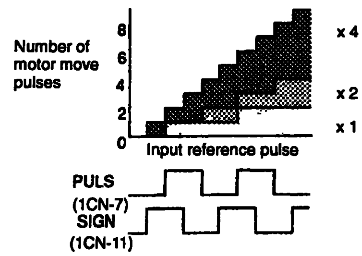
Set also the input pulse logic in bit D of Cn-02.

Cn-02				Input Pulse Multiplier	Reference Pulse Form	Motor Forward Run Reference	Motor Reverse Run Reference
Bit D	Bit 5	Bit 4	Bit 3				
0 (Positive logic setting)	0	0	0		Sign + pulse train	PULS (1CN-7) SIGN (1CN-11) "H"	PULS (1CN-7) SIGN (1CN-11) "L"
	0	1	0	×1	Two-phase pulse train with 90° phase difference	90° PULS (1CN-7) SIGN (1CN-11)	90° PULS (1CN-7) SIGN (1CN-11)
	0	1	1	×2			
	1	0	0	×4			
	0	0	1		CW pulse + CCW pulse	PULS (1CN-7) "L" SIGN (1CN-11)	PULS (1CN-7) SIGN (1CN-11) "L"
1 (Negative logic setting)	0	0	0		Sign + pulse train	PULS (1CN-7) SIGN (1CN-11) "L"	PULS (1CN-7) SIGN (1CN-11) "H"
	0	1	0	×1	Two-phase pulse train with 90° phase difference	90° PULS (1CN-7) SIGN (1CN-11)	90° PULS (1CN-7) SIGN (1CN-11)
	0	1	1	×2			
	1	0	0	×4			
	0	0	1		CW pulse + CCW pulse	PULS (1CN-7) "H" SIGN (1CN-11)	PULS (1CN-7) SIGN (1CN-11) "H"

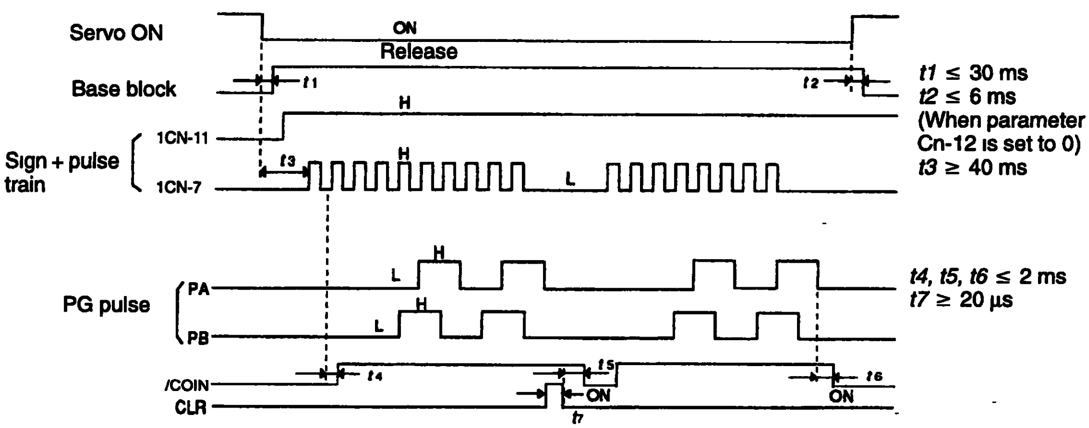
Input Pulse Multiply Function:

When the reference form is two-phase pulse train with 90° phase difference, the input pulse multiply function can be used.

The electronic gear function can also be used to convert input pulses.

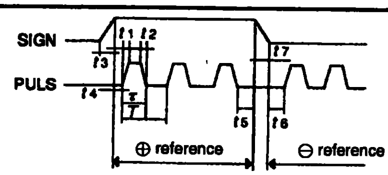
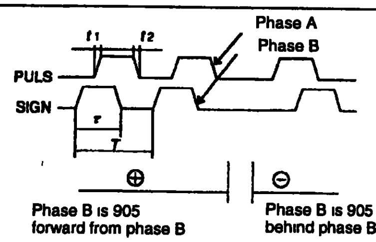
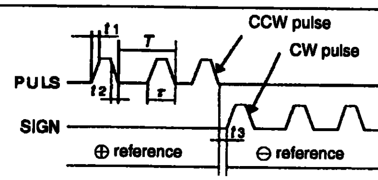


Example of I/O Signal Generation Timing



Note The interval from the time the servo ON signal is turned ON until a reference pulse is input must be at least 40 ms Otherwise, the reference pulse may not be input.
The error counter clear (CLR) signal must be ON for at least 20 µs Otherwise, it becomes invalid.

Allowable Voltage Level and Timing for Reference Pulse Input

Reference Pulse Form	Electrical Specifications	Remarks
Sign + pulse train input (SIGN + PULS signal) Maximum reference frequency: 450 kpps	 $t1, t2 \leq 0.1\mu s$ $\tau \geq 1.1\mu s$ $t3, t7 \leq 0.1\mu s$ $t4, t5, t6 > 3\mu s$	The signs for each reference pulse are as follows: ⊕: High level ⊖: Low level
90° different two-phase pulse train (phase A + phase B) Maximum reference frequency x 1 multiplier: 450 kpps x 2 multiplier: 400 kpps x 4 multiplier: 200 kpps	 $t1, t2 \leq 0.1\mu s$ $\tau \geq 1.1\mu s$ $\frac{\tau}{T} \times 100 \leq 50\%$	Parameter Cn-02 (bits 3, 4 and 5) is used to switch the input pulse multiplier mode.
CCW pulse + CW pulse Maximum reference frequency: 450 kpps	 $t1, t2 \leq 0.1\mu s$ $\tau \geq 1.1\mu s$ $t3 > 3\mu s$ $\frac{\tau}{T} \times 100 \leq 50\%$	

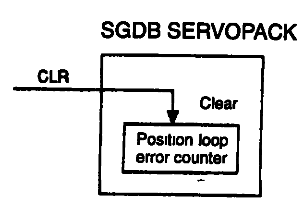
■ Clearing the Error Counter

The following describes how to clear the error counter.

→ Input CLR 1CN-15	Error Counter Clear Input	For Position Control Only
→ Input /CLR 1CN-14	Error Counter Clear Input	For Position Control Only

Setting the CLR signal to high level does the following:

- Sets the error counter inside the SERVOPACK to 0.
- Prohibits position loop control.

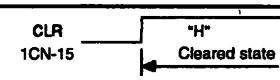
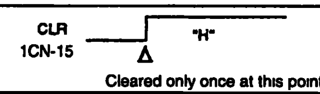


Use this signal to clear the error counter from the host controller.

Bit A of memory switch Cn-02 can be set so that the error counter is cleared only once when the leading edge of an input pulse rises.

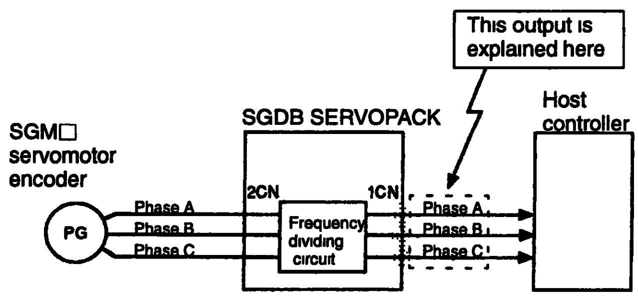
Cn-02 Bit A	Error Counter Clear Signal Selection	Factory Setting: 0	For Position Control Only

Selects the pulse form of error counter clear signal CLR (1CN-15).

Setting	Meaning	
0	Clears the error counter when the CLR signal is set at high level. Error pulses do not accumulate while the signal remains at high level.	
1	Clears the error counter only once when the rising edge of the CLR signal rises.	

3.2.3 Using Encoder Outputs

Encoder output signals **divided** inside the SERVOPACK can be output externally. These signals can be used to form a position control loop in the host controller.

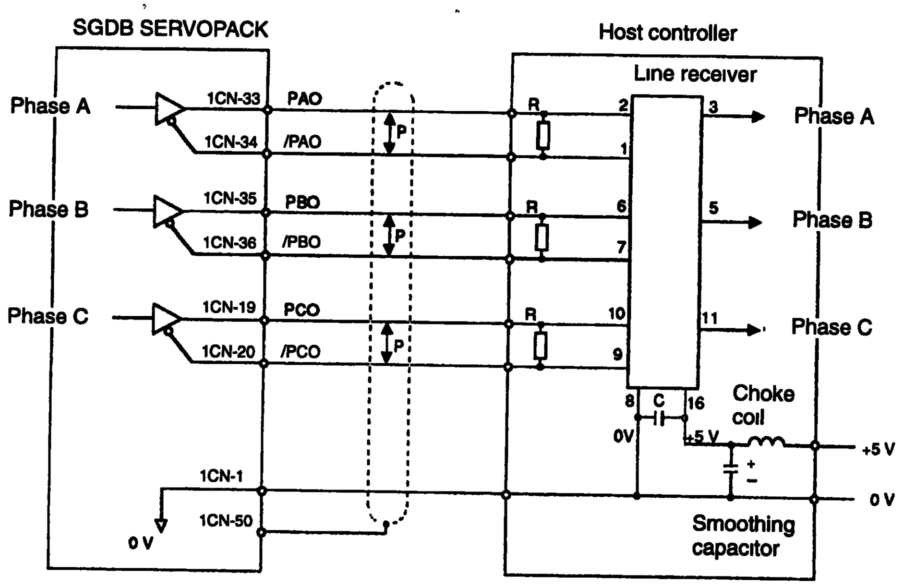


TERMS

◆ Divided (or dividing)

"Dividing" means converting an input pulse train from the encoder mounted on the motor according to the preset pulse density and outputting the converted pulse The unit is pulses per revolution

The output circuit is for line driver output. Connect each signal line according to the following circuit diagram.



↕P: Represents twisted-pair cables

Line receiver used SN75175 manufactured by Texas Instruments Inc. or MC3486 (or equivalent)

R (termination resistor): 220 to 470 Ω

C (decoupling capacitor): 0.1 μF

■ I/O Signals

I/O signals are described below.

Output → PAO 1CN-33	Encoder Output Phase-A	For Speed/Torque Control and Position Control
Output → /PAO 1CN-34	Encoder Output Phase-/A	For Speed/Torque Control and Position Control
Output → PBO 1CN-35	Encoder Output Phase-B	For Speed/Torque Control and Position Control
Output → /PBO 1CN-36	Encoder Output Phase-/B	For Speed/Torque Control and Position Control
Output → PCO 1CN-19	Encoder Output Phase-C	For Speed/Torque Control and Position Control
Output → /PCO 1CN-20	Encoder Output Phase-/C	For Speed/Torque Control and Position Control

Divided encoder signals are output.

Always connect these signal terminals when a position loop is formed in the host controller to perform position control.

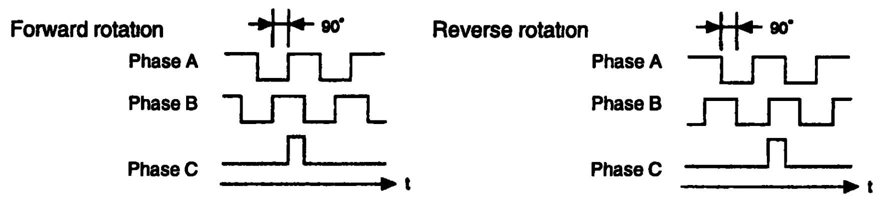
Set a dividing ratio in the following parameter.

Dividing ratio setting	Cn-0A PGRAT

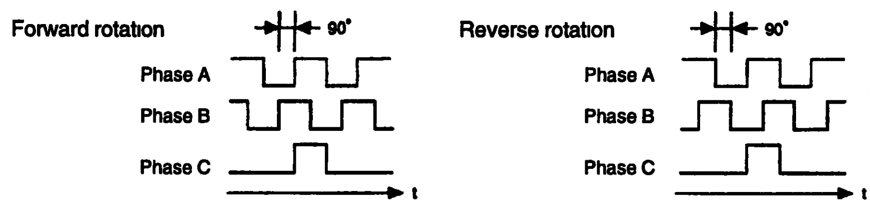
The dividing ratio setting is not relevant to the gear ratio setting (Cn-24, 25) for the electronic gear function of the SERVOPACK when used for position control.

Output Phase Form

Incremental Encoder



Absolute Encoder



→ Input SEN 1CN-4	SEN Signal Input	For Speed/Torque Control Only
→ Input SG 1CN-2	Signal Ground	For Speed/Torque Control Only
Output → PSO 1CN-48	Encoder Output Phase-S	For Speed/Torque Control and Position Control
Output → /PSO 1CN-49	Encoder Output Phase-/S	For Speed/Torque Control and Position Control
→ Input BAT 1CN-21	Battery (+)	For Speed/Torque Control and Position Control
→ Input BAT0 1CN-22	Battery (–)	For Speed/Torque Control and Position Control

Use these signals (SEN to BAT0) for absolute encoders. For details, refer to *Section 3.8.5 Using an Absolute Encoder.*

Output → SG 1CN-1	Signal Ground	For Speed/Torque Control and Position Control
Output → FG 1CN-50	Frame Ground	For Speed/Torque Control and Position Control

SG: Connect to 0 V on the host controller.

FG: Connect to the cable shielded wire.

■ Setting the Type of Encoder

Use the following memory switch to specify the type of the encoder to be used.

Cn-01 Bit E	Encoder Type Selection	Factory Setting: 0	For Speed/Torque Control and Position Control

Sets the encoder type according to the servomotor type as shown in the table.

After changing the memory switch setting, always turn the power OFF, then ON.

Motor Type encoder specifications	Number of Encoder Pulses Per Revolution (P/R)	Setting
2	Incremental encoder: 8192 pulses per revolution	0
6	Incremental encoder: 4096 pulses per revolution	
W	Absolute encoder. 1024 pulses per revolution	1
S	Absolute encoder: 8192 pulses per revolution	

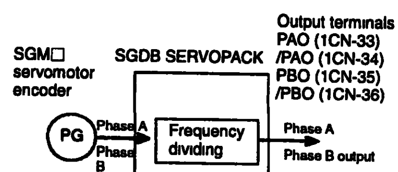
■ Setting the Pulse Dividing Ratio

Set the pulse dividing ratio in the following parameter.

Cn-0A	PGRAT Dividing Ratio Setting	Unit: P/R	Setting Range: 16 to 32768		For Speed/Torque Control and Position Control

Sets the number of output pulses for PG output signals (PAO, /PAO, PBO and /PBO).

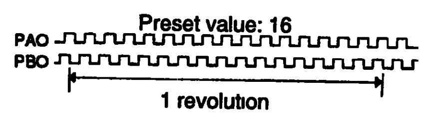
Pulses from motor encoder (PG) are divided by the preset number of pulses before being output.



The number of output pulses per revolution is set in this parameter. Set this value according to the reference unit of the machine or controller to be used.

The setting range varies according to the encoder used.

Setting example:



Motor Type Encoder Specifications	Number of Encoder Pulses Per Revolution	Setting Range
2	Incremental encoder. 8192 pulses per revolution	16 to 8192
3	Incremental encoder: 2048 pulses per revolution	16 to 2048
6	Incremental encoder: 4096 pulses per revolution	16 to 4096
W	Absolute encoder: 1024 pulses per revolution	16 to 1024
S	Absolute encoder. 8192 pulses per revolution	16 to 8192

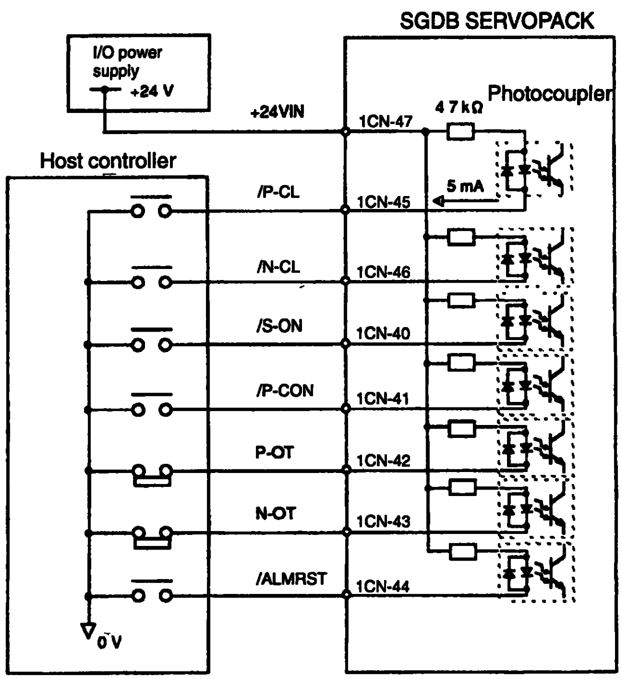
rAfter changing the parameter setting, always turn the power OFF, then ON.

3.2.4 Using Contact I/O Signals

These signals are used to control SGDB SERVOPACK operation Connect these signal terminals as necessary.

■ Contact Input Signal Terminal Connections

Connect the contact input signals as follows:



IMPORTANT

Provide an external I/O power supply separately.
There are no power terminals available from the SGDB SERVOPACK outputs signals externally.

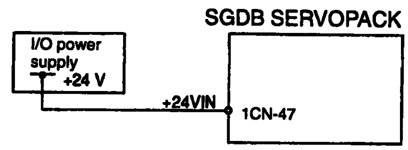
External Power Supply: 24 ± 1 VDC
50 mA or more

Yaskawa recommends that this external power supply be the same type as for the output circuit.

→ Input +24VIN 1CN-47	24 V I/O Power Supply	For Speed/Torque Control and Position Control

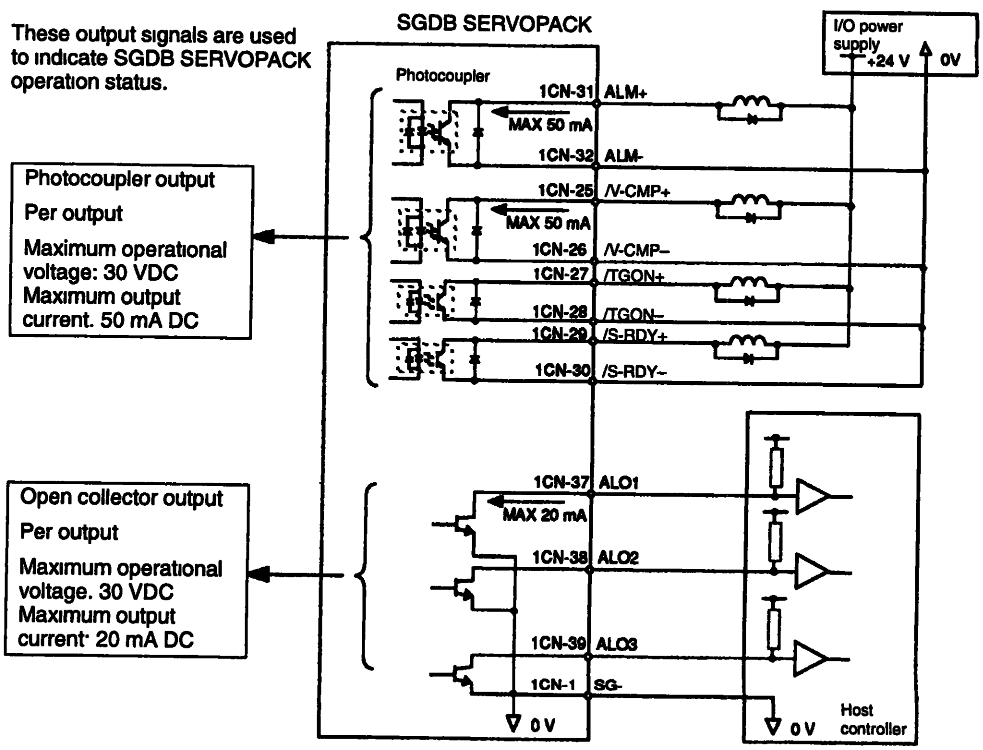
This external power supply input terminal is common to the following contact input signals:

Contact Input Signals:	/P-CL	(1CN-45)
	/N-CL	(1CN-46)
	/S-ON	(1CN-40)
	/P-CON	(1CN-41)
	P-OT	(1CN-42)
	N-OT	(1CN-43)
	/ALMRST	(1CN-44)



Connect an external I/O power supply

■ Contact Output Signal Terminal Connections

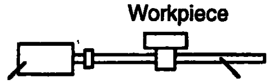


IMPORTANT	Provıde an external I/O power supply separately There are no power termınals to whıch the SGDB SERVOPACK outputs sıgnals externally. Yaskawa recommends that thıs external power supply be the same type as for the ınput cırcuıt.

3.2.5 Using the Electronic Gear

The electronic gear function enables the motor travel distance per input reference pulse to be set to any value. It allows the host controller to perform control without having to consider the machine gear ratio and the number of encoder pulses.

When Electronic Gear Function is Not Used



To move a workpiece 10 mm,

One revolution is equivalent to 6 mm, so 10 ÷ 6 = 1 6666 (revolutions)
2048 x 4 (pulses) is equivalent to one revolution, so 1.6666 x 2,048 x 4 = 13,653 (pulses)
A total of 13653 pulses must be input as a reference

The host controller needs to make this calculation

When Electronic Gear Function is Used

Machine conditions and reference unit must be defined for the electronic gear function beforehand.

To move a workpiece 10 mm:

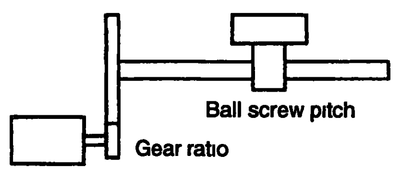
Reference unit is 1 µm, so
10 mm ÷ 1 µm = 10,000 pulses

■ Setting the Electronic Gear

Calculate the electronic gear ratio (B/A) according to the procedure below and set the value in Cn-24 and Cn-25.

1. Check the machine specifications.

   Items related to electronic gear:
   – Gear ratio
   – Ball screw pitch
   – Pulley diameter



2. Check the number of encoder pulses for the SGM□ servomotor.

Motor Type Encoder Specifications	Encoder Type	Number of Encoder Pulses Per Revolution (P/R)*
2	Incremental encoder	8192
6		4096
W	Absolute encoder	1024
S		8192

* Same as parameter Cn-11 settings

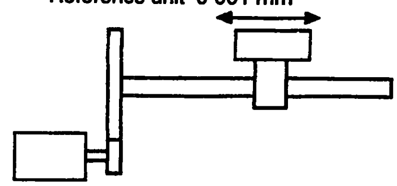
3. Determine the reference unit to be used.

Reference unit is the minimum unit of position data used for moving the load.
(Minimum unit of reference from host controller)

Examples:
0.01 mm, 0.001 mm, 0.1°, 0.01 inch

Reference input of one pulse moves the load by one reference unit.

To move a table in 0.001 mm units
Reference unit 0.001 mm



Determine the reference unit according to machine specifications and positioning accuracy

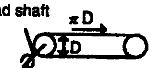
Example: When reference unit is 1 μm
If a reference of 50,000 pulses is input, the load moves 50 mm (50,000 x 1 μm).

4. Determine the load travel distance per revolution of load shaft in reference units.

Load travel distance per revolution of load shaft (in reference units)

$$= \frac{\text{Load travel distance per revolution of load shaft (in unit of distance)}}{\text{Reference unit}}$$

Example: When ball screw pitch is 5 mm and reference unit is 0.001 mm
5/0.001 = 5,000 (reference units)

Ball Screw	Disc Table	Belt & Pulley
Load shaft  P Pitch 1 revolution $= \frac{P}{\text{Reference unit}}$	 Load shaft 1 revolution $= \frac{360°}{\text{Reference unit}}$	Load shaft  D Pulley diameter 1 revolution $= \frac{\pi D}{\text{Reference unit}}$

5. Determine the electronic gear ratio $\left(\frac{B}{A}\right)$.

If the load shaft makes "n" revolutions when the motor shaft makes "m" revolutions, the gear ratio of motor shaft and load shaft is $\frac{n}{m}$

$$\text{Electronic gear ratio } \left(\frac{B}{A}\right) = \frac{\text{Number of encoder pulses x 4}}{\text{Travel distance per revolution of load shaft (in reference units)}} \times \frac{m}{n}$$

IMPORTANT

Make sure that the electronic gear ratio meets the following condition.

$$0.01 \leq \text{Electronic gear ratio } \left(\frac{B}{A}\right) \leq 100$$

If the electronic gear ratio is outside this range, the SERVOPACK does not work properly. In this case, modify the load configuration or reference unit

6. Set the electronic gear ratio in the parameters below.

Reduce the electronic gear ratio $\left(\frac{B}{A}\right)$ to their lowest terms so that both A and B are an integer smaller than 65535, then set A and B in the following parameters.

$\left(\frac{B}{A}\right)$

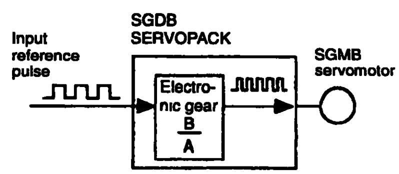
Cn-24	RATB Electronic gear ratio (numerator)
Cn-25	RATA Electronic gear ratio (denominator)

This is all that is required to set the electronic gear.

Cn-24	RATB Electronic Gear Ratio (Numerator)	Unit: None	Setting Range: 1 to 65535	Factory Setting: 4	For Position Control Only
Cn-25	RATA Electronic Gear Ratio (Denominator)	Unit. None	Setting Range: 1 to 65535	Factory Setting: 1	For Position Control Only

Set the electronic gear ratio according to machine specifications.

Electronic gear ratio $\left(\frac{B}{A}\right) = \frac{\text{Cn-24}}{\text{Cn-25}}$



B = [(Number of encoder pulses) x 4] x [Motor shaft rotating speed]

A = [Reference unit (load travel distance per revolution of load shaft)] x [Load shaft rotating speed]

Note that the parameter settings must meet the following condition:

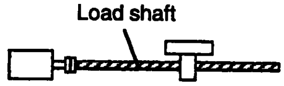
$$0.01 \leq \left(\frac{B}{A}\right) \leq 100$$

■ Examples of Setting an Electronic Gear Ratio for Different Load Mechanisms

Ball Screw

Reference unit: 0.001 mm

Load shaft



Incremental encoder:
2048 pulses per revolution

Ball screw pitch 6 mm

$$\text{Travel distance per revolution of load shaft} = \frac{6mm}{0.001mm} = 6000$$

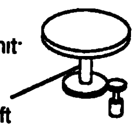
$$\text{Electronic gear ratio } \left(\frac{B}{A}\right) = \frac{2048 \times 4 \times 1}{6000 \times 1} = \frac{Cn\text{-}24}{Cn\text{-}25}$$

Preset values

Cn-24	8192
Cn-25	6000

Disc Table

Reference unit: 0.1°



Gear ratio 3 : 1

Load shaft

Incremental encoder:
2048 pulses per revolution

$$\text{Travel distance per revolution of load shaft} = \frac{360°}{0.1°} = 3600$$

$$\text{Electronic gear ratio } \left(\frac{B}{A}\right) = \frac{2048 \times 4 \times 3}{3600 \times 1} = \frac{Cn\text{-}24}{Cn\text{-}25}$$

Preset values

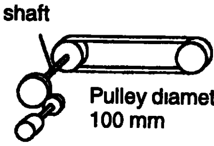
Cn-24	24576
Cn-25	3600

Belt & Pulley

Reference unit: 0.0254 mm

Load shaft

Gear ratio: 2.4 : 1



Pulley diameter 100 mm

Absolute encoder:
1024 pulses per revolution

$$\text{Travel distance per revolution of load shaft} = \frac{3.14 \times 100mm}{0.0254mm} = 12362$$

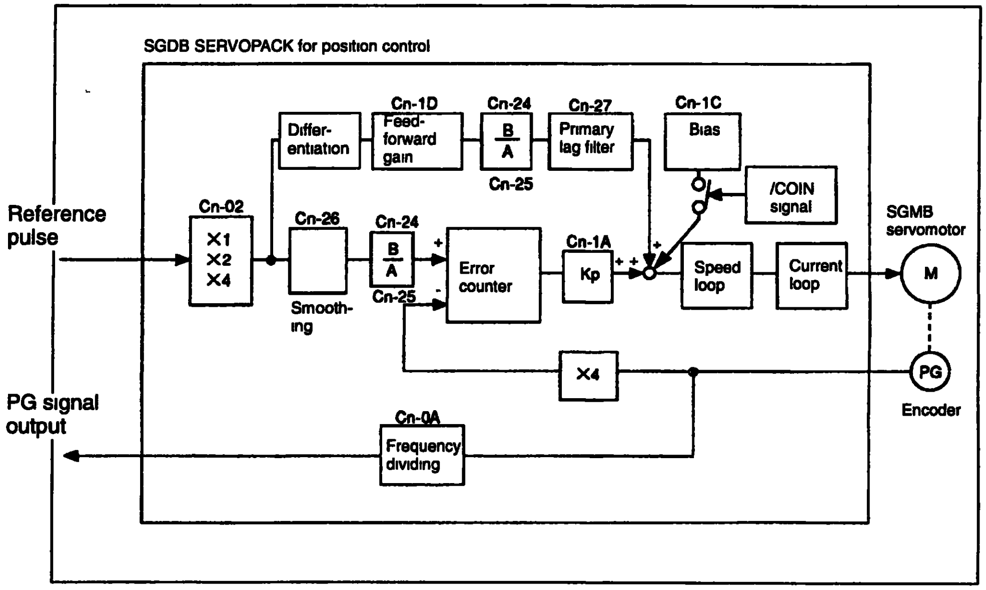
$$\text{Electronic gear ratio } \left(\frac{B}{A}\right) = \frac{1024 \times 4 \times 2.4}{12362 \times 1} = \frac{Cn\text{-}24}{Cn\text{-}25}$$

$$= \frac{9830.4}{12362} = \frac{49152}{61810}$$

Preset values

Cn-24	49152
Cn-25	61810

■ Control Block Diagram for Position Control



7. Set the travel distance in the parameters.

3.2.6 Using Torque Control

The SERVOPACK can provide the following torque control:

- Torque restriction
  - Level 1. To restrict the maximum output torque to protect the machine or workpiece
  - Level 2. To restrict torque after the motor moves the machine to a specified position
- Torque control
  - Level 3: To always control output torque, not speed
  - Level 4: To switch between torque control and other control

This section describes how to use levels 3 and 4 of the torque control function.

■ Selecting Torque Control

Use the following parameter to select level 3 or level 4 torque control.

Cn-2B	Control Mode Selection	Factory Setting: 0	For Speed/Torque Control and position Control

This is dedicated torque control.

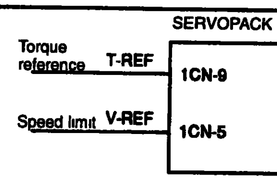
A motor torque reference value is externally input into the SERVOPACK to control torque.

Examples of Use: Tension control
Pressure control

Cn-2 B	Control Mode

2

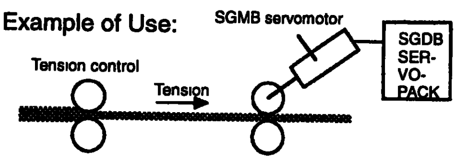
Torque Control



This is a dedicated torque control mode.

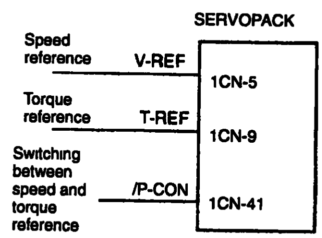
- A torque reference is input from T-REF (1CN-9).
- /P-CON is not used
- Speed reference input V-REF (1CN-5) can be used as speed limit when bit 2 of Cn-02 is set to 1.
- Parameter Cn-14 can be used for maximum speed control.

Example of Use:



9

Torque Control ↔ Speed Control (Analog Reference)



Torque control and speed control can be switched.

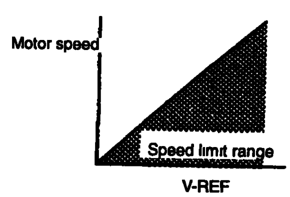
- A speed reference or speed limit value is input from V-REF (1CN-5).
- T-REF (1CN-9) inputs a torque reference, torque feed-forward reference or torque limit value depending on the control mode used
- /P-CON (1CN-41) is used to switch between torque control and speed control.

When 1CN-41 is open	Torque control
When 1CN-41 is at 0 V	Speed control

In the Torque Control mode (/P-CON is OFF):

- T-REF reference controls torque.
- V-REF can be used to limit motor speed. (when bit 2 of Cn-02 is 1)
  V-REF voltage (+) limits motor speed during forward or reverse rotation.
- Parameter Cn-14 can be used to limit the maximum motor speed.

Principle of Speed Restriction

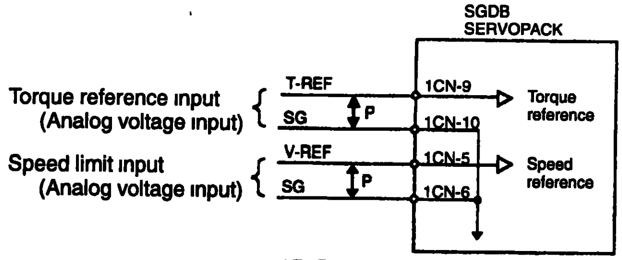


When the speed exceeds the speed limit, negative feedback of torque proportional to the difference between the current speed and the limit speed is performed to return the speed to within the normal speed range. Therefore, the actual motor speed limit value has a certain range depending on the load conditions

<table>
<tr><th>Cn-2
B</th><th>Control Mode</th></tr>
<tr><td>9</td><td>
In the Speed Control mode (/P-CON is ON):
Values set in bit 9 of parameter Cn-02 and bit 8 of Cn-02 determine the following:
<table>
<tr><td colspan="2">Parameter</td><td rowspan="3">Speed Reference Input (V-REF) (1CN-5, 6)</td><td rowspan="3">Torque Input (T-REF) (1CN-9, 10)</td><td rowspan="3">Remarks</td></tr>
<tr><td>Cn-02</td><td>Cn-02</td></tr>
<tr><td>Bit 9</td><td>Bit 8</td></tr>
<tr><td rowspan="2">0</td><td rowspan="2">0</td><td colspan="2">Speed control</td><td rowspan="2"></td></tr>
<tr><td>Speed reference</td><td>Cannot be used</td></tr>
<tr><td rowspan="2">1</td><td rowspan="2">—</td><td colspan="2">Speed control with torque feed-forward</td><td rowspan="2">Any value can be set in bit 8 of Cn-02 (0 and 1 have the same effect).
For details of speed control with torque feed-forward, refer to Section 3.2.7 Using Torque Feed-forward Function.</td></tr>
<tr><td>Speed reference</td><td>Torque feed-forward</td></tr>
<tr><td rowspan="2">0</td><td rowspan="2">1</td><td colspan="2">Speed control with torque limit by analog voltage reference</td><td rowspan="2">For details of speed control with torque limit by analog voltage reference, refer to Section 3.2.8 Using Torque Restriction by Analog Voltage Reference.</td></tr>
<tr><td>Speed reference</td><td>Torque limit value</td></tr>
</table>
</td></tr>
<tr><td>8</td><td>
<u>Position Control ↔ Torque Control</u>
This mode allows switching between position control and torque control.
/P-CON (1CN-41) is used to switch the control mode between position control and torque control.
<table>
<tr><td>When 1CN-41 is open</td><td>Position control</td></tr>
<tr><td>When 1CN-41 is at 0 V</td><td>Torque control</td></tr>
</table>
</td></tr>
</table>

■ Input Signals for Torque Control

The following input signals perform torque control.

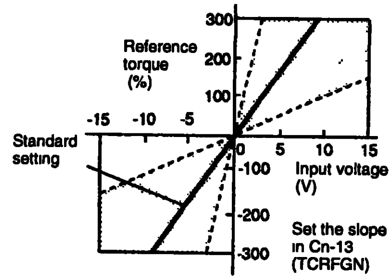


↕P Represents twisted-pair cables

→ Input T-REF 1CN-9	Torque Reference Input	For Speed/Torque Control Only
→ Input SG 1CN-10	Signal Ground for Torque Reference Input	For Speed/Torque Control Only

These signals are used when torque control is selected.

Motor torque is controlled so that it is proportional to the input voltage between T-REF and SG.



Standard Setting

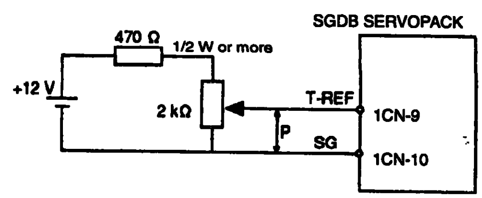
Cn-13 = 30: This setting means that 3 V is equivalent to rated torque.

Examples: +3 V input → Rated torque in forward direction
+9 V input → 300% of rated torque in forward direction
–0.3 V input → 10% of rated torque in reverse direction

Parameter Cn-13 can be used to change the voltage input range.

Example of Input Circuit:
See the figure on the right.

- For noise control, always use twisted-pair cables.



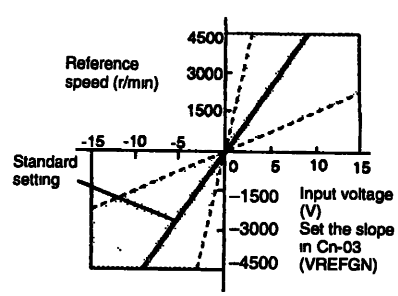
- Example of Variable Resistor for Speed Setting:
  Model 25HP-10B manufactured by Sakae Tsushin Kogyo Co., Ltd.

→ Input V-REF 1CN-5	Speed Reference Input (or Speed Limit Input)	For Speed/Torque Control Only
→ Input SG 1CN-6	Signal Ground for Speed Reference Input	For Speed/Torque Control Only

These signals are used when speed control is selected.

For normal speed control, always connect these signal terminals.

Motor speed is controlled so that it is proportional to the input voltage between V-REF and SG.



Standard Example

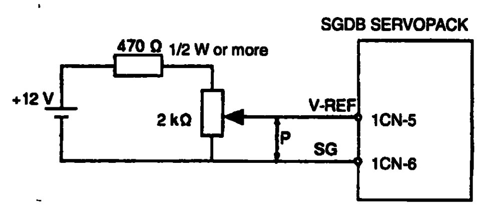
Cn-03 = 500: This setting means that 6 V is equivalent to 3000 r/min.

Examples: +6 V input → 3000 r/min in forward direction
+1 V input → 500 r/min in forward direction
–3 V input → 1500 r/min in reverse direction

Parameter Cn-03 can be used to change the voltage input range (This is also applicable to speed restriction.)

Example of Input Circuit:
See the figure on the right.

- For noise control, always use twisted-pair cables.

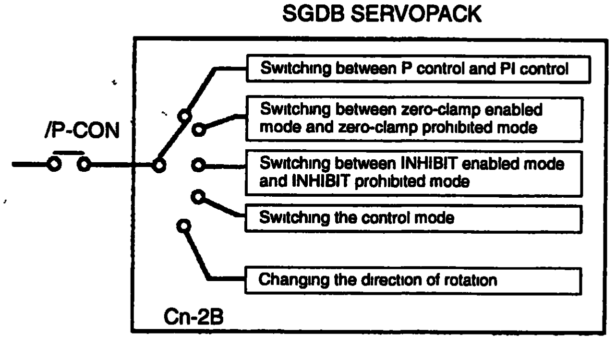


- Example of Variable Resistor for Speed Setting:
  Model 25HP-10B manufactured by Sakae Tsushin Kogyo Co., Ltd.

- Using /P-CON Signal

→ Input /P-CON 1CN-41	Proportional Control, etc	For Speed/Torque Control and Position Control

The function of this input signal varies according to the Cn-2B setting.



Cn-2B Setting	Meaning of /P-CON Signal
0, 1	Switching between P control and PI control
2	Not used
7, 8, 9	Switching the control mode.
10	Switching between zero-clamp enabled and zero-clamp prohibited modes.
11	Switching between INHIBIT enabled and INHIBIT prohibited modes.

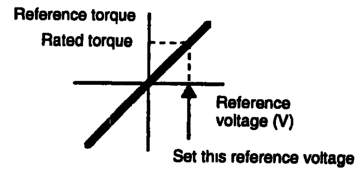
■ Parameters for Torque Control

Set the following parameters for torque control according to the servo system used.

Cn-13	TCRFGN Torque Reference Gain	Unit. 0.1 V/Rated Torque	Setting Range: 10 to 100	Factory Setting. 30	For Speed/Torque Control Only

Sets the voltage range of torque reference input T-REF (1CN-9) according to the output form of the host controller or external circuit.

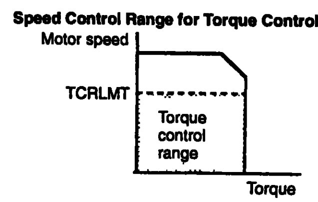
The factory setting is 30, so the rated torque is 3 V (30 x 0.1).



Cn-14	TCRLMT Speed Limit for Torque Control	Unit: r/min	Setting Range: 0 to 10000	Factory Setting. 10000	For Speed/Torque Control Only

Sets a motor speed limit value in torque control mode.

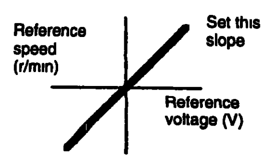
This parameter is used to prevent machine over-speed during torque control.



Cn-03	VREFGN Speed Reference Gain	Unit: (r/min)/V	Setting Range. 0 to 2000		For Speed/Torque Control Only

Sets the voltage range of speed reference input V-REF (1CN-5) according to the output form of the host controller or external circuit.

The factory setting is rated speed ±1%/6V.



Motor Series	Factory Setting
SGMB (1500 r/min)	250

3.2.7 Using the Torque Feed-forward Function

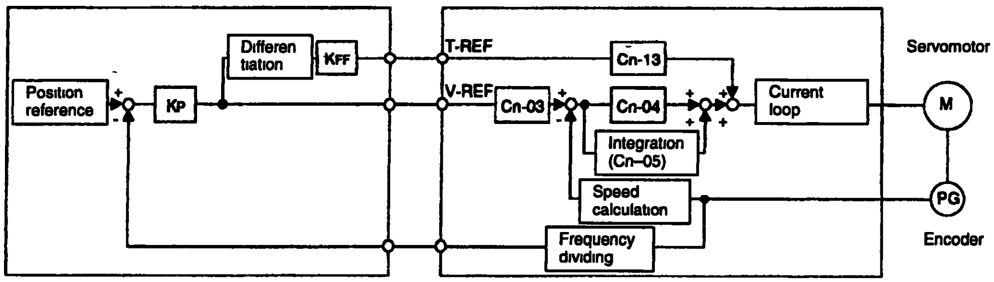
For speed control (analog reference) only.

The torque feed-forward function reduces positioning time. It differentiates a speed reference at the host controller (prepared by the customer) to generate a torque feed-forward reference, then sends this torque feed-forward reference and the speed reference to the SERVOPACK.

Too high a torque feed-forward value will result in overshoot or undershoot. To prevent this, set the optimum value while observing system response.

Connect a speed reference signal line and torque feed-forward reference signal line from the host controller to V-REF (1CN-5, 1CN-6) and T-REF (1CN-9, 1CN-10), respectively.

Schematic Block Diagram for Torque Feed-forward Control



KP: Position loop gain
KFF. Feed-forward gain

■ How to Use Torque Feed-forward Function

To use the torque feed-forward function, set the following memory switch to 1.

Cn-02 Bit 9	Selection of Torque Feed-forward Function	Factory Setting 0	For Speed/Torque Control Only

Enables the torque feed-forward function.

To use the torque feed-forward function, input a speed reference to the V-REF terminal and a torque feed-forward reference to the T-REF terminal.

The host controller must generate a torque feed-forward reference.

Setting	Meaning
0	Does not use the torque feed-forward function
1	**Uses the torque feed-forward function.**

This function cannot be used with the function for torque restriction by analog voltage reference, described in *Section 3.2.8 Using Torque Restriction by Analog Voltage Reference.*

For parameters and control modes, refer to *Appendix D List of Parameters.*

■ Setting a Torque Feed-forward Value in Parameter Cn-13

The factory setting is Cn-13 = 30. If, for example, the torque feed-forward value is ± 3 V, torque is restricted to ± 100% (rated torque).

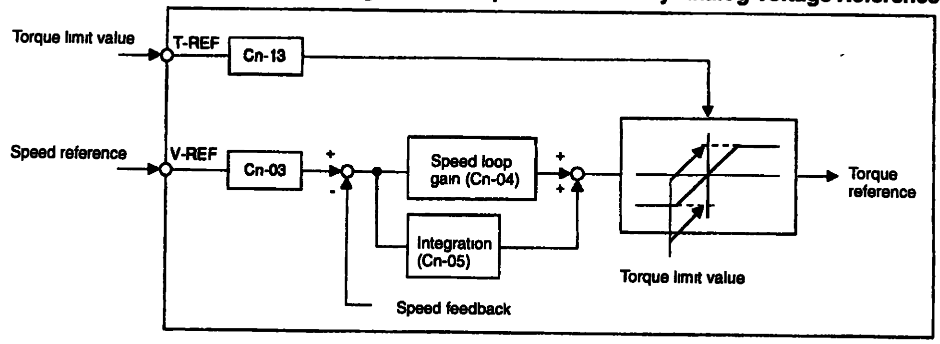
Cn-13	TCRFGN Torque Reference Gain	Unit. 0 1 V/Rated Torque	Setting Range: 10 to 100	Factory Setting: 30	For Speed/Torque Control Only

3.2.8 Using Torque Restriction by Analog Voltage Reference

For speed control (analog reference) only.

This function restricts torque by assigning the T-REF terminal (1CN-9, 1CN-10) a torque limit value in terms of analog voltage. Since torque reference input terminal T-REF is used as an input terminal, this function cannot be used for torque control.

Schematic Block Diagram for Torque Restriction by Analog Voltage Reference



■ How to Use Torque Restriction by Analog Voltage Reference

To use this torque restriction function, set the following memory switch to 1.

Cn-02 Bit 8	Torque Restriction by Analog Voltage Reference	Factory Setting: 0	For Speed/Torque Control Only

Enables this torque restriction function.

To use this function, input a speed reference to the V-REF terminal and a torque limit value to the T-REF terminal.

This function cannot be used for torque control.

Torque restriction cannot be set separately for forward and reverse rotation. (The same setting applies to both forward and reverse rotation.)

Setting	Meaning
0	Does not use the T-REF terminal as a torque limit value input terminal.
1	**Uses the T-REF terminal as a torque limit value input terminal.**

This function cannot be used with the torque feed-forward function described in *Section 3.2.7 Using Torque Feed-forward Function.*

For parameters and control modes, refer to *Appendix D List of Parameters.*

■ Setting a Torque Limit Value in Parameter Cn-13

The factory setting is Cn-13 = 30. If, for example, the torque limit value is 3 V, torque is restricted to 100% (rated torque).

Cn-13	TCRFGN Torque Reference Gain	Unit: 0.1 V/ Rated Torque	Setting Range: 10 to 100	Factory Setting. 30	For Speed/Torque Control Only

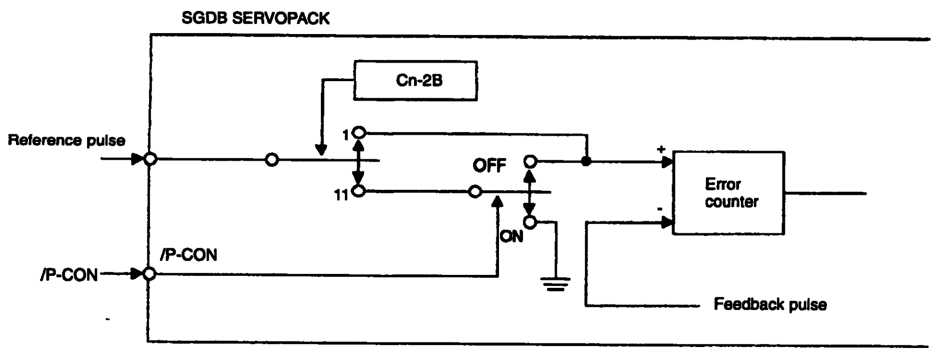
3.2.9 Using the Reference Pulse Inhibit Function (INHIBIT)

This function causes the SERVOPACK to stop counting input reference pulses in position control mode.

While this function is being used, the motor remains in servo locked (clamped) status. The /P-CON signal is used to enable or prohibit this function.

When this function is used, therefore, the /P-CON signal cannot be used to switch between proportion (P) control and proportional/integral (PI) control for speed loop (PI control is always used.)

Schematic Block Diagram for INHIBIT Function



■ How to Use Reference Pulse Inhibit Function: INHIBIT

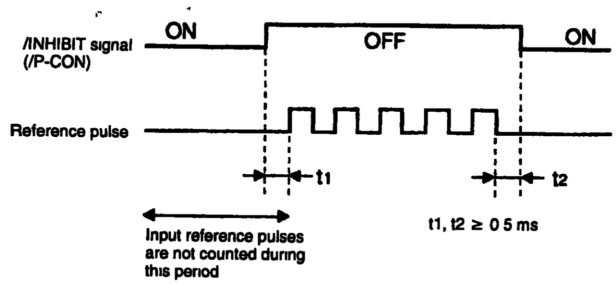
To use the INHIBIT function, set the Cn-2B constant as follows.

Cn-2B	Control Mode Selection	Factory Setting: 0	For Position Control Only

Enables the INHIBIT function.

<table>
<tr><th>Setting</th><th colspan="2">Meaning</th></tr>
<tr><td>0</td><td colspan="2">Does not use the INHIBIT function.
Reference pulses are always counted.</td></tr>
<tr><td rowspan="4">1</td><td colspan="2">Uses the INHIBIT function.
/P-CON signal is used to enable or prohibit the INHIBIT function.</td></tr>
<tr><td>/P-CON</td><td>Meaning</td></tr>
<tr><td>OFF</td><td>Counts reference pulses.</td></tr>
<tr><td>ON</td><td>Prohibits the SERVOPACK from counting reference pulses
The motor remains in servo locked (clamped) status.</td></tr>
</table>

■ Relationship between INHIBIT Signal and Reference Pulse



3.2.10 Using the Reference Pulse Input Filter Selection Function

This function selects a reference pulse input filter inside the SERVOPACK according to the output form of reference pulses from the host controller.

■ How to Use Reference Pulse Input Filter

Set the following memory switch according to the output form of reference pulses from the host controller:

Cn-02 Bit F	Reference Pulse Input Filter Selection Function	Factory Setting: 0	For Position Control Only

Sets the memory switch according to the output form (line driver or open collector) of reference pulses from the host controller.

Setting	Meaning
0	Output form of reference pulses from host controller: Line driver output (maximum frequency of reference pulse 450 kpps)
1	**Output form of reference pulses from host controller: Open collector output (maximum frequency of reference pulse: 200 kpps)**

For open collector output, the wire length must be as short as possible (maximum 3 m).

3.2.11 Using the Analog Monitor

The following two analog voltage monitor signals are output.

Output → TRQ-M 1CN-16	Torque Monitor	For Speed/Torque Control and Position Control
Output → VTG-M 1CN-17	Speed Monitor	For Speed/Torque Control and Position Control

The following memory switch is used to modify the signal specifications.

Cn-02	Bit 6	TRQ-M Specifications	Factory Setting: 0	
	Bit 7	VTG-M Specifications	Factory Setting: 0	
	Bit E	Error Pulse Monitor Level Changeover	Factory Setting: 0	

TRQ-M

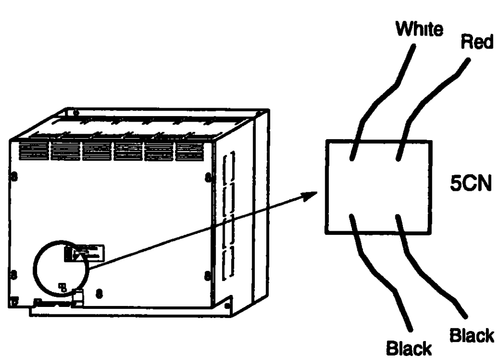
Cn-02 Bit 6	Control Mode	Specifications
0	——	Torque monitor (∓2 V/± 100% torque)
1	Torque control	Undefined
	Speed control	Speed reference monitor*
	Position control	Reference pulse speed monitor*

VTG-M

Cn-02 Bit 7	Control Mode	Specifications	
0	——	Speed monitor*	
1	Speed/torque control	Undefined	
	Position control	Error pulse monitor	Cn-02 bit E = 0: ∓0.05 V/± 1 reference unit Cn-02 bit E = 1: ∓0.05 V/± 100 reference units

* The unit is ∓2V/± 1000 r/min

Analog monitor can also be available with exclusive-use cable (Model: DE9404559) from 5CN connector.



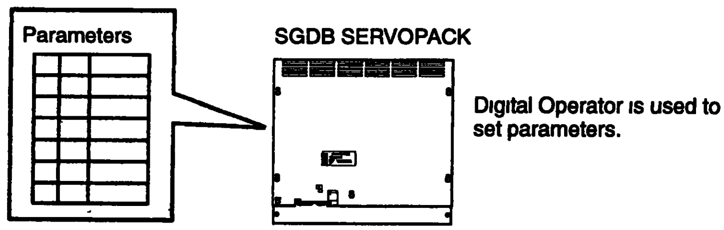
Cable Color	Signal Name	Contents
Red	VTG-M	Speed/error pulse monitor
White	TRQ-M	Torque/speed reference monitor
Black (x2)	GND	Grounding

3.3 Setting Up the Σ SERVOPACK

This section describes how to set parameters to operate the SGDB SERVOPACK.

3.3.1 Setting Parameters

Σ-series SERVOPACKs provide many functions, and have parameters called "parameters" to allow the user to specify each function and perform fine adjustment.



Parameters are divided into the following two types.

Memory switch Cn-01, Cn-02	Each bit of this switch is turned ON or OFF to specify a function.
Parameter setting Cn-03 and later	A numerical value such as a torque limit value or speed loop gain is set in this constant.

Parameter	Name and Code		Remarks
Cn-01	Memory switch		Each bit number has a switch (ON/OFF).
Cn-02	Memory switch		
Cn-03	VREFGN	Speed reference gain	Parameter setting
Cn-..		...	
Cn-..	...	...	
Cn-2D	OUTSEL	Output signal selection	

For a list of parameters, refer to *Appendix D List of Parameters*.

For details of how to set parameters, refer to *Section 4.1.6 Operation in Parameter Setting Mode*.

3.3.2 Setting the Jog Speed

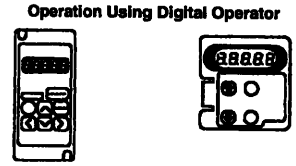
Use the following parameter to set or modify a motor speed when operating the Σ-series Servo from a Digital Operator:

Cn-10	JOGSPD Jog Speed	Unit. r/min	Setting Range: 0 to 10000	Factory Setting: 500	For Speed/Torque Control and Position Control

This constant is used to set a motor speed when the motor is operated using a Digital Operator.

If a value higher than the maximum speed is set, the maximum speed value is used.

Operation Using Digital Operator



3.3.3 Setting the Number of Encoder Pulses

To ensure that the Σ-senes Servo System operates properly, set the type of the encoder to be used and the number of encoder pulses per revolution in the following parameters:

Cn-01 Bit E	Encoder Type Selectıon	Factory Settıng: 0	For Speed/Torque Control and Posıtıon Control

Set the encoder type according to the servomotor type to be used.

After changing the memory swıtch setting, turn the power OFF, then ON.

Motor Type Encoder Specifications	Number of Encoder Pulses Per Revolution	Preset Value
2	Incremental encoder: 8192 pulses per revolutıon	0
6	Incremental encoder. 4096 pulses per revolutıon	
W	Absolute encoder. 1024 pulses per revolutıon	1
S	Absolute encoder: 8192 pulses per revolutıon	

Cn-11	PULSNO Number of Encoder Pulses	Unıt. Pulses Per Revolutıon	Settıng Range: Number of Encoder Pulses		For Speed/Torque Control and Posıtıon Control

Set the number of encoder pulses accordıng to the servomotor type to be used. If this parameter is set ıncorrectly, system operation cannot be guaranteed.

After changing the memory switch settıng, turn the power OFF, then ON.

Motor Type Encoder Specifications	Number of Encoder Pulses Per Revolution	Preset Value
2	Incremental encoder· 8192 pulses per revolutıon	8192
6	Incremental encoder: 4096 pulses per revolutıon	4096
W	Absolute encoder. 1024 pulses per revolutıon	1024
S	Absolute encoder. 8192 pulses per revolutıon	8192

3.3.4 Setting the Motor Model

To ensure that the Σ-series Servo System operates properly, set the model of the servomotor to be used in the following parameter.

Cn-2A	Motor Selection	For Speed/Torque Control and Position Control

Set this memory switch according to the servomotor model to be used.
After changing the parameter setting, turn the power OFF, then ON.

Group	SERVOPACK Model	Motor Model	Cn-2A Setting
2BA	SGDB-2BAD	SGMB-2BA□A	211
		SGMB-2BA□B	215
3ZA	SGDB-3ZAD	SGMB-3ZA□A	213
		SGMB-3ZA□B	214
3GA	SGDB-3GAD	SGMB-3GA□A	216
		SGMB-3GA□B	217
2BD	SGDB-2BDD	SGMB-2BA□D	218
		SGMB-2BA□E	219
3ZD	SGDB-3ZDD	SGMB-3ZA□D	220
		SGMB-3ZA□E	226
3GD	SGDB-3GDD	SGMB-3GA□D	227
		SGMB-3GA□E	228
4ED	SGDB-4EDD	SGMB-4EA□D	229
		SGMB-4EA□E	230
5ED	SGDB-5EDD	SGMB-5EA□D	231
		SGMB-5EA□E	232

The motor model used can be changed within the same group by altering the Cn-2A setting.

3.3.5 Adjusting the Encoder Supply Voltage

The encoder power voltage at the encoder input part must be between 4.75 and 5.25 V. If the encoder cable is long, adjust the encoder supply voltage by setting the following parameter.

Cn-2C	Encoder Power Voltage Adjustment	Unit. 0 1 mV	Factory Setting· 52500	For Speed/Torque Control and Position Control

The following values apply to standard cables:

Length of cables / Encoder	3 m	5 m	10 m	15 m	20 m
15-bit absolute encoder	52500			55000	57000
12-bit absolute encoder Incremental encoder				54000	55500

IMPORTANT Note that the system may fail to operate normally or break down if the setting is too high or too low.

3.4 Setting the Stop Mode

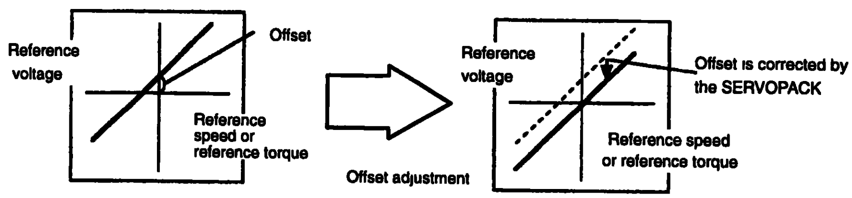
This section describes how to stop the motor properly.

3.4.1 Adjusting the Offset

■ "Why Does the Motor Not Stop?"

When 0 V is specified as reference voltage for speed/torque control (analog reference), the motor may rotate at a very slow speed and fail to stop. This happens when reference voltage from the host controller or external circuit has a slight reference offset (in mV units). If this offset is adjusted to 0 V, the motor will stop.

When reference voltage from the host controller or external circuit has an offset



■ Adjusting the Reference Offset

The following two methods can be used to adjust the reference offset to 0 V.

Automatic adjustment of reference offset	Reference offset is automatically adjusted to 0 V.
Manual adjustment of reference offset	Reference offset can be intentionally set to a specified value.

IMPORTANT

If a position control loop is formed in the host controller, do not use automatic adjustment. Always use manual adjustment.

For detailed adjustment procedures, refer to the following sections.

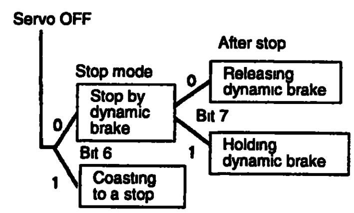
	Adjustment Method
Automatic adjustment of reference offset	*Section 4.2.4 Reference Offset Automatic Adjustment*
Manual adjustment of reference offset	*Section 4.2.5 Reference Offset Manual Adjustment Mode*

3.4.2 Using the Dynamic Brake (DB)

To stop the servomotor by applying **dynamic brake (DB)**, set desired values in the following memory switch. If dynamic brake is not used, the servomotor will stop naturally due to machine friction.

Cn-01 Bit 6	How to Stop Motor When Servo is Turned OFF	Factory Setting: 0	For Speed/Torque Control and Position Control
Cn-01 Bit 7	Operation to Be Performed When Motor Stops After Servo is Turned OFF		For Speed/Torque Control and Position Control

The SERVOPACK enters servo OFF status when:



- Servo ON input signal (/S-ON, 1CN-40) is turned OFF
- Servo alarm arises
- Power is turned OFF

Specify how to stop the motor when one of the above events occurs during operation.

	Setting	Meaning
Cn-01 bit 6	0	Stops the motor by dynamic brake
	1	Causes the motor to coast to a stop. The motor power is OFF and stops due to machine friction.

If dynamic brake stop mode is selected, specify the operation to be performed when the motor stops.

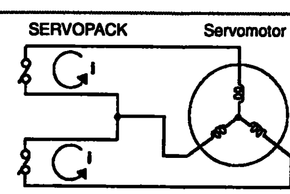
	Setting	Meaning
Cn-01 bit 7	0	Releases dynamic brake after the motor stops.
	1	Does not release dynamic brake even after the motor stop.

For 2.0-kW models, bit 7 of Cn-01 can be set to 0 only.

TERMS

◆ Dynamic brake (DB)

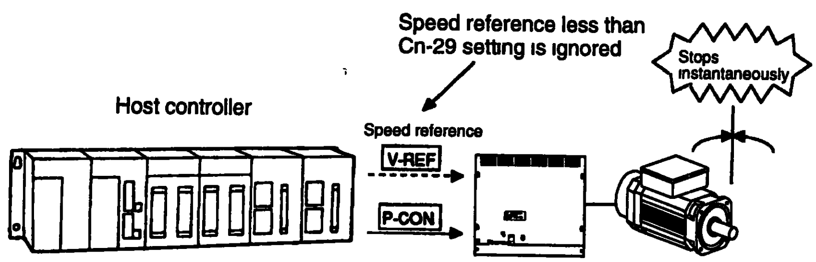
One of the general methods to cause a motor to stop suddenly
"Dynamic brake" suddenly stops a servomotor by shorting its electrical circuit



3.4.3 Using the Zero-Clamp

The zero-clamp function is used for a system in which the host controller does not form a position loop by speed reference input.

In other words, this function is used to cause the motor to stop and enter a servo locked status when the input voltage of speed reference V-REF is not 0 V. When the zero-clamp function is turned ON, an internal position loop is temporarily formed, causing the motor to be clamped within one pulse. Even if the motor is forcibly rotated by external force, it returns to the zero-clamp position.



■ Setting the Memory Switch

Set the following memory switch so that input signal /P-CON can be used to enable or disable the zero-clamp function.

Cn-2B	Control Mode Selection	Factory Setting:0	For Speed Control Only

→ Input /P-CON 1CN-41	Proportional Control, etc.	For Speed/Torque Control and Position Control

<table>
<tr><th>Cn-2B</th><th colspan="2">Control Mode</th></tr>
<tr><td>10</td><td>Zero-clamp Speed Control
This speed control allows the zero-clamp function to be set when the motor stops.
• A speed reference is input from V-REF (1CN-5).
• /P-CON (1CN-41) is used to turn the zero-clamp function ON or OFF.
<table><tr><td>/P-CON (1CN-41) is open (OFF)</td><td>Turns zero-clamp function OFF</td></tr><tr><td>/P-CON (1CN-41) is closed (0 V)</td><td>Turns zero-clamp function ON</td></tr></table></td><td>SGDB SERVOPACK
Speed reference — V-REF — 1CN-5
Zero-clamp — /P-CON — 1CN-41

Zero-clamp is performed when the following two conditions are met:
/P-CON signal is closed.
Motor speed is below the value set in Cn-29 (ZCLVL).</td></tr>
</table>

■ Setting the Motor Speed Level

Set in the following parameter the motor speed level at which zero-clamp is to be performed:

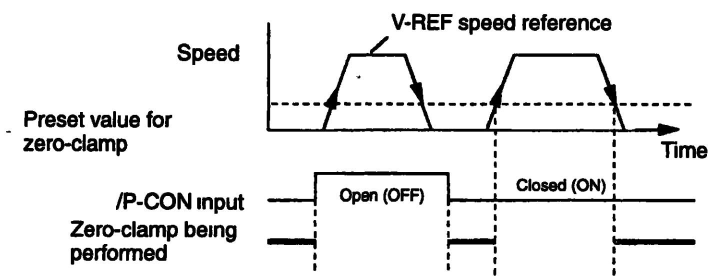
Cn-29	ZCLVL Zero-Clamp Level	Unit: r/min	Setting Range: 0 to 10000	Factory Setting: 10	For Speed Control Only

If zero-clamp speed control is selected, set the motor speed level at which zero-clamp is to be performed. If a value higher than the maximum motor speed is set, the maximum speed value is used.

Conditions for Zero-clamp

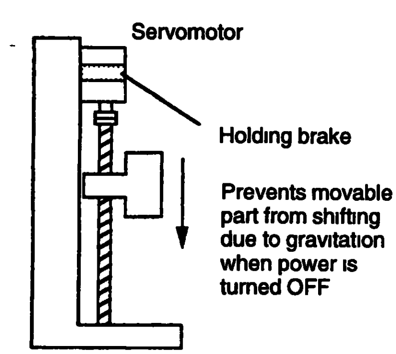
Zero-clamp is performed when all the following conditions are met:

- Zero-clamp speed control is selected (Parameter Cn-2B=10).
- /P-CON (1CN-41) is turned ON (0 V).
- Motor speed drops below the preset value.



3.4.4 Using the Holding Brake

Holding brake is useful when a servo drive is used to control a vertical axis. A servomotor with brake prevents the movable part from dropping due to gravitation when the system power is turned OFF.



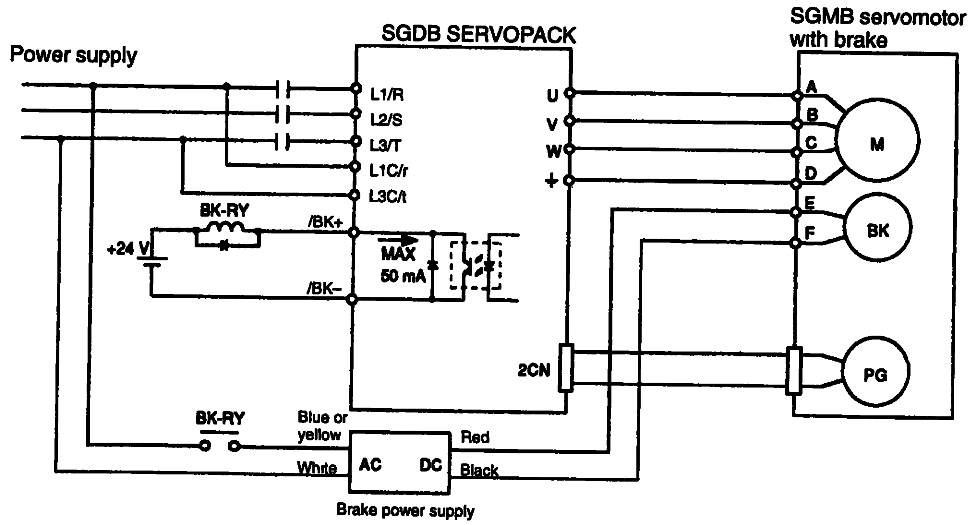
IMPORTANT

The built-in brake in servomotor with brake is a de-energization operation type, which is used for holding purposes only and cannot be used for braking purposes. Use the holding brake only to retain a stopped motor. Brake torque is more than about 120% of the rated motor torque.

■ Wiring Example

Use SERVOPACK contact output-signal /BK and brake power supply to form a brake ON/OFF circuit.

An example of standard wiring is shown below.



BK-RY: Brake control relay

Brake power supply has two types (200 V, 100 V).
Do not use a 400-V power supply for the brake.

Output → /BK	Brake Interlock Output	For Speed/Torque Control and Position Control

This output signal controls the brake when a motor with brake is used. This signal terminal need not be connected when a motor without brake is used.

Related Parameters

Cn-12	Time delay from brake signal until servo OFF
Cn-15	Speed level for brake signal output during operation
Cn-16	Output timing of brake signal during motor operation

ON Status: Circuit is closed or signal is at low level	Releases the brake.
OFF Status: Circuit is open or signal is at high level.	Applies the brake.

Set the following parameter to specify the 1CN pin to which the BK signal is output.

Cn-2D	OUTSEL Output Signal Selection	Setting Range: 110 to 666	Factory Setting: 210	For Speed/Torque Control and Position Control

This parameter is used to select a function signal as the 1CN output signal.

1s place	Select the 1CN-25 and 1CN-26 (/COIN//V-CMP) functions.
10s place	Select the 1CN-27 and 1CN-28 (/TGON) functions.
100s place	Select the 1CN-29 and 1CN-30 (/S-RDY) functions.

Example: /BK is output to 1CN-27 and 1CN-28.

Cn-2D=□4□

Preset value	Function
0	/COIN//V-CMP (Can be allocated to 1CN-25 and 1CN-26 only.)
1	/TGON
2	/S-RDY
3	/CLT
4	/BK
5	Overload warning
6	Overload alarm

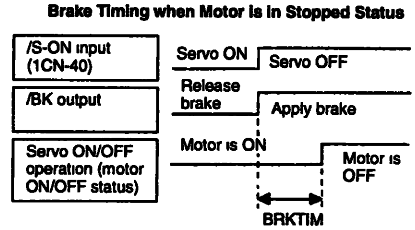
■ Brake ON Timing

If the machine moves slightly due to gravity when the brake is applied, set the following parameter to adjust brake ON timing:

Cn-12	BRKTIM	Time delay from the time a brake signal is output until servo OFF status occurs	Unit: 10 ms	Setting Range 0 to 50	Factory Setting: 0	For Speed/Torque Control and Position Control

This parameter is used to set output timing of brake control signal /BK and servo OFF operation (motor output stop) when SGMB servomotor with brake is used.

Brake Timing when Motor Is In Stopped Status



With the standard setting, the servo is turned OFF when /BK signal (brake operation) is output. The machine may move slightly due to gravitation. This movement depends on machine configuration and brake characteristics. If this happens, use this parameter to delay servo OFF timing to prevent the machine from moving.

For brake ON timing during motor operation, use Cn-15 and Cn-16.

■ Setting the Holding Brake

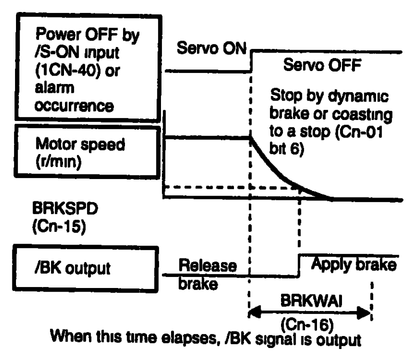
Set the following parameters to adjust brake ON timing so that holding brake is applied when the motor stops.

Cn-15	BRKSPD	Speed Level at which Brake Signal Is Output during Motor Operation	Unit r/min	Setting Range: 0 to 10000	Factory Setting: 100	For Speed/Torque Control and Position Control
Cn-16	BRKWAI	Output Timing of Brake Signal during Motor Operation	Unit: 10 ms	Setting Range: 10 to 100	Factory Setting. 50	For Speed/Torque Control and Position Control

Cn-15 and Cn-16 are used for SGMB servomotors with brake. Use these parameters to set brake timing used when the servo is turned OFF by input signal /S-ON (1CN-40) or alarm occurrence during motor rotation.

Brakes for SGMB servomotors are designed as holding brakes. Therefore, brake ON timing when the motor stops must be appropriate. Adjust the parameter settings while observing machine operation.

Brake Timing when Motor Is In Stopped Status



Conditions for /BK Signal Output During Motor Operation

The circuit is opened in either of the following situations:

- Motor speed drops below the value set in Cn-15 (BRKSPD) after servo OFF occurs.
- The time set in Cn-16 (BRKWAI) has elapsed since servo OFF occurred.

If a value higher than the maximum speed is set, the maximum speed value is used.

3.5 Running the Motor Smoothly

This section explains how to run the servomotor smoothly.

3.5.1 Using the Soft Start Function

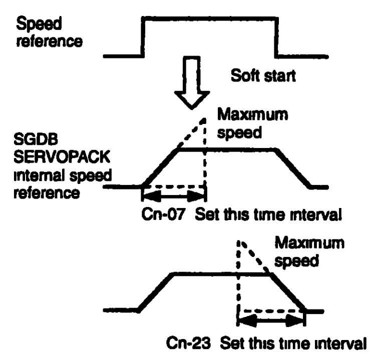
The soft start function adjusts progressive speed reference input inside the SERVOPACK so that acceleration and deceleration can be as constant as possible To use this function, set the following parameters.

Cn-07	SFSACC Soft Start Time (Acceleration)	Unit: ms	Setting Range. 0 to 10000	Factory Setting: 0	For Speed Control Only
Cn-23	SFSDEC Soft Start Time (Deceleration)	Unit: ms	Setting Range: 0 to 10000	Factory Setting: 0	For Speed Control Only

In the SERVOPACK, a speed reference is multiplied by the acceleration or deceleration value set in Cn-07 or Cn-23 to provide speed control.

Smooth speed control can be achieved when progressive speed references are input or when contact input speed control is used.

Set these parameters as follows.



Cn-07: Time interval from the time the motor starts until the maximum speed is reached

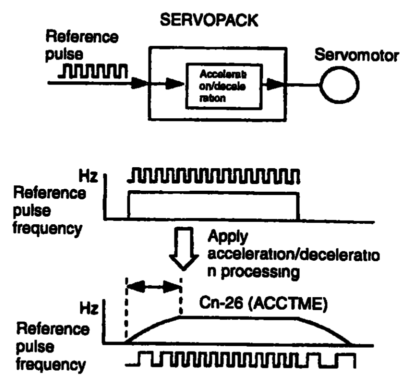
Cn-23: Time interval from the time the motor is running at the maximum speed until it stops

3.5.2 Using the Smoothing Function

The smoothing function adjusts constant-frequency reference input inside the SERVOPACK so that acceleration and deceleration can be as constant as possible. To use this function, set the following parameter.

Cn-26	ACCTME	Position Reference Acceleration/Deceleration Time Constant (Smoothing)	Unit: 0.1 ms	Setting Range: 0 to 640	Factory Setting: 0	For Position Control Only

This function performs acceleration/deceleration processing for input reference pulses (primary lag characteristics).



This function prevents the motor from running at progressive speeds in the following cases:

- When the host controller which outputs references cannot perform acceleration/deceleration processing
- When reference pulse frequency is too low
- When reference electronic gear ratio is too high (more than 10 times)

This function does not change the travel distance (number of pulses).

3.5.3 Adjusting the Gain

If speed loop gain or position loop gain exceeds the allowable limit for the servo system including the machine to be controlled, the system will vibrate or become too susceptible. Under such conditions, smooth operation cannot be expected. Reduce each loop gain value to an appropriate value.

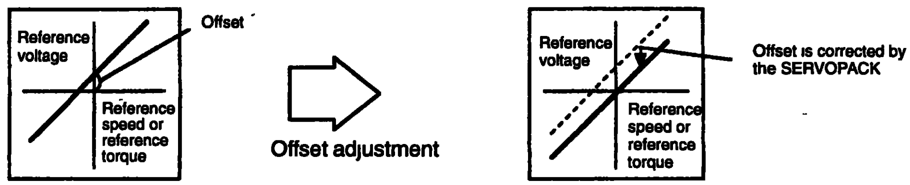
For servo gain adjustment, refer to the following section:

Section 3.6.2 Setting Servo Gain

3.5.4 Adjusting the Offset

If reference voltage from the host controller or external circuit has an offset in the vicinity of 0 V, smooth operation cannot be expected. Adjust the reference offset to 0 V.

When Reference Voltage from Host Controller or External Circuit has an Offset



■ How to Adjust the Reference Offset

The following two methods are available to adjust the reference offset to 0 V.

Automatic adjustment of reference offset	Reference offset is automatically adjusted.
Manual adjustment of reference offset	Reference offset can be intentionally set to a specified value.

IMPORTANT

If a position control loop is formed in the host controller, do not use automatic adjustment. Always use manual adjustment.

For detailed adjustment procedures, refer to the following sections:

	Adjustment Method
Automatic adjustment of reference offset	*Section 4.2.4 Reference Offset Automatic Adjustment*
Manual adjustment of reference offset	*Section 4.2.5 Reference Offset Manual Adjustment Mode*

3.5.5 Setting the Torque Reference Filter Time Constant

If the machine causes vibration, possibly resulting from the servo drive, adjust the following filter time constant. Vibration may stop.

Cn-17	TRQFIL Torque Reference Filter Time Constant	Unit: 100 μs	Setting Range: 0 to 250		For Speed/Torque Control and Position Control

Cn-17 is a torque reference filter time constant for the SGDB SERVOPACK. The smaller the value, the higher the torque control response. There is, however, a certain limit depending on machine conditions.

With the standard setting, the machine may cause vibration resulting from the servo drive. In this case, increase the constant setting. Vibration may stop. Vibration can be caused by incorrect gain adjustment, machine problems and so on.

Switching between the Primary and Secondary Torque Reference Filters

8. The following memory switch can be used to switch between the primary and secondary torque reference filters. The filter to be used depends on machine characteristics. If vibration occurs, select the appropriate filter by changing the memory switch setting.

Cn-02 Bit C	Torque Reference Filter Selection	Factory Setting: 0		For Speed/Torque Control and Position Control

0: Primary filter
1: Secondary filter

3.6 Minimizing Positioning Time

This section describes how to minimize positioning time.

3.6.1 Using the Autotuning Function

If speed loop gain and position loop gain for the servo system are not set properly, positioning may become slow. Techniques and experience are required to set these servo gain values according to machine configuration and machine rigidity.

Σ-series SERVOPACKs have an autotuning function that automatically measures machine characteristics and sets the necessary servo gain values. With this function, even first-time servo users can easily perform tuning for servo gain. Servo gain values are set in parameters.

The following parameters can be automatically set by the autotuning function.

Parameter	Meaning
Cn-04	Speed loop gain
Cn-05	Speed loop integration time constant
Cn-1A	Position loop gain

For details of how to perform autotuning, refer to *Section 4.2.3 Autotuning*.

3.6.2 Setting the Servo Gain

Check and reset the servo gain when:

- Automatically set servo gain values need to be checked after autotuning.
- Each servo gain value checked in the above procedure is to be directly set for another SERVOPACK.
- Response performance needs to be further enhanced after autotuning, or servo gain values need to be reset for a system with lower response performance.

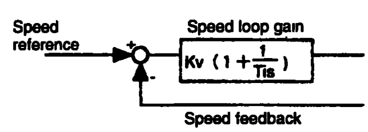
■ Setting the Speed Loop

Set the following parameters related to speed loop as necessary.

Cn-04	LOOPHZ Speed Loop Gain (Kv)	Unit: Hz	Setting Range: 1 to 2000	Factory Setting: 80	For Speed/Torque Control and Position Control
Cn-05	PITIME Speed Loop Integration Time Constant (Ti)	Unit: 0.01 ms	Setting Range: 200 to 51200	Factory Setting: 2000	For Speed/Torque Control and Position Control

Cn-04 and Cn-05 are a speed loop gain and an integration time constant for the SERVOPACK, respectively.

The higher the speed loop gain value or the smaller the speed loop integration time constant value, the higher the speed control response. There is, however, a certain limit depending on machine characteristics.



Note If the Cn-28 constant is set, the maximum allowable Cn-04 setting may become smaller than 2000.

The unit of speed loop gain (Kv) is Hz, but this value is obtained when J_M equals J_L. Therefore, the value must be converted using load J (= J_L) as follows:
Kv value=setting x 2/[1 + (JL/JM)

$$Kv\ value = \frac{setting \times 2}{1 + (J_L/J_L)}$$

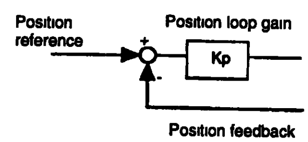
These parameters are automatically set by the autotuning function.

■ Setting the Position Loop

Set the following parameters related to position loop as necessary.

Cn-1A	POSGN Position Loop Gain (Kp)	Unit: 1/s	Setting Range: 1 to 200	Factory Setting. 40	For Position Control Only

This parameter is a position loop gain for the SERVOPACK.

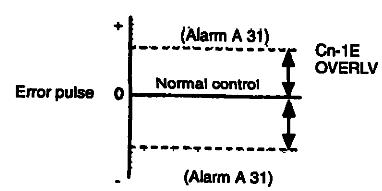


Increasing the position loop gain value provides position control with higher response and less error. However, there is a certain limit depending on machine characteristics. This gain is also valid for zero clamp operation.

This parameter is automatically set by the autotuning function.

Cn-1E	OVERLV Overflow	Unit: 256 References	Setting Range: 1 to 32767	Factory Setting: 1024	For Position Control Only

Set in this parameter the error pulse level at which a position error pulse overflow alarm (alarm A.31) is detected.



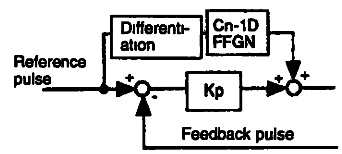
If the machine permits only a small position loop gain value to be set in Cn-1A, an overflow alarm may arise during high-speed operation. In this case, increase the value set in this parameter to suppress alarm detection.

3.6.3 Using Feed-forward Control

Feed-forward control shortens positioning time. To use **feed-forward control**, set the following parameter.

Cn-1D	FFGN Feed-forward Gain	Unit %	Setting Range: 0 to 100	Factory Setting: 0	For Position Control Only

This parameter is set to apply feed-forward frequency compensation to position control inside the SERVOPACK.
Use this parameter to shorten positioning time.
Too high a value may cause the machine to vibrate.
For ordinary machines, set 80% or less in this constant.

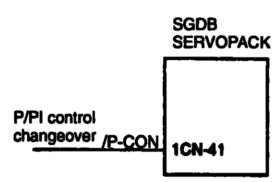


3.6.4 Using Proportional Control

If parameter Cn-2B is set to 0 or 1 as shown below, input signal /P-CON serves as a PI/P control changeover switch.

- PI Control: Proportional/Integral control
- P Control: Proportional control

Cn-2B	Control Mode Selection	Factory Setting. 0	For Speed Control and Position Control

<table>
<tr><th>Cn-2B</th><th colspan="2">Control Mode</th></tr>
<tr><td>0, 1</td><td>Speed Control, Position Control
This is normal speed control or position control.
• Signal /P-CON (1CN-41) is used to switch between P control and PI control.
<table><tr><td>/P-CON (1CN-41) is open (OFF)</td><td>PI control</td></tr><tr><td>/P-CON (1CN-41) is closed (0V)</td><td>P control</td></tr></table></td><td></td></tr>
</table>

TERMS

◆ Feed-forward control

Control for making necessary corrections beforehand to prevent the control system from receiving the effects of disturbance
Using feed-forward control increases effective servo gain, enhancing response performance

How to Use Proportional Control

Proportional control can be used in the following two ways.

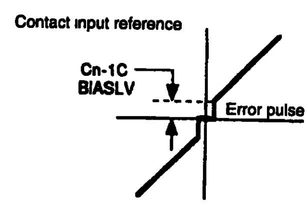
- When operation is performed by sending speed references from the host controller to the SERVOPACK, the host controller can selectively use P control mode for particular conditions only. This method can prevent the occurrence of overshoot and also shorten settling time. For particular conditions, refer to *Section 3.6.6 Using Mode Switch.*
- If PI control mode is used when the speed reference has a reference offset, the motor may rotate at a very slow speed and fail to stop even if 0 is specified as a speed reference. In this case, use P control mode to stop the motor.

3.6.5 Setting the Speed Bias

The settling time for positioning can be reduced by assigning bias to the speed reference output part in the SERVOPACK. To assign bias, use the following constant.

Cn-1C	BIASLV Bias	Unit: r/min	Setting Range: 0 to 450	Factory Setting: 0	For Position Control Only

This parameter is set to assign an offset to a speed reference in the SGDB SERVOPACK. (In position control mode)



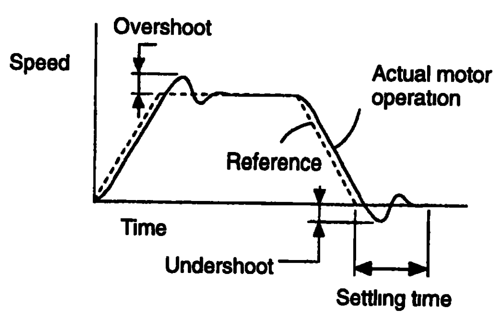
Use this constant to reduce the settling time.

Set this parameter according to machine conditions.

3.6.6 Using the Mode Switch

Use the mode switch for the following purposes:

- To prevent overshoot during acceleration or deceleration (for speed control).
- To prevent undershoot during positioning in order to reduce settling time (for position control).



In other words, the mode switch is a function that automatically switches the speed control mode inside the SERVOPACK **from PI control to P control** while certain conditions are being established.

IMPORTANT

The mode switch is used to fully utilize performance of a servo drive to achieve very high-speed positioning. The speed response waveform must be observed to adjust the mode switch.
For normal use, the speed loop gain and position loop gain set by autotuning provide sufficient speed/position control.
Even if overshoot or undershoot occurs, they can be suppressed by setting the acceleration/deceleration time constant for the host controller, the soft start time constants (Cn-07, Cn-23), or smoothing time constant (Cn-26) for the SERVOPACK.

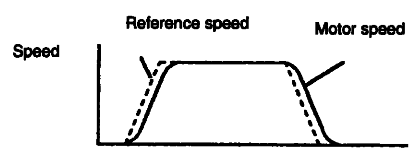
■ Selecting a Mode Switch

SERVOPACKs can use four types of mode switches (1 to 4). To select a mode switch, use the following memory switch.

Memory Switch Cn-01			Mode Switch Setting	Parameter	Unit
Bit D	Bit C	Bit B			
–	–	1	Does not use mode switch.		
0	0	0	Uses torque reference as a detection point. (Standard setting)	Cn-0C	Percentage of rated torque. %
0	1	0	Uses speed reference as a detection point.	Cn-0D	Motor speed. r/min
1	0	0	Uses acceleration reference as a detection point.	Cn-0E	Motor acceleration: 10 (r/min)/s
1	1	0	Uses error pulse as a detection point.	Cn-0F	Reference unit

When Torque Reference Is Used as a Detection Point of Mode Switch (Standard Setting)

If a torque reference exceeds the torque value set in parameter Cn-0C, the speed loop switches to P control.

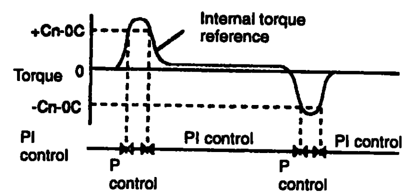


TERMS

◆ From PI control to P control

PI control means proportional/integral control and P control means proportional control. In short, switching "from PI control to P control" reduces effective servo gain, making the servo system more stable.

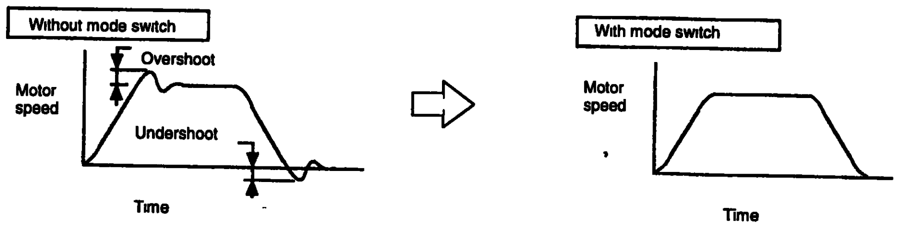
The SGDB SERVOPACK is factory set to this standard mode (Cn-0C = 200).



Example of Use:

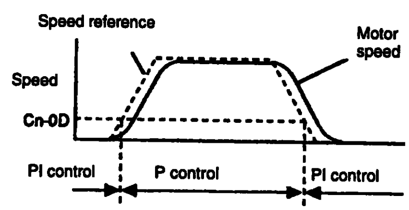
If a mode switch is not used and PI control is always performed, torque may enter a saturation state during acceleration or deceleration, causing the motor speed to have overshoot or undershoot.

Using the mode switch suppresses torque saturation and prevents the motor speed from having overshoot and undershoot.



When Speed Reference Is Used as a Detection Point of Mode Switch

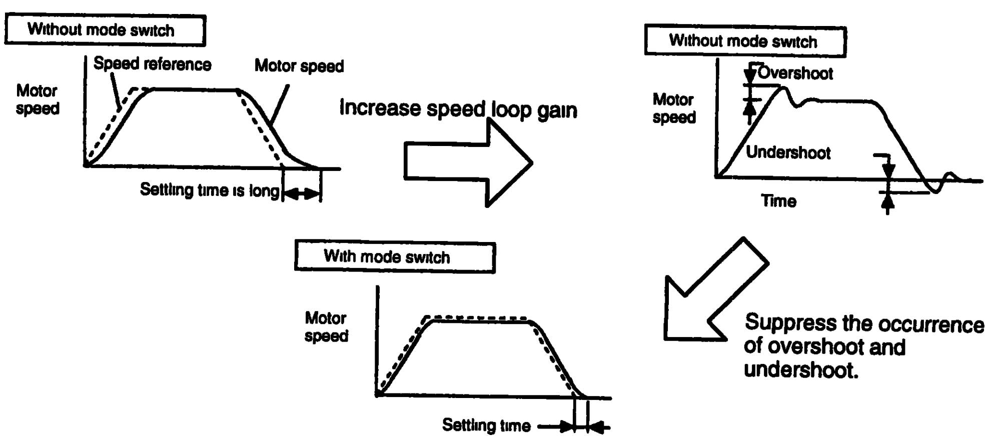
If a speed reference exceeds the value set in parameter Cn-0D, the speed loop switches to P control.



Example of Use:

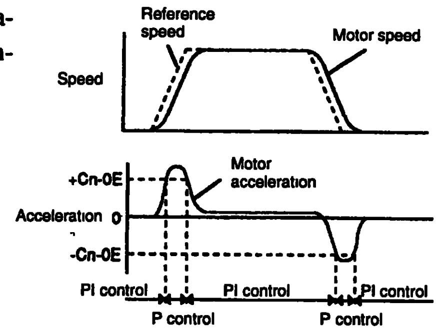
The mode switch is used to reduce settling time.

Generally, speed loop gain must be increased to reduce settling time. Using the mode switch suppresses the occurrence of overshoot and undershoot when speed loop gain is increased.



When Acceleration Is Used as a Detection Point of Mode Switch

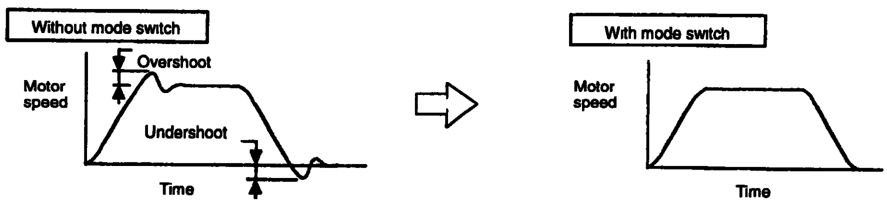
If motor acceleration exceeds the value set in parameter Cn-0E, the speed loop switches to P control.



Example of Use:

If a mode switch is not used and PI control is always performed, torque may enter a saturation state during acceleration or deceleration, causing the motor speed to have overshoot or undershoot.

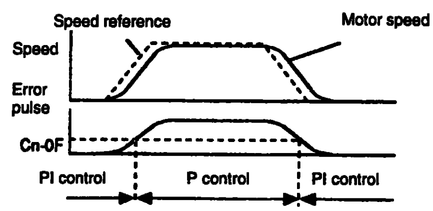
Using the mode switch suppresses torque saturation and prevents the motor speed from having overshoot and undershoot.



When Error Pulse Is Used as a Detection Point of Mode Switch

This is for position control only.

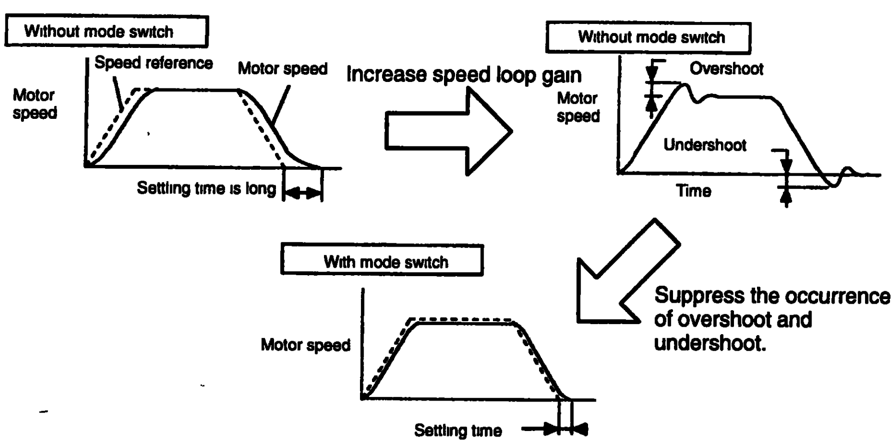
If an error pulse exceeds the value set in parameter Cn-0F, the speed loop switches to P control.



Example of Use:

The mode switch is used to reduce settling time.

Generally, speed loop gain must be increased to reduce settling time. Using the mode switch suppresses the occurrence of overshoot and undershoot when speed loop gain is increased.



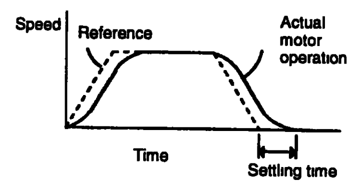
■ Parameters

The parameters required to set each mode switch are summarized as follows.

Cn-01 Bit B	Mode Switch ON/OFF	Factory Setting: 0	For Speed Control and Position Control

This parameter is used to enable or disable the mode switch function.

Setting	Meaning
0	Uses the mode switch function
1	Does not use the mode switch function



Mode switch is used to reduce settling time and suppress undershoot when the motor stops. It switches PI control to P control when certain conditions are met.

The SERVOPACK allows use of four different types of mode switch. To select a mode switch, set bits C and D of memory switch Cn-01.

Cn-01 Bit C	Mode Switch Selection	Factory Setting: 0	For Speed Control and Position Control
Cn-01 Bit D	Mode Switch Selection	Factory Setting: 0	For Speed Control and Position Control

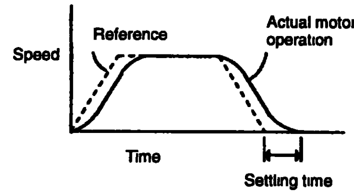
Use the following parameters to set the mode switch to be used.

Memory Switch Cn-01 Bit D	Memory Switch Cn-01 Bit C	Mode Switch Type	Parameter for Setting Detection Point
0	0	Uses torque reference as a detection point	Cn-0C
0	1	Uses speed reference as a detection point.	Cn-0D
1	0	Uses acceleration reference as a detection point	Cn-0E
1	1	Uses error pulse as a detection point.	Cn-0F

Mode switch is used to reduce settling time and suppress undershoot when the motor stops. It switches PI control to P control when certain conditions are met.

Cn-0C	TRQMSW	Mode Switch (Torque Reference)	Unit: %	Setting Range: 0 to 800	Factory Setting: 200	For Speed Control and Position Control
Cn-0D	REFMSW	Mode Switch (Speed Reference)	Unit: r/min	Setting Range: 0 to 10000	Factory Setting: 0	For Speed Control and Position Control
Cn-0E	ACCMSW	Mode Switch (Acceleration Reference)	Unit: 10 (r/min)/s	Setting Range. 0 to 3000	Factory Setting: 0	For Speed Control and Position Control
Cn-0F	ERPMSW	Mode Switch (Error Pulse)	Unit: Reference Unit	Setting Range. 0 to 10000	Factory Setting: 10000	For Position Control Only

Mode switch is used to reduce settling time and suppress undershoot when the motor stops. It switches PI control to P control when certain conditions are met.



The SERVOPACK allows use of four different types of mode switch. To select a mode switch, set bits B, C and D of memory switch Cn-01.

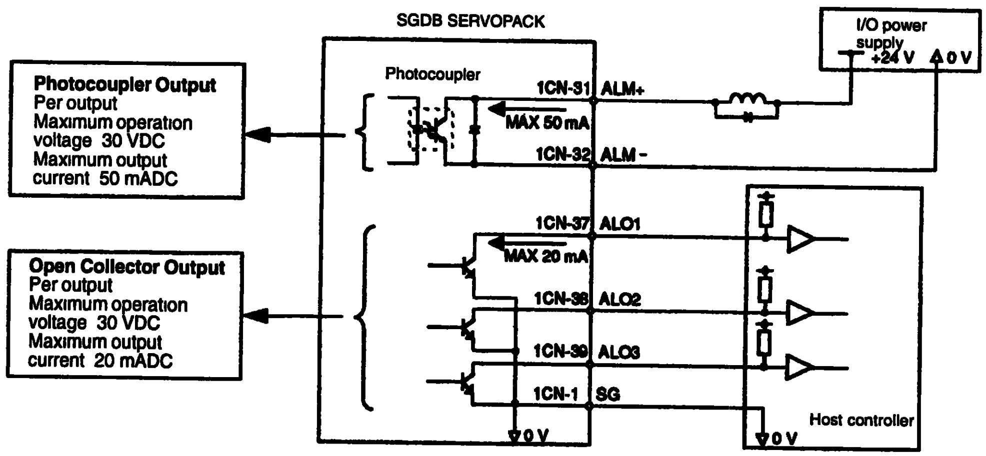
Memory Switch Cn-01			Mode Switch Setting	Parameter	Unit
Bit D	Bit C	Bit B			
–	–	1	Does not use mode switch.	–	–
0	0	0	Uses torque reference as a detection point	Cn-0C	Percentage of rated torque: %
0	1	0	Uses speed reference as a detection point	Cn-0D	Motor speed: r/min
1	0	0	Uses acceleration reference as a detection point.	Cn-0E	Motor acceleration: 10 (r/min)/s
1	1	0	Uses error pulse as a detection point.	Cn-0F	Reference unit

3.7 Forming a Protective Sequence

This section describes how to use I/O signals from the SERVOPACK to form a protective sequence for safety purposes.

3.7.1 Using the Servo Alarm Output and Alarm Code Output

■ Basic Wiring for Alarm Output Signals



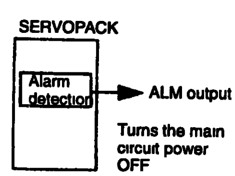
Provide an external I/O power supply separately. There is no DC power available from SERVOPACK for output signals.

■ Contact Output Signal ALM

Output → ALM+ 1CN-31	Servo Alarm Output	For Speed/Torque Control and Position Control
Output → ALM– 1CN-32	Signal Ground for Servo Alarm Output	For Speed/Torque Control and Position Control

Signal ALM is output when the SERVOPACK detects an alarm.

Design the external circuit so that the main circuit power to the SGDB SERVOPACK is turned OFF by this alarm output signal.



ON status:	Circuit between 1CN-31 and 1CN-32 is closed. 1CN-31 is at low level.	Normal state
OFF status:	Circuit between 1CN-31 and 1CN-32 is open. 1CN-31 is at high level.	Alarm state

Alarm codes ALO1, ALO2, and ALO3 are output to indicate each alarm type.

■ Open Collector Output Signals ALO1, ALO2, and ALO3

Output → ALO1 1CN-37	Alarm Code Output	For Speed/Torque Control and Position Control
Output → ALO2 1CN-38	Alarm Code Output	For Speed/Torque Control and Position Control
Output → ALO3 1CN-39	Alarm Code Output	For Speed/Torque Control and Position Control
Output → SG 1CN-1	Signal Ground for Alarm Code Output	For Speed/Torque Control and Position Control

These signals output an alarm code to indicate the type of an alarm detected by the SERVOPACK.

Use these signals to display alarm codes at the host controller.

■ Relationship between Alarm Display and Alarm Code Output

Alarm Display and Alarm Code Output:

Alarm Display	Alarm Code Output ALO1	Alarm Code Output ALO2	Alarm Code Output ALO3	Servo Alarm (ALM) Output	Alarm Type	Alarm Description
A.0□*	×	×	×	×	Parameter error	An absolute encoder error occurred or parameter is faulty.
A.10	○	×	×	×	Overcurrent	Overcurrent flowed thorough the main circuit. SERVOPACK overheated.
A.3□*	○	○	×	×	Regenerative error Position error pulse overflow	Regenerative circuit is faulty. The number of pulses in error counter has exceeded the preset value
A.40	×	×	○	×	Main power voltage error	Main circuit DC voltage has exceeded approximately 420 V.
A.51	○	×	○	×	Overspeed	Motor speed has exceeded the maximum allowable speed.
A.7□*	○	○	○	×	Overload	Motor and SERVOPACK are overloaded.
A.C□*	○	×	○	×	Overrun Disconnection of PG signal line	Overrun occurred due to motor or encoder signal wiring faults. Encoder signal line is disconnected.
A.8□*	×	×	×	×	Absolute encoder error	Absolute encoder is faulty.
A.A1	○	○	○	×	Heatsink overheat	SERVOPACK heat sink overheated.
A.b1	×	×	×	×	Reference input read error	Reference input failed to be detected.
A.F□*	×	○	×	×	Power line open phase Power loss alarm Main circuit contactor error	One phase is missing from main circuit power supply. Power loss has occurred during operation. Main circuit contactor is defective.
CPF00 CPF01	Undefined				Digital Operator transmission error	Communication error occurred between Digital Operator and SERVOPACK.
A.99	×	×	×	○	No error	

O : Output transistor is ON
X : Output transistor is OFF
* : Displays an alarm category number.
For details, refer to *Appendix E List of Alarm Displays.*

When the servo alarm (ALM) is output, eliminate the cause of the alarm and the turn ON the following /ALMRST input signal to reset the alarm state.

→ Input /ALMRST 1CN-44	Alarm Reset	For Speed/Torque Control and Position Control

This signal is used to reset the servo alarm state.

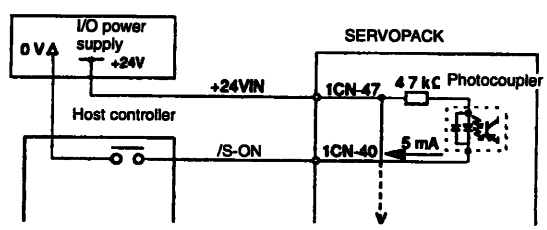
Form an external circuit so that the main circuit power supply is turned OFF when servo alarm is output. Alarm state is automatically reset when control power supply is turned OFF.

Alarm state can be reset using the Digital Operator.

When an alarm occurs, always eliminate the cause before resetting the alarm state. *6.2.1 Troubleshooting Problems with Alarm Display* describes how to troubleshoot the system when an alarm arises.

3.7.2 Using the Servo ON Input Signal

This section describes how to wire and use contact input signal "servo ON (/S-ON)." Use this signal to forcibly turn the servomotor OFF from the host controller.

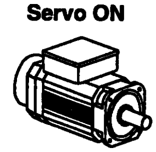


→ Input /S-ON 1CN-40	Servo ON	For Speed/Torque Control and Position Control

This signal is used to turn the motor ON or OFF.

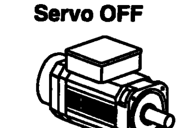
ON: 1CN-14 is at low level	Turns the motor ON. This is normal operation state (called "servo ON state").
OFF: 1CN-14 is at high level	Turns the motor OFF. This is inoperable state (called "servo OFF state"). The servo can be turned OFF during motor operation only when an emergency stop is required.

Servo ON



Motor is ON
Motor is operated according to input signals.

Servo OFF



Motor is OFF
Motor cannot run.

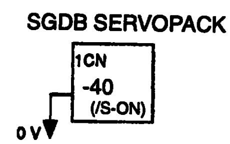
IMPORTANT Do not use the /S-ON signal to start or stop the motor. Always use an input reference to start and stop the motor.

If the /S-ON signal is not to be used, set the following memory switch to 1:

Cn-01 Bit 0	Use of Servo ON Input Signal	Factory Setting: 0	For Speed/Torque Control and Position Control

This memory switch is used to enable or disable the servo ON input signal /S-ON (1CN-40).

When external short-circuit wiring is omitted, set the memory switch to "1."

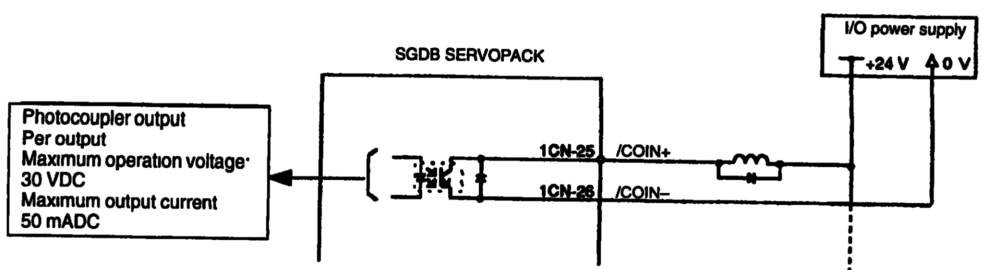


When /S-ON is not used, this short-circuit wiring can be omitted.

Setting	Meaning
0	Uses servo ON signal /S-ON. (When 1CN-40 is open, servo is OFF. When 1CN-40 is at 0 V, servo is ON.)
1	Does not use servo ON signal /S-ON. (The servo is always ON. This is the same as shorting 1CN-40 to 0 V.)

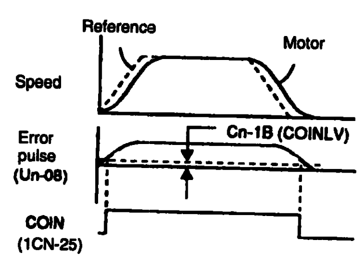
3.7.3 Using the Positioning Complete Signal

This section describes how to wire and use contact output-signal "positioning complete output (/COIN)." This signal is output to indicate that servomotor operation is complete.



Output → /COIN 1CN-25	Positioning Complete Output	For Position Control Only

This output signal indicates that motor operation is complete during position control. The host controller uses this signal as an interlock to confirm that positioning is complete.



ON status:	Circuit between 1CN-25 and 1CN-26 is closed. 1CN-25 is at low level.	Positioning is complete (position error is below the preset value).
OFF status:	Circuit between 1CN-25 and 1CN-26 is open. 1CN-25 is at high level.	Preset value. Cn-1B (positioning complete range)

Preset Value: Cn-1B (positioning complete range)

Use the following parameter to output the /COIN signal.

Cn-2D	OUTSEL	Output signal selection	Setting Range. 110 to 666	Factory Setting. 210	

This parameter is used to specify a function signal as the 1CN output signal.

1s place	Select the 1CN-25 and 1CN-26 (/COIN//V-CMP) functions.
10s place	Select the 1CN-27 and 1CN-28 (/TGON) functions.
100s place	Select the 1CN-29 and 1CN-30 (/S-RDY) functions.

Example: Outputting a COIN signal
Cn-2D=□□0
(COIN is output to 1CN-25 and 1CN-26 only.)

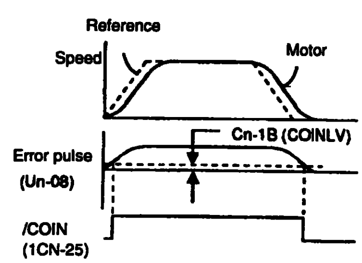
Preset Value	Function
0	/COIN//V-CMP (Can be allocated to 1CN-25 and 1CN-26 only.)
1	/TGON
2	/S-RDY
3	/CLT
4	/BK
5	Overload warning
6	Overload alarm

Set the number of error pulses in the following parameter to adjust output timing of COIN (positioning complete output).

Cn-1B	COINLV	Positioning Complete Range	Unit: Reference Unit	Setting Range: 0 to 250	Factory Setting: 1	For Position Control Only

This parameter is used to set output timing of positioning complete signal (/COIN, 1CN-25) to be output when motor operation is complete after a position reference pulse has been input.

Set the number of error pulses in terms of reference unit (the number of input pulses that is defined using the electronic gear function).



If too large a value is set in this parameter, error may become too small when the motor runs at a low speed, causing COIN to be output continuously.

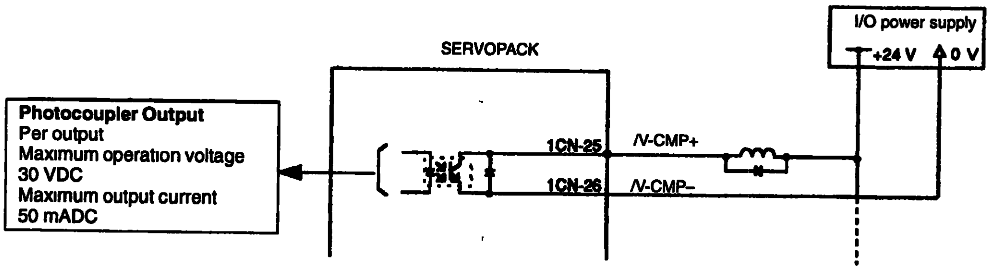
COINLV does not affect the final positioning accuracy.

IMPORTANT

/COIN is a signal for position control.
For speed control, /V-CMP (speed coincidence output) is used instead. For torque control, /COIN is always ON.

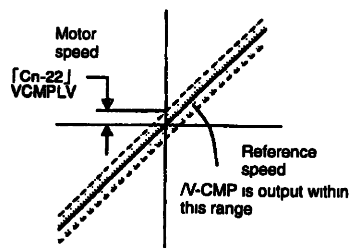
3.7.4 Using the Speed Coincidence Output Signal

This section describes how to wire and use contact output signal "speed coincidence output (/V-CMP)." This signal is output to indicate that actual motor speed matches a reference speed. The host controller uses this signal as an interlock.



Output → /V-CMP 1CN-25	Speed Coincidence Output	For Speed Control Only

This output signal indicates that actual motor speed matches the input speed reference during speed control.



ON status:	Circuit between 1CN-25 and 1CN-26 is closed. 1CN-25 is at low level.	Actual motor speed matches the speed reference (speed difference is below the preset value).
OFF status:	Circuit between 1CN-25 and 1CN-26 is open. 1CN-25 is at high level.	Actual motor speed does not match the speed reference (speed difference is greater than the preset value).

Preset value: Cn-22 (speed coincidence signal output width)

Use the following parameter to output the /V-CMP signal.

Cn-2D	OUTSEL	Output signal selection	Setting Range: 110 to 666	Factory Setting. 210	

This parameter is used to specify a function signal as the 1CN output signal.

1s place	Select the 1CN-25 and 1CN-26 (/COIN//V-CMP) functions.
10s place	Select the 1CN-27 and 1CN-28 (/TGON) functions.
100s place	Select the 1CN-29 and 1CN-30 (/S-RDY) functions.

Example: Outputting a /V-CMP signal
Cn-2D=□□0
(/V-CMP is output to 1CN-25 and 1CN-26 only.)

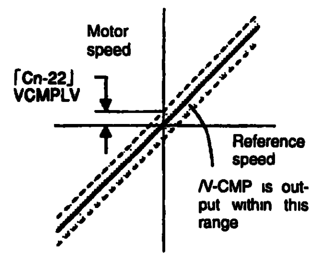
Preset Value	Function
0	/COIN//V-CMP (Can be allocated to 1CN-25 and 1CN-26 only.)
1	/TGON
2	/S-RDY
3	/CLT
4	/BK
5	Overload warning
6	Overload alarm

Set the following parameter to specify the output conditions for speed coincidence signal /V-CMP.

Cn-22	VCMPLV	Speed Coincidence Signal Output Width	Unit. r/min	Setting Range· 0 to 100	Factory Setting. 10	For Speed Control Only

Set the output conditions for speed coincidence signal /V-CMP (1CN-25).

/V-CMP signal is output when the difference between the reference speed and actual motor speed is not greater than the preset value.



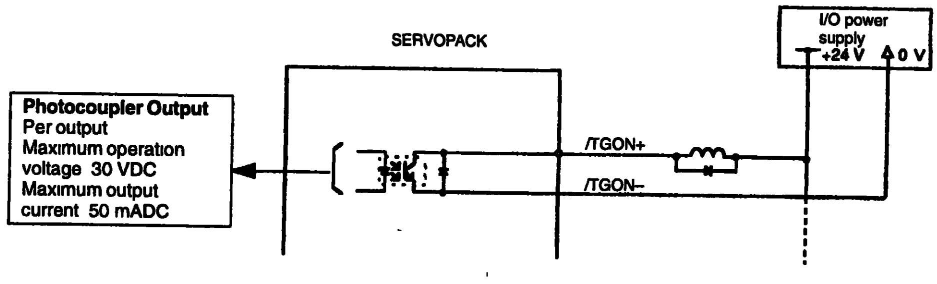
Example: When preset value is 100 and reference speed is 2000 r/min.
/V-CMP is ON (circuit between 1CN-25 and 1CN-26 is closed) when the speed is between 1900 and 2100 r/min.

IMPORTANT

/V-CMP is a signal for speed control.
For position control, /COIN (position complete output) is used instead. For torque control, /V-CMP is always ON.

3.7.5 Using the Running Output Signal

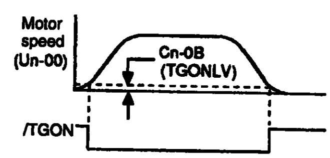
This section describes how to wire and use photocoupler output: a running output signal /TGON. This signal indicates that a servomotor is currently running.



Output → /TGON	Running Output	For Speed/Torque Control and Position Control

This output signal indicates that the motor is currently running.

It is used as an external interlock.



ON status:	Circuit is closed or signal is at low level	Motor is running. (Motor speed is greater than the preset value.)
OFF status:	Circuit is open or signal is at high level.	Motor is stopped. (Motor speed is below the preset value.)

Preset value: Cn-0B (zero-speed level)

Use the following parameter to specify the pin to which the /TGON signal is to be output.

Cn-2D	OUTSEL	Output signal selection	Setting Range: 110 to 666	Factory Setting: 210	

This parameter is used to specify a function signal as the 1CN output signal.

1s place	Select the 1CN-25 and 1CN-26 (/COIN//V-CMP) functions.
10s place	Select the 1CN-27 and 1CN-28 (/TGON) functions.
100s place	Select the 1CN-29 and 1CN-30 (/S-RDY) functions.

Example: /TGON is output to 1CN-27 and 1CN-28.
Cn-2D=□1□

Preset value	Function
0	/COIN//V-CMP (Can be allocated to 1CN-25 and 1CN-26 only)
1	/TGON
2	/S-RDY
3	/CLT
4	/BK
5	Overload warning
6	Overload alarm

Use the following parameter to specify the output conditions for /TGON (running output signal).

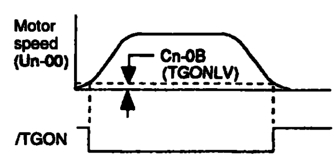
Cn-0B	TGONLV	Zero-Speed Level	Unit: r/min	Setting Range: 1 to 10000	Factory Setting: 20	For Speed/Torque Control and Position Control

This parameter is used to set the speed level at which the SERVOPACK determines that the motor is running and then outputs a signal.

The following signals are output when motor speed exceeds the preset value. (The circuit is closed when motor speed exceeds the preset value.)

Output signal of zero-speed

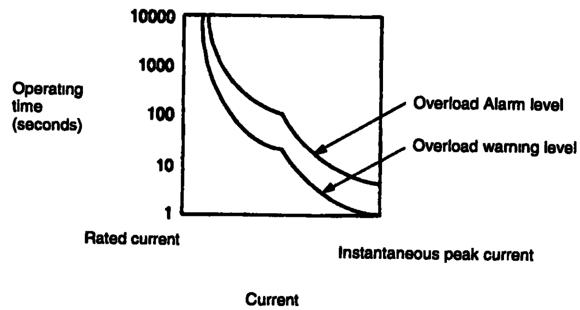
- /TGON
- Status indication mode bit data
- Monitor mode Un-05 bit 4

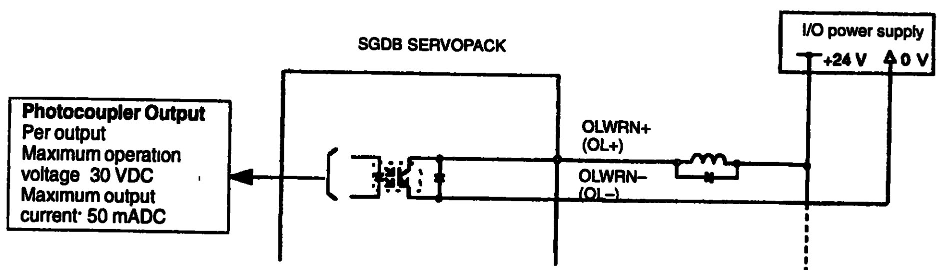


3.7.6 Using the OL Warning and Alarm Output Signals

This section describes how to wire and use photocoupler output signals OLWRN (overload warning) and OL (overload alarm).

These two output signals are output when operation under the rated current or more continues for a certain period of time. The overload warning signal is output in 20% of the time required to output the overload alarm signal.





Output → OLWRN	Overload Warning Output	For Speed/Torque Control and Position Control
Output → OL	Overload Alarm Output	For Speed/Torque Control and Position Control

OLWRN is an overload warning output signal, and OL is an overload alarm output signal.

ON status:	Circuit is closed or signal is at low level.	Normal state
OFF status:	Circuit is open or signal is at high level.	Warning or alarm state

Use the following parameter to specify the pin to which the signal is to be output.

Cn-2D	OUTSEL	Output signal selection	Setting Range: 110 to 666	Factory Setting: 210		For Speed/Torque Control and Position Control

This parameter is used to specify a function signal as the 1CN output signal.

1s place	Select the 1CN-25 and 1CN-26 (/COIN//V-CMP) functions.
10s place	Select the 1CN-27 and 1CN-28 (/TGON) functions.
100s place	Select the 1CN-29 and 1CN-30 (/S-RDY) functions.

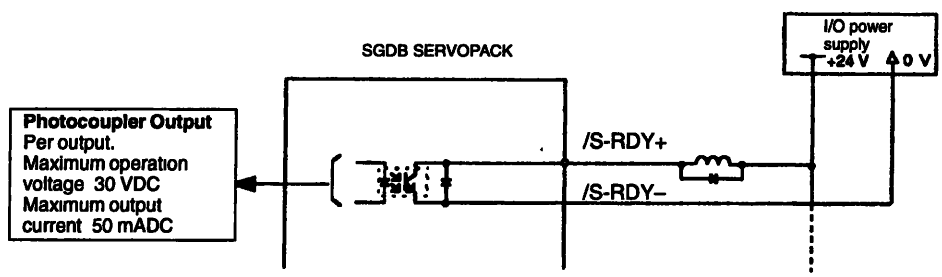
Example: Overload warning is output to 1CN-27 and 1CN-28.
Cn-2D=□5□

Preset Value	Function
0	/COIN//V-CMP (Can be allocated to 1CN-25 and 1CN-26 only.)
1	/TGON
2	/S-RDY
3	/CLT
4	/BK
5	Overload warnıng
6	Overload alarm

3.7.7 Using the Servo Ready Output Signal

This section describes how to wıre and use photocoupler output signal /S-RDY (servo ready).

"Servo ready" means that the SERVOPACK ıs not ın servo alarm state when the main cırcuit is turned ON. For absolute encoder specifications, "servo ready" means that, in addition to the above, the SEN signal is at high level and the absolute encoder is also in ready state.



Output → /S-RDY	Servo Ready Output	For Speed/Torque Control and Posıtıon Control

This signal indicates that the SERVOPACK ıs ready to receıve servo ON signals.

ON status:	Cırcuıt ıs closed or sıgnal ıs at low level.	Servo ready state
OFF status:	Cırcuıt ıs open or sıgnal ıs at hıgh level.	Not ın servo ready state

Use the following parameter to specify the pın to which the /S-RDY signal is to be output.

Cn-2D	OUTSEL	Output sıgnal selectıon	Settıng Range: 110 to 666	Factory Settıng: 210		For Speed/Torque Control and Posıtıon Control

This parameter is used to specify a function signal as the 1CN output signal.

1s place	Select the 1CN-25 and 1CN-26 (/COIN//V-CMP) functions.
10s place	Select the 1CN-27 and 1CN-28 (/TGON) functions.
100s place	Select the 1CN-29 and 1CN-30 (/S-RDY) functions

Example: /S-RDY is output to 1CN-29 and 1CN-30.
Cn-2D=2□□

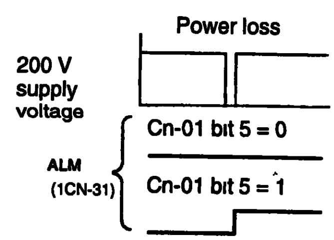
Preset Value	Function
0	/COIN//V-CMP (Can be allocated to 1CN-25 and 1CN-26 only.)
1	/TGON
2	/S-RDY
3	/CLT
4	/BK
5	Overload warning
6	Overload alarm

3.7.8 Handling of Power Loss

Use the following memory switch to specify whether to output a servo alarm when power loss occurs.

Cn-01 Bit 5	Operation to Be Performed at Recovery from Power Loss	Factory Setting: 0	For Speed/Torque Control and Position Control

If the SGDB SERVOPACK detects instantaneous voltage drop in power supply, it can output servo alarm A.F3 to prevent a hazardous situation. This memory switch is used to specify whether to output this alarm.



Setting	Meaning
0	Does not output a servo alarm after recovery from power loss.
1	Outputs a servo alarm after recovery from power loss.

Normally, set this memory switch to 0. If the /S-RDY signal is not to be used, set the memory switch to 1. The /S-RDY signal remains OFF while the main power supply is OFF, regardless of the memory switch setting.

3.8 Special Wiring

This section describes special wiring methods including the one for noise control. Always refer to *Section 3.8.1 Wiring Instructions* and *3.8.2 Wiring for Noise Control,* and refer to other sections as necessary.

3.8.1 Wiring Instructions

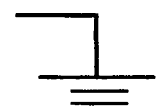
To ensure safe and stable operation, always refer to the following wiring instructions.

IMPORTANT

Always use the following cables for reference input and encoder wiring

	Cable Type	**Yaskawa Drawing No.**	**Maximum Allowable Length**
For reference input	Twisted-pair cables	DE9406969	3 m (9.8 ft.)
For encoder	Multiconductor shielded twisted-pair cable	DE9414800 (for incremental encoder) DE9414801 (for absolute encoder)	20 m (65.6 ft.)

For a ground wire, use as thick a cable as possible.



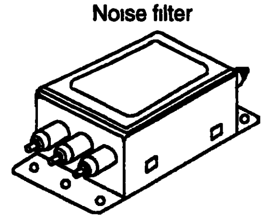
- Trim off the excess portion of the cable to minimize the cable length.
- At least class 3 grounding (ground to 100 Ω or less) is recommended
- Always use one-line grounding.
- If the motor is insulated from the machine, ground the motor directly.
- Select grounding phase and grounding point in accordance with the national code and consistent with sound local practices.

Do not bend or apply tension to cables.

- Since the conductor of a signal cable is very thin (0 2 to 0.3 mm), handle it with adequate care.

Use a noise filter to prevent noise interference.
(For details, refer to the following precaution.)

Noise filter



- If the servo is to be used near private houses or may receive noise interference, install a noise filter on the input side of the power supply line. Since this SERVOPACK is designed as an industrial device, it provides no mechanism to prevent noise interference

To prevent malfunction due to noise, take the following actions:

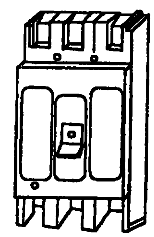
- Position the input reference device and noise filter as close to the SERVOPACK as possible
- Always install a surge absorber circuit in the relay, solenoid and magnetic contactor coils.
- The distance between a power line (such as a power supply line or motor cable) and a signal line must be at least 30 cm (12 in). Do not put the power and signal lines in the same duct or bundle them together.
- Do not share the power supply with an electric welder or electrical discharge machine. When the SERVOPACK is placed near a high-frequency oscillator, install a noise filter on the input side of the power supply line.

Note 1 Since SERVOPACK uses high-speed switching elements, signal lines may receive noise To prevent this, always take the above actions

2 For details of grounding and noise filters, refer to *Section 3 8 2 Wiring for Noise Control*

Use a molded-case circuit breaker (MCCB) or fuse to protect the power supply line from high voltage.

- This SERVOPACK is directly connected to commercial power supply without a transformer. Always use an MCCB or fuse to protect the servo system from accidental high voltage
- Select an appropriate MCCB or fuse according to the SERVOPACK capacity and the number of SERVOPACKs to be used as shown below.



MCCB or Fuse for Each Power Capacity

SERVOPACK Model	Power Supply Capacity per SERVOPACK*1 (kVA)	Power Supply Capacity per MCCB or Fuse*2 (A)
SGDB-2BAD	36.7	150
SGDB-3ZAD	50.1	200
SGDB-3GAD	61.8	225
SGDB-2BDD	36.7	100
SGDB-3ZDD	50.1	150
SGDB-3GDD	61.8	150
SGDB-4EDD	75.2	225
SGDB-5EDD	91.9	225

* 1 Power capacity at rated load

* 2 Operating characteristics (25°C). 2 seconds or more for 200%, 0 01 second or more for 700%

Note A fast-operating fuse cannot be used because the SERVOPACK power supply is a capacitor input type A fast-operating fuse may blow out when the power is turned ON

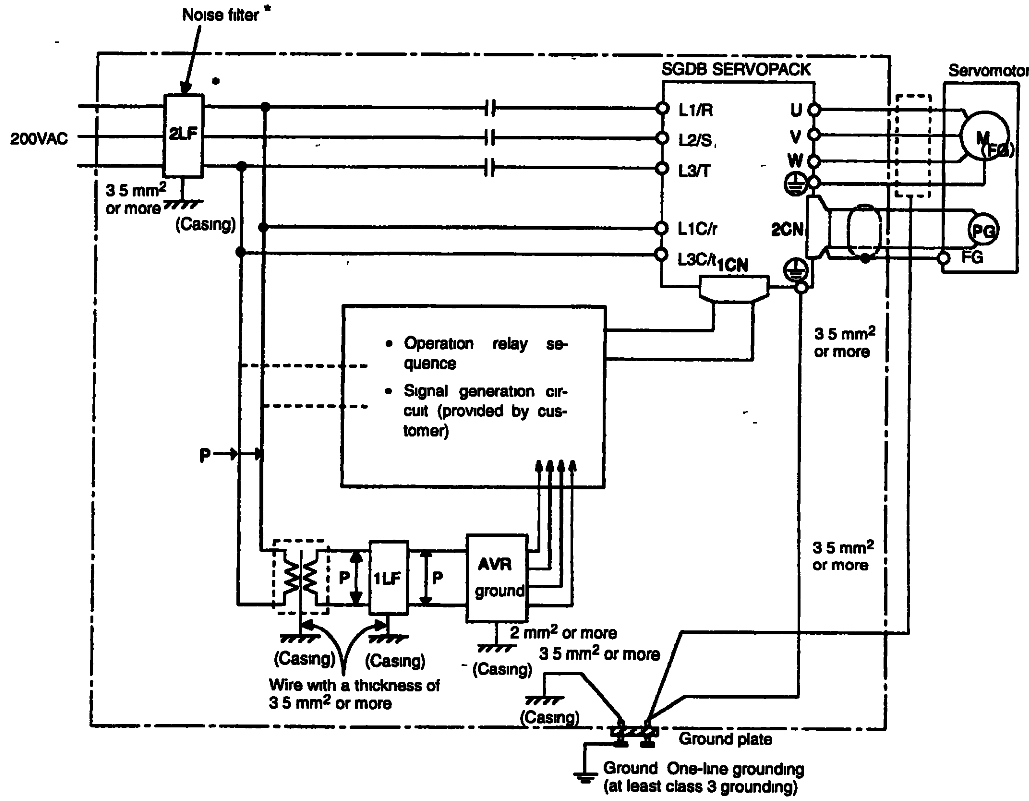
3.8.2 Wiring for Noise Control

■ Example of Wiring for Noise Control

This SERVOPACK uses high-speed switching elements in the main circuit. It may receive "switching noise" from these high-speed switching elements if wiring or grounding around the SERVOPACK is not appropriate. To prevent this, always wire and ground the SERVOPACK correctly.

This SERVOPACK has a built-in microprocessor (CPU). To protect the microprocessor from external noise, install a noise filter in place.

The following is an example of wiring for noise control.



* When using a noise filter, always observe the following wiring instructions:

Note 1. For a ground wire to be connected to the casing, use a thick wire with a thickness of at least 3.5 mm^2 (preferably, plain stitch cooper wire).

2. For wires indicated by P↕, use twisted-pair cables whenever possible.

■ Correct Grounding

- Always ground the motor frame.

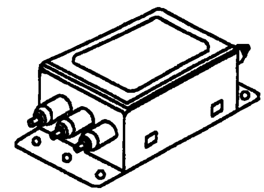
Always connect servomotor frame terminal FG to the SERVOPACK ground terminal ⊕. Be sure to ground the ground terminal ⊕.

If the servomotor is grounded via the machine, a switching noise current will flow from the SERVOPACK power unit through motor stray capacitance. The above grounding is required to prevent the adverse effects of switching noise.

- If the reference input line receives noise, do the following.

Ground the 0 V line (SG) of the reference input line. If the main circuit wiring for the motor is accommodated in a metal conduit, ground the conduit and its junction box. For all grounding, always use one-line grounding.

■ Noise Filter Installation



Use an inhibit type noise filter to prevent noise from the power supply line.

Install a noise filter on the power supply line for peripheral equipment as necessary.

The following table lists recommended noise filters for each SERVOPACK type.

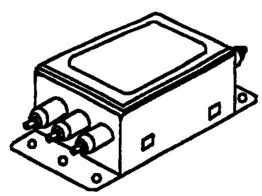
SERVOPACK Model		Noise Filter Connection	Recommended Noise Filter
0.3 kW	SGDB-2BAD	(Correct)	FN258L-130-35
0.5 kW	SGDB-3ZAD		FN258L-180-07
0.7 kW	SGDB-3GAD		FN359P-250-99
1.0 kW	SGDB-2BDD		FN258L-75-34
1.5 kW	SGDB-3ZDD	(Incorrect)	FN258L-100-35
2.0 kW	SGDB-3GDD		FN258L-130-35
3.0 kW	SGDB-4EDD		FN258L-180-07
4.4 kW	SGDB-5EDD		FN258L-180-07

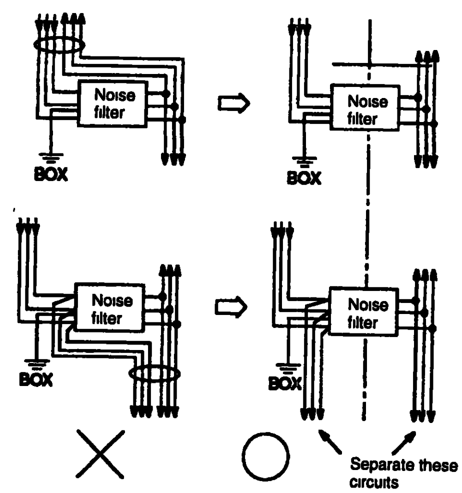
Note: These noise filters are manufactured by Tokin Corp and available from Yaskawa For noise filters, contact your nearest Yaskawa sales representatives

Always observe the following installation and wiring instructions. Incorrect use of a noise filter halves its benefits.

- Separate input lines from output lines.

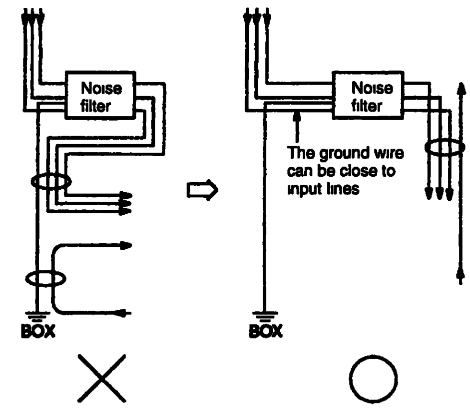
Do not put the input and output lines in the same duct or bundle them together.





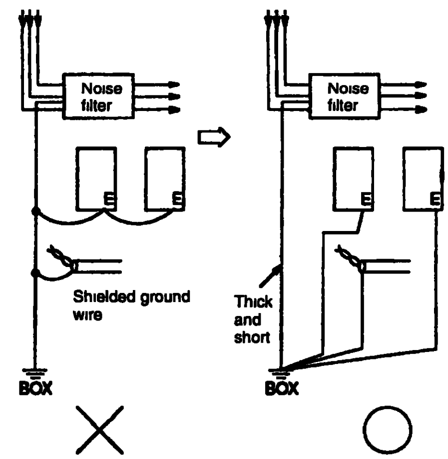
- Separate the noise filter ground wire from the output lines.

Do not accommodate the noise filter ground wire, output lines and other signal lines in the same duct or bundle them together



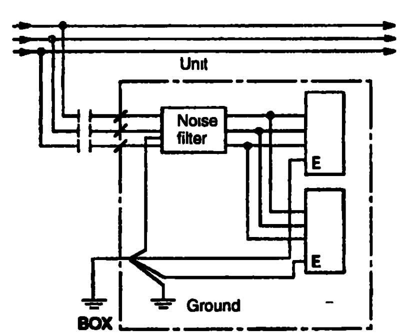
- Connect the noise filter ground wire directly to the ground plate.

Do not connect the noise filter ground wire to other ground wires



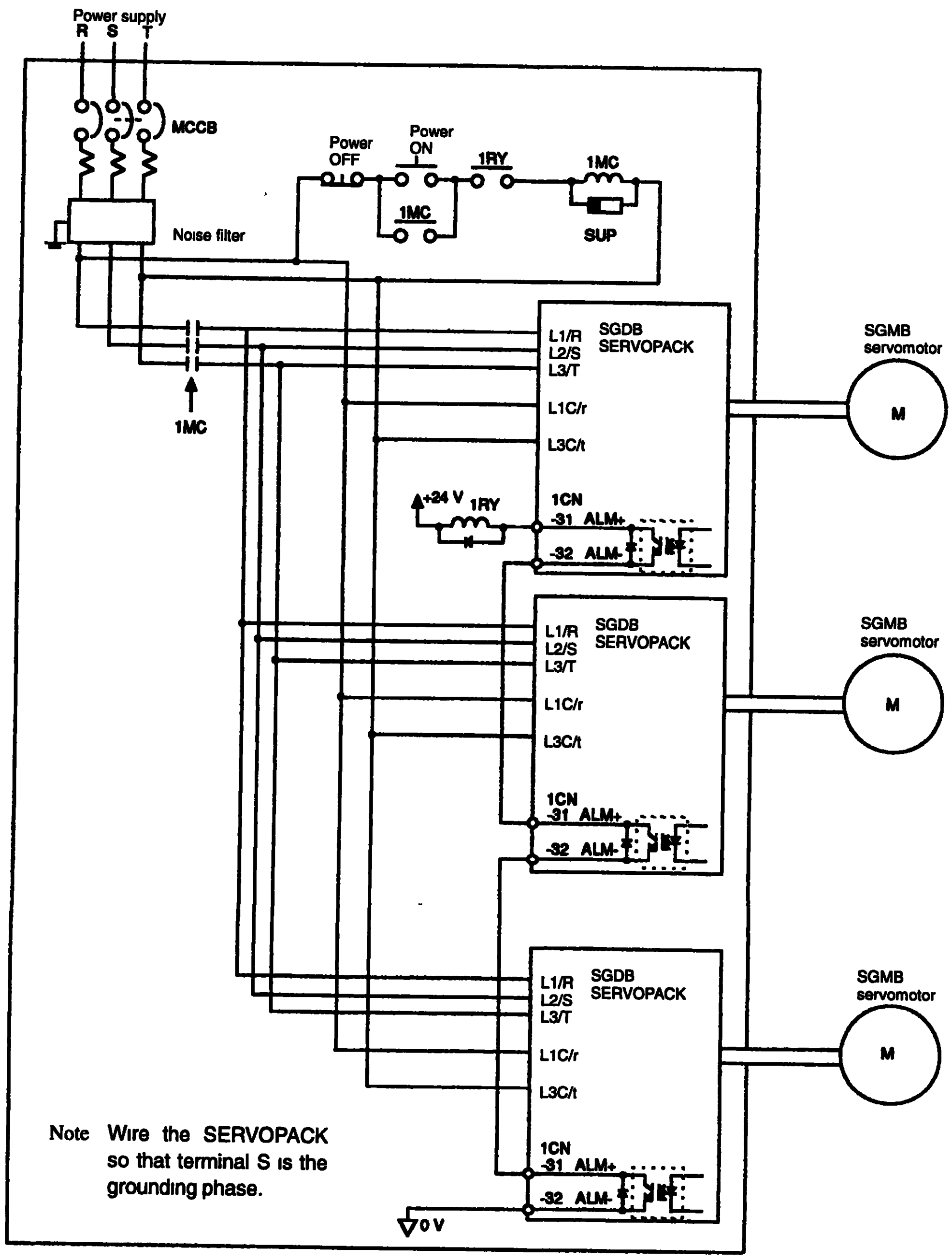
- When grounding a noise filter inside a Unit.

If a noise filter is located inside a Unit, connect the noise filter ground wire and the ground wires from other devices inside the Unit to the ground plate for the Unit first, then ground these wires



3.8.3 Using More Than One Servo Drive

An example of wiring more than one servo drive is shown below.



Note Wire the SERVOPACK so that terminal S is the grounding phase.

Connect the alarm output (ALM) terminals for the three SERVOPACKs in series to enable alarm detection relay 1RY to operate. This is because ALM is a logical complement output signal, so the output transistor is turned OFF when the system enters an alarm state.

The output transistor is turned OFF when the ALM output signal invokes alarm state.

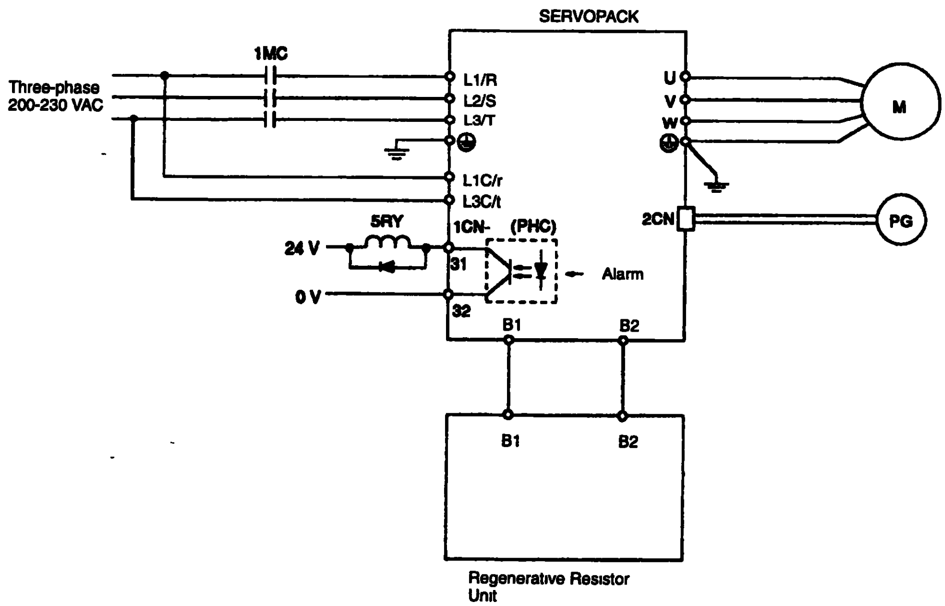
Multiple servos can share a single MCCB or noise filter. Always select a MCCB or noise filter that has enough capacity for the total power capacity (load conditions) of those servos. For details, refer to page 3 -83.

3.8.4 Using the Regenerative Resistor Units

High-capacity SERVOPACKs have no built-in regenerative resistor. For such SERVOPACKs, connect an external Regenerative Resistor Unit.

■ Connecting a Regenerative Resistor Unit

The standard connection diagram for a Regenerative Resistor Unit is shown below.
The following connection example is for a 200-V Regenerative Resistor Unit. For a 400-V Regenerative Resistor Unit, connect the B1 and B2 terminals in the same way.



Connecting a Regenerative Resistor Unit

■ Regenerative Resistor Units

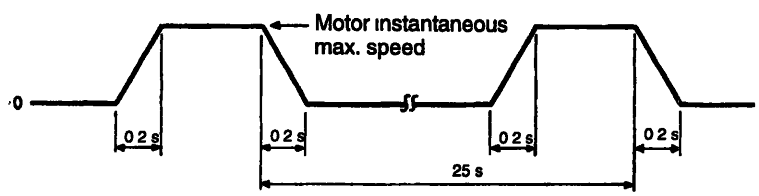
SERVOPACK Model	Regenerative Resistor Unit Model	Regenerative Resistance (Ω)	Capacity (W)
SGDB-2BAD	JUSP-RA08	2.4	2400
SGDB-3ZAD	JUSP-RA09	1.8	4800
SGDB-3GAD	JUSP-RA11	1.6	4800
SGDB-2BDD	JUSP-RA12	9	3600
SGDB-3ZDD	JUSP-RA13	6.7	3600
SGDB-3GDD	JUSP-RA14	5	4800
SGDB-4EDD	JUSP-RA15	4	6000
SGDB-5EDD	JUSP-RA16	3 75	7200

IMPORTANT

A Regenerative Resistor Unit becomes very hot under some regenerative operation conditions of the servo system. Therefore, provide a cooling mechanism for the Regenerative Resistor Unit, use heat resistant and incombustible cables, and route the cables so that they are not in contact with the unit.

The allowable dissipation of regenerative resistance is approximately 20% of the rated allowable dissipation of the resistor. If the regenerative power (average) exceeds the allowable limit of 20% when the servo system is operating in regenerative operation mode, select an additional regenerative resistor that has a greater rated allowable dissipation (W). Always take the servo system operation conditions into consideration when determining which Regenerative Resistor Unit to use.

Example of allowable motor duty conditions is shown below.

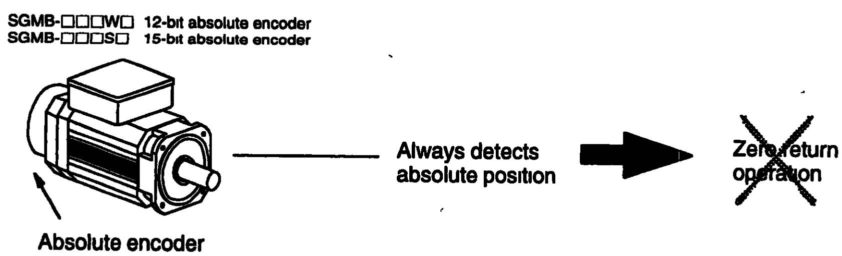


- Motor deceleration torque: Maximum torque
- Load inertia: Five times the motor rotor inertia

Assuming that there is no mechanical loss.

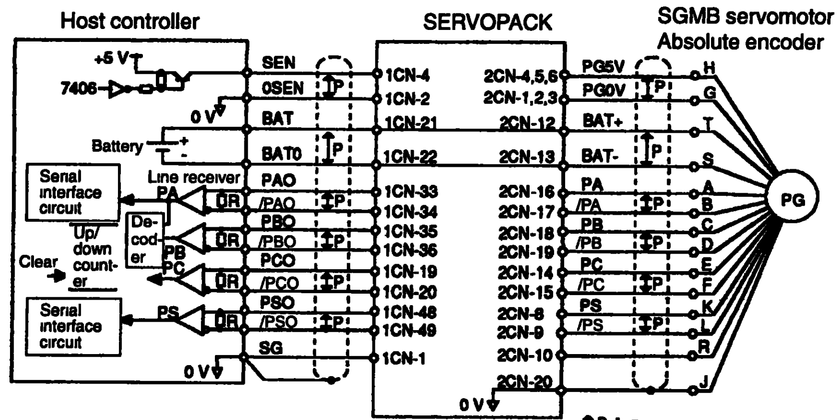
3.8.5 Using an Absolute Encoder

An absolute value detection system detects an absolute position of the machine even when the servo system is OFF. If such a system is to be formed in the host controller, use an SGMB servomotor with absolute encoder. Consequently, automatic operation can be performed without zero point return operation immediately after the power is turned ON.



The standard connection diagram for an absolute encoder mounted on a servomotor is shown below.

- **Interface Circuit**



Line Receiver Used: SN75175 or MC3486 manufactured by Texas Instruments Inc.
Termination Resistor R: 220 to 470 W

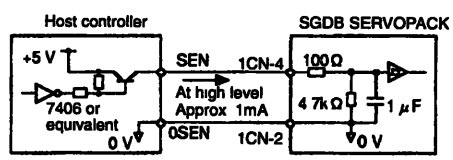
P : Represents twisted pair wires

PS, /PS, PSO and /PSO are for 12-bit absolute encoders only.

SEN signal

- The SEN signal must be set at high level after at least three seconds after the power is turned ON.
- When the SEN signal is changed from low level to high level, +5 V is applied to the absolute encoder, and serial data and initial incremental pulses are transmitted.

Electrical Specifications



- A PNP transistor is recommended
- Signal level: High level: Min. 2.5 V; Low level: Max. 0.8 V

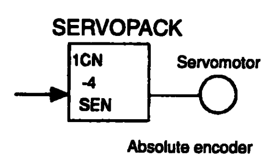
- The motor is not turned ON until these operations are complete, regardless of the servo ON signal (/S-ON).

■ Memory Switch to Determine Whether to Use Input Signal SEN

Cn-01 Bit 1	Use of SEN Input Signal	Factory Setting: 0	For Speed/Torque Control and Position Control

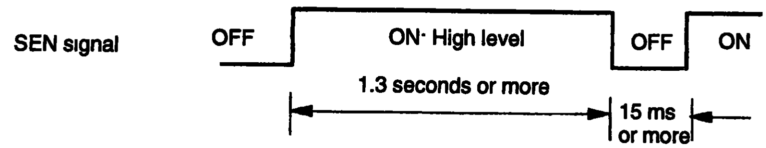
This memory switch is used to determine whether to use input signal SEN (1CN-4).

This memory switch is available for absolute encoders only (not for incremental encoders).



Setting	Meaning
0	Uses SEN signal.
1	Does not use SEN signal. (The SGDB SERVOPACK always assumes that the SEN signal is at high level, regardless of the actual signal level.)

IMPORTANT If the SEN signal is to be turned OFF, then ON again, it must remain at high level for at least 1.3 seconds before being turned OFF.



■ Memory Switch to 1 to Select Absolute Encoder

Cn-01 Bit E	Encoder Type Selection	Factory Setting: 0	For Speed/Torque Control and Position Control

Sets the encoder type according to the servomotor type to be used.

After changing the memory switch setting, turn the power OFF, then ON.

Motor Type Encoder Specifications	Number of Encoder Pulses Per Revolution	Preset Value
2	Incremental encoder. 8192 pulses per revolution	0
6	Incremental encoder: 4096 pulses per revolution	
W	Absolute encoder: 1024 pulses per revolution	1
S	Absolute encoder: 8192 pulses per revolution	

Use the following parameter to set the number of pulses for the absolute encoder to be used:

Cn-11	PULSNO Number of Encoder Pulses	Unit: P/R	Setting Range: Number of Encoder Pulses	For Speed/Torque Control and Position Control

Sets the number of encoder pulses according to the servomotor type to be used.

After changing the memory switch setting, turn the power OFF, then ON.

Motor Type Encoder Specifications	Number of Encoder Pulses Per Revolution	Preset Value
2	Incremental encoder: 8192 pulses per revolution	8192
6	Incremental encoder: 4096 pulses per revolution	4096
W	Absolute encoder. 1024 pulses per revolution	1024
S	Absolute encoder: 8192 pulses per revolution	8192

IMPORTANT Incorrect settings of the above parameters may result in abnormal motor operation. To prevent this, always set the parameter correctly.

Using a Battery

Use the following battery to enable the absolute encoder to store position information even when the power is turned OFF. Load the battery in the host controller and connect it to SERVOPACK input terminals BAT and BAT0.

Recommended battery: **Lithium battery** **Toshiba Battery Model ER6V C3** **3.6 V, 2000 mAH**	• Connect the battery securely to prevent contact faults resulting from environmental changes or aging. • Battery voltage is not monitored inside the SERVOPACK. Provide a battery voltage monitor circuit as necessary. Minimum voltage: 2.8 V

Setting up Absolute Encoder

Set up the absolute encoder in the following cases:

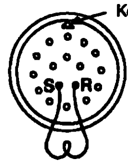
- When starting the machine for the first time
- When the absolute encoder is not connected to power supply or backup power supply (battery) for more than two days

The setup procedure is as follows:

15-bit absolute encoder (Motor type encoder specifications=S)

1 Discharging Electricity from the Encoder

- Turn the SGDB SERVOPACK OFF, then disconnect the encoder connector
- Short-circuit encoder connector terminals R and S for at least two minutes



2 Turning the Power ON

- Return the wiring to the normal state
- Connect the battery, turn the SGDB SERVOPACK ON, and set the SEN signal at high level
- If alarm "A.00" arises, repeat the same procedure from the beginning
- If no problem has occurred, the setup procedure is complete

12-bit absolute encoder (Motor type encoder specifications=W)

1 Turning SGDB SERVOPACK ON

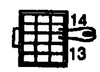
- Wire the SGDB SERVOPACK, motor and encoder in the normal way
- Connect the battery and turn the SGDB SERVOPACK ON

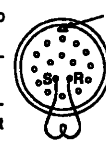
2 Turning the Encoder ON

- Set the SEN signal at high level
- Keep the encoder turned ON for at least three minutes
- It does not matter even if alarm status arises

3 Resetting Data

- Turn the SGDB SERVOPACK OFF, then disconnect the encoder connector
- Short-circuit encoder connector terminals 13 and 14 for two seconds or more (For SGM and SGMP servomotors)
- Short-circuit encoder connector terminals R and S for at least two seconds (For SGMG, SGMD, and SGMS servomotors)





4 Turning the Power ON

- Return the wiring to the original state
- Turn the SGDB SERVOPACK ON and set the SEN signal at high level
- If alarm "A.00" arises, repeat the same procedure from the beginning
- If no problem has occurred, the setup procedure is complete

IMPORTANT

Setting up the encoder sets the revolution count inside the encoder to 0.
After setting up the encoder, always reset the machine home position. Operating the machine without the home position being reset does not only damage the machine but may also cause an accident resulting in injury or death.

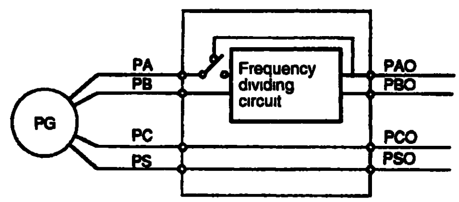
Absolute Data Exchange Sequence

The SERVOPACK sends absolute data to the host controller when receiving output from an absolute encoder. This data exchange sequence is described below.

Use the following detailed information when designing a host controller.

Outline of Absolute Signal

The absolute encoder outputs PAO, PBO, PCO and PSO as shown on the right.

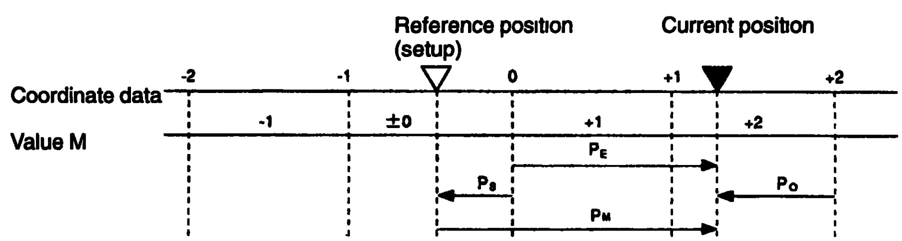


Signal Name	Status	Contents
PAO	Initial state	Serial data Initial incremental pulse
	Normal state	Incremental pulse
PBO	Initial state	Initial incremental pulse
	Normal state	Incremental pulse
PCO	Normal state	Home position pulse
PSO	Normal state	Rotation count serial data (12-bit absolute encoder only)

Contents of Absolute Data

Serial Data: Indicates how many turns the motor shaft has made from the reference position (position specified at setup).

Initial Incremental Pulse: Outputs pulses at the same pulse rate as when the motor shaft rotates from the home position to the current position at the maximum speed of 4,900 r/min.



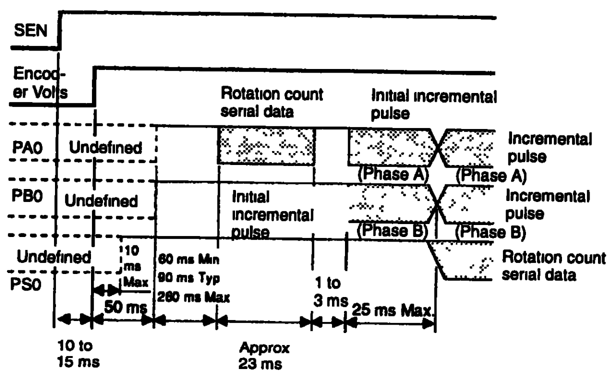
Absolute data P_M can be determined using the following formula

$$P_E = M \times R + P_O$$
$$P_M = P_E - P_S$$

P_E	Current value read by encoder
M	Serial data (rotation count data)
P_O	Number of initial incremental pulses (Normally, this is a negative value)
P_S	Number of initial incremental pulses read at setup (This is normally a negative value. This value is stored and managed at the host controller.)
P_M	Current value required for the customer system
R	Number of pulses per encoder revolution (pulse count after dividing, value of Cn-0A)

Absolute Data Transmitting Sequence

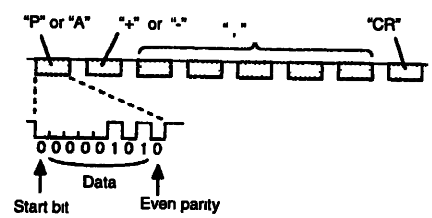
1. Set the SEN signal at high level.
2. After 100 ms, set the system to serial data reception-waiting-state. Clear the incremental pulse up/down counter to zero.
3. Receive eight bytes of serial data.
4. The system enters a normal incremental operation state approximately 50 ms after the last serial data is received.



Detailed Specifications of Each Signal

- Specifications of PAO Serial Data:

The number of revolutions is output in five digits.



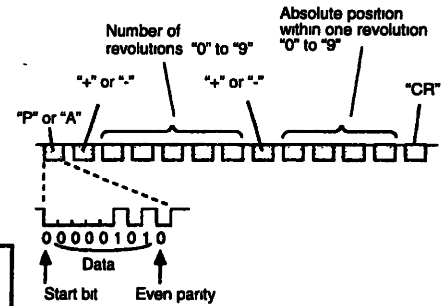
Data transmission method	Start-stop synchronization (ASYNC)
Baud rate	9600
Start bit	1 bit
Stop bit	1 bit
Parity	Even number
Character code	ASCII 7-bit code
Data format	8 characters. As shown on the right.

- Data is P+0000 (CR) or P-0000 (CR) when the number of revolutions is zero
- The maximum number of revolutions is ±99999. If this value is exceeded, it returns to 0000.

- Specifications of PSO Serial Data:

The number of revolutions and the absolute position within one revolution are always output in five and four digits, respectively. The transmission cycle is approximately 40 ms.

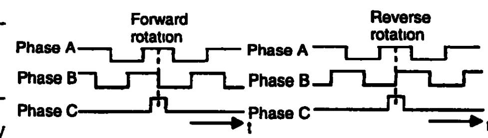
Data transmission method	Start-stop synchronization (ASYNC)
Baud rate	9600
Start bit	1 bit
Stop bit	1 bit
Parity	Even number
Character code	ASCII 7-bit code
Data format	13 characters. As shown on the right.



- Absolute position data within one revolution is a value before frequency dividing. (4,096 pulses per revolution)
- Absolute position data increases during forward rotation (standard setting). (Not valid in reverse rotation mode)

- Incremental Pulse and Home Position Pulse:

Initial incremental pulses which provide absolute data are first divided by the frequency divider inside the SERVOPACK and then output in the same way as normal incremental pulses.



- Note that phase C is not divided so its pulse width is narrower than phase A.

- Use the following parameter to set the pulse dividing ratio.

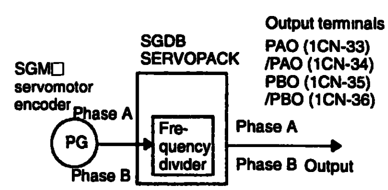
Cn-0A	PGRAT Dividing Ratio Setting	Unit. P/R	Setting Range: 16 to Number of Encoder Pulses		For Speed/Torque Control and Position Control

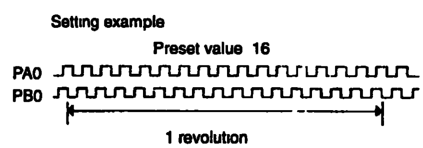
Set the number of output pulses for PG output signals (PAO, /PAO, PBO and /PBO).

Pulses from motor encoder (PG) are divided by the preset number of pulses before being output.

The number of output pulses per revolution is set in this parameter. Set this value according to the reference unit of the machine or controller to be used.

The setting range varies according to the encoder used.





■ Alarm Display

When a 12-bit absolute encoder is used, the following alarms are detected and displayed.

List of Alarms

Alarm Type	Meaning	Digital Operator Display	PAO Serial Data	PSO Serial Data
Backup Alarm	Indicates that backup voltage drop was detected. (This alarm helps maintain reliability of rotation count data.)	A81	ALM81. CR	ALARMOA BACK CR
Battery Alarm	Indicates that backup voltage drop was detected. (This alarm warns of battery replacement and disconnection.)	A83	ALM83. CR	ALARMOD BATT CR
Checksum Error	Indicates that an error was detected in memory data check.	A82	ALM82. CR	ALARMOB CHEC CR
Overspeed	Indicates that the motor was running at a speed exceeding 400 r/min when the encoder was turned ON.	A85	ALM85. CR	ALARMOP OVER CR
Absolute Error	Indicates that an error was detected in sensor check inside the encoder.	A84	ALM84. CR	ALARMOH ABSO CR
Backup/Battery Combination Alarm		A81	ALM81. CR	ALARMOE BACK (BATT) CR

The SEN signal can be used to output alarm information from PAO and PSO as serial data.

SEN Signal	"H" Error detection "H"		"L"	"H"	"L"
Digital Operator Display	rUn or bb	A80 Absolute encoder alarm (Details unknown)		A8* Absolute encoder alarm (Alarm type identified)	
PAO Serial Data	Incremental pulse		ALM80. CR	ALARMO* CR	ALM8*. CR
PSO Serial Data	P±□□□□□, □□□□ CR	H±□□□□□, □□□□ CR and so on	(Undefined)	ALARMO* **** CR	(Undefined)

Absolute Encoder Home Position Error Detection

Cn-02 Bit 1	Absolute Encoder Home Position Error Detection	Factory Setting: 0	For Speed/Torque Control and Position Control

This memory switch is used to specify whether to use **home position error detection** (alarm A.80) when an absolute encoder is used.

Setting	Meaning
0	Detects a home position error.
1	Does not detect a home position error

Normally, set this memory switch to “0”.

This memory switch has no significance when an incremental encoder is used.

TERMS

◆ Home position error detection

This function detects an encoder count error resulting from noise It checks the number of pulses per motor revolution, and outputs a home position error alarm if that number is incorrect
If the absolute encoder detects an error, it inverts phase C and notifies the SERVOPACK of the error In this case, this “home position error detection” function also works

3.8.6 Connector Terminal Layouts

This section describes connector terminal layouts for SERVOPACKs, SGMB servomotors and Digital Operators.

■ SERVOPACK Connectors

1CN Terminal Layout

1	SG	0V
2	SG	0V
3	PL1	Power supply for open collector reference
4	SEN	SEN signal input
5	V-REF	Speed reference input
6	SG	0V
7	PULS	Reference pulse input
8	/PULS	Reference pulse input
9	T-REF	Torque reference input
10	SG	0V
11	SIGN	Reference sign input
12	/SIGN	Reference sign input
13	PL2	Power supply for open collector reference
14	CLR	Error counter clear input
15	CLR	Error counter clear input
16	TQR-M	Torque monitor
17	VTG-M	Speed monitor
18	PL3	Power supply for open collector reference
19	PCO	PG dividing output phase C
20	/PCO	PG dividing output phase C
21	BAT	Battery (+)
22	BAT0	Battery (–)
23	+12V	Power supply for speed/torque reference
24	–12V	Power supply for speed/torque reference
25	/V-CMP (/COIN+)	Speed coincidence signal output
26	/V-CMP (/COIN–)	Speed coincidence output
27	/TGON+	TGON output signal
28	/TGON–	TGON output signal
29	/S-RDY+	Servo ready output
30	/S-RDY–	Servo ready output
31	ALM+	Servo alarm output
32	ALM–	Servo alarm output
33	PAO	PG dividing output phase A
34	/PAO	PG dividing output phase A
35	PBO	PG dividing output phase B
36	/PBO	PG dividing output phase B
37	ALO1	Alarm code output (open collector output)
38	ALO2	Alarm code output (open collector output)
39	ALO3	Alarm code output (open collector output)
40	/S-ON	Servo ON input
41	/P-CON	P control input
42	P-OT	Forward overtravel input
43	N-OT	Reverse overtravel input
44	/ALM-/RST	Alarm reset input
45	/P-CL	Forward external torque limit ON input
46	/N-CL	Reverse external torque limit ON input
47	+24V IN	External power supply input
48	PSO	Phase S Signal output
49	/PSO	Phase S Signal output
50	FG	Frame ground

- SERVOPACK End Connector model: 10250-52A2JL (manufactured by 3M)
- Cable End Connector model: 10150-3000VE (manufactured by 3M)
  Connector case model: 10350-52A0-008 (manufactured by 3M)

2CN Terminal Layout

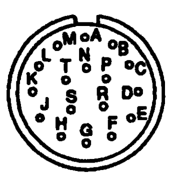
2	PG0V	PG power supply 0 V	1	PG0V	PG power supply 0 V	12	BAT +	Battery (+) (for absolute encoder only)	11		
4	PG5V	PG power supply +5 V	3	PG0V	PG power supply 0 V	14	PC	PG input phase C	13	BAT –	Battery (–) (for absolute encoder only)
6	PG5V	PG power supply +5 V	5	PG5V	PG power supply +5 V	16	PA	PG input phase A	15	/PC	PG input phase C
8	PS	PG input phase S (for absolute encoder only)	7	DIR	Rotation direction input	18	PB	PG input phase B	17	/PA	PG input phase A
10			9	/PS	PG input phase S (for absolute encoder only)	20	FG	Frame ground	19	/PB	PG input phase B

- SERVOPACK End — Connector model. 10220-52A2JL (manufactured by 3M)
- Cable End — Connector model: 10120-3000VE (manufactured by 3M)
  Connector case model: 10320-52A0-008 (manufactured by 3M)

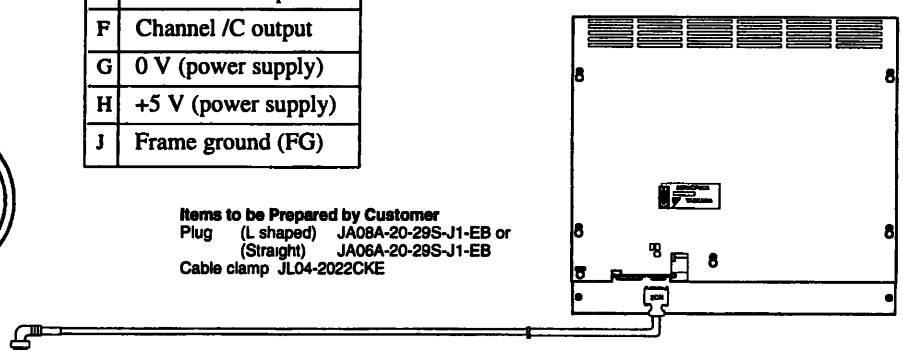
■ Connectors for Incremental Encoder

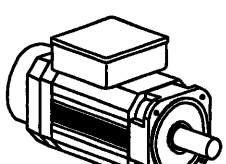
SGMB series

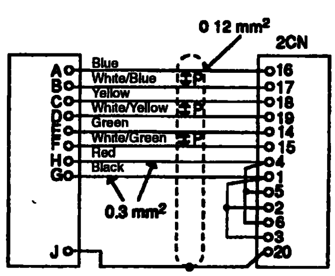
A	Channel A output
B	Channel /A output
C	Channel B output
D	Channel /B output
E	Channel C output
F	Channel /C output
G	0 V (power supply)
H	+5 V (power supply)
J	Frame ground (FG)



Items to be Prepared by Customer
Plug (L shaped) JA08A-20-29S-J1-EB or
(Straight) JA06A-20-29S-J1-EB
Cable clamp JL04-2022CKE





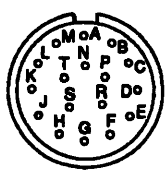


Items to be Prepared by Customer
Case:
10320-52A0-008
(manufactured by 3M)
Connector:
10120-3000VE
(manufactured by 3M)

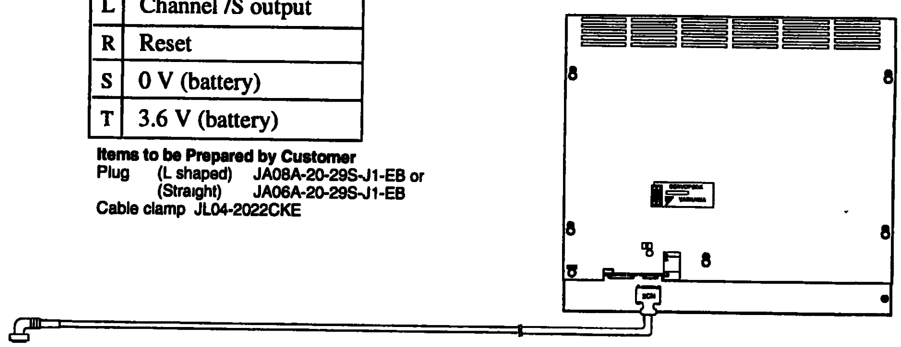
■ Connectors for Absolute Encoder

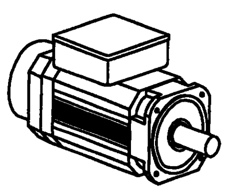
SGMB series

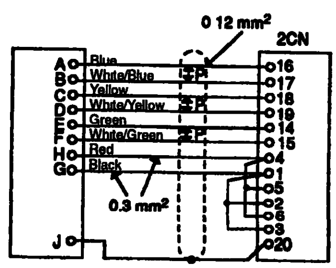
A	Channel A output
B	Channel /A output
C	Channel B output
D	Channel /B output
E	Channel Z output
F	Channel /Z output
G	0 V (power supply)
H	+5 V (power supply)
J	Frame ground (FG)
K	Channel S output
L	Channel /S output
R	Reset
S	0 V (battery)
T	3.6 V (battery)



Items to be Prepared by Customer
Plug (L shaped) JA08A-20-29S-J1-EB or
(Straight) JA06A-20-29S-J1-EB
Cable clamp JL04-2022CKE



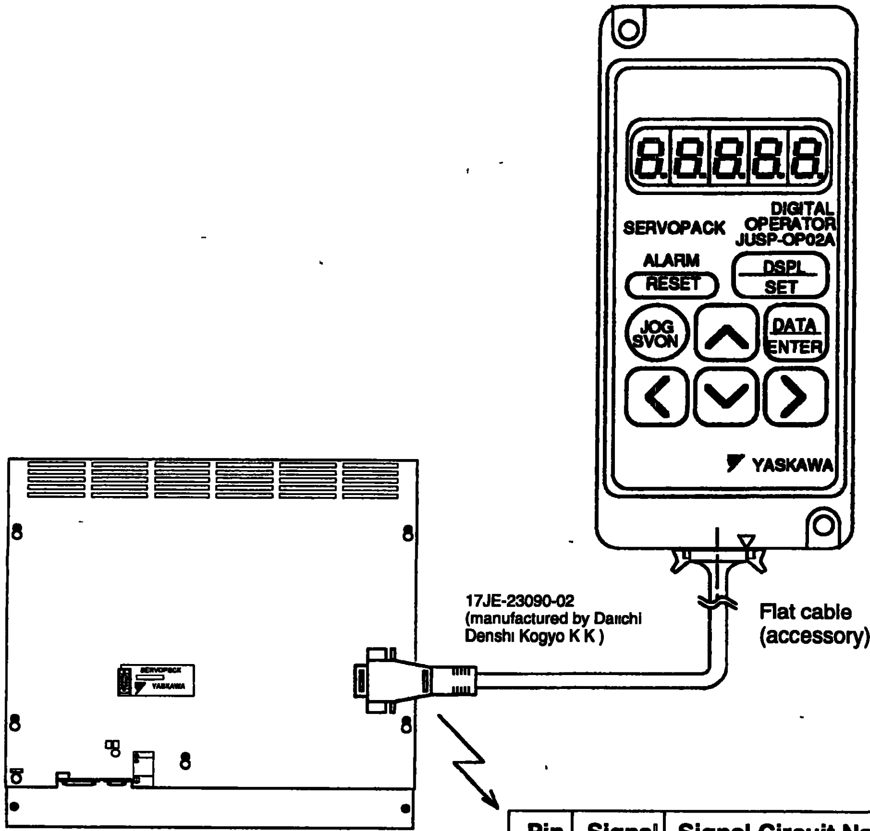




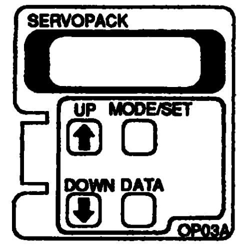
Items to be Prepared by Customer
Case·
10320-52A0-008
(manufactured by 3M)
Connector:
10120-3000VE
(manufactured by 3M)

■ Connectors for Digital Operator

- JUSP-OP02A-1 (Hand-held Type)



- JUSP-OP03A (Mount Type)



Fits directly into "OPERATOR" on the SERVOPACK.

Pin No.	Signal Name	Signal Circuit Name	Signal Direction
1	TXD	Transmit data (non-inversion side)	P ← S
2	/TXD	Transmit data (inversion side)	P ← S
3	RXD	Receive data (non-inversion side)	P → S
4	/RXD	Receive data (inversion side)	P → S
5	OPH		#
6	/RXD	Shorting pins 6 and 7 produces a terminal resistance of 220 Ω between RXD and /RXD	
7	RT		
8	5VPP		#
9	GND	Signal ground 0 V	

4

USING THE DIGITAL OPERATOR

This chapter describes the basic operation of the Digital Operator and the convenient features it offers.
All constant settings and motor operations are possible by simple, convenient, operation.
Operate the Digital Operator as you read through this chapter.

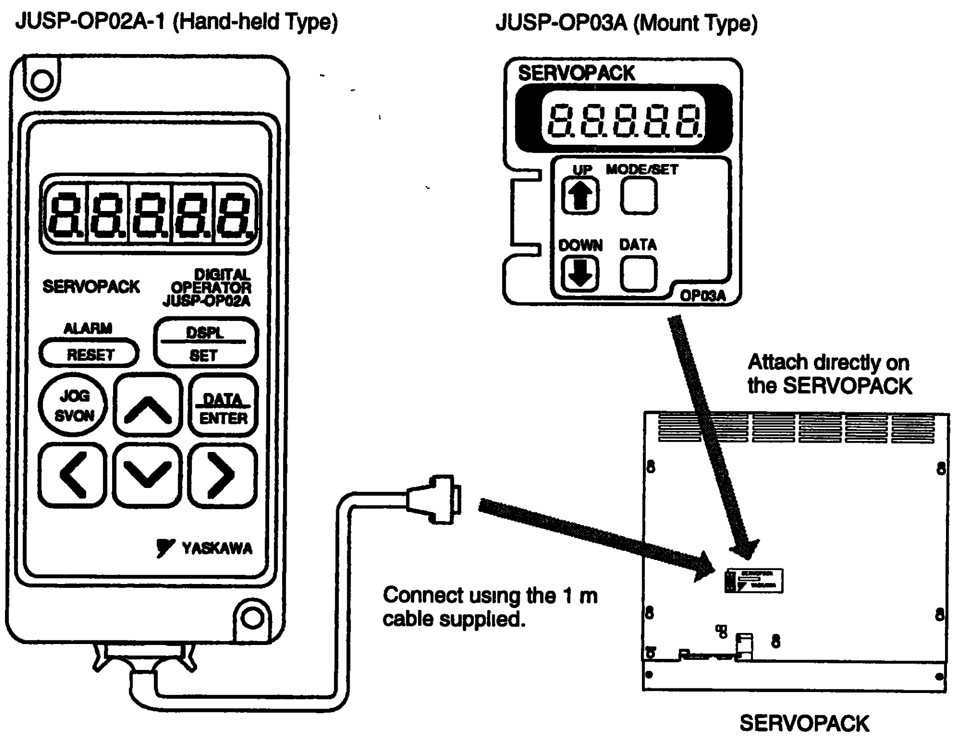
4

4.1 Basic Operations

This section describes the basic operations using the Digital Operator.

4.1.1 Connecting the Digital Operator

The Digital Operator is available as two models: JUSP-OP02A-1 (Hand-held Type) and JUSP-OP03A (Mount Type).
Each model is connected to the SERVOPACK as shown below.



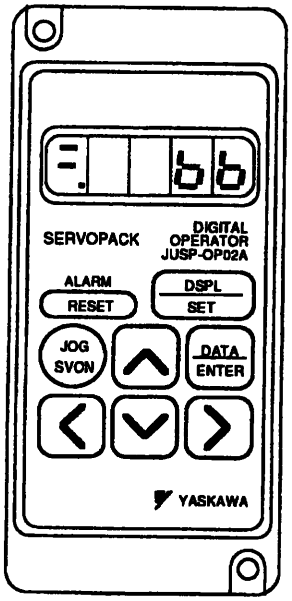
- The Digital Operator connector can be connected or disconnected while the SERVOPACK power is ON.

4.1.2 Key Functions

The Digital Operator can be used to set parameters, operation references, and to show display status.

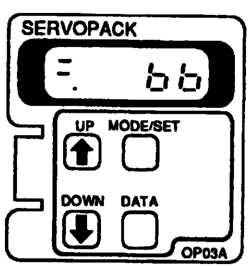
This section describes the Digital Operator key names and their functions available from the initial displays.

Digital Operator (Hand-held Type)



	Name		Function
ALARM RESET	RESET Key		Press this key to reset the servo alarm.
DSPL SET	DSPL/SET Key		Press this key to select the status display mode, setting mode, monitor mode, or alarm trace-back mode. This key is used for data selection when set to setting mode.
DATA ENTER	DATA/ENTER Key		Press this key to set parameters or to display set values of parameters.
∧	Value Change/ JOG Key	Up Cursor Key	Press this key to increase the set value. This key is used as a forward start key in jog operation
∨		Down Cursor Key	Press this key to decrease the set value. This key is used as a reverse start key in jog operation.
>	Digit Select Key	Right Cursor Key	Press this key to select the digit to be changed. The selected digit will flash. Press the Right Cursor Key to shift to the next digit on the right.
<		Left Cursor Key	Press the Left Cursor Key to shift to the next digit on the left.
JOG SVON	SVON Key		Press this key to perform the jog operation with the Digital Operator.

Digital Operator (Mount Type)



	Name	Function
UP	UP Key	Press these keys to set user constants or display the set values of parameters. Press the UP Key to increase the set value.
DOWN	DOWN Key	Press the DOWN Key to decrease the set value. Press the UP and DOWN Keys together to reset the servo alarm.
MODE/SET	MODE/SET Key	Press this key to select the status display mode, setting mode, monitor mode, or alarm trace-back mode.
DATA	DATA Key	Press this key to set parameter values or to display the values of parameters. This key is used for data selection in setting mode.

4.1.3 Resetting Servo Alarms

Servo alarms can be reset using the Digital Operator. Use either of the following methods, according to the type of Digital Operator being used.

Servo alarms can also be reset by the 1CN-44, /ALMRST input signal. Refer to *Section 3.7.1 Using Servo Alarm Output and Alarm Code Output* for details.

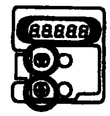
The servo alarm need not be reset if the control power supply is turned OFF.

Model: JUSP-OP02A-1

Press ALARM RESET → Alarm Reset

Model. JUSP-OP03A

Press UP DOWN simultaneously. → Alarm Reset



INFO

After an alarm occurs, remove the cause of the alarm before resetting it. Refer to *Section 6 2 Troubleshooting* to determine and remedy the cause of an alarm.

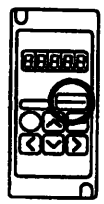
4.1.4 Basic Functions and Mode Selection

Digital Operator operation allows status display, parameter setting, operating reference, and auto-tuning operations.

Basic Mode Selection

The four basic modes are listed below. Each time the mode key is pressed, the next mode in the sequence is selected.

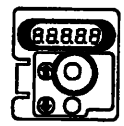
JUSP-OP02A-1



Press the

key to switch the mode

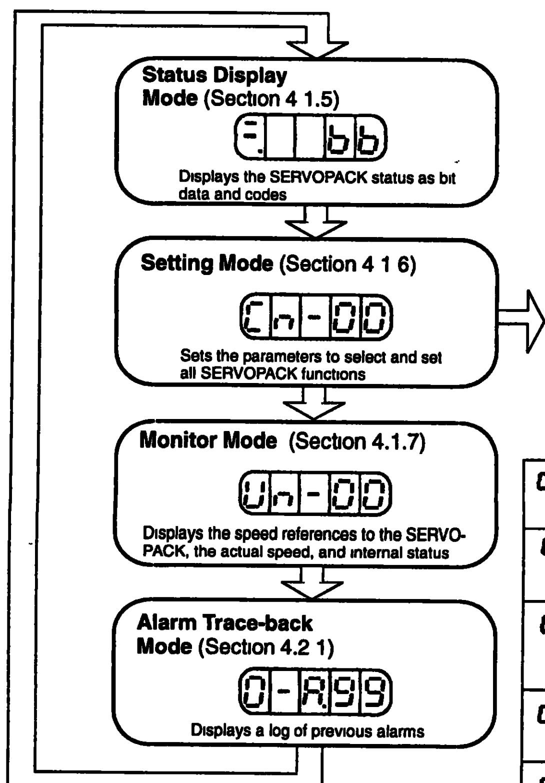
JUSP-OP03A



Press the

MODE/SET

key to switch the mode.



Special Modes

These modes are selected by setting a value for parameter Cn-00

Hand-held Digital Operator.
Press the DATA/ENTER Key.

Mounted Digital Operator·
Press the DATA Key.

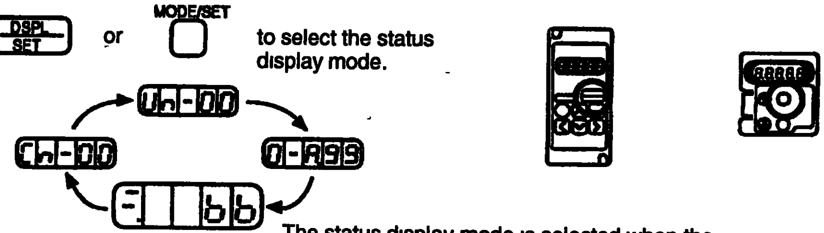
Cn-00 Setting	Mode
00-00	Operation mode from Digital Operator (Section 4.2.2)
00-01	Reference offset automatic adjustment mode (Section 4.2.4)
00-02	Clear alarm trace-back data (Section 4.2.6)
00-03	Reference offset manual adjustment mode (Section 4.2.5)
00-04	Motor-model check mode (Section 4.2.7)
00-05	Auto-tuning mode (Section 4.2.3)
00-06	Software-version check mode (Section 4.2.7)
00-08	Current detection offset manual adjustment mode (Section 4 2.8)

4.1.5 Operation in Status Display Mode

The status display mode displays the SERVOPACK status as bit data and codes.

- Selecting Status Display Mode

Press DSPL/SET or MODE/SET to select the status display mode.

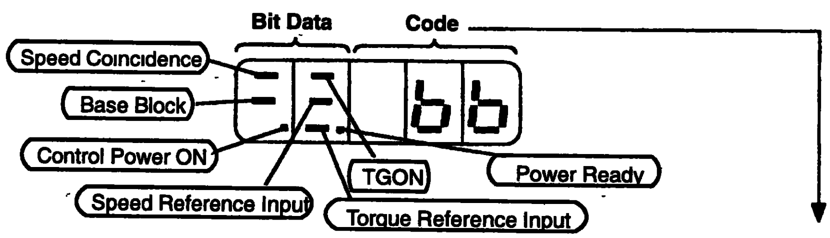


Status Display Mode

The status display mode is selected when the power supply is turned ON.

Keys to the status display are shown below.

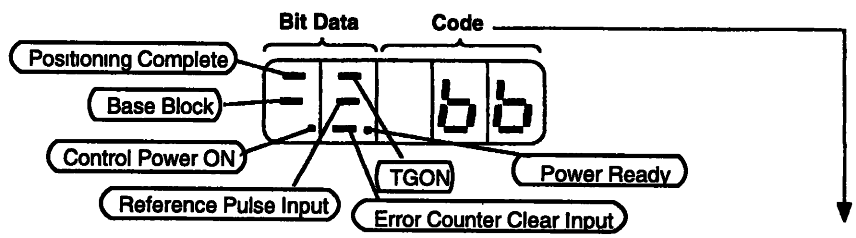
For Speed Control



Code	Status
bb	Base block Servo OFF (motor power OFF)
run	Run Servo ON (motor power ON)
Pot	Forward Rotation Prohibited (P-OT) 1CN-42 (P-OT) OFF. See Cn-01 Bit 2 (page 3 -7).
not	Reverse Rotation Prohibited (N-OT) 1CN-43 (N-OT) OFF. See Cn-01 Bit 3 (page 3 -7).
A.00	Alarm Status Displays the alarm number. See the table of alarms on page 4 -18.
A.02	
≀	

Bit Data	Description
Control Power ON	Lit when SERVOPACK control power ON. Not lit when SERVOPACK control power OFF.
Base Block	Lit for base block. Not lit at servo ON.
Speed Coincidence	Lit if motor speed reaches speed reference. Otherwise, not lit.
TGON	Lit if motor speed exceeds preset value. Not lit if motor speed is below preset value. Preset value: Set in Cn-0B (20 r/min is factory setting)
Speed Reference Input	Lit if input speed reference exceeds preset value. Not lit if input speed reference is below preset value. Specified value: Set in Cn-0B (20 r/min is factory setting)
Torque Reference Input	Lit if input torque reference exceeds preset value. Not lit if input torque reference is below preset value. Preset value: Set in Cn-0B (10% rated torque is standard setting) (Used for torque feed-forward or current restriction)
Power Ready	Lit when main power supply circuit is normal. Not lit when power is OFF or main power supply circuit is faulty.

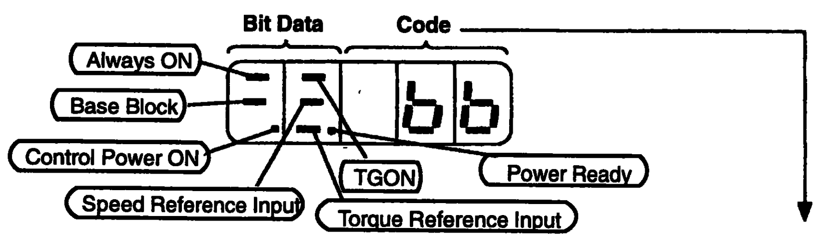
For Position Control



Code	Status
bb	Base block Servo OFF
run	Run Servo ON
Pot	Forward Rotation Prohibited 1CN-42 (P-OT) OFF. See Cn-01 Bit 2 (page 3 -7).
not	Reverse Rotation Prohibited 1CN-43 (N-OT) OFF. See Cn-01 Bit 3 (page 3 -7).
A.00	Alarm Status Displays the alarm number. See the table of alarms on page 4 -18.
A.02	
~	

Bit Data	Description
Control Power ON	Lit when SERVOPACK control power ON. Not lit when SERVOPACK control power OFF
Base Block	Lit for base block. Not lit at servo ON.
Positioning Complete	Lit if error between position reference and actual motor position is below preset value. Not lit if error between position reference and actual motor position exceeds preset value. Preset value. Set in Cn-1B (1 pulse is standard setting)
TGON	Lit if motor speed exceeds preset value. Not lit if motor speed is below preset value. Preset value: Set in Cn-0B (20 r/min is standard setting)
Reference Pulse Input	Lit if reference pulse is input Not lit if no reference pulse is input
Error Counter Clear Input	Lit when error counter clear signal is input. Not lit when error counter clear signal is not input.
Power Ready	Lit when main power supply circuit is normal. Not lit when power is OFF or main power supply circuit is faulty.

For Torque Control



Code	Status
bb	Base block Servo OFF (motor power OFF)
run	Run Servo ON (motor power ON)
Pot	Forward Rotation Prohibited (P-OT) 1CN-42 (P-OT) OFF. See Cn-01 Bit 2 (page 3 -7).
not	Reverse Rotation Prohibited (N-OT) 1CN-43 (N-OT) OFF. See Cn-01 Bit 3 (page 3 -7).
A.00	Alarm Status Displays the alarm number See the table of alarms on page 4 -18.
A.02	
⌇	

Bit Data	Description
Control Power ON	Lit when SERVOPACK control power ON. Not lit when SERVOPACK control power OFF.
Base Block	Lit for base block. Not lit at servo ON
Speed Coincidence	Lit if motor speed reaches speed reference. Otherwise, not lit
TGON	Lit if motor speed exceeds preset value. Not lit if motor speed is below preset value. Preset value: Set in Cn-0B (20 r/min is factory setting)
Speed Reference Input	Lit if input speed reference exceeds preset value. Not lit if input speed reference is below preset value. Preset value. Set in Cn-0B (20 r/min is factory setting) (Used as speed limit)
Torque Reference Input	Lit if input torque reference exceeds preset value. Not lit if input torque reference is below preset value. Preset value: Set in Cn-0B (10% rated torque is standard setting)
Power Ready	Lit when main power supply circuit is normal. Not lit when power is OFF or main power supply circuit is faulty.

4.1.6 Operation in Parameter Setting Mode

Two types of parameter are used:

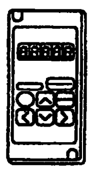
- Constant Settings (Cn-03 to Cn-2D)
- Memory Switches (Cn-01, Cn-02)

The setting method is different for each type.
The SERVOPACK offers a large number of functions, which are selected and adjusted by the parameter settings.
The constant settings (Cn-03 to Cn-2D) allow setting of a constant within a fixed range.
The memory switches (Cn-01, Cn-02) allow the required functions to be selected.
Refer to *Appendix D List of Parameters.*

■ Using the Setting Mode for Constant Settings (Cn-03 to Cn-2D)

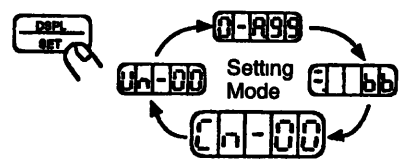
The constant settings (Cn-03 to Cn-23) allow setting of a constant. Check the permitted range of the constant in *Appendix D List of Parameters*, before changing the data. The example below shows how to change user setting Cn-15 from 100 to 85.

For JUSP-OP02A-1

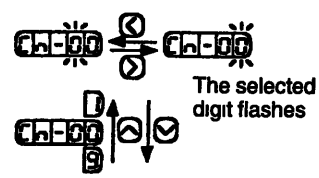


JUSP-OP02A-1

1. Press DSPL SET to select the parameter setting mode.

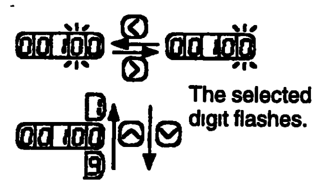


2. Select the parameter number to set.
   Press the < and > keys to select the digit.
   Press the ∧ and ∨ keys to change the value.



3. Press DATA ENTER to display the current data for the parameter selected at step 2.

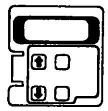
4. Set the required data.
   Press the < and > keys to select the digit.
   Press the ∧ and ∨ keys to change the value.



5. Press DATA ENTER to store the data.

6. Press DATA ENTER once more to display the parameter number again.

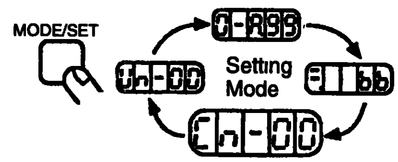
7. Repeat steps 2 to 6 as often as required.



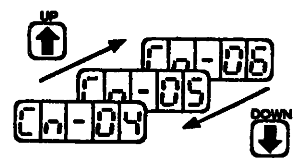
JUSP-OP03A

For JUSP-OP03A

1. Press MODE/SET to select the parameter setting mode.

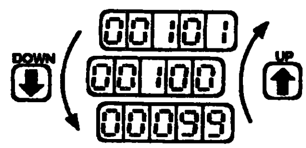


2. Press the UP and DOWN keys to select the parameter number to set.



3. Press DATA to display the current data for the parameter selected at step 2.

4. Press the UP and DOWN keys to change the data to the required value.

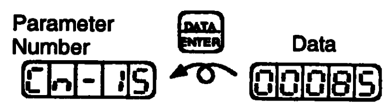


Value changes rapidly when key held down

5. Press DATA to store the data.

The stored data flashes.

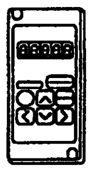
6. Press DATA once more to display the parameter number again.



7. Repeat steps 2 to 6 as often as required.
   - Refer to *Appendix D List of Parameters.*

■ Using the Setting Mode for Memory Switches (Cn-01, Cn-02)

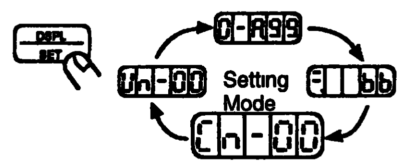
Turn the bits of the memory switches ON and OFF to select the functions required. The example below shows how to turn ON Bit 4 of memory switch Cn-01.



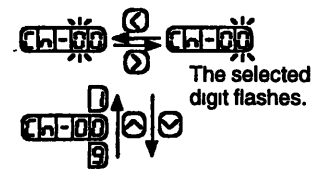
JUSP-OP02A-1

For JUSP-OP02A-1

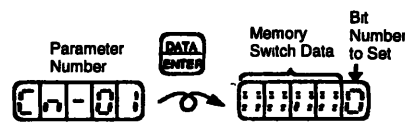
1. Press DSPL SET to select the parameter setting mode.



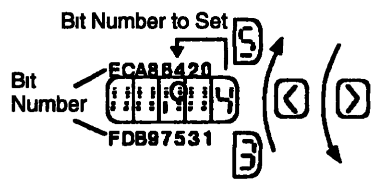
2. Select the parameter number to set.
   Press the < and > keys to select the digit.
   Press the ∧ and ∨ keys to change the value.



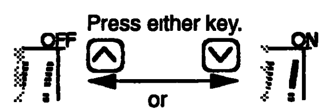
3. Press DATA ENTER to display the current data for the memory switch selected at step 2.



4. Press the < and > keys to select the bit number to set.

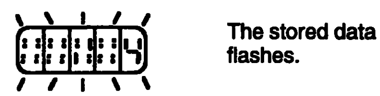


5. Press the ∧ and ∨ keys to set the memory switch data ON or OFF for the bit number.

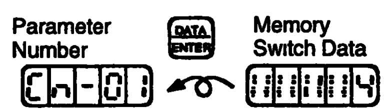


6. Repeat steps 4 and 5 as often as required.

7. Press DATA ENTER to store the data.



8. Press DATA ENTER once more to display the parameter number again.

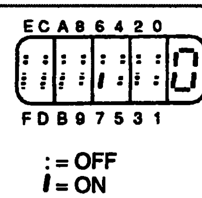


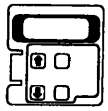
- Refer to *Appendix D List of Parameters.*

TERMS

◆ Turning Bits ON and OFF

Memory switches use bits, not numbers, to select functions
Sixteen bits are available (0 to 9 and A to F) Select the required functions by turning the appropriate bit ON (function ON) or OFF (function OFF)

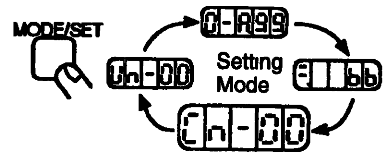




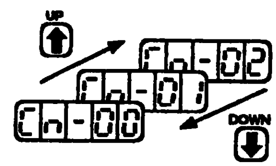
JUSP-OP03A

For JUSP-OP03A

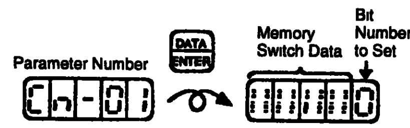
1. Press MODE/SET to select the parameter setting mode.



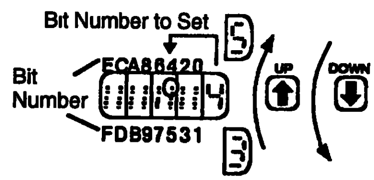
2. Press the UP and DOWN keys to select the parameter number to set.



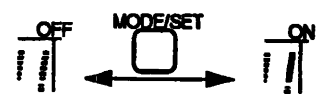
3. Press DATA to display the current data for the memory switch selected at step 2.



4. Press the UP and DOWN keys to select the bit number to set.



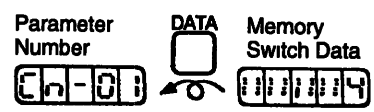
5. Press MODE/SET to set the memory switch data ON or OFF for the bit number.



6. Repeat steps 4 and 5 as often as required.

7. Press DATA to store the data.

8. Press DATA once more to display the parameter number again.



- Refer to *Appendix D List of Parameters.*

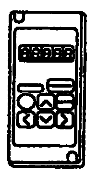
4.1.7 Operation in Monitor Mode

The monitor mode allows the reference values input into the SERVOPACK, I/O signal status, and SERVOPACK internal status to be monitored.
The monitor mode can be set during motor operation.

■ Using the Monitor Mode

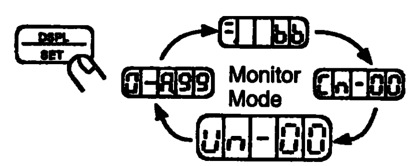
The example below shows how to display 1500, the contents of monitor number Un-00.

For JUSP-OP02A-1

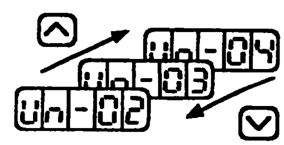


JUSP-OP02A-1

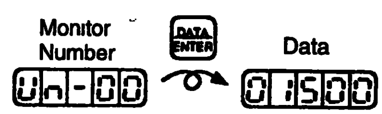
1. Press DSPL SET to select the monitor mode.



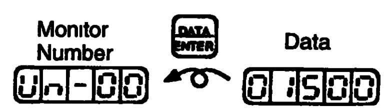
2. Press the ∧ and ∨ keys to select the monitor number to display.



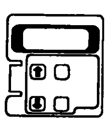
3. Press DATA ENTER to display the data for the monitor number selected at step 2.



4. Press DATA ENTER once more to display the monitor number again.

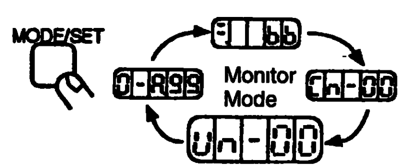


For JUSP-OP03A

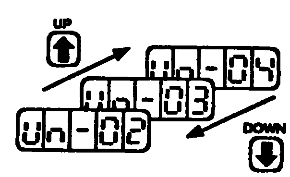


JUSP-OP03A

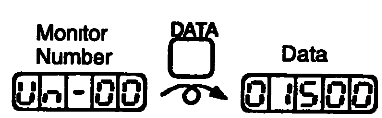
1. Press MODE/SET to select the monitor mode.



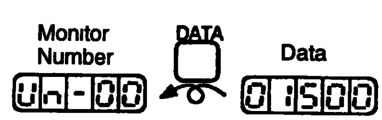
2. Press the UP and DOWN keys to select the monitor number to display.



3. Press DATA to display the data for the monitor number selected at step 2.



4. Press DATA once more to display the monitor number again.

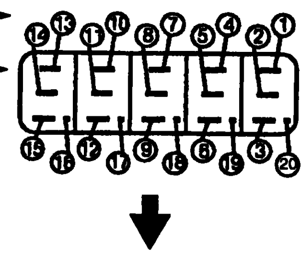


Monitor Mode Display

Keys to Monitor Mode Display are shown below.

Monitor Number	Monitor Display
Un-00	Actual motor speed Units: r/min.
Un-01	Input speed reference Units: r/min.
Un-02	Internal torque reference Units: % (with respect to rated torque)
Un-03	Number of pulses from motor U-phase edge Units: pulses
Un-04	Electrical angle Units deg
Un-05	Internal status bit display
Un-06	Internal status bit display
Un-07	Input reference pulse speed display Units: r/min.
Un-08	Positional error Units: x1 reference unit (Cn-02 Bit E = 0) x100 reference unit (Cn-02 Bit E = 1)
Un-09	Reference pulse counter reading Units: reference units A value between 0 to 65535 inclusive is displayed.

Internal Status
Bit Display



Monitor No	Bit No	Description		Related I/O Signal, Parameter
Un-05	1	Servo alarm		1CN-31 (ALM)
	2	Dynamic brake ON		
	3	Reverse rotation mode		Cn-02 Bit 0, 2CN-7 (DIR)
	4	During motor rotation		
	5	Speed coincidence or positioning complete		
	6	Mode switch ON		
	7	During forward current limit	Or contact input speed control	1CN-45 (/P-CL)
	8	During reverse current limit		1CN-46 (/N-CL)
	9	Motor power ON		
	10	Phase A		2CN-16(PA), 2CN-17 (/PA)
	11	Phase B		2CN-18(PB), 2CN-19 (/PB)
	12	Phase C		2CN-14(PC), 2CN-15 (/PC)
	13	Phase U		
	14	Phase V		
	15	Phase W		
	16	Servo ON		1CN-40 (/S-ON)
	17	P operation input		1CN-41 (/P-CON)
	18	Forward overtravel input		1CN-42 (P-OT), Cn-01 Bit 2
	19	Reverse overtravel input		1CN-43 (N-OT), Cn-01 Bit 3
	20	SEN signal input		1CN-4 (SEN), Cn-01 Bit 1

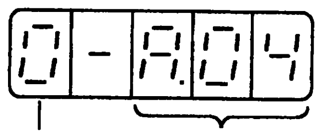
Monitor No	Bit No	Description	Related I/O Signal, Parameter
Un-06	1	Input reference pulse	1CN-7 (PLUS), 1CN-8 (/PULS)
	2	Input pulse sign	1CN-11 (SIGN), 1CN-12 (/SIGN)
	3	Error counter clear input	1CN-15 (CLR), 1CN-14 (/CLR)
	4	Current limit	
	5	Brake interlock output	
	6	Overload warning	
	7	Main power supply ON	
	8	Servo ready	
	9 to 20	Not used	

4.2 Using the Functions

This section describes how to use the basic operations described in section 1 to operate and adjust the motor.

4.2.1 Operation in Alarm Trace-back Mode

The alarm trace-back mode displays up to ten alarms which occurred previously. By allowing confirmation of what alarm occurred when, it is a useful aid to speed up troubleshooting.



Alarm Sequence Number
The higher the number, the older the alarm data

Alarm Code

See the table of alarms on page 4-18.

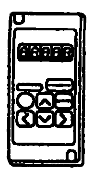
INFO

The alarm trace-back data is not cleared on alarm reset or when the SERVOPACK power is turned OFF. This does not adversely affect operation.
The data is cleared using the special mode. Clear alarm trace-back data.
Refer to *Section 4.2.6 Clearing Alarm Trace-back Data* for details.

■ Using the Alarm Trace-back Mode

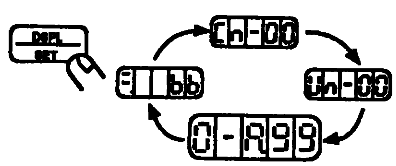
Follow the procedure below to determine which alarms occurred previously.

For JUSP-OP02A-1



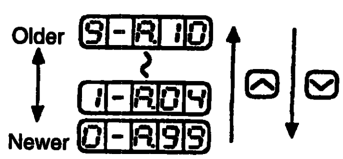
JUSP-OP02A-1

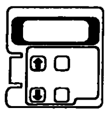
1. Press [DSPL SET] to select the alarm trace-back mode.



Alarm Trace-back Mode

2. Press the [∧] and [∨] keys to scroll the alarm sequence numbers up and down and display information on previous alarms. The higher the left-hand digit (alarm sequence number), the older the alarm data.

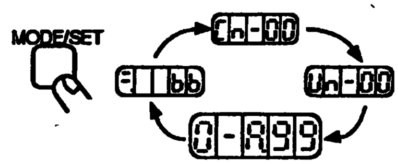




JUSP-OP03A

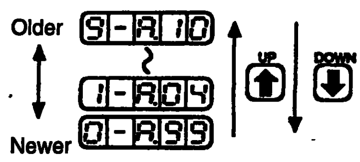
For JUSP-OP03A

1. Press MODE/SET to select the alarm trace-back mode.



Alarm Trace-back Mode

2. Press the UP and DOWN keys to scroll the alarm sequence numbers up and down and display information on previous alarms. The higher the left-hand digit (alarm sequence number), the older the alarm data.



■ Alarm Display

The table below lists the alarms displayed in the alarm trace-back mode.

Displayed Alarm Code	Description
A.00	Absolute data error
A.02	Parameter breakdown
A.04	Parameter setting error
A.10	Overcurrent
A.30	Regenerative error
A.31	Position error pulse overflow
A.40	Main circuit voltage error detection
A.51	Overspeed
A.71	Overload(Instantaneous)
A.72	Overload(Continuous)
A.80	Absolute encoder error
A.81	Absolute encoder back-up error
A.82	Absolute encoder checksum error
A.83	Absolute encoder battery error
A.84	Absolute encoder data error
A.85	Absolute encoder overspeed
A.A1	Heat sink overheated
A.b1	Reference input read error
A.C1	Servo overrun detected *

Displayed Alarm Code	Description
A.C2	Encoder output phase error
A.C3	Encoder A-, B-phase disconnection
A.C4	Encoder C-phase disconnection
A.F1	Power line open phase
A.F3	Power loss error. (Detected when turning ON the power during the power holding period.)
A.F4	Main circuit contactor error.
A.99	Not an alarm.

* This function prevents overrun

The following are operator-related alarms which are not recorded by alarm trace-back.

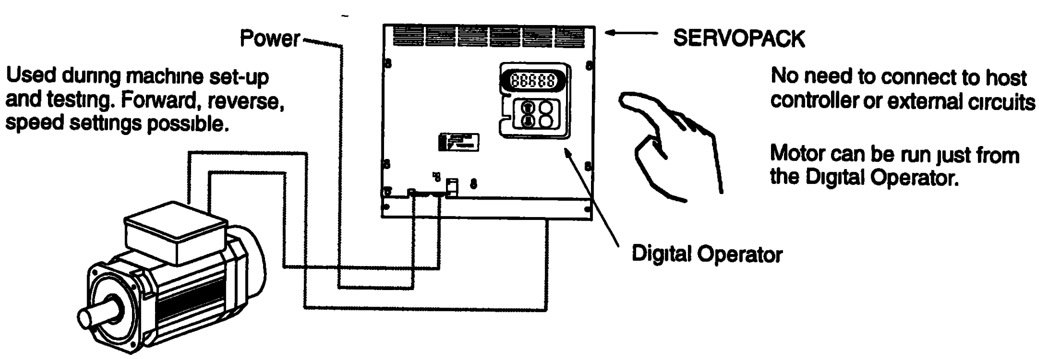
CPF00	Digital Operator transmission error 1
CPF01	Digital Operator transmission error 2

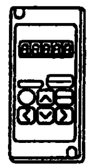
- Refer to the troubleshooting procedures when an alarm occurs, described in *Section 6.2 Troubleshooting.*

4.2.2 Operation Using the Digital Operator

Simple Motor Check

Operation from the Digital Operator allows the SERVOPACK to run the motor. This allows rapid checking of basic operations during machine set-up and testing, without the trouble of connecting a host controller.



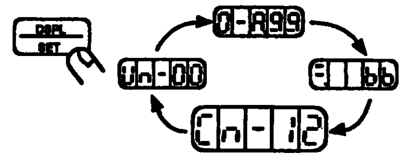


JUSP-OP02A-1

Use the following procedure to operate the motor from the Digital Operator.

For JUSP-OP02A-1

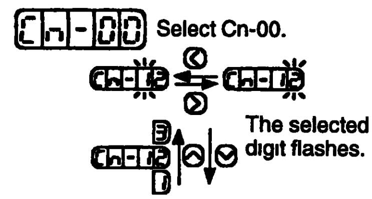
1. Press DSPL/SET to select the parameter setting mode.



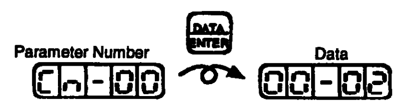
2. Select the parameter number Cn-00. (Parameter Cn-00 is selected when the power is turned ON.)

   Press the < and > keys to select the digit.

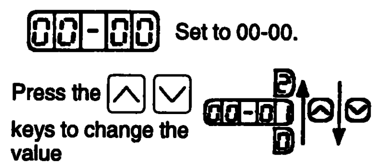
   Press the ∧ and ∨ keys to change the value.



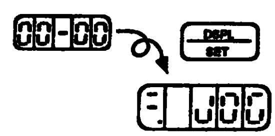
3. Press DATA/ENTER to display the current data for the parameter Cn-00.



4. Press the ∧ and ∨ keys to change the data to 00. (This parameter is set to 00 when the power is turned ON.)

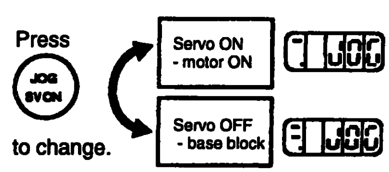


5. Press DSPL/SET to set the Digital Operator in operation mode. Operation is now possible under Digital Operator control.

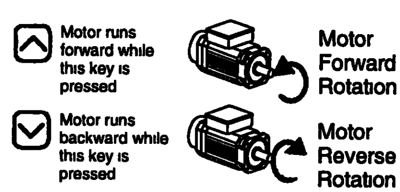


Display for operation mode from Digital Operator

6. Press JOG/SVON to set the servo ON status (motor power turned ON).

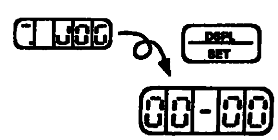


7. Press the ∧ and ∨ keys to operate the motor.

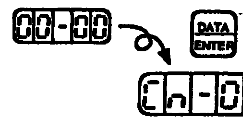


8. Press DSPL/SET to revert to 00-00. This sets the servo OFF status (motor power turned OFF).

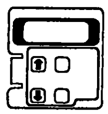
   (Alternatively, press JOG/SVON to set the servo OFF status.)



9. Press DATA/ENTER to return to the setting mode display. This disables operation under Digital Operator control.

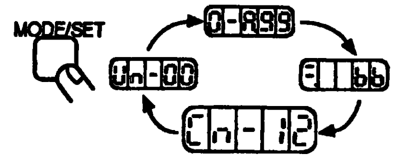


Setting Mode Display


JUSP-OP03A

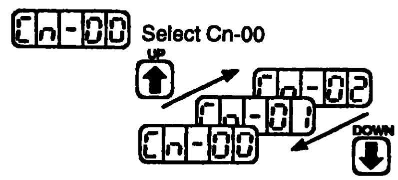
For JUSP-OP03A-1

1. Press MODE/SET to select the parameter setting mode.



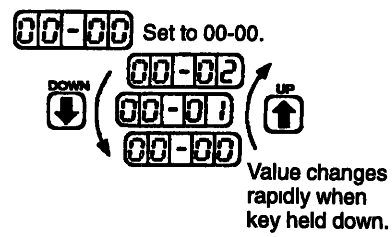
Setting Mode

2. Press the UP and DOWN keys to select the parameter number Cn-00. (Parameter Cn-00 is selected when the power is turned ON.)

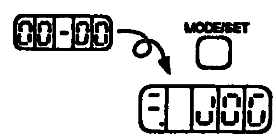


3. Press DATA to display the current data for the parameter Cn-00.

4. Press the UP and DOWN keys to change the data to 00. (This parameter is set to 00 when the power is turned ON.)

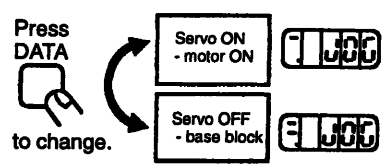


5. Press MODE/SET to set the Digital Operator in operation mode. Operation is now possible under Digital Operator control.

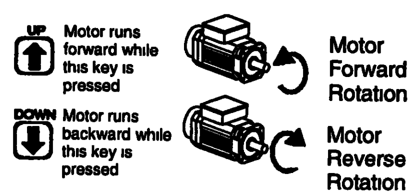


Display for operation mode from Digital Operator

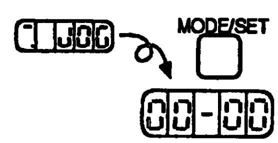
6. Press DATA to set the servo ON status (motor power turned ON).



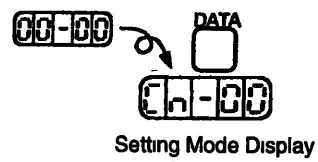
7. Press the UP and DOWN keys to operate the motor.



8. Press MODE/SET to revert to 00-00. This sets the servo OFF status (motor power turned OFF). (Alternatively, press DATA to set the servo OFF status.)



9. Press DATA to return to the setting mode display. This disables operation under Digital Operator control.



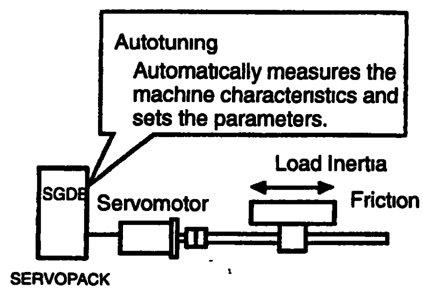
The motor speed for operation under Digital Operator control can be changed with a parameter:

Parameter: Cn-10 (JOGSPD), Units: r/min., Standard setting: 500

For details about setting the motor speed, refer to *Section 4.1.6 Operation in Parameter Setting Mode* and *Appendix D List of Parameters.*

4.2.3 Autotuning

The SERVOPACK contains a built-in autotuning function to automatically measure the machine characteristics and set the parameters.
Servo drives normally require tuning to match the machine configuration and rigidity. This tuning requires a great deal of experience and is difficult for a person unfamiliar with the tuning procedure.
However, autotuning allows even totally inexperienced people to easily complete the tuning.

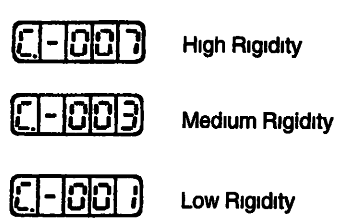


■ Precautions Relating to Autotuning

Speed Setting During Autotuning
The motor speed during autotuning is set by parameter Cn-10. Set to 500 r/min., which is the factory setting. Autotuning may be unsuccessful if this value is set too low.

The motor runs intermittently while the ∧ or ∨ (or UP ↑ or DOWN ↓) key is held down. The motor does not rotate continuously.

Machine Rigidity Selection
Select the machine rigidity as described below. If the actual rigidity is unknown, select medium rigidity.



- If the Machine Resonates

At servo ON when the JOG SVON (or DATA) key is pressed or when the motor is operated by pressing the ∧ or ∨ (DOWN or UP) key, machine resonance indicates an inappropriate machine rigidity setting.
Follow the procedure below to correct the machine rigidity setting, and run autotuning once more

1. Press the DSPL/SET (or MODE/SET) key to cancel autotuning.
2. Press the DSPL/SET (or MODE/SET) key once more to enter the machine rigidity setting mode. Reduce the setting by one.

   - If Autotuning Does Not End

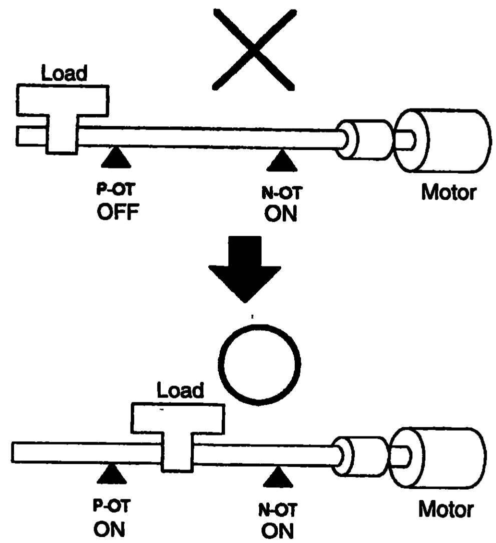
   Failure of autotuning to end - End, is caused by an inappropriate machine rigidity setting. Follow the procedure below to correct the machine rigidity setting, and run autotuning once more.

1. Press the DSPL/SET (or MODE/SET) key to cancel autotuning.
2. Press the DSPL/SET (or MODE/SET) key once more to enter the machine rigidity setting mode. Increase the setting by one.

   Autotuning may not end for machines with large play or extremely low rigidity.
   In these cases, use conventional manual adjustment.

Input Signals

- The P-OT signal, N-OT signal and SEN signal (absolute encoder only) are enabled during autotuning. Input the P-OT signal, N-OT signal and SEN signal (absolute encoder only) during autotuning.
  To conduct autotuning without inputting these signals, set parameter Cn-01 Bits 1, 2, and 3 to 1.
- Autotuning is not possible during overtravel (P-OT or N-OT signal OFF).
- Conduct autotuning when no overtravel has occurred (both P-OT and N-OT signal ON).



- Perform autotuning with the P-CON signal turned OFF.
- When using the mode switch function, perform one of the following before performing autotuning.

  Refer to *3.6.6 Using the Mode Switch* for details on the mode switch function.

  - Disable the mode switch function.
  - Set the mode switch operating level to a high value.

- If using the S-ON signal to set the servo ON status, display - tUn before turning ON the S-ON signal.
- Confirm that the machine can be operated, and then install the motor in the machine and perform autotuning.
- Confirm that the P-CON signal is OFF (indicating PI control) and then perform autotuning.
- Set the speed control mode to PI control when performing autotuning.

  The mode switch function will automatically switch control from PI to P control when the specified operating level is reached even if the P-CON signal is OFF. When using the mode switch function, perform one of the following before performing autotuning.

  - Set bit B of parameter Cn-01 to 1 to disable the mode switch.
  - Set the mode switch operating level for switching from PI to P control to a high enough level so that control will not switch to P control.

    Set the operating level as shown in the following table. The operating level is selected with bits C and D of parameter Cn-01.

Operating Level	Parameter Setting
Torque Reference	Set Cn-0C to the maximum torque
Speed Reference	Set Cn-0D to a value larger than the setting of Cn-10.
Acceleration	Set Cn-0E to the maximum value of 3,000.
Error Pulses	Set Cn-0F to the maximum value of 10,000.

■ Parameters Automatically Settable with Autotuning

Cn-04	Speed loop gain
Cn-05	Speed loop integration time constant
Cn-1A	Position loop gain

Once autotuning has been completed, the autotuning procedure can be omitted for subsequent machines, providing the machine specifications remain unchanged.
It is sufficient to directly set the parameters for subsequent machines.
The **machine rigidity** can be selected from one of seven levels.

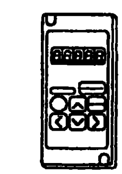
INFO

Conduct autotuning with the motor attached to the machine.
Make sure that the machine is ready for operation and take sufficient safety precautions when operating the machine

■ Using Autotuning

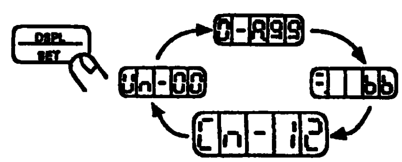
Follow the procedure below to run autotuning.

For JUSP-OP02A-1



JUSP-OP02A-1

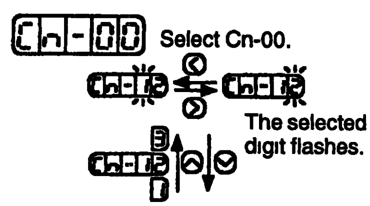
1. Press [DSPL/SET] to select the parameter setting mode.



2. Select the parameter number Cn-00.
(Parameter Cn-00 is selected when the power is turned ON.)

Press the [<] and [>] keys to select the digit.

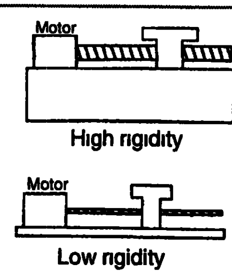
Press the [∧] and [∨] keys to change the value.



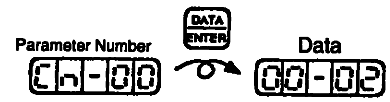
TERMS

◆ Machine Rigidity

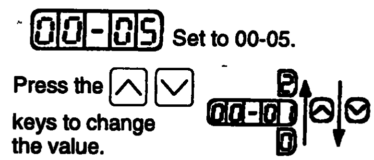
The machine rigidity is one of the machine characteristics related to servo control Set the servo to high response for a machine, such as a machine tool, with high rigidity, and to low response for a machine, such as a robot, with low rigidity



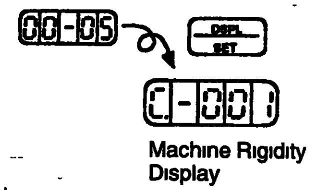
3. Press DATA/ENTER to display the current data for the parameter Cn-00.



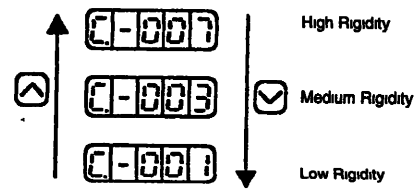
4. Press the ∧ and ∨ keys to change the data to 05.



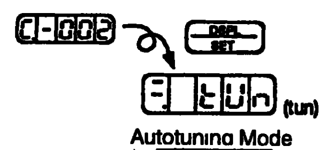
5. Press DSPL/SET to display the machine rigidity.



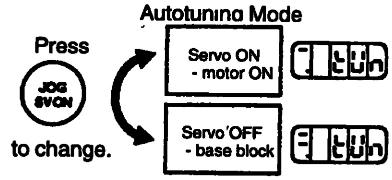
6. Press the ∧ and ∨ keys to select the machine rigidity. If the actual rigidity is unknown, select medium rigidity.



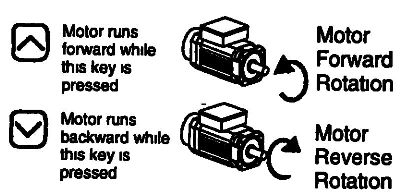
7. Press DSPL/SET to select autotuning mode.



8. Press JOG/SVON to set the servo ON status.



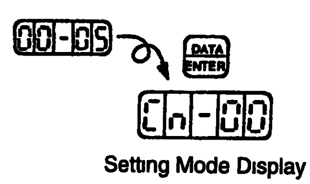
9. Press the ∧ and ∨ keys to operate the motor.



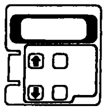
10. When autotuning is complete, the END message is displayed, as shown on the right. Servo OFF status is automatically selected. If Servo ON/Servo OFF is selected by a signal from an external contact, turn this signal OFF.

11. Release the ∧ and ∨ keys to revert to the 00-05 display.

12. Press DATA/ENTER to return to the setting mode display. This ends the autotuning operation.



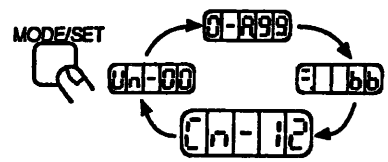
- Refer to page 4 -22 for the precautions relating to autotuning.



JUSP-OP03A

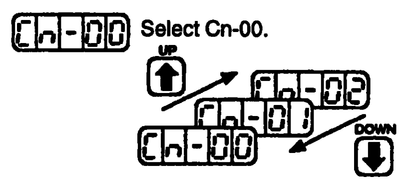
For JUSP-OP03A

1. Press MODE/SET to select the parameter setting mode.



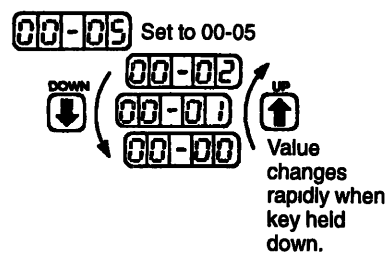
Setting Mode

2. Press the UP and DOWN keys to select the parameter number Cn-00.
(Parameter Cn-00 is selected when the power is turned ON.)

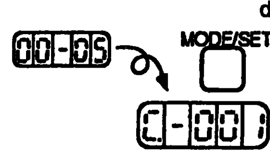


3. Press DATA to display the current data for the parameter Cn-00.

4. Press the UP and DOWN keys to change the data to 05.

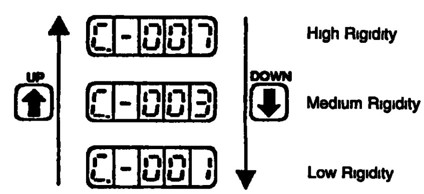


5. Press MODE/SET to display the machine rigidity.

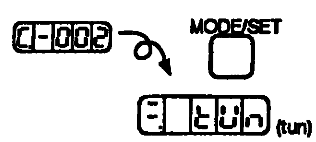


Machine Rigidity Display

6. Press the UP and DOWN keys to select the machine rigidity.

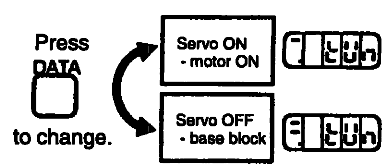


7. Press MODE/SET to select autotuning mode.

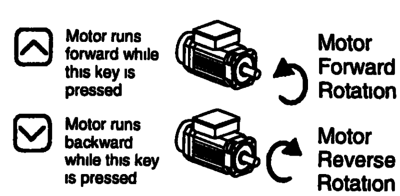


Autotuning Mode

8. Press DATA to set the servo ON status.



9. Press the UP and DOWN keys to operate the motor.

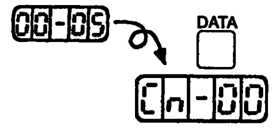


10. When autotuning is complete, the END message is displayed, as shown to the right.
Servo OFF status is automatically selected. If Servo ON/Servo OFF is selected by a signal from an external contact, turn this signal OFF.


Autotuning Complete

11. Release the UP and DOWN keys to revert to the 00-05 display.

12. Press DATA to return to the setting mode display.
This ends autotuning operation.
- Refer to page 4 -22 the precautions relating to autotuning.

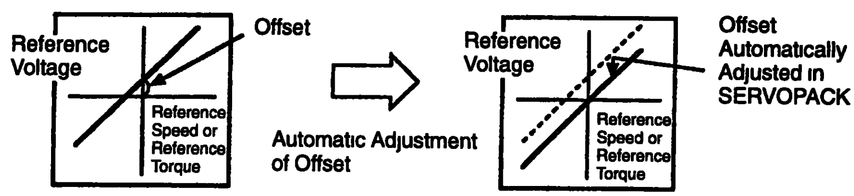

Setting Mode Display

4.2.4 Reference Offset Automatic Adjustment

The motor may rotate slowly when the reference voltage is intended to be 0 V.
This occurs when the host controller or external circuit has a small offset (measured in mV) in the reference voltage.

The reference offset automatic adjustment mode automatically measures the offset and adjusts the reference voltage. It adjusts both speed and torque references.

The following diagram illustrates automatic adjustment of an offset in the reference voltage from the host controller or external circuit.



After completion of offset automatic adjustment, the amount of offset is stored in the SERVOPACK.
The amount of offset can be checked in the speed reference offset manual adjustment mode. Refer to *Section 4.2.5 Reference Offset Manual Adjustment Mode* for details.

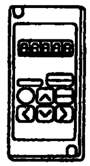
The reference offset automatic adjustment mode cannot be used where a position loop is formed with the host controller and the error pulses are zeroed when servo lock is stopped.

In this case, use the speed reference offset manual adjustment mode. Refer to *Section 4.2.5 Reference Offset Manual Adjustment Mode* for details.

Zero-clamp speed control is available to force the motor to stop during zero speed reference. Refer to *Section 3.4.3 Using Zero-Clamp* for details.

■ Using the Reference Offset Automatic Adjustment Mode

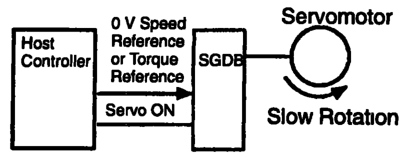
Follow the procedure below to automatically adjust the reference offset.



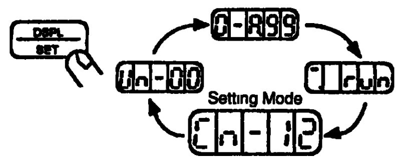
JUSP-OP02A-1

For JUSP-OP02A-1

1. Input the (intended) 0 V reference voltage from the host controller or external circuit.
2. Turn ON the servo ON (1CN-40, /S-ON) signal. The motor is set to operating mode.



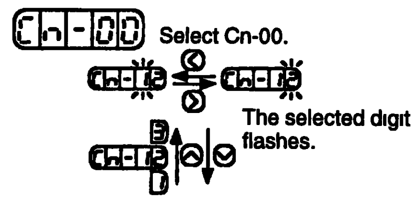
3. Press [DSPL/SET] to select the parameter setting mode.



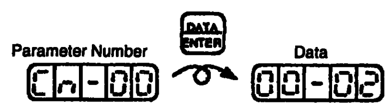
4. Select the parameter number Cn-00.
   (Parameter Cn-00 is selected when the power is turned ON.)

   Press the [<] and [>] keys to select the digit.

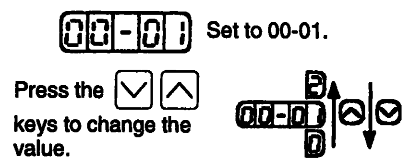
   Press the [∧] and [∨] keys to change the value.



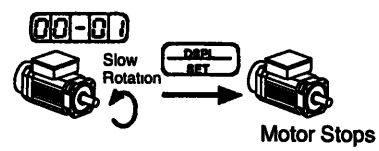
5. Press [DATA/ENTER] to display the current data for the parameter Cn-00.



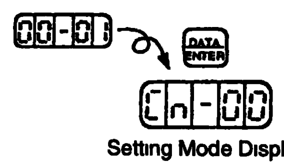
6. Press the [∨] and [∧] keys to change the data to 01.

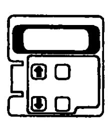


7. Press [DSPL/SET] to automatically adjust the reference offset. The motor rotation stops.



8. Press [DATA/ENTER] to return to the setting mode display. This ends reference offset automatic adjustment.



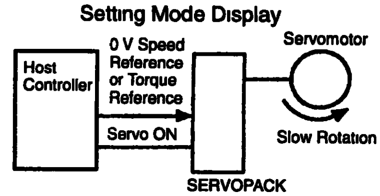


JUSP-OP03A

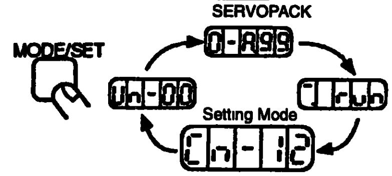
For JUSP-OP03A

1. Input the (intended) 0V reference voltage from the host controller or external circuit.
2. Turn ON the servo ON (1CN-40, /S-ON) signal.

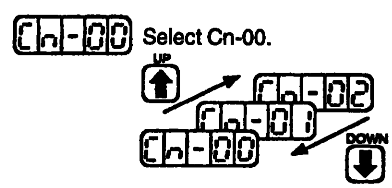
   The motor is set to operating mode.



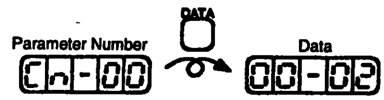
3. Press [MODE/SET] to select the parameter setting mode.



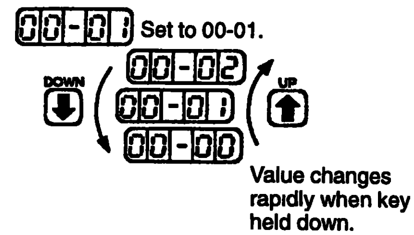
4. Press the [UP] and [DOWN] keys to select the parameter number Cn-00.
   (Parameter Cn-00 is selected when the power is turned ON.)



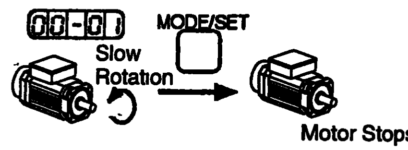
5. Press DATA to display the current data for the parameter Cn-00.



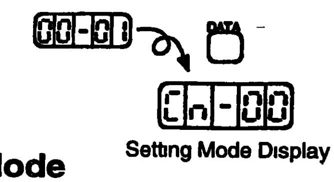
6. Press the UP and DOWN keys to change the data to 01.



7. Press MODE/SET to automatically adjust the reference offset. The motor rotation stops.



8. Press DATA to return to the setting mode display. This ends reference offset automatic adjustment.



4.2.5 Reference Offset Manual Adjustment Mode

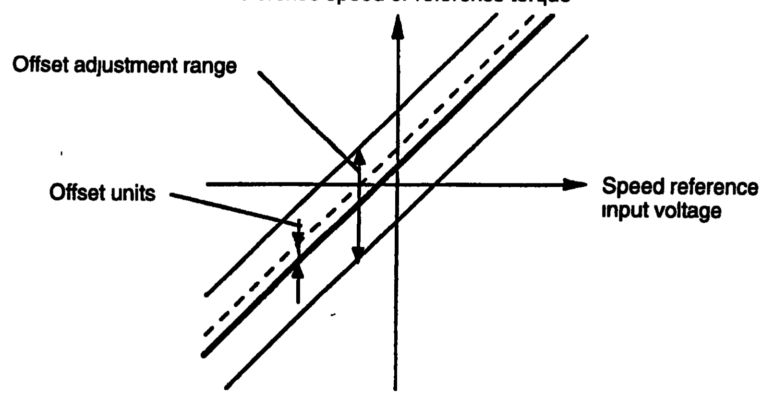
Speed reference offset manual adjustment is very convenient in the following situations:

- If a loop is formed with the host controller and the error is zeroed when servo lock is stopped.
- To deliberately set the offset to some value.

This mode can also be used to check the data set in the reference offset automatic adjustment mode.

In principle, this mode operates in the same way as the reference offset automatic adjustment mode, except that the amount of offset is directly input during the adjustment.

Offset Adjustment Range and Setting Units are as follows:



Offset adjustment range –512 to +511

Offset units·

Reference speed 0 038 r/min (0 076 mV)

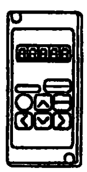
When Cn-03 = 500

Reference torque 0 02 % (0.61 mV)

When Cn-13 = 30

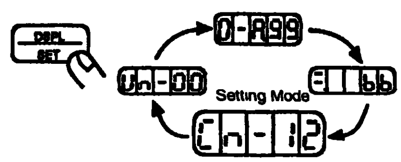
Follow the procedure below to manually adjust the reference voltage.

For JUSP-OP02A-1



JUSP-OP02A-1

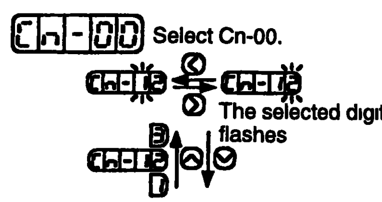
1. Press [DSPL SET] to select the parameter setting mode.



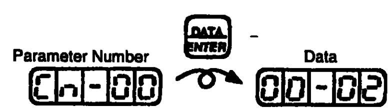
2. Select the parameter number Cn-00. (Parameter Cn-00 is selected when the power is turned ON.)

   Press the [<] and [>] keys to select the digit.

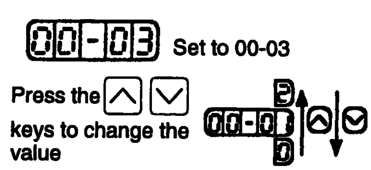
   Press [∧] and [∨] keys to change the value.



3. Press [DATA ENTER] to display the current data for the parameter Cn-00.

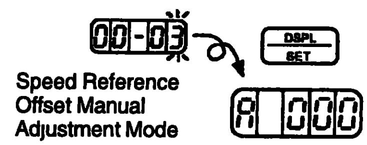


4. Press the [∧] and [∨] keys to change the data to 03.



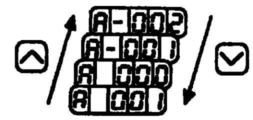
5. Press DSPL SET to select the speed reference offset manual adjustment mode.

   (The amount of speed reference offset is displayed.)



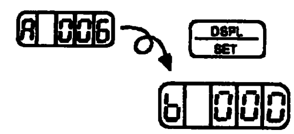
6. Press the ∧ and ∨ keys to adjust the amount of offset.

   (Adjust the speed references.)

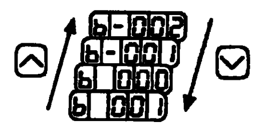


7. Press DSPL SET to select the torque reference offset manual adjustment mode.

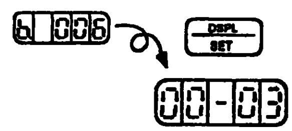
   (The amount of torque reference offset is displayed.)



8. Press the ∧ and ∨ keys to adjust the amount of offset.
   (Adjust the torque references.)

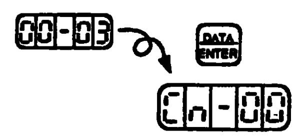


9. Press DSPL SET to return to the parameter data display.

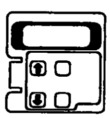


10. Press DATA ENTER to return to the setting mode display. This ends the reference offset manual adjustment.

    (Adjust the torque references.)



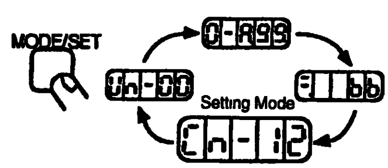
Setting Mode Display



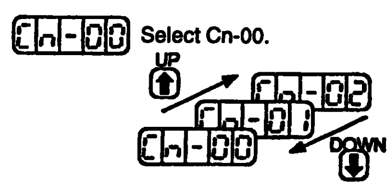
JUSP-OP03A

For JUSP-OP03A

1. Press MODE/SET to select the parameter setting mode.

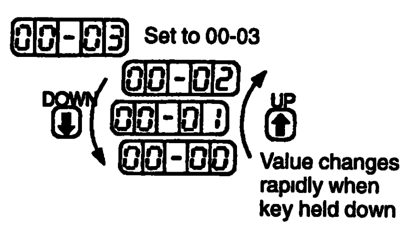


2. Press the UP and DOWN keys to select the parameter number Cn-00.
   (Parameter Cn-00 is selected when the power is turned ON.)



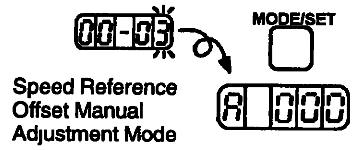
3. Press DATA to display the current data for the parameter Cn-00.

4. Press the UP and DOWN keys to change the data to 03.



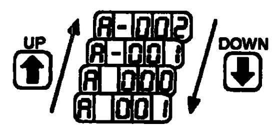
5. Press MODE/SET to select the speed reference offset manual adjustment mode.

   (The amount of speed reference offset is displayed.)



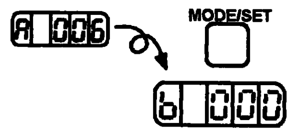
6. Press the UP and DOWN keys to adjust the amount of offset.

   (Adjust the speed references.)

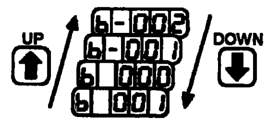


7. Press MODE/SET to select the torque reference offset manual adjustment mode.

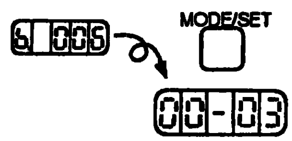
   (The amount of torque reference offset is displayed.)



8. Press the UP and DOWN keys to adjust the amount of offset.
   (Adjust the torque references.)

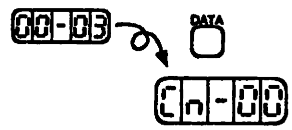


9. Press MODE/SET to return to the parameter data display.



10. Press DATA to return to the setting mode display. This ends the reference offset manual adjustment.

   (Adjust the torque references.)



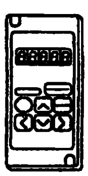
Setting Mode Display

4.2.6 Clearing Alarm Trace-back Data

This procedure clears the alarm history, which stores the alarms occurring in the SERVOPACK. Each alarm in the alarm history is set to A99, which is not an alarm code. Refer to *Section 4.2.1 Operation in Alarm Trace-back Mode* for details.

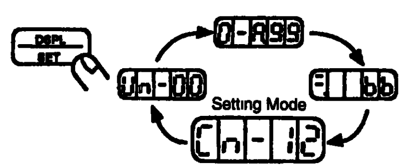
Follow the procedure below to clear the alarm trace-back data.

For JUSP-OP02A-1



JUSP-OP02A-1

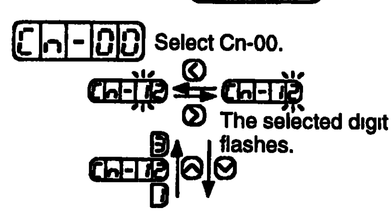
1. Press DSPL/SET to select the parameter setting mode.



2. Select the parameter number Cn-00. (Parameter Cn-00 is selected when the power is turned ON.)

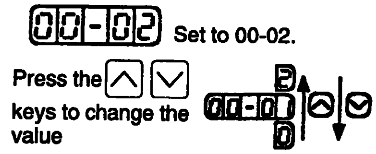
   Press the < and > keys to select the digit.

   Press the ∧ and ∨ keys to change the value.



3. Press [DATA ENTER] to display the current data for the parameter Cn-00.

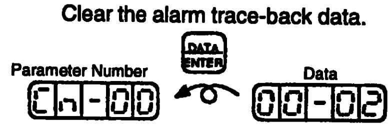
4. Press the [∧] and [∨] keys to change the data to 02.

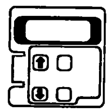


5. Press [DSPL SET] to clear the alarm trace-back data.

Clear the alarm trace-back data.

6. Press [DATA ENTER] to return to the parameter data display.

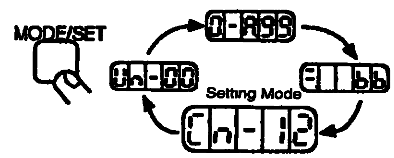




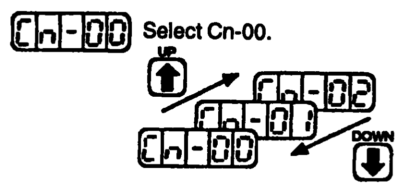
JUSP-OP03A

For JUSP-OP03A

1. Press [MODE/SET] to select the parameter setting mode.

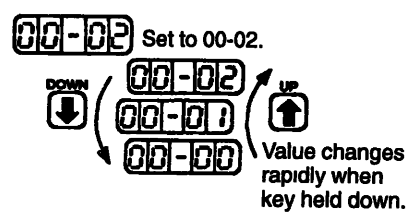


2. Press the [UP] and [DOWN] keys to select the parameter number Cn-00.
(Parameter Cn-00 is selected when the power is turned ON.)



3. Press [DATA] to display the current data for the parameter Cn-00.

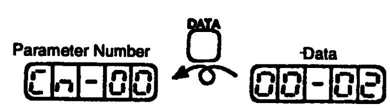
4. Press the [UP] and [DOWN] keys to change the data to 02.



5. Press [MODE/SET] to clear the alarm trace-back data.

Clear the alarm trace-back data.

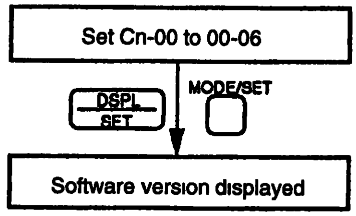
6. Press [DATA] to return to the parameter data display.



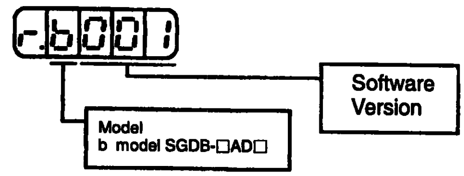
4.2.7 Checking the Software Version

Set Cn-00 to 00-06 to select the software-version check mode.
This mode is used for maintenance and is not normally used by the customer.

Operation



Software Version Display

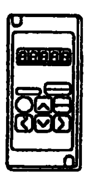


4.2.8 Current Detection Offset Manual Adjustment Mode

Current detection offset manual adjustment is performed at Yaskawa before shipping. Basically, the customer need not perform this adjustment. Perform this adjustment only if highly accurate adjustment is required when the Digital Operator is combined with a specific motor.

Run the motor at a speed of approximately 100 r/min, and adjust the Digital Operator until the torque monitor ripple is minimized. Adjust the U-phase and V-phase offsets alternately several times until these offsets are well balanced.

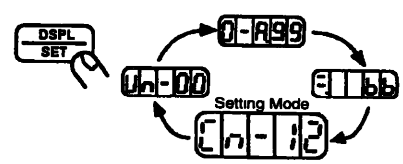
Follow the procedure below to perform current detection offset manual adjustment.



JUSP-OP02A-1

For JUSP-OP02A-1

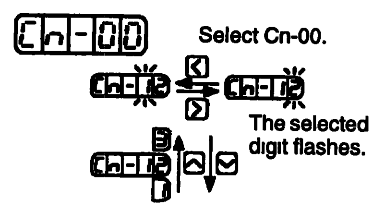
1. Press DSPL/SET to select the parameter setting mode.



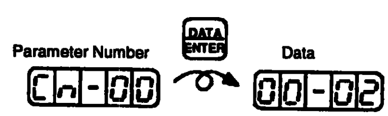
2. Select the parameter number Cn-00. (Parameter Cn-00 is selected when the power is turned ON.)

   Press the < and > keys to select the digit.

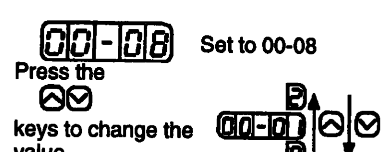
   Press ∧ and ∨ keys to change the value.



3. Press DATA/ENTER to display the current data for the parameter Cn-00.

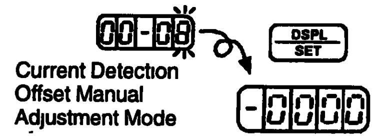


4. Press the ∧ and ∨ keys to change the data to 08.

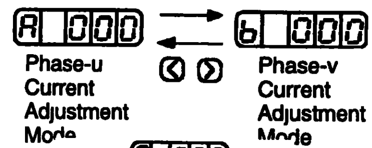


5. Press DSPL SET to select the current detection offset manual adjustment mode.

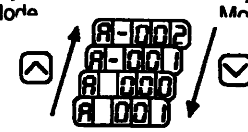
   (The amount of current detection offset is displayed.)



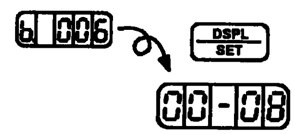
6. Press the < and > keys to switch between U-phase and V-phase current adjustment modes.



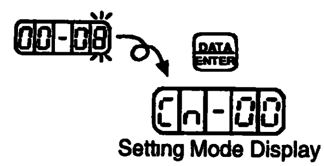
7. Press the ∧ and ∨ keys to adjust the amount of current detection offset.

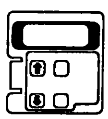


8. Press DSPL SET to return to the parameter data display.



9. Press DATA ENTER to return to the parameter setting mode display. This ends the current detection offset manual adjustment.

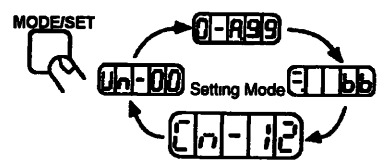




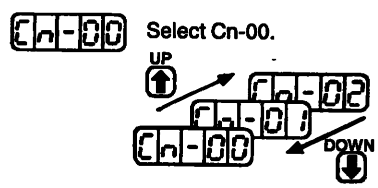
JUSP-OP03A

For JUSP-OP03A

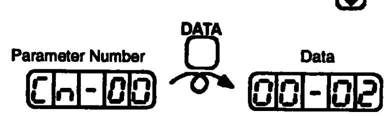
1. Press MODE/SET to select the parameter setting mode.



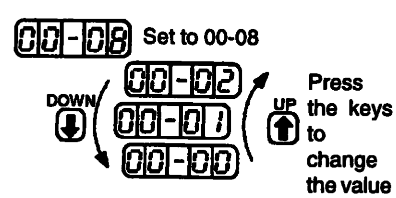
2. Press the UP and DOWN to select the parameter number Cn-00.
   (Parameter Cn-00 is selected when the power is turned ON.)



3. Press DATA to display the current data for the parameter Cn-00.

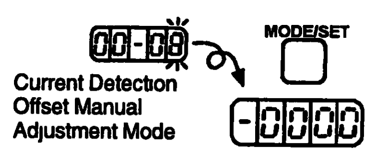


4. Press the UP and DOWN keys to change the data to 08.



5. Press MODE/SET to select the current detection offset manual adjustment mode.

   (The amount of current detection offset is displayed.)



5

SERVO SELECTION AND DATA SHEETS

This chapter describes how to select Σ-Series servo drives and peripheral devices.
The section also presents the specifications and dimensional drawings required for selection and design.
Choose and carefully read the relevant sections of this chapter.

5.1 Selecting a Σ-Series Servo

This section describes how to select the Σ-Series servomotor, SERVOPACK, and Digital Operator.

5.1.1 Selecting a Servomotor

Select an SGMB servomotor according to the servo system to be used. Each model can be identified by the seven-digit alphanumeric characters following "SGMB-." Refer to the flowchart for servomotor selection shown here to determine the appropriate servomotor.

SGM B- 2B A 2 A □ □

Σ-Series

Type
B. SGMB servomotor

Motor capacity
2B: 22 kW 4E 45 kW
3Z: 30 kW 5E: 55 kW
3G. 37 kW

Standards
A: Standard

Encoder specification
2: 8192 P/R incremental encoder (standard)
6: 4096 P/R incremental encoder (semi-standard)
W: 8192 P/R absolute encoder (semi-standard)
S: 1024 P/R absolute encoder (semi-standard)

Supply voltage, rated speed
A, B: 200 V, 1500 r/min
D, E: 400 V, 1500 r/min

Shaft specifications
Blank: Straight flange-type
A: Straight flange-type, (only used with option specifications)
B Straight flange-type, with key and shaft-end tap
K: Straight with foot
L: Straight with foot, key, and shaft-end tap

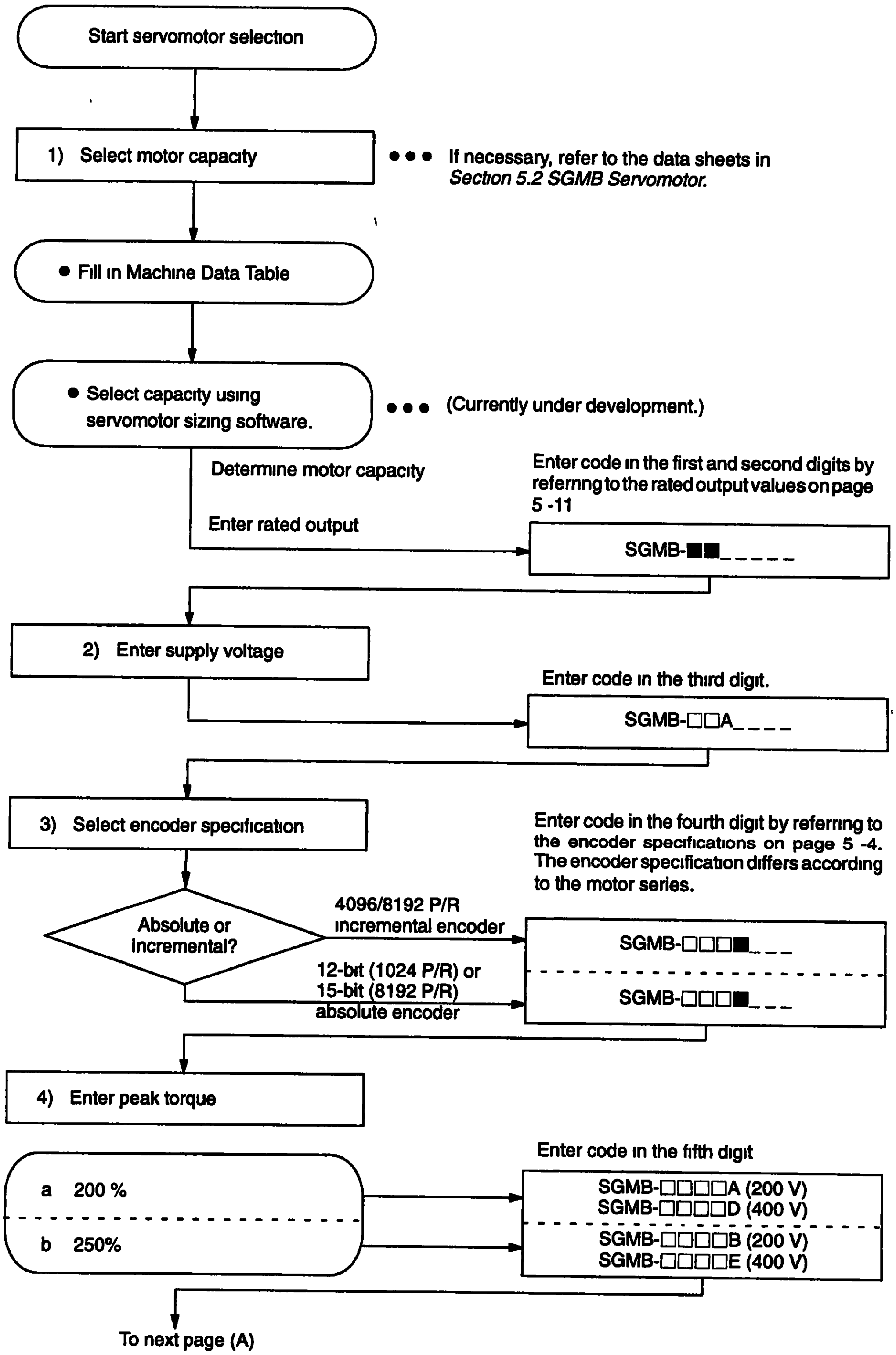
Options
B: 90-VDC brake
C: 24-VDC brake
S: Oil seal
F: Oil seal and 90-VDC brake
G: Oil seal and 24-VDC brake

Flowchart for servomotor selection

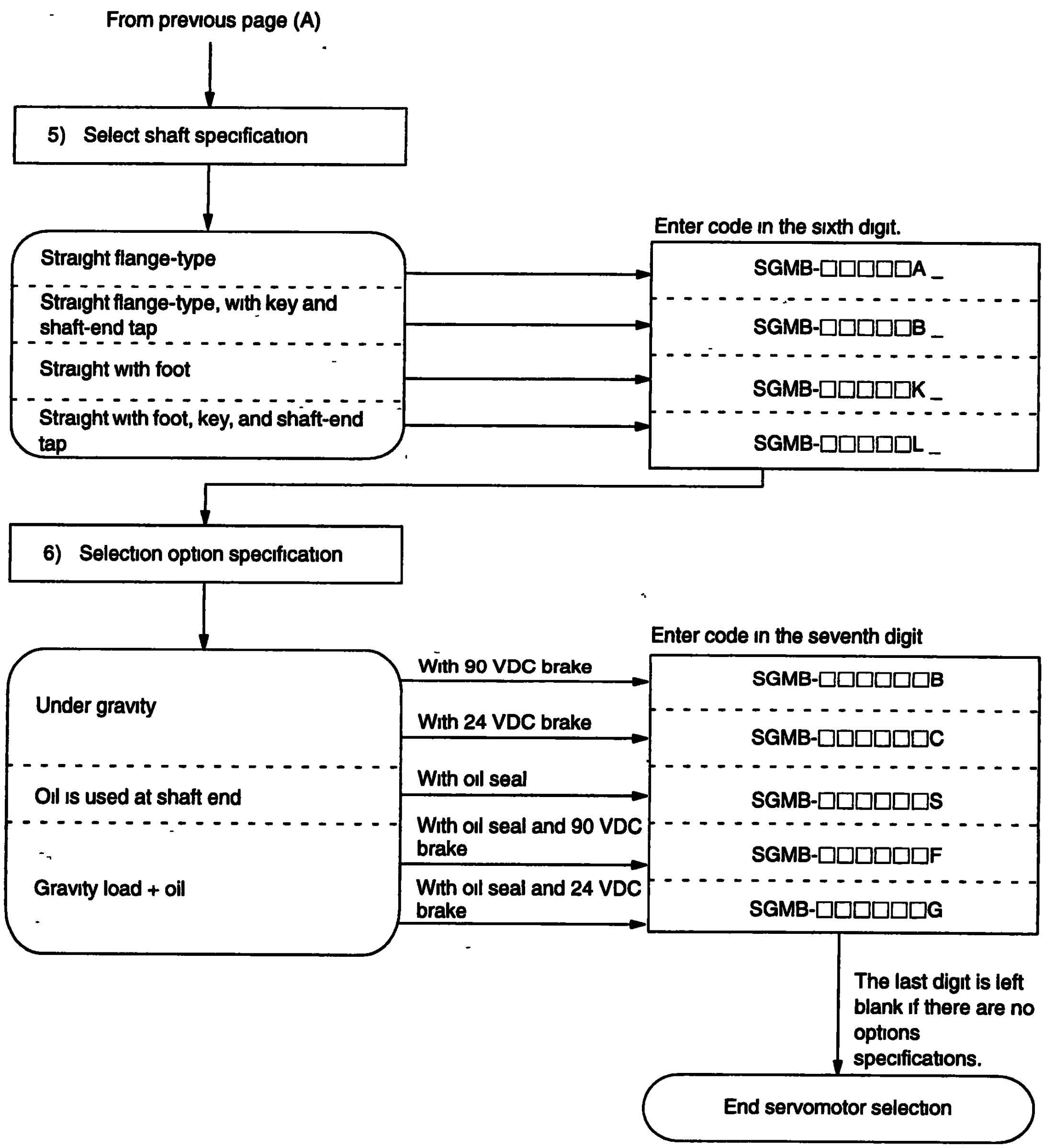
	Selected Motor Model
Example	SGMB-2BA2A□□
Axis 1	SGMB -□□□□□□□
Axis 2	SGMB -□□□□□□□
• • •	• • • • Blank for standard specification

■ Flowchart for Servomotor Selection

Select the actual SGMB servomotor according to the following flowchart.



5.1.1 Selecting a Servomotor

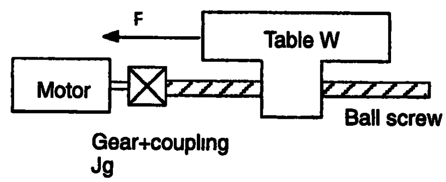


■ Machine Data Table

Fill out the machine data table below as an aid to selecting the drive system. When the machine data table is complete, use the servomotor sizing software to select the motor capacity.

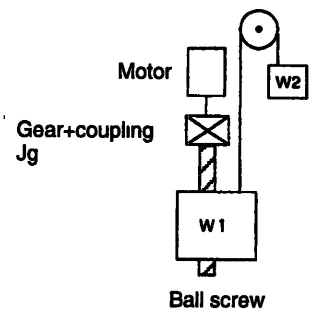
• Ball Screw Horizontal Axis

*1	Load mass	W	——kg (lb)
	Thrust	F	——kg (lb)
	Coefficient of friction	μ	——
	Overall efficiency	η	——
*2	Gear ratio	R (= Nm/Nl)	——
*3	Gear+coupling	Jg	——kg·cm² (lb·in².)
	Ball screw pitch	P	——mm (in.)
	Ball screw diameter	D	——mm (in.)
	Ball screw length	L	——mm (in.)



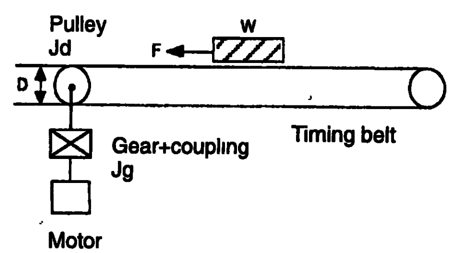
• Ball Screw Vertical Axis

Load mass	W_1	——kg (lb)
Counterweight	W_2	——kg (lb)
Coefficient of friction	μ	——
Overall efficiency	η	——
Gear ratio	R (= Nm/Nl)	——
Gear+coupling	Jg	——kg·cm² (lb·in².)
Ball screw pitch	P	——mm (in.)
Ball screw diameter	D	——mm (in.)
Ball screw length	L	——mm (in.)



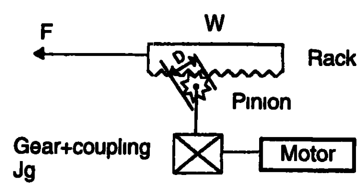
• Timing Belt

Load mass	W	——kg (lb)
Thrust	F	——kg (lb)
Coefficient of friction	μ	——
Overall efficiency	η	——
Gear ratio	R (= Nm/Nl)	——
Gear+coupling	Jg	——kg·cm² (lb·in².)
Pulley	Jd	——kg·cm² (lb·in².)
Pulley diameter	D	——mm (in.)

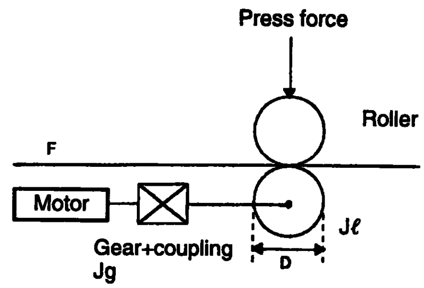


• Rack and Pinion

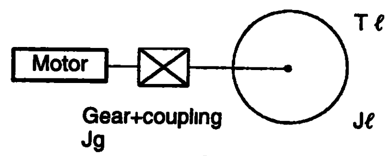
Load mass	W	——kg (lb)
Thrust	F	——kg (lb)
Coefficient of friction	μ	——
Overall efficiency	η	——
Gear ratio	R (= Nm/Nl)	——
Gear+coupling	Jg	——kg·cm² (lb·in².)
Pinion diameter	D	——mm (in.)
Pinion thickness	t	——mm (in.)



• **Roll Feeder**		
Load J	$J\ell$	—kg·cm² (lb·in².)
Tension	F	—kg (lb)
Press force	P	—kg (lb)
Roller diameter	D	—mm (in)
Coefficient of friction	μ	—
Overall efficiency	η	—
Gear ratio	R (= Nm/Nl)	—
Gear+coupling	Jg	—kg cm² (lb·in².)

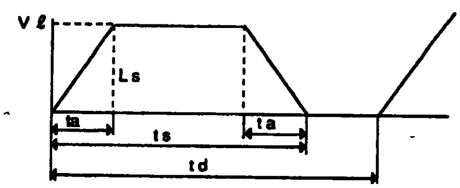


• **Rotor**		
Load J	$J\ell$	—kg·cm² (lb·in².)
Load torque	$T\ell$	—kg·cm (lb·in.)
Overall efficiency	η	—
Gear ratio	R (= Nm/Nl)	—
Gear+coupling	Jg	—kg cm² (lb in².)



• **Others**		
Load J	$J\ell$	—kg·cm² (lb·in².)
Load torque	$T\ell$	—kg·cm (lb·in)
Motor speed	Nm	—r/min
DUTY	td	—s
Positioning time	ts	—s
Accel/decel time	ta	—s
• **Duty cycle**		
DUTY	td	—s
Positioning distance	Ls	—mm (in.)
Moving member speed	$V\ell$	—m/min
Positioning time	ts	—s
Accel/decel time	ta	—s

Enter either $V\ell$ or ts. If both are entered, specify priority.



• **Operating environment**	Operating temperature
	Other

* 1. J (inertia) of Table W (load weight) and J (inertia) of the motor are automatically calculated by the servomotor sizing software
* 2 Gear ratio R = Nm/Nℓ = motor-speed/load-speed
* 3 Gear+coupling J g J of gear or coupling
This is J of the joint (including a gear) between the motor and the load (machine)

5.1.2 Selecting a SERVOPACK

Select an SGDB SERVOPACK accordıng to the servo system to be used. Each model can be identified as four-digıt alphanumeric characters following “SGDB-”.

SGDB- 2B A D

Σ-Senes
SGDB SERVOPACK

Rated output (motor capacıty)
2B· 22 KW   4E: 45 KW
3Z· 30 KW   5E: 55 KW
3G: 37 KW

Supply voltage
A· 200 V
D. 400 V

Model
D For speed/torque control and positıon control

Flowchart for SERVOPACK selection

	Selected SERVOPACK Model
Example	SGMB-$\boxed{2}\boxed{B}\boxed{A}\boxed{D}$
Axıs 1	SGMB-□□□□
Axıs 2	SGMB-□□□□
• • •	• • • • • •

* The motor model can be changed withın the same group by alterıng the parameter setting. (See the table on the next page.)

Select an SGDB SERVOPACK according to the motor to be used. The following table shows the correspondence between SERVOPACK and motor models.

Group	SERVOPACK Model	Motor Model
2BA	SGDB-2BAD	SGMB-2BA□A
		SGMB-2BA□B
3ZA	SGDB-3ZAD	SGMB-3ZA□A
		SGMB-3ZA□B
3GA	SGDB-3GAD	SGMB-3GA□A
		SGMB-3GA□B
2BD	SGDB-2BDD	SGMB-2BA□D
		SGMB-2BA□E
3ZD	SGDB-3ZDD	SGMB-3ZA□D
		SGMB-3ZA□E
3GD	SGDB-3GDD	SGMB-3GA□D
		SGMB-3GA□E
4ED	SGDB-4EDD	SGMB-4EA□D
		SGMB-4EA□E
5ED	SGDB-5EDD	SGMB-5EA□D
		SGMB-5EA□E

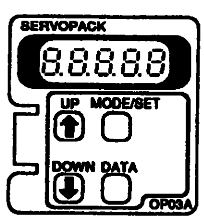
Note· The motor model can be changed within the same group by altering the setting in the parameters

5.1.3 Selecting a Digital Operator

The following two types of Digital Operator are available.

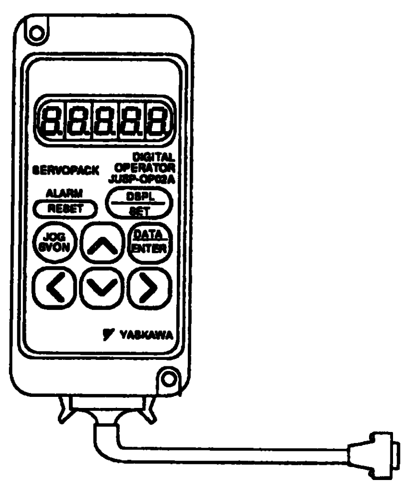
The two types cannot be used simultaneously. However, it is convenient to have both types and use whichever suits the circumstances.

Each type differs in shape but the operating functions are identical.



JUSP-OP03A (Mount Type)

- Use attached to the top of the SERVOPACK front face.



JUSP-OP02A-1 (Hand-held Type)

- Use held in the hand while connected with the 1 m cable supplied

5.2 SGMB Servomotor

This section provides tables of ratings and specifications for SGMB servomotors.

5.2.1 Ratings and Specifications

Ratings and Specifications of SGMB servomotors

Time rating:	Continuous
Thermal class:	F
Vibration class:	15μm or below
Withstand voltage:	1500 VAC
Insulation resistance:	500 VDC·10MΩ min.
Enclosure:	Totally enclosed, cooled separately IP44 specifications
Ambient temperature:	0 to 40°C
Ambient humidity:	20% to 80% (non-condensing)
Excitation:	Permanent magnet
Drive method:	Direct drive
Mounting:	Flange method

Servomotor SGMB-		2BA□A	2BA□B	3ZA□A	3ZA□B	3GA□A	3GA□B	2BA□D	2BA□E
Rated Output*	kW (HP)	22 (29.5)	22 (29.5)	30 (40.2)	30 (40.2)	37 (49 6)	37 (49.6)	22 (29.5)	22 (29.5)
Rated Torque*	N·m	140	140	191	191	236	236	140	140
	lbf·in	1239	1239	1690	1690	2088	2088	1239	1239
Instantaneous Peak Torque*	N·m	280	350	382	478	471	589	280	350
	lbf·in	2478	3097	3380	4230	4168	5213	2478	3097
Rated Current	A (rms)	120	100	175	145	210	180	60	50
Instantaneous Max Current*	A (rms)	240	240	340	340	460	460	120	120
Rated Speed*	r/min	1500							
Instantaneous Max Speed*	r/min	2000							
Moment of Inertia	$\times 10^{-4}$ kg·m^2	592	592	773	773	1390	1390	592	592
	$\times 10^{-3}$ lbf·in·s^2	524	524	685	685	1233	1233	524	524
Rated Power Rate*	kW/s	331	331	472	472	401	401	331	331
Rated Angular Acceleration*	rad/s^2	2360	2360	2470	2470	1700	1700	2360	2360

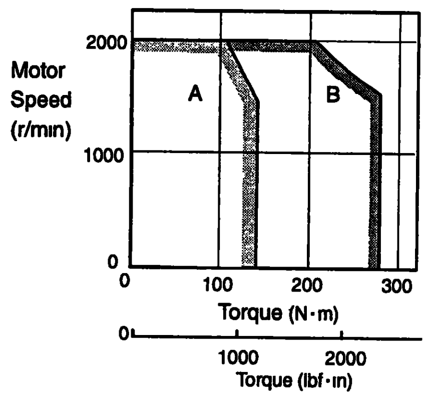
Servomotor SGMB-		3ZA□D	3ZA□E	3GA□D	3GA□E	4EA□D	4EA□E	5EA□D	5EA□E
Rated Output*	kW (HP)	30 (40.2)	30 (40 2)	37 (49.6)	37 (49.6)	45 (60.3)	45 (60 3)	55 (73.7)	55 (73.7)
Rated Torque*	N m	191	191	236	236	286	286	350	350
	lbf·in	1690	1690	2088	2088	2531	2531	3097	3097
Instantaneous Peak Torque*	N·m	382	478	471	589	572	715	700	875
	lbf·in	3380	4230	4168	5213	5062	6328	6195	7744
Rated Current	A (rms)	85	70	105	90	135	110	160	130
Instantaneous Max Current*	A (rms)	170	170	230	230	280	280	340	340
Rated Speed*	r/min	1500							
Instantaneous Max Speed*	r/min	2000							
Moment of Inertia	$\times 10^{-4}$ kg·m^2	773	773	1390	1390	1680	1680	1970	1970
	$\times 10^{-3}$ lbf·in·s^2	685	685	1233	1233	1484	1484	1745	1745
Rated Power Rate*	kW/s	472	472	401	401	487	487	622	622
Rated Angular Acceleration*	rad/s^2	2470	2470	1700	1700	1700	1700	1780	1780

* These items and torque-speed characteristics quoted in combination with an SGDB SERVOPACK at an armature winding temperature of 20°C

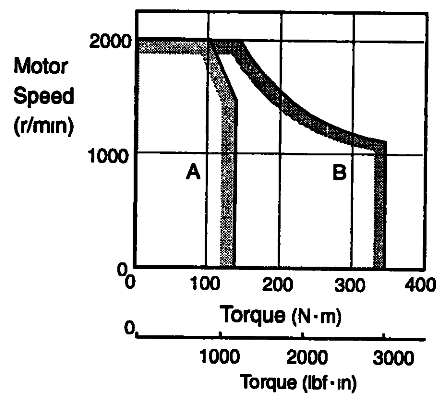
Note These characteristics can be obtained when the following heat sinks (steel plates) are used for cooling purposes
650×650×35 (mm) (25 59×25 59×1 38 (in))

SGMB Servomotor (Rated Motor Speed: 1500 r/min) Torque-Motor Speed Characteristics

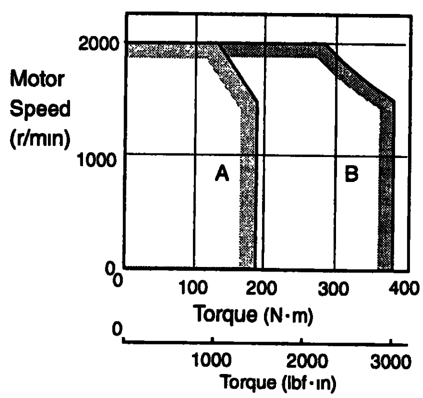
SGMB-2BA□A



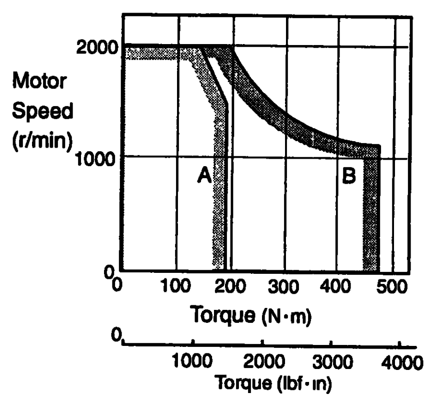
SGMB-2BA□B



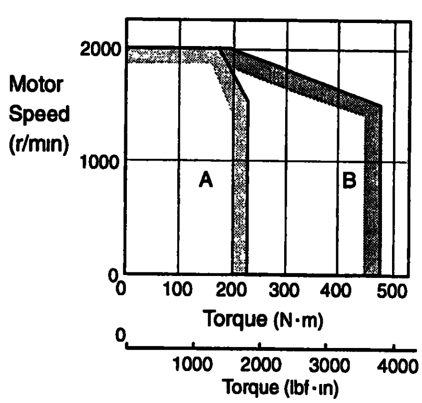
SGMB-3ZA□A



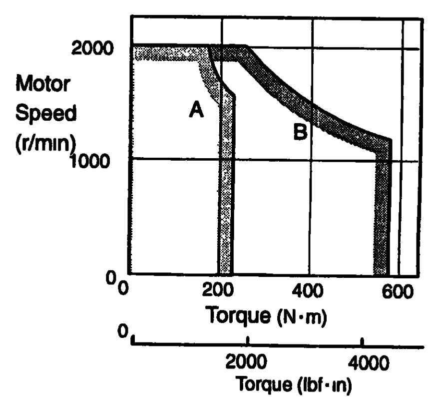
SGMB-3ZA□B



SGMB-3GA□A

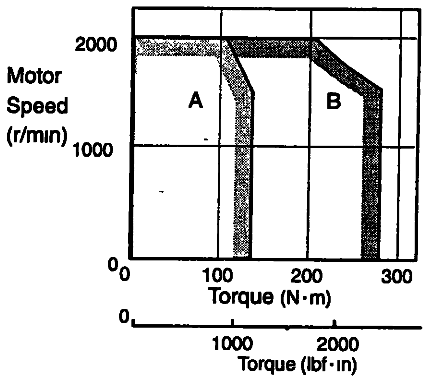


SGMB-3GA□B

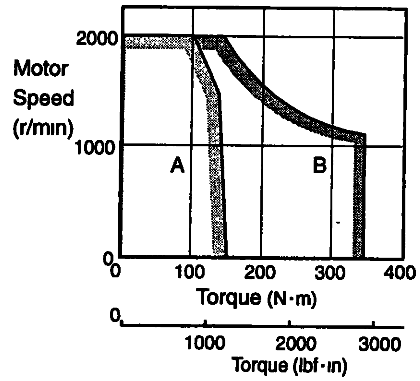


A: Continuous Duty Zone
B: Intermittent Duty Zone

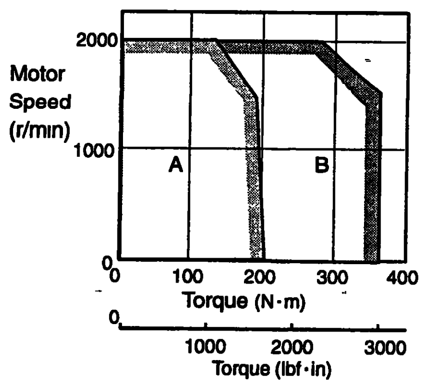
SGMB-2BA□D



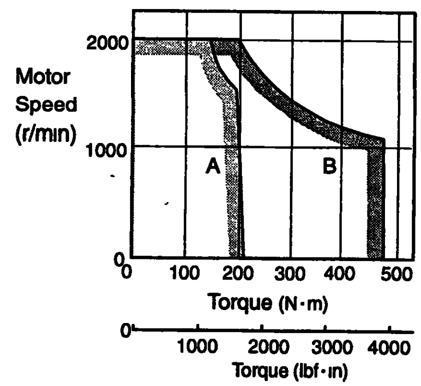
SGMB-2BA□E



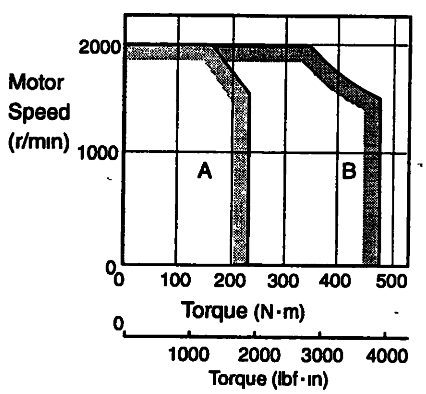
SGMB-2ZA□D



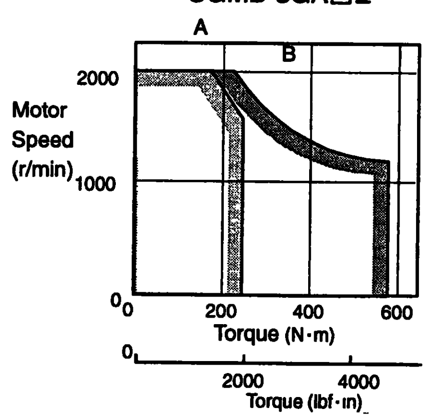
SGMB-3ZA□E



SGMB-3GA□D

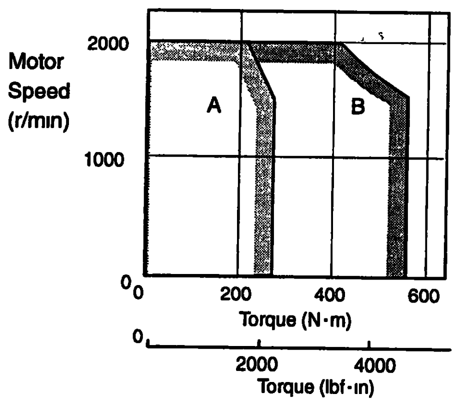


SGMB-3GA□E

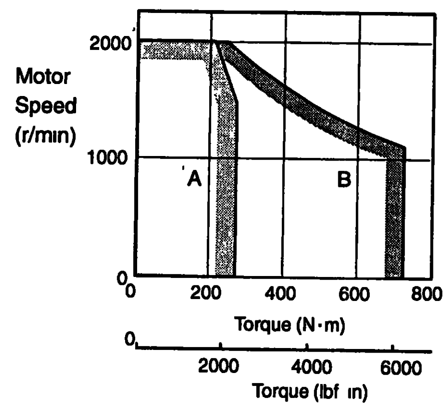


A: Continuous Duty Zone
B: Intermittent Duty Zone

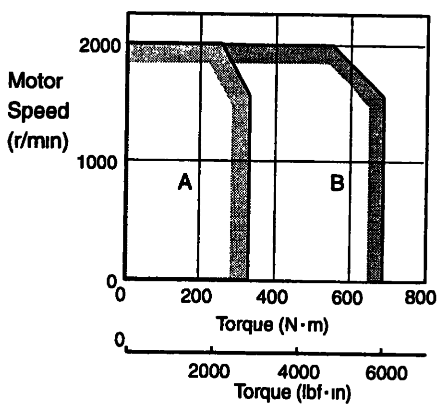
SGMB-4EA□D



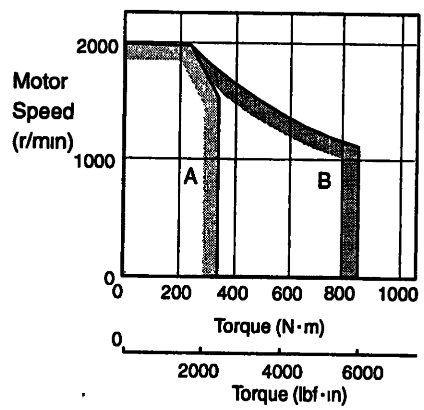
SGMB-4EA□E



SGMB-5EA□D



SGMB-5EA□E



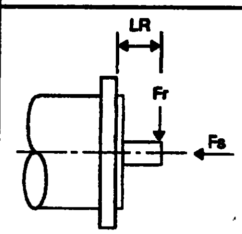
A: Continuous Duty Zone
B. Intermittent Duty Zone

5.2.2 Mechanical Characteristics

■ Allowable Radial Load, Allowable Thrust Load

The output shaft allowable loads for SGMB servomotor are shown below.

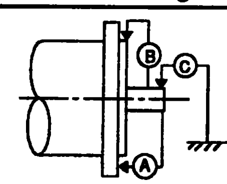
Conduct mechanical design such that the thrust loads and radial loads do not exceed the values stated below.

Servomotor Model	Allowable Radial Load Fr [N(lbf)]	Allowable Thrust Load Fs [N(lbf)]	LR mm (in.)	Reference Diagram
SGMB-2BA□□	5880 (1322)	2156 (485)	100 (3.94)	
SGMB-3ZA□□	6272 (1410)	2156 (485)	100 (3.94)	
SGMB-3GA□□	7448 (1675)	2156 (485)	100 (3.94)	
SGMB-4EA□□	7840 (1763)	2156 (485)	100 (3.94)	
SGMB-5EA□□	8428 (1895)	2156 (485)	110 (4.33)	

Note Allowable radial and thrust loads shown above are the maximum values that can be applied to the shaft end from motor torque or other loads

■ Mechanical Tolerance

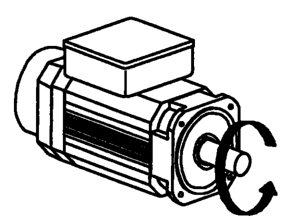
The tolerances of the SGMB servomotor output shaft and installation are shown in the table below.

Tolerance (T.I.R.)		Reference Diagram
Perpendicularity between flange face and output shaft (A)	0.04 mm (0.0016 in.)	
Mating concentricity of flange O.D. (B)	0.04 mm (0.0016 in.)	
Run-out at end of shaft (C)	0.02 mm (0.00079 in.)	

INFO

1. T.I.R. = Total Indicator Reading
2. As for the tolerance (C), refer to the each dimensional drawing
3. Direction of Motor Rotation

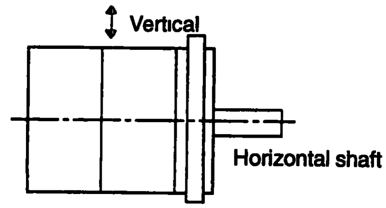
   Positive rotation of the servomotor is counterclockwise, viewing from the drive end.



Forward rotation

Impact Resistance

Mount the servomotor with the axis horizontal. The servomotor must withstand the following vertical impacts.



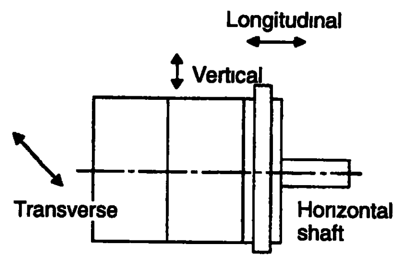
- Impact Acceleration: 490 m/s^2
- Number of Impacts: 2

IMPORTANT

In SGMB servomotors, an accurate detector is attached to the shaft at the opposite end from the load. Avoid applying impacts directly to the shaft as these may damage the detector.

Vibration Resistance

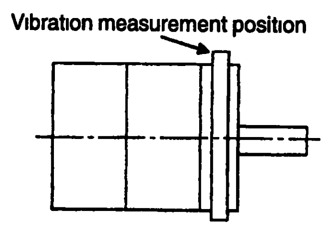
Mount the servomotor with the axis horizontal. The servomotor must withstand the following vibration accelerations in three directions: vertical, transverse, and longitudinal.



- Vibration Acceleration: 24.5 m/s^2

Vibration Class

The SGMB servomotor meets the following **vibration class** at rated speed.



- Vibration Class: 15μm or below

TERMS

◆ Vibration Class

Vibration class 15μm or below indicates that the total amplitude of vibration of the motor alone, running at rated speed, does not exceed 15μm

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5.3 SERVOPACK Ratings and Specifications

This section presents tables of SGDB SERVOPACK ratings and specifications.

5.3.1 Combined Specifications

The following table shows the specifications obtained when SGDB SERVOPACKs are combined with SGMB servomotors:

SERVOPACK SGDB-		2BAD		3ZAD		3GAD		2BDD		3ZDD		3GDD		4EDD		5EDD	
Motor	Model SGMB-	2BA □A	2BA □B	3ZA □A	3ZA □B	3GA □A	3GA □B	2BA □D	2BA □E	3ZA □D	3ZA □E	3GA □D	3GA □E	4EA □D	4EA □E	5EA □D	5EA □E
	Capacity kW (HP)	22 (29.5)		30 (40.2)		37 (49.6)		22 (29.5)		30 (40.2)		37 (49.6)		45 (60.3)		55 (73.7)	
	Rated/ Max. Motor Speed r/min	1000/2000															
Applicable Encoder		Standard: Incremental encoder (8192 P/R)															
Continuous Output Current A (rms)		120	100	175	145	210	180	60	50	85	70	105	90	135	110	160	130
Max. Output Current A (rms)		240	240	340	340	460	460	120	120	170	170	230	230	280	280	340	340
Allowable Load Inertia* J_L $\times 10^{-4}$ kg m² ($\times 10^{-3}$ oz in s²)		2960 (41910)		3865 (54730)		6950 (98420)		2960 (41910)		3865 (54730)		6950 (98420)		8400 (118900)		9850 (139400)	

5.3.2 Ratings and Specifications

The ratings and specifications of the SGDB SERVOPACK are shown below. Refer to them as required when selecting a SERVOPACK.

SERVOPACK SGDB-			200 V Series			400 V Series				
			2BAD	3ZAD	3GAD	2BDD	3ZDD	3GDD	4EDD	5EDD
Servomotor SGMB-□□			2BA□□	3ZA□□	3GA□□	3BA□□	3ZA□□	3GA□□	4EA□□	5EA□□
Continuous Output kW (HP)			22 (29.5)	30 (40.2)	37 (49.6)	22 (29.5)	30 (40.2)	37 (49.6)	45 (60.3)	55 (73.7)
Allowable Load Inertia* J_L $\times 10^{-4}$ kg·m^2 ($\times 10^{-3}$ oz·in·s^2)			2960 (41910)	3865 (54730)	6950 (98420)	2960 (41910)	3865 (54730)	6950 (98420)	8400 (118900)	9850 (139400)
Basic Specifications	Input Power Supply	Main Circuit*1	Three-phase 200 to 230 VAC +10% to –15%, 50/60 Hz			Three-phase 380 to 460 VAC +10% to –15%, 50/60 Hz				
		Main Circuit Power Supply Capacity kVA	36.7	50.1	61.8	36.7	50.1	61.8	75.2	91.9
		Control Circuit*1	Single-phase 200 to 220 VAC $^{+10}_{-15}$ %, 50 Hz Single-phase 200 to 230 VAC $^{+10}_{-15}$ %, 60 Hz							
		Control Circuit Power Supply Capacity	150 VA							
Basic Specifications	Control Mode		Three-phase, full-wave rectification IGBT PWM (sine-wave driven)							
	Feedback		Incremental encoder, absolute encoder							
	Location	Ambient/Storage Temp.*2	0 to 55°C/–20 to 85°C							
		Ambient/Storage Humidity	90% or less (no-condensing)							
		Vibration/Shock Resistance	4.9m/s^2 /19.6m/s^2							
	Structure		Base mounted							
	Approx mass kg(lb)		57 (126)	58 (128)	60 (132)	40 (88)	45 (99)	55 (121)	60 (132)	

SERVOPACK SGDB-				200 V Series			400 V Series				
				2BAD	3ZAD	3GAD	2BDD	3ZDD	3GDD	4EDD	5EDD
Speed/ Torque Control Mode	Performance	Speed Control Range		1:5000 (provided that the lower limit of the speed control range does not cause the motor to stop when the rated torque load is applied)							
		Speed Regulation*3	Load Regulation	0% to 100%: 0.01% max. (at rated speed)							
			Voltage Regulation	Rated voltage ±10%. 0% (at rated speed)							
			Temperature Regulation	25±25°C: 0.1% max. (at rated speed)							
		Frequency Characteristics		100Hz (at J_L=J_M)							
		Accel/Decel Time Setting		0 to 10 s							
	Input Signal	Speed Reference	Reference Voltage*4	±6 VDC (variable setting range. ±2 to ±10 VDC) at rated speed (forward rotation with positive reference)							
			Input Impedance	Approx. 30 kΩ							
			Circuit Time Constant	Approx. 47 μs							
		Torque Reference	Reference Voltage*4	±1 to ±10 VDC at rated speed (forward rotation with positive reference)							
			Input Impedance	Approx. 30 kΩ							
			Circuit Time Constant	Approx. 47 μs							
		Built-in Reference Power Supply		±12 V, ±30 mA							
Position Control Mode	Performance	Bias Setting		0 to 450 r/min (setting resolution: 1 r/min)							
		Feed-forward Compensation		0 to 100% (setting resolution: 1%)							
		Position Complete Width Setting		0 to 250 reference units (setting resolution. 1 reference unit)							
	Input Signal	Reference Pulse	Type	SIGN + PULSE train, 90° phase difference 2-phase pulse (phase A + phase B), or CCW + CW pulse train							
			Pulse Buffer	Line driver (+5 V level), open collector (+5 V or +12 V level)							
			Pulse Frequency	Max. 450/200 kpps (line driver/open collector)							
		Control Signal		CLEAR (input pulse form identical to reference pulse)							
		Built-in Open Collector Power Supply*5		+12 V (with built-in 1 kΩ resistor)							

SERVOPACK SGDB-			200 V Series			400 V Series				
			2BAD	3ZAD	3GAD	2BDD	3ZDD	3GDD	4EDD	5EDD
I/O Signals	Position Output	Output Form	Phases A, B and C. Line driver output Phase S: Line driver output (only when 12-bit absolute encoder is used)							
		Frequency Dividing Ratio	(16 to N)/N (N. Number of encoder pulses)							
	Sequence Input		Servo ON, P control (or forward/reverse rotation in contact input speed control mode), forward rotation prohibited (P-OT), reverse rotation prohibited (N-OT), alarm reset, forward rotation current limit, and reverse rotation current limit (or contact input speed control)							
	Sequence Output		Servo alarm, 3-bit alarm codes							
		Any 3 of those signals	Positioning complete (speed coincidence), TGON, servo ready, current limit, brake release, overload warning, overload detected							
	Analog Monitor Output	Any 2 of those signals	Speed: 2 V/1000 r/min or 1 V/1000 r/min Torque: 2 V/rated torque Error: 0 05 V/reference unit or 0.05 V/100 reference units							
Built-in Functions	Dynamic Brake (DB)		Activated at main power OFF, servo alarm, servo OFF or overtravel							
	Regenerative Processing		Incorporated. External regenerative resistor must be mounted.							
	Overtravel (OT) Prevention		Motor is stopped by dynamic brake, decelerates to a stop, or coasts to a stop when P-OT or N-OT is activated.							
	Protection		Overcurrent, overload, regenerative error, main circuit voltage error, heat sink overheat, power open phase, overflow, overspeed, encoder error, encoder disconnected, overrun, CPU error, parameter error							
	LED Display		POWER, ALARM, CHARGE							
	Analog Monitor (5CN)		Same analog monitor signal as 1CN is available.							
Built-in Functions	Communication	Interface	Digital Operator (mount type or hand-held type) RS422A port such as personal computer (RS232C port can be used if some conditions are met.)							
		1:N Communication	N can be up to 14 when RS422A port is used.							
		Axis Address Setting*6	Hexadecimal rotary switch (1SW) 1. 1:N communication, 0. 1:1 communication							
		Functions	Status display, parameter setting, monitor display, alarm traceback display, jogging, autotuning, etc							
	Others		Zero-clamp, reverse rotation connection							

* 1. The power voltage must not exceed 230 V + 10% (253 V). If it is likely to exceed this limit, use a step-down transformer
* 2 The ambient temperature must be within the specified range Even if the SERVOPACK is installed in a box, the temperature inside the box must not exceed the range
* 3 Speed regulation can be calculated using the following formula

$$\left(\text{Speed regulation} = \frac{(\text{no-load motor speed} - \text{full-load motor speed})}{\text{rated motor speed}} \times 100\%\right)$$

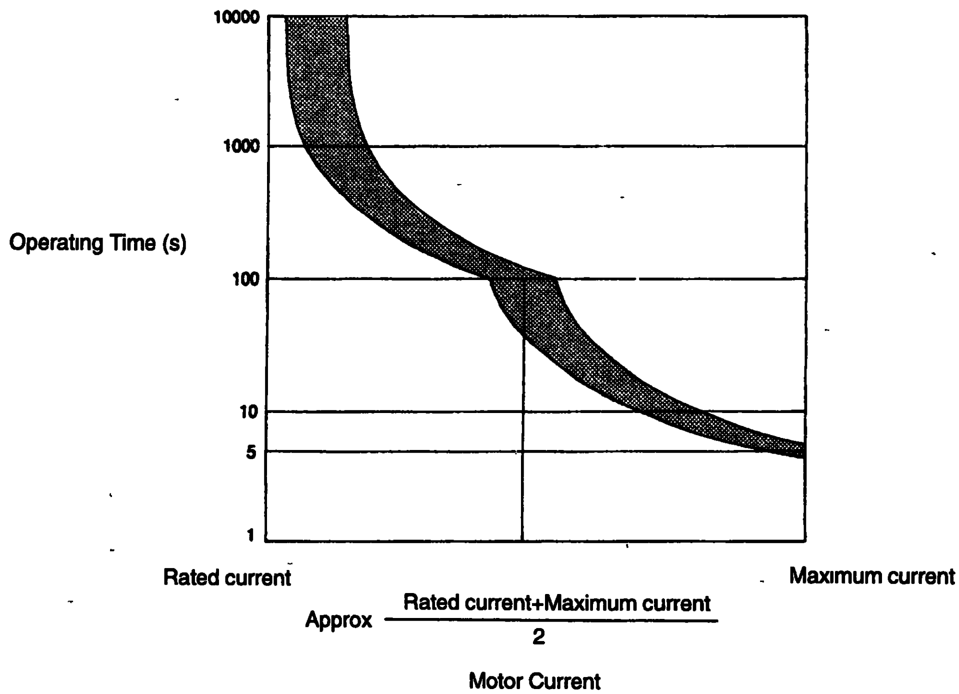
Under actual operating conditions, voltage or temperature fluctuation causes drift to the amplifier or changes the operating resistance, resulting in the motor speed being changed
The percentage of the motor speed change to the rated motor speed is called "speed regulation"

* 4 Forward rotation is defined as the clockwise rotation when viewed from the motor on the opposite side of the load (It is the counterclockwise rotation when viewed from the load or shaft)
* 5. Built-in open collector power supply is not electrically isolated from the control circuit inside the SERVOPACK
* 6 For 1 1 communication, set the rotary switch to "0"

5.3.3 Overload Characteristics

The SERVOPACK has a built-in overload protective function to protect the SERVOPACK and servomotor from overload. Therefore, the SERVOPACK allowable power is limited by the overload protective function, as shown below.

The overload detection level is quoted under **hot start** conditions at a motor ambient temperature of 40°C.



Overload Characteristics

TERMS

◆ Hot Start

Indicates that both SERVOPACK and servomotor have run long enough at rated load to be thermally saturated

5.3.4 Starting Time and Stopping Time

The motor starting time (tr) and stopping time (tf) under constant load are calculated by the following formulas. The motor viscous torque and friction torque are ignored.

Starting Time: $tf = \dfrac{2\pi \cdot N_m (J_M + J_L)}{60 \cdot (T_{PM} - T_L)}$ [s]

Stopping Time: $tf = \dfrac{2\pi \cdot N_m (J_M + J_L)}{60 \cdot (T_{PM} + T_L)}$ [s]

Nm: Motor speed used (r/min.)

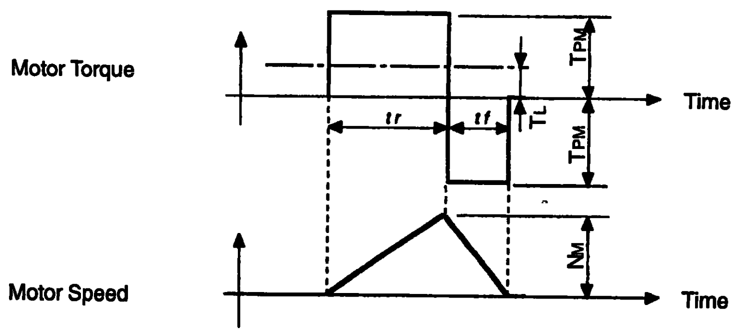
J_M: Motor moment of inertia (kg·m^2)

J_L: Load converted to shaft moment of inertia (kg·m^2)

T_{PM}: Maximum instantaneous motor torque obtained in combination with SERVOPACK (N·m)

T_L: Load torque (N·m)

To convert the motor current value into an equivalent torque value, use the following formula:
Motor torque constant x motor current value (effective value)



Motor Torque (size) - Motor Speed Timing Chart

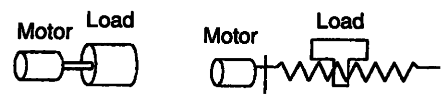
5.3.5 Load Moment of Inertia

The larger the load moment of inertia becomes, the worse the movement response of the load. The size of the load moment of inertia (J_L) allowable when using a servomotor must not exceed five times the motor moment of inertia (J_M).

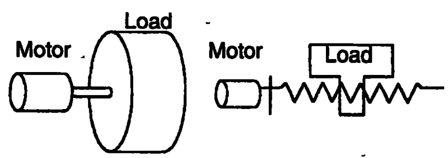
If the load moment of inertia exceeds five times the motor moment of inertia, an overvoltage alarm may arise during deceleration. To prevent this, take one of the following actions:

1. Reduce the torque limit value.
2. Reduce the slope of the deceleration curve.
3. Reduce the maximum motor speed.
4. Consult your Yaskawa representative.

- Small Load Inertia



- Large Load Inertia



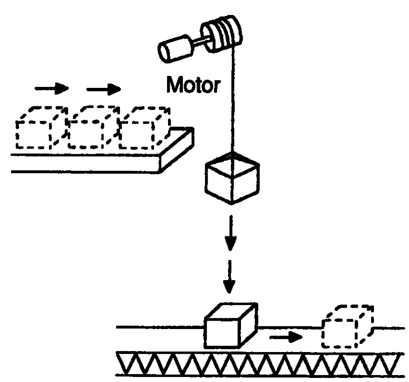
5.3.6 Overhanging Loads

A servomotor may not be operated under an overhanging load, that is a load which tends to continually rotate the motor.

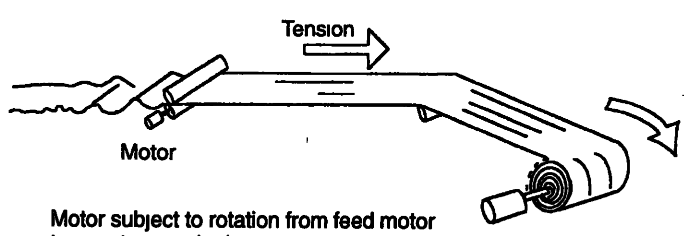
IMPORTANT

Under an overhanging load (e.g. when the direction of the torque applied by the motor is opposite from the direction of shaft rotation), the SERVOPACK regenerative brake is applied continuously and the regenerative energy of the load may exceed the allowable range and damage the SERVOPACK.
The regenerative brake capacity of the SGDB SERVOPACK is rated for short-time operation, approximately equivalent to the deceleration stopping time.

- Overhanging Load Example 1: Motor drive for vertical axis, using no counterweight



- Overhanging Load Example 2: Tension control drive



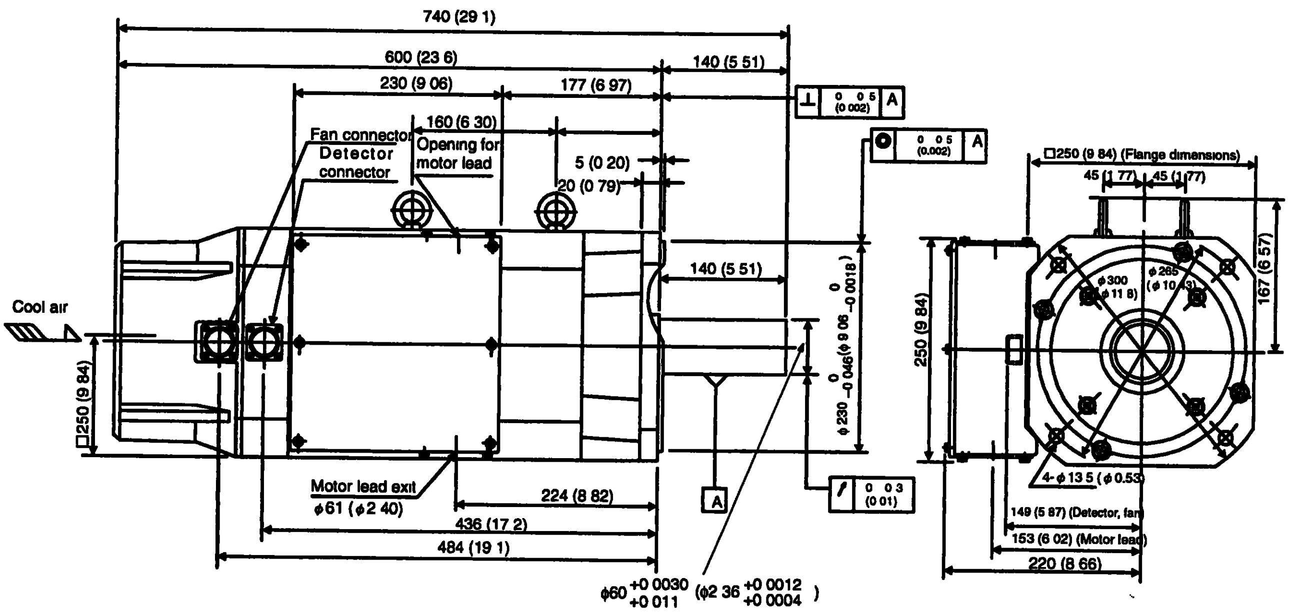
5.4 Σ-Series Dimensional Drawings

This section presents dimensional drawings of the Σ-Senes servomotor, SERVOPACK, and Digital Operator.

5.4.1 Servomotor Dimensional Drawings

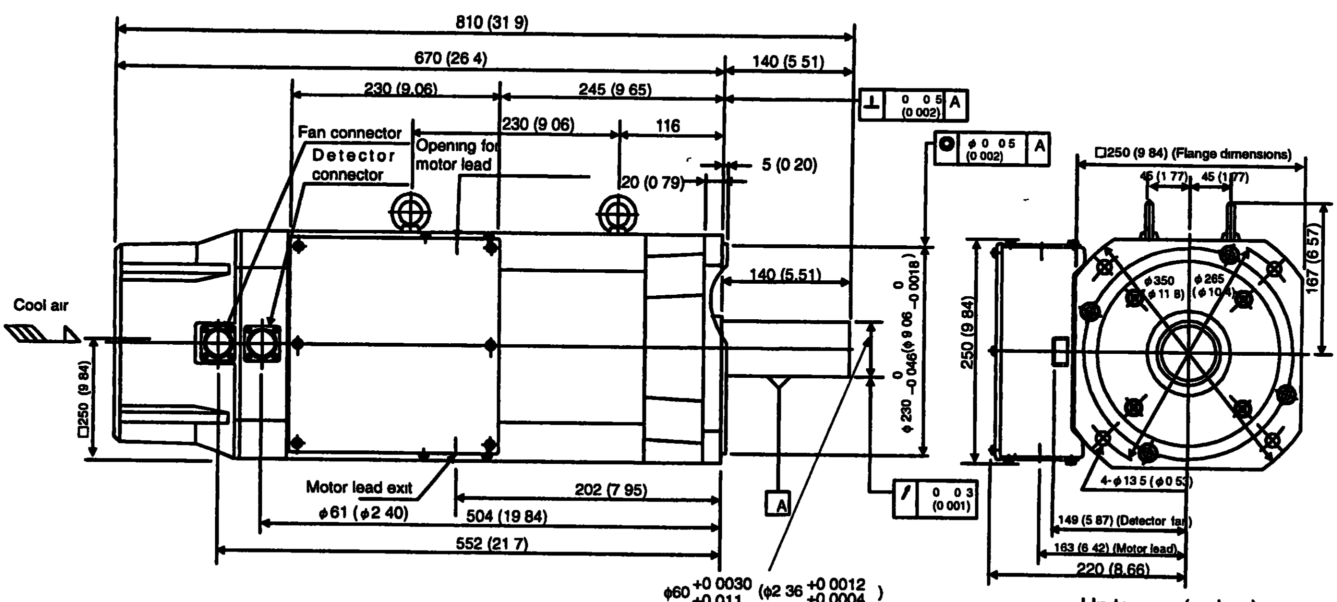
The dimensional drawings of the SGMB servomotors are shown on the following pages.

■ SGMB-2BA□□ Servomotors



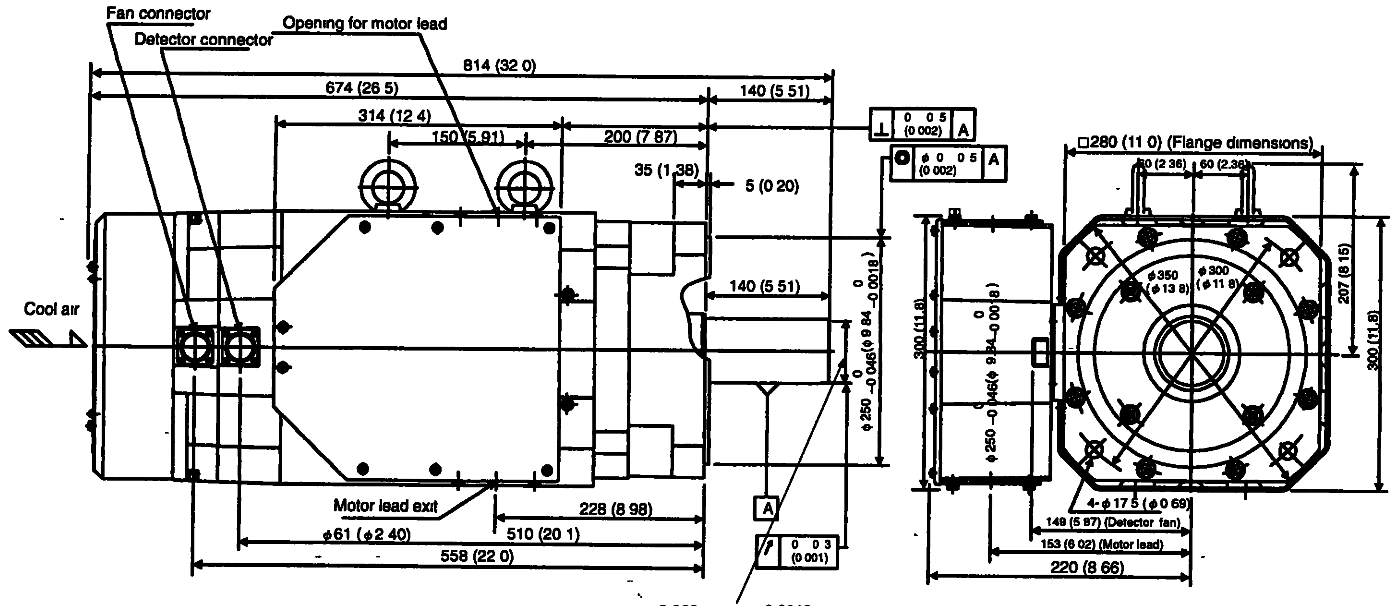
Units: mm (inches)

■ SGMB-3ZA□□ Servomotors



Units: mm (inches)

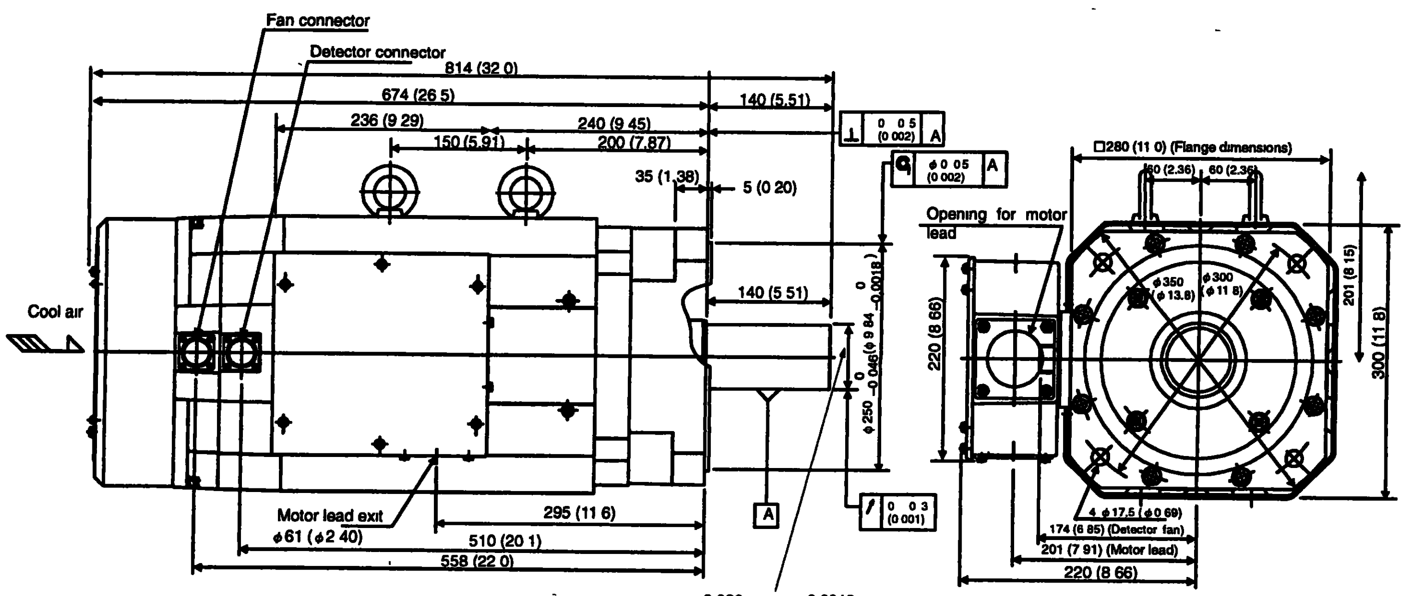
■ SGMB-3GA□A, -3GA□B Servomotors



$\phi 70^{+0.030}_{+0.011}$ ($\phi 2.76^{+0.0012}_{+0.0004}$)

Units: mm (inches)

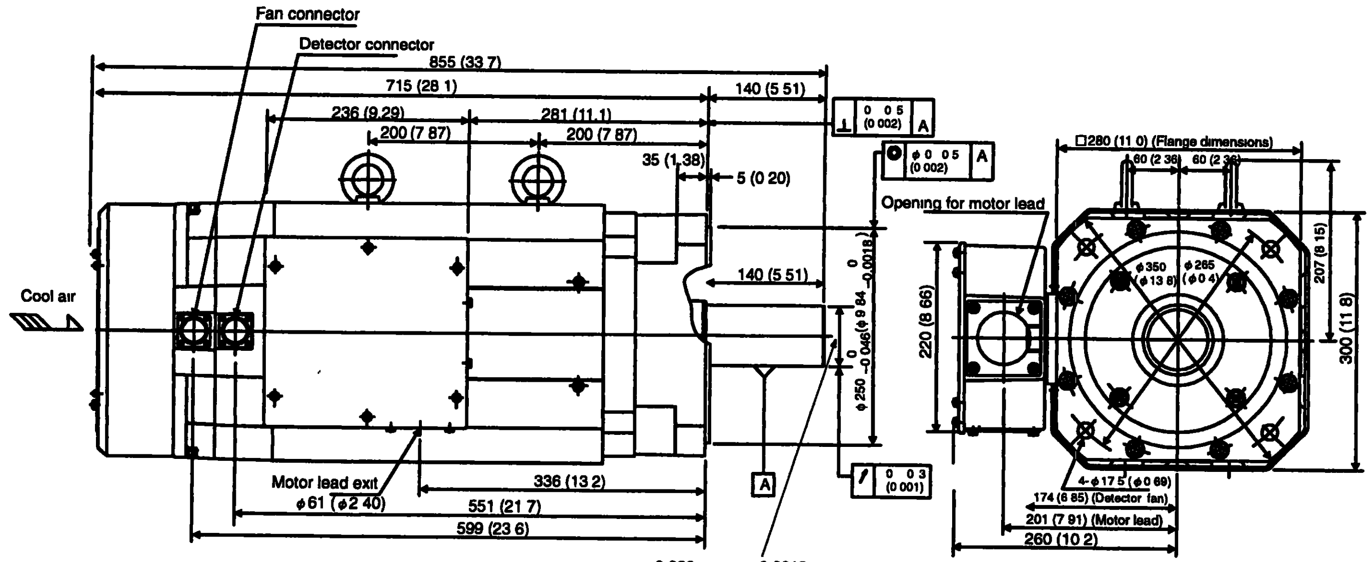
■ SGMB-3GA□D, -3GA□E Servomotors



$\phi 70^{+0.030}_{+0.011}$ ($\phi 2.76^{+0.0012}_{+0.0004}$)

Units: mm (inches)

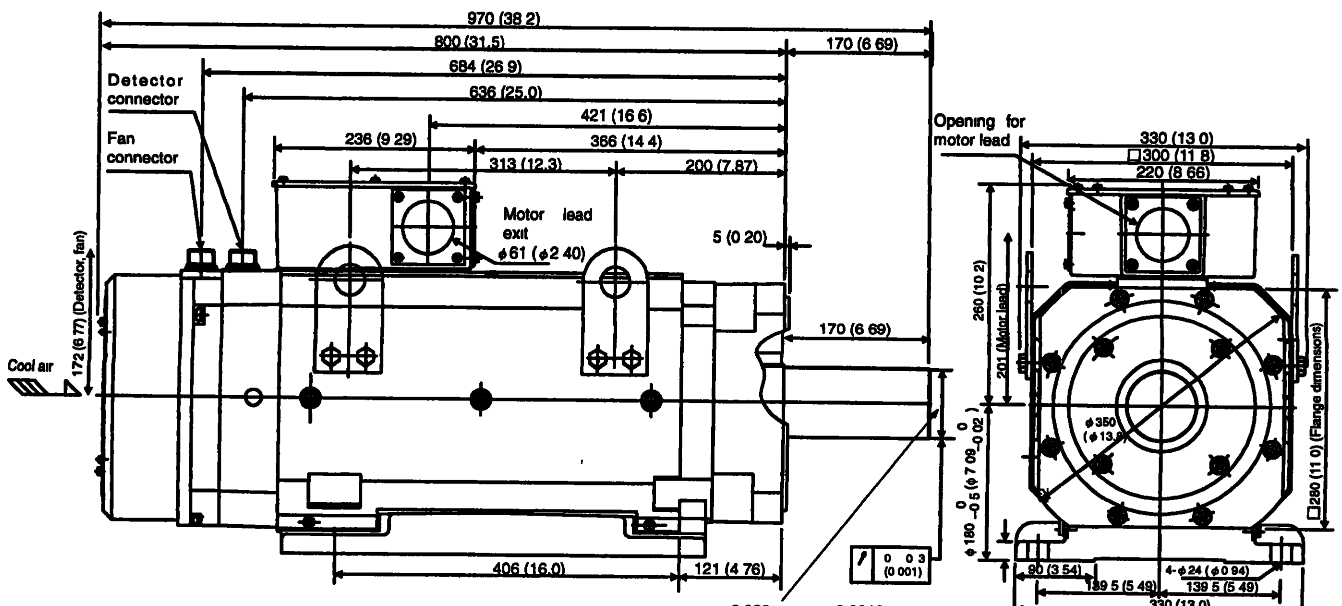
■ SGMB-4EA□□ Servomotors



$\phi 70^{+0.030}_{+0.011}$ ($\phi 2.76^{+0.0012}_{+0.0004}$)

Units: mm (inches)

■ SGMB-5EA□□K Servomotors



$\phi 80^{+0.030}_{+0.011}$ ($\phi 3.15^{+0.0012}_{+0.0004}$)

Units: mm (inches)

Connector Wiring on Detector End

- Incremental Encoders

Receptacle. 97F3102E20-29P
Plug (To be prepared by the customer):
(L-shaped type) JA08A-20-29S-JA-EB or MS3108B20-29S
(Straight type) JA06A-20-29S-J1-EB or MS3106B20-29S
Cable Clamp JL04-2022CKE (* *) or MS3057-12A
* * indicates the cable diameter.

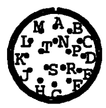
A	A channel output	K	Z channel output
B	/A channel output	L	/Z channel output
C	B channel output	M	–
D	/B channel output	N	–
E	C channel output	P	–
F	/C channel output	R	–
G	0 V	S	–
H	+5 V DC	T	–
J	FG (Frame Ground)		

- 12-bit Absolute Encoders

Receptacle: 97F3102E20-29P
Plug (To be prepared by the customer):
(L-shaped type) JA08A-20-29S-JA-EB or MS3108B20-29S
(Straight type) JA06A-20-29S-J1-EB or MS3106B20-29S
Cable Clamp: JL04-2022CKE (* *) or MS3057-12A
* * indicates the cable diameter.

A	A channel output	K	S channel output
B	/A channel output	L	/S channel output
C	B channel output	M	–
D	/B channel output	N	–
E	Z channel output	P	Capacitor reset
F	/Z channel output	R	Reset
G	0 V	S	0 V (battery)
H	+5 V DC	T	3.6 V (battery)
J	FG (Frame Ground)		

- 15-bit Absolute Encoders

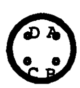


Receptacle: 97F3102E20-29P
Plug (To be prepared by the customer):
(L-shaped type) JA08A-20-29S-JA-EB or MS3108B20-29S
(Straight type) JA06A-20-29S-J1-EB or MS3106B20-29S
Cable Clamp: JL04-2022CKE (* *) or MS3057-12A
* * indicates the cable diameter.

A	A channel output	K	–
B	/A channel output	L	–
C	B channel output	M	–
D	/B channel output	N	–
E	Z channel output	P	–
F	/Z channel output	R	Reset
G	0 V	S	0 V (battery)
H	+5 V DC	T	3.6 V (battery)
J	FG (Frame Ground)		

Note: 1 Terminals K to P are not used
2 Receptacle, plug, and cable clamp are common regardless of motor capacity

Connector Wiring on Fan End



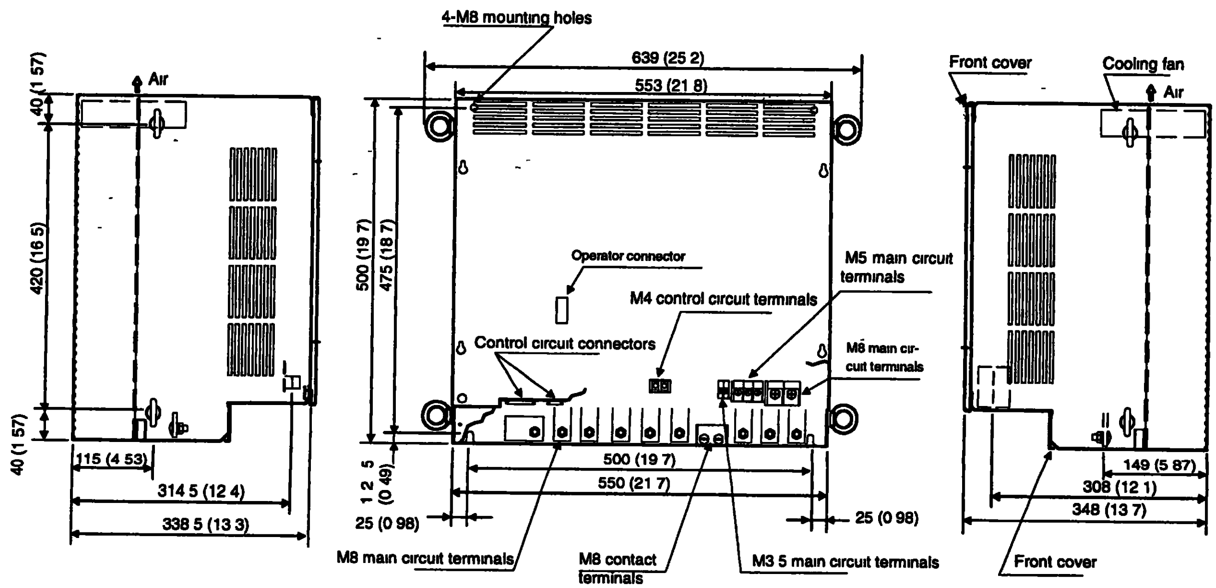
Receptacle: CE05-2A18-10PD-B
Plug (To be prepared by the customer):
(L-shaped type) CE05-8A18-10SD-B-BAS or MS3108B18-10S
(Straight type) CE05-6A18-10SD-B-BSS or MS3106B18-10S
Cable Clamp. CE3057-10A-* (D265) or MS3057-10A
* * indicates the cable diameter.

A	Fan terminal (U)
B	Fan terminal (V)
C	Fan terminal (W)
D	–

5.4.2 SERVOPACK Dimensional Drawings

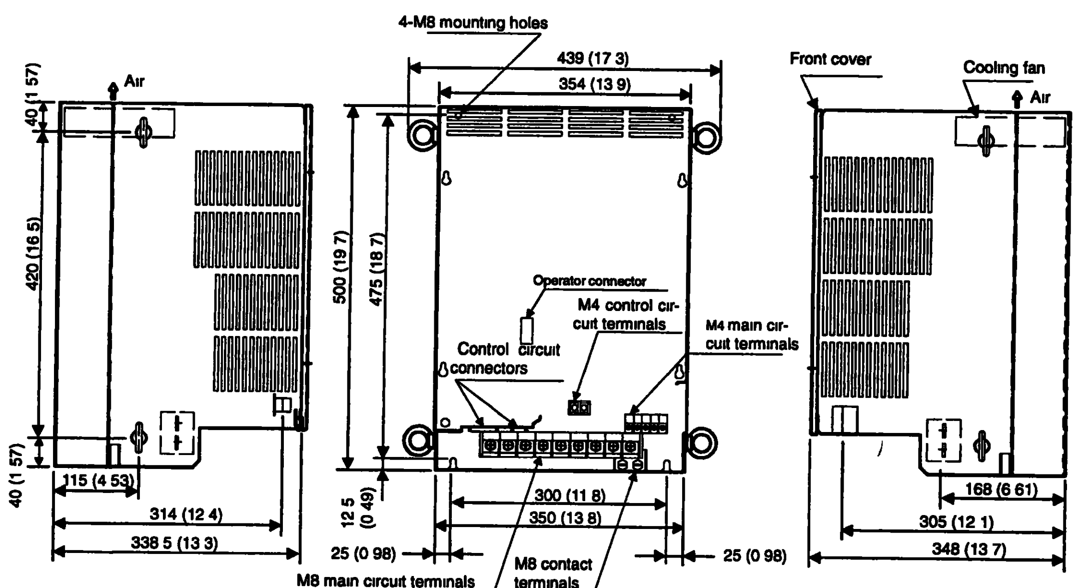
The dimensional drawings of the SGDB SERVOPACKs are shown on the following pages.

■ SGDB-3GAD SERVOPACK



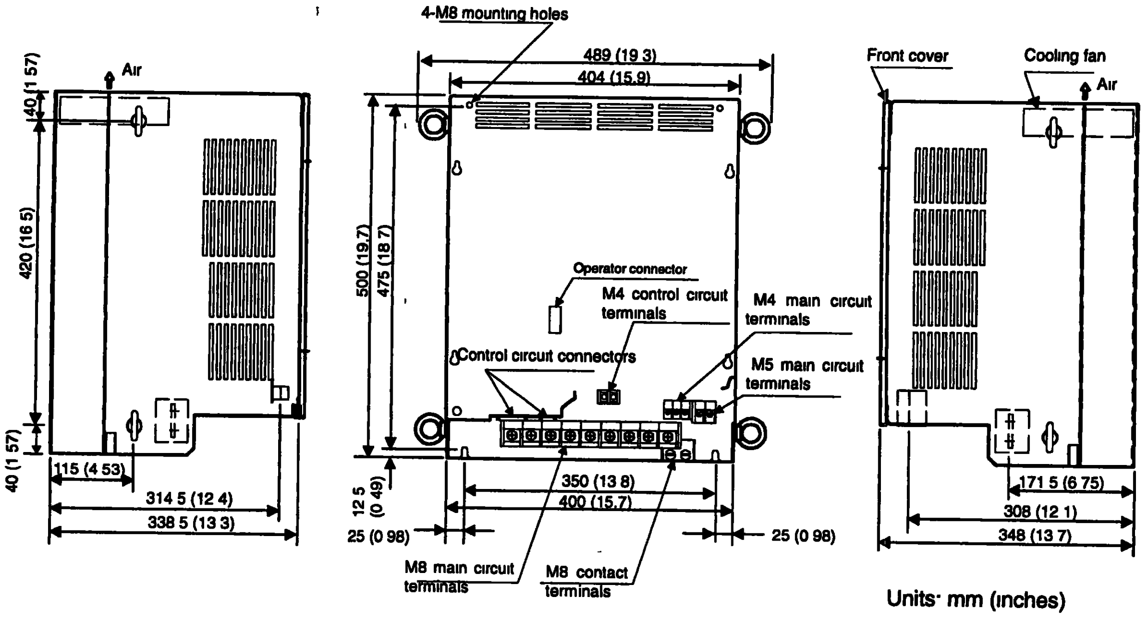
Units: mm (inches)

■ SGDB-2BDD SERVOPACK



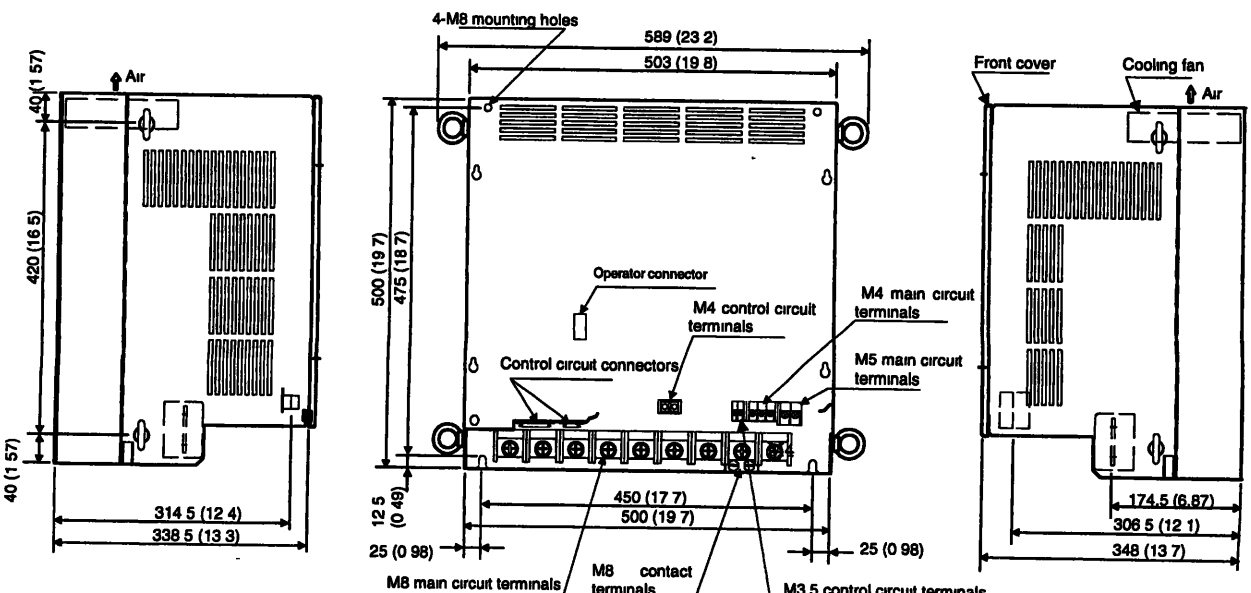
Units: mm (inches)

■ SGDB-3ZDD SERVOPACK



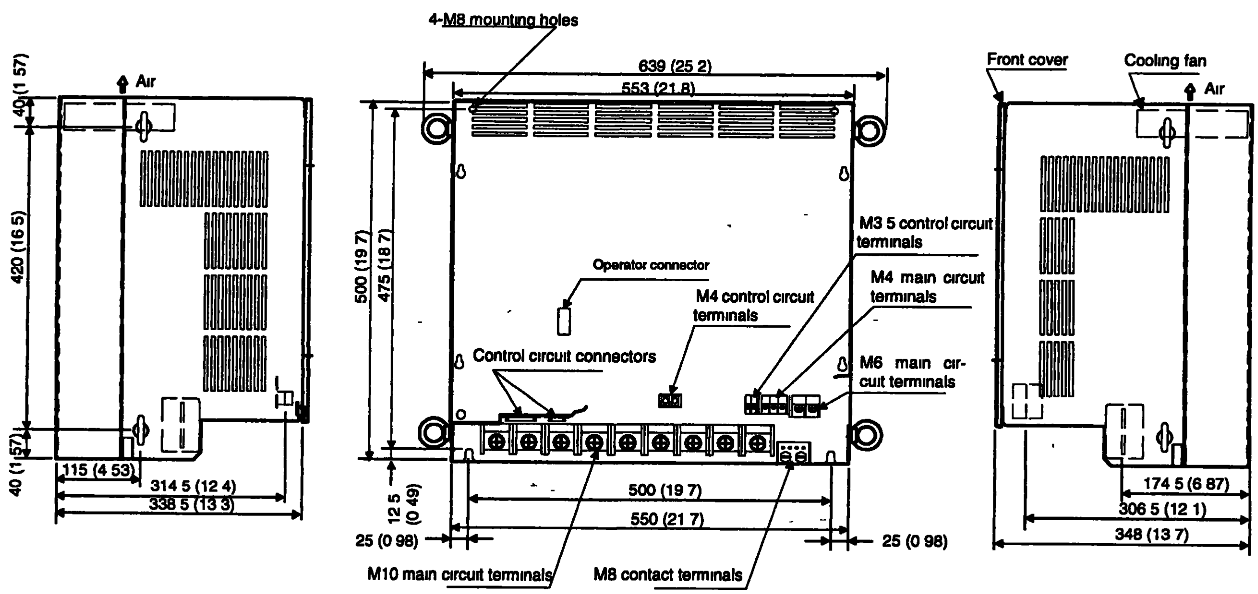
Units: mm (inches)

■ SGDB-3GDD SERVOPACK



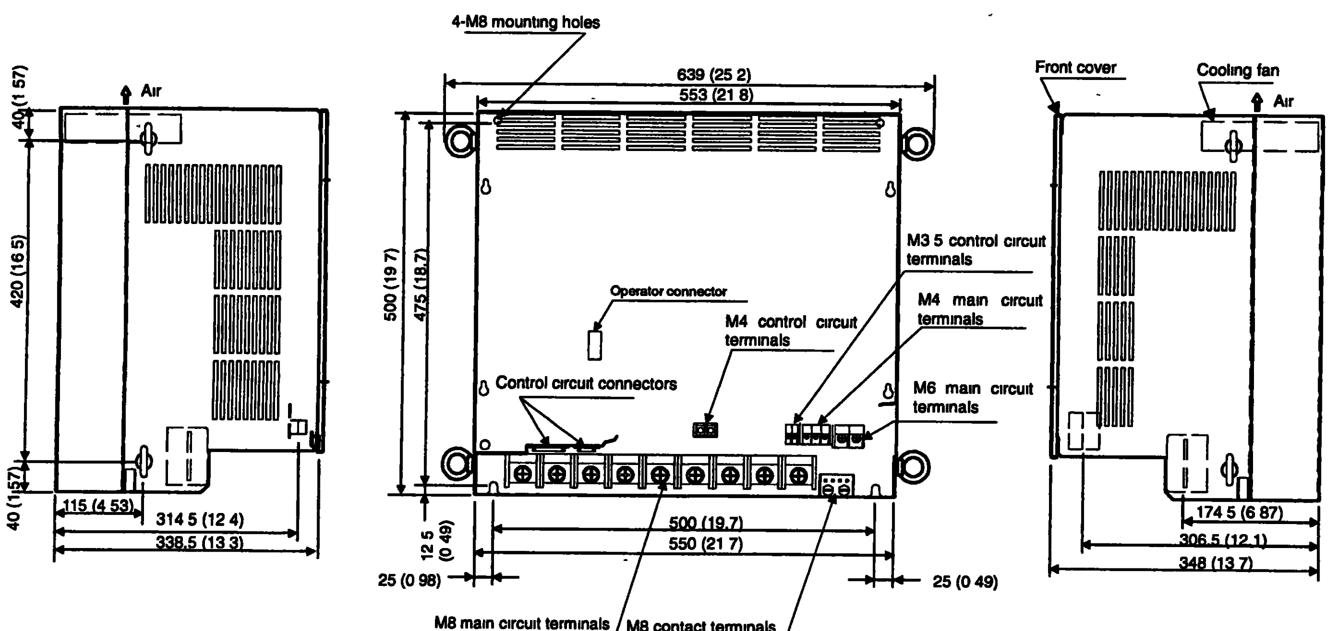
Units mm (inches)

■ SGDB-4EDD SERVOPACK



Units: mm (inches)

■ SGDB-5EDD SERVOPACK



Units: mm (inches)

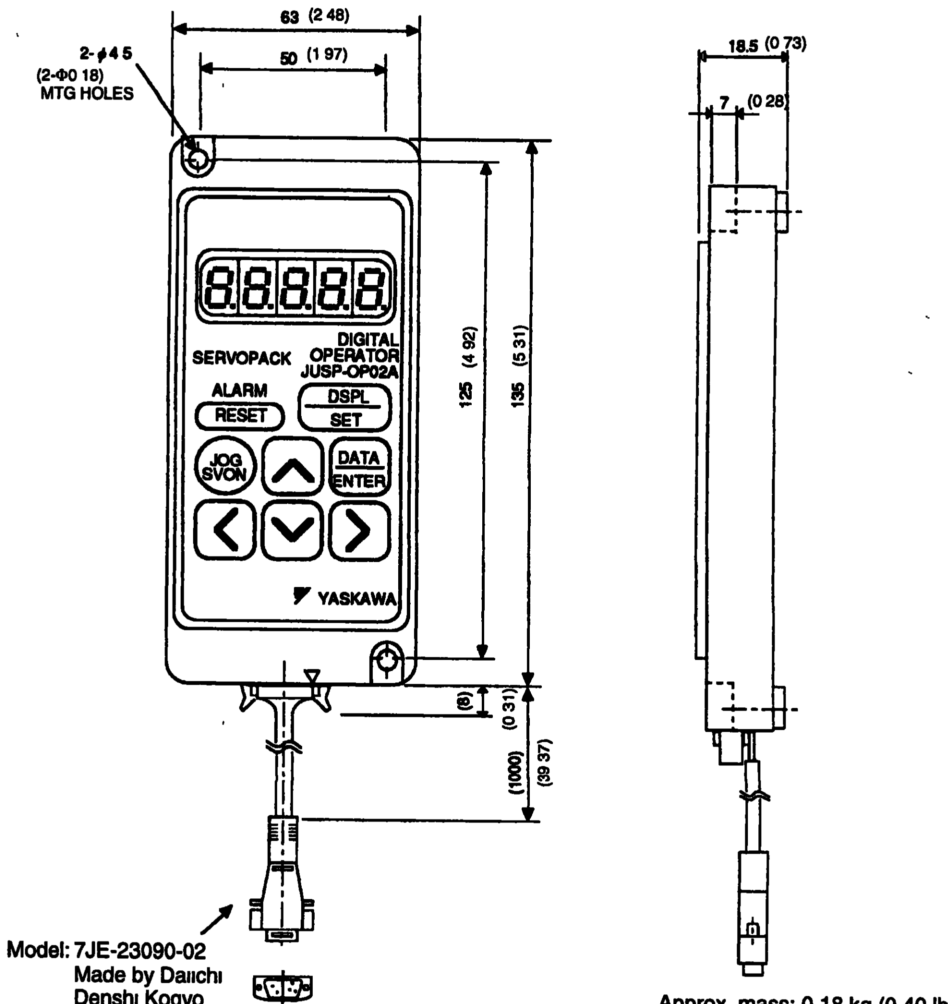
5.4.3 Digital Operator Dimensional Drawings

The following two types of Digital Operator are available.

JUSP-OP02A-1 (Hand-held Type)

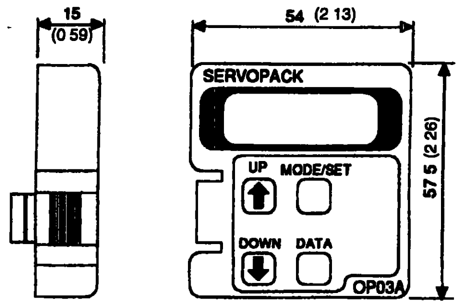
JUSP-OP03A (Mount Type)

- JUSP-OP02A-1



Approx. mass: 0.18 kg (0.40 lb)
Units: mm (inches)

- JUSP-OP03A



Approx. mass: 0.02 kg (0.041lb)
Units: mm (inches)

5.5 Specifications and Dimensional Drawings of Peripheral Devices

This section shows the specifications and dimensional drawings of the peripheral devices required for a Σ-Series servo system.

5.5.1 Cable Specifications and Peripheral Devices

The cable sizes and peripheral devices for SGDB SERVOPACKs are listed in the following tables.

The cable specifications were selected under conditions of three cables per bundle at an ambient temperature of 40°, with the rated current flowing.

IMPORTANT

Do not wire power lines and signal lines within the same duct, or bundle them together. Wire so that signals line are always kept apart from power lines by at least 30cm.

Use twisted pair or multi-core twisted pair shielded wires for signal lines and the encoder (PG) feedback line. The wiring length for reference input lines must be within 3m, and for the PG feedback line within 20m.

■ Cable Size

External Terminal Name		SGDB Model / Terminal Symbol	Cable Size							
			2BAD	3ZAD	3GAD	2BDD	3ZDD	3GDD	4EDD	5EDD
On-line Terminal	Main Circuit Power Input Terminal	L1/R, L2/S, L3/T, ⏚	HIV 30 or more	HIV 50 or more	HIV 60 or more	HIV 14 or more	HIV 14 or more	HIV 22 or more	HIV 30 or more	HIV 38 or more
	Motor Connection Terminal	U, V, W, ⏚	HIV 38 or more	HIV 60 or more	HIV 80 or more	HIV 14 or more	HIV 22 or more	HIV 30 or more	HIV 38 or more	HIV 50 or more
	Control Power Input Terminal	L1r, L3/t	HIV 1.25 or more							
	Regenerative Resistor Unit Connection Terminal	B1, B2	HIV 2.0 or more	HIV 3.5 or more		HIV 2.0 or more				HIV 3 5 or more
	Dynamic Brake Unit Connection Terminal	DU, DV, DW	HIV 1.25 or more							HIV 2.0 or more
		DBON, DB24	HIV 1 25 or more							
Off-line Terminal	Control I/O Signal Connector	1CN	Core of twisted pair or twisted pair shield wires: 0.12 mm² or more Outside dimensions of tinned annealed copper twisted wires: max. Ø16 (for 1CN), max. Ø11 (for 2CN)							
	PG Signal Connector	2CN								

Note. 1 Cable size selection conditions Ambient temperature 40°C, 3 wires per bundle, and rated current flowing

2 For the main circuit, use cables with a dielectric strength of 600 V or more.

3 If the cables are laid in a duct (rigid PVC tube or metal pipe), allow for the reduced current rating applicable to the cables

4 If the ambient temperature (inside the control panel) is high, cables sheathed with ordinary vinyl will be easily subjected to heat deterioration and become unusable in a short period of time To prevent this, always use heat-resistant cables

The types of cable are shown in the table below. Use it in combination with the tables.

Cable Type		Conductor Allowable Temperature °C
Symbol	Name	
PVC	Normal vinyl cable	---
IV	600 V vinyl cable	60
HIV	Temperature-resistant vinyl cable	75

Note 1 Use cable with 600 V min rating for main circuits

2 Consider allowable current reduction ratio if cables are bundled in PVC or metal ducts

3 Use temperature-resistant cable under high ambient or panel temperature where normal vinyl cables rapidly deteriorate

■ Peripheral Devices

SERVOPACK Model SGDB-	Motor Model SGMB-	Power Supply Capacity*4	MCCB or Fuse Capacity*1	Main Power Inrush Current (peak value)	Recommended Line Filter*2	Magnetic Contactor
2BAD	2BA□A	36.7 kVA	150 A	325 A	FN258L-130-35	HI-65E2 (135 A)
	2BA□B					
3ZAD	3ZA□A	50.1 kVA	200 A	325 A	FN258L-180-07	HI-100E2 (180 A)
	3ZA□B					
3GAD	3GA□A	61.8 kVA	225 A	650 A	FN359P-250-99	HI-125E2 (220 A)
	3GA□B					
2BDD	2BA□D	36 7 kVA	100 A	162 A	FN258L-75-34	HI-50E (100 A)
	2BA□E					
3ZDD	3ZA□D	50.1 kVA	150 A	650 A	FN258L-100-35	HI-65E2 (135 A)
	3ZA□E					
3GDD	3GA□D	61.8 kVA	150 A	650 A	FN258L-130-35	HI-65E2 (135 A)
	3GA□E					
4EDD	4EA□D	75 2 kVA	225 A	1300 A	FN258L-180-07	HI-125E2 (220 A)
	4EA□E					
5EDD	5EA□D	91.9 kVA	225 A	1300 A	FN258L-180-07	HI-125E2 (220 A)
	5EA□E					

* 1 Braking characteristics (at 25°C) 200% for 2 s min , 700% for 0 01 s min
* 2 Manufactured by SCHAFFNER
* 3 Manufactured by Yaskawa Controls Co , Ltd
* 4 The supply voltage capacity shown is the value for a rated load

The appropriate cables for SERVOPACK connectors 1CN and 2CN are shown in the table below.

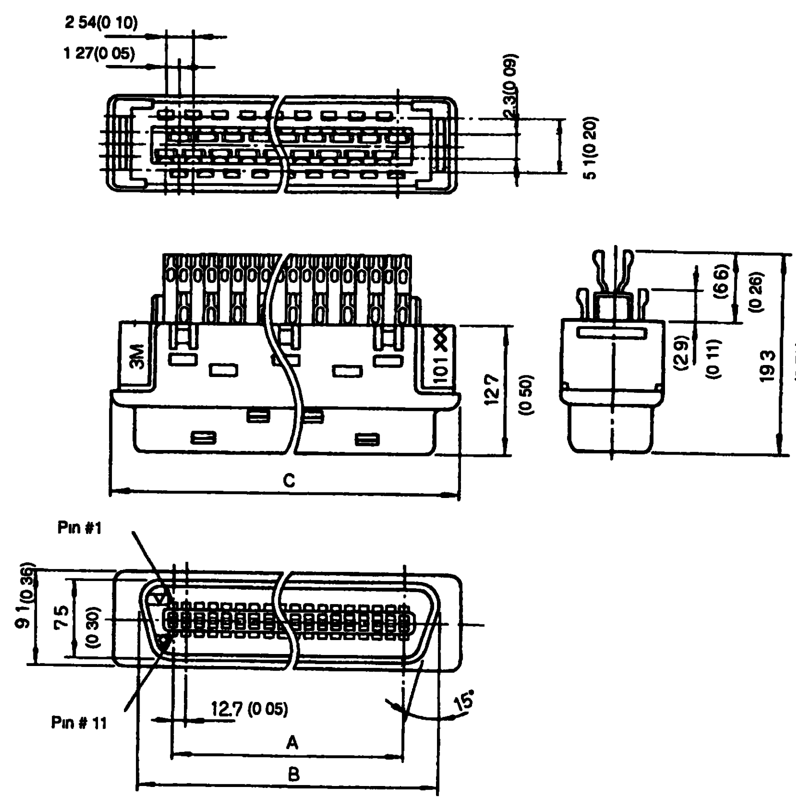
Control I/O Signal Connector	**1CN**	Cable	Use twisted-pair cable or twisted-pair shielded cable.
		Applicable Cable	AWG24,26,28,30
		Finished Cable Dimensions	⌀16.0 mm (⌀ 0.63 in.) MAX.
PG Signal Connector	**2CN**	Cable	Use Yaskawa cable. Use twisted-pair shielded cable if Yaskawa cable is not used.
		Applicable Cable	Applicable cable types: AWG24, 26, 28, 30. However, use AWG22 for encoder power supply and FG line. Use AWG26 for other signals. These connections permit wiring distances up to 20 m (65.6 ft).
		Finished Cable Dimensions	⌀11.6 mm (⌀0.46 in.) MAX.

Note. Cable selection conditions. three cables per bundle at 40 °C ambient temperature, with the rated current flowing

5.5.2 1CN Connector

This connector is required to connect the host controller to 1CN on the SERVOPACK.

- Connector



Units: mm (inches)

Connector Model	A	B	C
10150-3000VE	30.48 (1.20)	36.7 (1.44)	41.1 (1.62)

Manufactured by 3M.

- Case

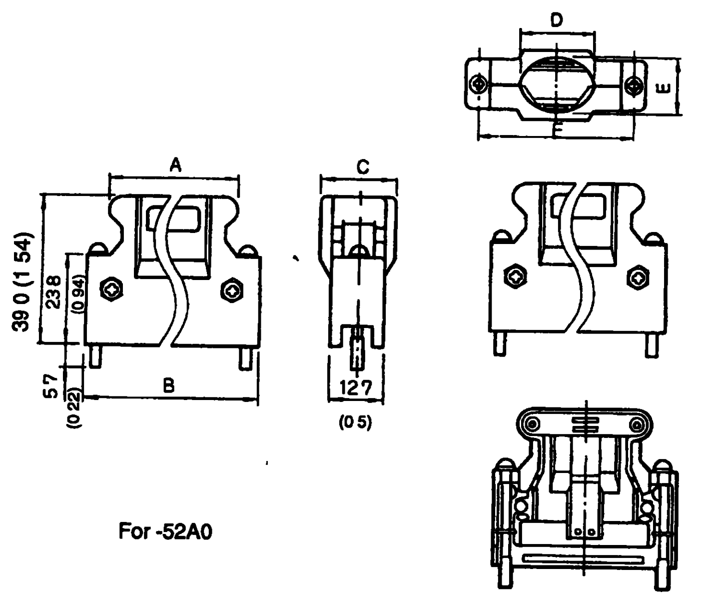


Diagram of Assembled Connector (for reference)

Units: mm (inches)

Connector Model	Case Model	A	B	C	D	E	F
10150-3000VE	10350-52A0-008	41.1 (1 62)	52.4 (2.06)	18.0 (0 71)	17.0 (0.67)	14.0 (0.55)	46.5 (1 83)

Manufactured by 3M.

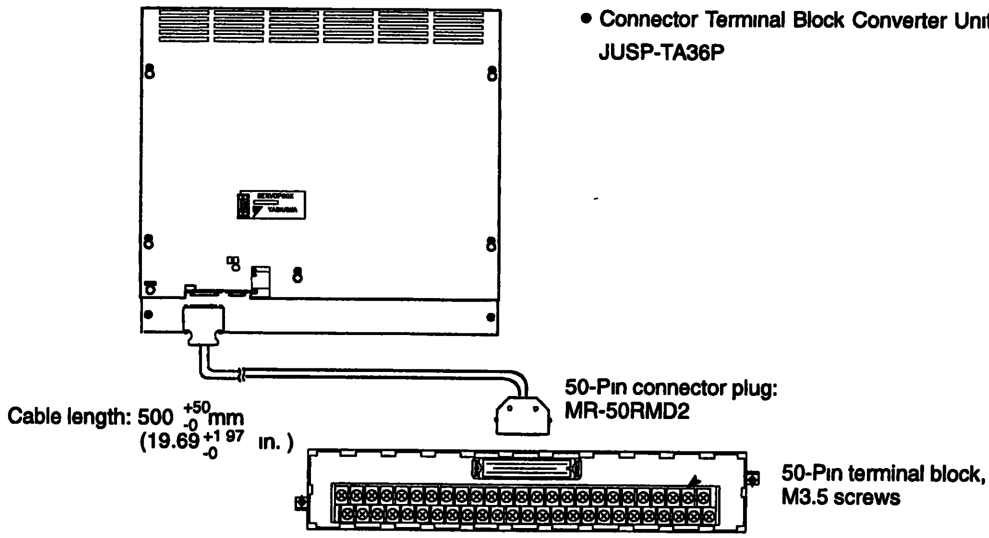
The 1CN connector model is shown below.

Connector Model	Application	Connector Part List			
		Connector		Case	
		Model	Qty	Model	Qty
DE9406970	I/O connector for 1CN	10150-3000VE*	1	10350-52A0-008*	1

* Manufactured by 3M

5.5.3 Connector Terminal Block Converter Unit

A connector terminal block converter unit comprises a 1CN connector 0.5 m (1.64 ft) cable. The terminal block numbers match the SERVOPACK 1CN connector numbers.



■ Terminal Block Pin Numbers and Signal Names

The relationships between terminal block pin numbers and signal names are shown in the table below.

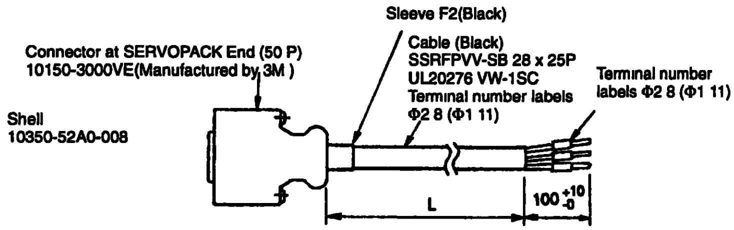
SGDB SERVOPACK Signal Name	1CN Pin No.		Terminal block unit Connector No	Terminal block No
SG	1		A1	1
SG	2	P	B1	2
PL1	3		A2	3
SEN	4		B2	4
V-REF	5	P	A3	5
SG	6		B3	6
PULS	7	P	A4	7
/PULS	8		B4	8
T-REF	9	P	A5	9
SG	10		B5	10
SIGN	11	P	A6	11
/SIGN	12		B6	12
PL2	13		A7	13
/CLR	14	P	B7	14
CLR	15		A8	15
TQR-M	16		B8	16
VTG-M	17		A9	17
PL3	18		B9	18
PCO	19	P	A10	19
/PCO	20		B10	20
BAT+	21	P	A11	21
BAT-	22		B11	22
+12 V	23		A12	23
-12 V	24		B12	24
/V-CMP+	25	P	A13	25
/V-CMP-	26		B13	26
/TGON+	27	P	A14	27
/TGON-	28		B14	28
/S-RDY+	29	P	A15	29
/S-RDY-	30		B15	30
ALM+	31	P	A16	31
ALM-	32		B16	32
PAO	33	P	A17	33
/PAO	34		B17	34
PBO	35	P	A18	35
/PBO	36		B18	36
ALO1	37		A19	37
ALO2	38		B19	38
ALO3	39		A20	39
/S-ON	40		B20	40
/P-CON	41		A21	41
P-OT	42		B21	42
N-OT	43		A22	43
/ALM-RST	44		B22	44
/P-CL	45		A23	45
/N-CL	46		B23	46
+24 V IN	47		A24	47
PSO	48	P	B24	48
/PSO	49		A25	49
FG	50		B25	50
Connector Case				

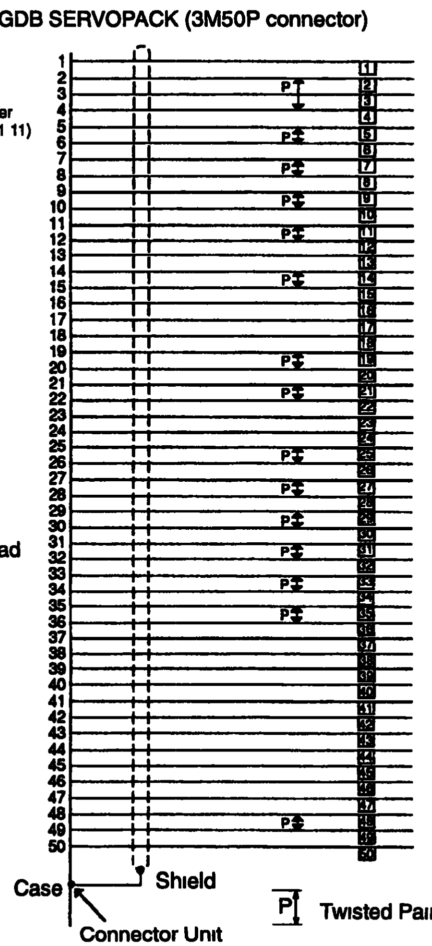
Cable: Supplied with terminal block

↕P : Twisted pair

5.5.4 Cable With 1CN Connector and One End Without Connector

Use a cable with no connector at the host controller end. The loose wires are marked with labels with terminal numbers indicated.



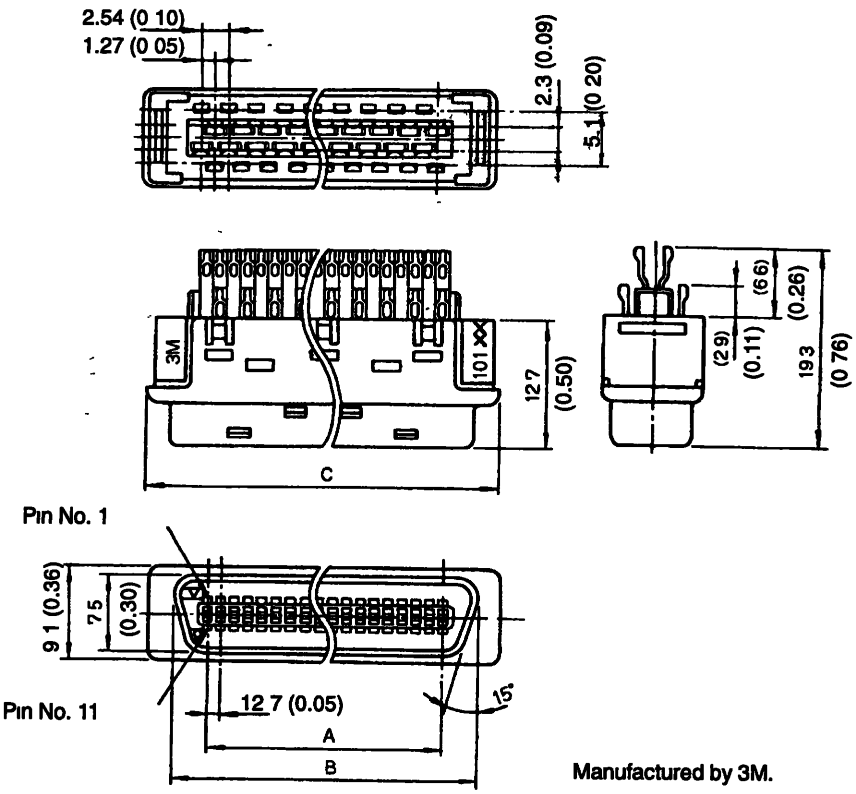


Model	L in mm (feet)
DE9406969-1	1000^{+30}_{0} $(3.33^{+0.1}_{0})$
DE9406969-2	2000^{+50}_{0} $(6.67^{+0.17}_{0})$
DE9406969-3	3000^{+50}_{0} $(10^{+0.17}_{0})$

5.5.5 2CN Encoder Connector on SERVOPACK End

Only one type of 2CN encoder connector is available for the SERVOPACK end of the cable, as shown in the following diagram.

- Connector

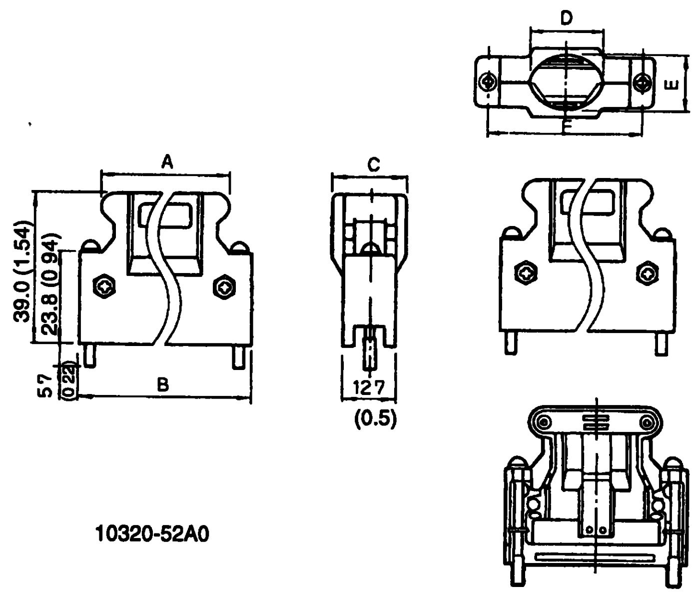


Manufactured by 3M.

Units: mm (inches)

Connector Model	A	B	C
10120-3000VE	11.43 (0.45)	17.6 (0.69)	22.0 (0.87)

• Case



10320-52A0

Assembled Connector

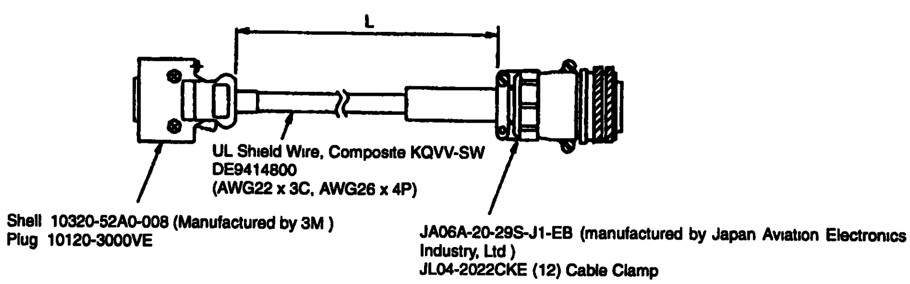
Units: mm (inches)

Connector Model	Case Model	A	B	C	A	B	C
DE9406973	10320-52A0-008	22.0 (0.87)	33.3 (1.31)	14.0 (0.55)	12.0 (0.47)	10.0 (0.39)	27.4 (1.08)

5.5.6 Encoder Cables

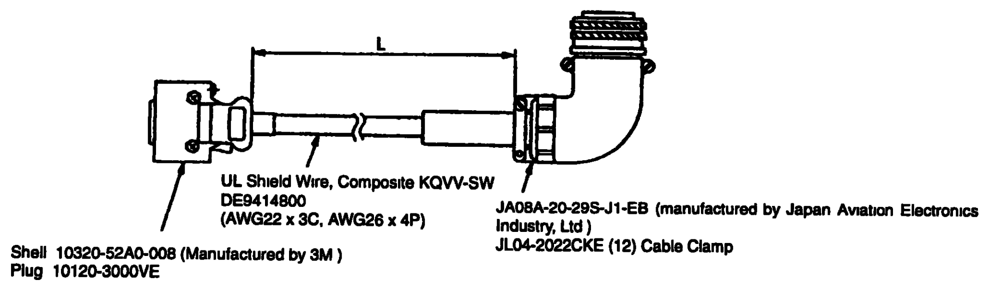
The dimensions and appearance of the encoder cables are shown below. Specify the cable type when ordering.

■ Cables for Incremental Encoder (with Straight Plug)



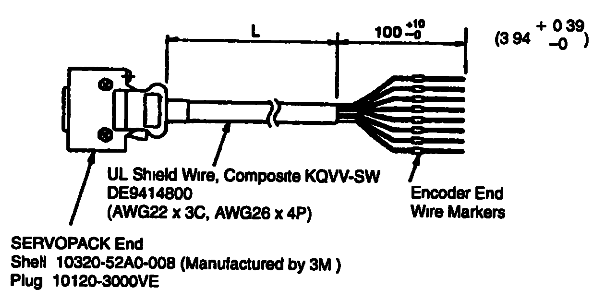
Model	L in mm (feet)
JZSP-VBP01-03	3000^{+100}_{0} $(10^{+0.33}_{0})$
JZSP-VBP01-05	5000^{+100}_{0} $(16.7^{+0.33}_{0})$
JZSP-VBP01-10	10000^{+500}_{0} $(33.3^{+1.67}_{0})$
JZSP-VBP01-15	15000^{+500}_{0} $(50^{+1.67}_{0})$
JZSP-VBP01-20	20000^{+500}_{0} $(66.7^{+1.67}_{0})$

■ Cables for Incremental Encoder (with L-shaped Plug)

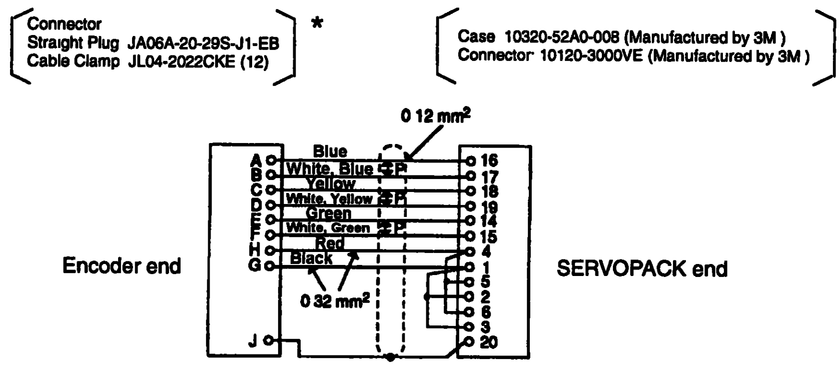


Model	L in mm (feet)
JZSP-VBP02-03	3000^{+100}_{0} $(10^{+0.33}_{0})$
JZSP-VBP02-05	5000^{+100}_{0} $(16.7^{+0.33}_{0})$
JZSP-VBP02-10	10000^{+500}_{0} $(33.3^{+1.67}_{0})$
JZSP-VBP02-15	15000^{+500}_{0} $(50^{+1.67}_{0})$
JZSP-VBP02-20	20000^{+500}_{0} $(66.7^{+1.67}_{0})$

■ Cables for Incremental Encoder (without Connector on Encoder End)



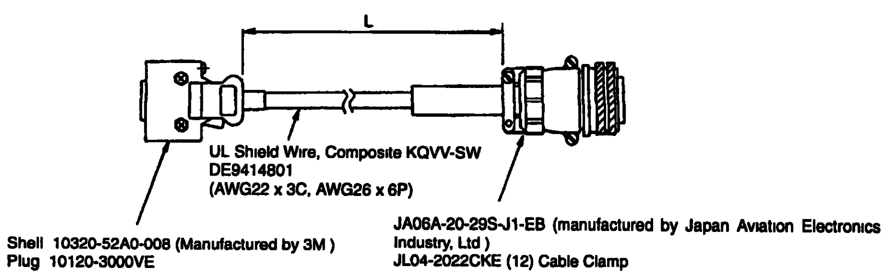
Model	L in mm (feet)
JZSP-VBP00-03	3000^{+100}_{0} $(10^{+0.33}_{0})$
JZSP-VBP00-05	5000^{+100}_{0} $(16.7^{+0.33}_{0})$
JZSP-VBP00-10	10000^{+500}_{0} $(33.3^{+1.67}_{0})$
JZSP-VBP00-15	15000^{+500}_{0} $(50^{+1.67}_{0})$
JZSP-VBP00-20	20000^{+500}_{0} $(66.7^{+1.67}_{0})$



P twisted-pair shielded cables.

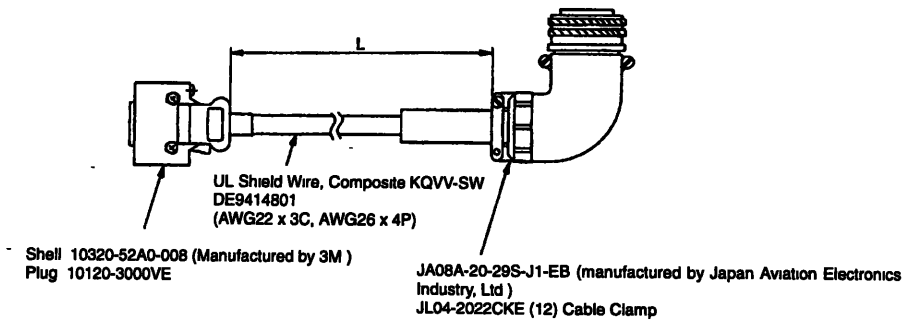
* Purchase cases and connectors separately.

■ Cables for Absolute Encoder (with Straight Plug)



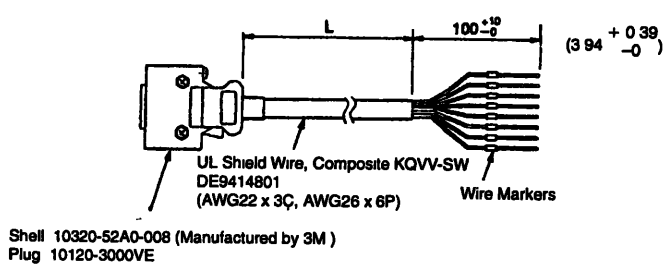
Model	L in mm (feet)
JZSP-VBP11-03	3000^{+100}_{0} $(10^{+0.33}_{0})$
JZSP-VBP11-05	5000^{+100}_{0} $(16.7^{+0.33}_{0})$
JZSP-VBP11-10	10000^{+500}_{0} $(33.3^{+1.67}_{0})$
JZSP-VBP11-15	15000^{+500}_{0} $(50^{+1.67}_{0})$
JZSP-VBP11-20	20000^{+500}_{0} $(66.7^{+1.67}_{0})$

■ Cables for Absolute Encoder (with L-shaped Plug)

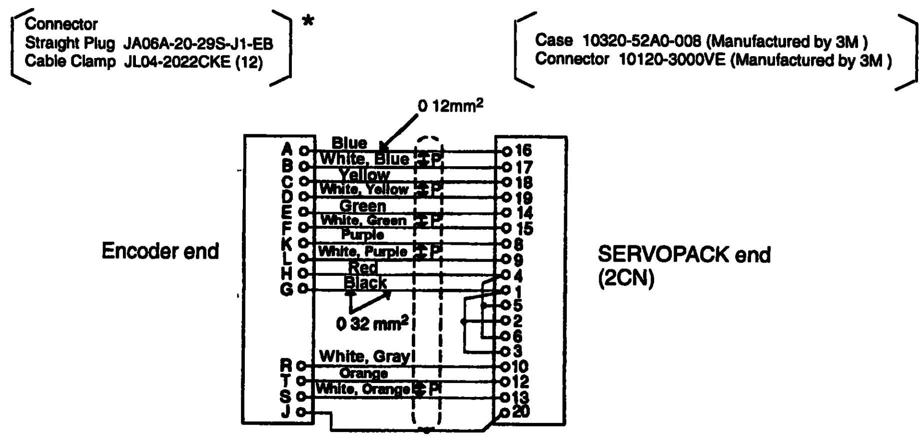


Model	L in mm (feet)
JZSP-VBP12-03	3000^{+100}_{0} $(10^{+0.33}_{0})$
JZSP-VBP12-05	5000^{+100}_{0} $(16.7^{+0.33}_{0})$
JZSP-VBP12-10	10000^{+500}_{0} $(33.3^{+1.67}_{0})$
JZSP-VBP12-15	15000^{+500}_{0} $(50^{+1.67}_{0})$
JZSP-VBP12-20	20000^{+500}_{0} $(66.7^{+1.67}_{0})$

■ Cables for Absolute Encoder (without Connector on Encoder End)



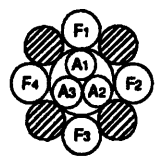
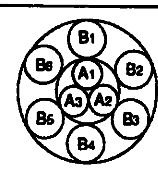
Model	L in mm (feet)
JZSP-VBP10-03	3000^{+100}_{0} $(10^{+0.33}_{0})$
JZSP-VBP10-05	5000^{+100}_{0} $(16.7^{+0.33}_{0})$
JZSP-VBP10-10	10000^{+500}_{0} $(33.3^{+1.67}_{0})$
JZSP-VBP10-15	15000^{+500}_{0} $(50^{+1.67}_{0})$
JZSP-VBP10-20	20000^{+500}_{0} $(66.7^{+1.67}_{0})$



P: twisted-pair shielded cables.

* Purchase cases and connectors separately

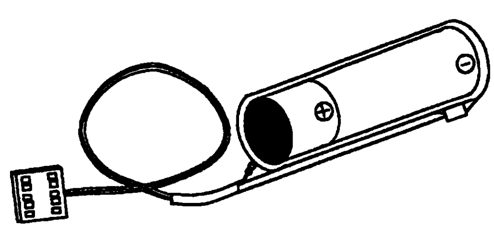
Details of the encoder cables are summarized in the table below.
These cables are not supplied as accessories with a SERVOPACK or servomotor.
Purchase in standard specified lengths as required.

Cable Specification	Incremental Encoder (Yaskawa Drg. DE9414800)	Absolute Encoder (Yaskawa Drg. DE9414801)
Basic Specifications	Compound KQVV-SW AWG22 x 3C, AWG26 x 4P	Compound KQVV-SW AWG22 x 3C, AWG26 x 6P
Finished Dimension	Ø9.9 mm (Ø0.30)	Ø10.7 mm (Ø0.31)
Internal Structure and Lead Colors	 A_1 Red A_2 Black A_3 Green/Yellow F_1 Blue - White/Blue (Twisted pair) F_2 Yellow - White/Yellow (Twisted Pair) F_3 Green - White/Green (Twisted Pair) F_4 Orange - White/Orange (Twisted Pair)	 A_1 Red A_2 Black A_3 Green/Yellow B_1 Blue - White/Blue (Twisted pair) B_2 Yellow - White/Yellow (Twisted Pair) B_3 Green - White/Green (Twisted Pair) B_4 Orange - White/Orange (Twisted Pair) B_5 Purple - White/Purple (Twisted Pair) B_6 Grey - White/Grey (Twisted Pair)
Yaskawa standard specifications	Standard lengths: 3 m (9.8) , 5 m (16 4) , 10 m (32.8), 15 m (49 2), 20 m (65.6) *	

* When the appropriate cable is used, the allowable wiring distance between the SERVOPACK and servomotor (PG) is 20 m (65 6) max

5.5.7 Battery for Absolute Encoder

Purchase the following battery if using an absolute encoder. (Manufactured by Toshiba Battery Co., Ltd.)

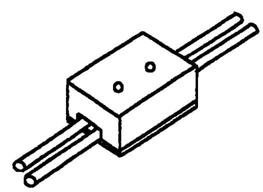


- Lithium Battery: ER 6 V C3
- Nominal Voltage: 3.6 V
- Standard Capacity: 2000 mAh

5.5.8 Brake Power Supply

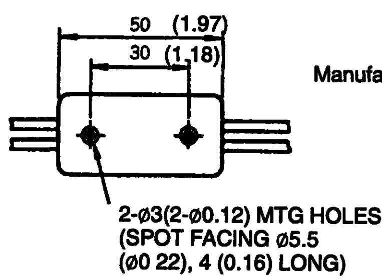
Brake power supplies are available for 200 V and 100 V input.

200 VAC Input: LPSE-2H01
100 VAC Input: LPDE-1H01

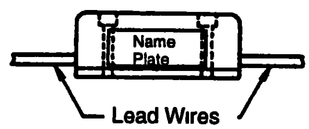


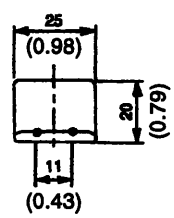
Use for servomotor with brake.

- Dimensional Drawings



Manufactured by Yaskawa Controls Co , Ltd.





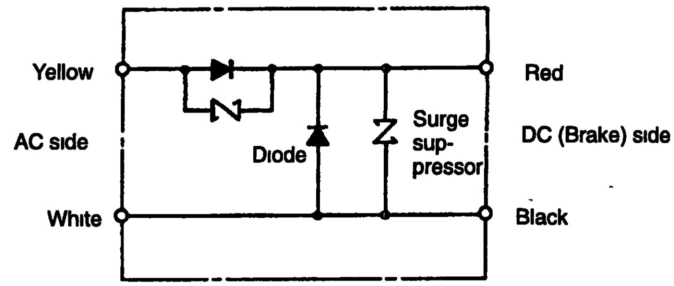
- Lead Wire Length: 500 mm each (19.69 in.)
- Max. Ambient Temperature: 60°C
- Lead Wires: Color Code

AC Input		Brake
100V	200V	
Blue/White	Yellow/White	Red/Black

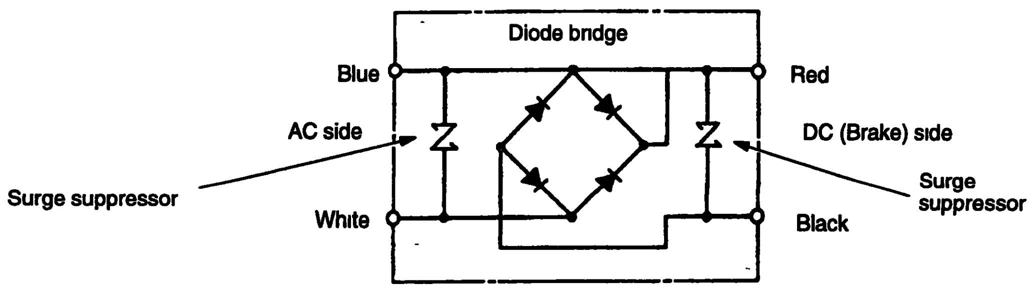
IMPORTANT

The internal circuits are shown below. While it is possible to switch either the AC or DC side of the brake power supply, it is normally safer to switch the AC side. If the DC side is to be switched, install a surge suppressor near the brake coil to prevent the surge voltages due to switching the DC side damaging the brake coil. Brake operation time delay occurs during brake power supply ON/OFF operation. Set output timing of servo OFF operation (motor output stop), referring to *3.4.4 Using Holding Brake*.
Especially, if the AC side of the brake power supply is to be switched, brake operation time is extended.

- Internal Circuit for 200 VAC Input (LPSE-2H01)

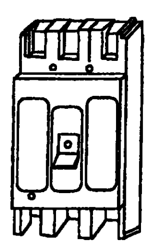


- Internal Circuit for 100 VAC Input (LPDE-1H01)



5.5.9 Circuit Breaker

The customer should purchase a circuit breaker (MCCB) of appropriate capacity.



- Recommended Product

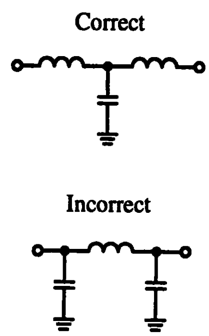
  Ground fault detector for motor protection manufactured by Mitsubishi Electric Co. Ltd.
  Model: MN50-CF

Use to protect the power lines.

SERVOPACK Model	Power Supply Capacity per SERVOPACK (kVA)	Power Supply Capacity per MCCB or Fuse (A)
SGDB-2BAD	36.7	150
SGDB-3ZAD	50.1	200
SGDB-3GAD	61.8	225
SGDB-2BDD	36 7	100
SGDB-3ZDD	50 1	150
SGDB-3GDD	61.8	150
SGDB-4EDD	75.2	225
SGDB-5EDD	91 9	225

5.5.10 Noise Filter

Select the noise filter from the following list according to the SERVOPACK capacity. *Section 5.5.1 Cable Specifications and Peripheral Devices* provides a summary list showing the relationship between SERVOPACK capacity and noise filter model.

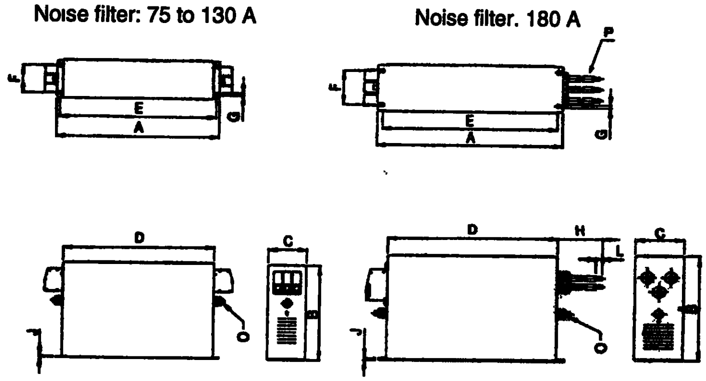
SERVOPACK Model	Noise Filter Reference Diagram	Recommended Noise Filter*
SGDB-2BAD		FN258L-130-35
SGDB-3ZAD		FN258L-180-07
SGDB-3GAD		FN359P-250-99
SGDB-2BDD		FN258L-75-34
SGDB-3ZDD		FN258L-100-35
SGDB-3GDD		FN258L-130-35
SGDB-4EDD		FN258L-180-07
SGDB-5EDD		FN258L-180-07

* Manufactured by SCHAFFNER

- Dimensional Diagrams
  - FN258L

Noise filter: 75 to 130 A

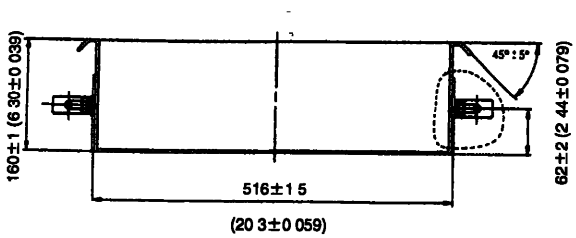
Noise filter. 180 A

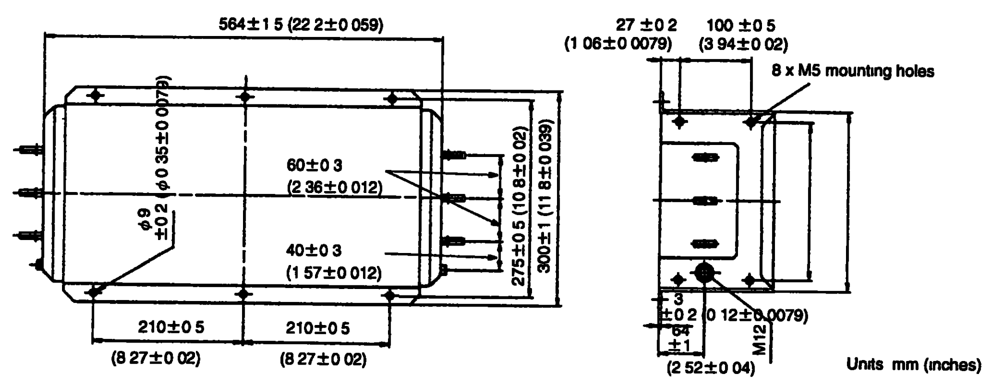


Units: mm (inches)

Noise Filter Model	A	B	C	D	E	F	G	H	J	L	O	P
FN258L-75-34	329 (13.0)	220 (8 66)	80 (3.15)	300 (11.8)	314 (12.36)	55 (2.17)	6.5 (0.26)	–	1.5 (0.059)	–	M6	–
FN258L-100-35	379±1.5 (14.91± 0.059)	220 (8.66)	90±0.8 (3.54± 0.031)	350±1.2 (13.8± 0.047	364 (14.3)	65 (2.56)	6.5 (0.26)	–	1.5 (0.059)	–	M10	–
FN258L-130-35	439±1.5 (17.26± 0.059)	240 (9.44)	110±0.8 (4.33± 0.031)	400±1.2 (15.7± 0.047)	414 (16.3)	80 (3.15)	6.5 (0.26)	–	3 (0.12)	–	M10	–
FN258L-180-07	438±1.5 (17.23± 0 059)	240 (9.44)	110±0.8 (4.33± 0.031)	400±1.2 (15.7± 0.047)	413 (16.3)	80 (3.15)	6.5 (0.26)	500 (19.7)	4 (0.16)	15 (0.59)	M10	50 (mm²)

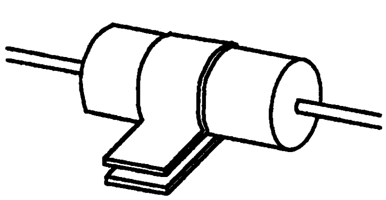
- FN359





5.5.11 Surge Suppressor

Attach a surge suppressor to the magnetic contactor to prevent power supply noise and protect contacts.



- **Recommended Product**

  Spark Killer manufactured by Okaya Electric Industries Co., Ltd.
  Model: CR50500BA (250 VAC)
  Capacitance: 0.5 μF ± 20%
  Resistance· 50 Ω (1/2 W) ±30%

5.5.12 Regenerative Resistor Unit

Externally attach a regenerative resistor to the SERVOPACK. This resistor is used for dissipating regenerative energy.

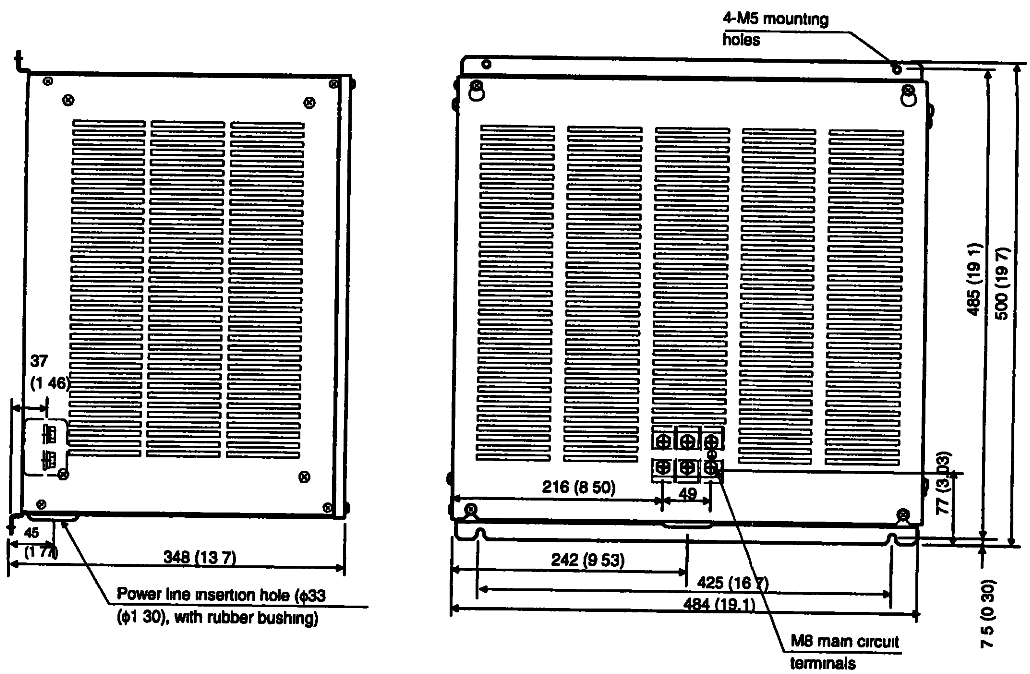
■ Specifications

Use one of the following Regenerative Resistor Units according to the SERVOPACK model:

SGDB SERVO-PACK Model	2BAD	3ZAD	3GAD	2BDD	3ZDD	3GDD	4EDD	5EDD
Regenerative Resistor Unit	JUSP-RA08	JUSP-RA09	JUSP-RA11	JUSP-RA12	JUSP-RA13	JUSP-RA14	JUSP-RA15	JUSP-RA16
Resistance	2.4 Ω	1.8 Ω	1.6 Ω	9 Ω	6.7 Ω	5 Ω	4 Ω	3.8 Ω
Resistance Capacity	2400 W	4800 W	4800 W	3600 W	3600 W	4800 W	6000 W	7200 W
Allowable Load Moment of Inertia	5 times the load moment of inertia at motor shaft.							
Allowable Duty	2% ED at maximum speed and torque deceleration.							

■ Dimensional Drawings

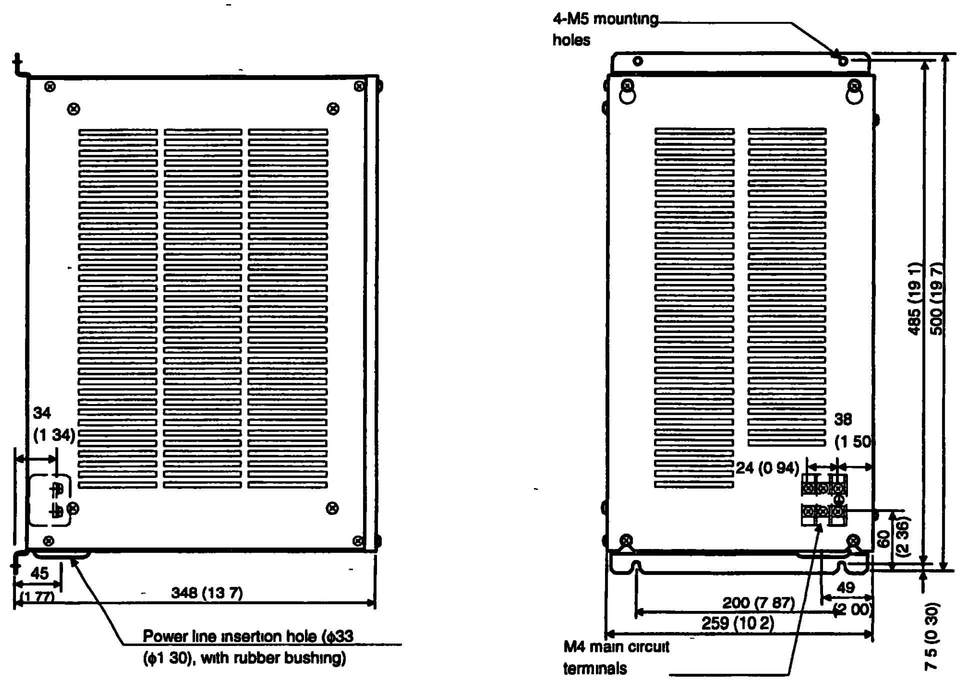
- JUSP-RA11 Regenerative Resistor Unit



Units: mm (inches)

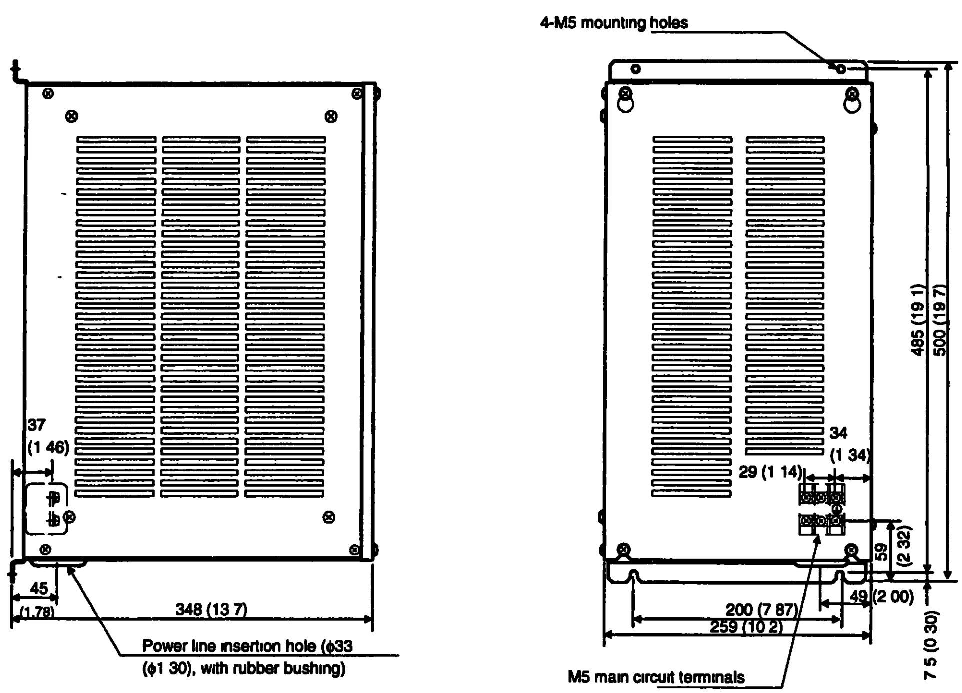
5 5.12 Regenerative Resistor Unit

- JUSP-RA12 Regenerative Resistor Unit



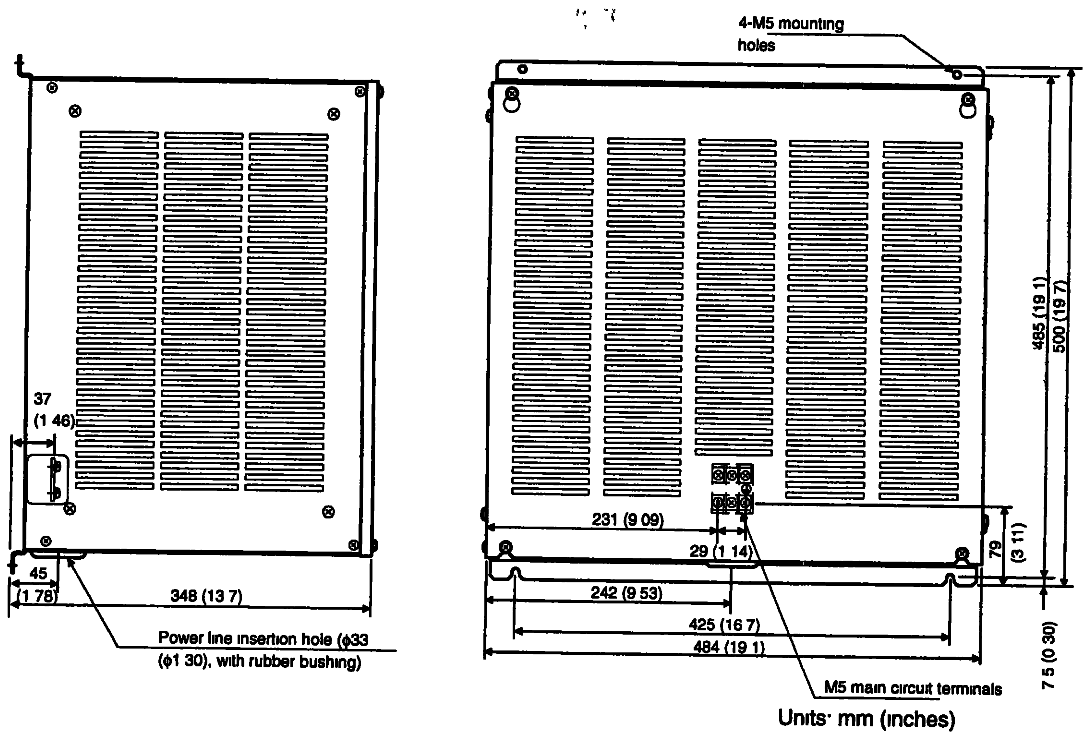
Units: mm (inches)

- JUSP-RA13 Regenerative Resistor Unit

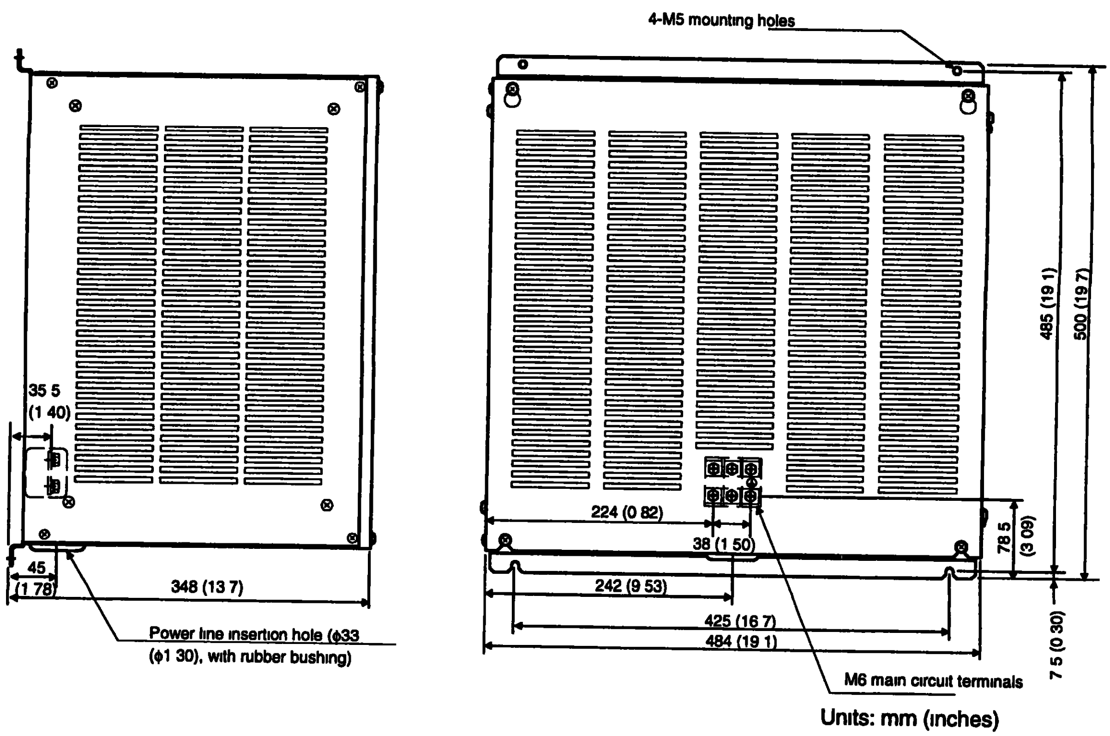


Units: mm (inches)

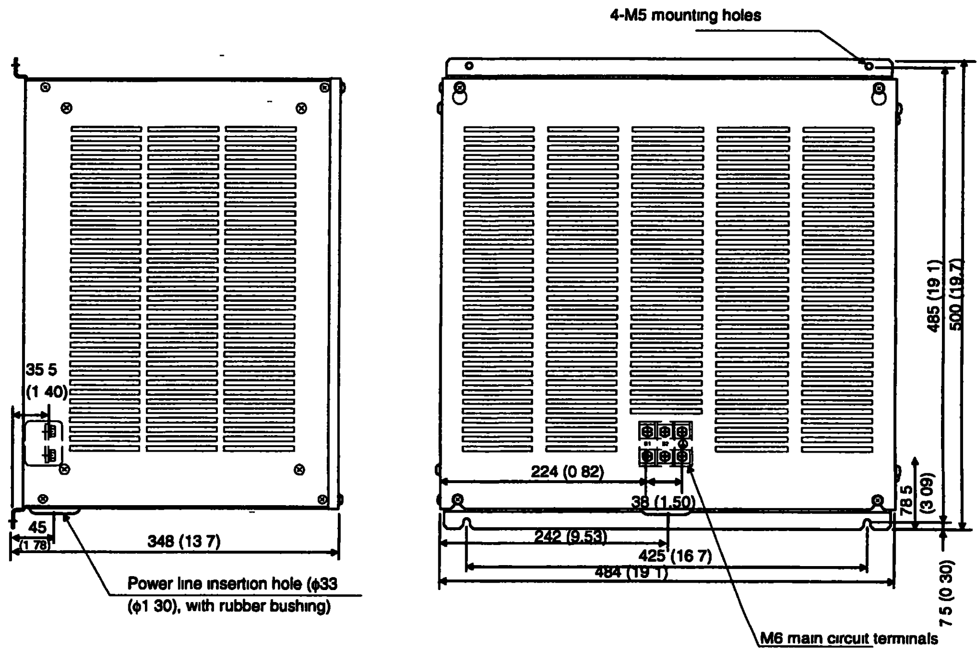
- JUSP-RA14 Regenerative Resistor Unit



- JUSP-RA15 Regenerative Resistor Unit



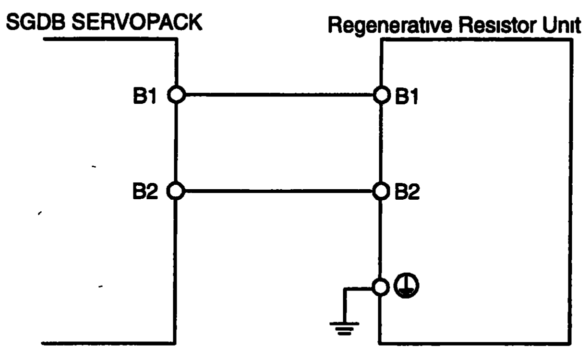
- JUSP-RA16 Regenerative Resistor Unit



Units: mm (inches)

Connections

Connect the Regenerative Resistor Unit to the SERVOPACK as shown in the following diagram.



5.5.13 Dynamic Brake (DB) Unit

Externally attach a dynamic brake resistor to the SERVOPACK to dissipate regenerative energy when using the dynamic brake function. The dynamic brake resistor does not need to be installed if the dynamic brake function is not required.

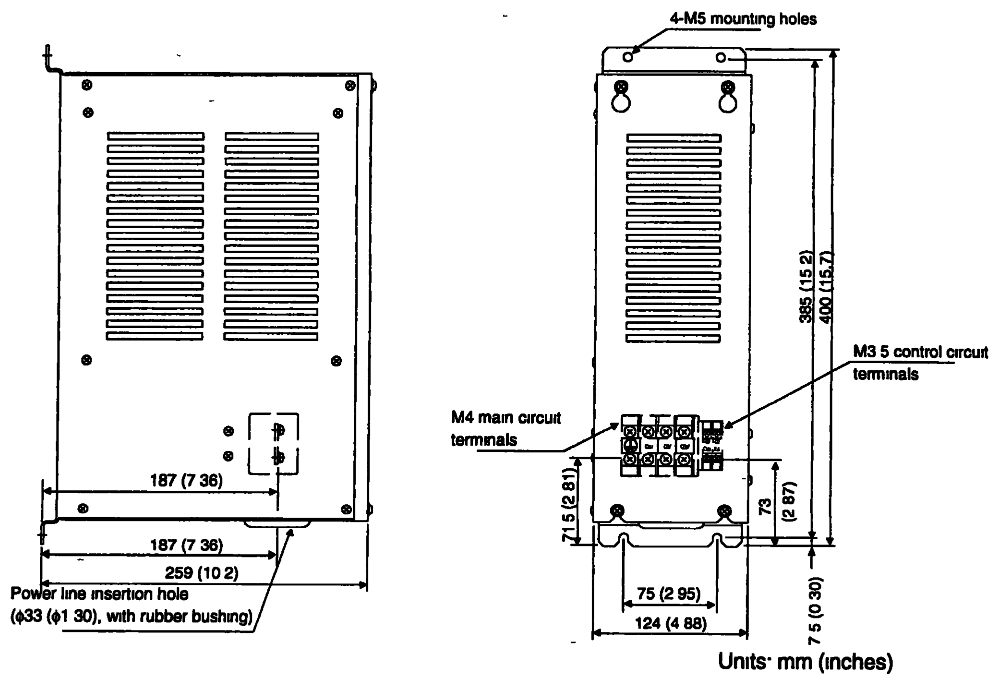
■ Specifications

Select one of the following Dynamic Brake Units according to the SERVOPACK being used.

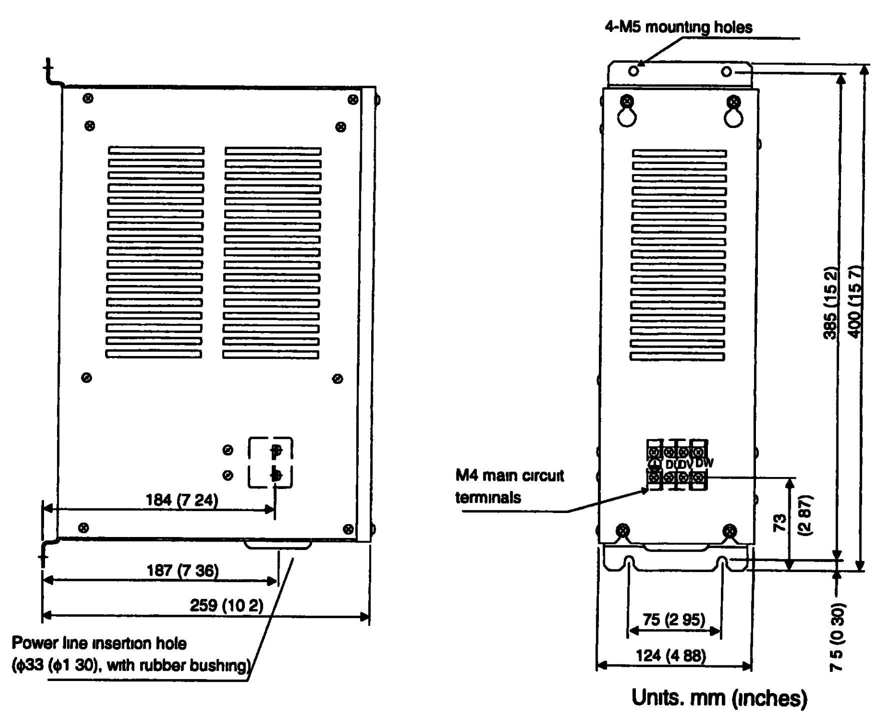
Dynamic Brake (DB) Unit Model	SGDB SERVO-PACK Model	Resistance Specifications	DB Contactor and Surge Absorption Unit
JUSP-DB01	2BAD, 3ZAD	180 W 0.3 Ω	Built into SERVO-PACK
JUSP-DB02	3GAD	180 W 0.3 Ω	Built into Dynamic Brake Unit
JUSP-DB03	2BDD, 3ZDD	180 W 0.8 Ω	Built into SERVO-PACK
JUSP-DB04	3GDD	180 W 0.8 Ω	Built into Dynamic Brake Unit
JUSP-DB05	4EDD	180 W 0.8 Ω	Built into Dynamic Brake Unit
JUSP-DB06	5EDD	300 W 0.8 Ω	Built into Dynamic Brake Unit

■ Dimensional Drawings

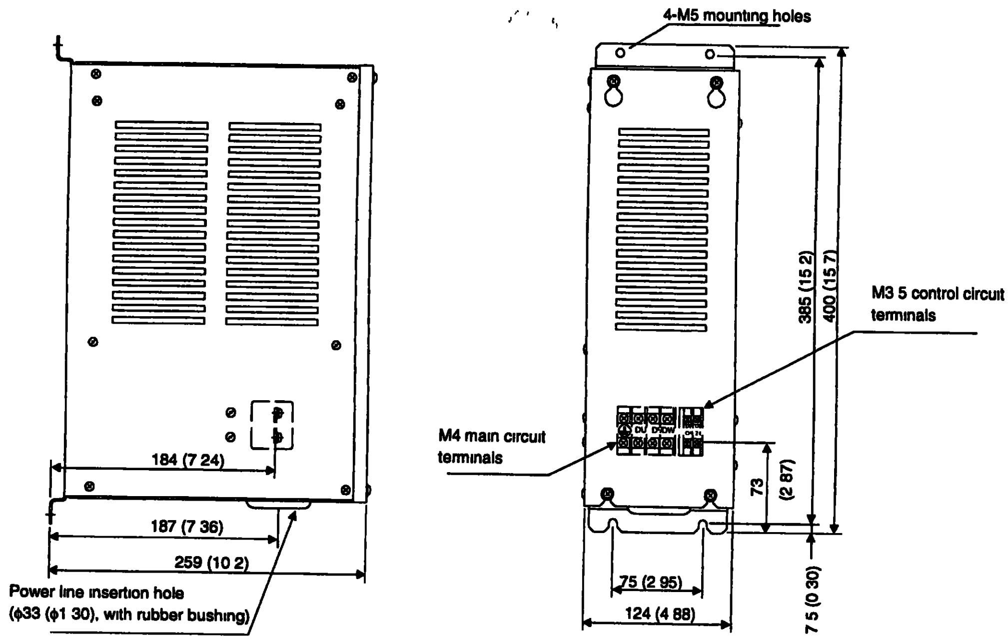
- JUSP-DB02 Dynamic Brake Unit



- JUSP-DB03 Dynamic Brake Unit

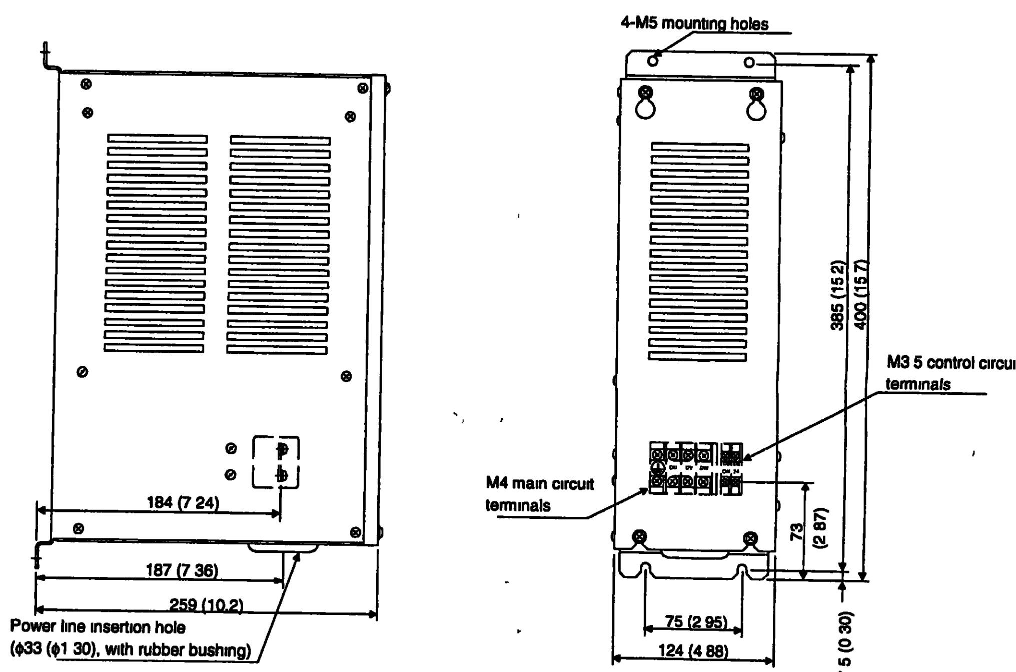


- JUSP-DB04 Dynamic Brake Unit



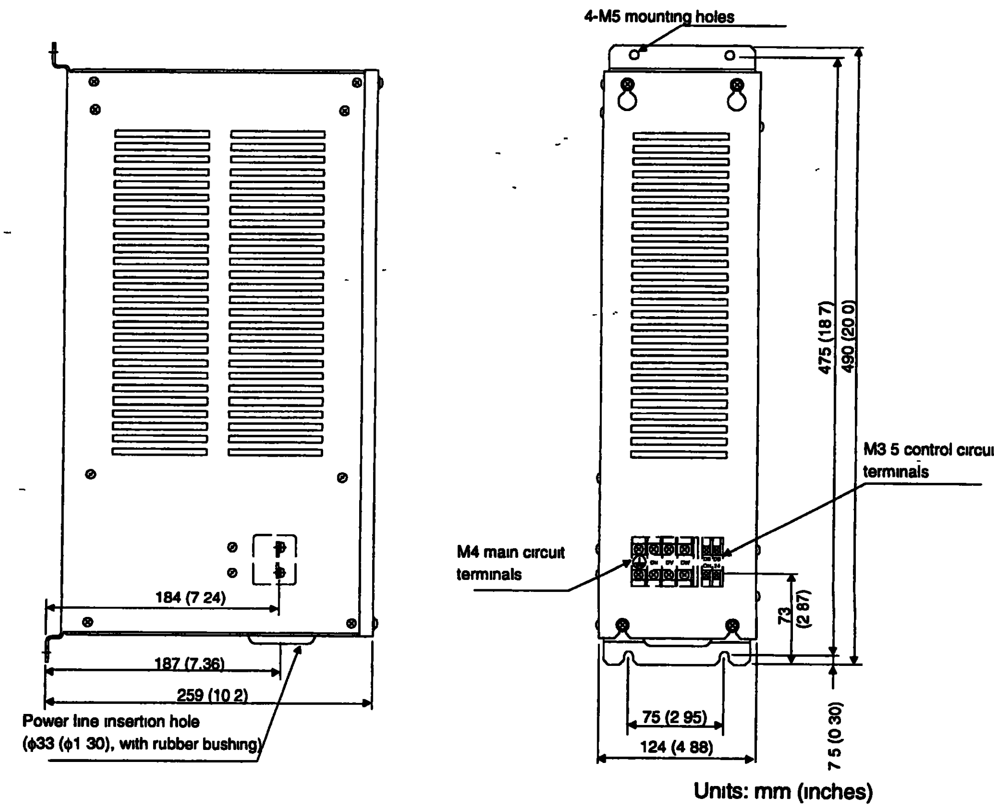
Units: mm (inches)

- JUSP-DB05 Dynamic Brake Unit



Units: mm (inches)

- JUSP-DB06 Dynamic Brake Unit

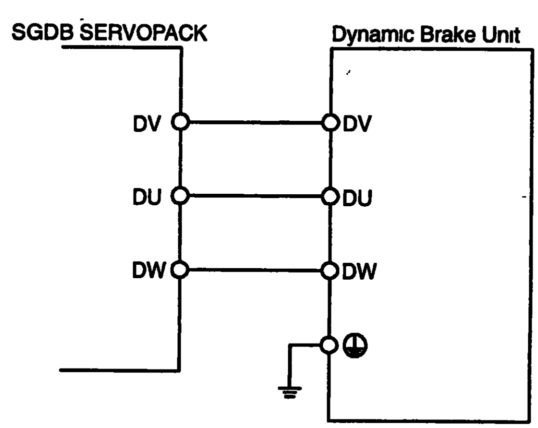


■ Connections

Using a Yaskawa Dynamic Brake Unit

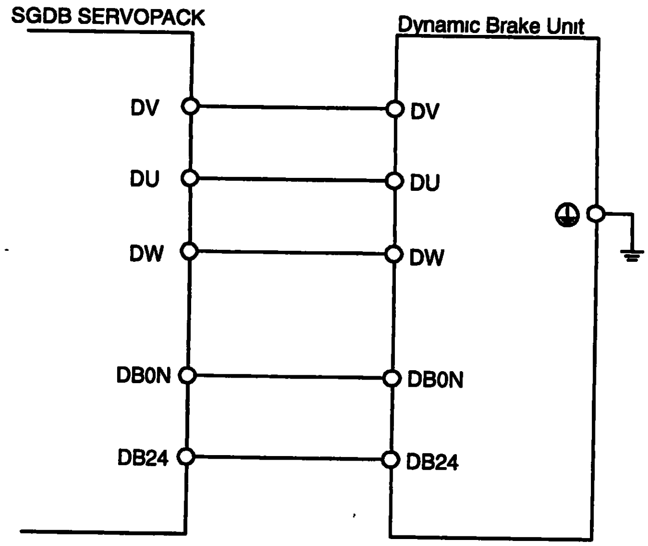
- SGDB-2BAD, 3ZAD, 2BDD, and 3ZDD SERVOPACKs

The dynamic brake contactor and Surge Absorption Unit are built into the SERVOPACK. Connect the DU, DV, and DW terminals and the Frame Ground on the Dynamic Brake Unit, as shown in the following diagram.



- SGDB-3GAD, 3GDD, 4EDD, and 5EDD SERVOPACKs

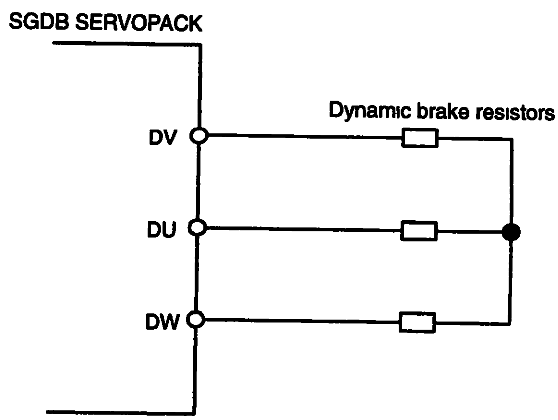
The dynamic brake contactor and Surge Absorption Unit are built into the Dynamic Brake Unit. Connect the DU, DV, and DW terminals and the Frame Ground on the Dynamic Brake Unit, and also connect the terminals DBON and DB24 for dynamic brake contactor control, as shown in the following diagram.



Using Dynamic Brake Units Prepared by the Customer

- SGDB-2BAD, 3ZAD, 2BDD, and 3ZDD SERVOPACKs

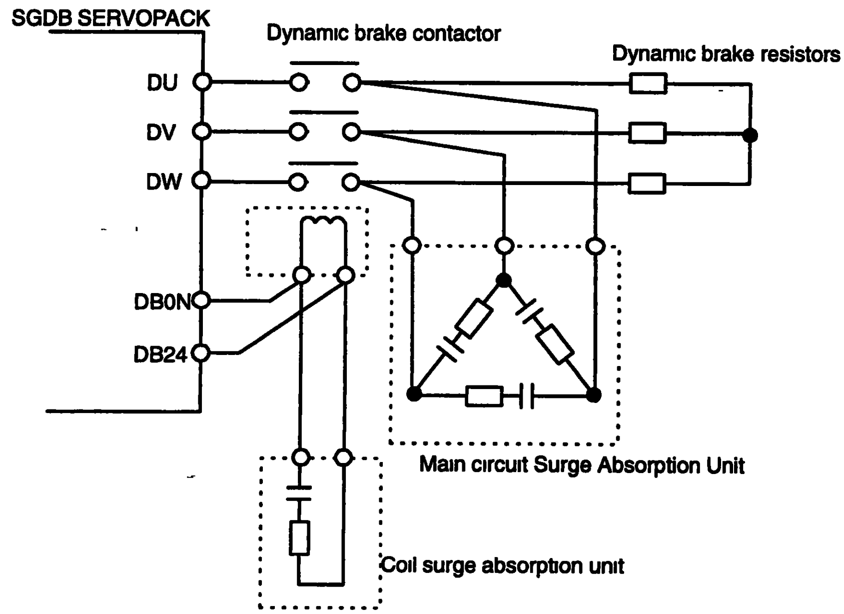
The dynamic brake contactor and Surge Absorption Unit are built into the SERVOPACK. Connect the dynamic brake resistors only, as shown in the following diagram.



Note Connect dynamic brake resistors with the following resistance specifications.
200-V SERVOPACKs: Higher than 0.3 Ω, 180 W
400-V SERVOPACKs: Higher than 0.8 Ω, 180 W

- SGDB-3GAD, 3GDD, 4EDD, and 5EDD SERVOPACKs

Connect a dynamic brake contactor and Surge Absorption Unit, as shown in the following diagram.



Note: Connect dynamic brake resistors with the following resistance specifications.
200-V SERVOPACKs: Higher than 0.3 Ω, 180 W
400-V SERVOPACKs: Higher than 0.8 Ω, 180 W (37 kW, 45 kW)
Higher than 0.8 Ω, 300 W (55 kW)

Use the following dynamic brake contactor and Surge Absorption Unit. The main circuit Surge Absorption Unit is available as a side-connection type or a front-connection type.

Name		Model	Manufacturer
Contactor		SC-4-1/G 24-VDC coil	Fuji Electric Co., Ltd.
Main Circuit Surge Absorption Unit	Front Connection	SZ-ZM1	
	Side Connection	SZ-ZM2	
Coil Surge Absorption Unit		SZ-Z4	

5.5.14 Thermal Relays

Connect a thermal relay to the SERVOPACK to protect the regenerative resistor and dynamic brake resistor from heat damage when operating under extreme conditions.

■ Recommended Thermal Relay Models

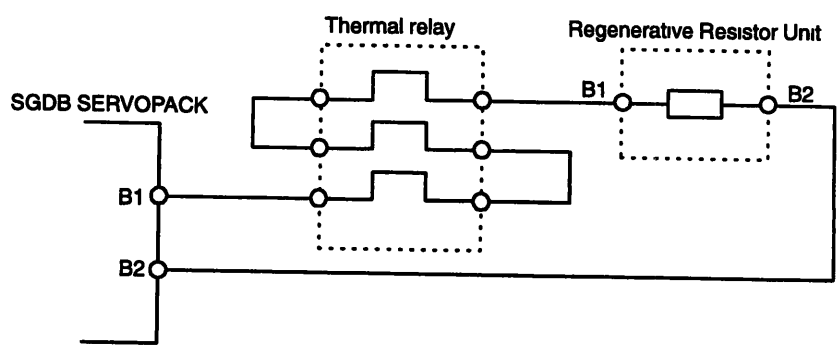
Select the appropriate thermal relay from the following list when using Yaskawa Regenerative Resistor Units and Dynamic Brake Units.

Dynamic Brake (DB) Unit and Regenerative Resistor Unit Model	Thermal Relay Model	Thermal Relay Current Range	Thermal Relay Current	Manufacturer
JUSP-DB01 JUSP-DB02	TR-3N/3 9 A	9 to 13 A	10 A	Fuji Electric Co., Ltd.
JUSP-DB03 JUSP-DB04 JUSP-DB05	TR-3N/3 7 A	7 to 11 A	7 A	
JUSP-DB06	TR-3N/3 7 A	7 to 11 A	9 A	
JUSP-RA08	TR-3N/3 12 A	12 to 18 A	14 A	
JUSP-RA09	TR-3N/3 18 A	18 to 26 A	23 A	
JUSP-RA11	TR-3N/3 18 A	18 to 26 A	24 A	
JUSP-RA12	TR-3N/3 7 A	7 to 11 A	9 A	
JUSP-RA13	TR-3N/3 9 A	9 to 13 A	10 A	
JUSP-RA14	TR-3N/3 12 A	12 to 18 A	14 A	
JUSP-RA15	TR-3N/3 12 A	12 to 18 A	17 A	
JUSP-RA16	TR-3N/3 18 A	18 to 26 A	19 A	

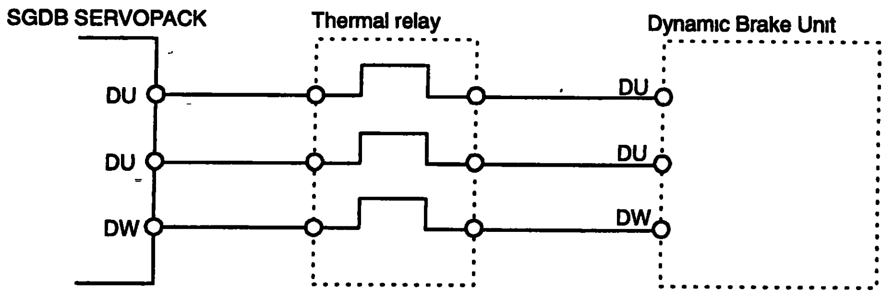
■ Connections

Connect the thermal relay as shown in the following diagram.

- Connecting to a Regenerative Resistor Unit



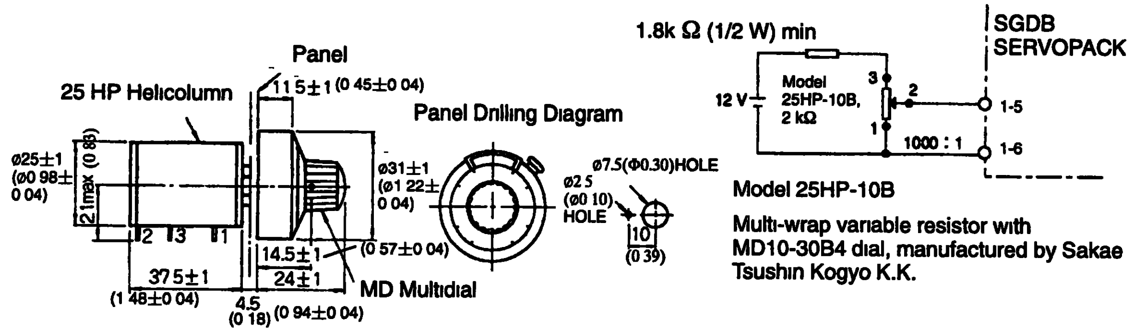
- Connecting to a Dynamic Brake Unit



5.5.15 Variable Resistor for Speed Setting

This variable resistor is used to give speed references by applying the speed reference voltage from an external power supply across 1CN pins #5 and #6.

Dimensional Drawings

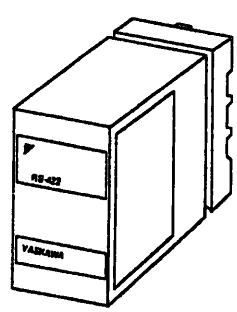


Model 25HP-10B

Multi-wrap variable resistor with MD10-30B4 dial, manufactured by Sakae Tsushin Kogyo K.K.

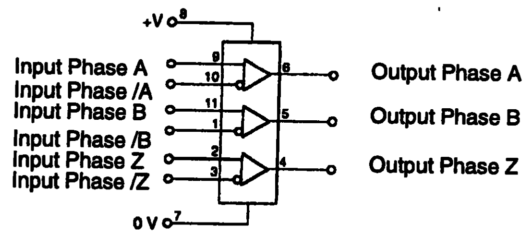
5.5.16 Encoder Signal Converter Unit

Unit to convert the encoder signal output from the line driver to an open collector output or voltage pulse output.

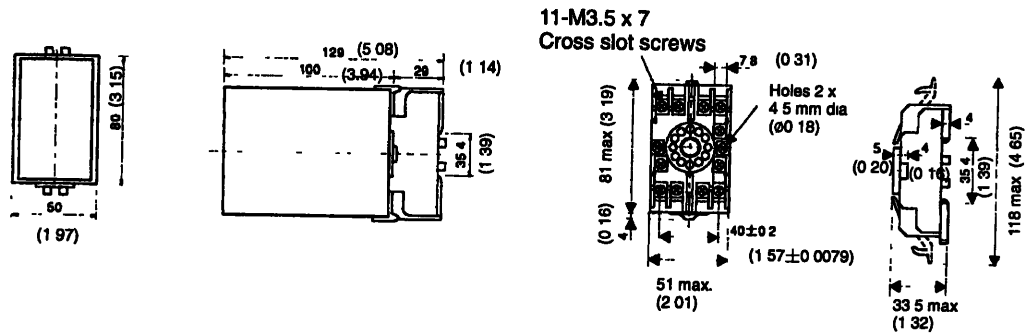


Line Receiver Unit

■ Terminal Numbers



■ Dimensional Drawings



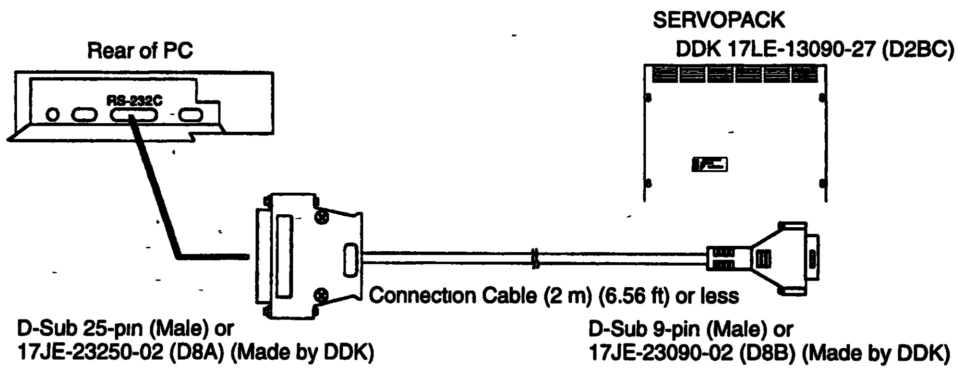
■ Specifications

The encoder signal converter unit specifications are as follows:

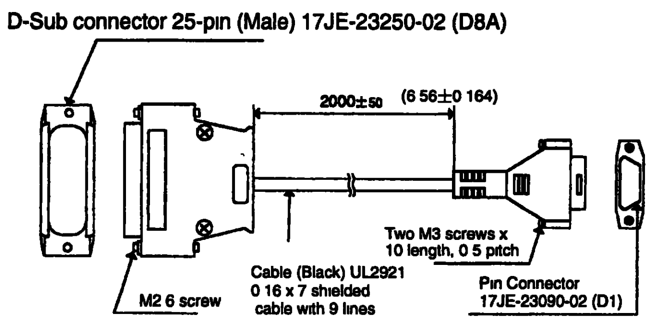
Model	Receiver Unit			
Spec.	LRX-01/A1	LRX-01/A2	LRX-01/A3	LRX-01/A4
Power Supply	12 VDC ± 10%, 100 mA		5 VDC ± 5%, 100 mA	
Input Signals	Balanced line driver input (RS-422)			
Output Signals	Voltage pulse output	Open collector output	Voltage pulse output	Open collector output
Input Signal Level	Voltage differential ≧ 0.3 V, internal termination resistance 100 Ω			
Output Signal Level	H: 10 V min. (1 mA) L: 0.5 V max. (30 mA)	L: 0.5 V max. (30 mA) Withstand voltage: 50 V	H: 3 V min. (1 mA) L: 0.5 V max. (30 mA)	L: 0.5 V max. (30 mA) Withstand voltage: 50 V
Operating Ambient Temperature Range	0 to +60°C			
IC Used	AM26LS32C Receiver IC, or equivalent			

5.5.17 Cables for Connecting PC and SERVOPACK

Special cables for connecting a PC to a SERVOPACK. Usıng these cables allows monıtoring and setting of parameters with a PC.
PC software ıs available for these communications. Ask your Yaskawa representative for details. Operate the software as described in the manual supplied.



■ Dimensional Drawings for Model DE9405258 (for NEC PC)

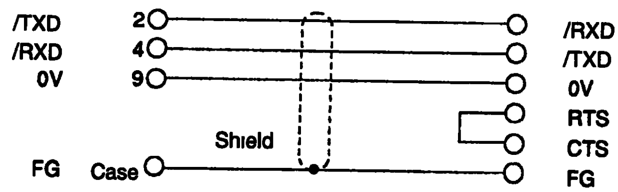


Note: Fold the cable shielding back at each end of the cable and secure it with clamps.

■ Communications Specifications and Connecting-circuit Specifications

• Baud Rate:		9600 bps
• Number of Bits	Start:	1 bit
	Data:	7 bits
	Stop:	1 bit
	Parity:	1 bit (even)
• Synchronization		Start-Stop
• XON/XOFF Control		None
• Shift Control:		None

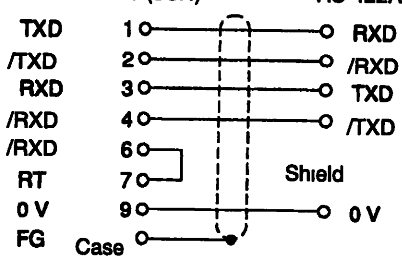
- Communications Method: Semi-duplex



Note: Maximum cable length is 2 m (6.56 ft).

Connection is also possible to the RS-422A port. In this case, the connection circuit is as follows:

- Transmission Distance: 30 m (98.4 ft) max.
- Transmission System: RS-422A



Terminal Arrangement at SERVOPACK End

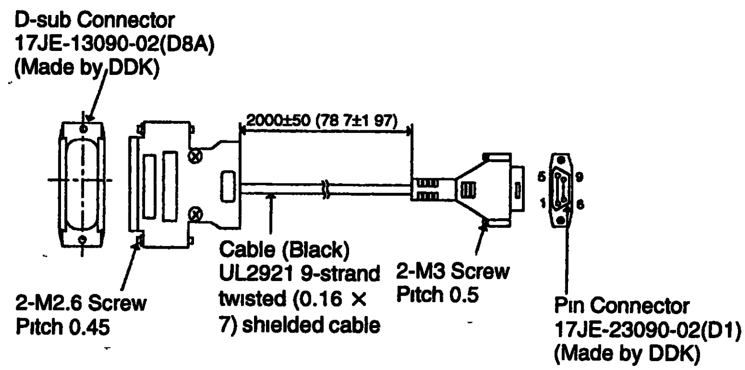
Pin #	Signal Name	Signal Circuit Name	Signal Direction
1	TXD	Transmit data (not inverted)	P←S
2	/TXD	Transmit data (inverted)	P←S
3	RXD	Receive data (not inverted)	P→S
4	/RXD	Receive data (inverted)	P→S
5	OPH	–	#
6	/RXD	Shorting pins 6 and 7 inserts 220 Ω termination resistance between RXD and /RXD.	
7	RT		
8	5VPP	–	#
9	GND	Signal ground 0 V	–

P: Personal computer
S: SERVOPACK
#: Terminal not used, leave open.

Cable for Connecting SERVOPACK and IBM PC (IBM or Compatible PC)

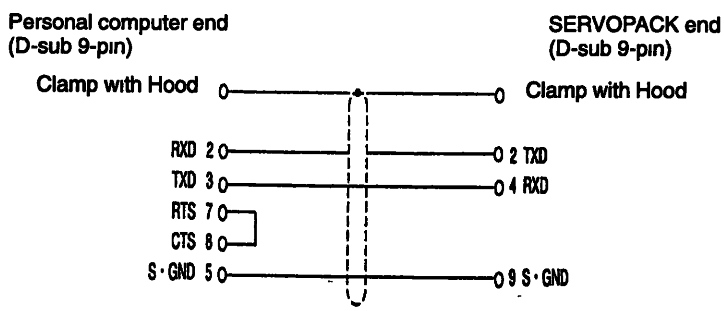
Use Yaskawa DE9408565 Cable.

- Dımensional Drawings: Model DE9408565



Note: Fold back the cable shıelding at each end of the cable and secure it with clamp.

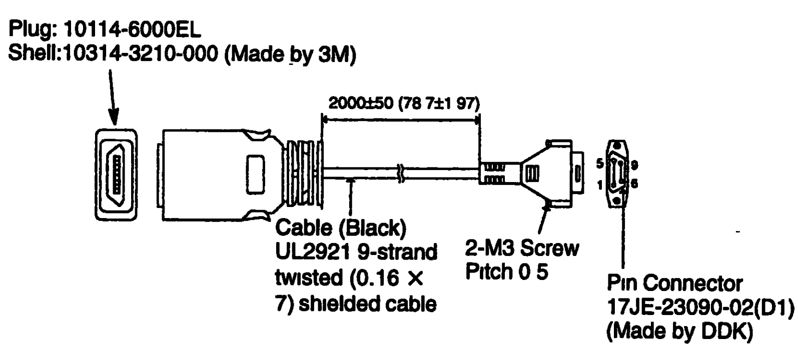
- Connectıon



Cable for Connecting SERVOPACK and NEC PC-98 Half-pitch Connector

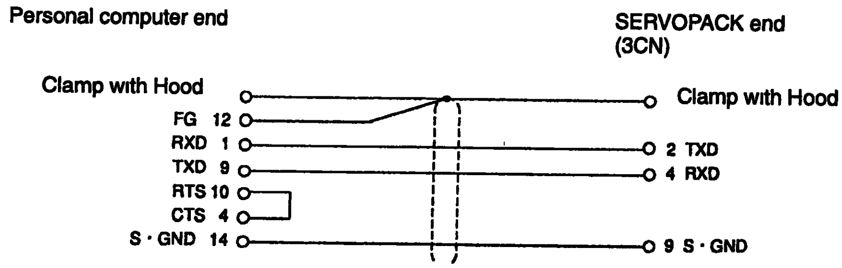
Use Yaskawa DE9408564 Cable.

- Dimensional Drawings: Model DE9408564



Note: Fold back the cable shıeldıng at each end of the cable and secure ıt wıth clamp.

- Connection


Personal computer end
SERVOPACK end
(3CN)
Clamp with Hood
FG 12
RXD 1
TXD 9
RTS 10
CTS 4
S・GND 14
Clamp with Hood
2 TXD
4 RXD
9 S・GND

6

INSPECTION, MAINTENANCE, AND TROUBLESHOOTING

This chapter describes the basic inspections and maintenance to be carried out by the customer.
In addition, troubleshooting procedures are described for problems which cause an alarm display and for problems which result in no alarm display.

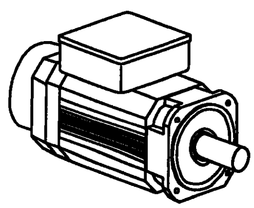
6.1 Inspection and Maintenance

This section describes the basic inspections and maintenance for Σ-Series servo drives.

6.1.1 Servomotor

For inspection and maintenance of servomotors, follow the simple, daily inspection procedures in the table below.

The AC servomotors are brushless. Simple, daily inspection is sufficient. The inspection and maintenance frequencies in the table are only guidelines. Increase or decrease the frequency to suit the operating conditions and environment.



Item	Frequency	Procedure	Comments
Vibration and noise	Daily	Touch and listen.	Levels higher than normal?
Appearance	According to degree of contamination	Clean with cloth or compressed air.	
Insulation resistance measurement	At least once a year	Disconnect SERVOPACK and test insulation resistance at 500 V. Must exceed 10 MΩ. (See note below)	Contact your Yaskawa representative if the insulation resistance is below 10 MΩ.
Replace oil seal	At least once every 5,000 hours	Remove servomotor from machine and replace oil seal.	Applies only to motors with oil seal.
Overhaul	At least once every 20,000 hours or 5 years	Contact your Yaskawa representative.	The customer should not disassemble and clean the servomotor.

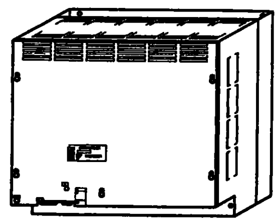
Note Measure across the servomotor FG and the U-phase, V-phase, or W-phase power lead

During inspection and maintenance, do not disassemble the servomotor.
If disassembly of the servomotor is required, contact your Yaskawa representative.

6.1.2 SERVOPACK

For inspection and maintenance of the SERVOPACK, follow the inspection procedures in the table below at least once every year.

The SERVOPACK contains highly reliable parts and daily inspection is not required. Carry out the inspections and maintenance in the table below once every year.



Item	Frequency	Procedure	Remedy
Clean unit interior and circuit boards	At least once a year	Check for dust, dirt, and oil on the surfaces	Clean with compressed air
Loose screws	At least once a year	Check for loose terminal block and connector screws.	Tighten any loose screws.
Defective parts in unit or on circuit boards.	At least once a year	Check for discoloration, damage or discontinuities due to heating	Contact your Yaskawa representative.

Part Replacement Schedule

The following parts are subject to mechanical wear or deterioration over time. To avoid failure, replace these parts at the frequency indicated.

Part	Standard Replacement Period	Replacement Method
Cooling fan	4 to 5 years	Replace with new part.
Smoothing Capacitor	7 to 8 years	Test. Replace with new part if necessary.
Relays	–	Test. Replace if necessary.
Fuse	10 years	Replace with new part.
Aluminum Electrolytic Capacitor on Circuit Board	5 years	Test. Replace with new circuit board if necessary.

INFO

Operating Conditions:

- Ambient Temperature. annual average 30°C
- Load Factor: 80% max.
- Operation Rate: 20 hours/day max.

If the SERVOPACK has been already overhauled at YASKAWA, its parameters are set back to the standard settings on shipment. Always check the parameters before operating the motor.

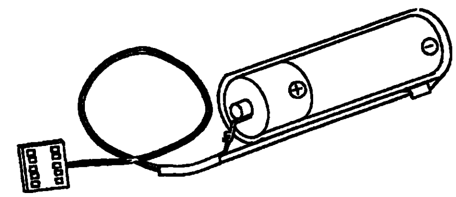
6.1.3 Replacing Battery for Absolute Encoder

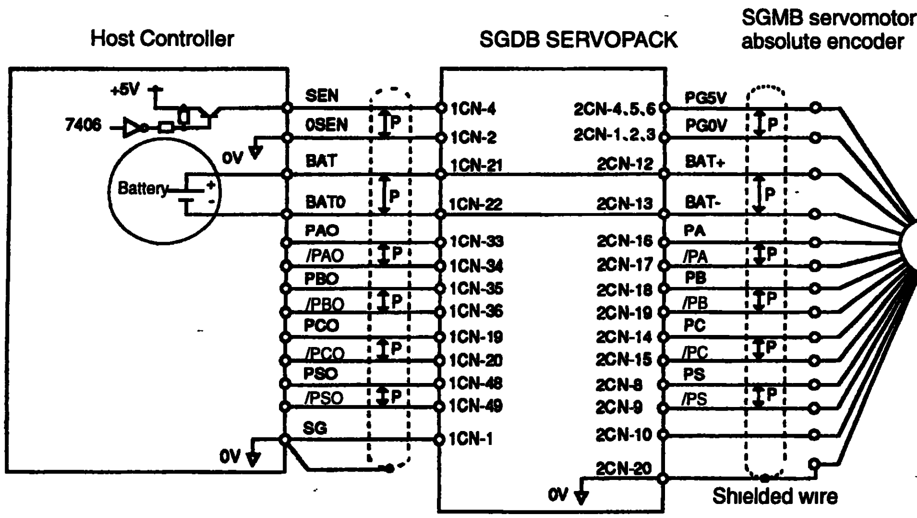
Battery replacement is only required for servo systems using an absolute encoder.

The battery model recommended below (purchased by the customer) is installed in the host controller to allow the absolute encoder to store position data when the power is turned OFF.

Recommended Battery:

- Lithium Battery
  ER 6 V C3, manufactured by Toshiba Battery Co., Ltd. 3.6 V; 2000 mAh
  Estimated Life: Approximately 10 years





Note. PS, PSO signals are used only for 12 bit absolute encoder.

The battery voltage is not internally monitored in the SERVOPACK. Therefore, detect low battery voltage at the host controller.

Minimum required battery voltage is 2.8 V.

Replace the battery according to the following procedure if the battery voltage drops to the minimum required battery voltage. The battery maintains absolute position data stored in the encoder.

Battery Replacement Procedure:

1. Turn ON the SERVOPACK and wait at least 3 minutes. The absolute encoder capacitors are charged.
2. Replace the battery in the host controller. The SERVOPACK power supply can be ON or OFF during battery replacement.

INFO After completing step 1 above, the absolute encoder will function normally for up to 2 days with no battery.

6.2 Troubleshooting

This section describes causes and remedies for problems which cause an alarm display and for problems which result in no alarm display.

6.2.1 Troubleshooting Problems with Alarm Display

Refer to the tables below to identify the cause of a problem which causes an alarm display and take the remedy described.
Note that A.99 does not indicate an alarm.

Contact your Yaskawa representative if the problem cannot be solved by the described procedures.

■ Alarm Display and Troubleshooting Table

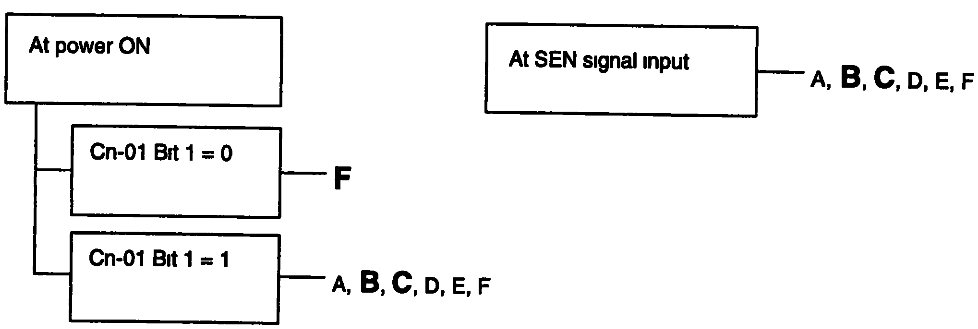
Display and Outputs

Digital Operator Display and Alarm Name	Alarm Output			
	Alarm Code Output			Alarm Output
	ALO1	ALO2	ALO3	
A.00 Absolute data error	OFF	OFF	OFF	OFF

OFF: Output transistor is OFF
ON: Output transistor is ON

Status When Alarm Occurred

The letters A to F in the diagram indicate the causes in the following table. The letters for the main causes are given in bold.



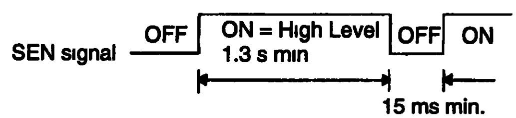
	Cause	Remedy
A	Absolute encoder power not supplied from SERVOPACK.	Use the SERVOPACK power supply for the absolute encoder.
B	Incorrect absolute encoder wiring (PA, PB, RESET, SEN signal etc).	Check and correct the absolute encoder wiring.
C	Absolute encoder malfunctioned.	• If Cn-01 Bit 1 = 0, turn SEN signal OFF and back ON. (See note on page.) • If Cn-01 Bit 1 = 1, turn SERVOPACK power OFF and back ON.
D	Incorrect parameter setting. Incremental encoder used with Cn-01 Bit E set to 1.	Set Cn-01 Bit E to 0.
E	Absolute encoder defective.	Replace servomotor.
F	Circuit board (1PWB) defective.	Replace SERVOPACK.

Note Alarm A 00 is reset when the power is turned OFF and back ON It is not reset by the normal alarm reset

INFO

Resetting SEN Signal

When resetting the SEN signal (i.e., turning it OFF and then back ON) for any reason, keep the SEN signal at the high level for more than 1.3 s before turning it OFF.



Display and Outputs

Digital Operator Display and Alarm Name	Alarm Output			
	Alarm Code Output			Alarm Output
	ALO1	ALO2	ALO3	
A 02 Parameters breakdown	OFF	OFF	OFF	OFF

OFF: Output transistor is OFF
ON: Output transistor is ON

Status When Alarm Occurred

At power ON	A, B

	Cause	Remedy
A	Power turned OFF during parameter write. Alarm occurred next power ON.	Replace SERVOPACK.
B	Circuit board (1PWB) defective	Replace SERVOPACK.

Display and Outputs

Digital Operator Display and Alarm Name	Alarm Output			
	Alarm Code Output			Alarm Output
	ALO1	ALO2	ALO3	
A.04 Parameter setting error	OFF	OFF	OFF	OFF

OFF: Output transistor is OFF
ON: Output transistor is ON

Status When Alarm Occurred

At power ON — A, B

	Cause	Remedy
A	An out-of-range parameter was previously set or loaded.	Reset all parameters in range. Otherwise, re-load correct parameters.
B	Circuit board (1PWB) defective.	Replace SERVOPACK.

Display and Outputs

Digital Operator Display and Alarm Name	Alarm Output			
	Alarm Code Output			Alarm Output
	ALO1	ALO2	ALO3	
A.10 Overcurrent	ON	OFF	OFF	OFF

OFF: Output transistor is OFF
ON: Output transistor is ON

Status When Alarm Occurred

During servomotor operation — A, B, D

When servo ON (/S-ON) signal turned ON — C, D

At power ON — C

	Cause	Remedy
A	Wiring grounded between SERVOPACK and servomotor.	Check and correct wiring.
B	Servomotor phase U, V, or W grounded.	Replace servomotor.
C	• Circuit board (1PWB) defective. • Power transistor defective.	Replace SERVOPACK.
D	Current feedback circuit, power transistor, DB circuit, or circuit board defective.	Replace SERVOPACK.

Display and Outputs

Digital Operator Display and Alarm Name	Alarm Output			
	Alarm Code Output			Alarm Output
	ALO1	ALO2	ALO3	
A.30 Regenerative error detection	ON	ON	OFF	OFF

OFF: Output transistor is OFF
ON: Output transistor is ON

Status When Alarm Occurred

During servomotor operation — A, B

Occurred when the control power turned ON — D

Occurred approximately 1 second after the main circuit power ON — A, B, C

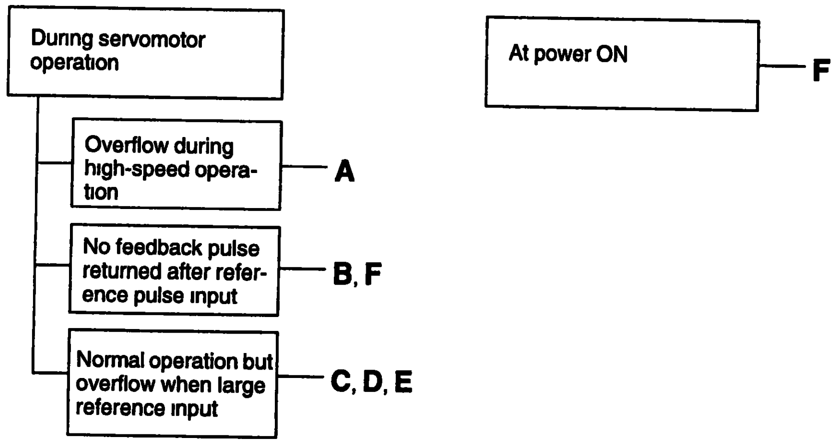
	Cause	Remedy
A	Regenerative transistor is abnormal.	Replace SERVOPACK.
B	Disconnection of the regenerative resistor unit.	Replace SERVOPACK or regenerative resistor unit.
C	Regenerative resistor unit disconnected (for more than 6.0 kW).	Check wiring of the regenerative resistor unit.
D	SERVOPACK defective.	Replace SERVOPACK

Display and Outputs

Digital Operator Display and Alarm Name	Alarm Output			
	Alarm Code Output			Alarm Output
	ALO1	ALO2	ALO3	
A.31 Position error pulse overflow	ON	ON	OFF	OFF

OFF: Output transistor is OFF
ON: Output transistor is ON

Status When Alarm Occurred



	Cause	Remedy
A	Servomotor wiring incorrect.	Check and correct wiring. (Check phase-A, -B, -C pulses correct at 2CN.)
B	Encoder wiring incorrect (disconnection, shortcircuit, power supply, etc.)	
C	SERVOPACK adjustment incorrect	Increase speed loop gain (Cn-04) and/or position loop gain (Cn-1A).
D	Servomotor overloaded	Reduce load torque and inertia. Otherwise, replace with larger capacity servomotor.
E	Position reference pulse frequency too high.	• Decrease reference pulse frequency. • Use smoothing function. • Change electronic gear ratio.
F	Circuit board (1PWB) defective.	Replace SERVOPACK.

Display and Outputs

Digital Operator Display and Alarm Name	Alarm Output			
	Alarm Code Output			Alarm Output
	ALO1	ALO2	ALO3	
A.40 Main circuit voltage error detection.	OFF	OFF	ON	OFF

OFF: Output transistor is OFF
ON: Output transistor is ON

Status When Alarm Occurred

At power ON — A, B, C, D

Occurred when the control power turned ON — E

Occurred approximately 0.6 second after the main circuit power turned ON — A, D

	Cause	Remedy
A	The power supply voltage is not within the range of specifications.	Check power supply.
B	Load exceeds capacity of the regenerative unit.	Check specifications of load inertia and overhanging load.
C	Regenerative transistor is abnormal.	Replace SERVOPACK.
D	• Rectifying diode defective. • Fuse blown • Inrush current-limited resistor disconnected.	
E	SERVOPACK defective.	

Display and Outputs

Digital Operator Display and Alarm Name	Alarm Output			
	Alarm Code Output			Alarm Output
	ALO1	ALO2	ALO3	
A.51 Overspeed	ON	OFF	ON	OFF

OFF: Output transistor is OFF
ON: Output transistor is ON

Status When Alarm Occurred

When servo ON (/S-ON) signal turned ON — A, B, C, D, E

During high-speed servomotor rotation after reference input — A, B, C, D, E

At power ON — E

	Cause	Remedy
A	• Servomotor wiring incorrect. • Encoder wiring incorrect (disconnection, shortcircuit, power supply, etc.).	Check and correct wiring. (Check phase -A, -B, -C pulses correct at 2CN.)
B	Incremental encoder power not supplied from SERVOPACK.	Use the SERVOPACK power supply for the encoder.
C	Noise in encoder wiring.	Separate encoder wiring from main wiring circuits.
D	Incorrect parameter (number of encoder pulses) setting	Set parameter Cn-11 to the correct number of pulses.
E	Circuit board (1PWB) defective	Replace SERVOPACK.

Display and Outputs

Digital Operator Display and Alarm Name	Alarm Output			
	Alarm Code Output			Alarm Output
	ALO1	ALO2	ALO3	
A.71 Overload (High load) A.72 Overload (Low load)	ON	ON	ON	OFF

OFF: Output transistor is OFF
ON: Output transistor is ON

Status When Alarm Occurred

When servo ON (/S-ON) signal turned ON — A, B, D

At power ON — E

When speed reference input
- No servomotor rotation — B, C, D
- During normal operation — C, D

	Cause	Remedy
A	Servomotor wiring incorrect or disconnected.	Check wiring and connectors at servomotor.
B	Encoder wiring incorrect or disconnected.	Check wiring and connectors at encoder.
C	Load greatly exceeds rated torque.	Reduce load torque and inertia. Otherwise, replace with larger capacity servomotor.
D	Incremental encoder power not supplied from SERVOPACK	Use the SERVOPACK power supply for the encoder.
E	Circuit board (1PWB) defective	Replace SERVOPACK.

Display and Outputs

Digital Operator Display and Alarm Name	Alarm Output			
	Alarm Code Output			Alarm Output
	ALO1	ALO2	ALO3	
A.80 Absolute encoder error (only when absolute encoder is used)	OFF	OFF	OFF	OFF

OFF: Output transistor is OFF
ON: Output transistor is ON

Status When Alarm Occurred

At power ON
- Cn-01 Bit 1 = 0 — C
- Cn-01 Bit 1 = 1 — A, B, C

During servomotor operation — A, B, D, E

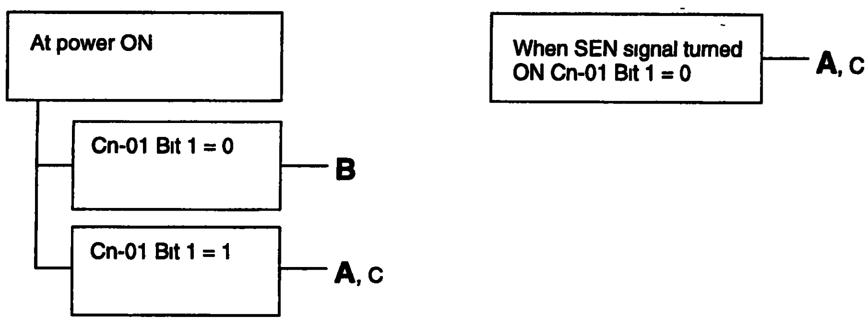
	Cause	Remedy
A	Incorrect absolute encoder wiring (PA, PB, RESET, SEN signal etc.).	Check and correct the absolute encoder wiring
B	Absolute encoder malfunctioned.	• At Cn-01 Bit 1 = 0, turn SEN signal OFF then back ON. • At Cn-01 Bit 1 = 1, turn SERVOPACK power OFF then back ON
C	Circuit board (1PWB) defective.	Replace SERVOPACK.
D	Error occurred in absolute encoder. Another encoder alarm displayed when SEN signal or power supply turned back ON.	• At Cn-01 Bit 1 = 0, turn SEN signal OFF then back ON (if servomotor is running, first turn servo OFF). • At Cn-01 Bit 1 = 1, turn SERVOPACK power OFF then back ON.
E	SERVOPACK miscounted pulses (positional displacement) or malfunctioned due to noise.	• Separate encoder wiring from main wiring circuits. • At Cn-01 Bit 1 = 0, turn SEN signal OFF then back ON (if servomotor is running, first turn servo OFF). • At Cn-01 Bit 1 = 1, turn SERVOPACK power OFF then back ON.

Display and Outputs

Digital Operator Display and Alarm Name	Alarm Output			
	Alarm Code Output			Alarm Output
	ALO1	ALO2	ALO3	
A.81 Absolute encoder back-up error (only when 12 bit absolute encoder is used)	OFF	OFF	OFF	OFF

OFF: Output transistor is OFF
ON: Output transistor is ON

Status When Alarm Occurred



	Cause	Remedy
A	The following power supplied to the absolute encoder all failed: • +5 V supply • Battery (ER6V C3) • Internal capacitor	Follow absolute encoder set-up procedures
B	Circuit board (1PWB) defective.	Replace SERVOPACK.
C	Absolute encoder malfunctioned.	Replace servomotor.

Display and Outputs

Digital Operator Display and Alarm Name	Alarm Output			
	Alarm Code Output			Alarm Output
	ALO1	ALO2	ALO3	
A.82 Absolute encoder sum-check error (only when 12 bit absolute encoder is used)	OFF	OFF	OFF	OFF

OFF: Output transistor is OFF
ON: Output transistor is ON

Status When Alarm Occurred

At power ON
- Cn-01 Bit 1 = 0 — B
- Cn-01 Bit 1 = 1 — A, B

When SEN signal turned ON, Cn-01 Bit 1 = 0 — A

During operation (see note) — A

	Cause	Remedy
A	Abnormality during absolute encoder memory check.	• Follow absolute encoder set-up procedures. • Replace servomotor if error occurs frequently.
B	Circuit board (1PWB) defective	Replace SERVOPACK

INFO

An absolute encoder error (A.80) is given initially if a sum-check error (A.82) is generated during operation. The sum-check error (A.82) occurs after turning the SEN signal (or SERVOPACK power supply) OFF and back ON.
However, the sum-check error (A.82) does occur during operation if the host controller is receiving the phase-S signal (serial data).

Display and Outputs

Digital Operator Display and Alarm Name	Alarm Output			
	Alarm Code Output			Alarm Output
	ALO1	ALO2	ALO3	
A.83 Absolute encoder battery error	OFF	OFF	OFF	OFF

OFF: Output transistor is OFF
ON: Output transistor is ON

Status When Alarm Occurred

- At power ON
  - Cn-01 Bit 1 = 0 — C
  - Cn-01 Bit 1 = 1 — A, B
- When SEN signal turned ON, Cn-01 Bit 1 = 0 — A, B
- During operation (see note) — A, B

	Cause	Remedy
A	• Battery not connected. • Battery connection defective.	Check and correct battery connection
B	Battery voltage below specified value. Specified value. 2.8 V.	Install new battery and turn SEN signal (or SERVOPACK) ON.
C	Circuit board (1PWB) defective.	Replace SERVOPACK.

INFO

No alarm occurs at the SERVOPACK when a battery error (A.83) is generated. The battery error (A.83) occurs the next time the SEN signal (or SERVOPACK) turns ON.
However, the battery error (A.83) can be read during operation if the host controller is receiving the phase-S signal (serial data).

Display and Outputs

Digital Operator Display and Alarm Name	Alarm Output			
	Alarm Code Output			Alarm Output
	ALO1	ALO2	ALO3	
A.84 Absolute encoder data error (only when absolute encoder is used)	OFF	OFF	OFF	OFF

OFF: Output transistor is OFF
ON: Output transistor is ON

Status When Alarm Occurred

At power ON
- Cn-01 Bit 1 = 0 — B
- Cn-01 Bit 1 = 1 — A

When SEN signal turned ON, Cn-01 Bit 1 = 0 — B

During operation (see note) — B

	Cause	Remedy
A	Absolute encoder malfunctioned.	• At Cn-01 Bit 1 = 0, turn SEN signal OFF then back ON. • At Cn-01 Bit 1 = 1, turn SERVOPACK power OFF then back ON. • Replace servomotor if error occurs frequently
B	Circuit board (1PWB) defective.	Replace SERVOPACK

INFO

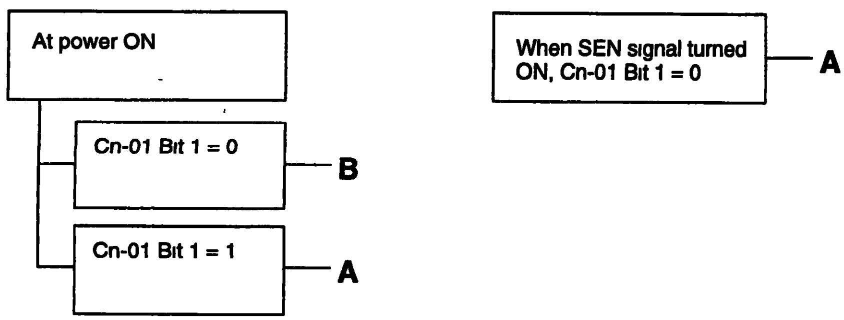
No alarm occurs at the SERVOPACK when a data error (A.84) is generated. The data error (A.84) occurs the next time the SEN signal (or SERVOPACK) turns ON.
However, the data error (A.84) can be read during operation if the host controller is receiving the phase-S signal (serial data).

Display and Outputs

Digital Operator Display and Alarm Name	Alarm Output			
	Alarm Code Output			Alarm Output
	ALO1	ALO2	ALO3	
A 85 Absolute encoder overspeed (only when absolute encoder is used)	OFF	OFF	OFF	OFF

OFF: Output transistor is OFF
ON: Output transistor is ON

Status When Alarm Occurred



	Cause	Remedy
A	Absolute encoder turned ON at a speed exceeding 400 r/min.	Turn ON encoder power supply (or SEN signal or SERVOPACK power supply) at a speed not exceeding 400 r/min.
B	Circuit board (1PWB) defective.	Replace SERVOPACK

Display and Outputs

Digital Operator Display and Alarm Name	Alarm Output			
	Alarm Code Output			Alarm Output
	ALO1	ALO2	ALO3	
A.A1 Heat sink overheated	ON	ON	ON	OFF

OFF: Output transistor is OFF
ON: Output transistor is ON

Status When Alarm Occurred

During servomotor operation — A, B, C, D

Occurred when the control power turned ON — E

	Cause	Remedy
A	The ambient temperature of the SERVOPACK exceeds 55°C.	Alter conditions so that the ambient temperature goes below 55°C
B	The air flow around the heat sink is bad	Follow installing method and provide sufficient surrounding space as specified
C	Fan stopped.	Replace SERVOPACK.
D	SERVOPACK is running under overload	Reduce load.
E	SERVOPACK defective.	Replace SERVOPACK.

Display and Outputs

Digital Operator Display and Alarm Name	Alarm Output			
	Alarm Code Output			Alarm Output
	ALO1	ALO2	ALO3	
A.b1 Reference input read error	OFF	OFF	OFF	OFF

OFF: Output transistor is OFF
ON: Output transistor is ON

Status When Alarm Occurred

During servomotor operation — A, B

At power ON — C

	Cause	Remedy
A	Part malfunctioned in reference read-in unit (A/D converter, etc.).	Reset alarm and restart operation.
B	Part defective in reference read-in unit (A/D converter, etc.).	Replace SERVOPACK.
C	Circuit board (1PWB) defective.	Replace SERVOPACK

Display and Outputs

Digital Operator Display and Alarm Name	Alarm Output			
	Alarm Code Output			Alarm Output
	ALO1	ALO2	ALO3	
A C1 Servo overrun	ON	OFF	ON	OFF

OFF: Output transistor is OFF

ON: Output transistor is ON

Status When Alarm Occurred

At power ON

- Parameter Cn-01 Bit 0 = 0 — E

Occurred 1 to 3 seconds after power ON

- Parameter Cn-01 Bit 0 = 1 — A, B, C, D, E

When servo ON (/S-ON) signal turned ON — A, B, C, D, E

On speed reference input — A, B, C, D, E

	Cause	Remedy
A	Servomotor wiring incorrect or disconnected.	Check wiring and connectors at servomotor
B	Encoder wiring incorrect or disconnected.	Check wiring and connectors at encoder.
C	Incremental encoder power not supplied from SERVOPACK.	Use the SERVOPACK power supply for the encoder
D	Encoder defective.	Replace servomotor.
E	Circuit board (1PWB) defective.	Replace SERVOPACK.

Display and Outputs

Digital Operator Display and Alarm Name	Alarm Output			
	Alarm Code Output			Alarm Output
	ALO1	ALO2	ALO3	
A.C2 Encoder phase detection error	ON	OFF	ON	OFF

OFF: Output transistor is OFF
ON: Output transistor is ON

Status When Alarm Occurred

At power ON — D

During servomotor operation — A, B, C, D

Occurred 1 to 3 seconds after power ON — A, B, C, D

	Cause	Remedy
A	Noise in encoder wiring.	Separate encoder wiring from main wiring circuits.
B	Encoder wiring incorrect or poor connection.	Check wiring and connectors at encoder.
C	Encoder defective.	Replace servomotor
D	Circuit board (1PWB) defective	Replace SERVOPACK.

Display and Outputs

Digital Operator Display and Alarm Name	Alarm Output			
	Alarm Code Output			Alarm Output
	ALO1	ALO2	ALO3	
A.C3 Encoder phase-A, -B disconnection	ON	OFF	ON	OFF

OFF: Output transistor is OFF
ON: Output transistor is ON

Status When Alarm Occurred

At power ON
- Parameter Cn-01 Bit 0 = 0 — D

Occurred 1 to 3 seconds after power ON
- Parameter Cn-01 Bit 0 = 1 — A, B, C, D

When servo ON (/S-ON) signal turned ON — A, B, C, D

During servomotor operation — A, B, C, D

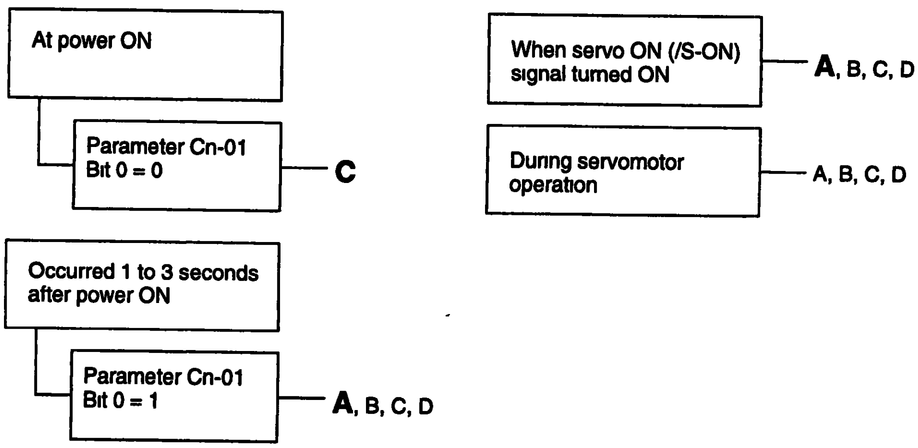
	Cause	Remedy
A	Encoder wiring incorrect or poor connection	Check wiring and connectors at encoder.
B	Noise in encoder wiring.	Separate encoder wiring from main wiring circuits.
C	Encoder defective.	Replace servomotor.
D	Circuit board (1PWB) defective.	Replace SERVOPACK.

Display and Outputs

Digital Operator Display and Alarm Name	Alarm Output			
	Alarm Code Output			Alarm Output
	ALO1	ALO2	ALO3	
A C4 Encoder phase-C disconnection	ON	OFF	ON	OFF

OFF: Output transistor is OFF
ON: Output transistor is ON

Status When Alarm Occurred



	Cause	Remedy
A	Encoder wiring incorrect or poor connection.	Check wiring and connectors at encoder.
B	Noise in encoder wiring.	Separate encoder wiring from main wiring circuits.
C	Encoder defective.	Replace servomotor
D	Circuit board (1PWB) defective.	Replace SERVOPACK.

Display and Outputs

Digital Operator Display and Alarm Name	Alarm Output			
	Alarm Code Output			Alarm Output
	ALO1	ALO2	ALO3	
A.F1 Power line open phase	OFF	ON	OFF	OFF

OFF: Output transistor is OFF
ON: Output transistor is ON

Status When Alarm Occurred

At main circuit power supply ON — A, B

Occurred when the control power turned ON — C

	Cause	Remedy
A	One phase (R,S,T) of the main circuit power supply is disconnected	• Check power supply. • Check wiring of the main circuit power supply. • Check MCCB, noise filter, magnetic contactor.
B	There is one phase where the line voltage is low	Check power supply.
C	SERVOPACK defective	Replace SERVOPACK.

Display and Outputs

Digital Operator Display and Alarm Name	Alarm Output			
	Alarm Code Output			Alarm Output
	ALO1	ALO2	ALO3	
A.F3 Power loss error	OFF	ON	OFF	OFF

OFF: Output transistor is OFF
ON: Output transistor is ON

Status When Alarm Occurred

At main circuit power supply ON — A, B

During servomotor operation — A, C

	Cause	Remedy
A	Although power loss alarm is not necessary, its parameter is set valid.	Set the parameter Cn-01 bit 5 to 0.
B	Time between turning power OFF and back ON was shorter than 0.5 second.	After turning power OFF, wait for at least 0.5 second, before turning the power back ON.
C	If any of the following power supply conditions are met during motor operation: • Complete power failure : half cycle of supply frequency • Voltage drop. full cycle of supply frequency Note. Because of detector lag or detector margin, there may be no alarm even if the above values are exceeded	Check the power supply. **Terms** • Complete power failure=Power failure where voltage drops to zero. • Voltage drop=Power failure where voltage drops, but not to zero.

Display and Outputs

Digital Operator Display and Alarm Name	Alarm Output			
	Alarm Code Output			Alarm Output
	ALO1	ALO2	ALO3	
A.F4 Main circuit contactor error	OFF	ON	OFF	OFF

OFF: Output transistor is OFF
ON: Output transistor is ON

Status When Alarm Occurred

Occurred when the control power turned ON — A

Occurred after main circuit contact turned ON — A, B

	Cause	Remedy
A	Controller defective	Replace SERVOPACK.
B	Main circuit MC defective.	Replace SERVOPACK.

Display and Outputs

Digital Operator Display and Alarm Name	Alarm Output			
	Alarm Code Output			Alarm Output
	ALO1	ALO2	ALO3	
CPF00 Digital operator transmission error 1	Not specified			

INFO: This alarm is not stored in alarm trace-back function memory.

Status When Alarm Occurred

At power ON (Digital operator connected before SERVOPACK power turned ON) — A, B, C, D

Digital operator connected to SERVOPACK while power turned ON — A, B, C, D

	Cause	Remedy
A	Cable defective or poor contact between digital operator and SERVOPACK.	• Check connector connections. • Replace cable.
B	Malfunction due to external noise.	Separate digital operator and cable from noise source.
C	Digital operator defective.	Replace digital operator
D	SERVOPACK defective.	Replace SERVOPACK.

Display and Outputs

Digital Operator Display and Alarm Name	Alarm Output			
	Alarm Code Output			Alarm Output
	ALO1	ALO2	ALO3	
CPF01 Digital operator transmission error 2	Not specified			

INFO This alarm is not stored in alarm trace-back function memory.

Status When Alarm Occurred

During operation — A, B, C, D

	Cause	Remedy
A	Cable defective or poor contact between digital operator and SERVOPACK.	• Check connector connections. • Replace cable.
B	Malfunction due to external noise.	Separate digital operator and cable from noise source.
C	Digital operator defective.	Replace digital operator.
D	SERVOPACK defective.	Replace SERVOPACK.

Display and Outputs

Digital Operator Display and Alarm Name	Alarm Output			
	Alarm Code Output			Alarm Output
	ALO1	ALO2	ALO3	
A.99	OFF	OFF	OFF	ON

OFF: Output transistor is OFF
ON: Output transistor is ON

Status When Alarm Occurred

Indicates normal operation. Not an alarm.

6.2.2 Troubleshooting Problems With No Alarm Display

Refer to the tables below to identify the cause of a problem which causes no alarm display and take the remedy described.

Turn OFF the servo system power supply before commencing the shaded procedures.

Contact your Yaskawa representative if the problem cannot be solved by the described procedures.

Troubleshooting Table No Alarm Display

Symptom	Cause	Inspection	Remedy
Servomotor does not start	Power not connected	Check voltage between power supply terminals	Correct the power circuit.
	Loose connection	Check terminals of connectors (1CN, 2CN)	Tighten any loose parts.
	Connector (1CN) external wiring incorrect	Check connector (1CN) external wiring.	Refer to connection diagram and correct wiring.
	Servomotor or encoder wiring disconnected		Reconnect wiring.
	Overloaded	Run under no load.	Reduce load or replace with larger capacity servomotor.
	Speed/position references not input	Check reference input pins.	Correctly input speed/position references.
	/S-ON is turned OFF	Cn-01 Bit 0 is 0.	Turn /S-ON input ON.
	/P-CON input function setting incorrect	Check parameter Cn-2B.	Refer to *Section 3.2.1* and set parameters to match application.
	Reference pulse mode selection incorrect	Refer to *Section 3.2.2.*	Select correct parameters Cn-02 Bits 3, 4, and 5.
	Encoder type differs from parameter setting	Incremental or absolute encoder?	Set parameters Cn-01 Bit E to the encoder type used.
	P-OT and N-OT inputs are turned OFF.	(If Cn-01 Bits 2, 3 are 0)	Turn P-OT and N-OT input signals ON.
	CLR input is turned ON	Check status of error counter clear input	Turn CLR input OFF.
	SEN input is turned OFF.	Absolute encoder used with Cn-01 Bit 1 set to 0.	Turn SEN input ON.
Servomotor moves instantaneously, then stops	Number of encoder pulses differs from parameter setting.		Set the parameter (Cn-11) to match the number of encoder pulses.
	Servomotor or encoder wiring incorrect		Refer to *Section 3.8.6* and correct wiring.
Suddenly stops during operation and will not restart	Alarm reset signal (/ALM-RST) is turned ON because an alarm occurred.		Remove cause of alarm. Turn alarm reset signal (ALM-RST) from ON to OFF.
Servomotor speed unstable	Wiring connection to motor defective	Check connection of power lead (phase U, V, and W) and encoder connectors.	Tighten any loose terminals or connectors

Symptom	Cause	Inspection	Remedy
Servomotor vibrates at approximately 200 to 400 Hz.	Speed loop gain value too high		Reduce speed loop gain (Cn-04) preset value
	Speed/position reference input lead too long		Minimize length of speed/position reference input lead, with impedance not exceeding several hundred Ω
	Speed/position reference input lead is bundled with power cables.		Separate reference input lead at least 30 cm from power cables.
High rotation speed overshoot on starting and stopping	Speed loop gain value too high		Reduce speed loop gain (Cn-04) preset value.
Servomotor overheated	Ambient temperature too high	Measure servomotor ambient temperature.	Reduce ambient temperature to 40°C max.
	Servomotor surface dirty	Visual check	Clean dust and oil from motor surface.
	Overloaded	Run under no load.	Reduce load or replace with larger capacity servomotor.
Abnormal noise	Mechanical mounting incorrect	Servomotor mounting screws loose?	Tighten mounting screws.
		Coupling not centered?	Center coupling.
		Coupling unbalanced?	Balance coupling.
	Bearing defective	Check noise and vibration near bearing.	Consult your Yaskawa representative if defective.
	Machine causing vibrations	Foreign object intrusion, damage or deformation of sliding parts of machine.	Consult with machine manufacturer.
Speed reference 0 V but servomotor rotates	Speed reference voltage offset applied	---	Refer to *Sections 4.2.4* and *4.2.5* and adjust reference offset.

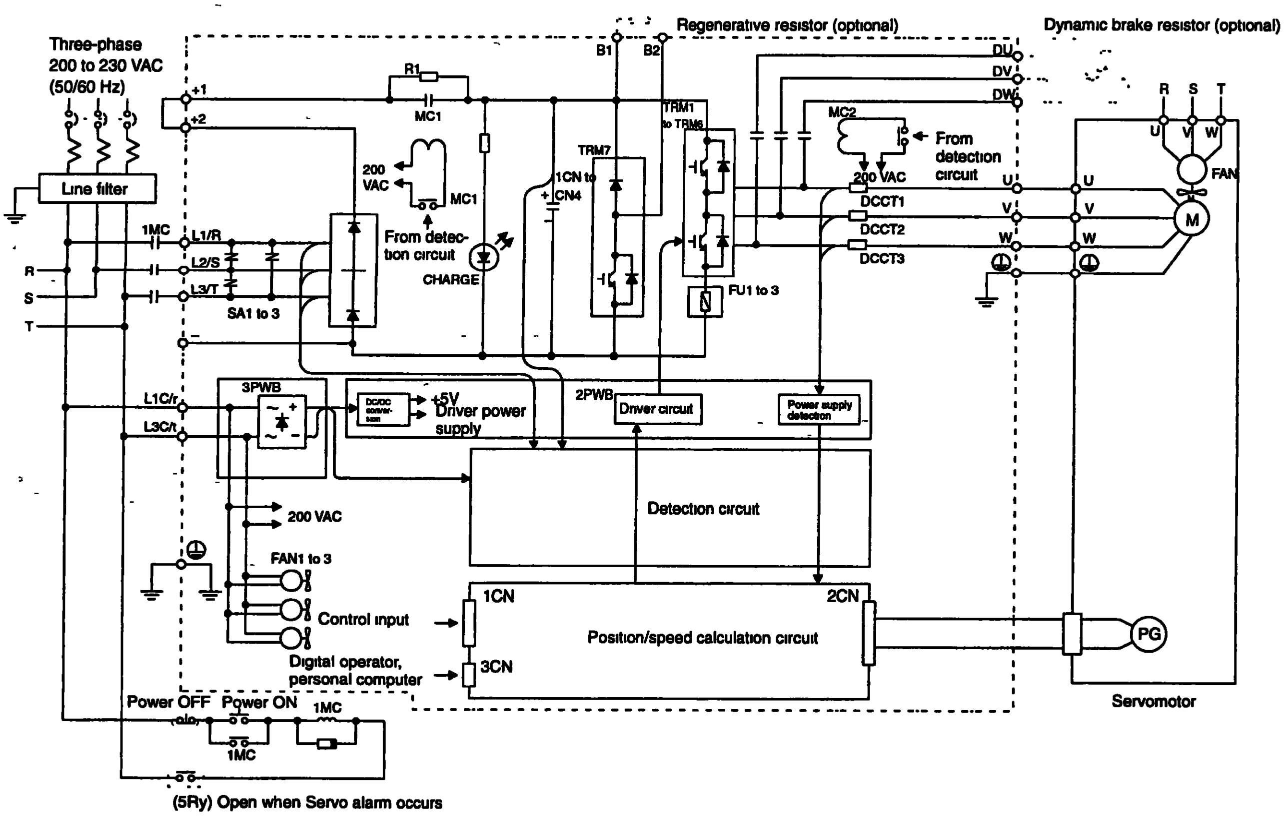
6

6.2.3 Internal Connection Diagram and Instrument Connection Examples

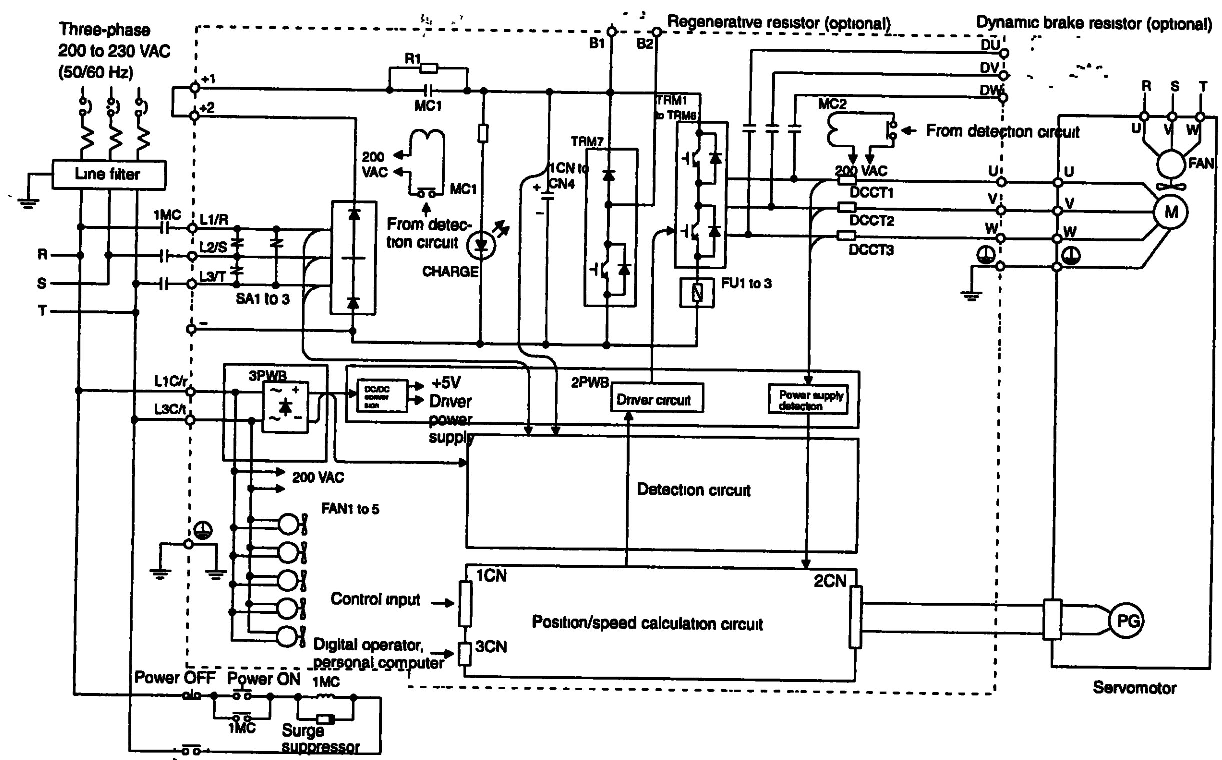
The SGDB SERVOPACK internal connection diagram and instrument connection examples are given below.
Refer to these diagrams during inspection and maintenance.

■ Internal Connection Diagram

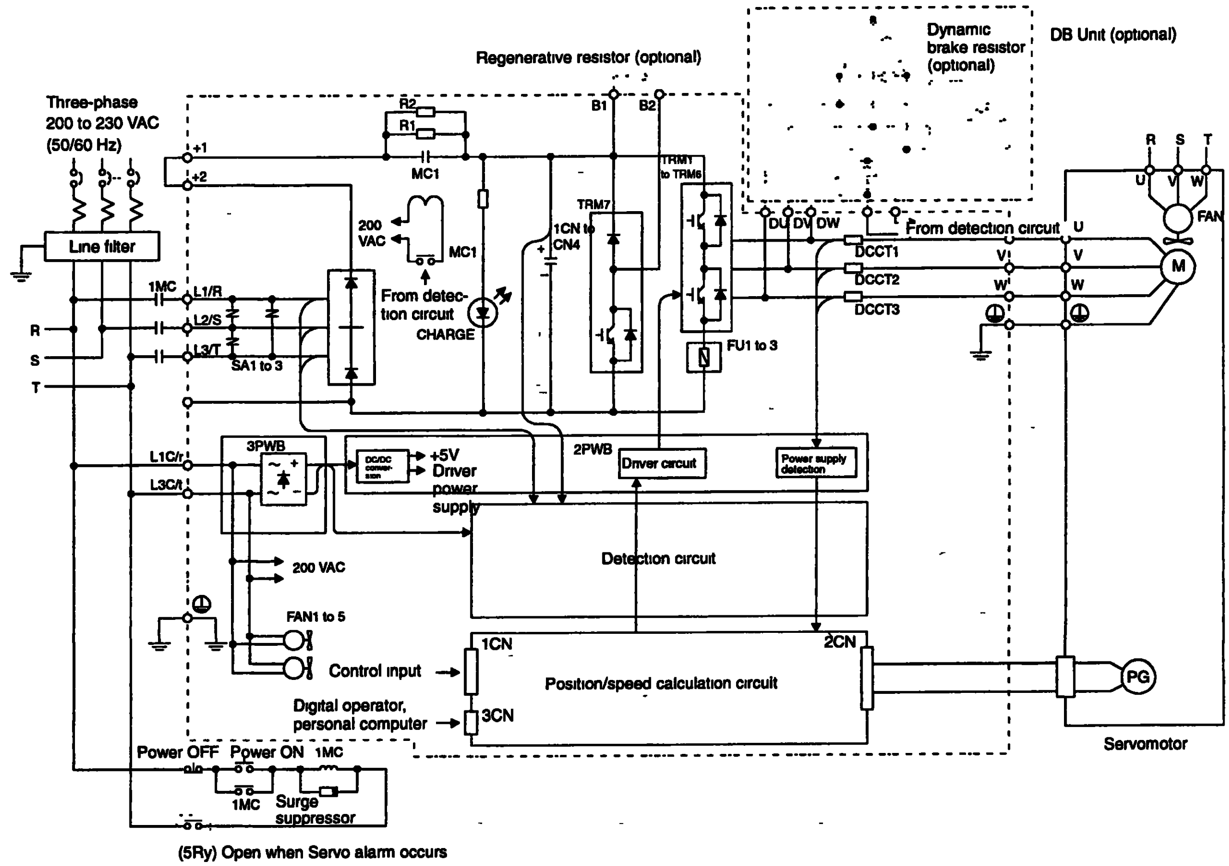
- 22 kW for 200 V



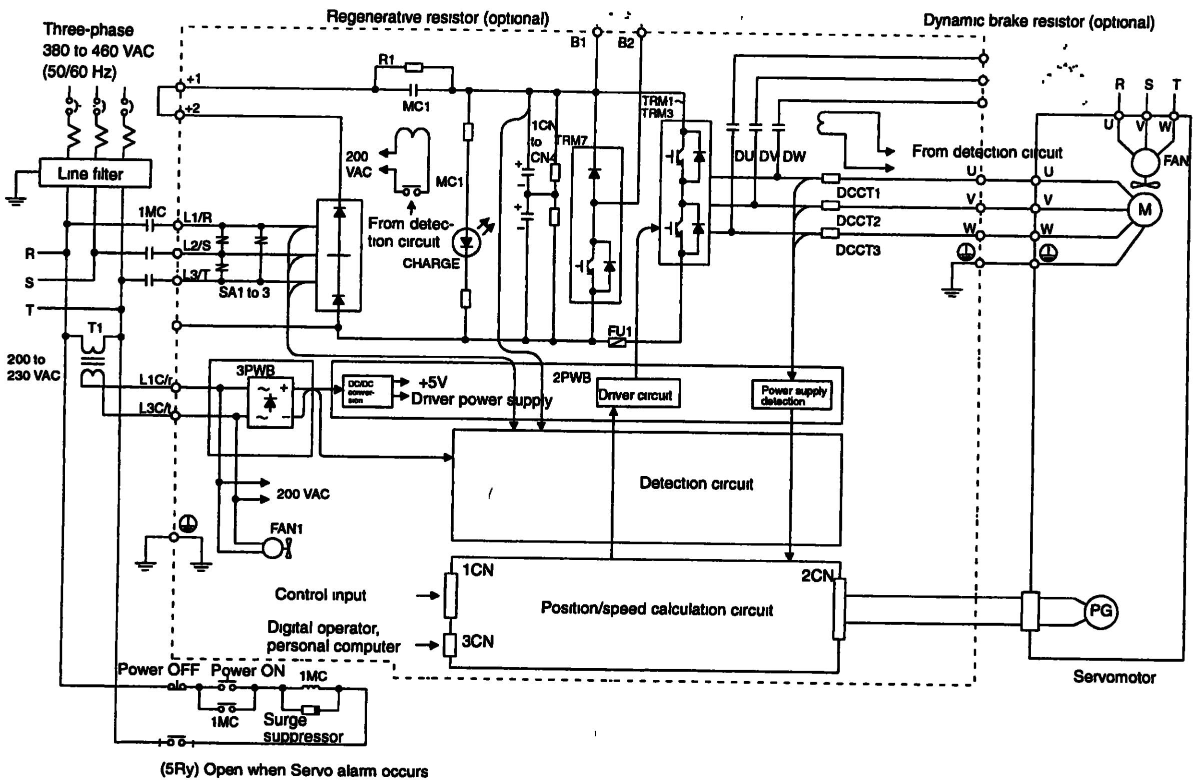
- 30 kW for 200 V



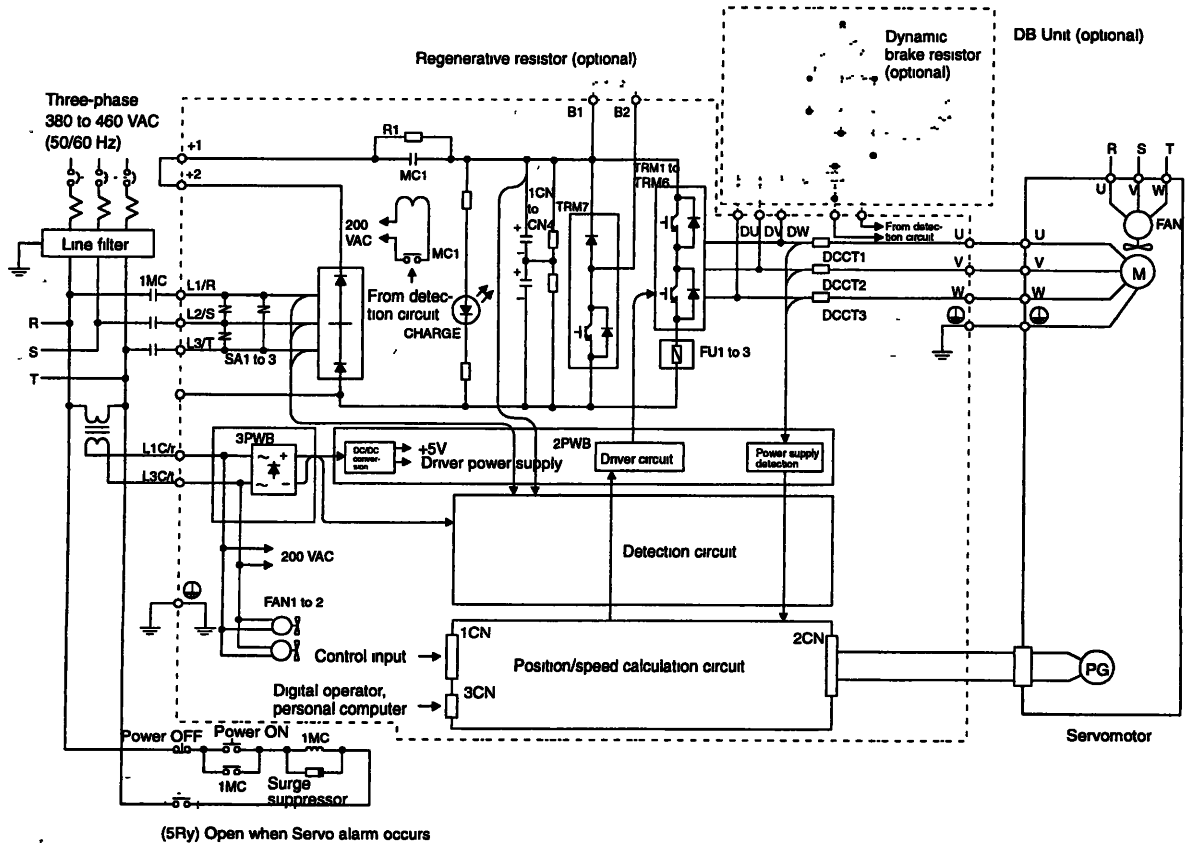
• 37 kW for 200 V



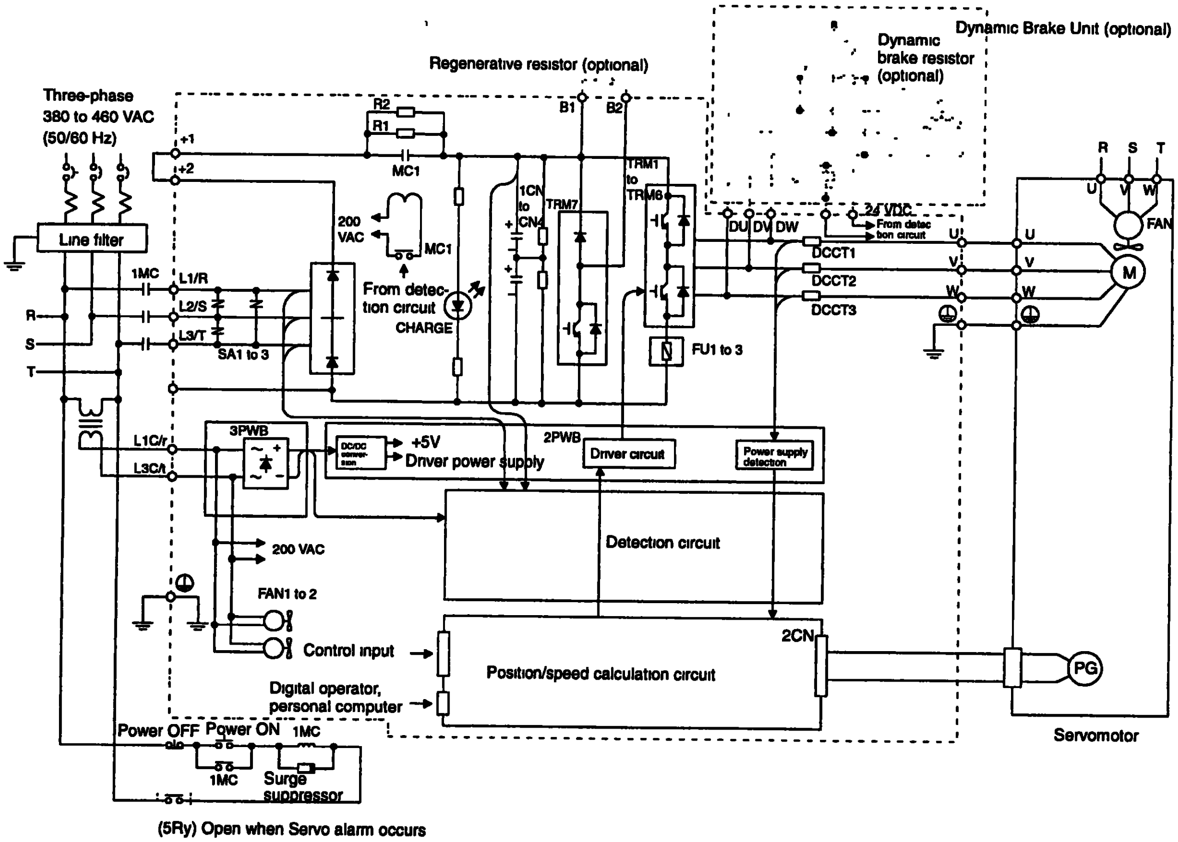
- 22 kW, 30 kW for 400 V



• 37 kW for 400 V



• 45 kW, 55 kW for 400 V



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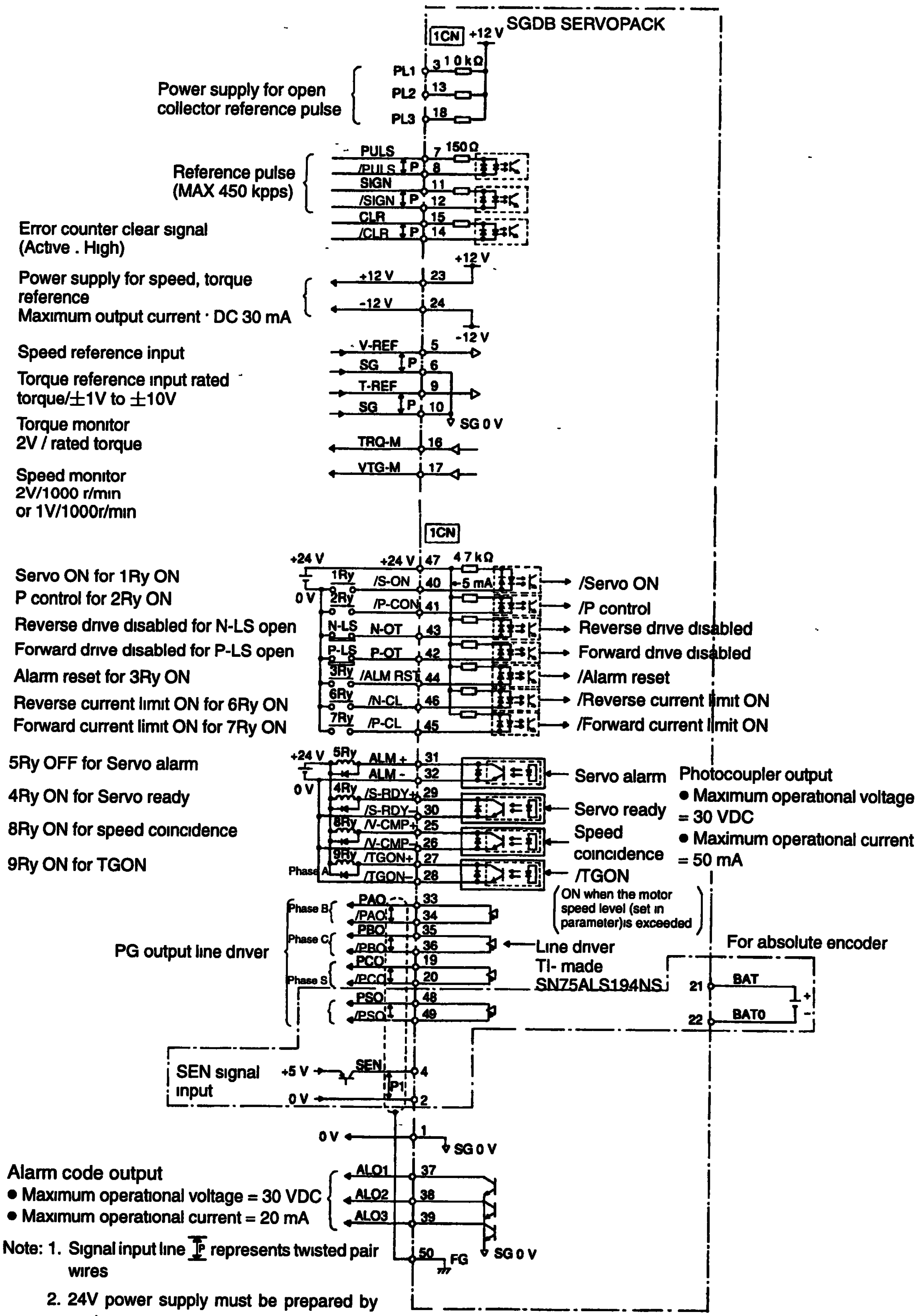
■ Instrument Connection Examples

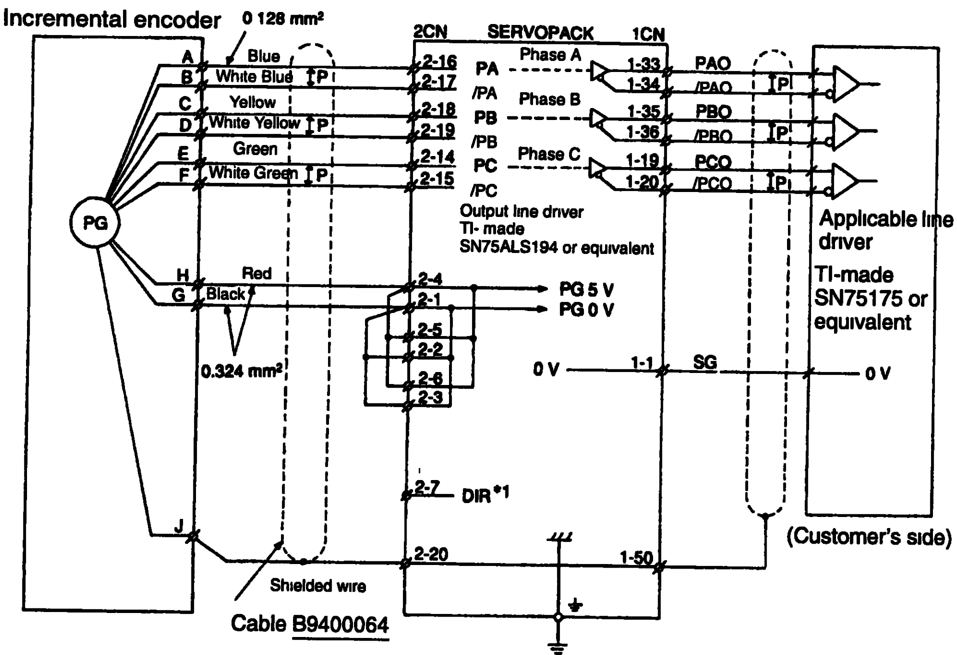


Note: 1. Signal input line represents twisted pair wires

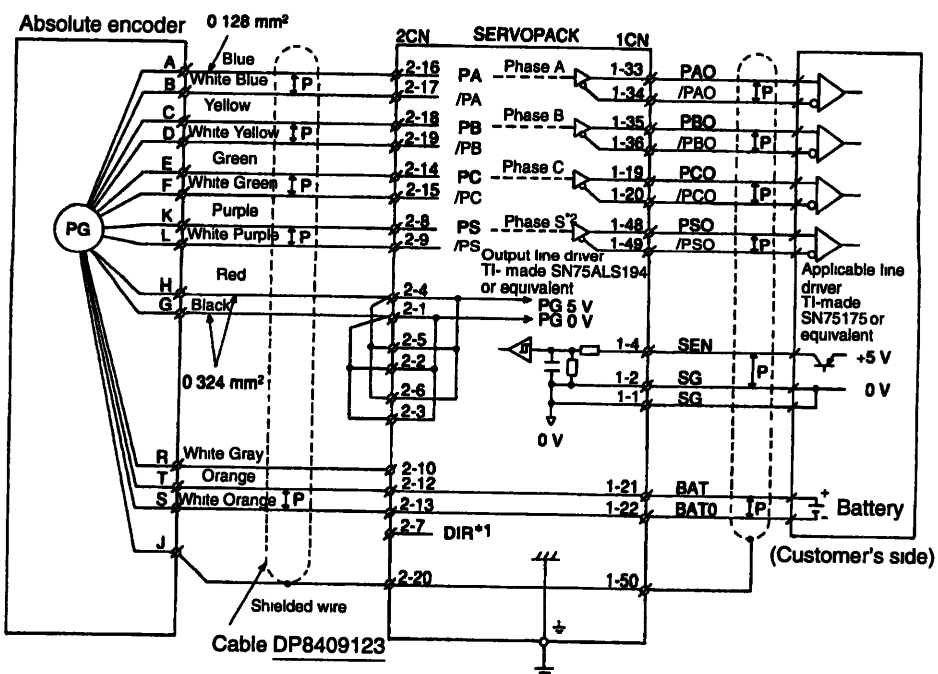
2. 24V power supply must be prepared by customers

■ Connection Method Between SERVOPACK and Encoder

In case of incremental encoder



In case of absolute encoder



* 1. By connecting DIR (2CN-7) to PG0V, the motor will be in reverse connection (motor reversed by forward reference).

* 2. Phase-S signal is valid only when 12 bit absolute encoder is used.

Note: P represents twisted pair wires.

A

Servo Adjustment

This appendix presents the basic rules for Σ-Series AC SERVOPACK gain adjustment, describes various adjustment techniques, and gives some preset values as guidelines.

A.1 Σ-Series AC SERVOPACK Gain Adjustment

This section gives some basic information required to adjust the servo system.

A.1.1 Σ-Series AC SERVOPACKs and Gain Adjustment Methods

Five types of Σ-Series AC SERVOPACK are available: SGD, SGDA, DR1, DR2, and the current SGDB.

The adjustment method is basically identical for each SERVOPACK type, except that auto-tuning is not available for some types.

The SGDB, SGDA, SGD, and DR2 SERVOPACKs allow both manual adjustment by the conventional method of observing the machine response and automatic adjustment using the internal auto-tuning function. The DR1 SERVOPACK does not offer auto-tuning.

The main parameters changed by the customer to adjust the servo system include the following:

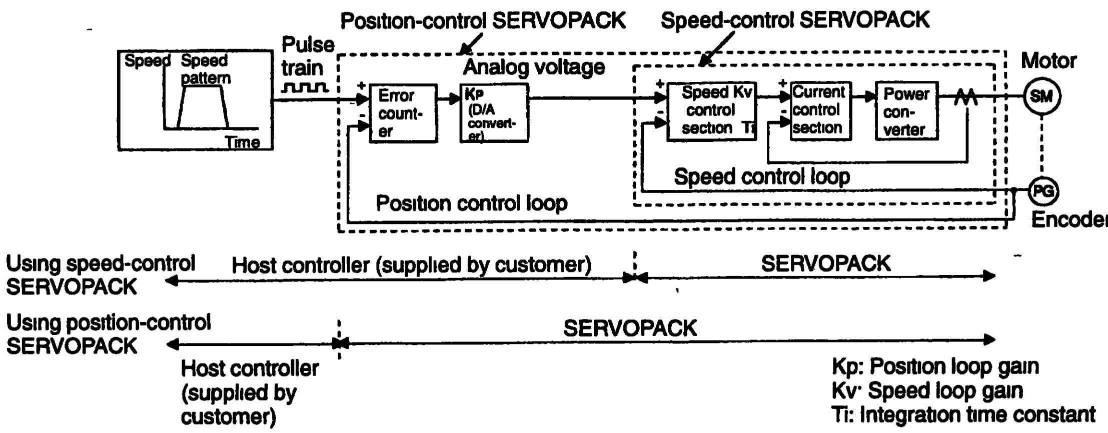
- Cn-04 (Speed Loop Gain)
- Cn-05 (Speed Loop Integration Time Constant)
- Cn-17 (Torque Reference Filter Time Constant)
- Cn-1A (Position Loop Gain)

In a speed-control SERVOPACK (where speed references are applied as analog voltages), the position loop is controlled by the host controller, so the position loop gain is normally adjusted at the host controller.

If adjustment is not possible at the host controller, the same adjustment can be achieved using Cn-03 (Speed Reference Gain), but the servomotor may not reach maximum speed for some preset values of this parameter.

A simple block diagram of the servo system is shown below.

Servo System Block Diagram

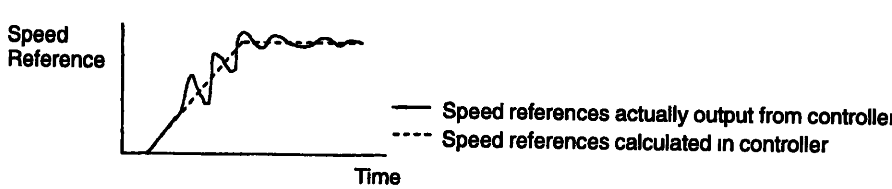


Note: A position-control SERVOPACK has no D/A converter for speed reference output. This conversion is handled by internal calculations.

A.1.2 Basic Rules for Gain Adjustment

- The servo system comprises three feedback systems: position loop, speed loop, and current loop. The response must increase from outer loop to inner loop (see Servo System Block Diagram, above). The response deteriorates and oscillates if this principle is not obeyed.
  The customer cannot adjust the current loop. Sufficient response is assured for the current loop.
  The customer can adjust the position loop gain and speed loop gain, as well as the speed loop integration time constant and torque reference filter.
- The position loop and speed loop must be adjusted to provide a balanced response.
  In particular, if the position loop gain only is increased (adjustment with Cn-03 at the SERVOPACK if position loop gain adjustment is not possible at the host controller), the speed references oscillate and the result is increased, oscillating position control times.
  If the position loop gain (or Cn-03) is increased, the speed loop gain (Cn-04) must be similarly increased.
  If the mechanical system starts to oscillate after the position loop gain and speed loop gain are increased, do not increase the gains further.
- The position loop gain should not normally be increased above the characteristic frequency of the mechanical system.
  For example, the harmonic gears used in an articulated robot form a structure with extremely poor rigidity and a characteristic frequency of approximately 10 to 20 Hz. This type of machine allows a position loop gain of only 10 to 20 (1/sec).
  Conversely, the characteristic frequency of a precision machine tool such as a chip mounter or IC bonder exceeds 70 Hz, allowing a position loop gain exceeding 70 (1/sec) for some machines.
  Therefore, although the response of the servo system (controller, servo driver, motor, detectors, etc.) is an important factor where good response is required, it is also important to improve the rigidity of the mechanical system.
- In cases where the position loop response is greater than or equal to the speed loop response and linear acceleration or deceleration is attempted, the poor speed loop response and follow-up cause an accumulation of position loop errors and result in increased output of speed references from the position loop.
  The motor moves faster and overshoots as a result of increased speed references, and the position loop tends to decrease the speed references. However, the poor motor follow-up due to the poor speed loop response results in oscillating speed references, as shown in the diagram below.
  If this problem occurs, reduce the position loop gain or increase the speed loop gain to eliminate the speed reference oscillations.

Speed Reference Output with Unbalanced Position Loop Gain and Speed Loop Gain



A.2 Adjusting a Speed-control SERVOPACK

This section gives examples of adjusting the gains of a speed-control SERVOPACK manually and using auto-tuning.

A.2.1 Adjusting Using Auto-tuning

The DR1 SERVOPACK does not offer auto-tuning.

■ Important Points About Auto-tuning

- Speed During Auto-tuning
  Auto-tuning may not function correctly if the speed is too low. Set the speed to approximately 500 r/min.
  Set the speed with the parameter Cn-10 (Jog speed).
- Selecting Machine Rigidity
  If the machine rigidity is unknown, select the rigidity according to the following standards.

Drive Method	Machine Rigidity	
	SGDB, SGDA, DR2	SGD
Ball screw, direct	3 (C-003) to 7 (C-007)	High/medium response
Ball screw, with reduction gears	2 (C-002) to 3 (C-003)	Medium response
Timing belt	1 (C-001) to 3 (C-003)	Low/medium response
Chain	1 (C-001) to 2 (C-002)	Low response
Wave reduction gears*	1 (C-001) to 2 (C-002)	Low response

* Product name Harmonic Drive

Select the machine rigidity level for SGDB, SGDA and DR2 according to the table.

Level	Rigidity
7 (C-007)	High
6 (C-006)	:
5 (C-005)	:
4 (C-004)	:
3 (C-003)	Medium
2 (C-002)	:
1 (C-001)	Low

Auto-tuning may not end if high response is selected for a low-rigidity machine or low response is selected for a high-rigidity machine.
If this occurs, halt the auto-tuning and change the machine rigidity selection.

If Auto-tuning is Unsuccessful

Auto-tuning may be unsuccessful (the end of auto-tuning not displayed) for machines with large play or extremely low rigidity.
Similarly, auto-tuning may be unsuccessful for a machine with high load inertia (exceeding 15 to 30 times the motor moment of inertia).
In these cases, use conventional manual adjustment.
Even if auto-tuning is successful for a machine with large fluctuations in load inertia or load torque, vibrations or noise may still occur in some positions.

Response During Operation is Unsatisfactory after Auto-tuning

Auto-tuning sets the gain and integration time constant with some safety margin (to avoid oscillations). This can result in long positioning times.
In particular, the target position may not be reached if low response is selected, because the machine does not move in response to the final minute references. An excessively high setting of the integration time constant (Cn-05) during auto-tuning is one cause of this problem.
If response is slow after auto-tuning, the speed loop gain cannot be manually increased very much before oscillation starts.
In this case, manually reduce the integration time constant while observing the machine behavior to ensure oscillation does not occur.
Auto-tuning does not set the torque reference filter (Cn-17) or speed reference gain (Cn-03).

A.2.2 Manual Adjustment

Parameters

The role of each parameter is briefly described below.

- Speed Loop Gain (Cn-04)
  This parameter sets the speed loop response.
  The response is improved by setting this parameter to the maximum value in the range which does not cause vibrations in the mechanical system.
  The following formula relates the speed loop gain to the load inertia.

$$\text{Speed Loop Gain Kv [Hz]} = \frac{2}{\frac{J_L}{J_M} + 1} \times \text{(Cn-04 Preset value)}$$

J_L Motor Axis Converted Load Inertia
J_M: Motor Moment of Inertia

- Speed Loop Integration Time Constant (Cn-05)
  The speed loop has an integration element to allow response to micro-inputs.
  This integration element can produce a delay in the servo system, and the positioning setting time increases and response becomes slower as the time constant increases.
  However, the integration time constant must be increased to prevent machine vibration if the load inertia is large or the mechanical system includes a element that is prone to vibra-

tion.
The following formula calculates a guideline value.

$$T_I \geq 2.3 \times \frac{1}{2\pi \times Kv}$$

T_I Integration Time Constant (sec)
Kv Speed Loop Gain (Hz) (calculated above)

- Torque Reference Filter Time Constant (Cn-17)
  When a ball screw is used, torsional resonance may occur which increases the pitch of the vibration noise.
  This vibration can sometimes be overcome by increasing the torque reference filter time constant.
  However, this filter will produce a delay in the servo system, just like the integration time constant, and its value should not be increased more than necessary.
- Speed Reference Gain (Cn-03)
  Changing the speed reference gain (Cn-03) changes the position loop gain an equivalent amount. That is, reducing the speed reference gain is equivalent to reducing the position loop gain and increasing it is equivalent to increasing the position loop gain.
  Use this parameter (Cn-03) in the following circumstances:
  - No position loop gain adjustment at host controller (including cases where fine adjustment not possible by changing number of D/A converter bits)
  - Clamping the speed reference output range to specific speeds

  Normally leave at the factory setting.

IMPORTANT

For a speed-control SGD or SGDA SERVOPACK, or SGDB or DR2 SERVOPACK used for speed control, the position loop gain (Cn-1A) is valid in zero-clamp mode only.
The position loop gain (Cn-1A) parameter is always invalid for a DR1 SERVOPACK.
For normal control, change the position loop gain at the host controller or adjust the speed reference gain (Cn-03) in the SERVOPACK.
Changing Cn-1A does not change the position loop gain.

■ Adjustment Procedure

1. Set the position loop gain at the host controller to a low value and increase the speed loop gain (Cn-04) within the range that no abnormal noise or vibration occurs.
   If adjustment of the position loop gain is not possible at the host controller, reduce the speed reference gain (Cn-03).
2. Slightly reduce the speed loop gain from the value at step 1, and increase the position loop gain at the host controller in the range that no overshooting or vibration occurs.
   If adjustment of the position loop gain is not possible at the host controller, increase the speed reference gain (Cn-03).
3. Determine the speed loop integration time constant (Cn-05), by observing the positioning setting time and vibrations in the mechanical system.
   The positioning setting time may become excessive if the speed loop integration time constant (Cn-05) is too large.

4. It is not necessary to change the torque reference filter time constant (Cn-17) unless torsional resonance occurs in the machine shafts.
   Torsional resonance may be indicated by a high vibration noise. Adjust the torque reference filter time constant (Cn-17) to reduce the vibration noise.

5. Finally, fine adjustment of the position gain, speed gain, and integration time constant is required to determine the optimum point for step response.

A.3 Adjusting a Position-control SERVOPACK

This section gives examples of adjusting the gains of a position-control SERVOPACK manually and using auto-tuning.

A.3.1 Adjusting Using Auto-tuning

The DR1 SERVOPACK does not offer auto-tuning.

■ Important Points About Auto-tuning

- Speed During Auto-tuning
  Auto-tuning may not function correctly if the speed is too low. Set the speed to approximately 500 r/min.
  Set the speed with the parameter Cn-10 (Jog speed).
- Selecting Machine Rigidity
  If the machine rigidity is unknown, select the rigidity according to the following standards.

Drive Method	Machine Rigidity	
	SGDB, SGDA, DR2	SGD
Ball screw, direct	3 (C-003) to 7 (C-007)	High/medium response
Ball screw, with reduction gears	2 (C-002) to 3 (C-003)	Medium response
Timing belt	1 (C-001) to 3 (C-003)	Low/medium response
Chain	1 (C-001) to 2 (C-002)	Low response
Wave reduction gears*	1 (C-001) to 2 (C-002)	Low response

* Product name: Harmonic Drive

Select the machine rigidity level for SGDB, SGDA and DR2 according to the table.

Level	Rigidity
7 (C-007)	High
6 (C-006)	:
5 (C-005)	:
4 (C-004)	:
3 (C-003)	Medium
2 (C-002)	:
1 (C-001)	Low

Auto-tuning may not end if high response is selected for a low-rigidity machine or low response is selected for a high-rigidity machine.
If this occurs, halt the auto-tuning and change the machine rigidity selection.

If Auto-tuning is Unsuccessful

Auto-tuning may be unsuccessful (the end of auto-tuning not displayed) for machines with large play or extremely low rigidity.
Similarly, auto-tuning may be unsuccessful for a machine with high load inertia (exceeding 15 to 30 times the motor moment of inertia).
In these cases, use conventional manual adjustment.
Even if auto-tuning is successful for a machine with large fluctuations in load inertia or load torque, vibrations or noise may still occur in some positions.

Response During Operation is Unsatisfactory after Auto-tuning

Auto-tuning sets the gain and integration time constant with some safety margin (to avoid oscillations). This can result in long positioning times.
In particular, the target position may not be reached if low response is selected, because the machine does not move in response to the final minute references. An excessively high setting of the integration time constant (Cn-05) during auto-tuning is one cause of this problem.
If response is slow after auto-tuning, the speed loop gain cannot be manually increased very much before vibration starts.
In this case, manually reduce the integration time constant while observing the machine behavior to ensure oscillation does not occur.
Auto-tuning does not set the torque reference filter (Cn-17).

A.3.2 Manual Adjustment

Parameters

The role of each parameter is briefly described below.

- Speed Loop Gain (Cn-04)
  This parameter sets the speed loop response.
  The response is improved by setting this parameter to the maximum value in the range which does not cause vibrations in the mechanical system.
  The following formula relates the speed loop gain to the load inertia.

$$\text{Speed Loop Gain Kv [Hz]} = \frac{2}{\frac{J_L}{J_M} + 1} \times (\textit{Cn-04 Preset value})$$

J_L: Motor Axis Converted Load Inertia
J_M: Motor Moment of Inertia

- Speed Loop Integration Time Constant (Cn-05)
  The speed loop has an integration element to allow response to micro-inputs.
  This integration element can produce a delay in the servo system, and the positioning setting time increases and response becomes slower as the time constant increases.
  However, the integration time constant must be increased to prevent machine vibration if

the load inertia is large or the mechanical system includes a vibration elements.
The following formula calculates a guideline value.

$$T_i \geq 2.3 \times \frac{1}{2\pi \times Kv}$$

Ti Integration Time Constant (sec)
Kv Speed Loop Gain (Hz) (calculated above)

- Torque Reference Filter Time Constant (Cn-17)
  When a ball screw is used, torsional resonance may occur which increases the pitch of the vibration noise.
  These vibrations can sometimes be overcome by increasing the torque reference filter time constant.
  However, this filter can produce a delay in the servo system, as is the integration time constant, and its value should not be increased more than necessary.
- Position Loop Gain
  The position loop gain parameter sets the servo system response.
  The higher the position loop gain is set, the better the response and shorter the positioning times.
  To enable a high setting of the position loop gain, increase the machine rigidity and raise the machine characteristic frequency.
  Increasing the position loop gain only to improve the response can result in oscillating response of the overall servo system, that is, the speed references output from the position loop oscillate. Therefore, also increase the speed loop gain while observing the response.

Adjustment Procedure

1. Set the position loop gain to a low value and increase the speed loop gain (Cn-04) within the range that no abnormal noise or oscillation occurs.
2. Slightly reduce the speed loop gain from the value at step 1, and increase the position loop gain in the range that no overshooting or vibration occurs.
3. Determine the speed loop integration time constant (Cn-05), by observing the positioning set time and vibrations in the mechanical system.
   The positioning set time may become excessive if the speed loop integration time constant (Cn-05) is too large.
4. It is not necessary to change the torque reference time constant (Cn-17) unless torsional resonance occurs in the machine shafts.
   Torsional resonance may be indicated by a high vibration noise. Adjust the torque reference filter time constant to reduce the vibration noise.
5. Finally, fine adjustment of the position gain, speed gain, and integration time constant is required to determine the optimum point for step response, etc.

Functions to Improve Response

The mode switch, feed-forward, and bias functions improve response.
However, they are not certain to improve response and may even worsen it in some cases. Follow the points outlined below and observe the actual response while making adjustments.

- Mode Switch

  The mode switch improves the transition characteristics when the torque references become saturated during acceleration or deceleration.
  Above the set level, the speed loop control switches from PI (proportional/integral) control to P (proportional) control.

- Feed-forward Function

  Use feed-forward to improve the response speed. However, feed-forward may be ineffective in systems where a sufficiently high value of position loop gain is not possible.
  Follow the procedure below to adjust the feed-forward amount (Cn-1D).

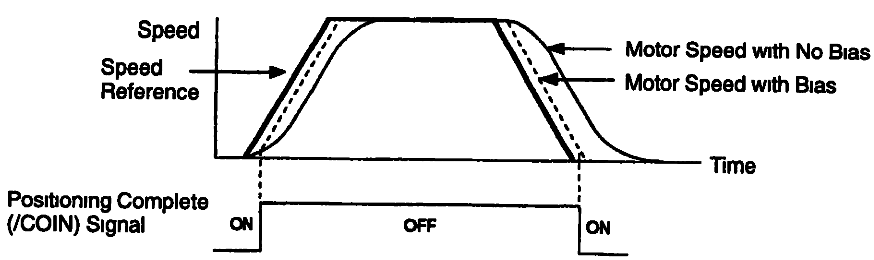
1. Adjust the speed loop and position loop, as described above.
2. Gradually increase the feed-forward amount (Cn-1D), such that the positioning complete (/COIN) signal is output early.

   At this point, ensure that the positioning complete (/COIN) signal breaks up (alternately turns ON/OFF) and that the speed does not overshoot. These problems can arise if the feed-forward is set too high.

   For all types of SERVOPACK except DR1, a primary delay filter can be applied to feed-forward. This filter can be used to correct breakup (alternately turning ON/OFF) of the positioning complete (/COIN) signal or speed overshoot arising when feed-forward is activated.

- Bias Function

  When the lag pulses in the error counter exceeds the positioning complete width (Cn-1B), the bias amount (Cn-1C) is added to the error counter output (speed reference). If the lag pulses in the error counter lies within the positioning complete width (Cn-1B), the bias amount (Cn-1C) is no longer added.
  This reduces the number of pulses in the error counter and shortens the positioning time.
  The motor speed becomes unstable if the bias amount is too large.
  Observe the response during adjustment as the optimum value depends on the load, gain, and positioning complete width.
  Set Cn-0C to zero (0) when the bias is not used.



The adjustment procedures described above are common for all Yaskawa digital AC SERVOPACKs. However, not all functions are available on each SERVOPACK. Consult the technical specifications of your SERVOPACK for details.
The adjustment procedures are also identical for conventional analog servos. However, in this case, the adjustments are made using potentiometers instead of the parameters.

A.4 Guidelines for Gain Settings According to Load Inertia Ratio

This section presents tables of load inertia values for reference when adjusting the gain.

Adjustment guidelines are given below according to the rigidity of the mechanical system and load inertia. Use these values as guidelines when adjusting according to the procedures described above. These values are given as guidelines only. Oscillations and poor response may occur inside the specified value ranges. Observe the response (waveform) when optimizing the adjustment.
Higher gains are possible for machines with high rigidity.

Machines with High Rigidity

Ball Screw, Direct Drive Machines
Example: Chip mounter, IC bonder, precision machine tools

Load/Inertia Ratio (J_L/J_M)	Position Loop Gain (Cn-1A) [1/s]	Speed Loop Gain (Cn-04)	Speed Loop Integration Time Constant (Cn-05) [ms]
1 x	50 to 70	50 to 70	5 to 20
3 x		100 to 140	Slightly increase for inertia ratio of 20 x, or greater.
5 x		150 to 200	
10 x		270 to 380	
15 x		400 to 560	
20 x		500 to 730	
30 x		700 to 1100	

For an inertia ratio of 10 x, or greater, slightly reduce the position loop gain and speed loop gain below the values shown and set the integration time constant to a higher value before starting the adjustment.
As the inertia ratio increases, set the position loop gain and speed loop gain to the lower limit of the range of values specified. Conversely, increase the speed loop integration time constant.

Machines with Medium Rigidity

Machines driven by ball screw through reduction gears, or machines directly driven by long ball screws.
Example: General machine tools, orthogonal robots, conveyors

Load/Inertia Ratio (J_L/J_M)	Position Loop Gain (Cn-1A) [1/s]	Speed Loop Gain (Cn-04)	Speed Loop Integration Time Constant (Cn-05) [ms]
1 x	30 to 50	30 to 50	10 to 40 Slightly increase for inertia ratio of 20 x, or greater.
3 x		60 to 100	
5 x		90 to 150	
10 x		160 to 270	
15 x		240 to 400	
20 x		310 to 520	
30 x		450 to 770	

For an inertia ratio of 10 x, or greater, slightly reduce the position loop gain and speed loop gain below the values shown and set the integration time constant to a higher value before starting the adjustment.

As the inertia ratio increases, set the position loop gain and speed loop gain to the lower limit of the range of values specified. Conversely, increase the speed loop integration time constant.

Machines with Low Rigidity

Machines driven by timing belts, chains or wave reduction gears (product name: Harmonic Drive).

Example: Conveyors, articulated robots

Load/Inertia Ratio (J_L/J_M)	Position Loop Gain (Cn-1A) [1/s]	Speed Loop Gain (Cn-04)	Speed Loop Integration Time Constant (Cn-05) [ms]
1 x	10 to 20	10 to 20	50 to 120 Slightly increase for inertia ratio of 20 x, or greater.
3 x		20 to 40	
5 x		30 to 60	
10 x		50 to 110	
15 x		80 to 160	
20 x		100 to 210	
30 x		150 to 310	

For an inertia ratio of 10 x, or greater, slightly reduce the position loop gain and speed loop gain below the values shown and set the integration time constant to a higher value before starting the adjustment.

As the inertia ratio increases, set the position loop gain and speed loop gain to the lower limit of the range of values specified. Conversely, increase the speed loop integration time constant.

When a speed-control SERVOPACK is used, set the position loop gain at the host controller. If the position loop gain cannot be set at the host controller, adjust the SERVOPACK speed reference gain (Cn-03).

The position loop gain (Cn-1A) of a speed-control SERVOPACK is valid in zero-clamp mode only.

The position loop gain is determined from the following relationship.

$$K_P = \frac{V_S}{\epsilon}$$

K_P [1/s]	Position loop gain
V_S [PPS]	Steady speed reference
e (pulse)	Steady error
	(The number of pulses in the error counter at steady speed)

B

COMPARISON WITH PREVIOUS SERVOPACKS

This appendix describes the different functions provided on the new SGDB SERVOPACKs.

B.1 Functional Differences

B.1.1 Dynamic Brake (DB)

The dynamic brake (DB) in SGDB SERVOPACKs with a capacity of 15 kW or less operates when a power loss occurs because the dynamic brake driver uses a normally-closed contact relay or a thyristor.

The dynamic brake in SGDB SERVOPACKs with a capacity between 22 kW and 55 kW functions differently according to the SERVOPACK used as follows:

The dynamic brake driver uses a 24-V DC contactor. If the control power supply is interrupted, 24 VDC can be maintained for approximately 2 seconds only.

Resistors for dynamic brake control are not built into 22- to 55-kW, 400-V SERVOPACKs, unlike SERVOPACKs with a capacity of 15 kW or less. Connect a Dynamic Brake Unit (JUSP-DB□□) or other type of dynamic brake resistor (prepared by the customer) to the dynamic brake connection terminals, DU, DV, and DW.

A dynamic brake resistor does not need to be connected if the dynamic brake function is not required.

B.1.2 Contact Input Speed Control

The contact input speed control function available for SERVOPACKs with a capacity of 15 kW or less is not available for 22- to 55-kW SGDB SERVOPACKs.

Refer to *Chapter 3* in the *Σ-Series SGM□/SGDB User's Manual* (Manual No.: TSE-S800-16) for more details on contact input speed control.

B.2 Different Parameters and Alarms

B.2.1 Parameters

The function of the following parameters differ when the contact input speed control function is not available, as shown below.

Parameter	SERVOPACKs of 15 kW or less	SERVOPACKs of 22 kW to 55 kW
Cn-1F	Contact input speed control (Speed 1)	Not used.
Cn-20	Contact input speed control (Speed 2)	Not used.
Cn-21	Contact input speed control (Speed 3)	Not used

B.2.2 Alarms

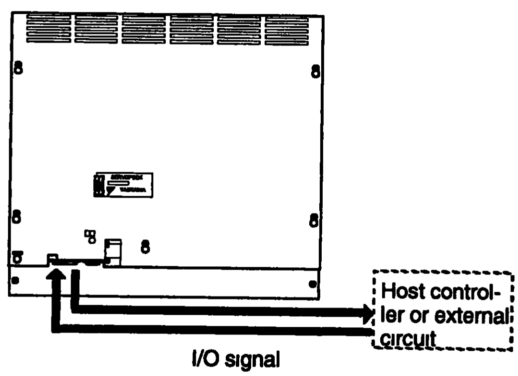
The following alarm occurs in SGDB SERVOPACKs with a capacity of 22 kW to 55 kW only. It does not occur in SERVOPACKs with a capacity of 15 kW or less.

Digital Operator Display and Alarm Name	Alarm Output				Cause	Remedy
	Alarm Code Output			ALM Output		
	ALO3	ALO2	ALO3			
AF4 Main circuit contactor error	OFF	ON	OFF	OFF	Main circuit contactor defective.	Replace SERVOPACK.

C

List of I/O Signals

This appendix lists I/O signal terminals (connector 1CN) on SERVOPACKs which connect to a host controller or external circuit.



IMPORTANT

1. Refer to *Chapter 3* for details of how to use I/O signals.
2. Note that the functions of I/O signal terminals differ according to the memory switch (Cn-01, Cn-02) settings.

List of Input Output Signals

Number "x.x.x" in box represents a section number corresponding to each signal name. For example, 3.2.1 represents Section 3.2.1.

1CN Terminal Number	Abbreviated symbol	Signal name		
1	SG	Signal ground		
2	SG	Signal ground		
3	PL1	Power supply for open collector reference	3.2.2	*2
4	SEN	Sensor ON	3.8.5	*6
5	V-REF	Speed reference input	3.2.1	*1
6	SG	Signal ground		
7	PULS	Reference pulse input	3.2.2	*2
8	/PULS			
9	T-REF	Torque reference input	3.2.6	*1
10	SG	Signal ground		
11	SIGN	Reference sign input	3.2.2	*2
12	/SIGN			
13	PL2	Power supply for open collector reference	3.2.2	*2
14	/CLR	Clear signal input	3.2.2	*2
15	CLR			
16	TRQ-M	Torque monitor	3.2.11	*3
17	VTG-M	Speed monitor	3.2.11	*3
18	PL3	Power supply for open collector reference	3.2.2	*2
19	PCO	Phase-C output signal	3.2.3	
20	/PCO			
21	BAT	Back-up battery input	3.8.5	*6
22	BAT0			
23	+12V	Power supply for analog reference	3.2.1	*1
24	–12V			
25	/V-CMP/ /COIN	Speed coincidence output/positioning completion signal	3.7.4 3.7.3	*4
26	/V-CMP/ /COIN	Speed coincidence output/positioning completion signal	3.7.4 3.7.3	*4
27	/TGON+	Rotating detection	3.7.5	*4
28	/TGON–			

29	/S-RDY+	Servo ready	3.7.7	*4
30	/S-RDY–			
31	ALM+	Alarm output	3.7.1	
32	ALM–			
33	PAO	Phase-A output signal	3.2.3	
34	/PAO			
35	PBO	Phase-B output signal	3.2.3	
36	/PBO			
37	ALO1	Alarm code output	3 7.1	
38	ALO2			
39	ALO3			
40	/S-ON	Servo ON	3.7.2	
41	/P-CON	Proportional control (P control) reference	3.2 1	*5
42	P-OT	Forward drive disabled	3.1.2	
43	N-OT	Reverse drive disabled	3.1.2	
44	/ALMRST	Alarm reset	3.7.1	
45	/P-CL	Forward torque limit	3.1.3	*5
46	/N-CL	Reverse torque limit	3.1.3	*5
47	+24 V IN	24V external power supply input	3.2.4	
48	PSO	Phase-S input signal	3.8.5	*6
49	/PSO			
50	FG	Frame ground	3.2.3	

* 1 Used for analog reference . . See page C -4

* 2 Used for pulse reference See page C -4

* 3 Specifications vary depending on bits 6, 7 of Cn-02 refer to page C -5

* 4 Specifications vary according to setting values of Cn-2D refer to page E - 1

* 5 Specifications vary according to setting values of Cn-2B refer to page C -5

* 6 Used only for absolute encoder (used only when bit E of Cn-01 equal to 1)

C

*1 Signals used for analog reference

For speed control

Specifications / Setting / 1CN Terminal number	Speed control		Speed control with torque limit by analog voltage reference		Speed control with torque feed-forward	
	Cn-02 Bit 8 = 0 Bit 9 = 0		Cn-02 Bit 8 = 1 Bit 9 = 0		Cn-02 Bit 8 = 0 Bit 9 = 1	
5	V-REF	Speed reference	V-REF	Speed reference	V-REF	Speed reference
9	---	Terminal unused	T-REF	Torque limit input	T-REF	Torque feed-forward reference

For torque control

Specifications / Setting / 1CN Terminal number	Torque control		Torque control with speed limit by analog voltage reference	
	Cn-02 Bit 2= 0		Cn-02 Bit 2= 1	
5	---	Terminal unused	V-REF	Speed limit value
9	T-REF	Torque reference	T-REF	Torque reference

*2 Signals used for pulse reference

Specifications / Setting / 1CN Terminal number	Sign + pulse train input reference		CCW pulse + CW pulse reference		Two phase pulse reference with 90° phase difference	
	Cn-02 Bit 5 = 0 Bit 4 = 0 Bit 3 = 0		Cn-02 Bit 5 = 0 Bit 4 = 0 Bit 3 = 1		Cn-02 bits 5, 4, 3 = 0, 1, 0 (x1 multiplication) = 0, 1, 1 (x2 multiplication) = 1, 0, 0 (x4 multiplication)	
7	PULS	Reference pulse input	PULS	Forward reference pulse input (CCW)	PULS	Phase-A reference pulse input
8	/PULS		/PULS		/PULS	
11	SIGN	Reference sign input	SIGN	Reverse reference pulse input (CW)	SIGN	Phase-B reference pulse input
12	/SIGN		/SIGN		/SIGN	

*3 Analog monitor signals

Control mode	----------		Speed mode		Position control	Torque control
Setting / 1CN Terminal number	Cn-02 Bit 6 = 0		Cn-02 Bit 6 = 1			
16	TRQ-M	Torque monitor	TRQ-M	Speed reference monitor	Reference pulse speed monitor	×
Setting / 1CN Terminal number	Cn-02 Bit 7 = 0		Cn-02 Bit 7 = 1			
17	VTG-M	Speed monitor	VTG-M	×	Position error monitor	×

Note x means don't care for voltage values

*5

Specifications	Speed control Position control		Torque control	
Setting / 1CN Terminal number	Cn-2B = 0, 1		Cn-2B = 2	
41	/P-CON	Proportional control reference	---	Terminal unused
45	/P-CL	Forward (Reverse) torque limit	/P-CL	Forward (Reverse) torque limit
46	/N-CL		/N-CL	

Specifications	Position ⟷ Speed Position ⟷ Torque Torque ⟷ Speed		Speed control with zero clamp		Position control with reference pulse inhibit function	
Setting / 1CN Terminal number	Cn-2B = 7, 8, 9		Cn-2B = 10		Cn-2B = 11	
41	/P-CON	Control mode switching signal	/P-CON	Zero clamp operation reference	/P-CON	Reference pulse inhibit reference
45	/P-CL	Forward (Reverse) torque limit	/P-CL	Forward (Reverse) torque limit	/P-CL	Forward (Reverse) torque limit
46	/N-CL		/N-CL		/N-CL	

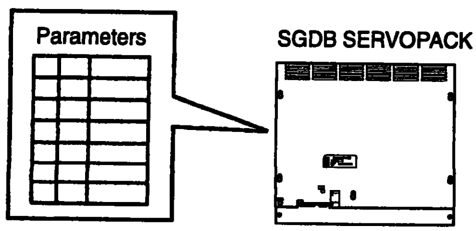
D

List of Parameters

Σ-Series SERVOPACKs provide many functions, and have parameters called "parameters" to allow the user to select each function and perform fine adjustment. This appendix lists these parameters.

Parameters are divided into the following two types.

Memory switch Cn-01, Cn-02	Each bit of this switch is turned ON or OFF to select a function.
Parameter setting Cn-03 and later	A numerical value such as a torque limit value or speed loop gain is set in this constant.



IMPORTANT

1. Refer to *Chapter 3* for details of how to use parameters.
2. For details of how to set parameters, refer to *Section 4.1.6 Operation in Parameter Setting Mode.*

List of Parameters (Parameter Setting)

Category	Parameter No.	Code	Name	Unit	Lower Limit	Upper Limit	Factory Setting	Remarks
	Cn-00	Not a parameter. (Cn-00 is used to select a special mode for digital operator)						
	Cn-01	Memory switch (See page D -4)bit E (encoder selection) *2						
	Cn-02	Memory switch (See page D -5) *2(Except bit 6, 7, E)						
Basic Constants	Cn-11	PULSNO	Number of encoder pulses	P/R	513	32768	*1	*2
	Cn-2B	CTLSEL	Control method selection	*1	0	11	0	*2
	Cn-2A	MTRSEL	Motor selection	*1	0	254	*1	*2
Gain Related Constants	Cn-03	VREFGN	Speed reference adjustment gain	(r/min)/V	10	2000	*1	
	Cn-04	LOOPHZ	Speed loop gain	Hz	1	2000	80	*3
	Cn-05	PITIME	Speed loop integration time constant	0.01 ms	200	51200	2000	*3
	Cn-1A	POSGN	Position loop gain	1/s	1	1000	40	*3
	Cn-1C	BIASLV	Bias	r/min	0	450	0	
	Cn-1D	FFGN	Feed-forward	%	0	100	0	
	Cn-17	TRQFIL	Torque reference filter time constant	0.1 ms	0	250	16	
	Cn-28	NFBCC	Speed loop compensation constant	---	0	100	0	
	Cn-0C	TRQMSW	Mode switch torque reference	%	0	800	200	
	Cn-0D	REFMSW	Mode switch speed reference	r/min	0	10000	0	
	Cn-0E	ACCMSW	Mode switch acceleration	10 r/min/s	0	3000	0	
	Cn-0F	ERPMSW	Mode switch error pulse	reference unit	0	10000	0	
Reference related constants	Cn-0A	PGRAT	PG dividing ratio	P/R	16	32768	*1	
	Cn-24	RATB	Electronic gear ratio (numerator)	---	1	65535	4	*2
	Cn-25	RATA	Electronic gear ratio (denominator)	---	1	65535	1	*2
	Cn-07	SFSACC	Soft start acceleration time	ms	0	10000	0	*4
	Cn-23	SFSDEC	Soft start deceleration time	ms	0	10000	0	*4
	Cn-26	ACCTME	Position reference acceleration/deceleration constant	0.1 ms	0	640	0	
	Cn-27	FFFILT	Feed-forward filter	0.1 ms	0	640	0	

Category	Parameter No.	Code	Name	Unit	Lower Limit	Upper Limit	Factory Setting	Remarks
Torque Related Constants	Cn-08	TLMTF	Forward rotation torque limit	%	0	800	800	
	Cn-09	TLMTR	Reverse rotation torque limit	%	0	800	800	
	Cn-18	CLMIF	Forward external current limit	%	0	800	100	
	Cn-19	CLMIR	Reverse external current limit	%	0	800	100	
	Cn-06	EMGTRQ	Emergency stop torque	%	0	800	800	
	Cn-13	TCRFGN	Torque reference gain	0.1 V/ 100%	10	100	30	
	Cn-14	TCRLMT	Speed limit for torque control	r/min	0	10000	10000	
Sequence Related Constants	Cn-2D	OUTSEL	Output signal selection	*1	110	666	210	
	Cn-0B	TGONLV	Zero-speed level	r/min	1	10000	20	
	Cn-29	ZCLVL	Zero clamp level	r/min	0	10000	10	
	Cn-22	VCMPLV	Speed coincidence signal output range	r/min	0	100	10	
	Cn-1B	COINLV	Positioning completion range	reference unit	0	250	7	
	Cn-1E	OVERLV	Overflow	256 reference unit	1	32767	1024	
	Cn-12	BRKTIM	Time delay from brake reference until servo OFF	10 ms	0	50	0	
	Cn-15	BRKSPD	Speed level for brake reference output during motor operation	r/min	0	10000	100	
	Cn-16	BRKWAI	Output timing of brake reference during motor operation	10 ms	10	100	50	
Other Constants	Cn-10	JOGSPD	Jog speed	r/min	0	10000	500	
	Cn-1F	–	Not used	–	0	90	0	
	Cn-20	–	Not used	–	0	90	0	
	Cn-21	–	Not used	–	0	90	0	
	Cn-2C	PGPWR	PG power supply voltage change	0.1 mV	52000	58000	52500	

* [ ] . Parameters must be set and checked before turning the motor power ON

Note 1 Refer to page D -7

2 After changing the setting, always turn the power OFF, then ON This makes the new setting valid

3 Automatically set by auto tuning function

4 To use soft start function, always set both Cn-07 and Cn-23

List of Parameters (Memory Switch Setting) (1)

	Parameter No.	Bit No.	Setting 0	Setting 1	Factory Setting
Input signal enable/disable	Cn-01	0	0: Uses servo ON input (/S-ON).	1: Does not use servo ON input (/S-ON). Servo is always ON	0
		1	0: Uses SEN signal input (SEN) when absolute encoder is used.	1: Does not use SEN signal input (SEN) when absolute encoder is used. SERVOPACK automatically treats signal voltage as high level.	0
		2	0: Uses forward rotation prohibited input (P-OT).	1: Does not use forward rotation prohibited input (P-OT). Forward rotation is always possible.	0
		3	0: Uses reverse rotation prohibited input (N-OT).	1: Does not use reverse rotation prohibited input (N-OT). Reverse rotation is always possible.	0
Reserved		4	Reserved . Setting = 0 (do not change the setting)		0
Operation performed at recovery from power loss		5	0: Resets servo alarm status at power recovery from its momentary power loss.	1: Remains in servo alarm status at power recovery from momentary power loss	0
Sequence selection at alarm condition		6	0: Stops the motor by applying dynamic brake (DB)at base block.	1: Makes the motor coast to a stop at base block.	0
		7	0: At base block, stops the motor by applying dynamic brake (DB)and then release DB.	1: At base block, stops the motor by applying dynamic brake (DB)but does not release DB.	0
		8	0: Stops the motor according to bit 6 setting when overtravel is detected (P-OT, N-OT).	1: Decelerates the motor to a stop by applying the torque specified in Cn-06 when overtravel is detected (P-OT, N-OT).	0
		9	0: When overtravel is detected (P-OT, N-OT), decelerates the motor to a stop by applying the torque specified in Cn-06 and then performs Servo OFF.	1: When overtravel is detected (P-OT, N-OT), decelerates the motor to a stop by applying the torque specified in Cn-06 and then turns the zero-clamp	0
Process selection for Servo OFF		A	0: Clears error pulse at Servo OFF	1: Does not clear error pulse at Servo OFF	0
Mode switch selection		B	0: Uses mode switch function. Follows Cn-01 bits D, C	1: Does not use mode switch function.	0
		D·C	0·0: Uses internal torque reference as a condition (Level setting : Cn-0C) 0·1: Uses speed reference as a condition (Level setting : Cn-0D)	1·0: Uses acceleration as a condition (Level setting Cn-0E) 1·1: Uses error pulse as a condition (Level setting : Cn-0E)	0·0

	Parameter No.	Bit No.	Setting		Factory Setting
Encoder selection	Cn-01	E	0	1	0
			Uses incremental encoder.	Uses absolute encoder.	
Reserved		F	Reserved : Setting = 0 (do not change the setting)		0

* [shaded]. Parameters must be set and checked before turning the motor power ON

Note For the Cn-01 memory switch, always turn the power OFF, then ON after changing the setting This makes the new setting valid

List of Parameters (Memory Switch Setting) (2)

	Parameter No.	Bit No.	Setting					Factory Setting
Rotation direction selection	Cn-02	0	0		1			0
			Defines counterclockwise (CCW) rotation as forward rotation.		Defines clockwise (CW) rotation as forward rotation (reverse rotation mode).			
Home position error processing selection		1	0		1			0
			Detects home position error (when absolute encoder is used).		Does not detect home position error.			
Analog speed limit function		2	0		1			0
			Does not use analog speed limit function		Uses analog speed limit function			
Reference pulse form		5·4·3	0·0·0	0·0·1	0·1·0	0·1·1	1·0·0	0·0·0
			Sign + Pulse	CW+CCW	Phase-A + phase-B (x1 multiplication)	Phase-A + phase-B (x2 multiplication)	Phase-A + phase-B (x4 multiplication)	
Analog monitor selection		6	0		1			0
			Outputs torque to TRQ-M		Outputs reference speed to TRQ-M			
		7	0		1			0
			Outputs speed to VTG-M		Outputs position error to VTG-M			
Analog current limit function		8	0		1			0
			Does not use analog current limit function		Uses analog current limit function			
Torque feed-forward function		9	0		1			0
			Does not use torque feed-forward function		Uses torque feed-forward function			
Clear signal		A	0		1			0
			Clears the error counter when an error counter clear signal is at high level		Clears the error counter on the rising edge of an error counter clear signal			
Reserved		B	Reserved . Setting = 0 (do not change the setting)					0
Torque filter		C	0		1			1
			Uses torque filter as primary filter		Uses torque filter as secondary filter			
Reference pulse form		D	0		1			0
			Does not invert reference pulse logic		Inverts reference pulse logic			
Position error monitor		E	0		1			0
			Displays position error in x1 reference units while in monitor mode		Displays position error in x100 reference units while in monitor mode			
Reference pulse filter		F	0		1.			0
			Selects filter time constant 'small'. (450 kpps max)		Selects filter time constant 'large'. (200 kpps max)			

Note For the Cn-02 memory switch, always turn the power OFF, then ON after changing the setting This makes the new setting valid However, bits 6, 7, E become valid immediately after setting

*1 Control method selection (Cn-2B) Setting Values

Setting values	Control method	
0	Speed control (analog reference)	
1	Position control (pulse train reference)	
2	Torque control (analog reference)	
3	Do not set.	
4	Do not set.	
5	Do not set.	
6	Do not set.	
7	Position control (pulse train reference)	↔Speed control (analog reference)
8	Position control (pulse train reference)	↔Torque control (analog reference)
9	Torque control (analog reference)	↔Speed control (analog reference)
10	Speed control (analog reference)	↔Zero clamp control
11	Position control (pulse train reference)	↔Position control (inhibit)

- Outputs signal selection (CN-2D) setting values
  Selects which function of signal sent to output signal of 1CN.

1st decimal digit	to select function of CN-25, 26 (/COIN//V-CMP)
2nd decimal digit	to select function of CN-27, 28 (/TGON)
3rd decimal digit	to select function of CN-29, 30 (/S-RDY)

Setting value	Function
0	/COIN//V-CMP (only assigned to 1CN-25, 26)
1	/TGON
2	/S-RDY
3	/CLT
4	/BK
5	OL warning
6	OL alarm

- Factory settings

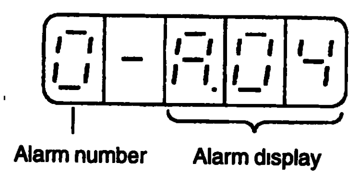
Group	SERVOPACK models	Applicable motor type	Cn-2A
2BA	SGDB-2BAD	SGMB-2BA□A	211
		SGMB-2BA□B	215
3ZA	SGDB-3ZAD	SGMB-3ZA□A	213
		SGMB-3ZA□B	214
3GA	SGDB-3GAD	SGMB-3GA□A	216
		SGMB-3GA□B	217
2BD	SGDB-2BDD	SGMB-2BA□D	218
		SGMB-2BA□E	219
3ZD	SGDB-3ZDD	SGMB-3ZA□D	220
		SGMB-3ZA□E	226
3GD	SGDB-3GDD	SGMB-3GA□D	227
		SGMB-3GA□E	228
4ED	SGDB-4EDD	SGMB-4EA□D	229
		SGMB-4EA□E	230
5ED	SGDB-5EDD	SGMB-5EA□D	231
		SGMB-5EA□E	232

D

E

List of Alarm Displays

SGDB SERVOPACK allows up to 10 last alarms to be displayed at a digital operator. This function is called a trace-back function.



This appendix provides the name and meaning of each alarm display.

For details of how to display an alarm, refer to the following section:
Section 4.2.1 Operation in Alarm Trace-back Mode

For the cause of each alarm and the action to be taken, refer to the following section:
Section 6.2.1 Troubleshooting Problems with Alarm Display

Alarm Display

Alarm Display on Digital Operator	Alarm Output				Alarm Name	Meaning	Remarks
	Alarm Code Output			ALM Output			
	ALO1	ALO2	ALO3				
A.00	OFF	OFF	OFF	OFF	Absolute data error	Absolute data fails to be received, or received absolute data is abnormal.	For absolute encoder only
A.02	OFF	OFF	OFF	OFF	Parameter breakdown	**Checksum** results of parameters are abnormal.	
A.04	OFF	OFF	OFF	OFF	Parameter setting error	The parameter setting is outside the allowable setting range	
A.10	ON	OFF	OFF	OFF	Overcurrent	An overcurrent flowed through the power transistor.	
A.30	ON	ON	OFF	OFF	Detection of regenerative error	Regenerative circuit is faulty	
A.31	ON	ON	OFF	OFF	Position error pulse overflow	Position error pulse has exceeded the value set in parameter Cn-1E (overflow).	
A.40	OFF	OFF	ON	OFF	Main circuit voltage error detection	Main circuit voltage is abnormal	
A.51	ON	OFF	ON	OFF	Overspeed	Rotation speed of the motor has exceeded detection level	Detection level = Maximum rotation speed x 1.1 or x1.2
A.71	ON	ON	ON	OFF	Overloaded (high load)	The motor was running for several seconds to several tens of seconds under a torque largely exceeding ratings.	
A.72	ON	ON	ON	OFF	Overloaded (low load)	The motor was running continuously under a torque largely exceeding ratings	
A.80	OFF	OFF	OFF	OFF	Encoder error	The number of pulses per encoder revolution is abnormal.	
A.81	OFF	OFF	OFF	OFF	Absolute encoder backup error	All three power supplies for the absolute encoder (+5 V, battery and internal capacitor) have failed.	For 12 bit absolute encoder only
A.82	OFF	OFF	OFF	OFF	Absolute encoder checksum error	The checksum results of absolute encoder memory is abnormal.	For 12 bit absolute encoder only
A.83	OFF	OFF	OFF	OFF	Absolute encoder battery error	Battery voltage for the absolute encoder is abnormal	For 12 bit absolute encoder only
A.84	OFF	OFF	OFF	OFF	Absolute encoder data error	Received absolute data is abnormal.	For 12 bit absolute encoder only
A.85	OFF	OFF	OFF	OFF	Absolute encoder overspeed	The motor was running at a speed exceeding 400 r/min when the absolute encoder was turned ON.	For 12 bit absolute encoder only

TERMS

◆ Checksum

An automatic check function for a set of data such as parameters It stores the sum of parameter data, recalculates the sum at specific timing, and then checks whether the stored value matches the recalculated value This function is a simple method of checking whether a set of data is correct

Alarm Display on Digital Operator	Alarm Output				Alarm Name	Meaning	Remarks
	Alarm Code Output			ALM Output			
	ALO1	ALO2	ALO3				
A.A1	ON	ON	ON	OFF	Heat sink overheated	Heat sink of SERVOPACK was overheated	
A.b1	OFF	OFF	OFF	OFF	Reference input read error	SERVOPACK CPU failed to detect reference input.	
A.C1	ON	OFF	ON	OFF	Servo overrun detected	The servomotor (encoder) ran out of control.	
A.C2	ON	OFF	ON	OFF	Encoder output phase error	Phases A, B and C output by the encoder are abnormal.	
A.C3	ON	OFF	ON	OFF	Encoder phase-A, -B disconnection	Wiring in encoder phase A or B is disconnected	
A.C4	ON	OFF	ON	OFF	Encoder phase-C disconnection	Wiring in encoder phases C is disconnected.	
A.F1	OFF	ON	OFF	OFF	Power lines open phase	One phase is not connected in the main power supply	
A.F3	OFF	ON	OFF	OFF	Power loss error	A power interruption exceeding one cycle occurred in AC power supply.	Only when bit 5 of Cn-01 set to 1
A F4	OFF	ON	OFF	OFF	Main circuit contactor error	Main circuit contactor is defective.	
CPF00	Undefined				Digital operator transmission error 1	Digital operator fails to communicate with SERVOPACK even five seconds after power is turned ON.	These alarms are not stored in alarm traceback memory.
CPF01	Undefined				Digital operator transmission error 2	Transmission error has occurred five consecutive times.	
A.99	OFF	OFF	OFF	ON	Not an error	Normal operation status	

OFF: Output transistor is OFF

ON: Output transistor is ON

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