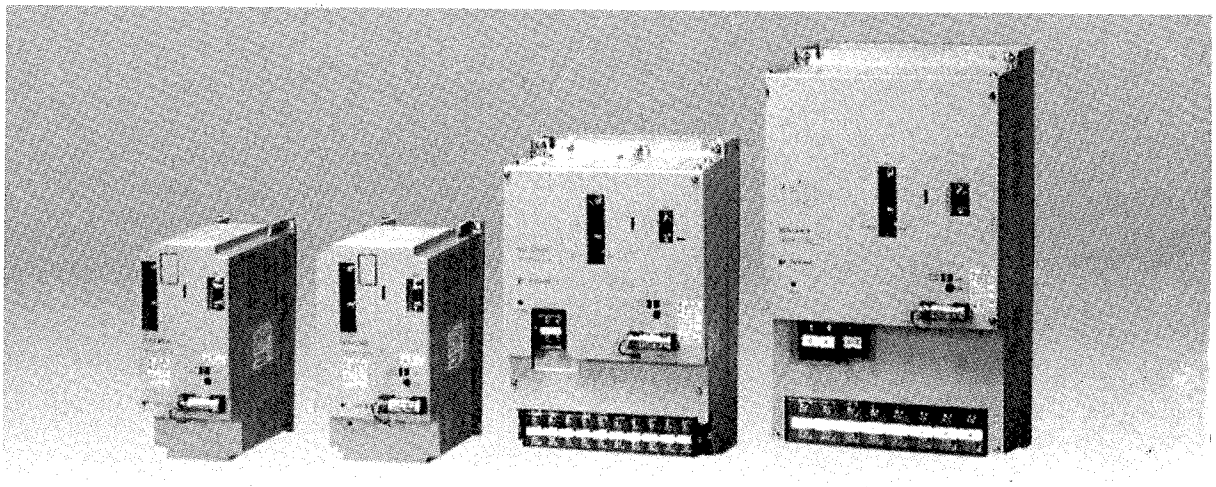
Σ Series SGM□/SGDB-□□AM

USER'S MANUAL

AC Servodrives

SGMG/SGMS/SDMD/SGMP/SGM Servomotors
SGDB-□□AM Servopack



YASKAWA

MANUAL NO. SIE-S800-16.3

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.

The warning symbols for ISO and JIS standards are different, as shown below.

ISO	JIS
	

The ISO symbol is used in this manual.

Both of these symbols appear on warning labels on Yaskawa products. Please abide by these warning labels regardless of which symbol is used.

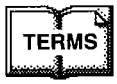
Visual Aids

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

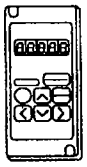
◀EXAMPLE▶ Indicates application examples.

Indicates supplemental information.

IMPORTANT Indicates important information that should be memorized.



Describes technical terms that are difficult to understand, or appear in the text without an explanation being given.



JUSP-OP02A-1

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

JUSP-OP03A

The text indicated by this icon explains the operating procedure using a Mounted Digital Operator (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 use of the servo.
- Advanced use of servo functions.
- 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 SGMG, SGMD, SGMS, SGM, or SGMP Servomotor
- SERVOPACK = Σ-Series SGDB-□□AM SERVOPACK (a trademark for Yaskawa servo amplifiers)
- Servodrive = A Servomotor and an amplifier (SGDB-□□AM SERVOPACK)
- Servo system = A complete servo control system consisting of servodrive, host controller, and peripheral devices

■ Explanation of Technical 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 Explained in This Manual

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.

Safety Precautions

Please read the following precautions on delivery checking, installation, wiring, operation, and inspection and maintenance.

■ Receiving

⚠ 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

- Ground the equipment ground terminal ⏚ according to electrical codes (ground resistance: 100 Ω or less).
  Failure to observe this warning may lead to electric shock or fire.

⚠ Caution

- Do not connect three–phase power supply to output terminals Ⓤ Ⓥ and Ⓦ.
  Failure to observe this caution may lead to personal injury or fire.
- Securely tighten screws on the power supply and motor output terminals.
  Failure to observe this caution can 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 lead to overrun or 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.

■ Inspection and Maintenance

⚠ WARNING

- Never touch the inside of the SERVOPACK.
  Failure to observe this warning may result in electric shock.
- Do not remove the panel cover while the power is ON.
  Failure to observe this warning may result in electric shock.
- Do not touch terminals for five minutes after the power is turned OFF.
  Residual voltage may result in electric shock.

⚠ Caution

- Do not disassemble the SERVOMOTOR.
  Failure to observe this caution may result in electric shock or personal injury.
- Never change wiring while power is ON.
  Failure to observe this caution may result in electric shock or personal injury.

■ General Precautions

Always note the following to ensure safe use.

- 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."

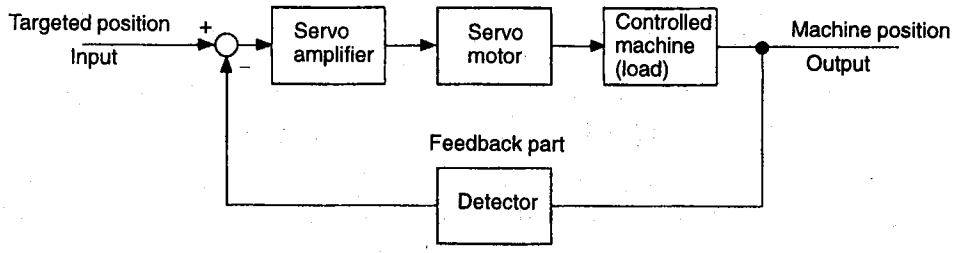
Servo system could be defined in more detail as a mechanism that moves at a specified speed and locates an object in a specified position.

◆ **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)

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 that returns process variables to the input side and forms a closed loop. It is also called closed-loop control.

1.1.2 Definition of Technical Terms

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

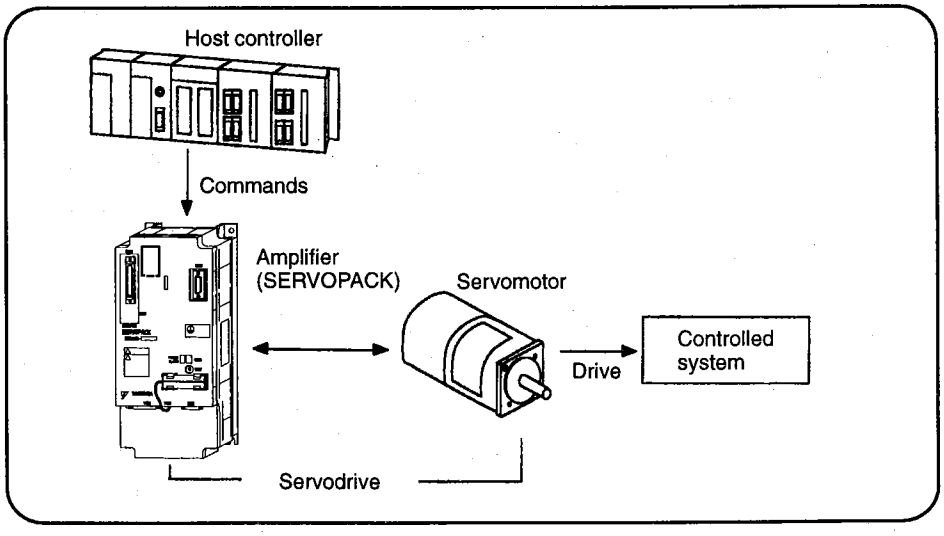
■ Servo

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 SGM□ Servomotors. In some cases, a position detector (encoder) is included in a servomotor.
SERVOPACK	Trademark of Yaskawa servo amplifier "SGDB SERVOPACK."
Servodrive	A Servomotor and amplifier pair. Also called "servo."
Servo system	A closed control system consisting of a host controller, servodrive and controlled system to form a servo mechanism.



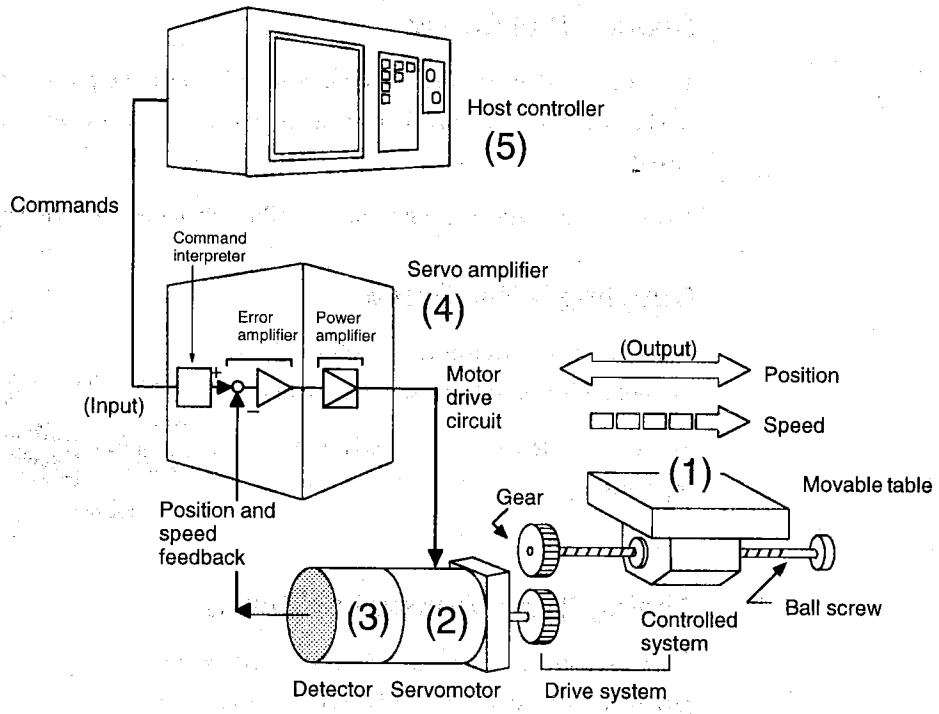
Servo System

1.2 Servo Configuration

This section describes the basic configuration of a servo system.

1.2.1 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 command and feedback data, and operates the servomotor accordingly. A servo amplifier consists of a command interpreter, which creates target movement patterns for the servomotor, an error amplifier, 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:

■ 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.

The **drive system** consists of the following parts.

Gears + Ball Screw

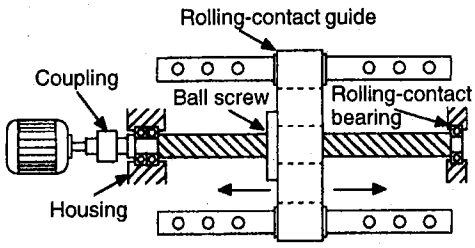
This drive system is most commonly used because the power transmission ratio (gear ratio) can be freely set to ensure high positioning accuracy. However, play in the gears must be minimized.

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

Coupling + Ball Screw

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

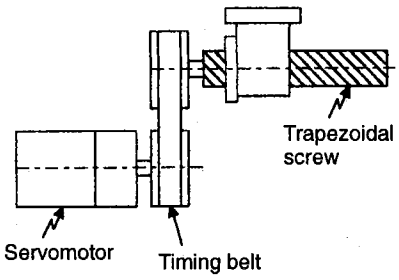
This drive system is widely used for machining tools.



Timing Belt + Trapezoidal Screw

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.

■ Servomotor

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 and other technologies. 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 7 Inspection, Maintenance, and Troubleshooting.*

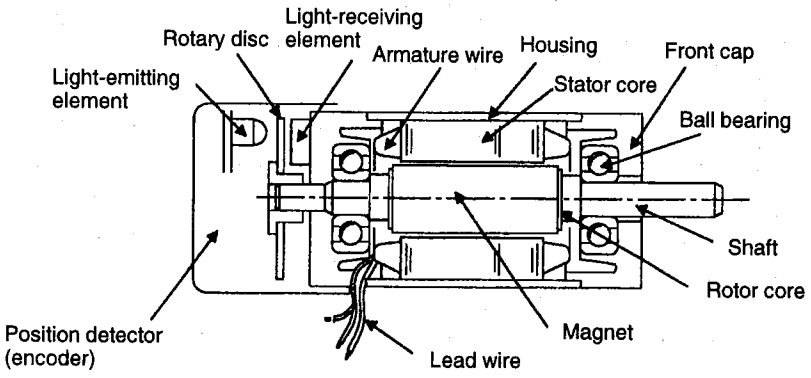
AC Servomotor

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

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

A synchronous 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 servomotor:



Yaskawa SGM□ Servomotors are of the synchronous type.

Performance of Servomotor

A servomotor must have "instantaneous power" so that it can start as soon as a start command 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.

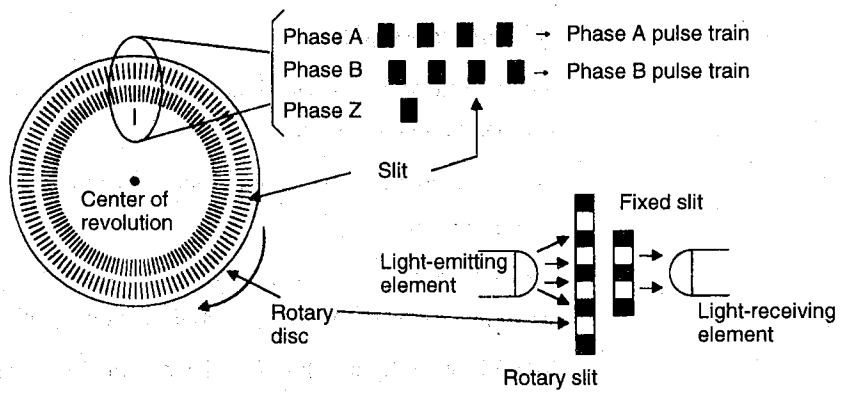
■ Detector

A servo system requires a detector to detect the position and speed. There are 2 detection methods: Optical and magnetic. The system uses an optical or magnetic encoder mounted on a servomotor as the detector.
There are two types of encoder: Incremental and absolute.

1

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 return operation must be performed before positioning.
The following figure illustrates the operation principle of a pulse generator:



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 return operation at the beginning of each operation.

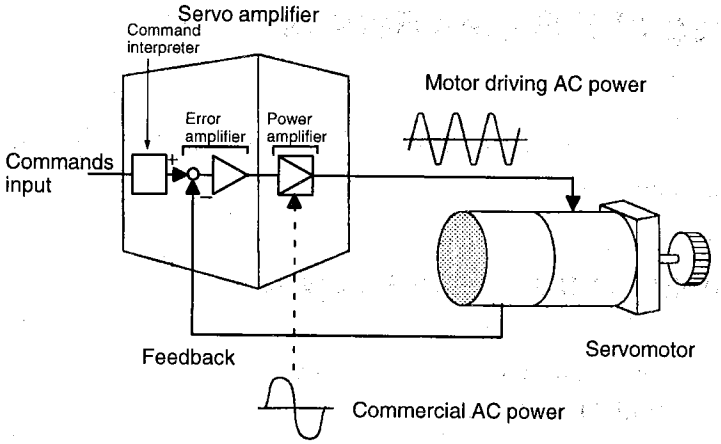
Difference between an Absolute and Incremental Encoder

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.

■ 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 three sections.

Command Interpreter

As shown in the device in the above figure, the command interpreter creates patterns for target movements for the servomotor based on commands sent via serial communications or contact points.

The movement patterns created in the command interpreter are sent to the error amplifier and power amplifier as target signals.

Error amplifier

The error amplifier compares the target signal 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.)

Power Amplifier

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

The Yaskawa SERVOPACK is equivalent to this servo amplifier.

Host Controller

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

TERMS

◆ **Proportional/integral (PI) control**

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

1.3 Features of Σ-Series Servos

A Σ-Series Servo consists of an SGM□ Servomotor and an SGDB-□□AM SERVOPACK (servo amplifier).

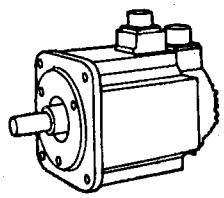
1.3.1 Outline of the Σ-Series Servos

This section describes the models of SGM□ Servomotors and the models of SGDB-□□AM SERVOPACK controls.

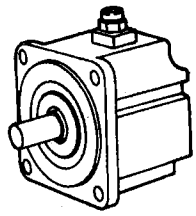
■ Models of SGM□ Servomotors

The SGM□ Servomotors are synchronous servomotors and have the following features:

Series	Rated Rotation Speed Maximum Rotation Speed	Rated Output
SGMG	1500 r/min 3000 r/min	0.45 to 15 kW (10 models)
	1000 r/min 2000 r/min	0.3 to 6.0 kW (8 models)
SGMS	3000 r/min 4500 r/min	1.0 to 5.0 kW (6 models)
SGMD	2000 r/min 3000 r/min	2.2 to 4.0 kW (3 models)
SGM	3000 r/min 4500 r/min	0.4 to 0.8 kW (2 models)
SGMP	3000 r/min 4500 r/min	0.4 to 1.5 kW (3 models)



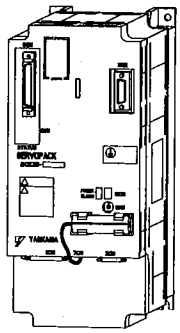
SGMG Servomotor



SGMP Servomotor

■ SGDB-□□AM SERVOPACK

The operation of the SGDB-□□AM SERVOPACK is based on commands sent via serial communications or contacts. Information of motor position is managed within the SERVOPACK, and there is no need to form a speed or position feedback loop between the host controller and SERVOPACK. Furthermore, acceleration and deceleration patterns can also be created based on user settings within the SERVOPACK.



SGDB-□□AM SERVOPACK

1.3.2 Using the SGDB SERVOPACK

■ Operation Modes

The SGDB-□□AM SERVOPACK has four operation modes. These modes can be switched at any time by means of a contact.

Automatic Mode

Following the input of command position data, the input of an operation start signal performs the positioning based on the input data.

The operation method in automatic mode can be selected from the following: Station numbers, digital switches, serial communications, and command table.

Manual Mode

The Servomotor runs at a constant speed while a manual mode signal is being input.

Pulse Mode

Positioning is performed by a pulse train command from an external pulse generator.

- Pulse system: Line driver, line receiver
- Pulse form: Two-phase pulse trains with 90° phase difference (×1) (450 kpps max.)
  Sign + pulse train (450 kpps max.)
  CW + CCW pulse trains (450 kpps max.)

An external PG input is triggered when an /LPG signal is input.

Zero Point Return Mode

This mode is used to perform a zero point return when an incremental encoder is used. The following three modes are available:

1. An STP signal (deceleration limit switch) is used together with the phase-C pulse of the encoder (method 1).
2. Only an STP signal (stop limit switch) is used.
3. An STP signal (deceleration limit switch) is used together with the phase-C pulse of the encoder (method 2).

■ Operation Methods in Automatic Mode

One of the following four operation methods can be selected in automatic mode by setting parameters.

Station Numbers

Performs indexed positioning.

A number attached to an index point (station number) is entered as position data.

Speed data is selected by a speed selection signal from among the four different speeds specified using parameters in the SERVOPACK.

Both one-way rotation and shortest-path rotation can be selected.

A station number can be between 0 and 999 if specified as a decimal number, or between 0 and 4095 if specified as a binary number.

If positioning points are evenly spaced, fewer command signals are needed than in when using digital switches.

Application examples: Disc tables, rotary-type automatic tool changers (ATCs), etc.

Digital Switches

Positioning data is input through digital switches, relays, or PLC contacts.

Positioning data can contain the following:

- Speed data: 6 digits max.
- Position data: Sign + 8 digits max.

This method is suited when the user wants to set positioning to an arbitrary position, and when the user wants to issue a position command without a host controller, such as a PLC or personal computer.

Application examples: Roll feeders, etc.

IMPORTANT

The digital switch method utilizes time-sharing to read data two digits at a time using a strobe signal. It is therefore necessary to use special Yaskawa Digital Switches for this purpose. If other digital switches or relays are used, be sure to use a Contact Input Unit. Also, when inputting data directly from a PLC, it is necessary to create a ladder program so that the strobe signal scan time (24 to 2,000 ms, variable) matches the PLC scan time.

Serial Communications

Serial commands are used to enter positioning data (position and speed).

Using multi-drop connections allows a single host controller to send commands to SERVOPACKs for up to 15 axes with a single group configuration or up to 32 axes with a multi-group configuration.

Settings allow the use of a fixed length mode, in which the serial command data length is set to a fixed value.

Serial communications can save the amount of wiring required, particularly in situations where commands are sent to multiple SERVOPACKs.

Application examples: X-Y tables (point-to-point configuration), etc.

Command Table

Positioning data is selected by means of a selection signal from a command table within the SERVOPACK.

Positioning data is selected as a set of position and speed data. Up to 512 sets can be entered.

This method is suited to situations where there are no more than 512 target positions, and these positions are not evenly spaced.

Application examples: Automated warehouses, etc.

2

Basic Use

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

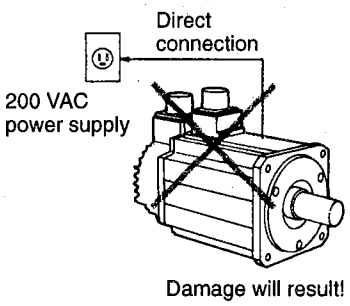
This section provides notes on using Σ-Series Servos.

■ Use 200 VAC Power Supply

Be sure to use 200 VAC power supply.

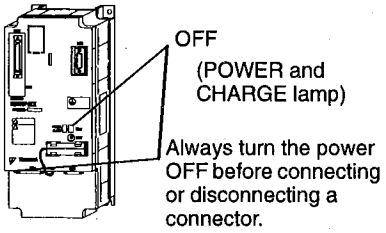
■ Do not plug the Servomotor directly into power outlet.

Do not plug the Servomotor directly into the power outlet. Doing so will damage the Servomotor. The Servomotor cannot be operated without an SGDB SERVOPACK.



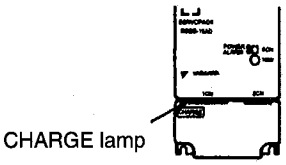
■ Do not change wiring when power is ON.

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



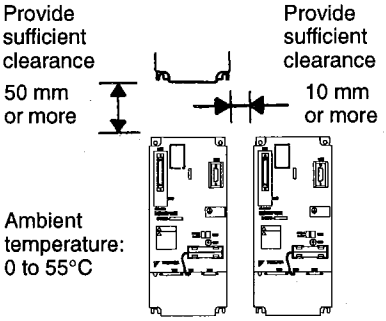
■ Wait 5 minutes or more for inspection after turning OFF the power.

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).



■ Provide at least 10 mm of clearance from other devices.

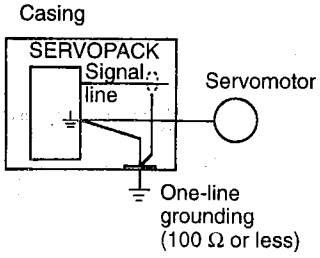
As shown in the diagram, provide as least 10 mm of clearance from other devices horizontally and at least 50 mm of clearance vertically. The SERVOPACKs generate heat and must be installed to allow sufficient heat dissipation. The SERVOPACKs must also be installed in locations where they will not be affected by 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.
- Use one-line grounding (ground resistance 100 Ω or less) for the Servomotor and SERVOPACK.
- Never use a noise filter for the power supply input between the motor and SERVOPACK.



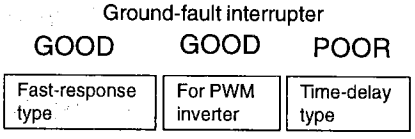
■ Conduct a voltage resistance test under the following conditions.

- Voltage: 1500 Vrms AC, one minute
- Interrupting current: 100 mA
- Frequency: 50/60 Hz
- Voltage application points: Between L1C, L3C, L1, L2, L3 terminals and frame ground (connect terminals securely).

Conduct a voltage resistance test under the conditions given on the left.

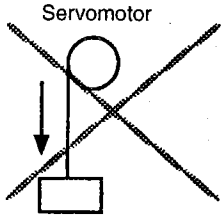
■ Use a fast-response ground-fault interrupter.

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.

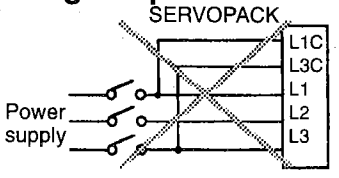
Continuous operation cannot be performed by rotating the motor from the load and applying regenerative braking. Regenerative braking by the SERVOPACK can be applied only for a short period, such as the motor deceleration time.



Regenerative braking continuously applied

■ 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 command signals.



Starting and stopping 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

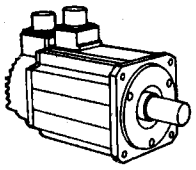
When Σ-Series products are delivered, check the following items:

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 table below).
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.

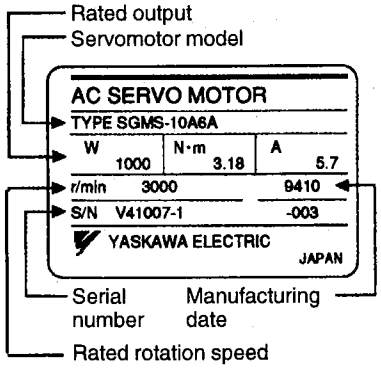
■ Servomotors

Appearance and Nameplate



Σ-Series Servomotor

(Example)



Models

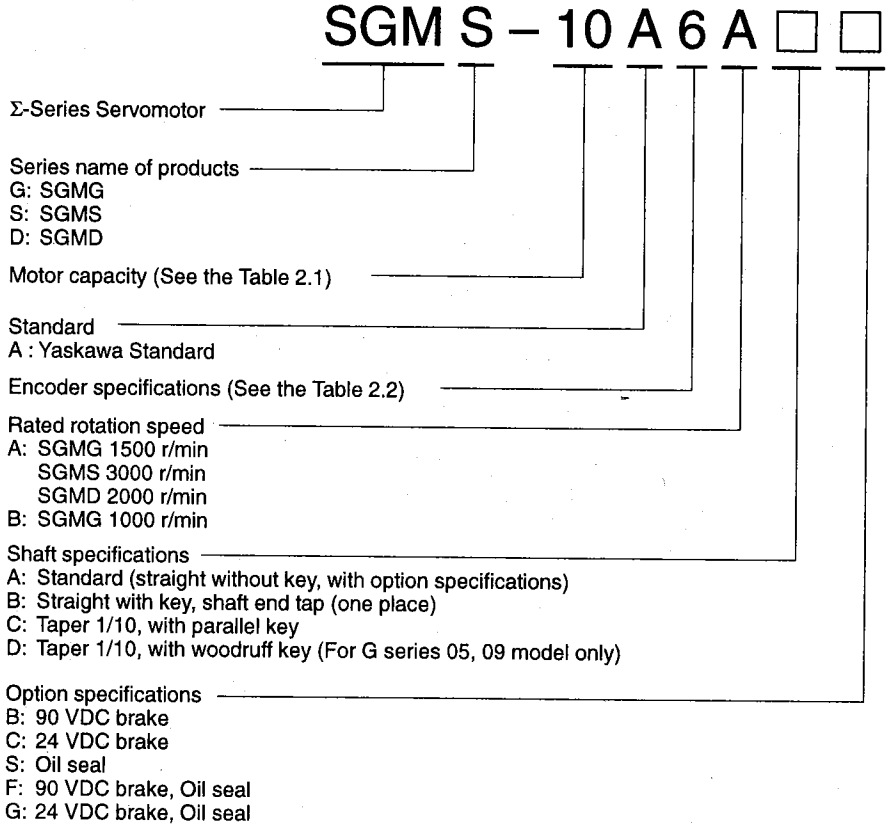


Table 2.1

(kW)

Series / Code	G		S	D	Series / Code	G		S	D
	1500 r/min	1000 r/min	3000 r/min	2000 r/min		1500 r/min	1000 r/min	3000 r/min	2000 r/min
03		0.3			30	2.9	3.0	3.0	
05	0.45				32				3.2
06		0.6			40			4.0	4.0
09	0.85	0.9			44	4.4	4.4		
10			1.0		50			5.0	
12		1.2			55	5.5			
13	1.3				60		6.0		
15			1.5		75	7.5			
20	1.8	2.0	2.0		1A	11.0			
22				2.2	1E	15.0			

Table 2.2

Code	Specification	SGMS	SGMG	SGMD
2	8192 P/R incremental	○	◎	○
6	4096 P/R incremental	◎	○	○
W	12 bit absolute	○	○	◎
S	15 bit absolute	○	○	○

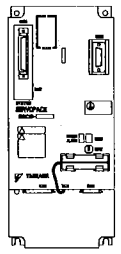
◎: Standard ○: Semi-standard

2

Note: Refer to *6.1.1 Selecting a Servomotor* for details on identifying the SGM and SGMP models.

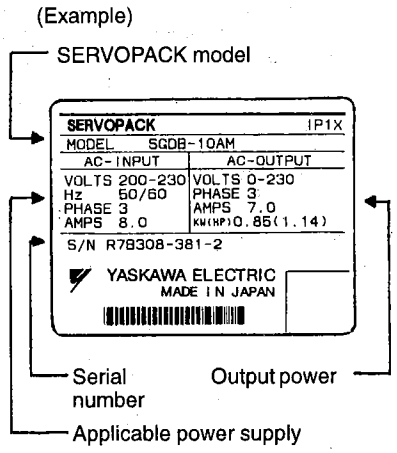
■ SERVOPACKs

Appearance and Nameplate

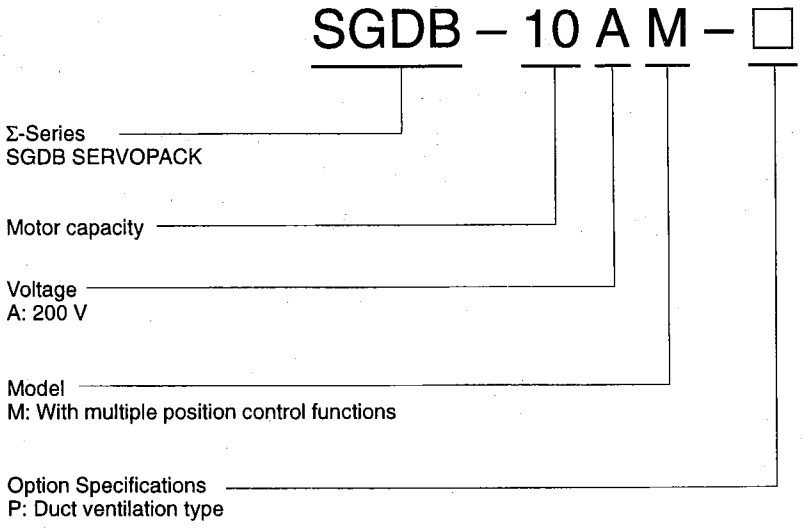


Σ-Series SGDB SERVOPACK

(Example)



Models



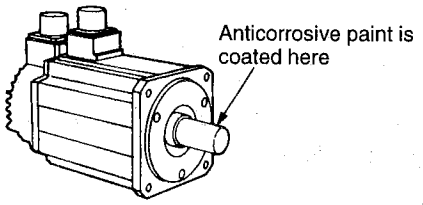
Code	Capacity (kW)	Code	Capacity (kW)
05	0.5	50	5.0
10	1.0	60	6.0
15	1.5	75	7.5
20	2.0	1A	11.0
30	3.0	1E	15.0

2.2.2 Installing a Servomotor

Servomotor SGM□ models 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.

■ 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 moistened with thinner before installing the motor.



IMPORTANT

When cleaning off the anticorrosive paint, do not allow thinner to come into contact with other parts of the Servomotor.

■ Storage

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

Between –20 and 60°C

■ Installation Sites

The Servomotor SGM□ modes are designed for indoor use. Install Servomotor in an environment which meets the following conditions:

- Indoor and free from corrosive and explosive gases
- Well-ventilated and free from dust and moisture

- Ambient temperature of 0 to 40°C
- Relative humidity of 20% to 80% (non-condensing)
- Inspection and cleaning can be performed easily

If the Servomotor is used in a location subject to water or oil mist, the motor can be protected by taking necessary precautions at the motor. However, if the **shaft opening** is to be sealed, specify the motor with oil seal.

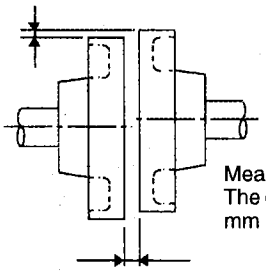
Install with the electrical connector facing downward.

■ Alignment

2

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.

Measure this distance at four different positions in the circumference.
The difference between the maximum and minimum measurements must be 0.03 mm or less.
(Turn together with couplings)



Measure this distance at four different positions in the circumference.
The difference between the maximum and minimum measurements must be 0.03 mm or less. (Turn together with couplings)

IMPORTANT

1. If the shafts are not aligned properly, vibration will occur, resulting in damage to the bearings.
2. Mount couplings carefully. A direct shock to the shaft may damage the encoder attached to the shaft on the end opposite the load.

■ Allowable Shaft-end Load Range

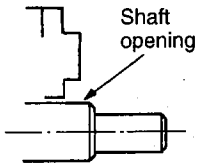
Perform a mechanical design so that **thrust load and radial load** applied to the servomotor shaft end falls within the range given in the following table.

Allowable radial loads shown below are the maximum values that could be applied to the shaft end.

TERMS

◆ **Shaft opening**

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



◆ **Thrust load and radial load**

Thrust load (Fs): Shaft-end load applied parallel to the center line of a shaft

Radial load (Fr): Shaft-end load applied perpendicular to the center line of a shaft

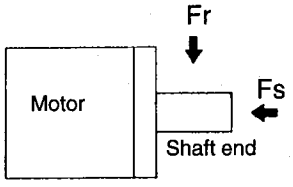
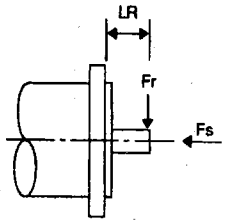


Table 2.3 Servomotors with Incremental Encoders

Motor Model		Allowable Radial Load Fr [N(lb)]	Allowable Thrust Load Fs [N(lb)]	LR [mm(in.)]	Reference Drawing
SGMG	-05A□A	490 (110)	98 (22)	58 (2.28)	
	-09A□A	490 (110)	98 (22)		
	-13A□A	686 (154)	343 (77)		
	-20A□A	1176 (264)	490 (110)	79 (3.11)	
	-30A□A	1470 (331)	490 (110)		
	-44A□A	1470 (331)	490 (110)		
	-55A□A	1764 (397)	588 (132)	113 (4.45)	
	-75A□A	1764 (397)	588 (132)		
	-1AA□A	1764 (397)	588 (132)	116 (4.57)	
	-1EA□A	4998 (1124)	2156 (485)	116 (4.57)	
SGMG	-03A□B	490 (110)	98 (22)	58 (2.28)	
	-06A□B	490 (110)	98 (22)		
	-09A□B	686 (154)	343 (77)		
	-12A□B	1176 (264)	490 (110)	79 (3.11)	
	-20A□B	1470 (331)	490 (110)		
	-30A□B	1470 (331)	490 (110)		
	-44A□B	1764 (397)	588 (132)	113 (4.45)	
	-60A□B	1764 (397)	588 (132)		
SGMS	-10A	686 (154)	196 (44)	45 (1.77)	
	-15A	686 (154)	196 (44)		
	-20A	686 (154)	196 (44)		
	-30A	980 (220)	392 (88)	63 (2.48)	
	-40A	1176 (264)	392 (88)		
	-50A	1176 (264)	392 (88)		
SGMD	-22A	1176 (264)	490 (110)	55 (2.17)	
	-32A	1176 (264)	490 (110)		
	-40A	1176 (264)	490 (110)	65 (2.56)	
SGM	-04A	245 (55)	74 (17)	25 (0.98)	
	-08A	392 (88)	147 (33)	35 (1.38)	
SGMP	-04A	245 (55)	68 (15)	25 (0.98)	
	-08A	392 (88)	147 (33)	35 (1.38)	
	-15A	490 (110)	147 (33)		

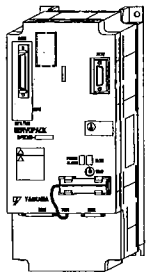
2.2.3 Installing a SERVOPACK

Σ-Series SGDB SERVOPACK is a base-mounted 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 and 85°C



SGDB SERVOPACK

■ Installation Sites

The following table lists some precautions on installation sites.

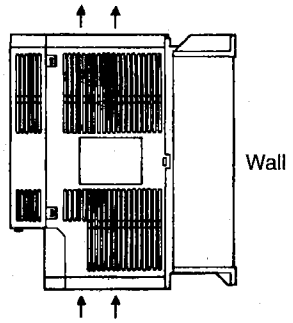
Situation	Precautions on Installation
When installed in a control panel	Design the control panel size, unit layout, and cooling method so that the temperature around the periphery of the SERVOPACK does not exceed 55°C.
When installed near a heating unit	Suppress radiation heat from the heating unit and 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.

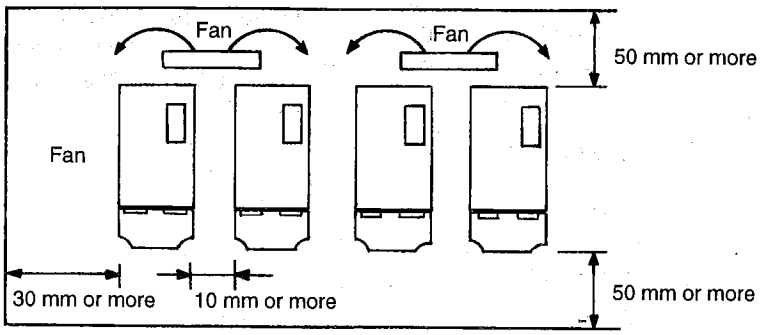
The SERVOPACK must be orientated as shown in the figure.

Secure the SERVOPACK securely to the wall using three or four of the mounting holes provided.



■ Installation Method

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



Orientation

Install SERVOPACK perpendicular to the wall so that the front panel (Digital Operator mounted face) faces outward.

Cooling

Provide sufficient space around each SERVOPACK to allow cooling by fan and natural convection.

Installing Side by Side

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.

Conditions Inside the Control Panel

- Ambient temperature for SERVOPACK: 0 to 55°C
- Humidity: 90% RH or less
- Vibration: 0.5 G (4.9 m/s^2)
- Altitude: 1,000 m or less
- Condensation and freezing: None
- Ambient temperature to ensure long-term reliability: 45°C or less

2.2.4 Power Losses

The power losses of the SERVOPACKs at rated output are given below:

SERVOPACK Model	Output Current (RMS Value) A	Power Loss in Main Circuit W	Power Loss of Regenerative Resistor W	Power Loss in Control Circuit W	Power Loss in Total W
SGDB-05AM	3.8	27	30	20	77
SGDB-10AM	7.6	55			105
SGDB-15AM	11.6	80			130
SGDB-20AM	18.5	120			170
SGDB-30AM	24.8	170		22	222
SGDB-50AM	32.9	220	–	27	247
SGDB-60AM	46.9	290			317
SGDB-75AM	54.7	330			357
SGDB-1AAM	58.6	360		30	390
SGDB-1EAM	78.0	490			520

The power loss of the regenerative resistor is the allowable loss. If the loss exceeds the allowable loss, the regenerative resistor inside the SERVOPACK should be removed and a regenerative resistor connected externally. Because the models in which the regenerative resistor is externally connected fall into non-standard specification categories, contact Yaskawa for further information.

For SGDB-50AM to 1EAM models, the regenerative resistor is placed separately.

The regenerative resistor unit provided from Yaskawa is described in *3.18.4 Using Regenerative Resistor Units*.

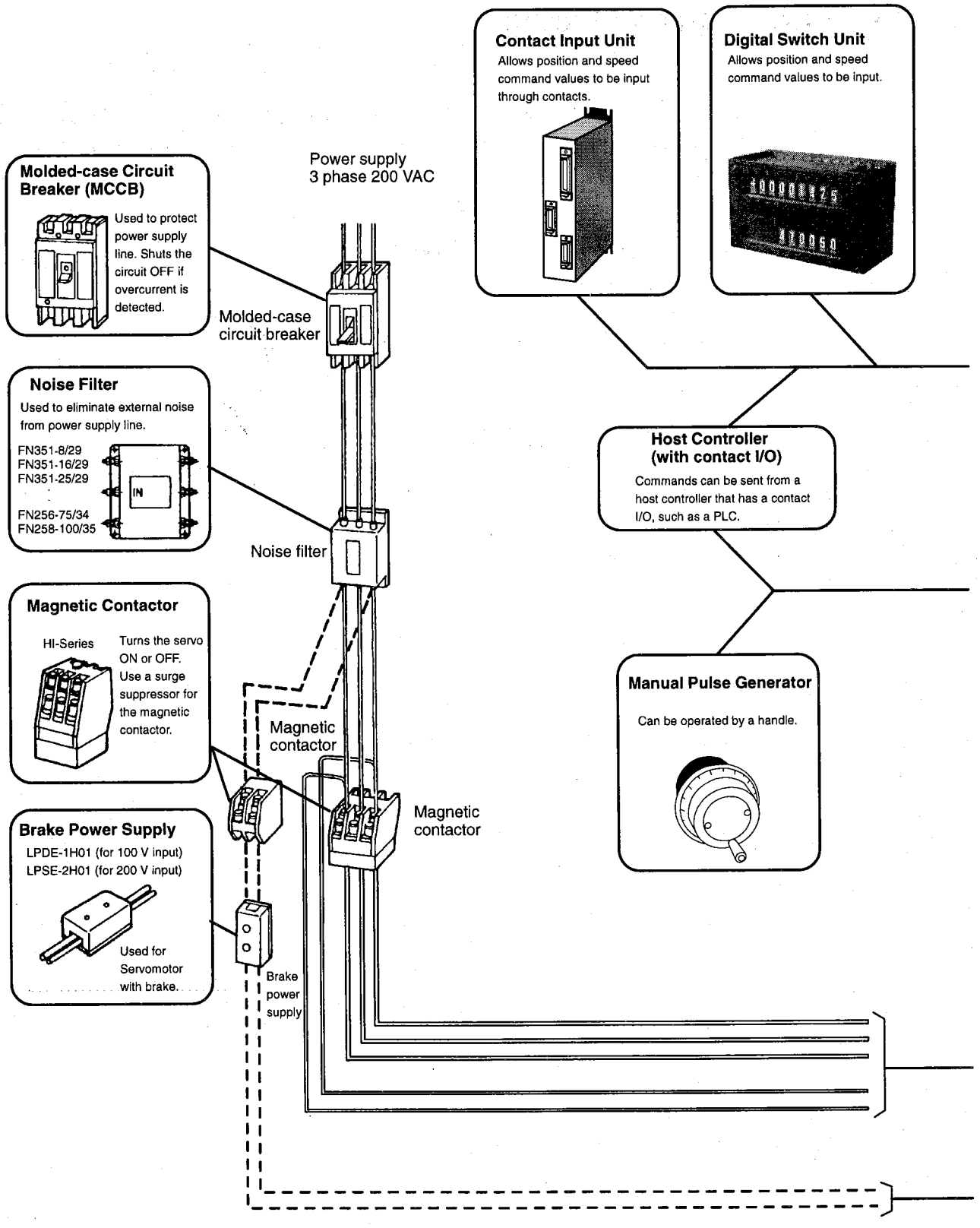
The power loss for JUSP-RA04 (for SGDB-50AM or SGDB-60AM) is 180 W, and for JUSP-RA05 (for SGDB-75AM, SGDB-1AAM, or SGDB-1EAM) is 350 W.

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.

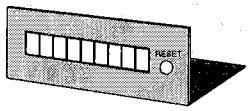
2.3.1 Connecting to Peripheral Devices

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


Contact Input Unit
Allows position and speed command values to be input through contacts.
Digital Switch Unit
Allows position and speed command values to be input.
Molded-case Circuit Breaker (MCCB)
Used to protect power supply line. Shuts the circuit OFF if overcurrent is detected.
Power supply
3 phase 200 VAC
Molded-case circuit breaker
Noise Filter
Used to eliminate external noise from power supply line.
FN351-8/29
FN351-16/29
FN351-25/29
FN256-75/34
FN258-100/35
IN
Noise filter
Host Controller (with contact I/O)
Commands can be sent from a host controller that has a contact I/O, such as a PLC.
Magnetic Contactor
HI-Series
Turns the servo ON or OFF. Use a surge suppressor for the magnetic contactor.
Magnetic contactor
Magnetic contactor
Manual Pulse Generator
Can be operated by a handle.
Brake Power Supply
LPDE-1H01 (for 100 V input)
LPSE-2H01 (for 200 V input)
Used for Servomotor with brake.
Brake power supply

External Position Indicator

Indicates the current position.



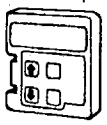
Host Controller (with RS-422A interface)

Serial commands can be sent from a host controller with an RS-422A interface. Up to 32 SGDB-□□AM Units can be connected to a serial interface port.

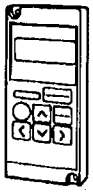
- Connector kit for 1CN, 3CN and 6CN.
- Connector terminal block conversion unit for cable with 1CN or 6CN connector and the other end without connector.
- Peripheral device connection cables
  Refer to the next page for details.

Digital Operator

Allows the user to set parameters and tables, and displays operation command status and alarm status. Two models of Digital Operator can be selected. Communications with a personal computer are also possible.



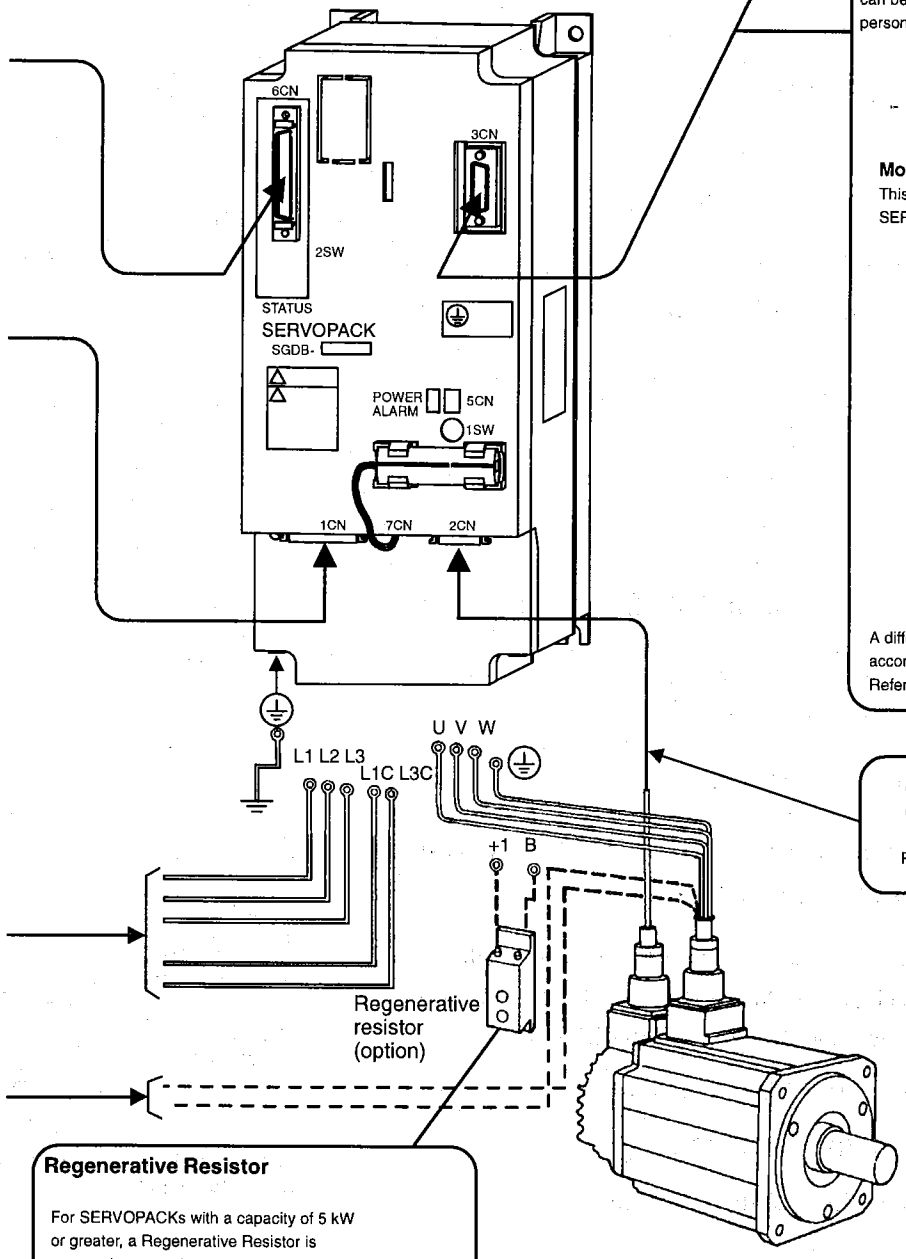
Mounted Operator (JUSP-OP03A)
This model can be mounted directly on the SERVOPACK.



Hand-held Operator (JUSP-OP02A-1)
1-meter(3.3ft.) cable included

Personal Computer

A different connector cable is required according to the type of personal computer.
Refer to the next page for details.



Cable for Encoder
Connector for Encoder

Refer to the next page for details.

Regenerative Resistor

For SERVOPACKs with a capacity of 5 kW or greater, a Regenerative Resistor is mounted separately.
The Regenerative Resistor is connected between +1 and B terminals.

■ Cable for Personal Computer

YS-11 IS THE SAME

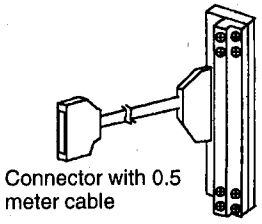
For IBM PC/AT or compatible computer: DE9408565

■ Connector Terminal Block Conversion Unit for 1CN and 6CN

The terminal block allows connection to a host controller.

For 1CN: JUSP-TA36Z

For 6CN: JUSP-TA50P



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■ Cable with a 1CN or 6CN Connector and One End without Connector

For 1CN

1 m (3.3ft): JZSP-VBI14-01

2 m (6.6ft): JZSP-VBI14-02

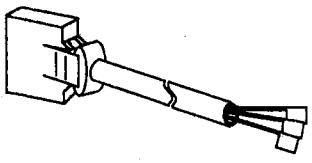
3 m (9.8ft): JZSP-VBI14-03

For 6CN

1 m (3.3ft): DE9411288-1

2 m (6.6ft): DE9411288-2

3 m (9.8ft): DE9411288-3



■ 1CN, 3CN, and 6CN Connector Kits

For 1CN: JZSP-VAI09

For 3CN: DE9409459

For 6CN: DE9411289

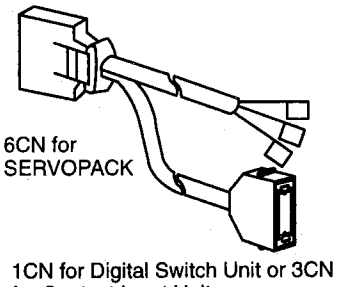
■ Connector Cable for Digital Switch Unit and Contact Input Unit

This cable can be used both to connect the Digital Switch Unit to the SERVOPACK, and to connect the Contact Input Unit to the SERVOPACK.

1 m (3.3ft): JZSP-VBX24-01

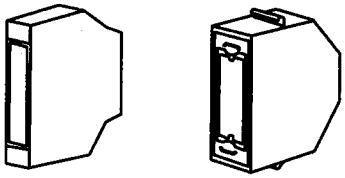
2 m (6.6ft): JZSP-VBX24-02

3 m (9.8ft): JZSP-VBX24-03



■ Digital Switch Unit Connector Kit (JZSP-VBX22)

This kit is a set of connectors for connecting a Digital Switch Unit and a SERVOPACK.



6CN for SERVOPACK

1CN for Digital Switch Unit

■ Contact Input Unit Connector Kit

This 6CN Connector Kit (DE9411289) is used with the connector provided with the Contact Input Unit.

6CN for SERVOPACK

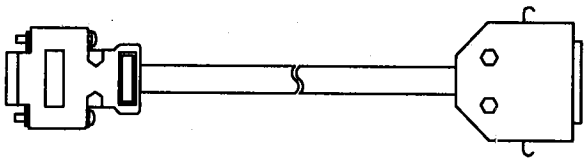
■ Cable for External Position Indicator

This cable is used to connect an external position indicator to a SERVOPACK.

1 m (3.3ft): JZSP-VBX10-01

2 m (6.6ft): JZSP-VBX10-02

3 m (9.8ft): JZSP-VBX10-03

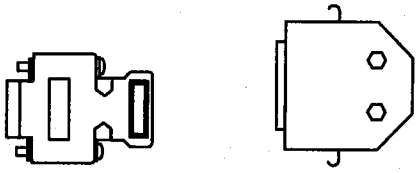


3CN for SERVOPACK

1CN for External Position Indicator

■ External Position Indicator Connector Kit (JZSP-VBX12)

This kit includes a set of connectors for connecting an external position indicator and a SERVOPACK.



3CN for SERVOPACK

1CN for External Position Indicator

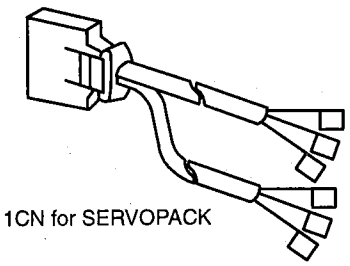
■ Cable for Manual Pulse Generator (Without Connector on Separated Ends)

This cable separates the manual pulse generator signal lines from another signal lines.

1 m (3.3ft): JZSP-VBX04-01

2 m (6.6ft): JZSP-VBX04-02

3 m (9.8ft): JZSP-VBX04-03



■ Cable for PG

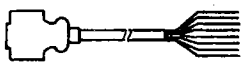
This cable is used to connect the encoder of Servomotor to the SERVOPACK.

The following three types of cables are available according to encoder types.

SGMG, SGMS, and SGMD

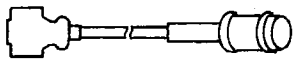
- Cables with One Connector (without Connector on Encoder End)

Length	Cable Model	
	Incremental	Absolute
3m (9.8ft)	DE9411276-1	DE9411277-1
5m (16.4ft)	DE9411276-2	DE9411277-2
10m (32.8ft)	DE9411276-3	DE9411277-3
15m (49.2ft)	DE9411276-4	DE9411277-4
20m (65.6ft)	DE9411276-5	DE9411277-5



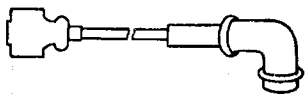
- Cables with Connectors on Both Ends (Straight Plug on Encoder End)

Length	Cable Model	
	Incremental	Absolute
3m (9.8ft)	JZSP-CBP0S-01	JZSP-CBP1S-01
5m (16.4ft)	JZSP-CBP0S-02	JZSP-CBP1S-02
10m (32.8ft)	JZSP-CBP0S-03	JZSP-CBP1S-03
15m (49.2ft)	JZSP-CBP0S-04	JZSP-CBP1S-04
20m (65.6ft)	JZSP-CBP0S-05	JZSP-CBP1S-05



- Cables with Connectors on both Ends (L-shape Plug on Encoder End)

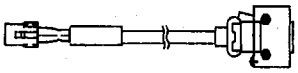
Length	Cable Model	
	Incremental	Absolute
3m (9.8ft)	JZSP-CBP0L-01	JZSP-CBP1L-01
5m (16.4ft)	JZSP-CBP0L-02	JZSP-CBP1L-02
10m (32.8ft)	JZSP-CBP0L-03	JZSP-CBP1L-03
15m (49.2ft)	JZSP-CBP0L-04	JZSP-CBP1L-04
20m (65.6ft)	JZSP-CBP0L-05	JZSP-CBP1L-05



For Models SGM, SGMP

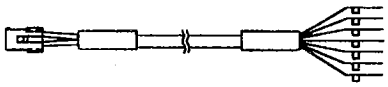
- Cables with Connectors on Both Ends

Length	Cable Model	
	Incremental	Absolute
3m (9.8ft)	JZSP-CAP00-01	JZSP-CAP10-01
5m (16.4ft)	JZSP-CAP00-02	JZSP-CAP10-02
10m (32.8ft)	JZSP-CAP00-03	JZSP-CAP10-03
15m (49.2ft)	JZSP-CAP00-04	JZSP-CAP10-04
20m (65.6ft)	JZSP-CAP00-05	JZSP-CAP10-05



- Cables with One Connector (without Connector on SERVOPACK End)

Length	Cable Model	
	Incremental	Absolute
3m (9.8ft)	DP9320086-1	DP9320085-1
5m (16.4ft)	DP9320086-2	DP9320085-2
10m (32.8ft)	DP9320086-3	DP9320085-3
15m (49.2ft)	DP9320086-4	DP9320085-4
20m (65.6ft)	DP9320086-5	DP9320085-5



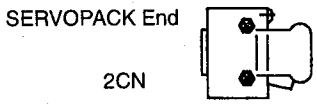
- Cables without Connectors

Length	Cable Model	
	Incremental	Absolute
3m (9.8ft)	DP9400064-1	DP8409123-1
5m (16.4ft)	DP9400064-2	DP8409123-2
10m (32.8ft)	DP9400064-3	DP8409123-3
15m (49.2ft)	DP9400064-4	DP8409123-4
20m (65.6ft)	DP9400064-5	DP8409123-5

2

■ Connector Kit (DE9411290) for PG

Connector on SERVOPACK end only.



2.3.2 Main Circuit Wiring and Power ON Sequence

This section describes the functions of the main circuit terminals, the main circuit wiring, and the power-ON sequence of a typical Σ-Series Servo.

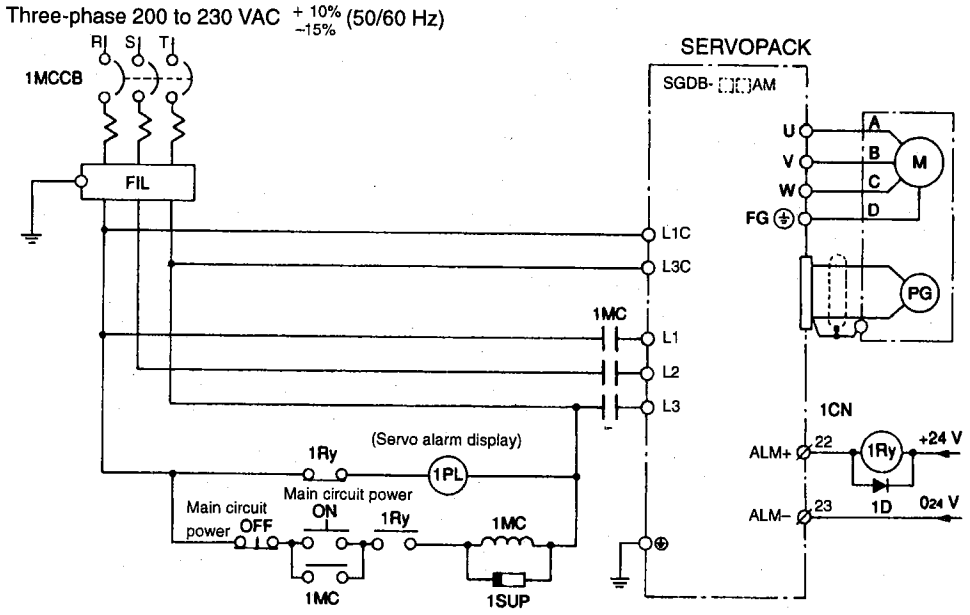
■ Functions of Main Circuit Terminals

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

Terminal Symbol	Name	Description
L1, L2, L3	Main power input terminals	Three-phase 200 to 230 VAC $^{+10}_{-15}$ %, 50/60 Hz
U, V, W	Motor connection terminal	Used to connect motor
L1C, L3C	Control power input terminals	Single phase 200 to 230 VAC $^{+10}_{-15}$ %, 50/60 Hz
⏚ × 2	Ground terminal	Connected to earth. (For power ground and motor ground).
+, B	Regenerative resistor unit connection terminal	Normally, external connection is not required.
+1, B	Regenerative resistor unit connection terminal	Terminal used to connect regenerative resistor for SERVOPACK with power capacity more than 5 kW.
N	Main circuit negative terminal	Normally, external connection is not required.

Note: A SERVOPACK with power capacity of 3 kW or less does not have a +1 terminal.

■ Typical Wiring Example

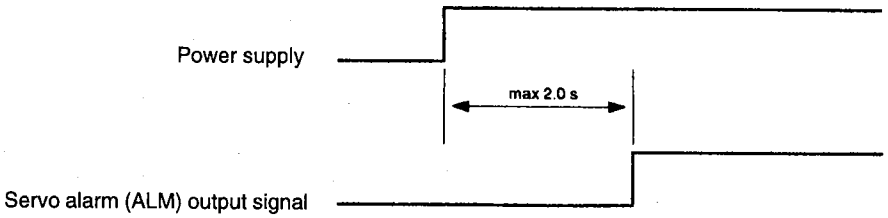


1MCCB:	Circuit breaker (for inverter type)	1PL:	Lamp for display
FIL:	Noise filter	1SUP:	Surge suppressor
1MC:	Contactor	1D:	Flywheel diode
1Ry:	Relay		

■ Power ON Sequence Design

Form a power ON sequence as follows:

- Form a power ON sequence so that the power is turned OFF when a servo alarm signal is output. (See the circuit diagram above.)
- Hold down the power ON push-button for at least two seconds. The SERVOPACK outputs a servo alarm signal for approximately two seconds or less when the power is turned ON. This operation is required to initialize the SERVOPACK.



■ Wiring Precautions

- 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 shielded multi-core twisted-pair wires should be used for signal lines, encoder (PG) feedback lines.

  The length for wiring is 5 m maximum for the command 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.

- Do not turn the power ON and OFF frequently.

  Since the SGDB SERVOPACK has a capacitor in the power supply unit, a high charging current will flow for approximately 0.2 seconds when 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.

2.4 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

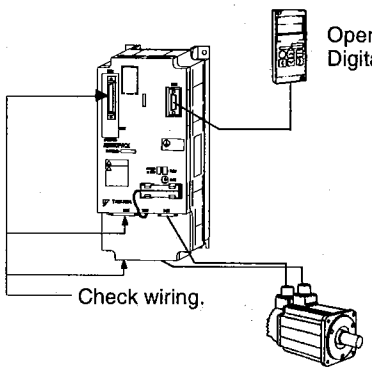
Conduct the test run when wiring is complete. Generally, conducting a test run for servo drives can be difficult. However, by following the two steps described below, the test run can be performed safely and correctly.

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.

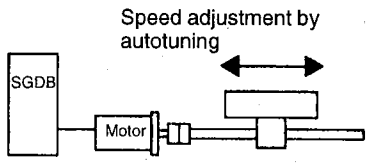
Step 1: Conducting a test run for the motor without load

Check that the motor is wired correctly.
Conduct a test run with the motor shaft disconnected from the machine.



Step 2: Conducting a test run with the motor and machine connected

Adjust SERVOPACK according to machine characteristics.
Connect to the machine and conduct a test run.



Connect to the machine.

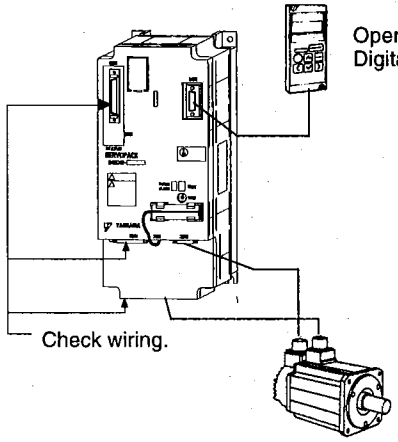
2.4.2 Step 1: Conducting a Test Run for Motor without Load

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.

- Check power supply circuit wiring.
- Check servomotor wiring.
- Check I/O signal wiring (1CN and 6CN).

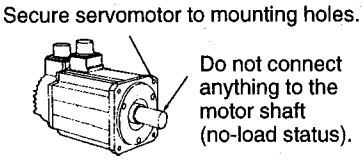
Wherever possible, perform host controller adjustments and other relevant operations in Step 1 (before installing a Servomotor on the machine).

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 *2.4.4 Supplementary Information on Test Run* before starting a test run.



■ Securing the Servomotor

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



■ Checking the Servomotor Wiring

Disconnect connector 1CN and 6CN, then check the motor wiring in the power supply circuit.
I/O signals (1CN and 6CN) are not to be used so leave connector 1CN and 6CN disconnected.