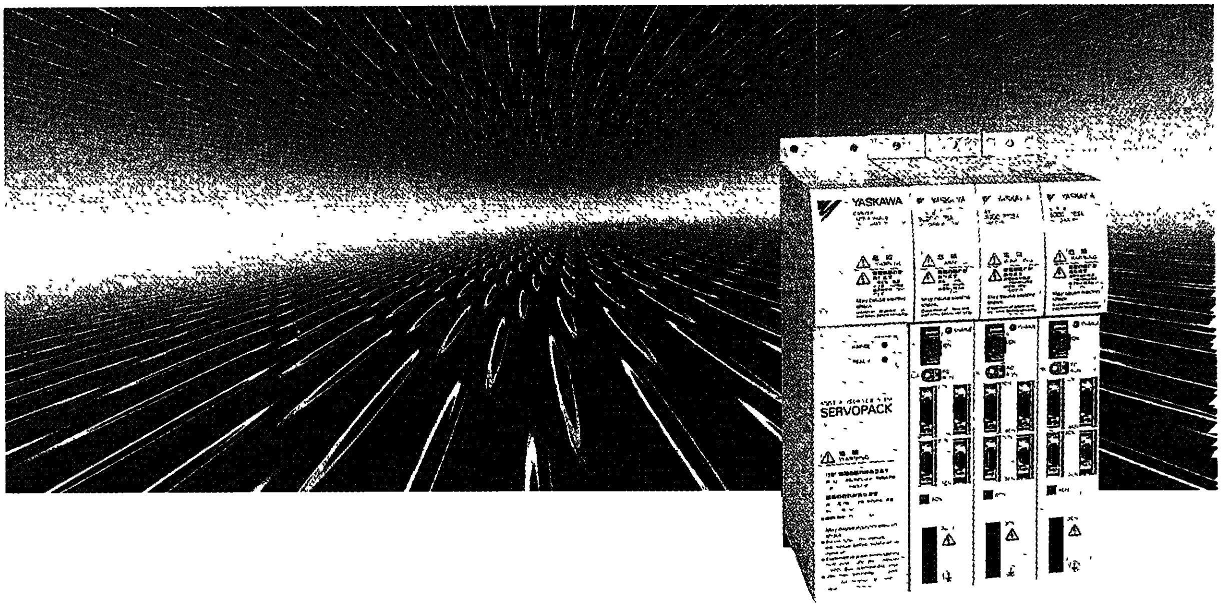
Σ Series SGM□/SGDC

USER'S MANUAL

AC Servomotors and Driver

SGMG/SGMS Servomotors
SGDC Servopack



YASKAWA

MANUAL NO. SIE-S800-22

PREFACE

The rapid progress being made in today's automation and information technologies is resulting in a growing need for even more-advanced motion control for future high-tech equipment. The end result is a need for devices that can provide more-precise and quicker motion at higher speeds. Servo control technology makes this possible. Launched by Yaskawa in 1993, the Σ Series consists of innovative AC Servos that were developed using leading-edge servo control technology.

This manual covers all products in the Σ Series, which feature superior functions and performance. This manual was designed to provide comprehensible information for users who are about to use a servo for the first time as well as for users who already have experience in using servos. This manual enables users to understand what Σ-Series AC Servos are all about and how to design, install, operate, and maintain a servo system. Keep this manual in a convenient location and refer to it whenever necessary in operating and maintaining the servo system.

YASKAWA ELECTRIC CORPORATION

General Precautions

- 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.

NOTES FOR SAFE OPERATION

Read this manual thoroughly before installation, operation, maintenance or inspection of the AC Servo Drives. In this manual, the NOTES FOR SAFE OPERATION are classified as "WARNING" or "CAUTION".

⚠ WARNING

Indicates a potentially hazardous situation which, if not avoided, could result in death or serious personal injury.

⚠ CAUTION

Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate personal injury and/or damage to the equipment.

In some instances, items described in **⚠ CAUTION** may also result in a serious accident. In either case, follow these important items.

⚠ WARNING

(WIRING)

- Grounding must be in accordance with the national code and consistent with sound local practices.
  Failure to observe this warning may lead to electric shock or fire.

(OPERATION)

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

(INSPECTION AND MAINTENANCE)

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

⚠ CAUTION

(RECEIVING)

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

(INSTALLATION)

- 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)

- 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.

⚠ CAUTION

(OPERATION)

- **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 user constants suitable for the machine.**
  Starting operation without setting up user constants may lead to 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.

(INSPECTION AND MAINTENANCE)

- **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.

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.

Manual Structure

All chapters in this manual are classified into one or more of three areas according to their contents: A, B, and C. Refer to the applicable chapters for the information you require.

A: Chapters explaining how to select a servo: For users who wish to gain a basic understanding of Σ Series products or who need to select an appropriate servo.

B: Chapters explaining how to design a servo system: For users who are about to design, install, and operate a Σ-Series Servo Control System.

C: Chapters explaining maintenance: For users who are going to maintain and troubleshoot Σ-Series products.

Basic Terms

Unless otherwise specified, the following definitions are used:

Servomotor: Σ-Series SGMG/SGMS Servomotor

Servopack: An amplifier (Trademark of Yaskawa servo amplifier "Σ-Series SGDC-□DSA Servopack")

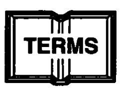
Servodrive: A Servomotor and an amplifier (SGDC Servopack)

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

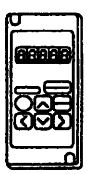
Visual Aids

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

Indicates references for additional information.



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-2

The text indicated by this icon explains the operating procedure using hand-held type digital operator (Type: JUSP-OP02A-2).

Indication of Reverse Signals

In this manual, the names of revrese signals are written with a forward slash (/) before the signal name, as shown in the following example:

- /S-ON
- /P-CON

NOTE A Σ-Series Servodrive alone cannot ensure the functionality and performance of the entire machine control system. It must be combined with an appropriate machine and host controller so that the entire control system works properly. Therefore, carefully read the instruction manuals for the machine to be used before attempting to operate the servodrive.

CONTENTS

CONTENTS

CONTENTS

BASIC USES OF Σ-SERIES PRODUCTS

1

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.

1.1 Precautions

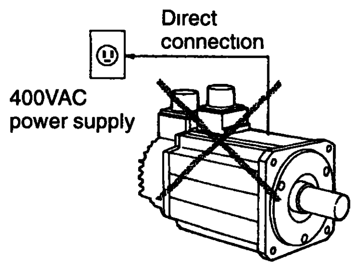
This section provides notes on using Σ-Series products.

1.1.1 Notes on Use

NOTE Always note the following to ensure safe use.

Use 400VAC power supply

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

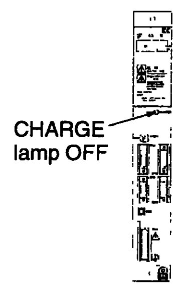


Always use the SGM□ Servomotor and SGDC Servopack in pairs.

Check whether the combination of applicable motor series of Servopack and of SGM□ (motor series) is correct or not. Check the setting of user constant Cn-2A (motor selection) and always after changing its combination. The motor may get damaged if the combination is not correct. Refer to Section *2.3.4.*

Do not change wiring when power is ON.

Always turn the power OFF before connecting or disconnecting a connector.
(Except for Digital Operator (Types: JUSP-OP02A-2))

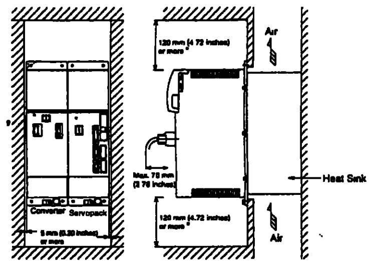


Note that residual voltage still remains in the Servopack even after the power is turned OFF.

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.

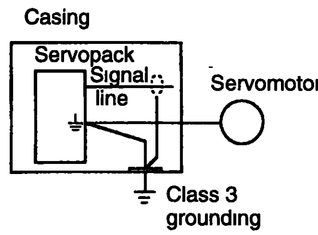
The Servopack generates heat. Install the Servopack so that it can radiate heat freely. Note also that the Servopack must be in an environment free from condensation, vibration and shock.



Perform noise reduction and grounding properly.

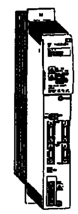
If the signal line is noisy, vibration or malfunction will result.

- Separate high-voltage cables from low-voltage cables.
- Use cables as short as possible.
- Use at least class 3 grounding (ground resistance 100Ω or below) 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 A1, A2, 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 type ground-fault interrupter.

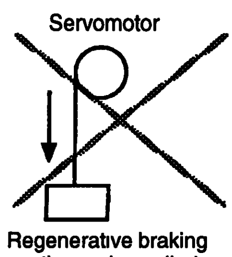
For a ground-fault interrupter, always use a fast-response type or one designed for PWM inverters. Do not use a time-delay type.

Ground-fault interrupter

GOOD	GOOD	POOR
Fast-response type	For PWM inverter	Time-delay type

Do not perform continuous operation under overhanging load.

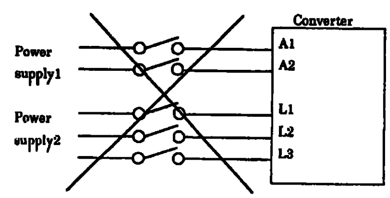
Continuous operation cannot be performed by rotating the motor from the load and applying regenerative braking. Regenerative braking by the Servopack can be applied only for a short period, such as the motor deceleration time.



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 reference pulses.



Starting and stopping by turning power ON and OFF

1.2 Installation

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

1.2.1 Checking on Delivery

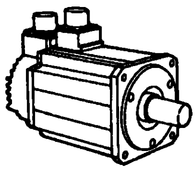
1) When Σ-Series products are delivered, check the following items:

Check Items	Remarks
Check if the delivered products are the ones you ordered.	Check the types 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.

	Appearance	Nameplate	Type
Servo motor	Σ-Series Servomotor	(Example)	SGM G - 05 V 2 D □ □

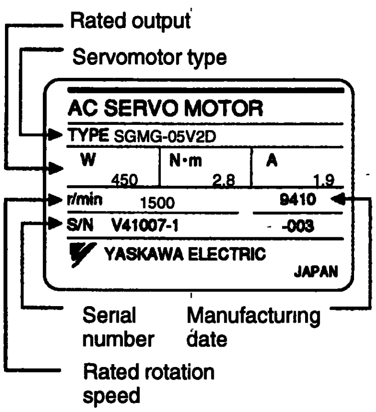
Appearance



Σ-Series Servomotor

Nameplate

(Example)



Type

SGM G - 05 V 2 D □ □

- SGM: Σ-Series Servomotor
- G: Series name of products
  - G SGMG
  - S SGMS
- 05: Motor capacity (See the Table below)
- V: Standard
  - V YASKAWA Standard
- 2: Encoder specifications (See the Table below)
- D: Rated rotation speed
  - D SGMG 1500 r/min
  - SGMS 3000 r/min
- □: Shaft specifications
  - A Standard (straight without key, with option specifications)
  - B Straight with key, shaft end tap (one place)
  - C Taper 1/10, with parallel key
  - D Taper 1/10, with semicircle key (For G series 05, 09 type only)
- □: Option specifications
  - B DC90V BRAKE
  - C DC24V BRAKE
  - S Oil seal
  - F DC90V BRAKE, Oil seal
  - G DC24V Brake Oil seal

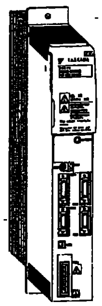
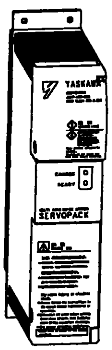
Motor capacity (kW)

Code \ Series	G	S
	1500 r/min	3000 r/min
05	0.45	
09	0.85	
10		1.0
13	1.3	
15		1.5
20	1.8	2.0
30	2.9	3.0
40		4.0
44	4.4	
50		5.0

Encoder specifications

◉ Standard ○ Non-standard

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

	Appearance	Nameplate	Type
Servo- pack	 Σ-Series SGDC Servopack	Servopack type DRIVEPACK SERVO UNIT MODEL SGDC-05DSA DC-INPUT / AC-OUTPUT VOLTS 560-650 / VOLTS 0-460 PHASE 3 AMPS 1.9 AMPS 13 / KW(HP) 0.5(0.67) S/N 831030-3-2 YASKAWA ELECTRIC MADE IN JAPAN Serial number Output power Applicable power supply	SGDC - 05 D S A Σ-Series SGDC SERVOPACK Rated output (See the Table below) Designed Order Model S Speed, torque control Supply Voltage D 400V
Con- verter		Converter type DRIVEPACK CONVERTER UNIT MODEL JUSP-ACP08GD AC-INPUT / DC-OUTPUT VOLTS 400-460 / VOLTS 560-650 Hz 50/60 PHASE 3 AMPS 7.0 / AMPS 8.0 S/N 866717-2-2 YASKAWA ELECTRIC MADE IN JAPAN Serial number Output power Input power	JUSP - ACP 08 G D Peripheral Devices for SERVOPACK Converter Unit for SERVOPACK Supply Voltage D 400V Designed Order Output Current (See the Table below)

Rated Outpu

Code	Capacity (kW)
05	0.5
10	1.0
15	1.5
20	2.0
30	3.0
50	5.0

Output Current

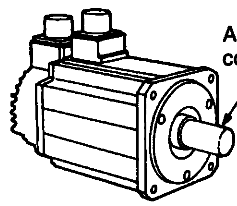
Code	Capacity (A)
08	8
15	15
30	30

1.2.2 Installing the Servomotor

Servomotor SGM□ type 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 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 Servomotor SGM□ type is designed for indoor use.
Install Servomotor in an environment which meets the following conditions:

a) Free from corrosive and explosive gases

b) Well-ventilated and free from dust and moisture

c) Ambient temperature of 0 to 40°C

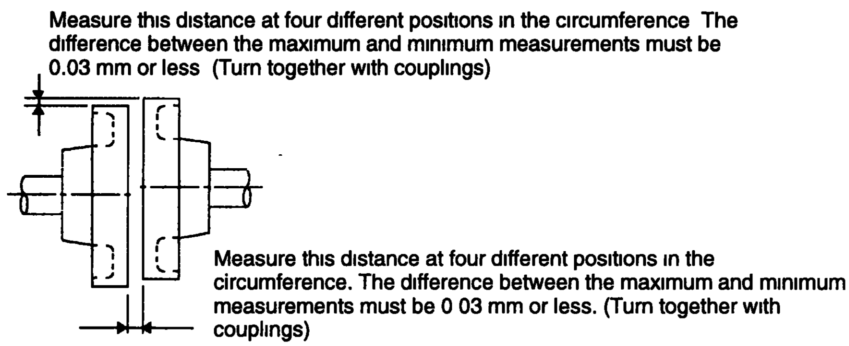
d) Relative humidity of 20% to 80% (non-condensing)

e) 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 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.

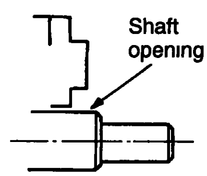


NOTE If the shafts are not aligned properly, vibration will occur, resulting in damage to the bearings.

TERMS

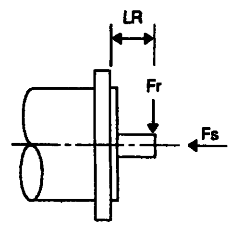
Shaft opening

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



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.

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.

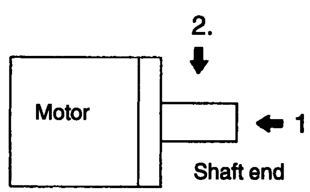
Motor Type	Allowable Radial Load Fr [N(lb)]	Allowable Thrust Load Fs [N(lb)]	LR [mm(in.)]	Reference Drawing
SGMG-05V□D	490 (110)	98 (22)	58 (2.28)	
-09V□D	490 (110)	98 (22)		
-13V□D	686 (154)	343 (77)		
-20V□D	1176 (265)	490 (110)	79 (3.11)	
-30V□D	1470 (331)	490 (110)		
-44V□D	1470 (331)	490 (110)		
SGMS-10V□D	686 (154)	196 (44)	45 (1.77)	
-15V□D	686 (154)	196 (44)		
-20V□D	686 (154)	196 (44)		
-30V□D	980 (221)	392 (88)	63 (2.48)	
-40V□D	1176 (265)	392 (88)		
-50V□D	1176 (265)	392 (88)		

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

TERMS

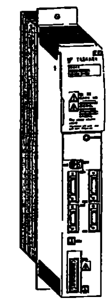
Thrust load and radial load

1. Thrust load: Shaft-end load applied parallel to the centerline of a shaft
2. Radial load: Shaft-end load applied perpendicular to the centerline of a shaft



1.2.3 Installing the Servopack

Σ-Series SGDC Servopack is a base-mount type servo controller.
Incorrect installation will cause problems. Always observe the installation instructions described below.



SGDC Servopack

Storage:

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

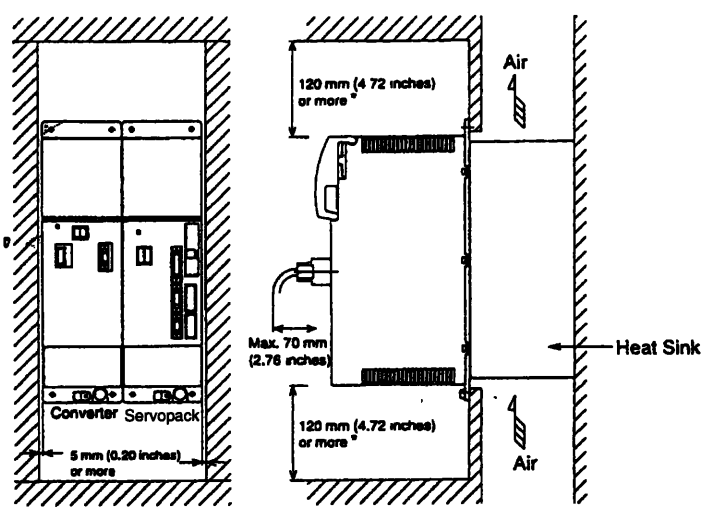
Between –20°C and 70°C

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 45°C.
When installed near a heating unit	Duct ventilation type: 0 to 55°C in panel. 0 to 45°C at duct side out of panel
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.

Clearances:

Install the Servopack and converter vertically and allow sufficient clearances for effective cooling as shown in the figure below.



a) The clearances required at top/bottom and both sides are common in open chassis type and heat sink externally cooling type.

b) For the external dimensions and mounting dimensions, refer to 4.4.2.

c) Allowable intake air temperature to the converter:

- Heat sink externally cooling type
  Inside of heat sink: 0°C to +45°C (32°F to 113°F)
  Inside of unit: 0°C to +55°C (32°F to 131°F)

d) Near the heat sink, cooling air speed should be 2.5 m/s for effective cooling.

e) Ensure sufficient space for the sections at the upper and lower parts marked with * in order to permit the flow of intake/exhaust air to/from the converter.

f) Maintain the following conditions inside the control panel:

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

Power loss

Power loss of Servopack is given below:

Power loss for rated output

Servopack type	Output current (RMS value) A	Power loss in main circuit W	Power loss in control circuit W	Power loss in total W
SGDC-05DSA	1.9	28	12	40
SGDC-10DSA	3.5	48		60
SGDC-15DSA	5.4	73		85
SGDC-20DSA	8.4	108		120
SGDC-30DSA	11.9	148		160
SGDC-50DSA	16.5	228		240

Converter type	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
JUSP-ACP08GD	8	17	45	10	62
JUSP-ACP15GD	15	32	---		42
JUSP-ACP30GD	30	65	---		75

Note a) Power loss of regenerative resistor is allowable loss. If the loss exceeds the allowable loss, the regenerative resistor inside the Converter should be removed and connected externally. Because the model in which the regenerative resistor is externally connected falls into non-standard specification categories, contact YASKAWA for further information.
For this non-standard type, "Y8" is appended to the end of the standard model number.

b) For JUSP-ACP1530GD models, the regenerative resistor is placed separately. The regenerative resistor unit provided from YASKAWA is described in *Section 2.8.4 Using Regenerative Resistor Units*. Its power loss for JUSP-ACP15GD is 180W (type: JUSP-RA06), and for JUSP-ACP30GD is 350W (type: JUSP-RA07).

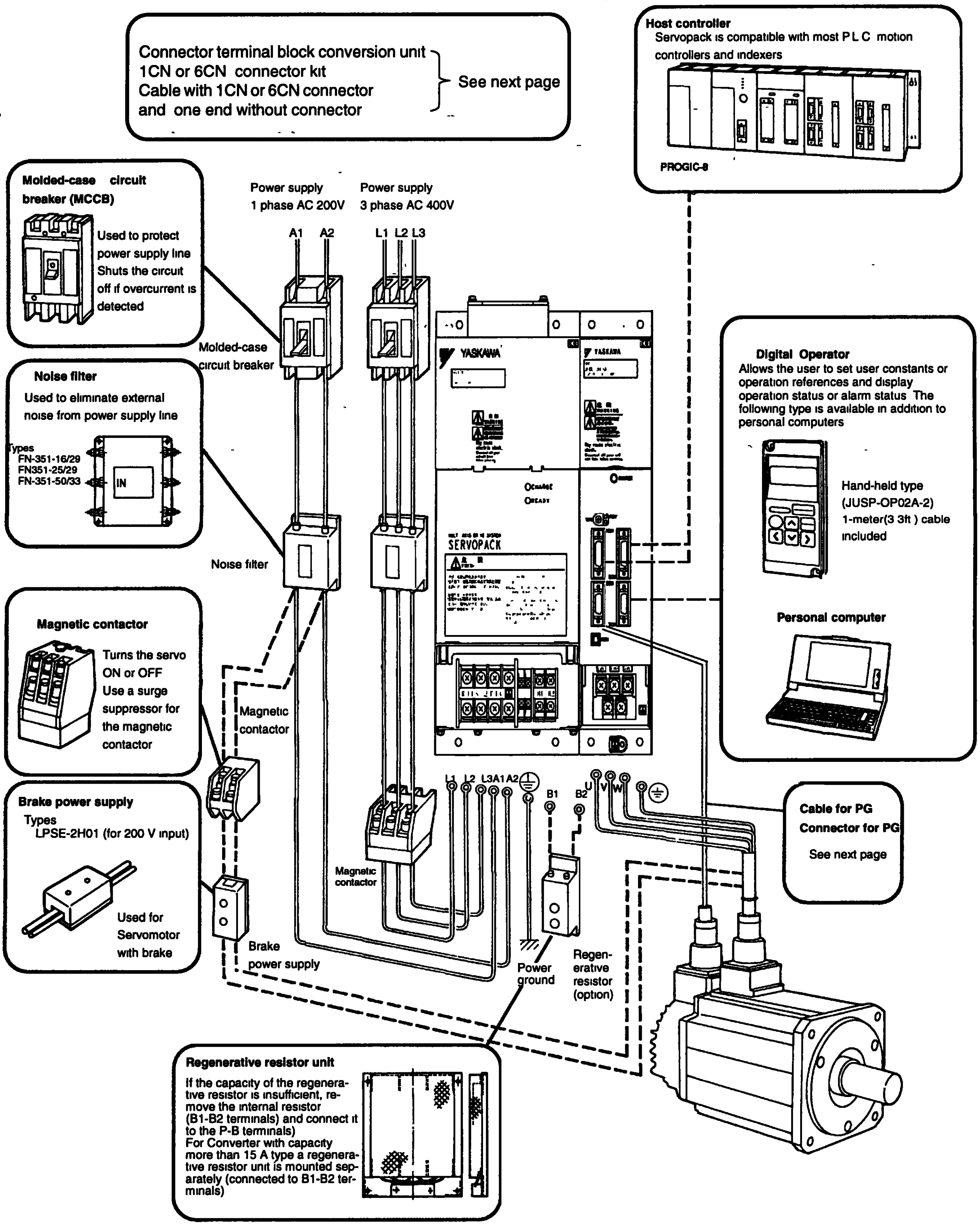
1.3 Connection and Wiring

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.

1.3.1 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.

1.3.1 Connecting to Peripheral Devices cont.



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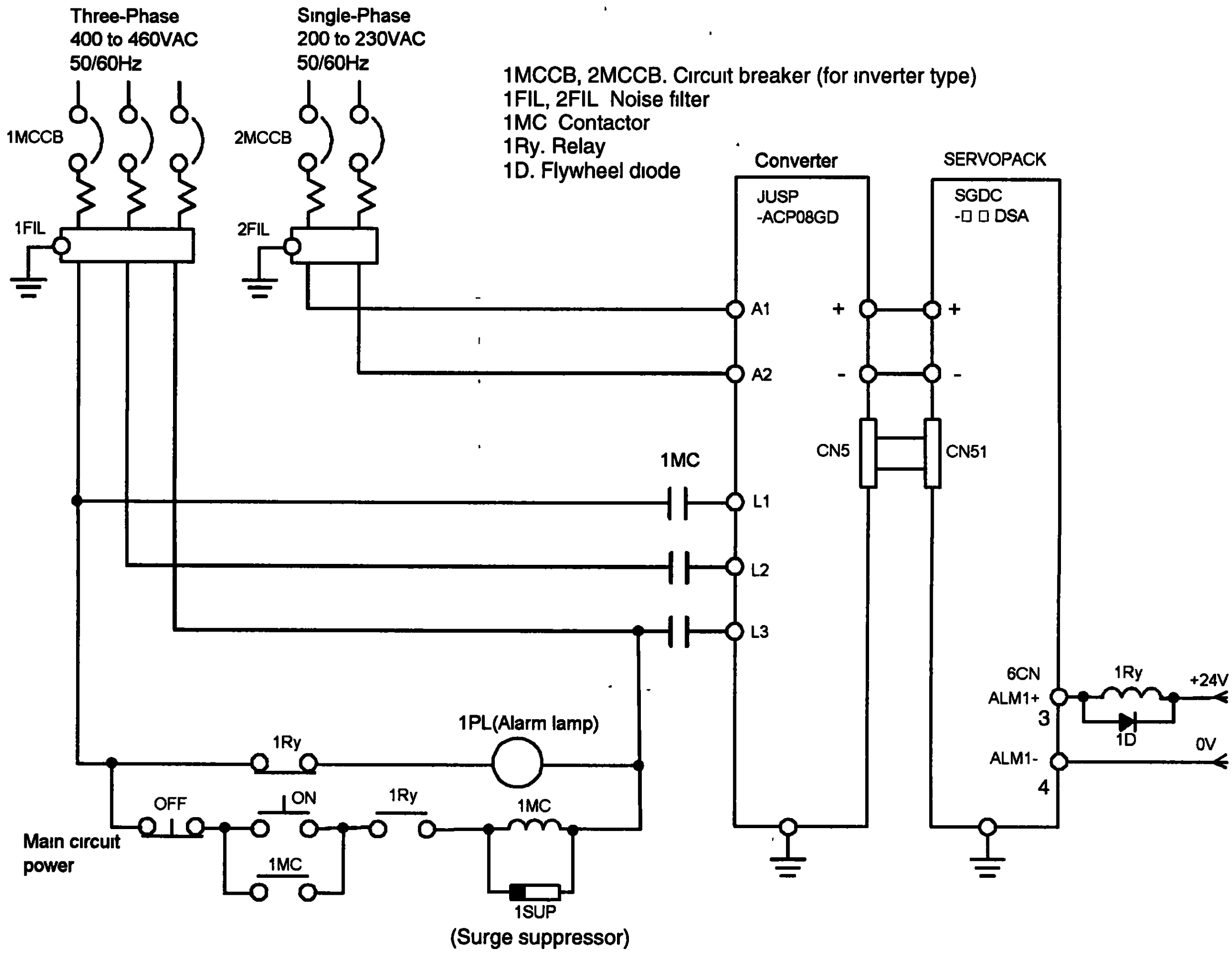
1.3.2 Main Circuit Wiring and Power ON Sequence

1) The following diagram shows a typical example of wiring the main circuit for Σ-Series products:



2) The following table shows the name and description of each main circuit terminal.

- Converter

Terminal Symbol	Name	Description
R/L1, S/L2, T/L3	Main power input terminals	Three-phase 400 to 460 VAC +10 to −15%, 50/60Hz
r/A1, t/A2	Control power input terminals	Single-phase 200 to 230 VAC +10 to −15%, 50/60Hz
⊕	Ground terminal	Connected to earth (For power ground)
B1, B2, BR	Regenerative resistor connection terminal	Used to connect regenerative resistor (Normally, 08 is not required)
P/+, N/−	Main circuit output terminals	560 to 650 VDC +10 to −15%

Note BR terminal is not available for 15, 30 converter.
B1, B2 terminals of 15 converter is connector.

• SERVOPACK

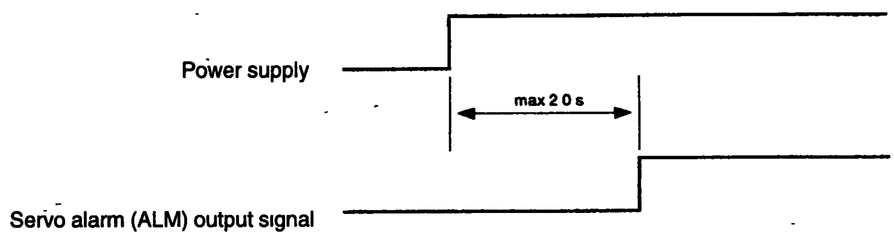
Terminal Symbol	Name	Description
P/+, N/–	Main circuit input terminals	560 to 650 VDC +10 to –15%
⊕	Ground terminal	Connected to earth (For power ground and motor ground)
U, V, W	Motor connection terminal	Used to connect motor

Note U, V, W is connector for SERVOPACK with power capacity less than 3 kW.

3) Form a power ON sequence as follows:

a) Form a power ON sequence so that the power is turned OFF when a servo alarm signal is output. (See the circuit diagram shown on the previous page.)

b) 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.



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.

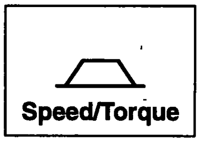
• Avoid frequently turning the power ON and OFF. Since the Servopack has a capacitor in the power supply, a high charging current flows (for 0.2 second) when the power is turned ON. Therefore, frequently turning the power ON and OFF causes the main circuit devices (such as capacitors and fuses) to deteriorate, resulting in unexpected problems.

1.3.3 Examples of Connecting I/O Signal Terminals

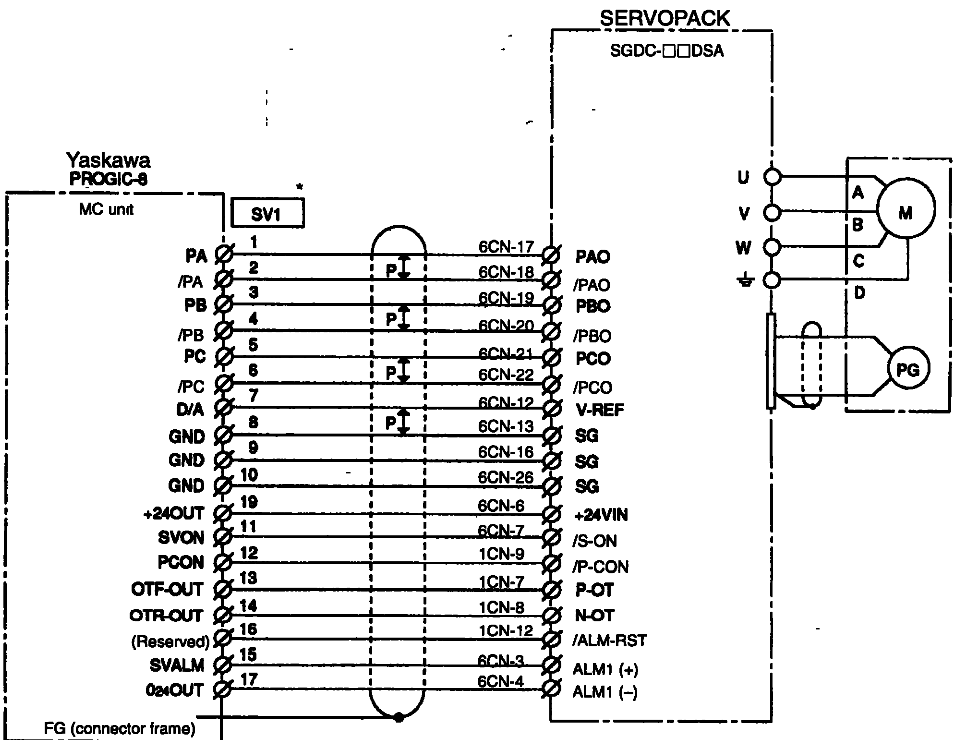
1) This sub-section provides typical examples of connecting to main host controllers. Connection to other host controllers is also possible. Connect to the host controller according to the connection examples shown below by referring to technical documentation for the host controller.

NOTE This sub-section describes signals related to the SGDC Servopack only. For other signals, refer to the relevant technical documentation.

2) Connection to PROGIC-8



Servopack for Speed/Torque Control

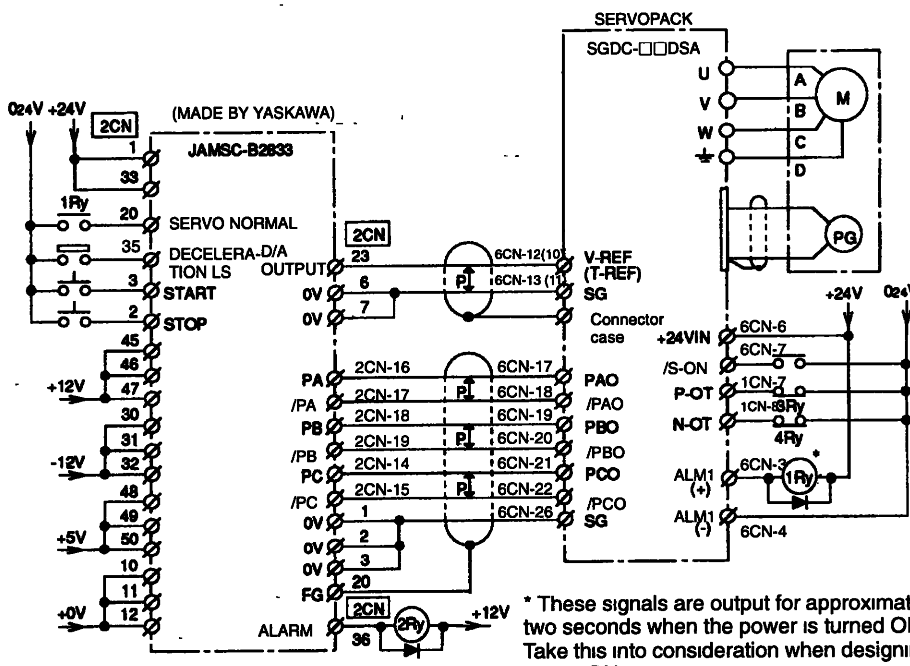


* These pin numbers are also applicable to SV2 to SV4.

3) Connection to GL-Series Positioning Module B2833

Speed/Torque

Servopack for Speed/Torque Control

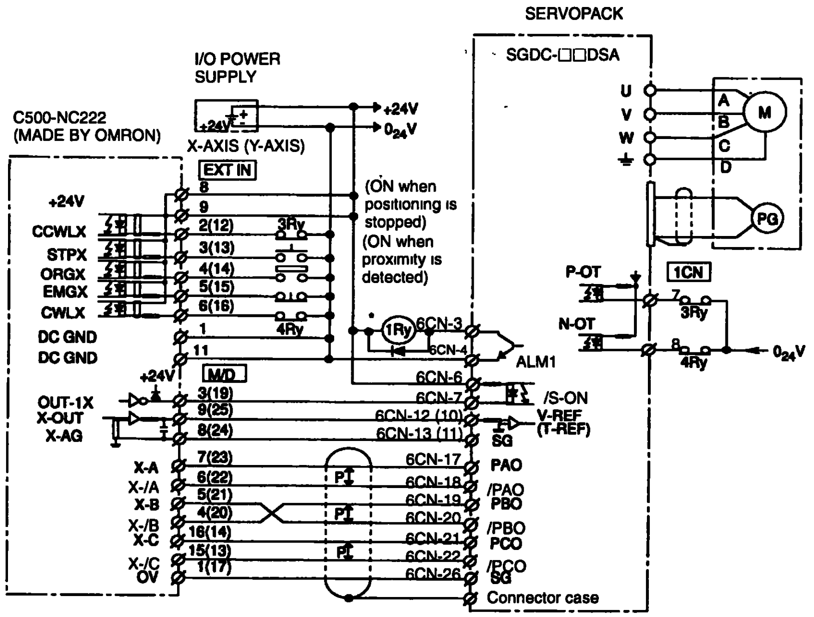


* These signals are output for approximately two seconds when the power is turned ON. Take this into consideration when designing a power ON sequence.
Relay 1Ry is used to stop main circuit power supply to the Servopack.

4) Connection to OMRON Position Control Unit C500-NC222

Speed/Torque

Servopack for Speed/Torque Control



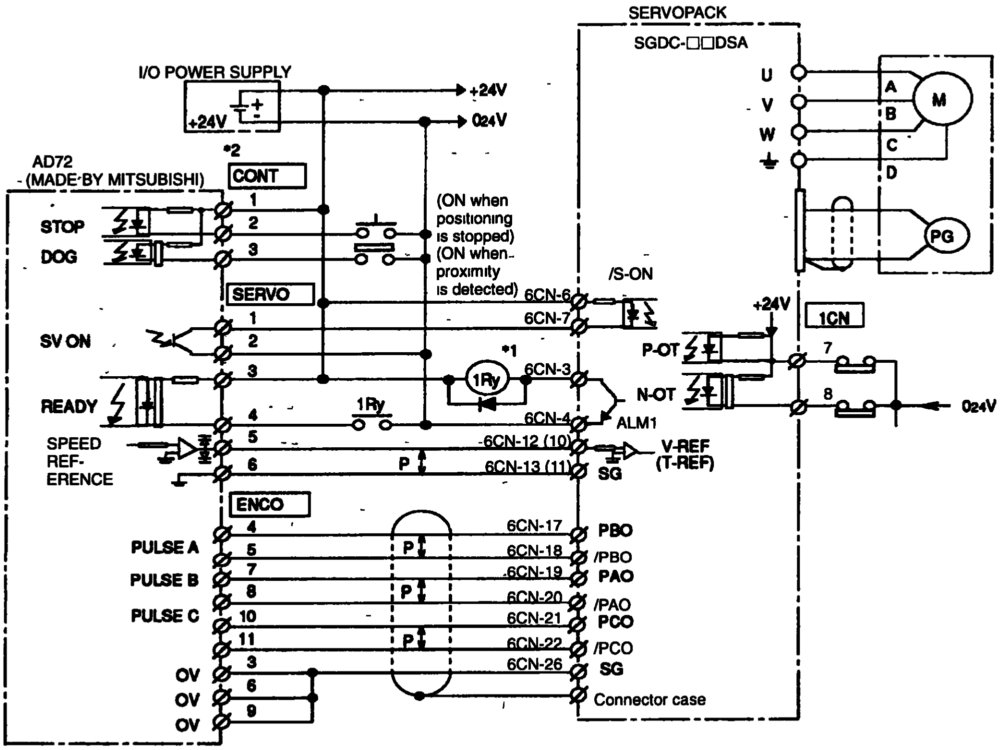
* These signals are output for approximately two seconds when the power is turned ON. Take this into consideration when designing a power ON sequence. Relay 1Ry is used to stop main circuit power supply to Servopack.

Note The signals shown here are applicable only to OMRON Sequencer C500-NC222 and Yaskawa Servopack SGDC-□□DSA.

5) Connection to MITSUBISHI Positioning Unit AD72

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 Sequencer AD72 and Yaskawa Servopack SGDC-□□DSA.

1.4 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.

1.4.1 Test Run in Two Steps

Conduct the test run when wiring is complete.

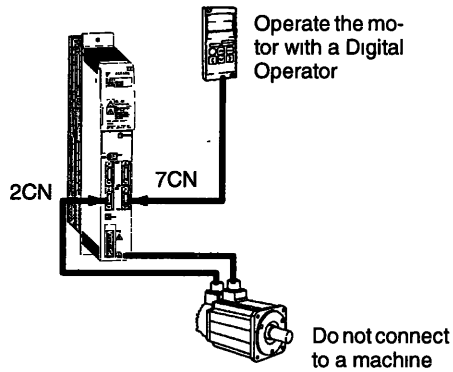
Generally, conducting a test run for servo drives can be difficult. However, by following the two steps described below, the test run can be performed safely and correctly.

NOTE 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



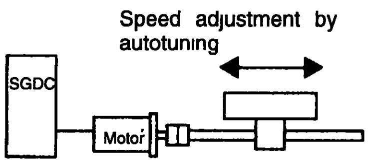
Check that the motor is wired correctly.

Conduct a test run with the motor shaft disconnected from the machine

Purpose:
- To check power supply circuit wiring
- To check motor wiring
- To check I/O signal (1CN, 6CN) wiring

Outline:
- Turn the power ON
- Operate the motor with a digital operator
- Check I/O signals (1CN, 6CN)
- Conduct a test run using I/O signals

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



Connect to the machine.

Adjust Servopack according to machine characteristics

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 user constant settings
- Record user constant settings

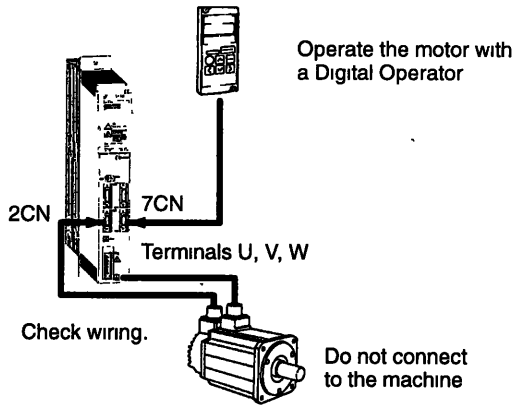
End of test run

For servomotors with a brake, refer to *Section 1.4.4 Supplementary Information on Test Run* before starting a test run.

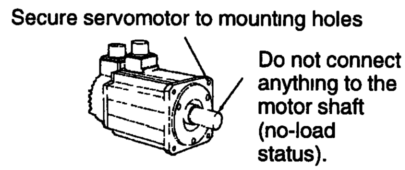
The following pages describe the test run procedure in detail.

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

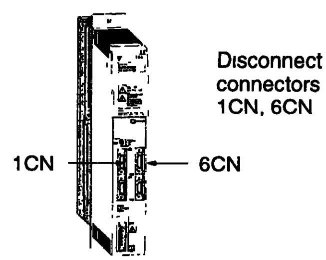
Check that the motor is wired correctly.
If the motor fails to rotate properly during a servo drive test run, the cause most frequently lies with incorrect wiring.
Conduct a test run for the motor without load according to the procedure described below.
For customers who use a servomotor with brake, refer to *Section 1.4.4 Supplementary Information on Test Run* before starting a test run.



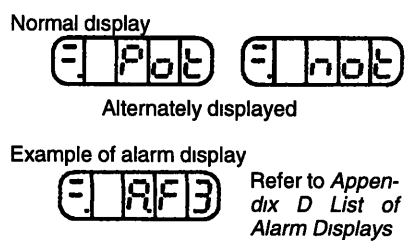
(1) Secure the servomotor.
Secure the servomotor to mounting holes to prevent it from moving during operation. Alternatively, install the servomotor on the machine and disconnect couplings and belts.



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



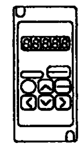
If an alarm display appears on the LED as shown in the figure above, the power supply circuit, motor wiring or encoder wiring is incorrect. In this case, turn the power OFF, then correct the problem.

(4) Operate using the Digital Operator

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

Refer to *Section 3.2.2 Operation Using the Digital Operator.*

Operation by Digital Operator



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

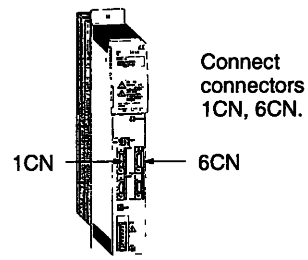
(5) Connect signal lines.

Connect connectors 1CN, 6CN as follows:

(1) Turn the power OFF.

(2) Connect connectors 1CN, 6CN.

(3) Turn the power ON again.

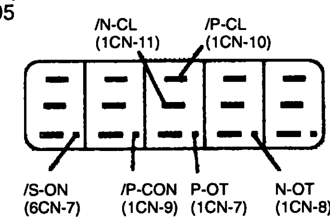


(6) Check input signals.

Check the input signal wiring in monitor mode. For the checking method, refer to *Section 3.1.6 Operation in Monitor Mode.*

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

Example of Un-05



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

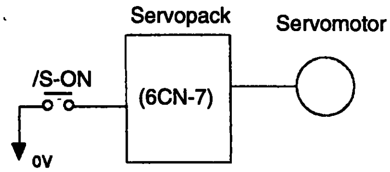
The memory switch can be used to eliminate the need for external short-circuits in wiring (see pages 36 and 92)

Input Signal	ON/OFF	Monitor Bit Display
High level or open	OFF	Extinguished
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.)

P-OT	1CN-7	Motor can rotate in forward direction when this input signal is at 0 V.
N-OT	1CN-8	Motor can reverse when this input signal is at 0 V.
/S-ON	6CN-7	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

Turn the servo ON as follows:

(1) Check that no reference has been input.

For speed/torque control:
V-REF (6CN-12) and T-REF (6CN-10) are at 0 V.

Note The user constant Cn-2B is used to set control modes (refer to *Section 2.2 Setting User Constants According to Host Controller*).

(2) Turn the servo ON signal ON.

Display when servo is turned ON

Set /S-ON (6CN-7) 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 D List of Alarm Displays.*

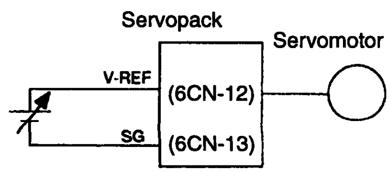
(8) Operate by reference input.

The operating procedure varies according to the setting of user constant 'Control mode selection (Cn-2B)'

Speed/Torque

Servopack for Speed/Torque

This section describes the standard speed control setting.



Servomotor rotates at a speed proportional to the reference voltage

(1) Gradually increase the speed reference input (V-REF, 6CN-12) voltage. The motor will rotate.

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 134):

(1) Has a reference speed been input?

(2) Is the rotation speed the same value as the setting one?

(3) Does the reference speed match the actual motor speed?

(4) Does the motor stop when no reference is input?

Un-00	Actual motor speed
Un-01	Reference speed

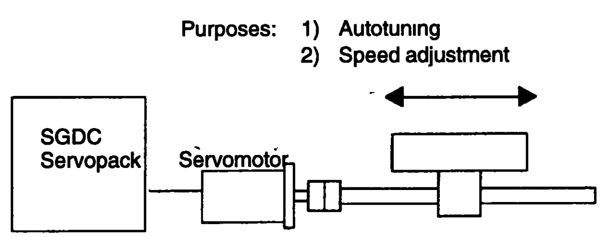
(3) If the motor rotates at an extremely slow speed when 0 V is specified as the reference voltage, correct the reference offset value as described in *Section 3.2.4 Reference Offset Automatic Adjustment*

(4) To change motor speed or the direction of rotation, reset the user constants shown below.

Cn-03	Speed reference gain (see page 46)
Cn-02 bit 0	Reverse rotation mode (see page 34)

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

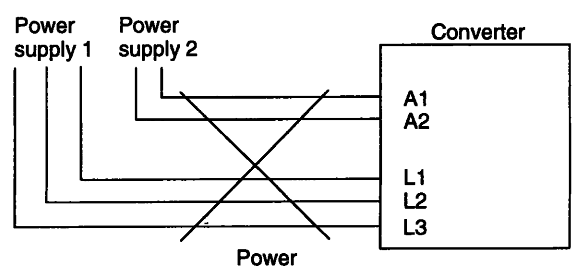
After step 1 is complete, proceed to step 2 in which a test run is conducted with the motor connected to the machine. The purpose of step 2 is to adjust the Servopack according to the machine characteristics.
Conduct a test run according to the procedure described below.



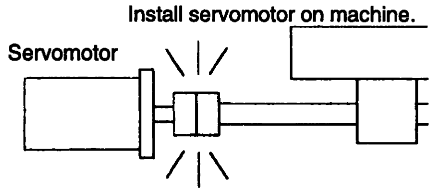
Connect to the machine.

NOTE 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 user constants setting and wiring should be tested as conclusively as possible before step 1 is complete.

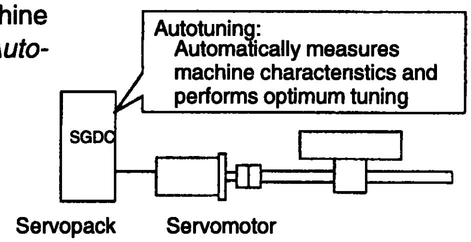
(1) Check that power is OFF.
Turn the Servopack power OFF.



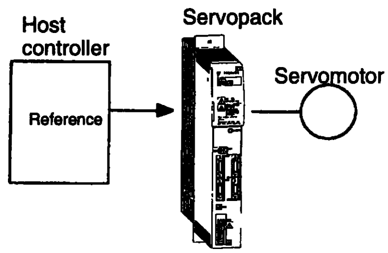
(2) Connect the servomotor to the machine.
Refer to *Section 1.2.2 Installing the Servomotor.*



(3) Perform autotuning.
Tune the Servopack according to the machine characteristics. Refer to *Section 3.2.3 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 25. Perform tuning associated with the host controller.



(5) Set user constants and record the settings.
Set user constants as necessary. Record all the user constant 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.

1.4.4 Supplementary Information on Test Run

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

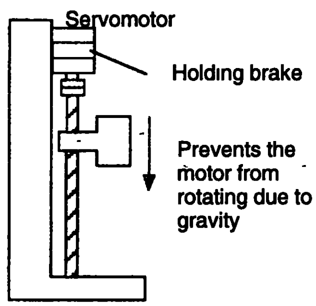
- When using a servomotor with a brake
- When performing position control from the host controller

2) **When using a servomotor with brake**

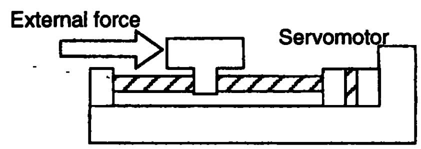
The brake prevents the motor shaft from rotating due to a backdriving torque. Such a torque may be created by an external force or the force of gravity acting on the load and may result in undesired motion or the load, should motor power be lost.

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

• Vertical axis

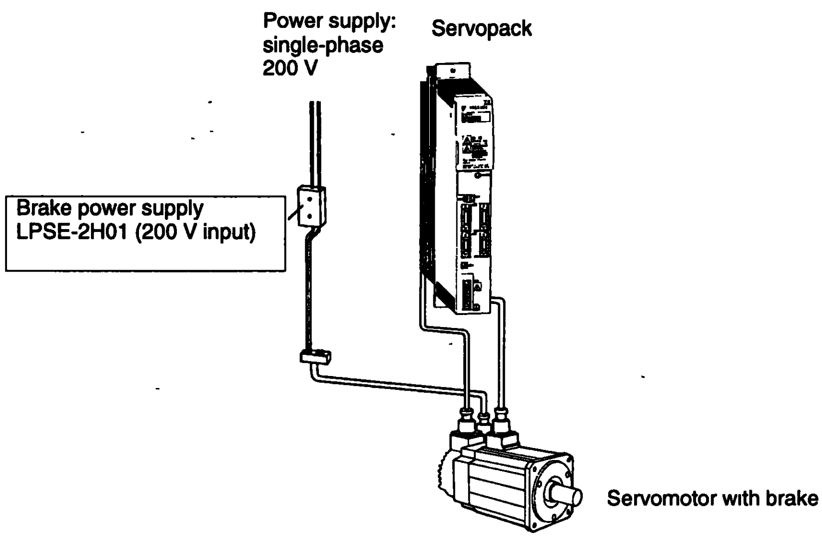


• Axis to which external force is applied

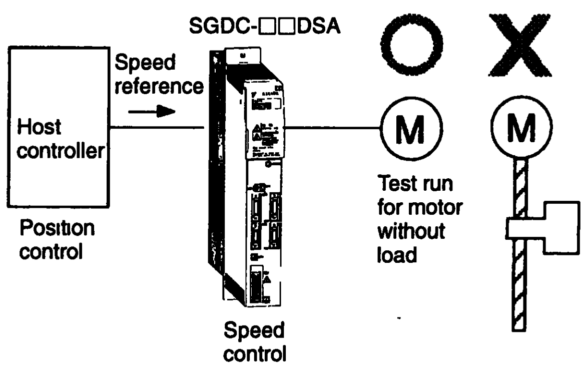


NOTE To prevent faulty operation caused by gravity (or external force), first check that the motor and holding brake operate normally with the motor disconnected from the machine. Then, connect the motor to the machine and conduct a test run.

For wiring of a servomotor with a brake, refer to *Section 2.4.4 Using Holding Brake*.



3) **When performing position control from the host controller**
Check motor operation first and then conduct a test run as described in the table below.



NOTE 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 (user constant 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 (user constant 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.

1.4.5 Minimum User Constants Required and Input Signals

1) This section describes the minimum user constants that must be set to conduct a test run. For details on how to set each user constant, refer to *Section 3.1.5 Operation in User Constant Setting Mode.*

a) 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
Cn-03	Speed reference gain (see page 46)
Cn-0A	Dividing ratio setting

2) 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 user constant:

Cn-02 (bit 0)	Reverse rotation mode (see page 34)

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

3) 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)	6CN-7	Switching between motor ON and OFF status. The memory switch can be used to eliminate the need for external short-circuit wiring (see page 92).
P-OT	(forward rotation prohibited)	1CN-7	Overtravel limit switch The memory switch can be used to eliminate the need for external short-circuit wiring (see page 36).
N-OT	(reverse rotation prohibited)	1CN-8	

APPLICATIONS OF Σ-SERIES PRODUCTS

2

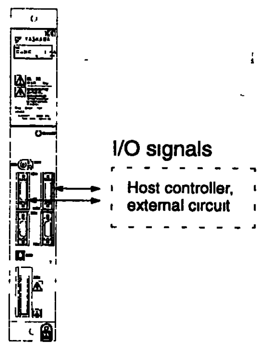
This chapter is prepared for readers who wish to learn more about the applications of Σ-series products after fully understanding *Chapter 1 Basic Uses of Σ-series Products*. It explains how to set user constants for each purpose and how to use each function. Read the applicable sections according to your requirements.

2

Before Reading this Chapter

1) This chapter describes how to use each 1CN, 6CN connector I/O signal for the SGDC Servopack and how to set the corresponding user constant.

2) For a list of I/O signals of 1CN, 6CN connector, refer to *Appendix B List of I/O Signals.* For terminal arrangement for I/O signals of 1CN, 6CN connector, refer to *Section 2.8.7 Connector Terminal Layouts.*



3) For a list of user constants, refer to *Appendix C List of User Constants.*

4) User constants are divided into the following two types.

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

5) For details on how to set user constants, refer to *Section 3.1.5 Operation in User Constant Setting Mode.*

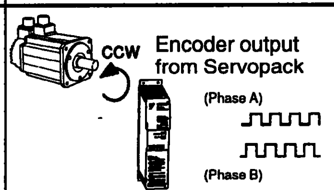
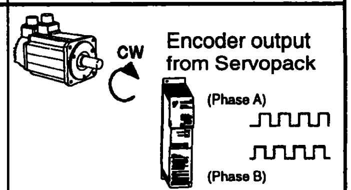
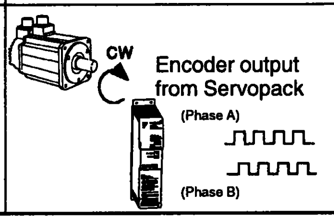
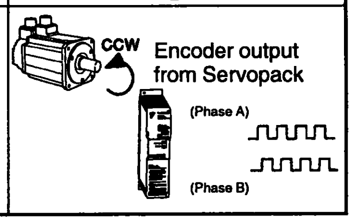
2.1 Setting User Constants According to Machine Characteristics

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

2.1.1 Changing the Direction of Motor Rotation

1) 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.

2) 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		

3) **Setting Reverse Rotation Mode:**

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

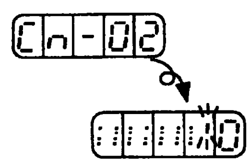
a) **Method 1: Setting Memory Switch**

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

Set the direction of rotation.

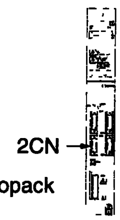
Setting	Meaning	
0	Forward rotation is defined as counterclockwise rotation when viewed from the drive end.	(Standard setting)
1	Forward rotation is defined as clockwise rotation when viewed from the drive end.	(Reverse rotation mode)

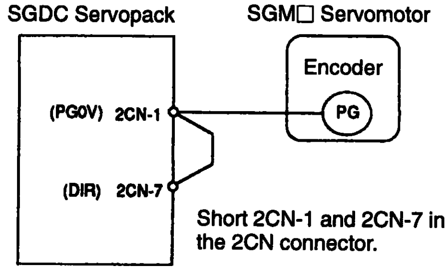


b) **Method 2: Shorting the Wiring in the 2CN Connector**

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

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





2.1.2 Setting the Overtravel Limit Function

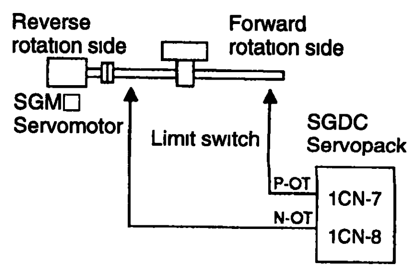
1) The overtravel limit function forces the moving part of the machine to stop when it exceeds the movable range.

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

→ Input P-OT 1CN-7	Forward Rotation Prohibited (Forward Overtravel)	For Speed/Torque Control
→ Input N-OT 1CN-8	Reverse Rotation Prohibited (Reverse Overtravel)	For Speed/Torque Control

Input terminals for overtravel limit switch.

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



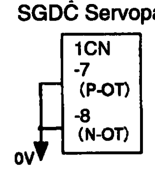
P-OT	ON: 1CN-7 is at low level.	Forward rotation allowed. Normal operation status.
	OFF: 1CN-7 is at high level.	Forward rotation prohibited (reverse rotation allowed).
N-OT	ON: 1CN-8 is at low level.	Reverse rotation allowed. Normal operation status.
	OFF: 1CN-8 is at high level.	Reverse rotation prohibited (forward rotation allowed).

3) Use the following user constants (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
Cn-01 Bit 3	Use of N-OT Input Signal	Factory Setting: 0	For Speed/Torque Control

Specifies whether the P-OT input signal for prohibiting forward rotation at overtravel (1CN-7) is to be used and whether the N-OT input signal for prohibiting reverse rotation at overtravel (1CN-8) is to be used.

SGDC Servopack



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

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

Bit	Setting	Meaning
Bit 2	0	Uses the P-OT input signal for prohibiting forward rotation. (Forward rotation is allowed when 1CN-7 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-7 to 0 V.)
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-8 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-8 to 0 V.)

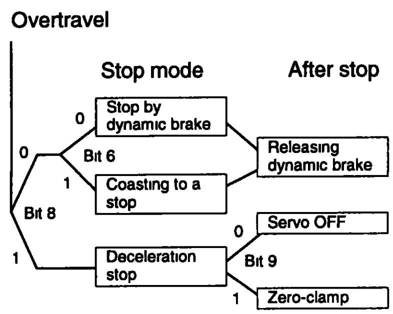
4) If the P-OT and N-OT input signals are used, set the following user constants to specify how to stop the motor.

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-7)

- Inputs signal for prohibiting reverse rotation (N-OT, 1CN-8)

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.

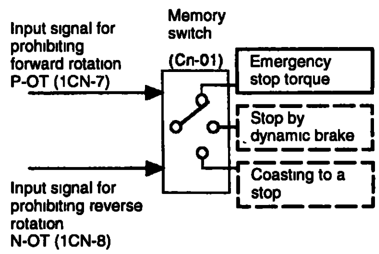
	Setting	Meaning
Cn-01 bit 9	0	Turns the servo OFF when the motor stops in deceleration stop mode.
	1	Causes the motor to enter zero-clamp status after it stops in deceleration stop mode.

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.

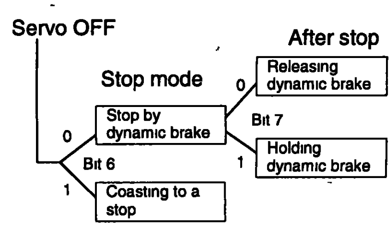


Cn-01 Bit 6	How to Stop Motor at Servo OFF	Factory Setting: 0	
Cn-01 Bit 7	Operation to Be Performed when Motor Stops after Servo OFF	Factory Setting: 1	Invalid for 2.0 kW or more

The Servopack enters servo OFF status when:

- Servo ON input signal (/S-ON, 6CN-7) 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.

2.1.3 Restricting Torque

1) 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.

2) **How to Set Level 1: Internal Torque Limit**

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

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

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

Sets these user constants 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.

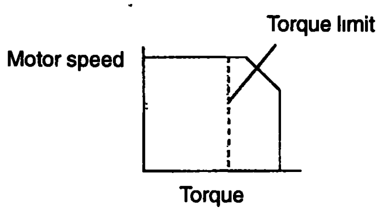
If a value higher than the maximum torque is set, the maximum torque value is used.

Output Signal for Torque Restriction Function

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

2

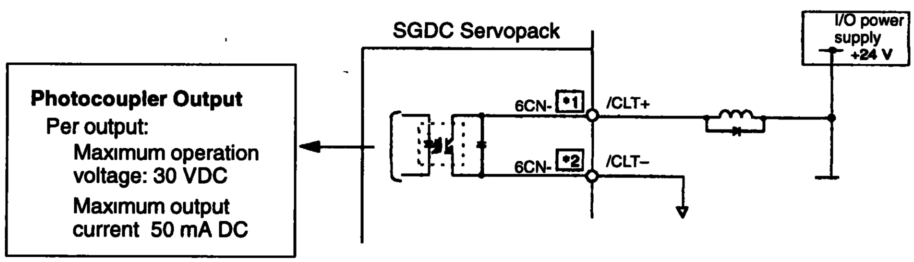
Example of Use: Machine Protection



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

• Using /CLT Signal

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



Output → /CLT 6CN-*1	Torque Limit Output	For Speed/Torque Control

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

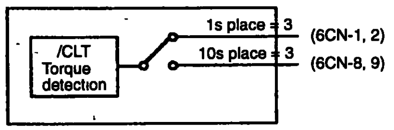
ON status: The circuit between 6CN-*1 and 6CN-*2 is closed. 6CN-*1 is at low level.	Motor output torque is being restricted. (Internal torque reference is greater than the preset value.)
OFF status: The circuit between 6CN-*1 and 6CN-*2 is open. 6CN-*1 is at high level.	Motor output torque is not being 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: 12	For Speed/Torque Control

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

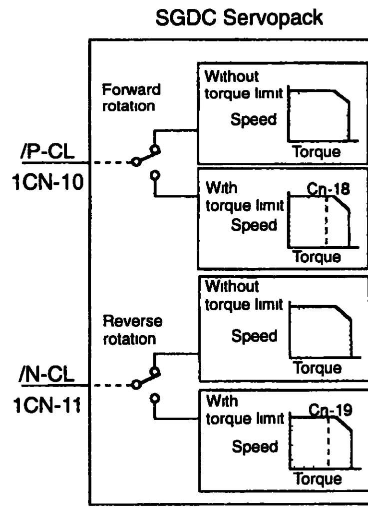
Setting	Output terminals (6CN-)	
	*1	*2
1s place = 3	1	2
10s place = 3	8	9



3) How to Set Level 2: External Torque Limit

First, use a contact input signal to make the torque (current) limit value set in the user constant 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-10 is at low level.	Torque restriction applies during forward rotation.	Limit value: Cn-18
	OFF: 1CN-10 is at high level.	Torque restriction does not apply during forward rotation.	
N-CL	ON: 1CN-11 is at low level.	Torque restriction applies during reverse rotation.	Limit value: Cn-19
	OFF: 1CN-11 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-06 bit 4
User Constant Setting: Cn-2D = □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
Cn-19	CLMIR Reverse External Torque Limit	Unit: %	Setting Range: 0 to 800	Factory Setting: 100	For Speed/Torque Control

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

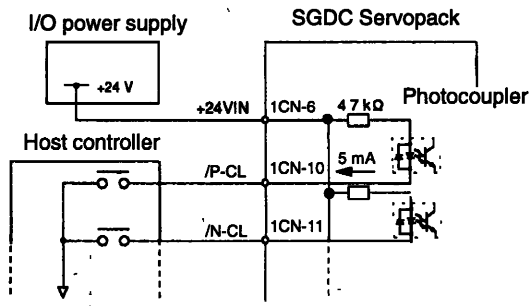
This function is valid when Cn-2B is set to 0, 2, 9, 10.

When /P-CL (1CN-10) is input	Applies torque restriction as specified in Cn-18
When /N-CL (1CN-11) is input	Applies torque restriction as specified in Cn-19

For torque restriction by analog voltage reference, refer to *Section 2.2.7 Using Torque Restriction by Analog Voltage Reference.*

- Using /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-10	Forward External Torque Limit Input (Speed Selection 1)	For Speed/Torque Control
→ Input /N-CL 1CN-11	Reverse External Torque Limit Input (Speed Selection 2)	For Speed/Torque 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
• User Constant Setting· Cn-2D = □3, 3□

P-CL	ON: 1CN-10 is at low level.	Torque restriction applies during forward rotation.	Limit value: Cn-18
	OFF: 1CN-10 is at high level.	Torque restriction does not apply during forward rotation. Normal operation status.	
N-CL	ON: 1CN-11 is at low level.	Torque restriction applies during reverse rotation.	Limit value: Cn-19
	OFF: 1CN-11 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.

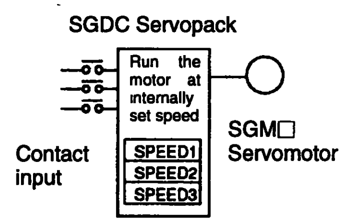
Note This function is changed to another function depending on the setting of memory switch Cn-2B (see below).

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

Prohibits the contact input speed control function.

If the contact input speed control function is used, the contents of the input signals shown below will change.



After this memory switch is reset, the meanings of the following signals will also change:

Monitor mode (Un-05) bit 7 and bit 8

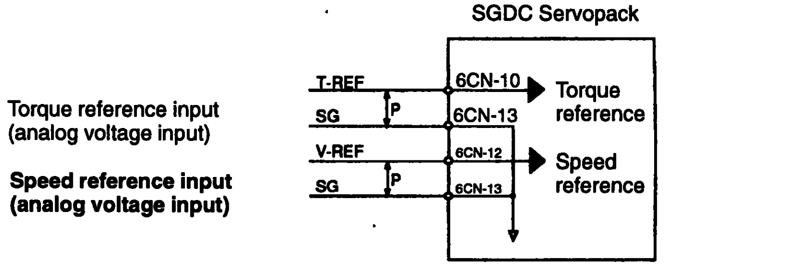
<table>
<tr><th>Setting</th><th>Meaning</th><th>Input Signal</th></tr>
<tr><td>0, 2, 9, 10</td><td>Does not use the contact input speed control function.</td><td>
<table>
<tr><td>/P-CON (1CN-9)</td><td>Used to switch between P control and PI control and to perform other functions.</td></tr>
<tr><td>/P-CL (1CN-10)</td><td>Used for forward external torque limit input</td></tr>
<tr><td>/N-CL (1CN-11)</td><td>Used for reverse external torque limit input</td></tr>
</table>
</td></tr>
<tr><td>3, 4, 6</td><td>Uses the contact input speed control function.</td><td>
0: OFF, 1: ON
<table>
<tr><th>/P-CON</th><th>/P-CL</th><th>/N-CL</th><th>Speed Setting</th></tr>
<tr><td rowspan="4">Direction of rotation
0. Forward
1. Reverse</td><td>0</td><td>0</td><td>0 reference and so on</td></tr>
<tr><td>0</td><td>1</td><td>Cn-1F (SPEED1)</td></tr>
<tr><td>1</td><td>1</td><td>Cn-20 (SPEED2)</td></tr>
<tr><td>1</td><td>0</td><td>Cn-21 (SPEED3)</td></tr>
</table>
</td></tr>
</table>

2.2 Setting User Constants According to Host Controller

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

2.2.1 Inputting Speed Reference

1) 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.



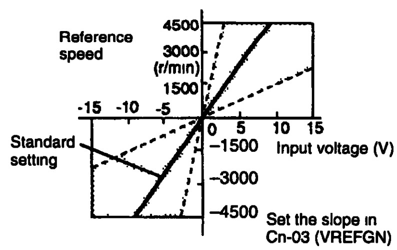
↕P: Represents twisted-pair cables

→ Input V-REF	6CN-12	Speed Reference Input	For Speed Control
→ Input SG	6CN-13	Signal Ground for Speed Reference Input	For Speed Control

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



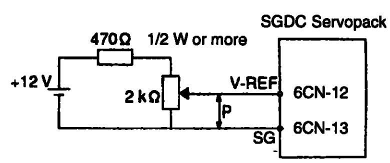
- Standard Example:

  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

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

- Example of Input Circuit
  (See the figure on the right)

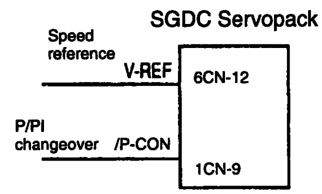
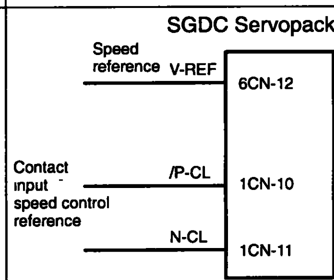
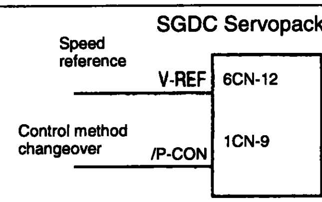


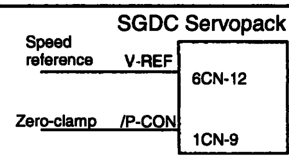
For noise control, always use twisted-pair cables.

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

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

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

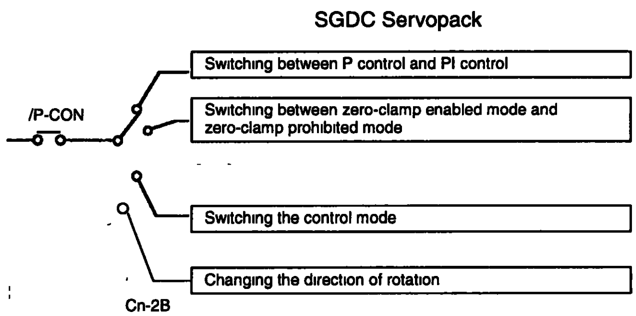
<table>
<tr><th>Cn-2B Setting</th><th colspan="2">Control Method</th></tr>
<tr><td>0</td><td>Speed Control
This is normal speed control.
• Speed reference is input from V-REF (6CN-12).
• /P-CON (1CN-9) signal is used to switch between P control and PI control.
<table>
<tr><td>1CN-9 is open</td><td>PI control</td></tr>
<tr><td>1CN-9 is at 0 V</td><td>P control</td></tr>
</table></td><td>
</td></tr>
<tr><td>4</td><td>Speed Control (Contact Reference) ↔ Speed Control (Analog Reference)
This speed control allows switching between contact and analog references.
• Analog reference is input from V-REF (6CN-12).
• /P-CON (1CN-10) and /N-CL (1CN-11) are used to switch between contact and analog references.
• Contact input speed is selected.
<table>
<tr><th>1CN-10</th><th>1CN-11</th><th></th></tr>
<tr><td>Open</td><td>Open</td><td>Analog reference</td></tr>
<tr><td>Closed</td><td>Open</td><td rowspan="3">Contact reference</td></tr>
<tr><td>Closed</td><td>Closed</td></tr>
<tr><td>Open</td><td>Closed</td></tr>
</table></td><td>
</td></tr>
<tr><td>9</td><td>Torque Control ↔ Speed Control
This control mode can be switched between torque control and speed control.
• Speed reference is input from V-REF (6CN-12).
• /P-CON (1CN-9) is used to switch the control mode between position/torque control and speed control.
<table>
<tr><td>1CN-9 is open</td><td>Torque control</td></tr>
<tr><td>1CN-9 is at 0 V</td><td>Speed control</td></tr>
</table></td><td>
</td></tr>
</table>

Cn-2B Setting	Control Method	
10	**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 (6CN-12). • /P-CON (1CN-9) signal is used to turn the zero-clamp function ON or OFF. 1CN-9 is open: Turns zero-clamp function OFF 1CN-9 is at 0 V: Turns zero-clamp function ON	 **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)**

• Using /P-CON Signal:

→ Input /P-CON 1CN-9	Proportional Control, etc.	For Speed Control

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



Cn-2B Setting	Meaning of /P-CON Signal
0	Switching between proportional (P) control and proportional/integral (PI) control
2	(Not used)
3, 4, 6	Changing the direction of rotation during contact input speed control
9	Switching the control mode
10	Switching between zero-clamp enabled and zero-clamp prohibited modes

TERMS

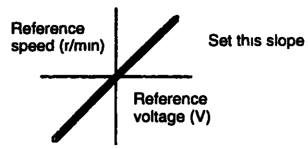
Zero-clamp function

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."

3) Adjust the speed reference gain using the following user constant.

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

Sets the voltage range for speed reference input V-REF (6CN-12). Sets this user constant according to the output form of the host controller or external circuit.

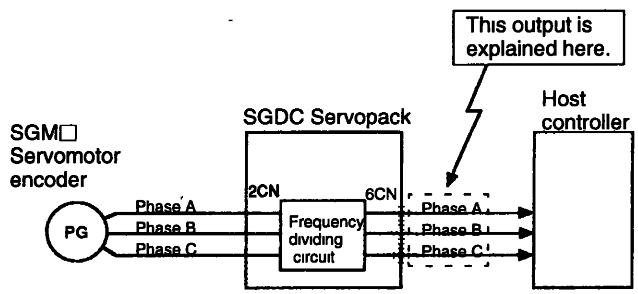


The factory setting is as follows:
Rated speed ±1%/6V

Motor Series	Factory Setting
SGMG (1500 r/min)	250
SGMS	500

2.2.2 Using Encoder Outputs

1) 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.

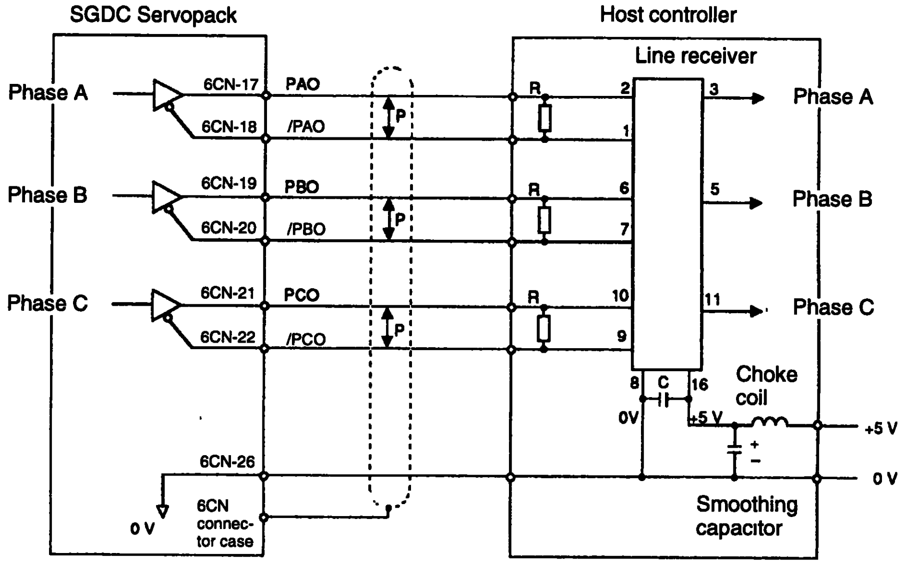


TERMS

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

2) I/O signals are described below.

Output → PAO 6CN-17	Encoder Output Phase-A	For Speed/Torque Control
Output → /PAO 6CN-18	Encoder Output Phase-/A	For Speed/Torque Control
Output → PBO 6CN-19	Encoder Output Phase-B	For Speed/Torque Control
Output → /PBO 6CN-20	Encoder Output Phase-/B	For Speed/Torque Control
Output → PCO 6CN-21	Encoder Output Phase-C	For Speed/Torque Control
Output → /PCO 6CN-22	Encoder Output Phase-/C	For Speed/Torque Control

Divided encoder signals are output.

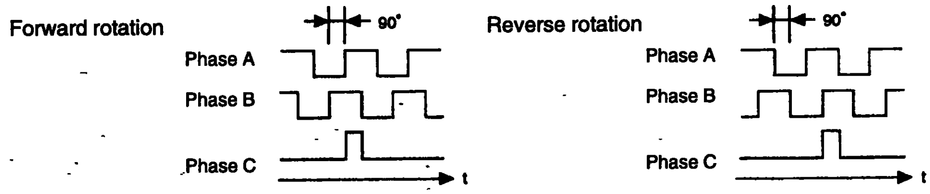
Always connect these signal terminals when a position loop is formed in the host controller to perform position control.

Set a dividing ratio in the following user constant.

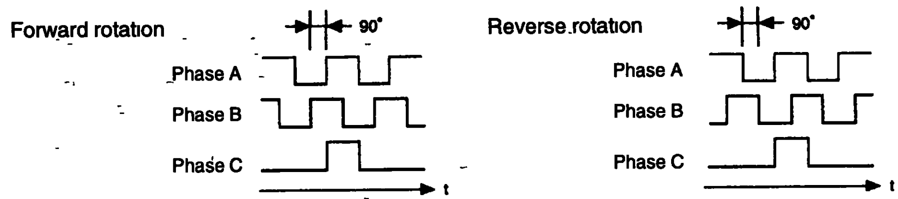
Dividing ratio setting	Cn-0A PGRAT

Output Phase Form

Incremental Encoder



Absolute Encoder



→ Input SEN 6CN-14	SEN Signal Input	For Speed/Torque Control
→ Input SG 6CN-16	Signal Ground	For Speed/Torque Control
→ Input BAT 6CN-14	Battery (+)	For Speed/Torque Control
→ Input BAT0 6CN-15	Battery (–)	For Speed/Torque Control

Use these signals (SEN to BAT0) for absolute encoders. For details, refer to *Section 2.8.5 Using an Absolute Encoder.*

Output → SG 6CN-26	Signal Ground	For Speed/Torque Control
Output → FG 1CN connector case	Frame Ground	For Speed/Torque Control

SG: Connect to 0 V on the host controller.
FG: Connect to the cable shielded wire.

3) 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

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.

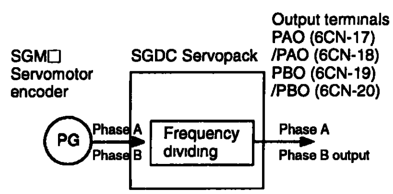
Motor Type encoder specifications	Number of Encoder Pulses Per Revolution (P/R)	Setting
2	Incremental encoder: 8192 pulses per revolution	0
3	Incremental encoder: 2048 pulses per revolution	
6	Incremental encoder: 4096 pulses per revolution	
W	Absolute encoder: 1024 pulses per revolution	1
S	Absolute encoder: 8192 pulses per revolution	

4) Set the pulse dividing ratio in the following user constant.

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

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

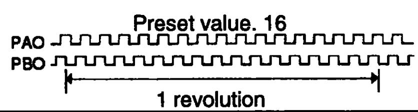
Pulses from motor encoder (PG) are divided by the preset number of pulses before being output.



The number of output pulses per revolution is set in this user constant. 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:



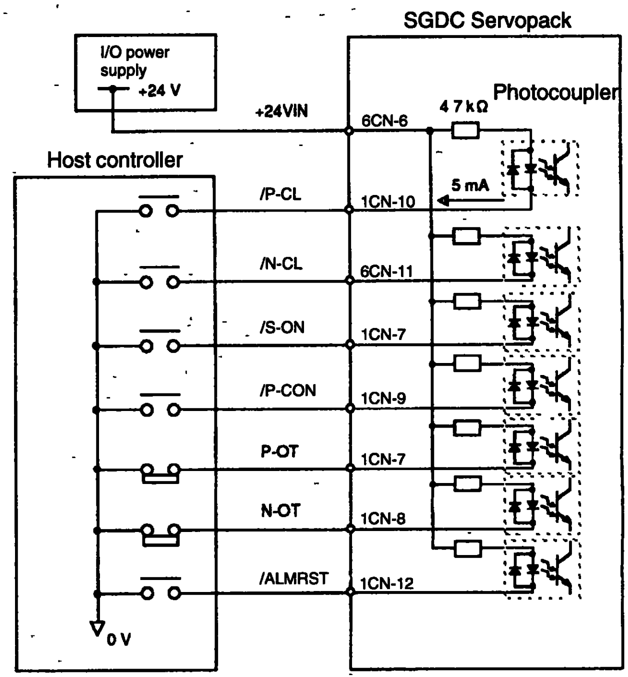
Motor Type encoder specifications	Number of Encoder Pulses Per Revolution	Setting Range
2	Incremental encoder: 8192 pulses per revolution	16 to 8192
3	Incremental encoder: 2048 pulses per revolution	16 to 2048
6	Incremental encoder: 4096 pulses per revolution	16 to 4096
W	Absolute encoder: 1024 pulses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

After changing the user constant setting, always turn the power OFF, then ON.

2.2.3 Using Contact I/O Signals

1) Contact Input Signal Terminal Connections

These signals are used to control SGDC Servopack operation. Connect these signal terminals as necessary.



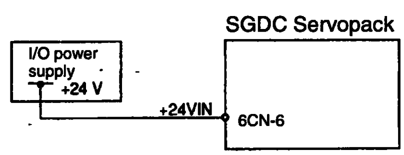
Note Provide an external I/O power supply separately.
There are no power terminals available from the SGDC Servopack outputs signals externally.

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 6CN-6	I/O Power Supply	For Speed/Torque Control

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

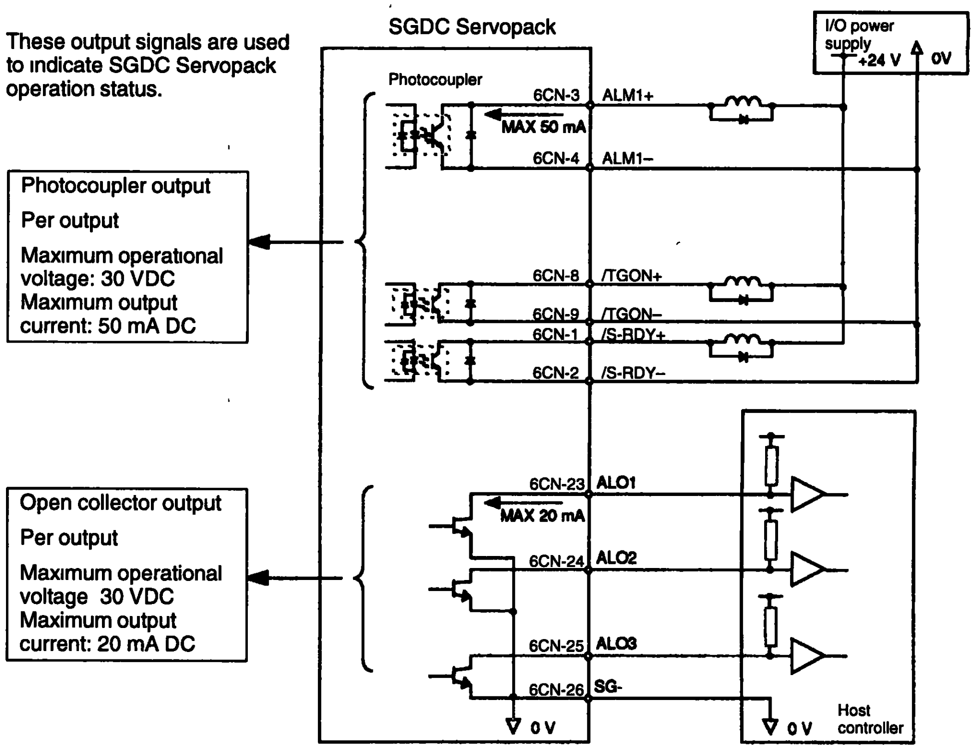


Connect an external I/O power supply.

Contact Input Signals:		
	/P-CL	**(1CN-10)**
	/N-CL	**(1CN-11)**
	/S-ON	**(6CN-7)**
	/P-CON	**(1CN-9)**
	P-OT	**(1CN-7)**
	N-OT	**(1CN-8)**
	/ALMRST	**(1CN-12)**

2) **Contact Output Signal Terminal Connections**

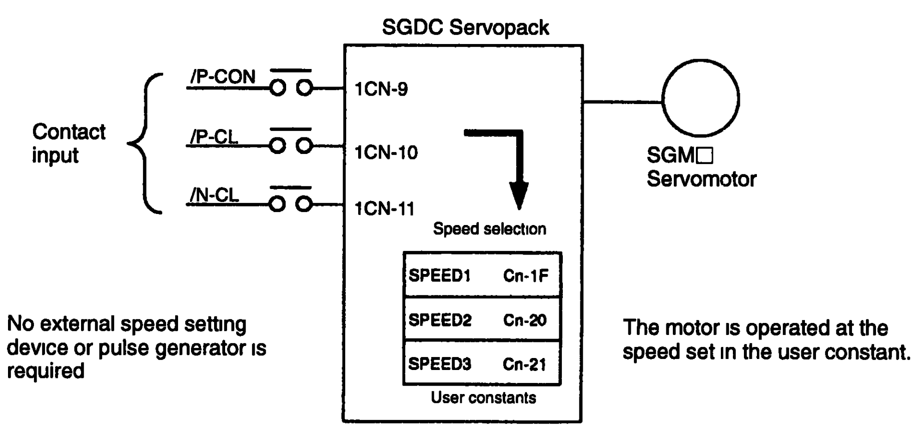
These output signals are used to indicate SGDC Servopack operation status.



Note Provide an external I/O power supply separately.
There are no power terminals to which the SGDC Servopack outputs signals externally.
Yaskawa recommends that this external power supply be the same type as for the input circuit.

2.2.4 Using Contact Input Speed Control

1) The contact input speed control function provides easy-to-use speed control. It allows the user to initially set three different motor speeds in user constants, select one of the speeds externally by contact input and run the motor.



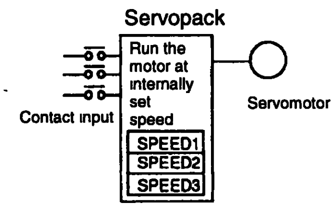
2) To use the contact input speed control function, perform Steps a) to c).

a) Set memory switch Cn-02 as follows.

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

Enables the contact input speed control function.

If the contact input speed control function is used, the contents of the input signals shown below will change.



When this memory switch is reset, the meanings of the following signals will also change:

Monitor mode (Un-05) bit 7 and bit 8

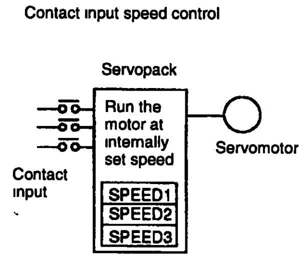
<table>
<tr><th>Setting</th><th>Meaning</th><th>Input Signal</th></tr>
<tr><td>0, 2, 9, 10</td><td>Does not use the contact input speed control function.</td><td>
<table>
<tr><td>/P-CON (1CN-9)</td><td>Used to switch between P control and PI control and to perform other functions</td></tr>
<tr><td>/P-CL (1CN-10)</td><td>Used for forward external current limit input</td></tr>
<tr><td>/N-CL (1CN-11)</td><td>Used for reverse external current limit input</td></tr>
</table>
</td></tr>
<tr><td>3, 4, 6</td><td>Uses the contact input speed control function.
Note In the case of the position control type, the reference pulse inhibit function (INHIBIT) cannot be used.</td><td>
0: OFF, 1: ON
<table>
<tr><th>/P-CON</th><th>/P-CL</th><th>/N-CL</th><th>Speed Setting</th></tr>
<tr><td rowspan="4">Direction of rotation

0: Forward
1: Reverse</td><td>0</td><td>0</td><td>0 reference and so on</td></tr>
<tr><td>0</td><td>1</td><td>Cn-1F, SPEED1</td></tr>
<tr><td>1</td><td>1</td><td>Cn-20, SPEED2</td></tr>
<tr><td>1</td><td>0</td><td>Cn-21, SPEED3</td></tr>
</table>
</td></tr>
</table>

b) Set three motor speeds in the following user constants.

Cn-1F	SPEED1 1st Speed (Contact Input Speed Control)	Unit: r/min	Setting Range: 0 to 10000	Factory Setting: 100	For Speed Control
Cn-20	SPEED2 2nd Speed (Contact Input Speed Control)	Unit: r/min	Setting Range: 0 to 10000	Factory Setting: 200	For Speed Control
Cn-21	SPEED3 3rd Speed (Contact Input Speed Control)	Unit: r/min	Setting Range: 0 to 10000	Factory Setting: 300	For Speed Control

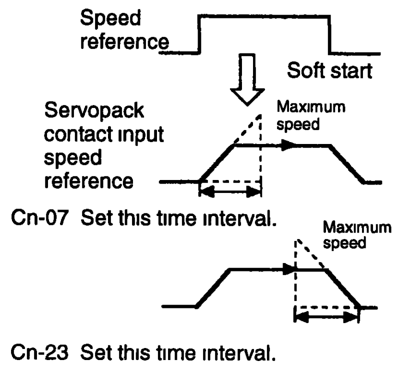
Use these user constants to set motor speeds when the contact input speed control function is used.
If a value higher than the maximum speed is set, the maximum speed value is used.



Speed selection input signals /P-CL (1CN-10) and /N-CL (1CN-11), and rotation direction selection signal /P-CON (1CN-9) enable the motor to run at the preset speeds.

c) Set the soft start time.

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



In the Servopack, a speed reference is multiplied by the preset acceleration or deceleration value to provide speed control.

When a progressive speed reference is input or contact input speed control is used, smooth speed control can be performed. (For normal speed control, set "0" in each user constant.)

Set the following value in each user constant.

- Cn-07: Time interval from the time the motor starts until it reaches the maximum speed
- Cn-23: Time interval from the time the motor is running at the maximum speed until it stops

3) Contact input speed control performs the following operation.

The following input signals are used to start and stop the motor.

→ Input /P-CL 1CN-10	Speed Selection 1 (Forward External Torque Limit Input)	For Speed/Torque Control
→ Input /N-CL 1CN-11	Speed Selection 2 (Reverse External Torque Limit Input)	For Speed/Torque Control

a) When Contact Input Speed Control is used:

Contact Signal			User Constant	Selected Speed
/P-CON	**/P-CL**	**/N-CL**	**Cn-2B**	
			3	Stopped by internal speed reference 0
—	0	0	4	Analog speed reference input (V-REF)
			6	Analog torque reference input (torque control)

Contact Signal			User Constant	Selected Speed
/P-CON	/P-CL	/N-CL	Cn-2B	
Direction of rotation 0: Forward rotation 1: Reverse rotation	0	1	Common to 3, 4, and 6	SPEED 1 (Cn-1F)
	1	1		SPEED 2 (Cn-20)
	1	0		SPEED 3 (Cn-21)

——: Not used

b) Modes Other Than Contact Input Speed Control

Input signals are used as external torque limit input.

Input signal /P-CON is used to specify the direction of motor rotation.

→ Input /P-CON 1CN-9	Proportional Control, etc.	For Speed/Torque Control

a) When Contact Input Speed Control is used:

Use input signal /P-CON to specify the direction of motor rotation.

/P-CON	Meaning
1	Reverse rotation
0	Forward rotation

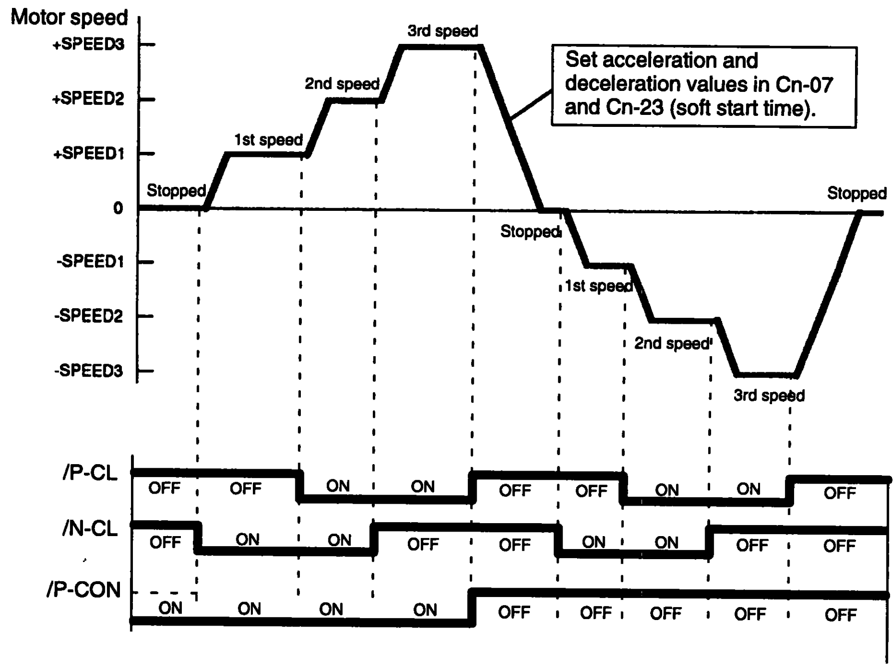
0: OFF (high level), 1: ON (low level)

b) Modes Other Than Contact Input Speed Control

/P-CON signal is used for proportional control, zero-clamp and torque/speed control changeover.

4) The figure below illustrates an example of operation in contact input speed control mode. Using the soft start function reduces physical shock at speed changeover.

When Contact Input Speed Control is Used



2.2.5 Using Torque Control

1) 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.

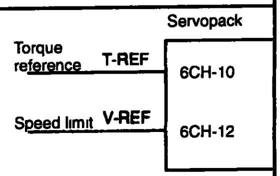
2) Use the following user constant to select level 3 or level 4 torque control.

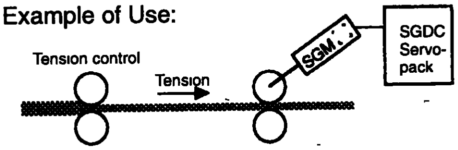
Cn-2B	Control Mode Selection	Factory Setting: 0	For Speed/Torque Control

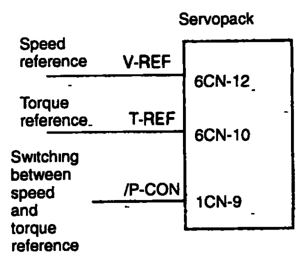
This is dedicated torque control.

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

Examples of Use: Tension control
Pressure control

<table>
<tr><th>Cn-2B</th><th>Control Mode</th></tr>
<tr><td>2</td><td>
<u>Torque Control</u>


This is a dedicated torque control mode.
• A torque reference is input from T-REF (6CN-10).
• /P-CON is not used.
• Speed reference input V-REF (6CN-12) can be used as speed limit when bit 2 of Cn-02 is set to 1.
• User constant Cn-14 can be used for maximum speed control.
Example of Use:


</td></tr>
<tr><td>9</td><td>
<u>Torque Control ↔ Speed Control (Analog Reference)</u>
Torque control and speed control can be switched.


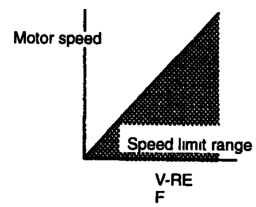
• A speed reference or speed limit value is input from V-REF (6CN-12).
• T-REF (6CN-10) inputs a torque reference, torque feed-forward reference or torque limit value depending on the control mode used.
• /P-CON (1CN-9) is used to switch between torque control and speed control.
<table>
<tr><td>When 1CN-9 is open</td><td>Torque control</td></tr>
<tr><td>When 1CN-9 is at 0 V</td><td>Speed control</td></tr>
</table>
</td></tr>
</table>

Cn-2B	Control Mode
	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.

- User constant 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.

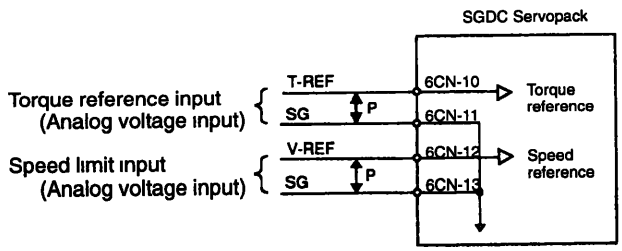
9 In the Speed Control mode (/P-CON is ON):
Values set in bit 9 of user constant Cn-02 and bit 8 of Cn-02 determine the following:

User Constant Cn-02 Bit 9	User Constant Cn-02 Bit 8	Speed Reference Input (V-REF) (6CN-12, 13)	Torque Input (T-REF) (6CN-10, 11)	Remarks
0	0	**Speed control**		
		Speed reference	Cannot be used	
1	—	**Speed control with torque feed-forward**		Any value can be set in bit 8 of Cn-02 (0 and 1 have the same effect).
		Speed reference	Torque feed-forward	For details of speed control with torque feed-forward, refer to *Section 2.2.6 Using Torque Feed-forward Function.*
0	1	**Speed control with torque limit by analog voltage reference**		For details of speed control with torque limit by analog voltage reference, refer to *Section 2.2.7 Using Torque Restriction by Analog Voltage Reference*
		Speed reference	Torque limit value	

Cn-2B	Control Mode
6	Speed Control (Contact Reference) ↔ Torque Control This mode allows switching between speed control (contact reference) and torque control. • /P-CL (1CN-10) and /N-CL (1CN-11) are used to switch the control mode between speed control (contact reference) and torque control.

1CN-10	1CN-11	
Open	Open	Torque control
Open	Closed	Speed control (contact reference)
Closed	Closed	
Closed	Open	

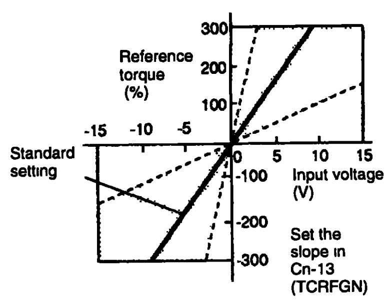
3) The following input signals perform torque control.



↕P: Represents twisted-pair cables

→ Input T-REF 6CN-10	Torque Reference Input	For Speed/Torque Control
→ Input SG 6CN-11	Signal Ground for Torque Reference Input	For Speed/Torque Control

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.

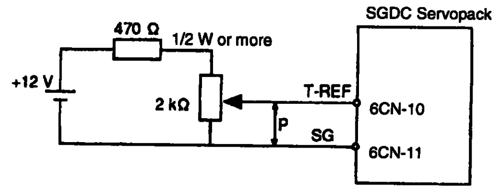
Standard Setting

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

User constant 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.

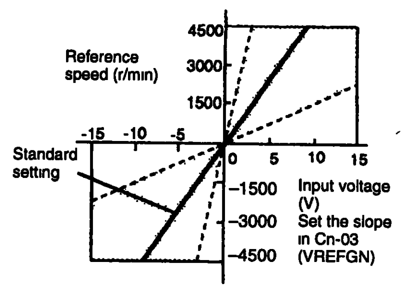
- Example of Variable Resistor for Speed Setting:
  Type 25HP-10B manufactured by Sakae Tsushin Kogyo Co., Ltd.

→ Input V-REF	6CN-12	Speed Reference Input (or Speed Limit Input)	For Speed/Torque Control
→ Input SG	6CN-13	Signal Ground for Speed Reference Input	For Speed/Torque Control

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.



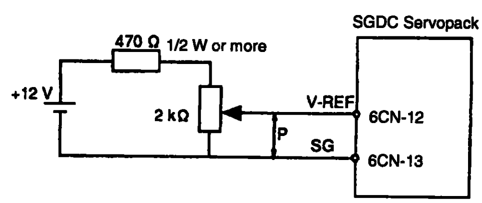
Standard Example

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

User constant 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.



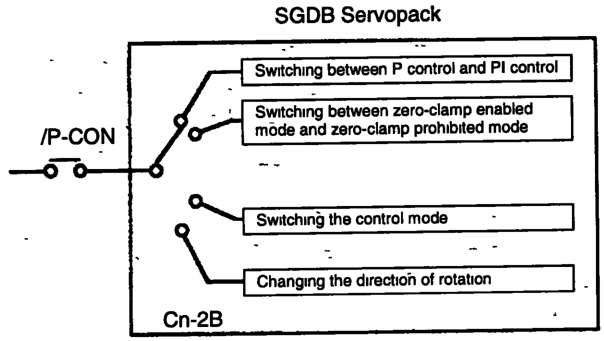
- For noise control, always use twisted-pair cables.

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

• Using /P-CON Signal

→ Input /P-CON	1CN-9	Proportional Control, etc.	For Speed/Torque Control

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

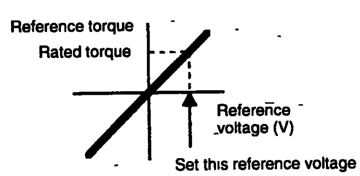


Cn-2B Setting	Meaning of /P-CON Signal
0	Switching between P control and PI control.
2	(Not used)
3, 4, 6	Switching the direction of rotation when contact input speed control mode is selected.
9	Switching the control mode.
10	Switching between zero-clamp enabled and zero-clamp prohibited modes.

4) Set the following user constants 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

Sets the voltage range of torque reference input T-REF (6CN-10) according to the output form of the host controller or external circuit.

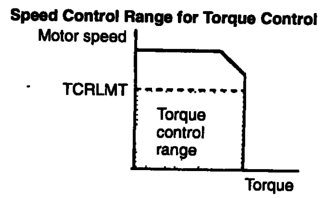


The factory setting is 30, so the rated torque is 3 V (30 x 0.1).

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

Sets a motor speed limit value in torque control mode.

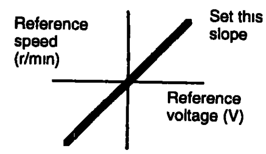
This user constant is used to prevent machine overspeed during torque control.



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

Sets the voltage range of speed reference input V-REF (6CN-12) according to the output form of the host controller or external circuit.

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



Motor Series	Factory Setting
SGMG (1500 r/min)	250
SGMS	500

2.2.6 Using Torque Feed-forward Function

For speed control (analog reference) only.

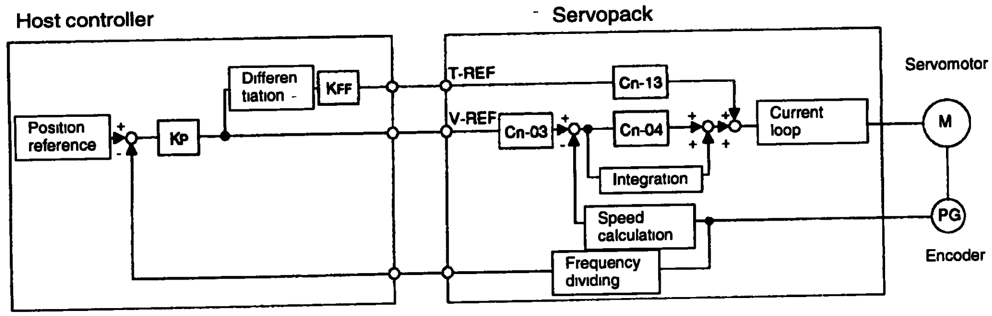
1) Outline

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 (6CN-12, 6CN-13) and T-REF (6CN-10, 6CN-11), respectively.

Schematic Block Diagram for Torque Feed-forward Control



KP: Position loop gain
KFF: Feed-forward gain

2) 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

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 2.2.7 Using Torque Restriction by Analog Voltage Reference.*
- For user constants and control modes, refer to *Appendix C List of User Constants.*

3) **Setting a Torque Feed-forward Value in User Constant 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

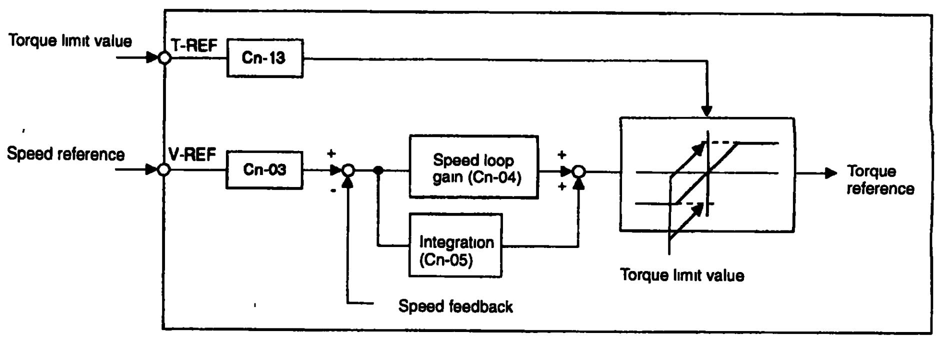
2.2.7 Using Torque Restriction by Analog Voltage Reference

For speed control (analog reference) only.

1) **Outline**

This function restricts torque by assigning the T-REF terminal (6CN-10, 6CN-11) 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



2) **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

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 2.2.6 Using Torque Feed-forward Function.*

- For user constants and control modes, refer to *Appendix C List of User Constants.*

3) Setting a Torque Limit Value in User Constant 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). A torque value in excess of 100% is clamped at 100%.

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

2.2.8 Using the Analog Monitor

1) The following two analog voltage monitor signals are output.

Output → TRQ-M 8CN	Torque Monitor	For Speed/Torque Control
Output → VTG-M 8CN	Speed Monitor	For Speed/Torque 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	

TRQ-M

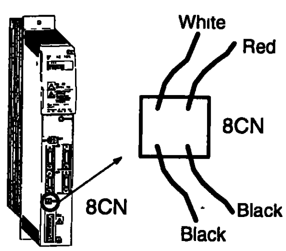
Cn-02 Bit 6	Control Mode	Specifications
0	——	Torque monitor (∓2V/±100% torque)
1	Torque control	(Undefined)
	Speed control	Speed reference monitor*

VTG-M

Cn-02 Bit 7	Control Mode	Specifications
0	——	Speed monitor*
1	Speed/torque control	(Undefined)

* For the SGMG, the unit is ∓2V/±1000 r/min.
For the SGMS, the unit is ∓1V/±1000 r/min.

2) Analog monitor can also be available with exclusive-use cable (type: JZSP-CA01) from 8CN connector.



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

2.3 Setting Up the Σ Servopack

This section describes how to set user constants to operate the SGDC Servopack.

2.3.1 Setting User Constants

1) Σ-series Servopacks provide many functions, and have parameters called "user constants" to allow the user to specify each function and perform fine adjustment. Digital Operator is used to set user constants.

2) User constants are divided into the following two types.

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

User Constant	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	User constant setting
Cn-..	...	...	
Cn-..	...	...	
Cn-2D	OUTSEL	Output signal selection	

3) For a list of user constants, refer to *Appendix C List of User Constants.*

4) For details of how to set user constants, refer to *Section 3.1.5 Operation in User Constant Setting Mode*

2.3.2 Setting the Jog Speed

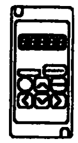
1) Use the following user constant to set or modify a motor speed when operating the Σ-series Servo from a Digital Operator:

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

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



2.3.3 Setting the Number of Encoder Pulses

1) To ensure that the Σ-series Servo System operates properly, set the type of the encoder to be used and the number of encoder pulses per revolution in the following user constants:

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

Set 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
3	Incremental encoder: 2048 pulses per revolution	
6	Incremental encoder: 4096 pulses per revolution	
W	Absolute encoder: 1024 pulses per revolution	1
S	Absolute encoder: 8192 pulses per revolution	

Cn-11	PULSNO Number of Encoder Pulses	Unit: Pulses Per Revolution	Setting Range: Number of Encoder Pulses		For Speed/Torque Control

Set the number of encoder pulses according to the servomotor type to be used. If this user constant is set incorrectly, system operation cannot be guaranteed.

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
3	Incremental encoder: 2048 pulses per revolution	2048
6	Incremental encoder: 4096 pulses per revolution	4096
W	Absolute encoder: 1024 pulses per revolution	1024
S	Absolute encoder: 8192 pulses per revolution	8192

2.3.4 Setting the Motor Type

1) To ensure that the Σ-series Servo System operates properly, set the type of the servomotor to be used in the following user constant.

Cn-2A	Motor Selection	For Speed/Torque Control

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

Group	Servopack Type	Motor Type	Cn-2A Setting
05	SGDC-05DSA	SGMG-05A□D	181
10	SGDC-10DSA	SGMG-09A□D	182
		SGMS-10A□D	201
15	SGDC-15DSA	SGMG-13A□D	183
		SGMS-15A□D	202
20	SGDC-20DSA	SGMG-20A□D	184
		SGMS-20A□D	203
30	SGDC-30DSA	SGMG-30A□D	185
		SGMS-30A□D	204
50	SGDC-50DSA	SGMG-44A□D	186
		SGMS-40A□D	205
		SGMS-50A□D	206

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

2.3.5 Adjusting the Encoder Supply Voltage

1) 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 user constant.

Cn-2C	Encoder Power Voltage Adjustment	Unit: 0.1 mV	Factory Setting: 52500	For Speed/Torque Control

The following values apply to standard cables:

Encoder \ Length of cables	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

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

2.4 Setting Stop Mode

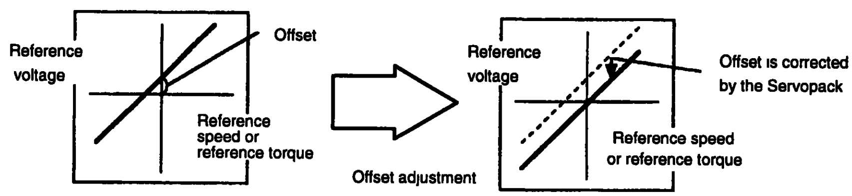
This section describes how to stop the motor properly.

2.4.1 Adjusting Offset

1) "Why does not the motor 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



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

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

NOTE If a position control loop is formed in the host controller, do not use automatic adjustment in 1. Always use manual adjustment in 2.

3) For detailed adjustment procedures, refer to the following sections.

	Adjustment Method
1) Automatic adjustment of reference offset	*Section 3.2.4 Reference Offset Automatic Adjustment*
2) Manual adjustment of reference offset	*Section 3.2.5 Reference Offset Manual Adjustment Mode*

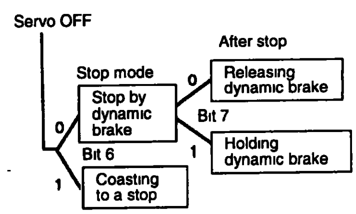
2.4.2 Using Dynamic Brake

1) 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
Cn-01 Bit 7	Operation to Be Performed When Motor Stops After Servo is Turned OFF		For Speed/Torque Control

The Servopack enters servo OFF status when:

- Servo ON input signal (/S-ON, 6CN-7) 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.

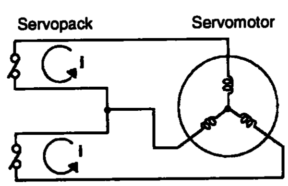
	Setting	Meaning
Cn-01 bit 6	0	Stops the motor by dynamic brake.
	1	Causes the motor to coast to a stop. The motor power is OFF and stops due to machine friction.

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.

TERMS

Dynamic brake (DB)

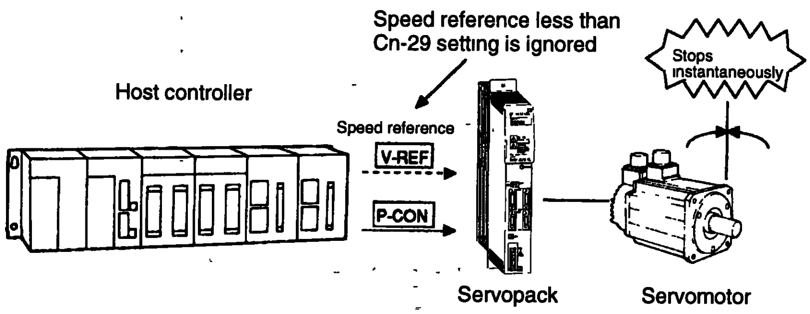


One of the general methods to cause a motor sudden stop.
"Dynamic brake" suddenly stops a servomotor by shorting its electrical circuit.
This dynamic brake circuit is incorporated in the Servopack.

2.4.3 Using Zero-Clamp

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

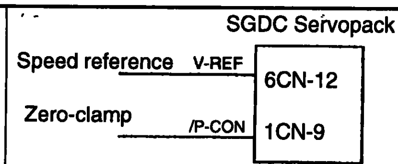
In other words, this function is used to cause the motor to stop and enter a servo locked status when the input voltage of speed reference V-REF is not 0 V. When the zero-clamp function is turned ON, an internal position loop is temporarily formed, causing the motor to be clamped within one pulse. Even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



2) 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

→ Input /P-CON 6CN-9	Proportional Control, etc.	For Speed/Torque 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 (6CN-12).
• P-CON (1CN-9) is used to turn the zero-clamp function ON or OFF.
<table><tr><td>/P-CON (1CN-9) is open (OFF)</td><td>Turns zero-clamp function OFF</td></tr><tr><td>/P-CON (1CN-9) is closed (0V)</td><td>Turns zero-clamp function ON</td></tr></table></td><td>
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>

3) Set in the following user constant 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.

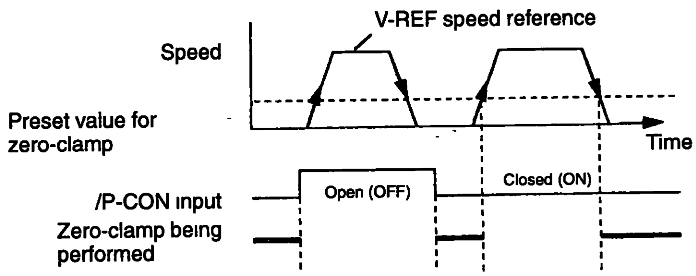
Conditions for Zero-clamp

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

a) Zero-clamp speed control is selected (User constant Cn-2B=10).

b) /P-CON (1CN-9) is turned ON (0 V).

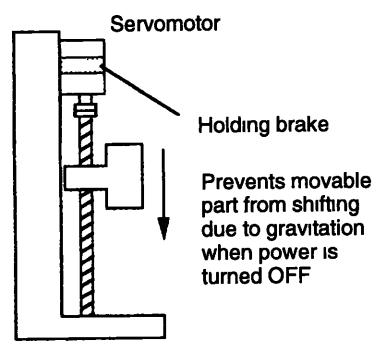
c) Motor speed drops below the preset value.



2.4.4 Using Holding Brake

1) **Outline**

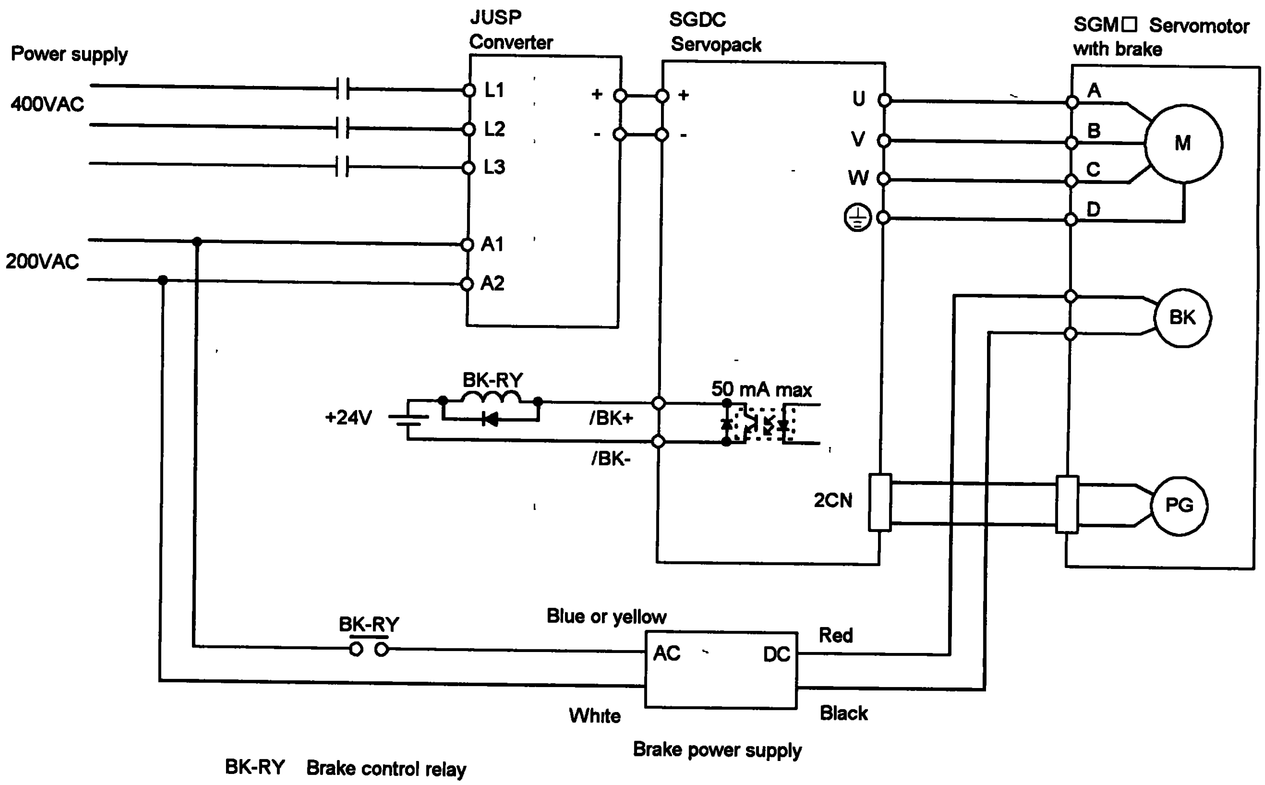
Holding brake is useful when a servo drive is used to control a vertical axis. A servomotor with brake prevents the movable part from dropping due to gravitation when the system power is turned OFF.



NOTE 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.

2) 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.



Output → /BK	Brake Interlock Output	For Speed/Torque 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 User Constants

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 user constant to specify the 6CN pin to which the BK signal is output.

Cn-2D	OUTSEL Output Signal Selection	Setting Range: 00 to 66	Factory Setting: 12	For Speed/Torque Control

This user constant is used to select a function signal as the 6CN output signal.

1s place	Select the 6CN-1 and 6CN-2 (/S-RDY) functions.
10s place	Select the 6CN-8 and 6CN-9 (/TGON) functions.

Example:/BK is output to 6CN-1 and 6CN-2.
Cn-2D = □4

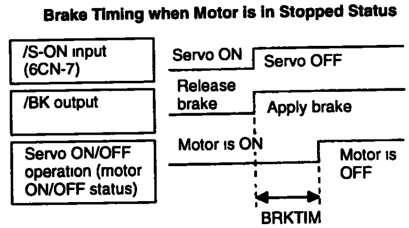
Preset value	Function
0	/COIN/ /V-CMP
1	/TGON
2	/S-RDY
3	/CLT
4	/BK
5	Overload warning
6	Overload alarm

3) If the machine moves slightly due to gravity when the brake is applied, set the following user constant 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

This user constant is used to set output timing of brake control signal /BK and servo OFF operation (motor output stop) when SGM□ 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 user constant to delay servo OFF timing to prevent the machine from moving.

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

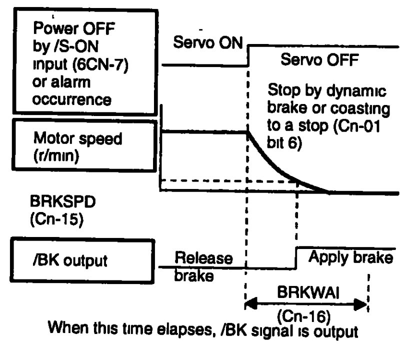
4) Set the following user constants to adjust brake ON timing so that holding brake is applied when the motor stops.

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
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

Cn-15 and Cn-16 are used for SGM□ Servomotors with brake. Use these user constants to set brake timing used when the servo is turned OFF by input signal /S-ON (6CN-7) or alarm occurrence during motor rotation.

Brakes for SGM□ Servomotors are designed as holding brakes. Therefore, brake ON timing when the motor stops must be appropriate. Adjust the user constant 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.

1	Motor speed drops below the value set in Cn-15 (BRKSPD) after servo OFF occurs.
2	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.

2.5 Running the Motor Smoothly

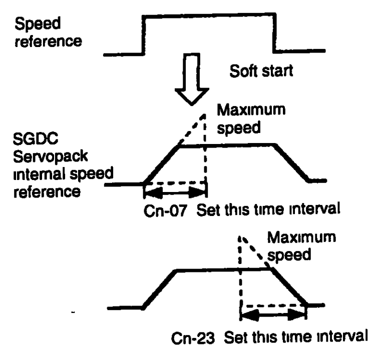
This section explains how to run the servomotor smoothly.

2.5.1 Using the Soft Start Function

1) 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 user constants.

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 user constants 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

2.5.2 Adjusting Gain

1) 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.

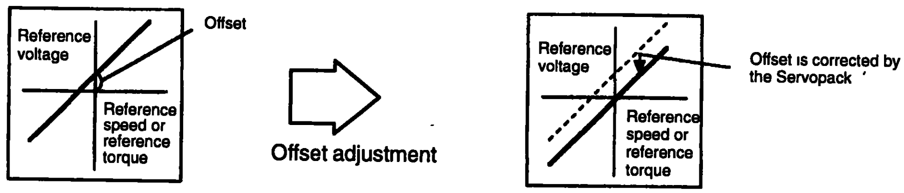
2) For servo gain adjustment, refer to the following section:

Section 2.6.2 Setting Servo Gain

2.5.3 Adjusting Offset

1) 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



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

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

NOTE If a position control loop is formed in the host controller, do not use automatic adjustment in 1). Always use manual adjustment in 2).

3) For detailed adjustment procedures, refer to the following sections:

	Adjustment Method
1) Automatic adjustment of reference offset	*Section 3.2.4 Reference Offset Automatic Adjustment*
2) Manual adjustment of reference offset	*Section 3.2.5 Reference Offset Manual Adjustment Mode*

2.5.4 Setting the Torque Reference Filter Time Constant

1) 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 SGDC 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.

2) 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-02Bit C	Torque Reference Filter Selection	Factory Setting: 0		For Speed/Torque Control

0: Primary filter
1: Secondary filter

2.6 Minimizing Positioning Time

This section describes how to minimize positioning time.

2.6.1 Using Autotuning Function

1) 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.

2) 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 user constants.

3) The following user constants can be automatically set by the autotuning function.

User Constant	Meaning
Cn-04	Speed loop gain
Cn-05	Speed loop integration time constant
Cn-1A	Position loop gain
Cn-28	Load inertia

4) For details of how to perform autotuning, refer to *Section 3.2.3 Autotuning*

2.6.2 Setting Servo Gain

1) Check and reset the servo gain when:

a) Automatically set servo gain values need to be checked after autotuning.

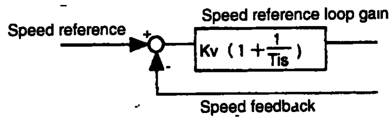
b) Each servo gain value checked in a) is to be directly set for another Servopack.

c) Response performance needs to be further enhanced after autotuning, or servo gain values need to be reset for a system with lower response performance.

2) Set the following user constants 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
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

The above constants are the Servopack's speed loop gain and integral time constant respectively. The higher the speed loop gain, or the smaller the speed loop integral time constant value, the faster the speed control response will be. There is, however, a certain limit depending on machine characteristics.



Speed loop gain Kv is adjusted in 1-Hz increments provided that the following user constant is set correctly.

Cn-28	Inertia Ratio	Unit: %	Setting Range: 0 to 10000	Factory Setting: 100	Speed/Torque Control

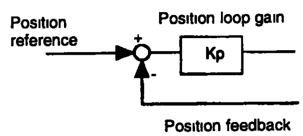
$$Inertia\ ratio = \frac{Motor\ axis\ conversion\ load\ inertia(J_L)}{Servomotor\ rotor\ inertia(J_M)} \times 100\%$$

The load inertia of the Servopack converted on the motor shaft is factory-set to the rotor inertia of the Servomotor. Therefore, obtain the autotuning operation.

3) Set the following user constants 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 Speed/Torque Control

This user constant 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 user constant is automatically set by the autotuning function.

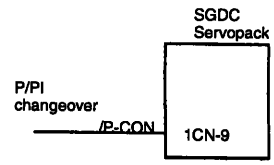
2.6.3 Using Proportional Control

1) If user constant 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

<table>
<tr><th>Cn-2B</th><th colspan="2">Control Mode</th></tr>
<tr><td>0, 1</td><td>Speed Control
This is normal speed control.
● Signal /P-CON (1CN-9) is used to switch between P control and PI control.
<table><tr><td>/P-CON (1CN-9) is open (OFF)</td><td>PI control</td></tr><tr><td>/P-CON (1CN-9) is closed (0V)</td><td>P control</td></tr></table></td><td>
</td></tr>
</table>

2) Proportional control can be used in the following two ways.

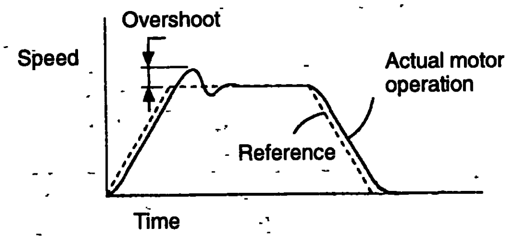
a) When operation is performed by sending speed references from the host controller to the Servopack, the host controller can selectively use P control mode for particular conditions only. This method can prevent the occurrence of overshoot and also shorten settling time. For particular conditions, refer to *Section 2.6.4 Using Mode Switch.*

b) 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.

2.6.4 Using Mode Switch

1) Use the mode switch for the following purposes:

a) To prevent overshoot during acceleration or deceleration (for speed control).



2) 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.

NOTE 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.

3) 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	User Constant	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

TERMS

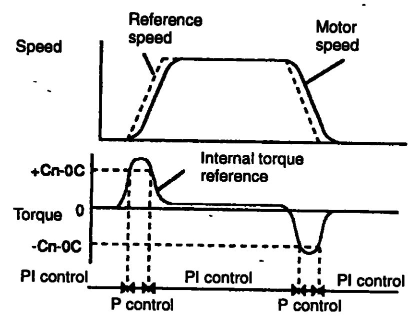
From PI control to P control

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.

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

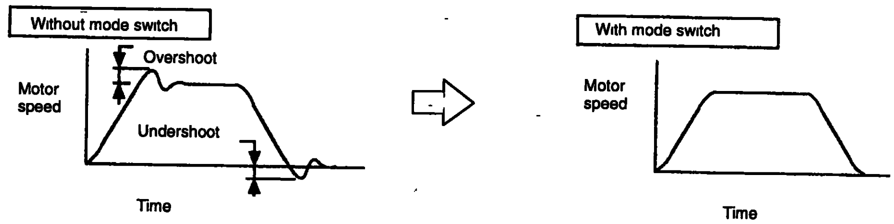
If a torque reference exceeds the torque value set in user constant Cn-0C, the speed loop switches to P control.

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



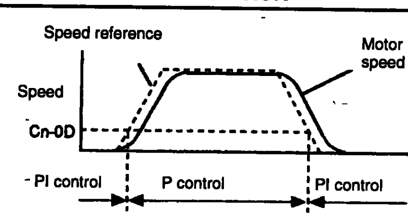
Example of Use:

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.



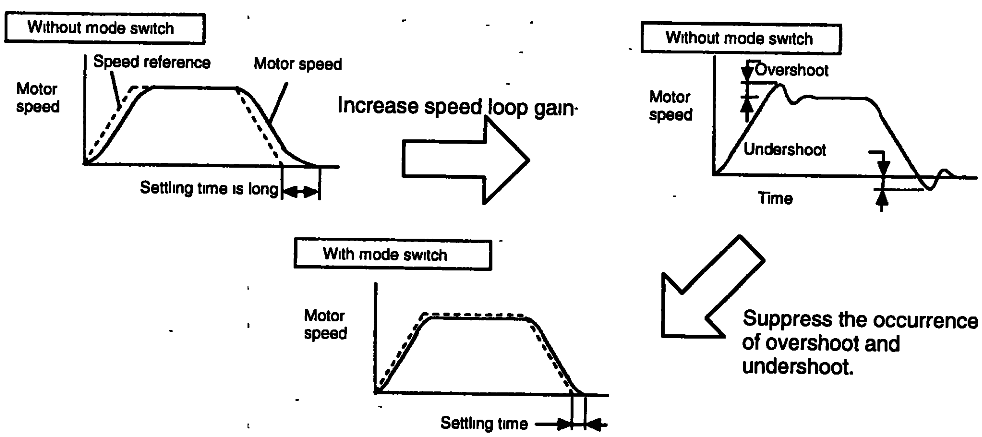
When Speed Reference Is Used as a Detection Point of Mode Switch

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



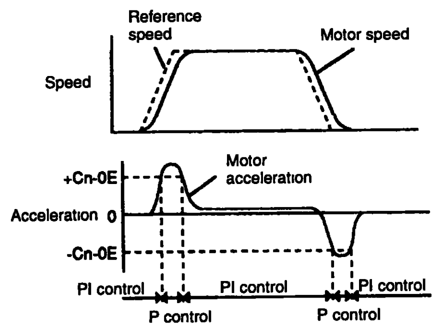
Example of Use:

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.



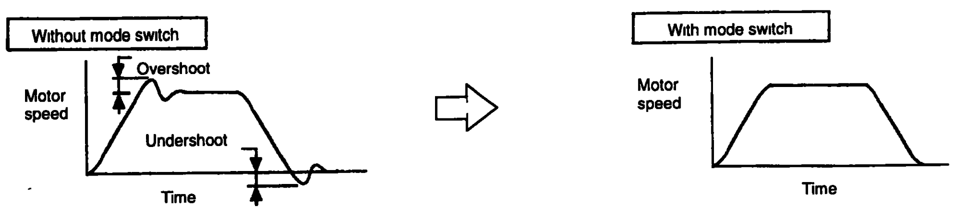
When Acceleration Is Used as a Detection Point of Mode Switch

If motor acceleration exceeds the value set in user constant 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.

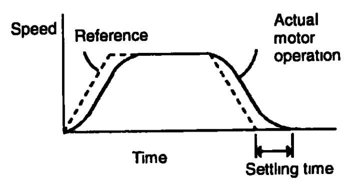


4) The user constants required to set each mode switch are summarized as follows.

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

This user constant 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
Cn-01 Bit D	Mode Switch Selection	Factory Setting: 0	For Speed Control

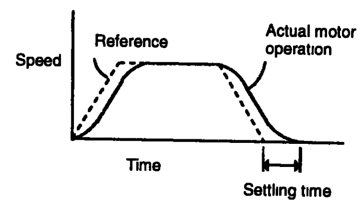
Use the following user constants to set the mode switch to be used.

Memory Switch Cn-01		Mode Switch Type	User Constant for Setting Detection Point
Bit D	**Bit C**		
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

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
Cn-0D	REFMSW	Mode Switch (Speed Reference)	Unit: r/min	Setting Range: 0 to 10000	Factory Setting: 0	For Speed Control
Cn-0E	ACCMSW	Mode Switch (Acceleration Reference)	Unit: 10 (r/min)/s	Setting Range: 0 to 3000	Factory Setting: 0	For Speed Control

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.

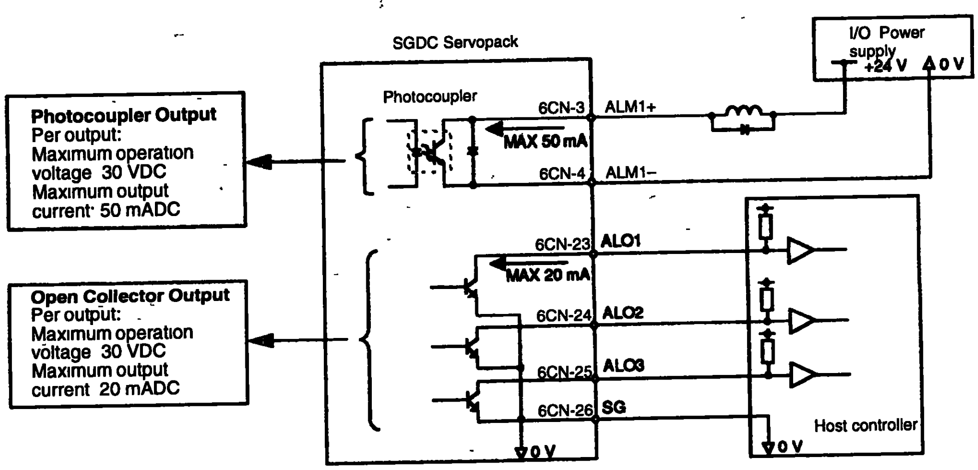
Memory Switch Cn-01			Mode Switch Setting	User Constant	Unit
Bit D	**Bit C**	**Bit B**			
–	–	1	Does not use mode switch.		
0	0	0	Uses torque reference as a detection point.	Cn-0C	Percentage of rated torque: %
0	1	0	Uses speed reference as a detection point.	Cn-0D	Motor speed: r/min
1	0	0	Uses acceleration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

2.7 Forming a Protective Sequence

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

2.7.1 Using Servo Alarm Output and Alarm Code Output

1) Basic Wiring for Alarm Output Signals

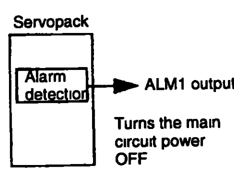


- **Provide an external I/O power supply separately. There is no DC power available from Servopack for output signals.**

2) Contact Output Signal ALM

Output → ALM1+ 6CN-3	Servo Alarm Output	For Speed/Torque Control
Output → ALM1− 6CN-4	Signal Ground for Servo Alarm Output	For Speed/Torque Control

Signal ALM is output when the Servopack detects an alarm.



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

ON status:	Circuit between 6CN-3 and 6CN-4 is closed. 6CN-3 is at low level.	Normal state
OFF status:	Circuit between 6CN-3 and 6CN-4 is open. 6CN-3 is at high level.	Alarm state

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

3) Open Collector Output Signals ALO1, ALO2, and ALO3

Output → ALO1 6CN-23	Alarm Code Output	For Speed/Torque Control
Output → ALO2 6CN-24	Alarm Code Output	For Speed/Torque Control
Output → ALO3 6CN-25	Alarm Code Output	For Speed/Torque Control
Output → SG 6CN-26	Signal Ground for Alarm Code Output	For Speed/Torque Control

2

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.

4) Relationship between Alarm Display and Alarm Code Output

Alarm Display and Alarm Code Output:

Alarm Display	Alarm Code Output			Servo Alarm (ALM) Output	Alarm Type	Alarm Description
	ALO1	ALO2	ALO3			
A.00	×	×	×	×	Absolute date error	Absolute data fails to be received, or received absolute data is abnormal.
A.02	×	×	×	×	User constant breakdown	Checksum results of user constants are abnormal.
A.03	×	×	×	×	User constant setting error	User constant setting is outside the allowable setting range.
A.05	×	×	×	×	Alarm traceback error	Checksum results of usre constants are abnormal.
A.10	○	×	×	×	Overcurrent	Overcurrent flowed through the power transistor.
A.20	×	○	×	×	Blown fuse	Fuse is blown.
A.40	×	×	○	×	Overvoltage	Main circuit voltage for motor operation has become too high.
A.51	○	×	○	×	Overspeed	Rotation speed of the motor has exceeded detection level.
A.71	○	○	○	×	Overloaded (high load)	Motor was running for several seconds to several tens of seconds under torque largely exceeding ratings.
A.72	○	○	○	×	Overloaded (low load)	Motor was running continuously under torque largely exceeding ratings.
A.80	×	×	×	×	Absolute encoder error	Number of pulses per absolute encoder revorution is abnormal.
A.81	×	×	×	×	Absolute encoder backup error	All three power supplies for the absolute encoder (+5 V battery and internal capacitor) have failed.
A.82	×	×	×	×	Absolute encoder checksum error	Checksum results of absolute encoder memory is abnormal.
A.83	×	×	×	×	Absolute encoder battery error	Battery voltage for absolute encoder is abnormal.
A.84	×	×	×	×	Absolute encoder data error	Recceived absolute data is abnormal.

○ : Output transistor is ON
× : Output transistor is OFF

Alarm Display	Alarm Code Output			Servo Alarm (ALM) Output	Alarm Type	Alarm Description
	ALO1	ALO2	ALO3			
A.85	×	×	×	×	Absolute encoder overspeed	Motor running at a speed exceding 400/min the absolute encoder was turned ON.
A.A1	O	O	O	×	Heatsink overheated	Heatsink of Servopack was overheated.
A.b1	×	×	×	×	Reference input read error	Servopack input read error
A.C1	O	×	O	×	Servo overrun detected	Servomotor (encoder) runs out of control.
A.C2	O	×	O	×	Encoder output phase error	Phases -A, -B, and -C output by encoder are abnormal.
A.C3	O	×	O	×	Encoder A, B phase disconnection	Wiring in encoder phase -A, or -B is disconnected.
A.C4	O	×	O	×	Encoder C phase disconnection	Wiring in encoder phase -C is disconnected.
A.F4	×	O	×	×	Converter error	Detection of regenerative error. Main circuit voltage error. Power lines open phase.
CPF00	Undefined				Digital operator transmission error 1	Digital operator fails to communicate with Servopack even 5 seconds after power is turned ON.
CPF01	Undefined				Digital operator transmission error 2	Transmission error has occurred 5 consecutive times.
A.99	×	×	×	O	Not an error	Normal operation status.

O : Output transistor is ON
× : Output transistor is OFF
For details, refeter to *Appendix D List of Alarm displays.*

5) 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-12	Alarm Reset	For Speed/Torque Control

This signal is used to reset the servo alarm state.

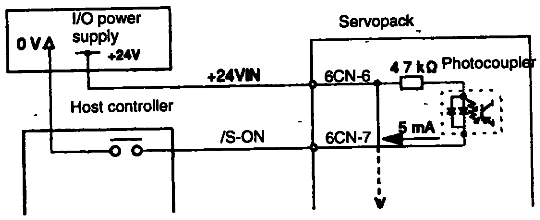
Form an external circuit so that the main circuit power supply is turned OFF when servo alarm is output. Alarm state is automatically reset when control power supply is turned OFF.

Alarm state can be reset using the Digital Operator.

When an alarm occurs, always eliminate the cause before resetting the alarm state. *5.2.1 Troubleshooting Problems with Alarm Display* describes how to troubleshoot the system when an alarm arises.

2.7.2 Using Servo ON Input Signal

1) 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.

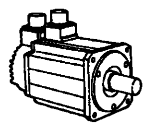


→ Input /S-ON 6CN-7	Servo ON	For Speed/Torque Control

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

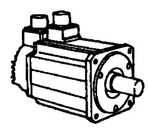
ON: 6CN-7 is at low level	Turns the motor ON. This is normal operation state (called "servo ON state").
OFF: 6CN-7 is at high level	Turns the motor OFF. This is inoperable state (called "servo OFF state"). The servo can be turned OFF during motor operation only when an emergency stop is required.

Servo ON



Motor is ON
Motor is operated according to input signals.

Servo OFF



Motor is OFF
Motor cannot run.

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

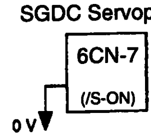
2) If the /S-ON signal is not to be used, set the following memory switch to 1:

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

This memory switch is used to enable or disable the servo ON input signal /S-ON (6CN-7).

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

SGDC Servopack

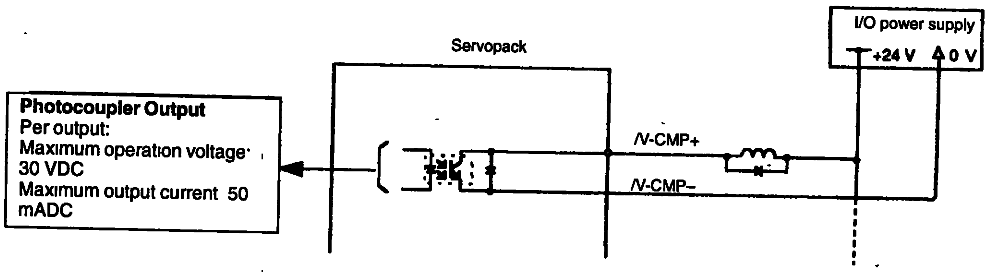


When /S-ON is not used, this short-circuit wiring can be omitted.

Setting	Meaning
0	Uses servo ON signal /S-ON. (When 6CN-7 is open, servo is OFF. When 6CN-7 is at 0 V, servo is ON.)
1	Does not use servo ON signal /S-ON.

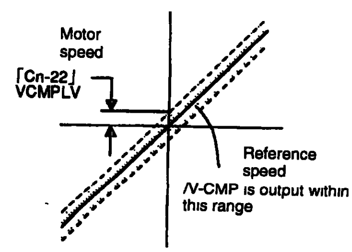
2.7.3 Using Speed Coincidence Output Signal

1) 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	Speed Coincidence Output	For Speed Control

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



ON status:	Circuit is closed or signal is at low level.	Actual motor speed matches the speed reference (speed difference is below the preset value).
OFF status:	Circuit is open or signal 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)

2) Use the following user constant to output the /V-CMP signal.

Cn-2D	OUTSEL	Output signal selection	Setting Range: 00 to 66	Factory Setting: 12	

This user constant is used to specify a function signal as the 6CN output signal.

1s place	Select the 6CN-1 and 6CN-2 (/S-RDY) functions.
10s place	Select the 6CN-8 and 6CN-9 (/TGON) functions.

Example: /V-CMP is output to 6CN-1 and 6CN-2.
Cn-2D = □0

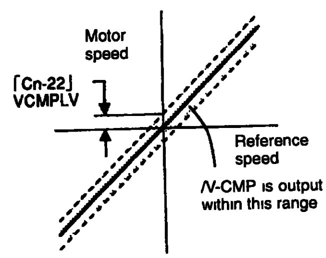
Preset Value	Function
0	/V-CMP
1	/TGON
2	/S-RDY
3	/CLT
4	/BK
5	Overload warning
6	Overload alarm

3) Set the following user constant 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

Set the output conditions for speed coincidence signal /V-CMP.

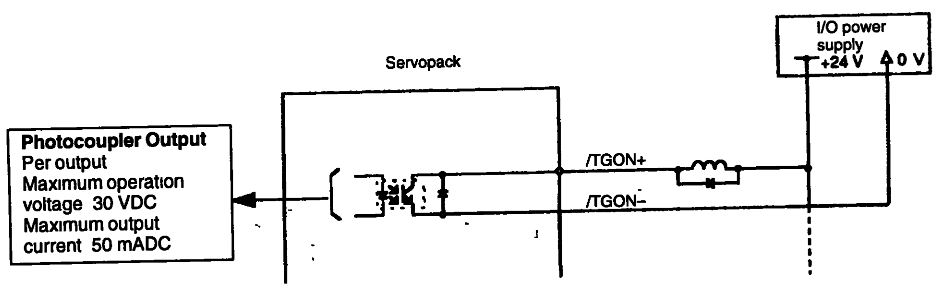
/V-CMP signal is output when the difference between the reference speed and actual motor speed is not greater than the preset value.



Example: When preset value is 100 and reference speed is 2000 r/min.
/V-CMP is ON (circuit between 6CN-1 and 6CN-2 is closed) when the speed is between 1900 and 2100 r/min.

2.7.4 Using Running Output Signal

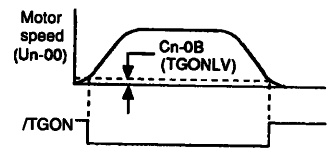
1) This section describes how to wire and use photocoupler output: a running output signal /TGON. This signal indicates that a servomotor is currently running.



Output → /TGON	Running Output	For Speed/Torque Control

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)

2) Use the following user constant to specify the pin to which the /TGON signal is to be output.

Cn-2D	OUTSEL	Output signal selection	Setting Range: 00 to 66	Factory Setting: 12	

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

1s place	Select the 6CN-1 and 6CN-2 (/S-RDY) functions.
10s place	Select the 6CN-8 and 6CN-9 (/TGON) functions.

Example: /TGON is output to 6CN-8 and 6CN-9.
Cn-2D = 1□

Preset value	Function
0	/V-CMP
1	/TGON
2	/S-RDY
3	/CLT
4	/BK
5	Overload warning
6	Overload alarm

3) Use the following user constant to specify the output conditions for /TGON (running output signal).

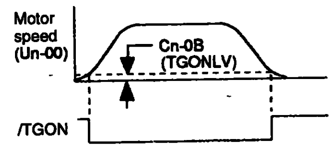
Cn-0B	TGONLV	Zero-Speed Level	Unit: r/min	Setting Range: 1 to 10000	Factory Setting: 20	For Speed/Torque Control

This user constant 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.)

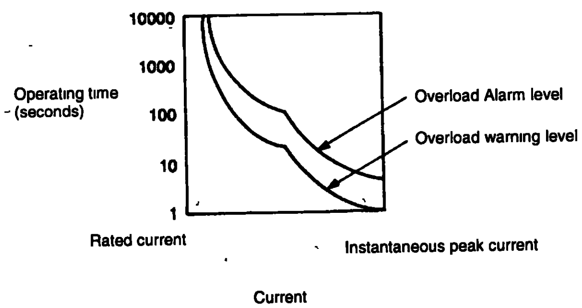
Output signal of zero-speed

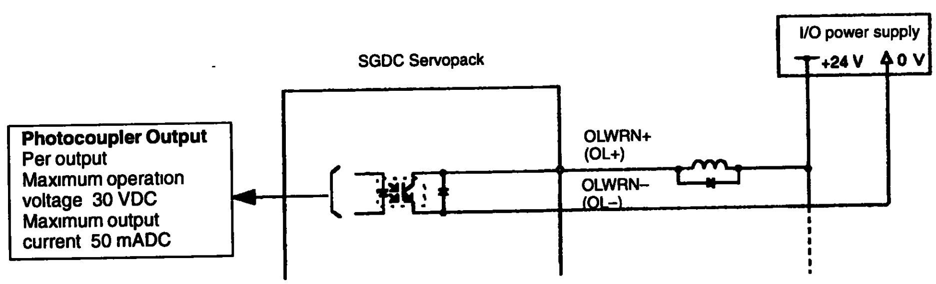
• /TGON • Status indication mode bit data • Monitor mode Un-05 bit 4



2.7.5 Using OL Warning and Alarm Output Signals

1) 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
Output → OL	Overload Alarm Output	For Speed/Torque 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

2) Use the following user constant to specify the pin to which the signal is to be output.

Cn-2D	OUTSEL	Output signal selection	Setting Range: 00 to 66	Factory Setting: 210		For Speed/Torque Control

This user constant is used to specify a function signal as the 6CN output signal.

1s place	Select the 6CN-1 and 6CN-2 (/S-RDY) functions.
10s place	Select the 6CN-8 and 6CN-9 (/TGON) functions.

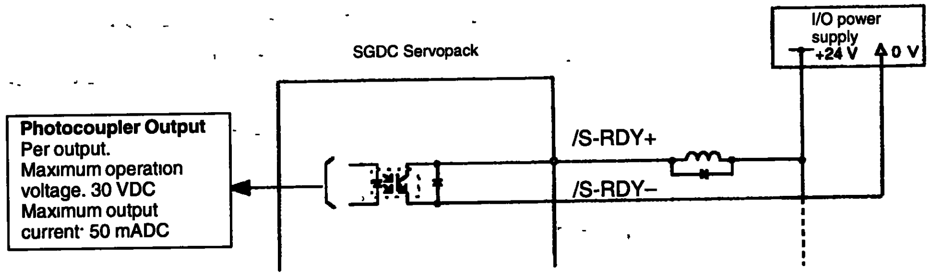
Example: Overload warning is output to 6CN-1 and 6CN-2.
Cn-2D = □5

Preset Value	Function
0	/V-CMP
1	/TGON
2	/S-RDY
3	/CLT
4	/BK
5	Overload warning
6	Overload alarm

2.7.6 Using Servo Ready Output Signal

1) This section describes how to wire and use photocoupler output signal /S-RDY (servo ready).

"Servo ready" means that the Servopack is not in servo alarm state when the main circuit 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

This signal indicates that the Servopack is ready to receive servo ON signals.

ON status:	Circuit is closed or signal is at low level.	Servo ready state
OFF status:	Circuit is open or signal is at high level.	Not in servo ready state

2) Use the following user constant to specify the pin to which the /S-RDY signal is to be output.

Cn-2D	OUTSEL	Output signal selection	Setting Range: 00 to 66	Factory Setting: 12		For Speed/Torque Control

This user constant is used to specify a function signal as the 6CN output signal.

1s place	Select the 6CN-1 and 6CN-2 (/S-RDY) functions.
10s place	Select the 6CN-8 and 6CN-9 (/TGON) functions.

Example: /S-RDY is output to 6CN-1 and 6CN-2.
Cn-2D = □□

Preset Value	Function
0	/V-CMP
1	/TGON
2	/S-RDY
3	/CLT
4	/BK
5	Overload warning
6	Overload alarm

2.8 Special Wiring

This section describes special wiring methods including the one for noise control. Always refer to *Section 2.8.1 Wiring Instructions* and *2.8.2 Wiring for Noise Control*, and refer to other sections as necessary.

2.8.1 Wiring Instructions

To ensure safe and stable operation, always refer to the following wiring instructions.

NOTE Always use the following cables for encoder wiring.

	Cable Type	Yaskawa Drawing No.	Maximum Allowable Length
For encoder	Multiconductor shielded twisted-pair cable	B9400064 (for incremental encoder) DP8409123 (for absolute encoder)	20 m (65.6 ft.)

NOTE For a ground wire, use as thick a cable as possible.

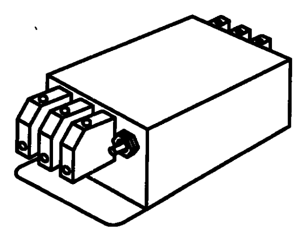
- Trim off the excess portion of the cable to minimize the cable length.
- At least class 3 grounding (ground to 100 Ω or less) is recommended.
- Always use one-line grounding.
- If the motor is insulated from the machine, ground the motor directly.
- Select grounding phase and grounding point in accordance with the national code and consistent with sound local practices.

NOTE 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.

NOTE Use a noise filter to prevent noise interference. (For details, refer to the following *Caution.*)

- 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.



NOTE 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.

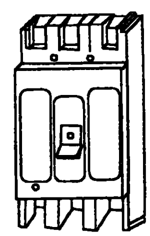
Note c) Since Servopack uses high-speed switching elements, signal lines may receive noise. To prevent this, always take the above actions.

d) For details of grounding and noise filters, refer to *Section 2.8.2 Wiring for Noise Control.*

NOTE 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 Converter capacity and the number of Converters to be used as shown below.

MCCB



MCCB or Fuse for Each Power Capacity

Converter type	Power capacity per Converter (see note 1)	Current capacity per MCCB or fuse (see note 2)
JUSP-ACP08GD	5.8 KVA	10 A
JUSP-ACP15GD	11.7 KVA	24 A
JUSP-ACP30GD	23.4 KVA	41 A

Note 1) Power capacity at rated load

2) Operating characteristics (25°C): 2 seconds or more for 200%, 0.01 second or more for 700%

3) A fast-operating fuse cannot be used because the Converter power supply is a capacitor input type. A fast-operating fuse may blow out when the power is turned ON.

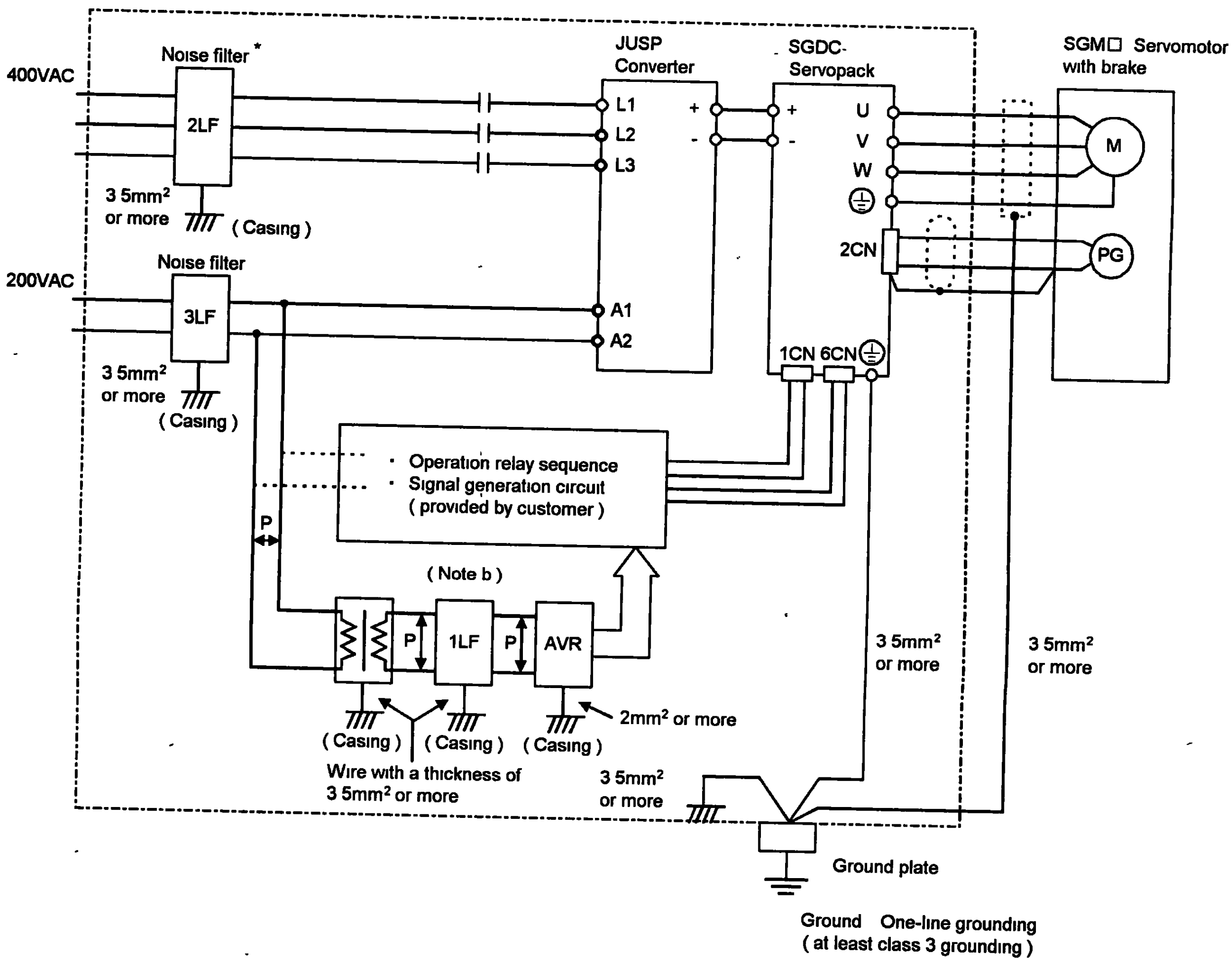
2.8.2 Wiring for Noise Control

1) Example of Wiring for Noise Control

a) 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.

b) This Servopack has a built-in microprocessor (CPU). To protect the microprocessor from external noise, install a noise filter in place.

c) The following is an example of wiring for noise control.



* When using a noise filter, always observe the following wiring instructions:

Note a) For a ground wire to be connected to the casing, use a thick wire with a thickness of at least 3.5 mm² (preferably, plain stitch cooper wire).

b) For wires indicated by P↕, use twisted-pair cables whenever possible.

2) **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 ⏚.

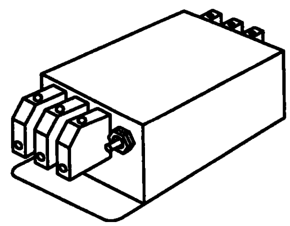
- If the servomotor is grounded via the machine, a switching noise current will flow from the Servopack power unit through motor stray capacitance. The above grounding is required to prevent the adverse effects of switching noise.

- 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.

3) **Noise Filter Installation**

a) 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 Converter type.

For Main Power Line

Servopack Type		Noise Filter Connection	Recommended Noise Filter	
			Type (see note)	Specifications
3.5 kW	JUSP-ACP08GD	(Correct)	FN351-16/29	Three-phase 440 VAC, 16 A
7.0 kW	JUSP-ACP15GD		FN351-25/29	Three-phase 440 VAC, 25 A
14.0 kW	JUSP-ACP30GD	(Incorrect)	FN351-50/33	Three-phase 440 VAC, 50 A

Note Manufactured by SCHAFFNER
Because of the high leakage current, care is required in the selection of the power breaker.

For Control Circuit Power Line

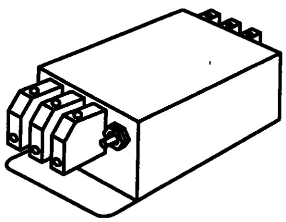
Servopack Type		Noise Filter Connection	Recommended Noise Filter	
			Type (see note)	Specifications
3.5 kW	JUSP-ACP08GD	(Correct)	FN2070-6/06	Single-phase 250 VAC, 6 A
7.0 kW	JUSP-ACP15GD			
14.0 kW	JUSP-ACP30GD	(Incorrect)		

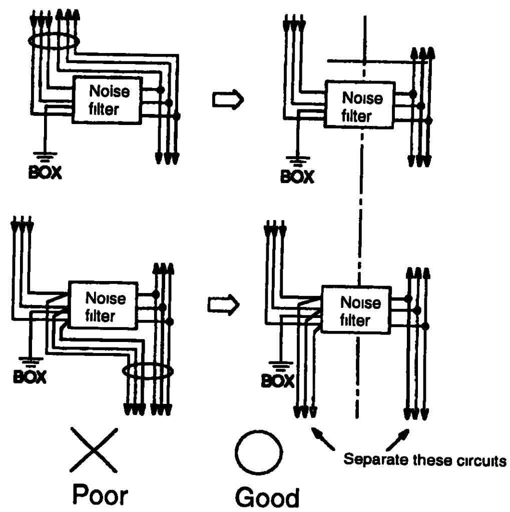
Note Manufactured by SCHAFFNER

b) Always observe the following installation and wiring instructions. Incorrect use of a noise filter halves its benefits.

- Separate input lines from output lines.

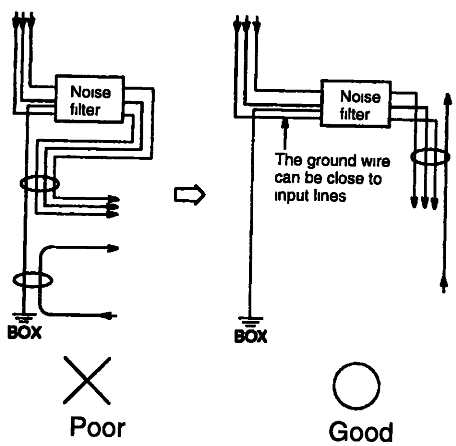
Do not put the input and output lines in the same duct or bundle them together.





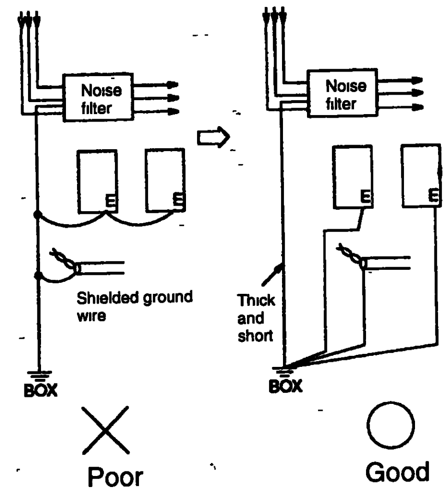
- Separate the noise filter ground wire from the output lines.

Do not accommodate the noise filter ground wire, output lines and other signal lines in the same duct or bundle them together.



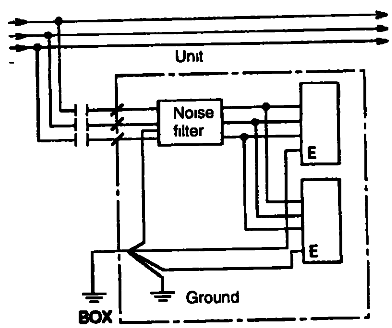
- Connect the noise filter ground wire directly to the ground plate.

Do not connect the noise filter ground wire to other ground wires.



- When grounding a noise filter inside a Unit.

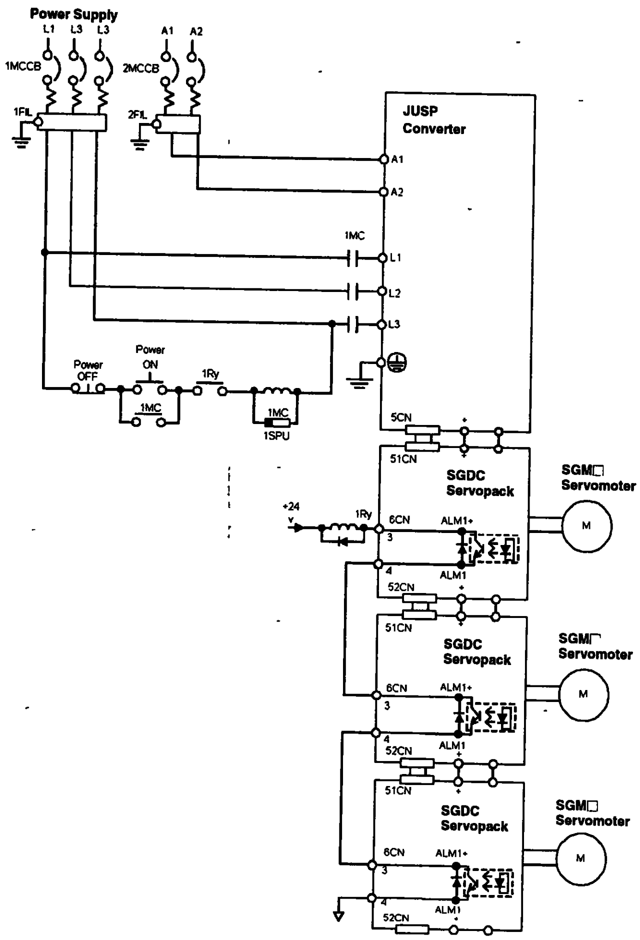
If a noise filter is located inside a Unit, connect the noise filter ground wire and the ground wires from other devices inside the Unit to the ground plate for the Unit first, then ground these wires.



2.8.3 Using More Than One Servo Drive

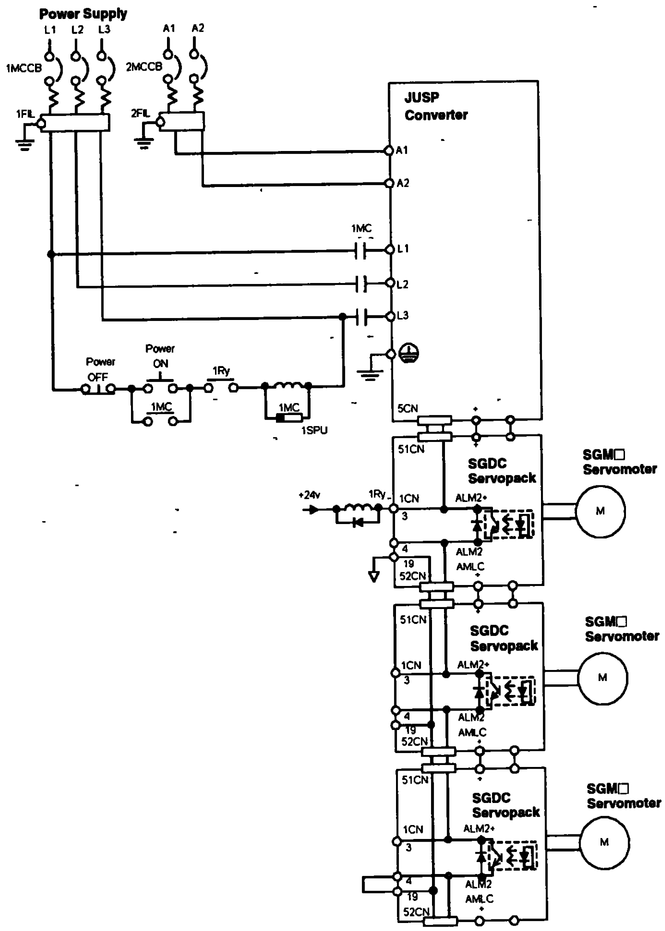
Example 1 of Wiring More than One Servo Drive

• When using ALM1 signal



Example 2 of Wiring More than One Servo Drive

• When using ALM2 signal



1) 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.

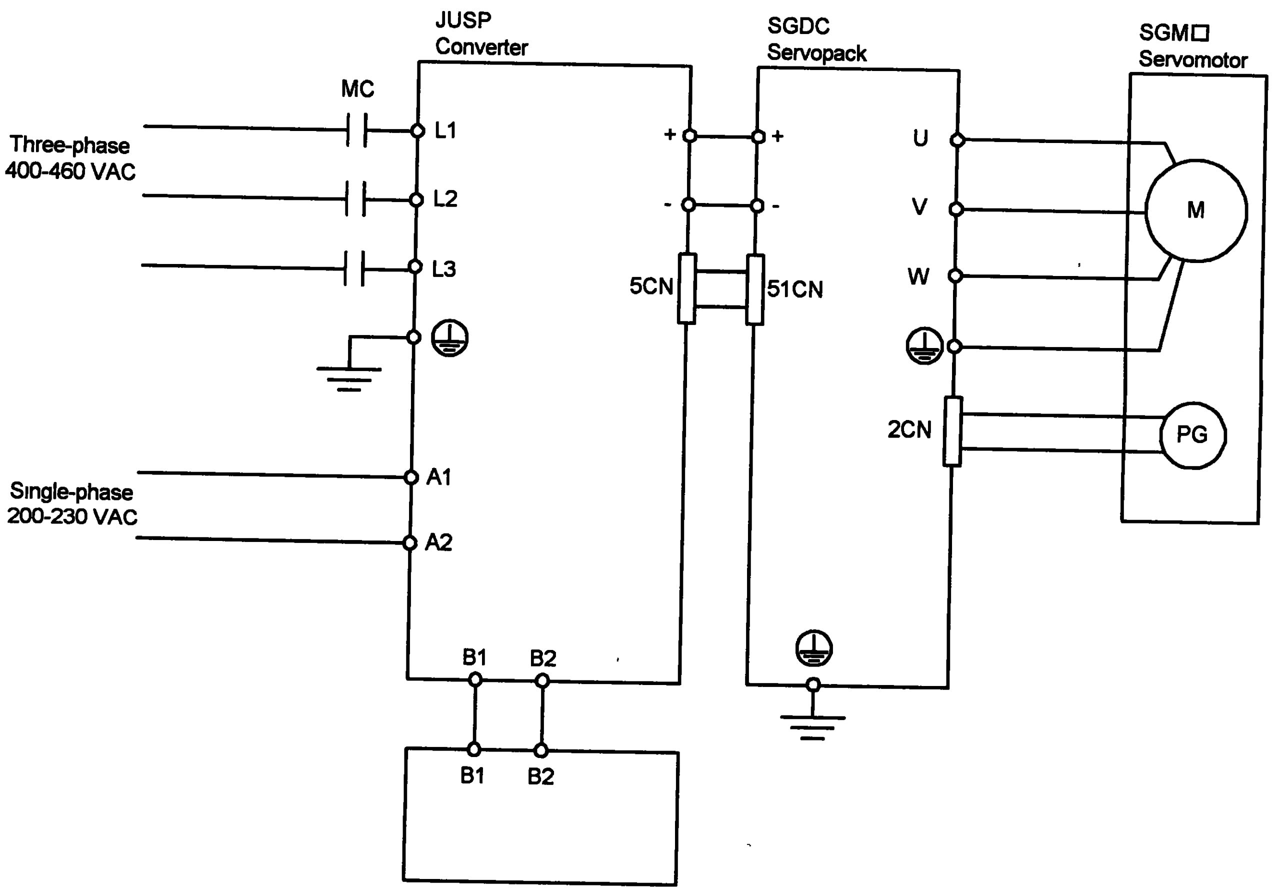
The output transistor is turned OFF when the ALM output signal invokes alarm state.

2.8.4 Using Regenerative Resistor Units

Converters of 15A types or higher have no built-in regenerative resistor. For such Converter, connect an external regenerative resistor unit.

1) Connecting a Regenerative Resistor Unit

The standard connection diagram for a regenerative resistor unit is shown below.



Regenerative resistor unit

2) Regenerative Resistor Units

Converter Type	Regenerative Resistor Unit Type	Regenerative Resistance (Ω)
JUSP-ACP15GD	JUSP-RA06	16
JUSP-ACP30GD	JUSP-RA07	8

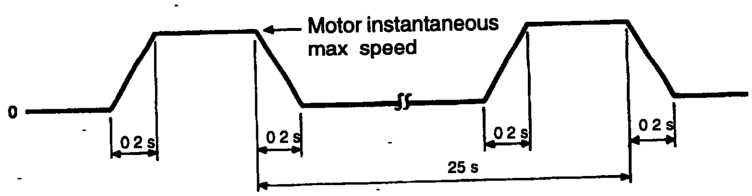
NOTE A regenerative resistor unit becomes very hot under some regenerative operation conditions of the servo system. Therefore, provide a cooling mechanism for the regenerative resistor unit, use heat resistant and incombustible cables, and route the cables so that

they are not in contact with the unit.
The resistor specifications of each regenerative resistor unit are as follows:

JUSP-RA06 Type: 64 Ω (220 W) x 4 (connected in parallel)
JUSP-RA07 Type: 64 Ω (220 W) x 8 (connected in parallel)

A regenerative resistor reaches approximately 90°C when it is used at 20% of the rated allowable dissipation value of the resistor. The allowable motor regenerative power (average) is 180 W for the JUSP-RA06 Type, and 350 W for the JUSP-RA07 Type. If the regenerative power (average) exceeds the allowable limit value when the servo system is operating in regenerative operation mode, select an additional regenerative resistor that has a greater rated allowable dissipation value (W). Therefore, always take the servo system operation conditions into consideration when determining which regenerative resistor unit to use.

Example of allowable motor duty conditions



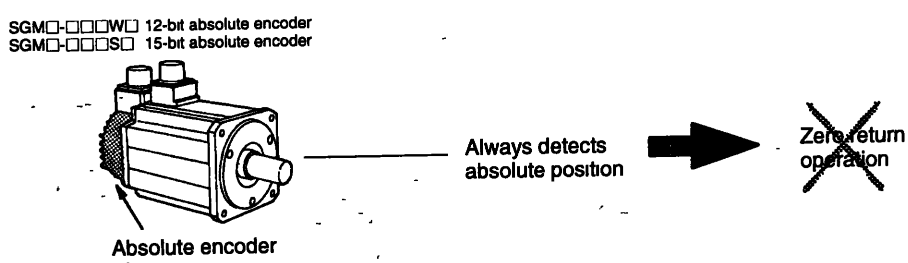
- Motor deceleration torque Maximum torque
- Load inertia: Five times the motor rotor inertia

Assuming that there is no mechanical loss.

2.8.5 Using an Absolute Encoder

1) Outline

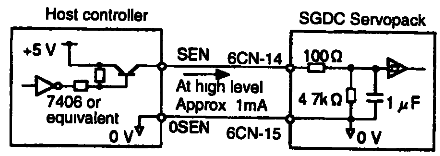
An absolute value detection system detects an absolute position of the machine even when the servo system is OFF. If such a system is to be formed in the host controller, use an SGM□ Servomotor with absolute encoder. Consequently, automatic operation can be performed without zero return operation immediately after the power is turned ON.



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.
- The motor is not turned ON until these operations are complete, regardless of the servo ON signal (/S-ON).

Electrical Specifications

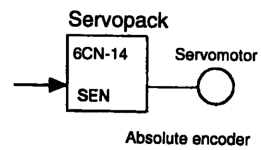


- A PNP transistor is recommended
- Signal level High level Min 2.5 V
  Low level Max 0.8 V

2) Memory Switch to Determine Whether to Use Input Signal SEN

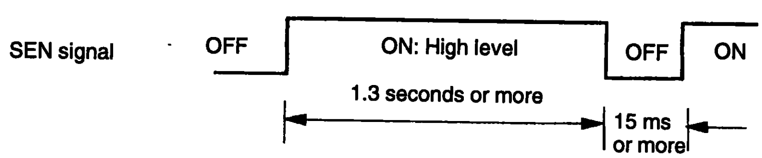
Cn-01 Bit 1	Use of SEN Input Signal	Factory Setting: 0	For Speed/Torque Control

This memory switch is used to determine whether to use input signal SEN (6CN-14).
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 SGDC Servopack always assumes that the SEN signal is at high level, regardless of the actual signal level.)

NOTE 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.



3) Memory Switch to 1 to Select Absolute Encoder

Cn-01 Bit E	Encoder Type Selection	Factory Setting: 0	For Speed/Torque 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
3	Incremental encoder: 2048 pulses per revolution	
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 user constant 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

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
3	Incremental encoder: 2048 pulses per revolution	2048
6	Incremental encoder: 4096 pulses per revolution	4096
W	Absolute encoder: 1024 pulses per revolution	1024
S	Absolute encoder: 8192 pulses per revolution	8192

NOTE Incorrect settings of the above user constants may result in abnormal motor operation. To prevent this, always set the user constant correctly.

4) **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 ER6V C3 Type** **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

5) Setting up Absolute Encoder

a) Set up the absolute encoder in the following cases:

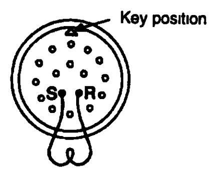
- When starting the machine for the first time
- When the absolute encoder is not connected to power supply or backup power supply (battery) for more than two days

b) The setup procedure is as follows:

15-bit absolute encoder (Motor type encoder specifications=S)

1 Discharging Electricity from the Encoder

- Turn the SGDC Servopack OFF, then disconnect the encoder connector
- Short-circuit encoder connector terminals R and S for at least two minutes



2 Turning Power ON

- Return the wiring to the normal state
- Connect the battery, turn the SGDC 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 SGDC Servopack ON

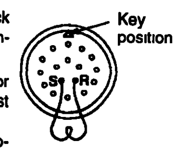
- Wire the SGDC Servopack, motor and encoder in the normal way
- Connect the battery and turn the SGDC Servopack ON

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 SGDC Servopack OFF, then disconnect the encoder connector
- Short-circuit encoder connector terminals R and S for at least two seconds (For SGMG, and SGMS Servomotors)



4 Turning the Power ON

- Return the wiring to the original state
- Turn the SGDC 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

NOTE 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.

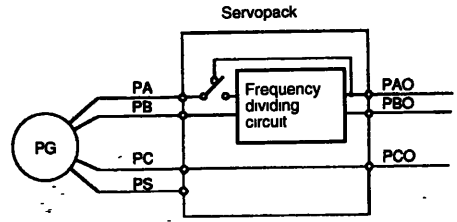
6) Absolute Data Exchange Sequence

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.

a) Outline of Absolute Signal

The absolute encoder outputs PAO, PBO, and PCO as shown on the right.

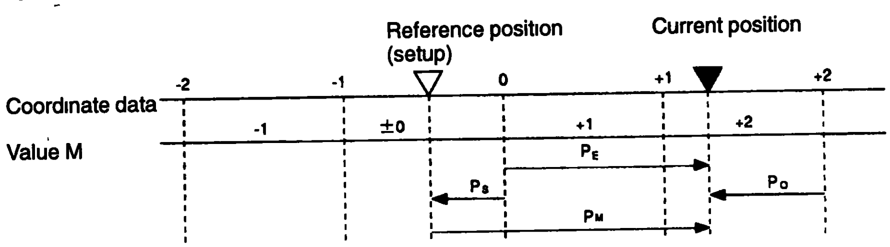


Signal Name	Status	Contents
PAO	Initial state	Serial data Initial incremental pulse
	Normal state	Incremental pulse
PBO	Initial state	Initial incremental pulse
	Normal state	Incremental pulse
PCO	Normal state	Home position pulse

b) 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.



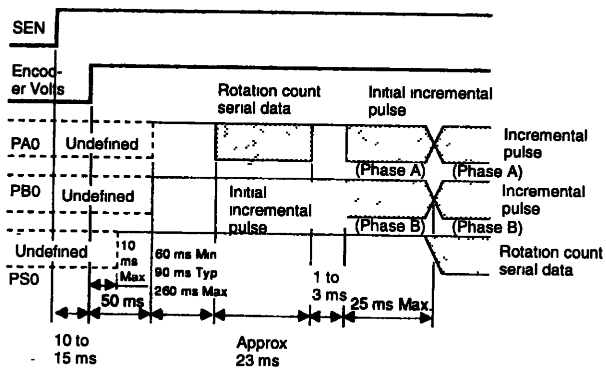
Absolute data P_M can be determined using the following formula.

$$P_E = M \times R + P_O$$
$$P_M = P_E - P_S$$

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
P_M	Current value required for the customer system
R	Number of pulses per encoder revolution (pulse count after dividing, value of Cn-0A)

c) **Absolute Data Transmitting Sequence**

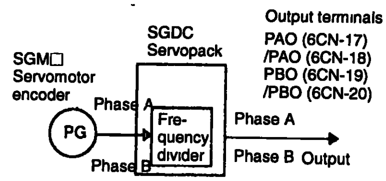
(1) Set the SEN signal at high level.
(2) After 100 ms, set the system to serial data reception-waiting-state. Clear the incremental pulse up/down counter to zero.
(3) Receive eight bytes of serial data.
(4) The system enters a normal incremental operation state approximately 50 ms after the last serial data is received.



• Use the following user constant to set the pulse dividing ratio.

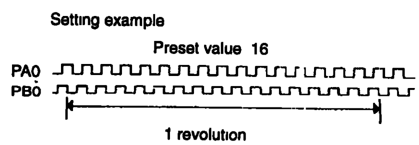
Cn-0A	PGRAT Dividing Ratio Setting	Unit: P/R	Setting Range: 16 to Number of Encoder Pulses		For Speed/Torque Control and Position Control

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 user constant. 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.

7) 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
Backup Alarm	Indicates that backup voltage drop was detected. (This alarm helps maintain reliability of rotation count data.)	A81
Battery Alarm	Indicates that backup voltage drop was detected. (This alarm warns of battery replacement and disconnection.)	A83
Checksum Error	Indicates that an error was detected in memory data check.	A82
Overspeed	Indicates that the motor was running at a speed exceeding 400 r/min when the encoder was turned ON.	A85
Absolute Error	Indicates that an error was detected in sensor check inside the encoder.	A84
Backup/Battery Combination Alarm		A81

The SEN signal can be used to output alarm information from Digital Operator.

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)

8) Absolute Encoder Home Position Error Detection

Cn-02 Bit 1	Absolute Encoder Home Position Error Detection	Factory Setting: 0	For Speed/Torque 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

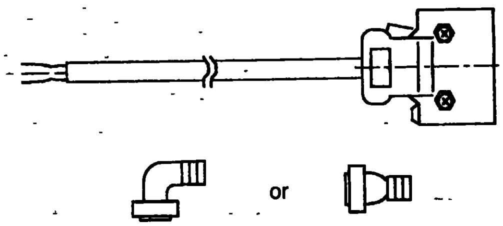
This function detects an encoder count error resulting from noise. It checks the number of pulses per motor revolution, and outputs a home position error alarm if that number is incorrect.
If the absolute encoder detects an error, it inverts phase C and notifies the Servopack of the error. In this case, this "home position error detection" function also works.

2.8.6 Extending an Encoder Cable

1) Both incremental and absolute encoders have a standard encoder cable (maximum 20 meters (65.6 ft.)). If a longer cable is required, prepare an extension cable as described below. The maximum allowable cable length is 50 meters (164 ft.).

a) 3-meter (1.98 ft) Cable with Connector

b) Encoder Plug and Cable Clamp (for SGMG, and SGMS)



- For incremental encoder: JZSP-VEP01-1
- For absolute encoder: JZSP-VEP11-1

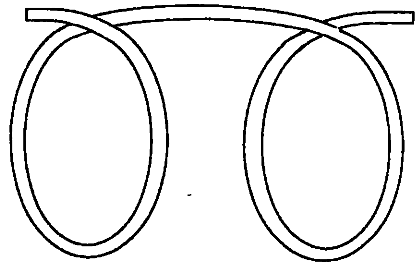
- L-type plug: JA08A-20-29S-J1-EB

or

- Straight plug: JA06A-20-29S-J1-EB

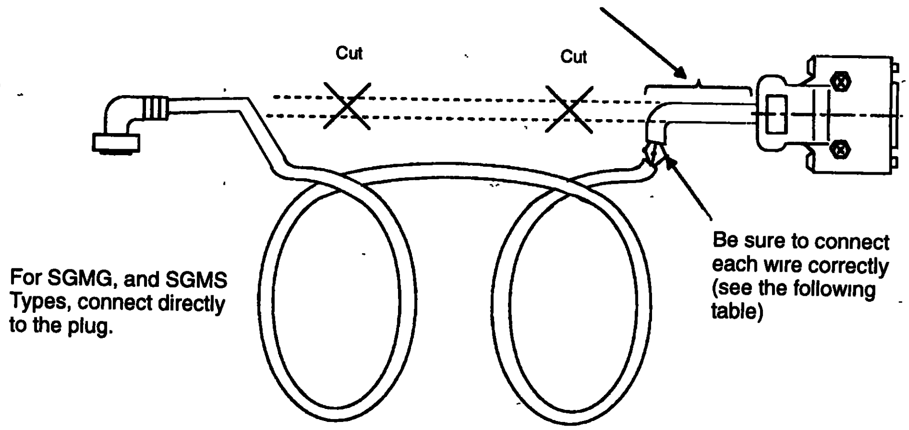
- Cable clamp: JL04-2022CKE(12)

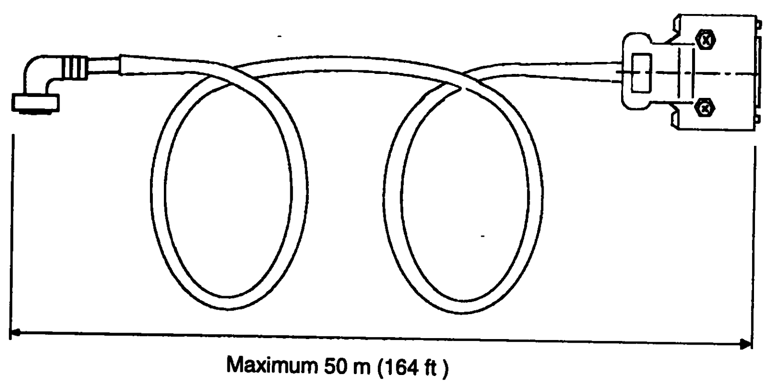
c) 50-meter (164 ft.) Extension Cable:



• For both incremental and absolute encoders: DP8409179

Cut this cable 30 cm (0 98 ft.) or less from each end.





2) Connect cables of the same color to each other as shown in the table below. Note that wiring for incremental and absolute encoders is different.

Signal Name	Color and Wire Size of Cable with Connectors		Color and Wire Size of 50-meter Extension Cable (DP8409179)	
PG5V	Red	AWG22	Red	AWG16
PG0V	Black	AWG22	Black	AWG16
PA	Blue	AWG26	Blue	AWG26
/PA	White/Blue	AWG26	White/Blue	AWG26
PB	Yellow	AWG26	Yellow	AWG26
/PB	White/Yellow	AWG26	White/Yellow	AWG26
PC	Green	AWG26	Green	AWG26
/PC	White/Green	AWG26	White/Green	AWG26
PS	Purple	AWG26	Purple	AWG26
/PS	White/Green	AWG26	White/Green	AWG26
RESET	White/Gray	AWG26	White/Gray	AWG26
BAT	Orange	AWG26	Orange	AWG26
BAT0	White/Orange	AWG26	White/Orange	AWG26

Only the absolute encoder can be connected.

Note Make sure to connect the shielded wires.

2.8.7 Connector Terminal Layouts

This section describes connector terminal layouts for Servopacks, SGM□ Servomotors and Digital Operators.

1) Connector Terminal(1CN,6CN) for Input/Output Signals

Connector 1CN Layout of SERVOPACK

2	/BK	Brake output	1	/BK+	Brake output	15	BATO	Battery(–) (for absolute only)	14	BAT	Battery(+) (for absolute only)
4	ALM2–	Servo alarm2 output	3	ALM2+	Servo alarm2 output	17	N C	No connected	16	N C	No connected
6	+24V IN	External power supply input	5	N C	No connected	19	ALMC	Servo alarm2 output	18	ESPO	Does not use
8	N-OT	Reverse prohibit input	7	P-OT	Forward prohibit input	21	N C	No connected	20	N C	No connected
10	/P-CL	Forward current limit ON input	9	/P-CON	P control input	23	N C	No connected	22	N C	No connected
12	/ALM-RST	Alarm reset input	11	/N-CL	Reverse current limit ON input	25	N C	No connected	24	N C	No connected
			13	N C	No connected				26	N C	No connected

- **SERVOPACK Side** Connector type: 10226-52A2JL (manufactured by 3M)
- **Cable Side** Connector type: 10126-3000VE (manufactured by 3M)
  Connector case type: 10326-52S0-00S (manufactured by 3M)

Note 14 pin and 15 pin are connected to CN51, CN52 in SERVOPACK.

Connector 6CN Layout of SERVOPACK

1	/S-RDY+	Servo ready output
2	/S-RDY−	Servo ready output
3	ALM1+	Servo alarm1 output
4	ALM1−	Servo alarm1 output
5	N C	No connected
6	+24V IN	External power supply input
7	/S-ON	Servo ON input
8	/TGON+	TGON output
9	/TGON−	TGON output
10	T-REF	Torque reference input
11	SG	0V
12	V-REF	Speed reference input
13	SG	0V
14	SEN	SEN signal input
15	SG	0V
16	SG	0V
17	PAO	Encoder output phase–A
18	/PAO	Encoder output phase–A
19	PBO	Encoder output phase–B
20	/PBO	Encoder output phase–B
21	PCO	Encoder output phase–C
22	/PCO	Encoder output phase–C
23	ALO1	Alarm code output (open corrector)
24	ALO2	Alarm code output (open corrector)
25	ALO3	Alarm code output (open corrector)
26	SG	0V

- **SERVOPACK Side** Connector type: 10226-52A2JL (manufactured by 3M)
- **Cable Side** Connector type: 10126-3000VE (manufactured by 3M)
  Connector case type: 10326-52S0-00S (manufactured by 3M)

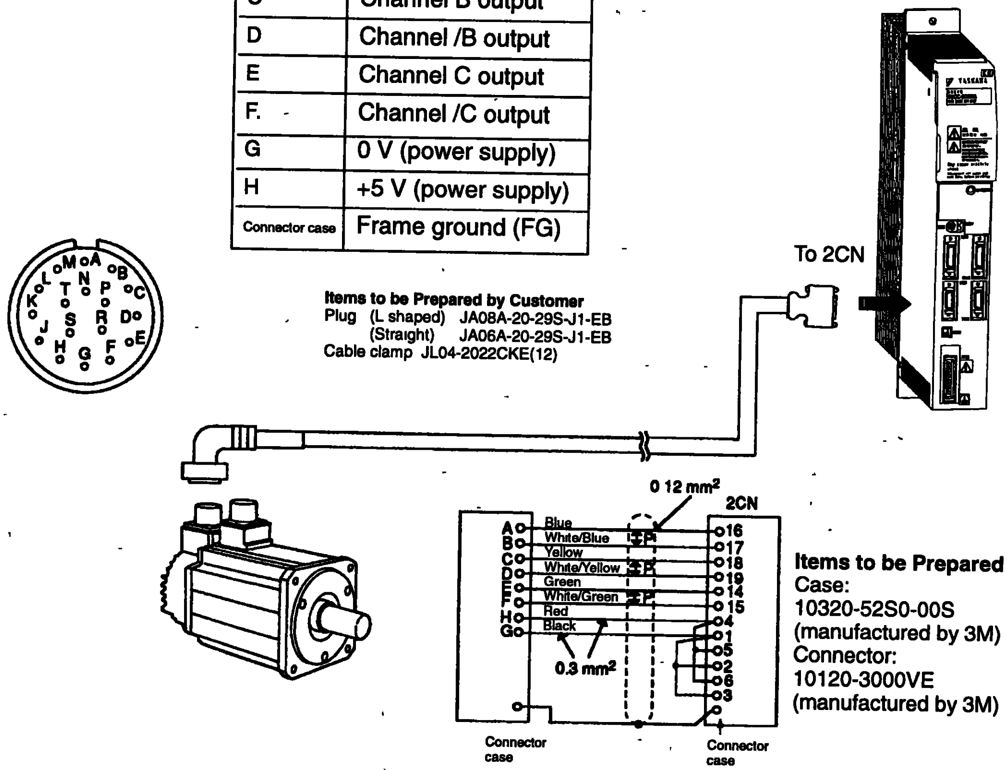
2) Connector 2CN Layout of SERVOPACK

1	PG0V	PG power supply 0V
2	PG0V	PG power supply 0V
3	PG0V	PG power supply 0V
4	PG5V	PG power supply +5V
5	PG5V	PG power supply +5V
6	PG5V	PG power supply +5V
7	DIR	Rotation direction
8	PS	PG input phase–S(for absolute only)
9	/PS	PG input phase–S (for absolute only)
10	N C	No connected
11	N C	No connected
12	BAT+	Battery(+) (for absolute only)
13	BAT−	Battery(−) (for absolute only)
14	PC	PG input phase–C
15	/PC	PG input phase–C
16	PA	PG input phase–A
17	/PA	PG input phase–A
18	PB	PG input phase–B
19	/PB	PG input phase–B
20	N C	No connected

- **SERVOPACK Side** Connector type: 10220-52A2JL (manufactured by 3M)
- **Cable Side** Connector type: 10120-3000VE (manufactured by 3M)
  Connector case type: 10320-52S0-00S (manufactured by 3M)

3) **Connectors for Incremental Encoder**
[SGMG and SGMS series]

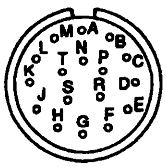
A	Channel A output
B	Channel /A output
C	Channel B output
D	Channel /B output
E	Channel C output
F	Channel /C output
G	0 V (power supply)
H	+5 V (power supply)
Connector case	Frame ground (FG)



Items to be Prepared by Customer
Case:
10320-52S0-00S
(manufactured by 3M)
Connector:
10120-3000VE
(manufactured by 3M)

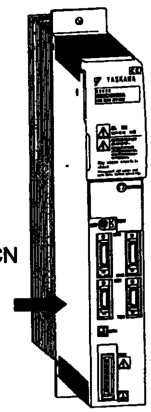
4) Connectors for Absolute Encoder
[SGMG and SGMS series]

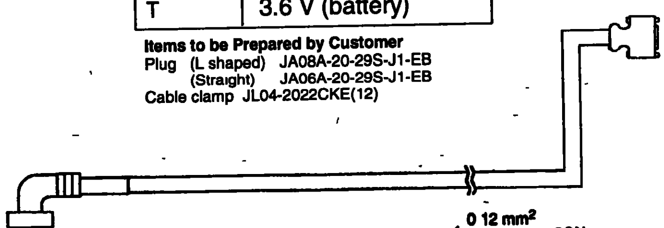
A	Channel A output
B	Channel /A output
C	Channel B output
D	Channel /B output
E	Channel Z output
F.	Channel /Z output
G	0 V (power supply)
H	+5 V (power supply)
Connector case	Frame ground (FG)
K	Channel S output
L.	Channel /S output
R	Reset
S	0 V (battery)
T	3.6 V (battery)

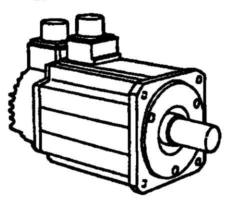


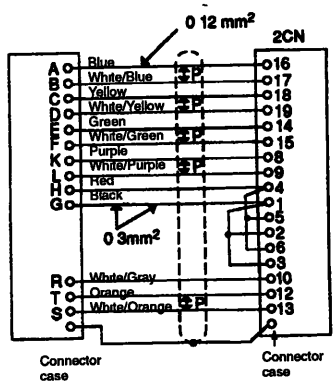
Items to be Prepared by Customer
Plug (L shaped) JA08A-20-29S-J1-EB
(Straight) JA06A-20-29S-J1-EB
Cable clamp JL04-2022CKE(12)

To 2CN





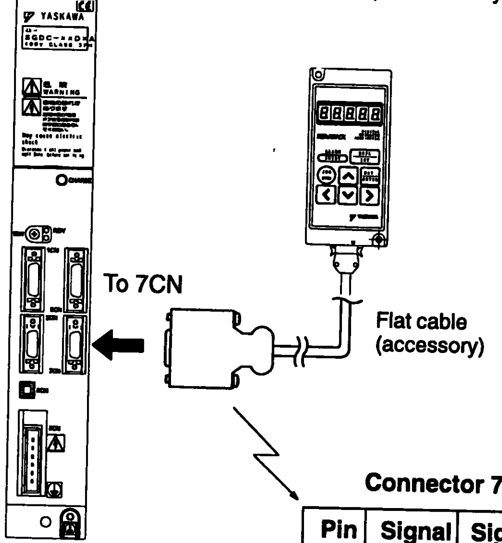




Items to be Prepared by Customer
Case:
10320-52S0-00S
(manufactured by 3M)
Connector:
10120-3000VE
(manufactured by 3M)

5) Connectors for Digital Operator

• JUSP-OP02A-2 (Hand-held Type)



Connector 7CN Layout of Servopack

Pin No.	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	Does not used	
6	/RXD	See note	
7	RT	See note	
8	TXD	Transmit data (not inverted)	P ← S
9	/TXD	Transmit data (Inverted)	P ← S
10	RXD	Receive data (Inverted)	P → S
11	N.C.	No connected	
12	N.C.	No connected	
13	5VPP	Does not used	
14	GND	Signal ground 0V	

P: Personal computer, S: SERVOPACK

Note Shorting pins 6 and 7 inserts 220 Ω termination resistance between RXD and /RXD.

3 USING THE DIGITAL OPERATOR

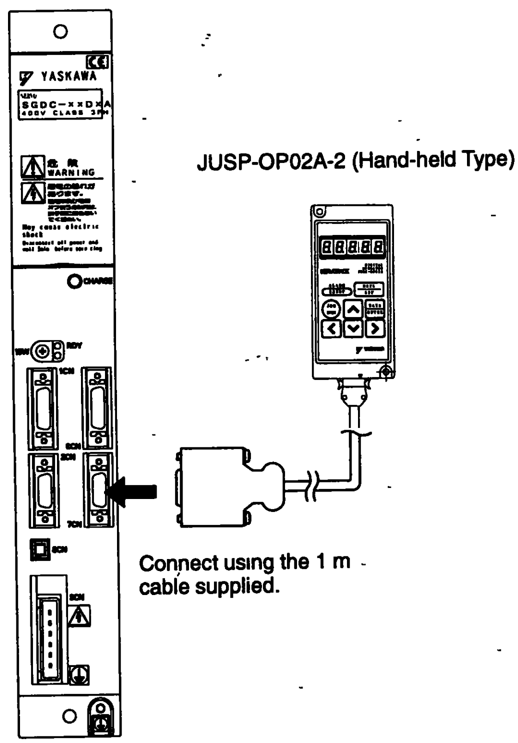
This chapter describes the basic operation of the digital operator and the convenient features it offers.
All constant settings and motor operations are possible by simple, convenient, operation.
Operate the digital operator as you read through this chapter.

3.1 Basic Operations

This section describes the basic operations using the Digital Operator.

3.1.1 Connecting the Digital Operator

The Digital Operator is available as two types: JUSP-OP02A-2 (Hand-held Type). JUSP-OP02A-2 type is connected to the Servopack as shown below.



- The Digital Operator connector can be connected or disconnected while the Servopack power is ON.

3.1.2 Resetting Servo Alarms

Servo alarms can be reset using the Digital Operator. (Servo alarms can also be reset by the 1CN-12, /ALMRST input signal. Refer to *Section 2.7.1 Using Servo Alarm Output and Alarm Code Output* for details.)
The alarm state can be cleared by turning the main power supply OFF, then turning the control power supply OFF.

Type: JUSP-OP02A-2

Press ALARM RESET Alarm Reset

NOTE After an alarm occurs, remove the cause of the alarm before resetting it. Refer to *Section 5.2 Troubleshooting* to determine and remedy the cause of an alarm.

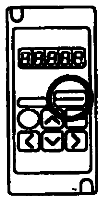
3.1.3 Basic Functions and Mode Selection

Digital Operator operation allows status display, user constant setting, operating reference, and auto-tuning operations.

Basic Mode Selection

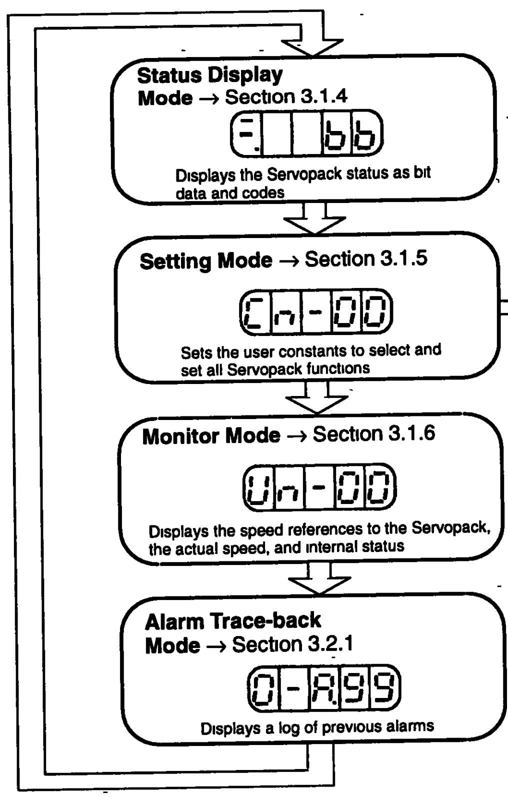
The four basic modes are listed below. Each time the mode key is pressed, the next mode in the sequence is selected.

JUSP-OP02A-2



Press the

key to switch the mode.



Special Modes

These modes are selected by setting a value for user constant Cn-00

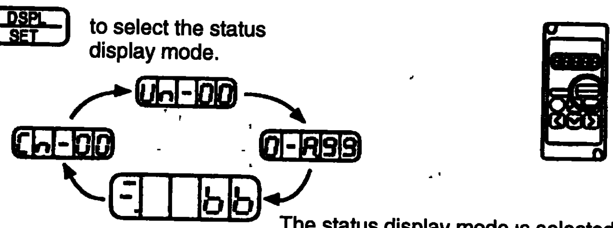
Cn-00 Setting	Mode
00-00	Operation mode from Digital Operator → Section 3.2.2
00-01	Reference offset automatic adjustment mode → Section 3.2.4
00-02	Clear alarm trace-back data → Section 3.2.6
00-03	Reference offset manual adjustment mode → Section 3.2.5
00-04	Motor-type check mode → Section 3.2.7
00-05	Auto-tuning mode → Section 3.2.3
00-06	Software-version check mode → Section 3.2.8
00-08	Current detection offset manual adjustment mode → Section 3.2.9

3.1.4 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 to select the status display mode.

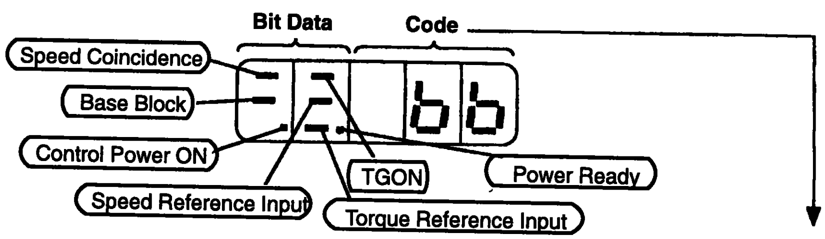


Status Display Mode

The status display mode is selected when the power supply is turned ON.

Keys to the status display are shown below.

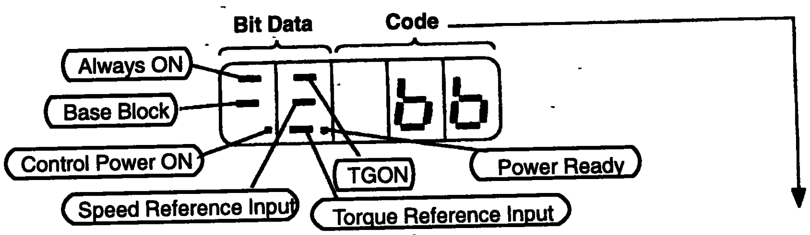
For Speed Control



Code	Status
bb	Base block Servo OFF (motor power OFF)
run	Run Servo ON (motor power ON)
Pot	Forward Rotation Prohibited (P-OT) 1CN-7 (P-OT) OFF. See Cn-01 Bit 2 (page 36).
not	Reverse Rotation Prohibited (N-OT) 1CN-8 (N-OT) OFF. See Cn-01 Bit 3 (page 36).
A.00	Alarm Status Displays the alarm number. See the table of alarms on page 138.
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 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-7 (P-OT) OFF. See Cn-01 Bit 2 (page 36).
not	Reverse Rotation Prohibited (N-OT) 1CN-8 (N-OT) OFF. See Cn-01 Bit 3 (page 36).
A.00	Alarm Status Displays the alarm number. See the table of alarms on page 138.
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.

3.1.5 Operation in User Constant Setting Mode

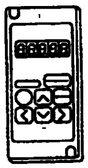
1) Two types of user constant are used

a) Constant Settings (Cn-03 to Cn-2D)
b) 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 user constant 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 C List of User Constants.*

2) Using the Setting Mode for Constant Settings (Cn-03 to Cn-2D)

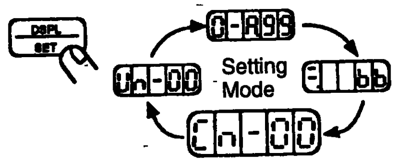
The constant settings (Cn-03 to Cn-23) allow setting of a constant. Check the permitted range of the constant in *Appendix C List of User Constants*, before changing the data. The example below shows how to change user setting Cn-15 from 100 to 85.



JUSP-OP02A-2

For JUSP-OP02A-2

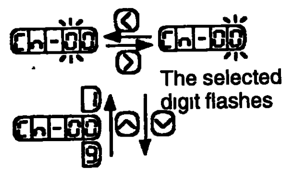
1) Press [DSPL SET] to select the user constant setting mode.



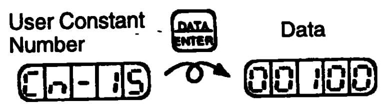
2) Select the user constant number to set.

   Press the [<] and [>] keys to select the digit.

   Press the [∧] and [∨] keys to change the value.



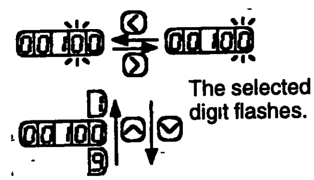
3) Press [DATA ENTER] to display the current data for the user constant selected at step 2.



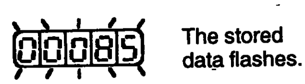
4) Set the required data.

   Press the [<] and [>] keys to select the digit.

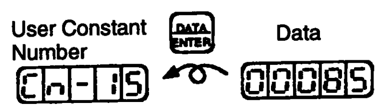
   Press the [∧] and [∨] keys to change the value.



5) Press [DATA ENTER] to store the data.



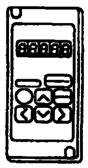
6) Press [DATA ENTER] once more to display the user constant number again.



7) Repeat steps 2 to 6 as often as required.

3) Using the Setting Mode for Memory Switches (Cn-01, Cn-02)

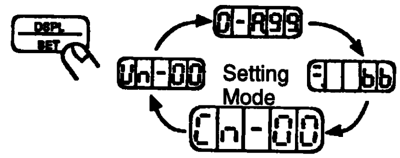
Turn the bits of the memory switches ON and OFF to select the functions required. The example below shows how to turn ON Bit 4 of memory switch Cn-01.



JUSP-OP02A-2

For JUSP-OP02A-2

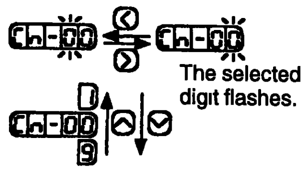
1) Press [DSPL SET] to select the user constant setting mode.



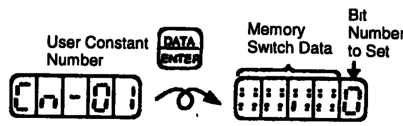
2) Select the user constant number to set.

   Press the [<] and [>] keys to select the digit.

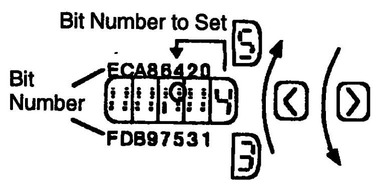
   Press the [∧] and [∨] keys to change the value.



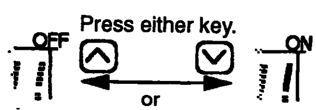
3) Press [DATA ENTER] to display the current data for the memory switch selected at step 2.



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.



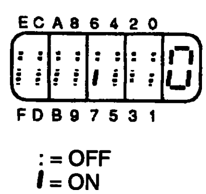
6) Repeat steps 4 and 5 as often as required.

7) Press [DATA ENTER] to store the data.

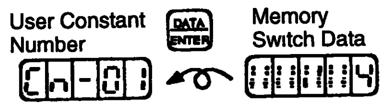
TERMS

Turning Bits ON and OFF

Memory switches use bits, not numbers, to select functions.
Sixteen bits are available (1 to 9 and A to E). Select the required functions by turning the appropriate bit ON (function ON) or OFF (function OFF).



8) Press DATA/ENTER once more to display the user constant number again.



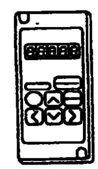
- Refer to *Appendix C List of User Constants.*

3.1.6 Operation in Monitor Mode

1) 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.

2) **Using the Monitor Mode**

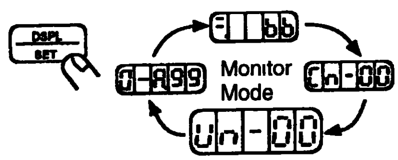
The example below shows how to display 1500, the contents of monitor number Un-00.



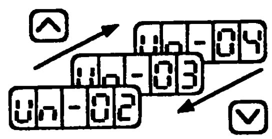
JUSP-OP02A-2

For JUSP-OP02A-2

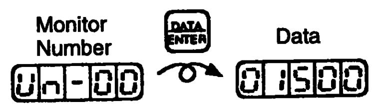
1) Press DSPL/SET to select the monitor mode



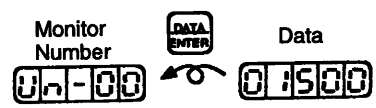
2) Press the ∧ and ∨ keys to select the monitor number to display.



3) Press DATA/ENTER to display the data for the monitor number selected at step 2.



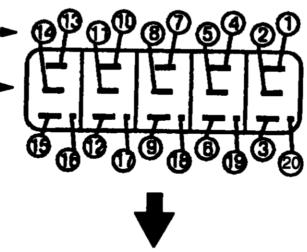
4) Press DATA/ENTER once more to display the monitor number again.



3) 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: 0.1 deg
Un-05	Internal status bit display
Un-06	Internal status bit display

Internal Status Bit Display



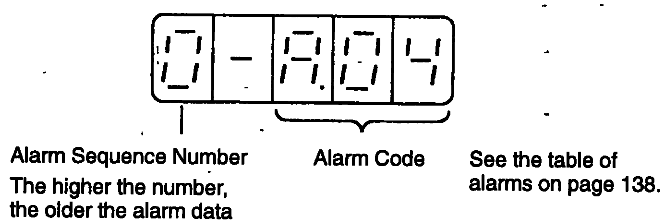
<table>
<tr><th>Monitor No</th><th>Bit No</th><th colspan="2">Description</th><th>Related I/O Signal, User Constant</th></tr>
<tr><td rowspan="20">Un-05</td><td>1</td><td colspan="2">Servo alarm</td><td>6CN-3 (ALM1), 1CN-3 (ALM2)</td></tr>
<tr><td>2</td><td colspan="2">Dynamic brake ON</td><td></td></tr>
<tr><td>3</td><td colspan="2">Reverse rotation mode</td><td>Cn-02 Bit 0, 2CN-7 (DIR)</td></tr>
<tr><td>4</td><td colspan="2">During motor rotation</td><td></td></tr>
<tr><td>5</td><td colspan="2">Speed coincidence</td><td></td></tr>
<tr><td>6</td><td colspan="2">Mode switch ON</td><td></td></tr>
<tr><td>7</td><td>During forward current limit</td><td rowspan="2">Or contact input speed control</td><td>1CN-10 (/P-CL)</td></tr>
<tr><td>8</td><td>During reverse current limit</td><td>1CN-11 (/N-CL)</td></tr>
<tr><td>9</td><td colspan="2">Motor power ON</td><td></td></tr>
<tr><td>10</td><td colspan="2">A-phase</td><td>2CN-16 (PA), 2CN-17 (/PA)</td></tr>
<tr><td>11</td><td colspan="2">B-phase</td><td>2CN-18 (PB), 2CN-19 (/PB)</td></tr>
<tr><td>12</td><td colspan="2">C-phase</td><td>2CN-14 (PC), 2CN-15 (/PC)</td></tr>
<tr><td>13</td><td colspan="2">U-phase</td><td></td></tr>
<tr><td>14</td><td colspan="2">V-phase</td><td></td></tr>
<tr><td>15</td><td colspan="2">W-phase</td><td></td></tr>
<tr><td>16</td><td colspan="2">Servo ON</td><td>6CN-7 (/S-ON)</td></tr>
<tr><td>17</td><td colspan="2">P operation or rotation direction input</td><td>1CN-9 (/P-CON)</td></tr>
<tr><td>18</td><td colspan="2">Forward overtravel</td><td>1CN-7 (P-OT), Cn-01 Bit 2</td></tr>
<tr><td>19</td><td colspan="2">Reverse overtravel</td><td>1CN-8 (N-OT), Cn-01 Bit 3</td></tr>
<tr><td>20</td><td colspan="2">SEN signal input</td><td>6CN-14 (SEN), Cn-01 Bit 1</td></tr>
<tr><td rowspan="6">Un-06</td><td>4</td><td colspan="2">Current limit</td><td></td></tr>
<tr><td>5</td><td colspan="2">Brake interlock output</td><td></td></tr>
<tr><td>6</td><td colspan="2">Overload warning</td><td></td></tr>
<tr><td>7</td><td colspan="2">Main power supply ON</td><td></td></tr>
<tr><td>8</td><td colspan="2">Servo ready</td><td></td></tr>
<tr><td>9 to 20</td><td colspan="2">Not used</td><td></td></tr>
</table>

3.2 Using the Functions

This section describes how to use the basic operations described in section 1 to operate and adjust the motor.

3.2.1 Operation in Alarm Trace-back Mode

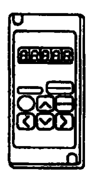
1) The alarm trace-back mode displays up to ten alarms which occurred previously. By allowing confirmation of what alarm occurred when, it is a useful aid to speed up troubleshooting.



NOTE 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 3.2.6 Clearing Alarm Trace-back Data* for details.

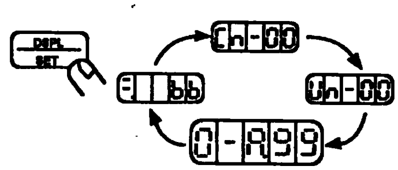
2) Using the Alarm Trace-back Mode
Follow the procedure below to determine which alarms occurred previously.

For JUSP-OP02A-2



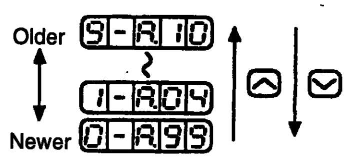
JUSP-OP02A-2

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.



3) The table below lists the alarms displayed in the alarm trace-back mode.

Displayed Alarm Code	Description
A.00	Absolute data error
A.02	User constant breakdown
A.03	User constant setting error
A.04	User constant setting error
A.05	Alarm traceback error
A.10	Overcurrent
A.20	Blown fuse
A.40	Overvoltage
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
A.C2	Encoder output phase error
A.C3	Encoder A-, B-phase disconnection
A.C4	Encoder C-phase disconnection
A.F4	Converter error
CPF00	Digital operator transmission error 1
CPF01	Digital operator transmission error 2
A.99	Not an alarm. Reset by alarm reset or Servopack power ON.

The following are operator-related alarms which are not recorded by alarm trace-back.

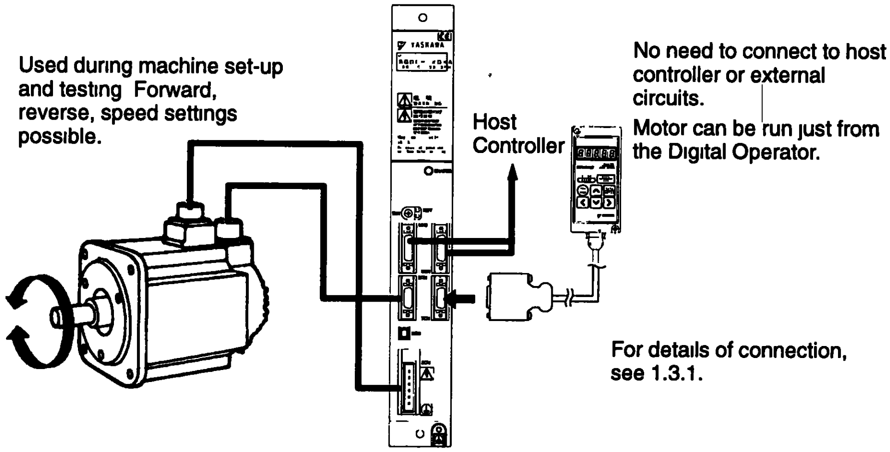
CPF00	Digital Operator transmission error 1
CPF01	Digital Operator transmission error 2

- Refer to the troubleshooting procedures when an alarm occurs, described in *Section 5.2 Troubleshooting.*

3.2.2 Operation Using the Digital Operator

Simple Motor Check

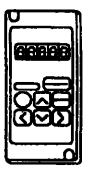
Operation from the Digital Operator allows the Servopack to run the motor. This allows rapid checking of basic operations during machine set-up and testing, without the trouble of connecting a host controller.



1) Operation Using the Digital Operator

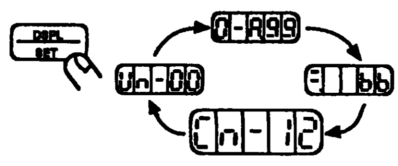
Use the following procedure to operate the motor from the Digital Operator

For JUSP-OP02A-2

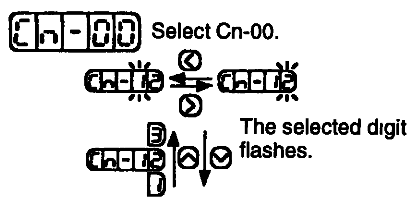


JUSP-OP02A-2

1) Press [DSPL SET] to select the user constant setting mode.



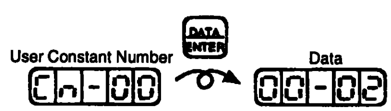
2) Select the user constant number Cn-00. (User constant Cn-00 is selected when the power is turned ON.)



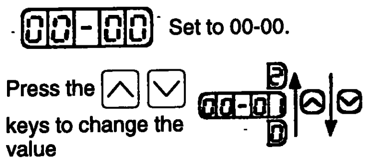
Press the [<] and [>] keys to select the digit.

Press the [∧] and [∨] keys to change the value.

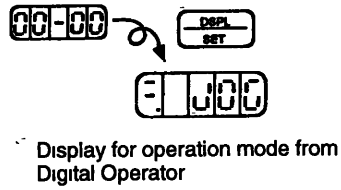
3) Press [DATA ENTER] to display the current data for the user constant Cn-00.



4) Press the [∧] and [∨] keys to change the data to 00.
(This user constant is set to 00 when the power is turned ON.)

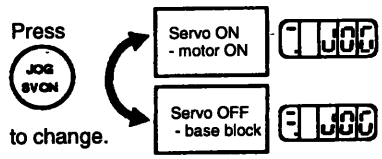


5) Press [DSPL SET] to set the Digital Operator in operation mode. Operation is now possible under Digital Operator control.



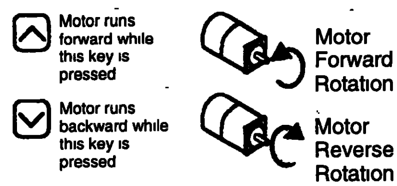
6) Press (JOG SVON) to set the servo ON status (motor power turned ON).

Select Servo ON/Servo OFF



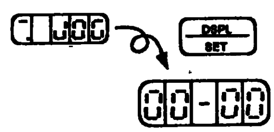
7) Press the [∧] and [∨] keys to operate the motor.

Motor Forward/Reverse Rotation

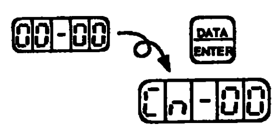


8) Press [DSPL SET] to revert to 00-00. This sets the servo OFF status (motor power turned OFF).

(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

2) **Changing Motor Speed**

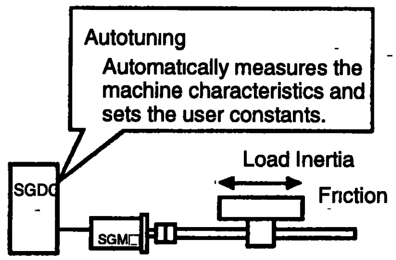
The motor speed for operation under Digital Operator control can be changed with a user constant:

User Constant: Cn-10 (JOGSPD), Units: r/min., Standard setting: 500

For details about setting the motor speed, refer to *Section 3.1.5 Operation in User Constant Setting Mode* and *Appendix C List of User Constants*.

3.2.3 Autotuning

No experience required to achieve optimum settings.
The Servopack contains a built-in autotuning function to automatically measure the machine characteristics and set the user constants.
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.



Autotuning is similar to auto-focus for a camera.

1) User Constants Automatically Settable with Autotuning

Cn-04	Speed loop gain
Cn-05	Speed loop integration time constant
Cn-1A	Position loop gain
Cn-28	Load inertia

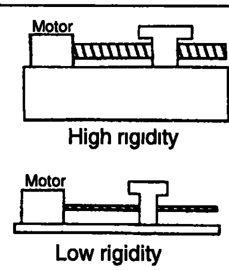
Once autotuning has been completed, the autotuning procedure can be omitted for subsequent machines, providing the machine specifications remain unchanged.
It is sufficient to directly set the user constants for subsequent machines.
The **machine rigidity** can be selected from one of seven levels.

NOTE
- 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.

TERMS

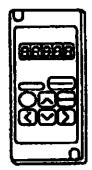
Machine Rigidity

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.



2) Using Autotuning

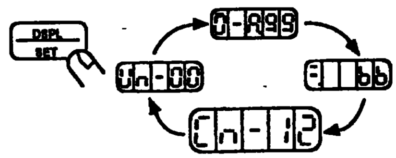
Follow the procedure below to run autotuning.



JUSP-OP02A-2

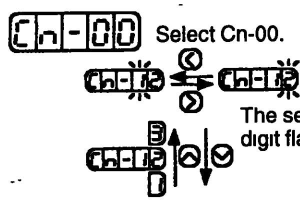
For JUSP-OP02A-2

1) Press [DSPL SET] to select the user constant setting mode.



Setting Mode

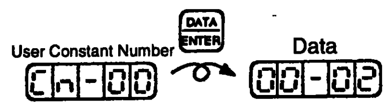
2) Select the user constant number Cn-00. (User constant Cn-00 is selected when the power is turned ON.)



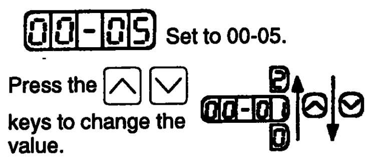
Press the [<] and [>] keys to select the digit.

Press the [∧] and [∨] keys to change the value.

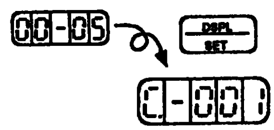
3) Press [DATA ENTER] to display the current data for the user constant Cn-00.



4) Press the [∧] and [∨] keys to change the data to 05.

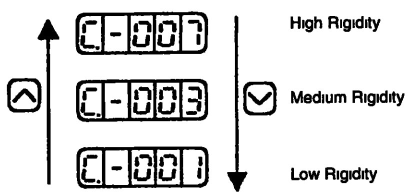


5) Press [DSPL SET] to display the machine rigidity.

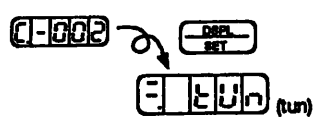


Machine Rigidity Display

6) Press the [∧] and [∨] keys to select the machine rigidity. If the actual rigidity is unknown, select medium rigidity.



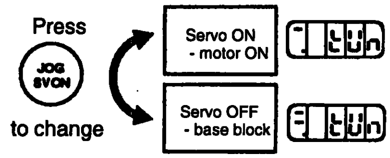
7) Press [DSPL SET] to select autotuning mode.



Autotuning Mode

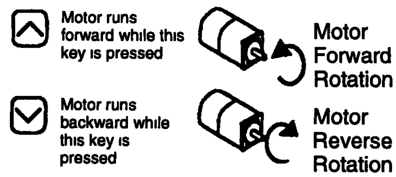
8) Press JOG SVON to set the servo ON status.

Select Servo ON/Servo OFF



9) Press the ∧ and ∨ keys to operate the motor.

Motor Forward/Reverse Rotation

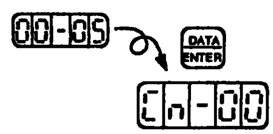


10) When autotuning is complete, the END message is displayed, as shown to the right.
Servo OFF status is automatically selected. If Servo ON/Servo OFF is selected by a signal from an external contact, turn this signal OFF.

Autotuning Complete

11) Release the ∧ 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.



Setting Mode Display

- Refer to the following *Subsection 3)* for the precautions relating to autotuning.

3) **Precautions Relating to Autotuning**

a) Speed Setting During Autotuning
The motor speed during autotuning is set by user constant 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 ∨ key is held down. The motor does not rotate continuously.

b) **Machine Rigidity Selection**
Select the machine rigidity as described below. If the actual rigidity is unknown, select medium rigidity.

C.-007	High Rigidity
C.-003	Medium Rigidity
C.-001	Low Rigidity

- If the Machine Resonates

At servo ON when the JOG SVON key is pressed or when the motor is operated by pressing the ∧ or ∨ 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 key to cancel autotuning.

(2) Press the DSPL 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 key to cancel autotuning.

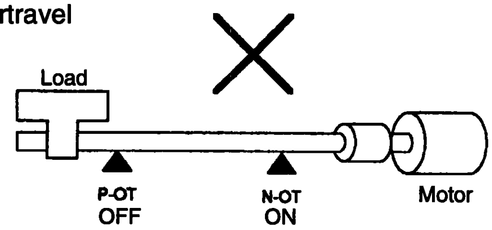
(2) Press the DSPL SET key once more to enter the machine rigidity setting mode. Increase the setting by one.

Autotuning may not end for machines with large play or extremely low rigidity.
In these cases, use conventional manual adjustment.

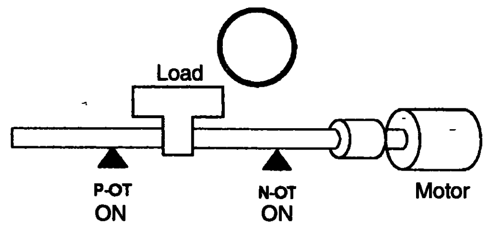
c) Input Signals

- 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 user constant 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).



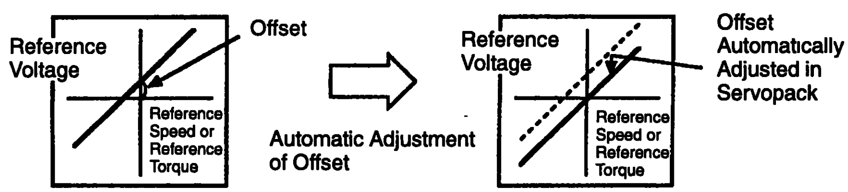
- If using the /S-ON signal to set the servo ON status, display [-. tUn] before turning ON the /S-ON signal.

3.2.4 Reference Offset Automatic Adjustment

1) Why Does Reference Offset Occur?
   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.

Automatic Adjustment of Reference Voltage
The reference offset automatic adjustment mode automatically measures the offset and adjusts the reference voltage. It adjusts both speed and torque references.

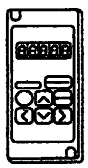
The following diagram illustrates automatic adjustment of an offset in the reference voltage from the host controller or external circuit.



2) 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 3.2.5 Reference Offset Manual Adjustment Mode* for details.

3) Using the Reference Offset Automatic Adjustment Mode

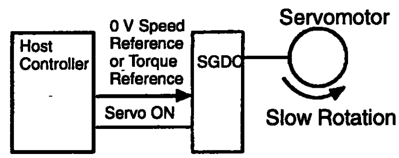
Follow the procedure below to automatically adjust the reference offset.



JUSP-OP02A-2

For JUSP-OP02A-2

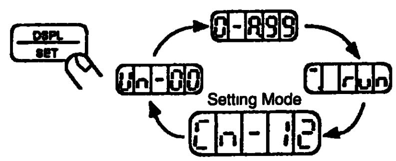
1) Follow the procedure below to set the motor into operating mode.



(1) Input the (intended) 0 V reference voltage from the host controller or external circuit.

(2) Then, turn ON the servo ON (6CN-7, /S-ON) signal.

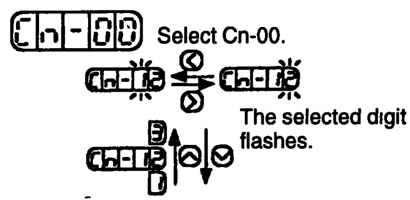
2) Press [DSPL SET] to select the user constant setting mode.



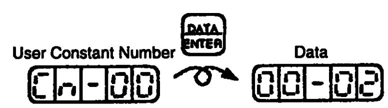
3) Select the user constant number Cn-00. (User constant Cn-00 is selected when the power is turned ON.)

Press the [<] and [>] keys to select the digit.

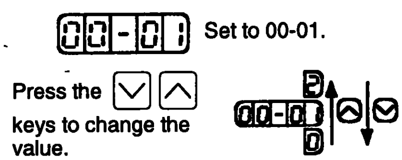
Press the [∧] and [∨] keys to change the value.



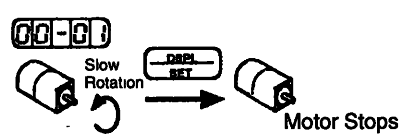
4) Press [DATA ENTER] to display the current data for the user constant Cn-00.



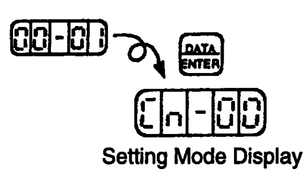
5) Press the [∨] and [∧] keys to change the data to 01.



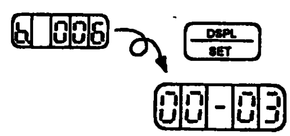
6) Press [DSPL SET] to automatically adjust the reference offset. The motor rotation stops.



7) Press [DATA ENTER] to return to the setting mode display. This ends reference offset automatic adjustment.

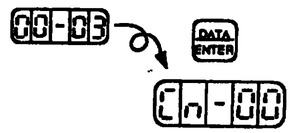


9) Press DSPL/SET to return to the user constant data display.



10) Press DATA/ENTER to return to the setting mode display. This ends the reference offset manual adjustment.

(Adjust the torque references.)

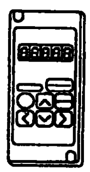


Setting Mode Display

3.2.6 Clearing Alarm Trace-back Data

1) 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 3.2.1 Operation in Alarm Trace-back Mode* for details.

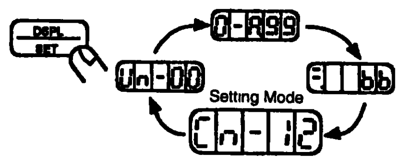
2) Follow the procedure below to clear the alarm trace-back data.



JUSP-OP02A-2

For JUSP-OP02A-2

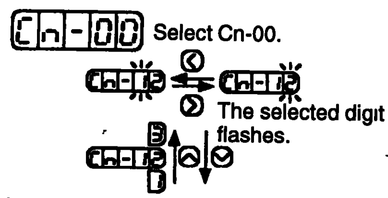
1) Press DSPL/SET to select the user constant setting mode.



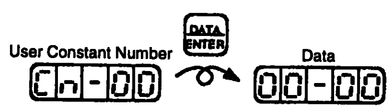
2) Select the user constant number Cn-00. (User constant Cn-00 is selected when the power is turned ON.)

Press the < and > keys to select the digit.

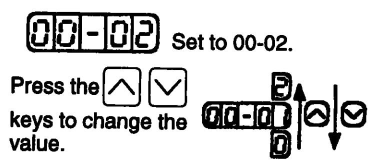
Press the ∧ and ∨ keys to change the value.



3) Press DATA/ENTER to display the current data for the user constant Cn-00.



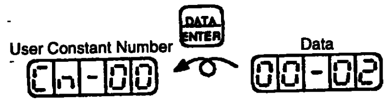
4) Press the ∧ and ∨ keys to change the data to 02.



5) Press DSPL/SET to clear the alarm trace-back data.

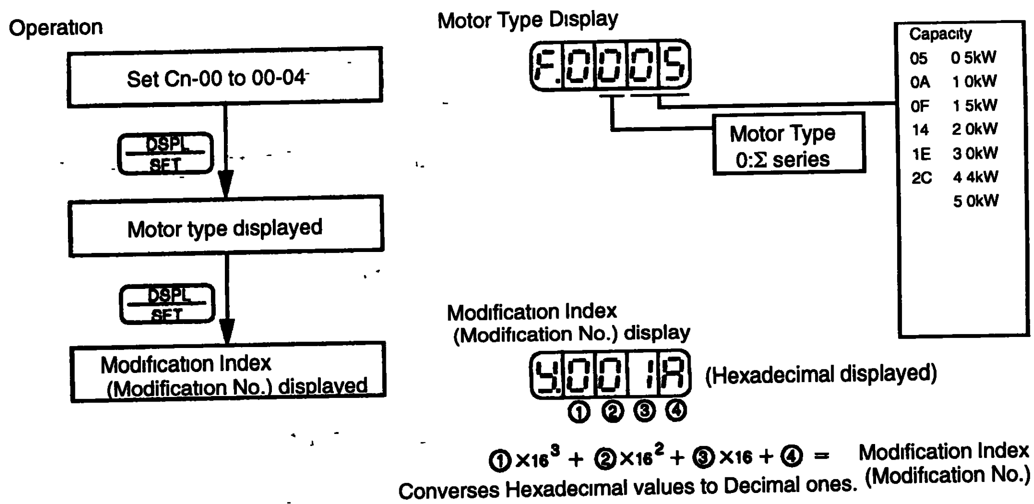
Clear the alarm trace-back data.

6) Press DATA/ENTER to return to the user constant data display.



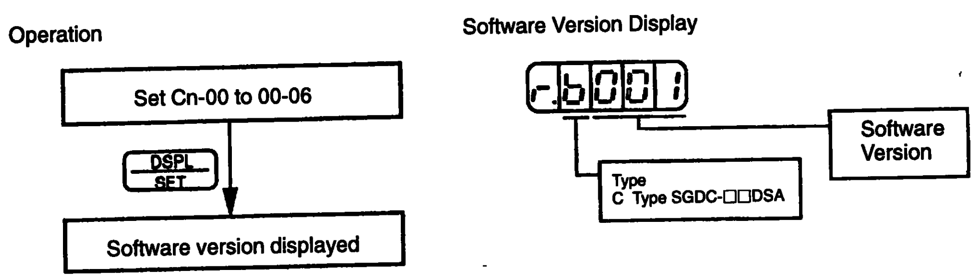
3.2.7 Checking Motor Type

Set Cn-00 to 00-04 to select the motor-type check mode.
This mode is used for maintenance and is not normally used by the customer.



3.2.8 Checking Software Version

1) 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.

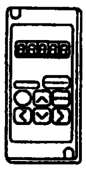


3.2.9 Current Detection Offset Manual Adjustment Mode

1) 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.

2) 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.

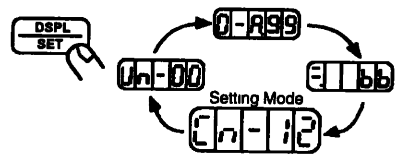
3) Follow the procedure below to perform current detection offset manual adjustment.



JUSP-OP02A-2

For JUSP-OP02A-2

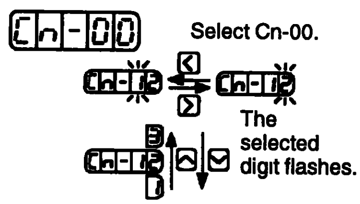
1) Press DSPL/SET to select the user constant setting mode.



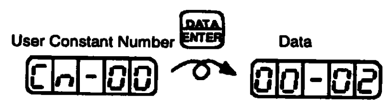
2) Select the user constant number Cn-00. (User constant Cn-00 is selected when the power is turned ON.)

Press the < and > keys to select the digit.

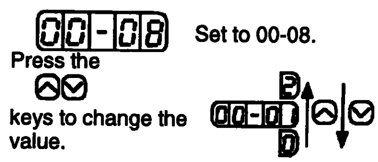
Press ∧ and ∨ keys to change the value.



3) Press DATA/ENTER to display the current data for the user constant Cn-00.

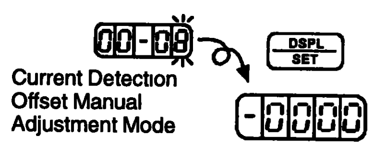


4) Press the ∧ and ∨ keys to change the data to 08.

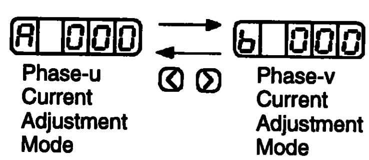


5) Press DSPL/SET to select the current detection offset manual adjustment mode.

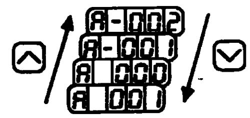
(The amount of current detection offset is displayed.)



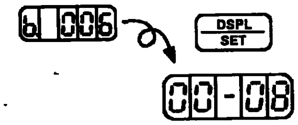
6) Press the < and > keys to switch between U-phase and V-phase current adjustment modes.



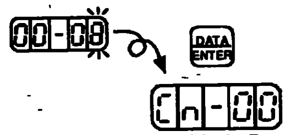
7) Press the ∧ and ∨ keys to adjust the amount of current detection offset.



8) Press DSPL/SET to return to the user constant data display.



9) Press DATA/ENTER to return to the user constant setting mode display. This ends the current detection offset manual adjustment.



Setting Mode Display

SERVO SELECTION AND DATA SHEETS

4

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.

4

4

4.1 Selecting a Σ-Series Servo

This section describes how to select the Σ-Series Servomotor, Servopack, and Digital Operator.

4.1.1 Selecting a Servomotor

1) Select an SGMG (1500 r/min), SGMS Servomotor according to the servo system to be used. Each type can be identified as eight-digit alphanumeric characters following "SGMG-", or "SGMS-". Numbers 1) to 6) shown in the following figure correspond to the numbers in the flowchart for Servomotor selection on the following pages.

SGMG- 05 V 2 D A □ □

Σ-Series
G: SGMG Servomotor
S: SGMS Servomotor

1) Rated output (motor capacity)
05: 0.45kW(0.60HP) 09: 0.85kW(1.14HP), 10: 1.0kW (1.34HP)
13: 1.3kW (1.74HP) 15: 1.5kW (2.01HP)
20: 1.8kW (2.41HP), 2.0kW (2.68HP)
30: 2.9kW (3.89HP), 3.0kW (4.02HP)
40: 4.0kW (5.36HP) 44: 4.4kW (5.90HP) 50: 5.0kW (6.71HP)

2) Standard
V: YASKAWA Standard

3) Encoder specification
2: 8192 P/R incremental encoder
6: 4096 P/R incremental encoder
W: 12-bit (1024 P/R) absolute encoder
S: 15-bit (8192 P/R) absolute encoder

4) Rated speed
D: SGMG Type (1500 r/min)
SGMS Type (3000 r/min)

5) Shaft specification
Blank: Standard (straight without key)
A : Standard (straight without key, only when "options" and "lead specification" columns are not blank)
B : Straight with key and one shaft-end tap
C : Taper 1/10 with parallel key
D : Taper 1/10 with Woodruff key (for G Series 05 and 09 only)

6) Options
Blank: Standard
1 : Standard (only when "lead specification" column is not blank)
S : With shaft seal
B : With 90 VDC brake
C : With 24 VDC brake
F : With shaft seal and 90 VDC brake
G : With shaft seal and 24 VDC brake Options

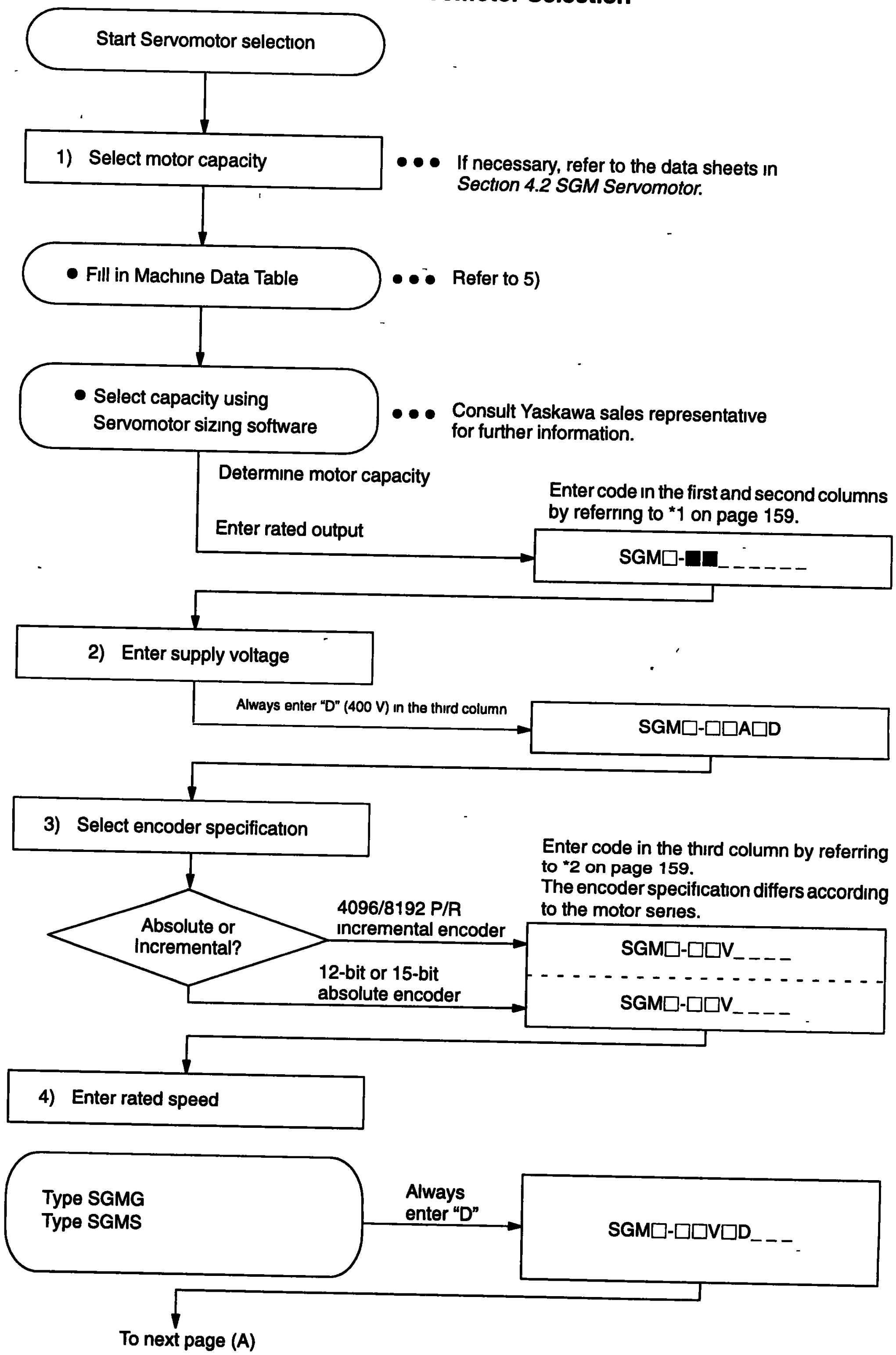
Lead specification
Blank: Standard (connector)

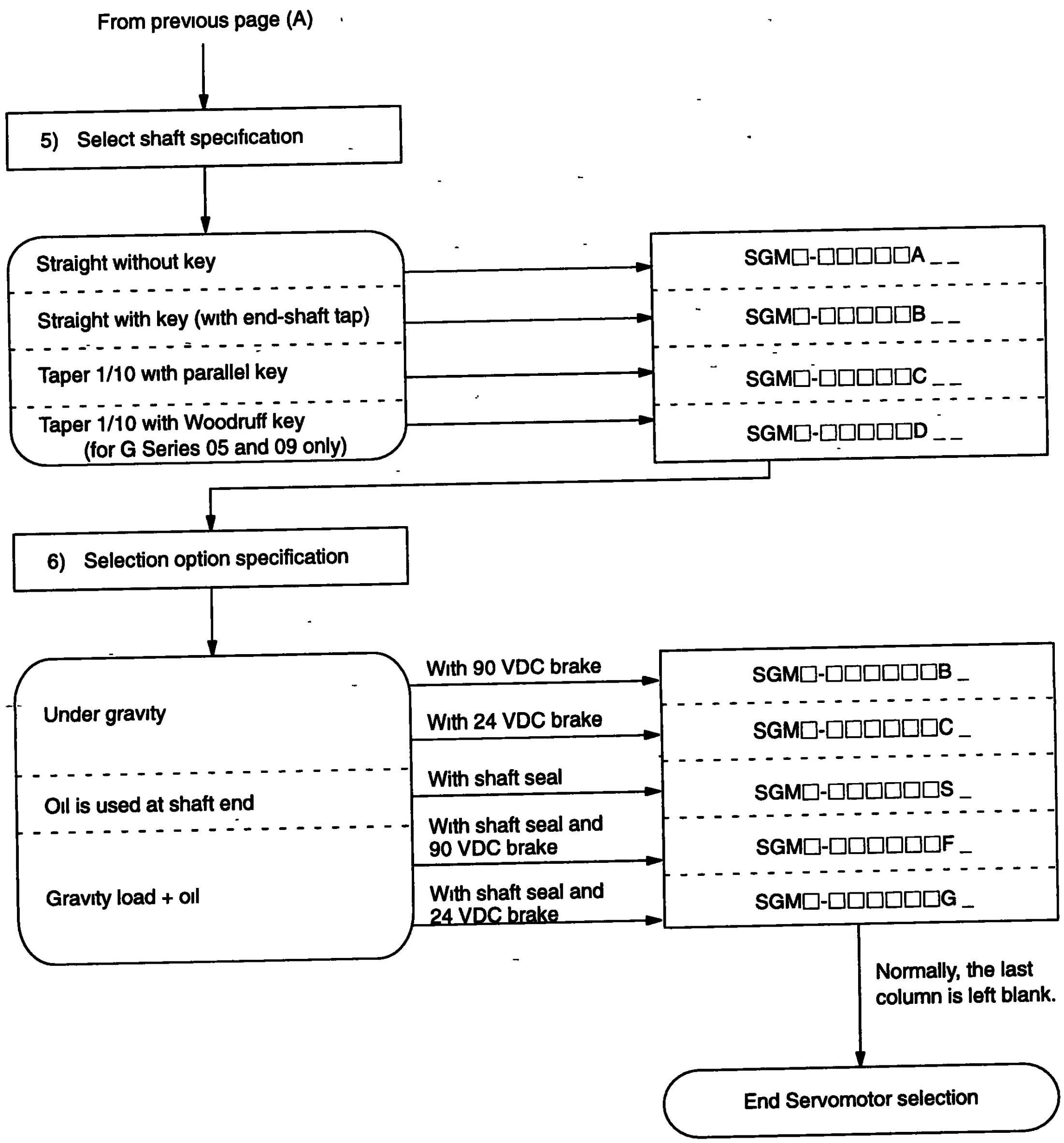
Flowchart for Servomotor selection

	Selected motor type
Example	SGMG-[0][5][V][2][D][A][ ][ ]
Axis 1	SGM[ ]-[ ][ ][ ][ ][ ][ ][ ][ ]
Axis 2	SGM[ ]-[ ][ ][ ][ ][ ][ ][ ][ ]
• • •	• • • • Blank for standard specification

2) The actual selection of the SGMG, or SGMS Servomotor is conducted according to the following flowchart.

Flowchart for Servomotor Selection




From previous page (A)
5) Select shaft specification
Straight without key
Straight with key (with end-shaft tap)
Taper 1/10 with parallel key
Taper 1/10 with Woodruff key
(for G Series 05 and 09 only)
SGM□-□□□□□A _ _
SGM□-□□□□□B _ _
SGM□-□□□□□C _ _
SGM□-□□□□□D _ _
6) Selection option specification
Under gravity
Oil is used at shaft end
Gravity load + oil
With 90 VDC brake
With 24 VDC brake
With shaft seal
With shaft seal and 90 VDC brake
With shaft seal and 24 VDC brake
SGM□-□□□□□□B _
SGM□-□□□□□□C _
SGM□-□□□□□□S _
SGM□-□□□□□□F _
SGM□-□□□□□□G _
Normally, the last column is left blank.
End Servomotor selection

*1 Rated output (motor capacity)

KW(HP)

Series / Code	G	S
	1500 r/min	3000 r/min
05	0.45 (0.60)	
09	0.85 (1.14)	
10		1.0 (1.34)
13	1.3 (1.74)	
15		1.5 (2.01)
20	1.8 (2.41)	2.0 (2.68)
30	2.9 (3.89)	3.0 (4.02)
40		4.0 (5.36)
44	4.4 (5.90)	
50		5.0 (6.71)

*2 Encoder specification

Symbol	Specifications	SGMG	SGMS
2	Incremental encoder: 8192 P/R	◎	○
6	Incremental encoder: 4096 P/R	○	◎
W	Absolute encoder: 12 bit (1024 P/R)	○	○
S	Absolute encoder: 15 bit (8192 P/R)	○	○

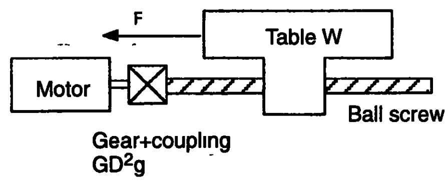
◎: Standard ○: Non-standard

3) 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.

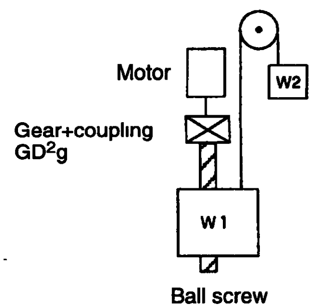
1) Ball Screw Horizontal Axis

*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	GD^2g	—kg·cm² (lb·in².)
	Ball screw pitch	P	—mm (in.)
	Ball screw diameter	D	—mm (in.)
	Ball screw length	L	—mm (in.)



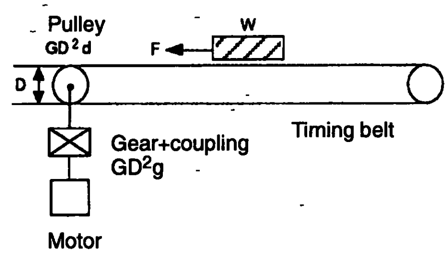
2) Ball Screw Vertical Axis

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	GD^2g	—kg·cm² (lb·in².)
Ball screw pitch	P	—mm (in.)
Ball screw diameter	D	—mm (in.)
Ball screw length	L	—mm (in.)



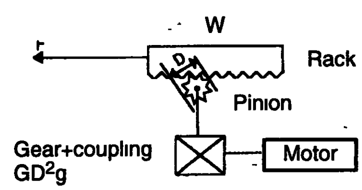
3) Timing Belt

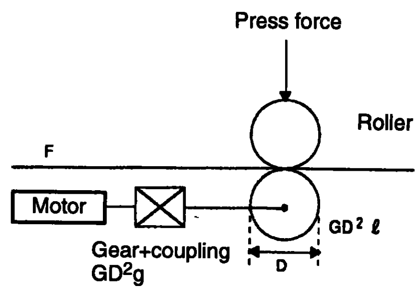
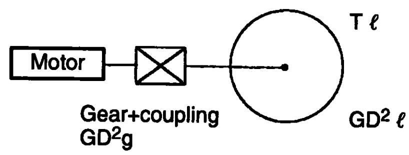
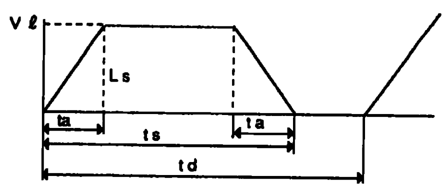
Load mass	W	—kg (lb)
Thrust	F	—kg (lb)
Coefficient of friction	μ	—
Overall efficiency	η	—
Gear ratio	R (= Nm/Nl)	—
Gear+coupling	GD^2g	—kg·cm² (lb·in².)
Pulley	GD^2d	—kg·cm² (lb·in².)
Pulley diameter	D	—mm (in.)



4) 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	GD^2g	—kg·cm² (lb·in².)
Pinion diameter	D	—mm (in.)
Pinion thickness	t	—mm (in.)



5) Roll Feeder			
Load GD^2	$GD^2\ell$	—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	GD^2g	—kg·cm² (lb·in².)	
6) Rotor			
Load GD^2	$GD^2\ell$	—kg·cm² (lb·in².)	
Load torque	$T\ell$	—kg·cm² (lb·in².)	
Overall efficiency	η	—	
Gear ratio	R (= Nm/Nl)	—	
Gear+coupling	GD^2g	—kg·cm² (lb·in².)	
7) Others			
Load GD^2	$GD^2\ell$	—kg cm² (lb·in².)	
Load torque	$T\ell$	—kg·cm² (lb·in².)	
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 GD^2 (inertia) of Table W (load weight) and GD^2 (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 GD^2 g: GD^2 of gear or coupling
This is GD^2 of the joint (including a gear) between the motor and the load (machine).

4.1.2 Selecting a Servopack

1) Select an SGDC Servopack according to the servo system to be used. Each type can be identified as five-digit alphanumeric characters following "SGDC-".

SGDC- 05 D S A

Σ-Series
SGDC Servopack

Rated output (motor capacity)

Code	Capacity (kW) (HP)
05	0.5 (0.67)
10	1.0 (1.34)
15	1.5 (2.01)
20	2.0 (2.68)
30	3.0 (4.02)
50	5 0 (6.71)

Supply voltage
D: 400 V

Model
S: For speed/torque control

Design order

Flowchart for Servopack selection

	Selected Servopack type
Example	SGDC-\[0\]\[5\]\[D\]\[S\]\[A\]
Axis 1	SGDC-□□□□□
Axis 2	SGDC-□□□□□
• • •	• • • • • •

* The motor type can be changed within the same group by altering the user constant setting. (See the table on the next page.)

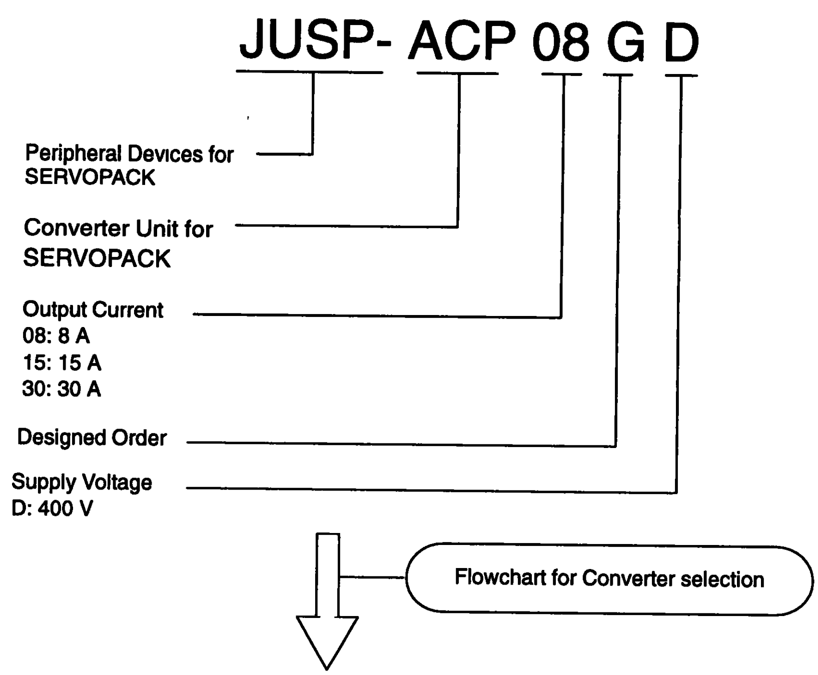
2) Select an SGDC Servopack according to the motor to be used. The following table shows the correspondence between Servopack and motor types.

Group	Servopack Type	Motor Type
05	SGDC-05DSA	SGMG-05A□D
10	SGDC-10DSA	SGMG-09A□D
		SGMS-10A□D
15	SGDC-15DSA	SGMG-13A□D
		SGMS-15A□D
20	SGDC-20DSA	SGMG-20A□D
		SGMS-20A□D
30	SGDC-30DSA	SGMG-30A□D
		SGMS-30A□D
50	SGDC-50DSA	SGMG-44A□D
		SGMS-40A□D
		SGMS-50A□D

The motor type can be changed within the same group by altering the user constant setting.

4.1.3 Selecting a Converter

1) Select a converter according to the servo system to be used. Each type can be identified as four-digit alphanumeric characters following "JUSP-ACP".



	Selected Converter type
Example	JUSP-ACP 15GD

4.2 SGM Servomotor

This section presents tables of ratings and specifications for SGMG, SGMS Servomotors. Refer to these tables when selecting a Servomotor.

4.2.1 Ratings and Specifications

1) Ratings and Specifications of SGMG Servomotors (Rated Motor Speed is 1500 r/min)

Time rating:	continuous
Insulation class:	Class F
Vibration class:	15µm or below
Withstand voltage:	1800 VAC
Insulation resistance:	500 VDC 10MΩ min.
Enclosure:	totally enclosed, self-cooled IP67(except for shaft opening)
Ambient temperature:	0 to 40°C
Ambient humidity:	20% to 80% (non-condensing)
Excitation:	permanent magnet
Drive method:	direct drive
Mounting:	flange method

Servomotor SGMG		05V□D	09V□D	13V□D	20V□D	30V□D	44V□D
Rated Output*	kW (HP)	0.45 (0.6)	0.85 (1.1)	1.3 (1.7)	1.8 (2.4)	2.9 (3.9)	4.4 (5.9)
Rated Torque*	N·m	2.84	5.39	8.34	11.5	18.6	28.4
	kgf·cm (lb·in)	29 (25)	55 (48)	85 (74)	117 (102)	190 (165)	290 (252)
Instantaneous Peak Torque*	N·m	8.92	13.8	23.3	28.7	45.1	71.1
	kgf·cm (lb·in)	91 (79)	141 (122)	238 (207)	293 (254)	460 (404)	725 (630)
Rated Current	A (rms)	1.9	3.5	5.4	8.4	11.9	16.5
Instantaneous Max Current*	A (rms)	5.5	8.5	14	20	28	40.5
Rated Speed*	r/min	1500					
Instantaneous Max Speed*	r/min	3000					
Torque Constant	N·m/A (rms)	1.64	1.65	1.68	1.46	1.66	1.82
	kgf·cm/A (lb·in/A) (rms)	16.8 (14.5)	16.8 (14.6)	17.1 (14.9)	14.9 (12.9)	16.9 (14.7)	18.5 (16.1)
Moment of Inertia	kg·m^2 $\times 10^{-4}$	7.24	13.9	20.5	31.7	46.0	67.5
	gf·cm·s^2 (lb·in·s^2 $\times 10^{-3}$)	7.39 (6.41)	14.2 (12.3)	20.9 (18.2)	32.3 (28.1)	46.9 (40.7)	68.9 (59.8)
Rated Power Rate*	kW/s	11.2	20.9	33.8	41.5	75.3	120
Rated Angular Acceleration*	rad/s^2	3930	3880	4060	3620	4050	4210
Inertia Time Constant	ms	5.6	3.1	2.9	2.4	2.0	1.4
Inductive Time Constant	ms	4.5	5.3	6.1	11.1	12.3	15.2

* These items and torque-speed characteristics quoted in combination with an SGDC 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:

Type 05V□D to 13V□D: 400×400×20 (mm) (16×16×0.8 (in))

Type 20V□D to 44V□D: 550×550×30 (mm) (22×22×1.2 (in))

NOTE The ratings and specifications above refer to a standard Servomotor.

Add the numerical values below to the moment of inertia values in the table for a motor fitted with **a holding brake** .

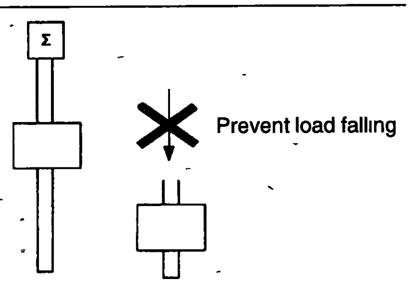
Other specifications will also change slightly.

Servomotor SGMG			**05V□D**	**09V□D**	**13V□D**	**20V□D**	**30V□D**	**44V□D**
Holding brake 24VDC	Moment of Inertia Increase	kg m$^2 \times 10^{-4}$	2.10			8.50		
		gf cm·s^2 (lb·in s$^2 \times 10^{-3}$)	2.14 (1.86)			8.67 (7.53)		
	Static Friction Torque	N·m	4.41	12.7		43.1		

TERMS

Holding Brake

The holding brake is automatically applied to the motor shaft to prevent the load falling in vertical axis applications when the motor power supply is turned off or fails. It is only to hold the load and cannot be used for stopping the motor.



4) **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 3.2.5 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 2.4.3 Using Zero-Clamp* for details.

3.2.5 Reference Offset Manual Adjustment Mode

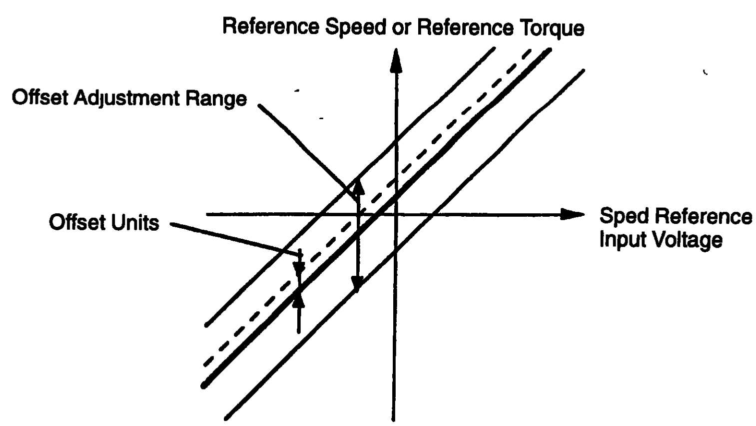
1) Speed reference offset manual adjustment is very convenient in the following situations:

- 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:



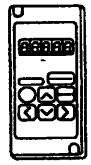
Offset Adjustment Range: -512 to +511

Offset Units:

Reference Speed 0.038 r/min. (0.076 mV)
When Cn-03 = 500

Reference Torque 0.02 r/min. (0.61 mV)
When Cn-13 = 30

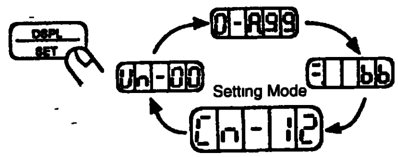
2) Follow the procedure below to manually adjust the reference voltage.



JUSP-OP02A-2

For JUSP-OP02A-2

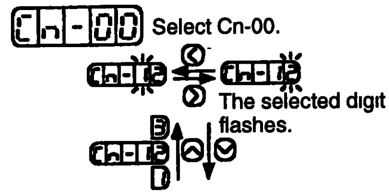
1) Press [DSPL/SET] to select the user constant setting mode.



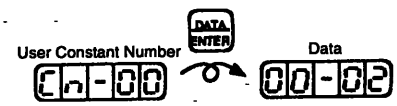
2) Select the user constant number Cn-00. (User constant Cn-00 is selected when the power is turned ON.)

Press the [<] and [>] keys to select the digit.

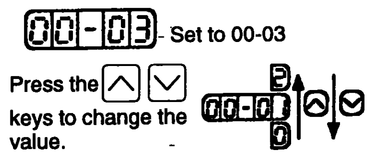
Press [∧] and [∨] keys to change the value.



3) Press [DATA/ENTER] to display the current data for the user constant Cn-00.

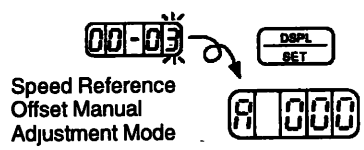


4) Press the [∧] and [∨] keys to change the data to 03.



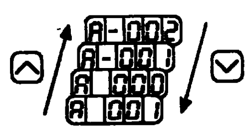
5) Press [DSPL/SET] to select the speed reference offset manual adjustment mode.

(The amount of speed reference offset is displayed.)



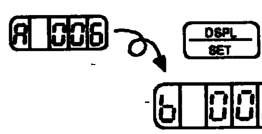
6) Press the [∧] and [∨] keys to adjust the amount of offset.

(Adjust the speed references.)

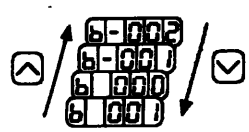


7) Press [DSPL/SET] to select the torque reference offset manual adjustment mode.

(The amount of torque reference offset is displayed.)

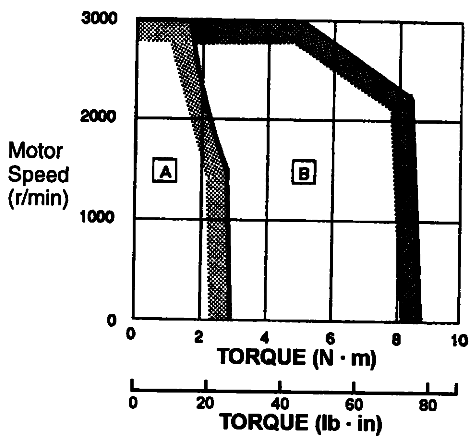


8) Press the [∧] and [∨] keys to adjust the amount of offset.
(Adjust the torque references.)

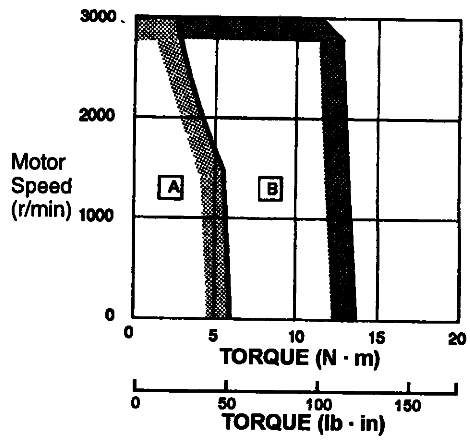


■ SGMG Servomotor (Rated Motor Speed is 1500 r/min) Torque-Motor Speed Characteristics

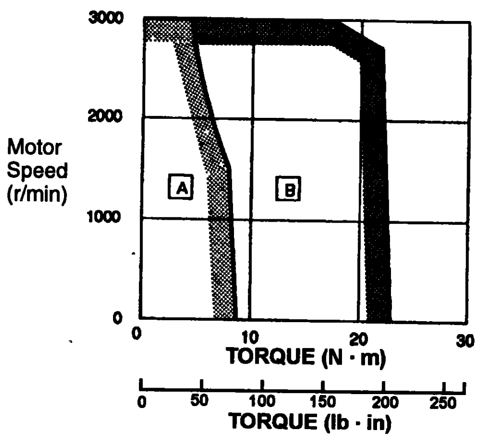
• SGMG-05V□D



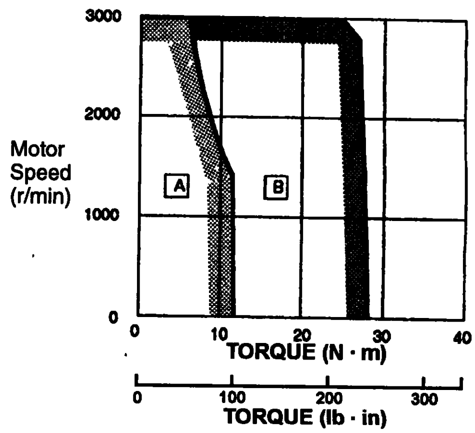
• SGMG-09V□D



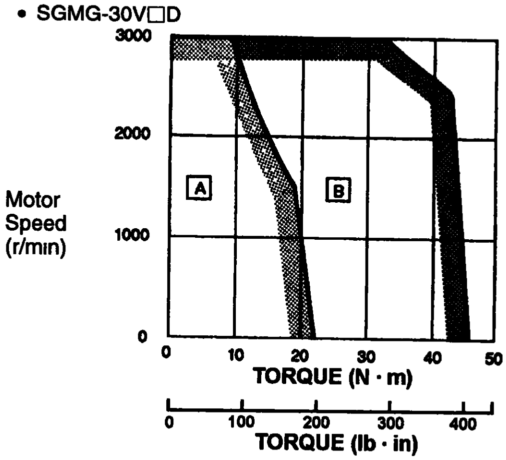
• SGMG-13V□D



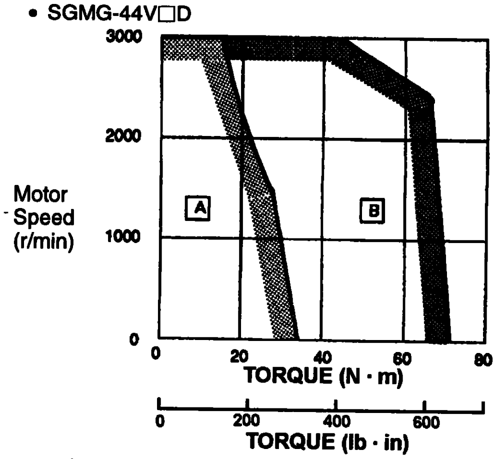
• SGMG-20V□D



• SGMG-30V□D



• SGMG-44V□D



A: Continuous Duty Zone
B: Intermittent Duty Zone

2) Ratings and Specifications of SGMS Servomotors

Time rating:	continuous
Insulation class:	Class F
Vibration class:	15µm or below
Withstand voltage:	1800 VAC
Insulation resistance:	500 VDC 10MΩ min.
Enclosure:	totally enclosed, self-cooled IP67 (except for shaft opening)
Ambient temperature:	0 to 40°C
Ambient humidity:	20% to 80% (non-condensing)
Excitation:	permanent magnet
Drive method:	direct drive
Mounting:	flange method

Servomotor SGMS		10V☐D	15V☐D	20V☐D	30V☐D	40V☐D	50V☐D
Rated Output*	kW (HP)	1.0 (1.3)	1.5 (2.0)	2.0 (2.7)	3.0 (4.0)	4.0 (5.4)	5.0 (6.7)
Rated Torque *	N·m	3.18	4.9	6.36	9.8	12.6	15.8
	kfg·cm (lb·in)	32.4 (28.1)	50 (43.4)	65 (56.4)	100 (86.8)	129 (112)	161 (140)
Instantaneous Peak Torque*	N·m	9.54	14.7	19.1	29.4	37.8	47.6
	kfg·cm (lb in)	97.2 (84.4)	150 (130)	195 (169)	300 (260)	387 (336)	486 (422)
Rated Current	A (rms)	2.8	4.7	6.2	8.9	12.5	13.8
Instantaneous Max Current*	A (rms)	8.5	14	19.5	28	38	42
Rated Speed*	r/min	3000					
Instantaneous Max Speed*	r/min	4500					
Torque Constant	N·m/A (rms)	1.27	1.15	1.12	1.19	1.07	1.24
	kgf·cm/A (lb·in/A) (rms)	13.0 (11.3)	11.7 (10.2)	11.4 (9.89)	12.1 (10.5)	11.0 (9.55)	12.7 (11.0)
Moment of Inertia	kg·m^2 $\times 10^{-4}$	1.74	2.47	3.19	7.00	9.60	12.3
	gf·cm·s^2 (lb·in·s^2 $\times 10^{-3}$)	1.78 (1.54)	2.52 (2.19)	3.26 (2.83)	7.14 (6.20)	9.80 (8.50)	12.6 (10.9)
Rated Power Rate*	kW/s	57.9	97.2	127	137	166	202
Rated Angular Acceleration*	rad/s^2	18250	19840	19970	14000	13160	12780
Inertia Time Constant	ms	0.97	0.8	0.66	0.76	0.62	0.55
Inductive Time Constant	ms	6.3	6.8	7.3	16.3	14.4	15.2

* These items and torque-speed characteristics quoted in combination with an SGDC Servopack at an armature winding temperature of 20°C.

Note These characteristics can be obtained when the following heat sinks (alumnium plates) are used for cooling purposes:
Type 10V☐D to 20V☐D: 300×300×12 (mm) (12×12×0.5 (in))
Type 30V☐D to 50V☐D: 400×400×20 (mm) (16×16×0.8 (in))

NOTE The ratings and specifications above refer to a standard Servomotor.

Add the numerical values below to the moment of inertia values in the table for a motor fitted with a holding brake.

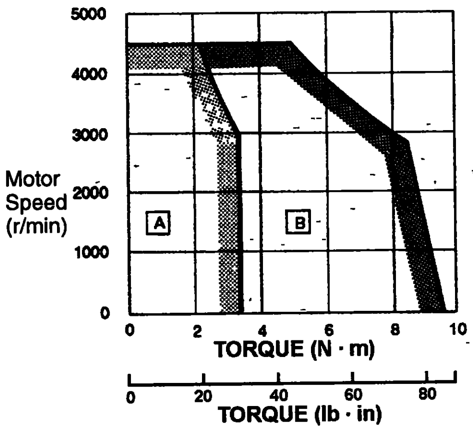
Other specifications will also change slightly.

Servomotor SGMS			10V□D	15V□D	20V□D	30V□D	40V□D	50V□D
Holding brake 24VDC	Moment of Inertia Increase	kg m$^2\times10^{-4}$	0.325			2.10		
		gf cm s^2 (lb in·s$^2\times10^{-3}$)	0.332 (0.288)			2.14 (1.86)		
	Static Friction Torque	N·m	7.84			20		

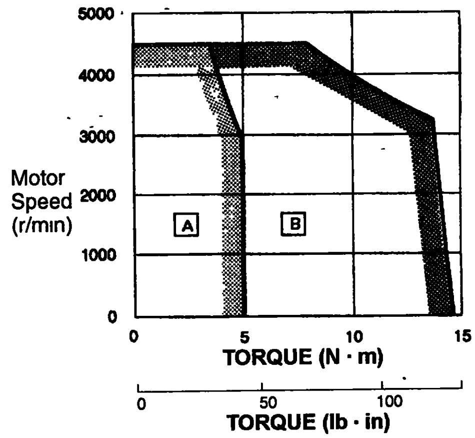
4

■ SGMS Servomotor (Rated Motor Speed is 1000 r/min) Torque-Motor Speed Characteristics

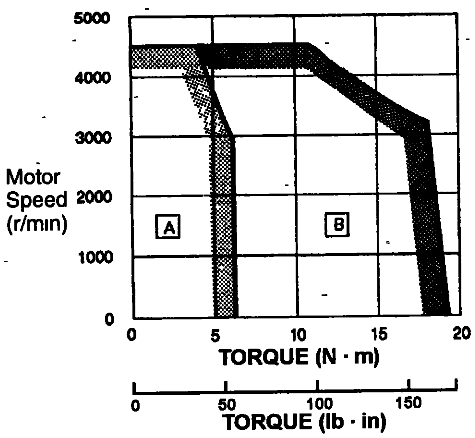
• SGMS-10V□D



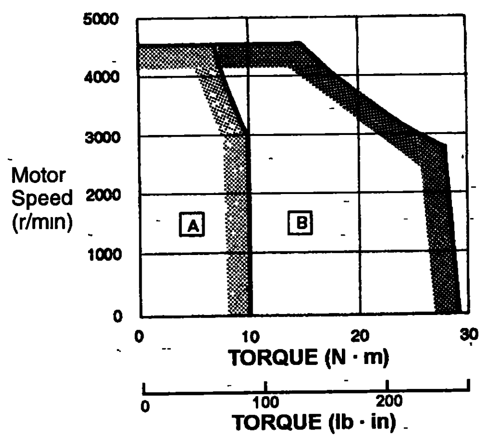
• SGMS-15V□D



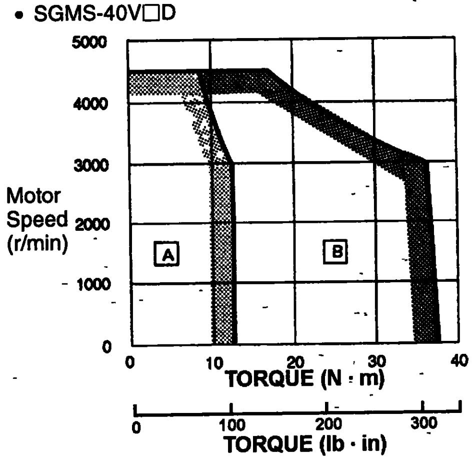
• SGMS-20V□D



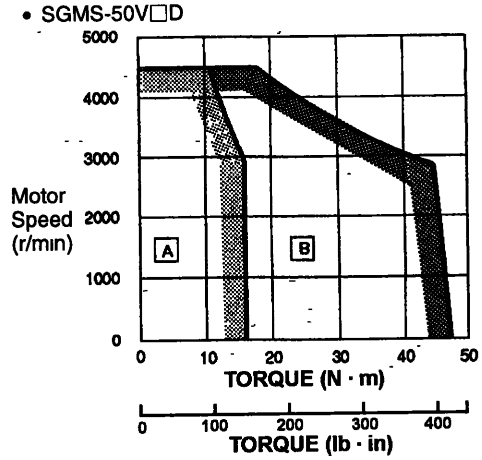
• SGMS-30V□D



• SGMS-40V□D



• SGMS-50V□D



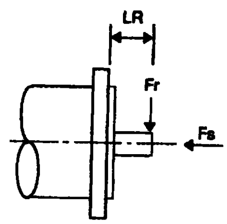
A: Continuous Duty Zone
B: Intermittent Duty Zone

4.2.2 Mechanical Characteristics

1) Allowable Radial Load, Allowable Thrust Load

The output shaft allowable loads for SGM□ Servomotor are shown below.

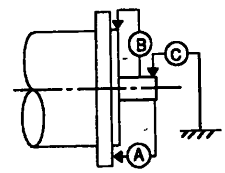
Conduct mechanical design such that the thrust loads and radial loads do not exceed the values stated below.

Servomotor Type	Allowable Radial Load Fr [N(lb)]	Allowable Thrust Load Fs [N(lb)]	LR mm (in.)	Reference Diagram
SGMG-05V□D	490 (110)	98 (22)	58 (2.28)	
-09V□D	490 (110)	98 (22)		
-13V□D	686 (154)	343 (77)		
-20V□D	1176 (265)	490 (110)	79 (3.11)	
-30V□D	1470 (331)	490 (110)		
-44V□D	1470 (331)	490 (110)		
SGMS-10V□D	686 (154)	196 (44)	45 (1.77)	
-15V□D	686 (154)	196 (44)		
-20V□D	686 (154)	196 (44)		
-30V□D	980 (221)	392 (88)	63 (2.48)	
-44V□D	1176 (265)	392 (88)		
-50V□D	1176 (265)	392 (88)		

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

2) Mechanical Tolerance

The tolerances of the SGM□ Servomotor output shaft and installation are shown in the table below.

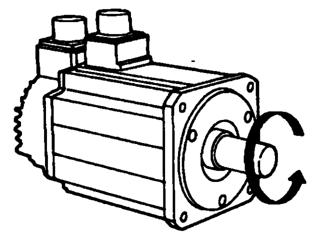
Tolerance (T.I.R.)		Reference Diagram
Perpendicularity between flange face and output shaft (A)	0.04mm (0.0016in.)	
Mating concentricity of flange O.D. (B)	0.04mm (0.0016in.)	
Run-out at end of shaft (C)	0.02mm (0.00079in.)	

Note 1) T.I.R. = Total Indicator Reading

2) As for the to lerance (C), refer to the each dimensional drawing.

3) Direction of Motor Rotation

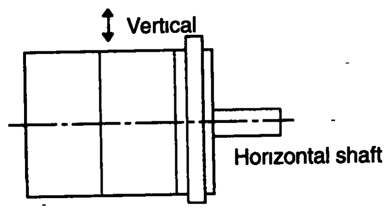
Positive rotation of the servomotor is counter-clockwise, viewing from the drive end.



4) Impact Resistance

Mount the servomotor with the axis horizontal. The servomotor must withstand the following vertical impacts.

- Impact Acceleration: 490 m/s^2 (50 G)
- Number of Impacts: 2

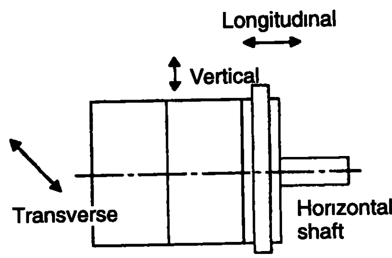


NOTE In SGM□ Servomotors, an accurate detector is attached to the shaft at the opposite end from the load.
Avoid applying impacts directly to the shaft as these may damage the detector.

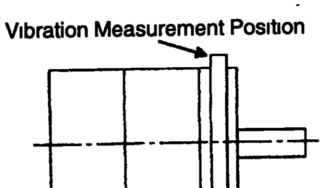
5) Vibration Resistance

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 (2.5 G)



6) Vibration Class



The SGM□ Servomotor meets the following **vibration class** at rated speed.

- Vibration Class: 15μm or below

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.

4.3 Servopack Ratings and Specifications

This section presents tables of SGDC Servopack ratings and specifications.

4.3.1 Combined Specifications

1) The following table shows the specifications obtained when SGDC Servopacks are combined with SGMG and SGMS Servomotors:

SGMG	Servopack SGDC-		05DSA	10DSA	15DSA	20DSA	30DSA	50DSA	
	Motor	Type SGMG-	05V□D	09V□D	13V□D	20V□D	30V□D	44V□D	---
		Capacity kW	0.45	0.85	1.3	1.8	2.9	4.4	---
		Rated/Max. Motor Speed r/min	1500/3000						
	Applicable Encoder		Standard: Incremental encoder (8192 P/R)						
	Continuous Output Current A (rms)		1.9	3.5	5.4	8.4	11.9	16.5	---
	Max. Output Current A (rms)		5.5	8.5	14	20	28	40.5	---
	Allowable Load Inertia* J_L kg m$^2\times10^{-4}$ (lb in s$^2\times10^{-3}$)		36.2 (32.0)	69.5 (61.5)	103 (91.2)	159 (141)	230 (204)	338 (299)	---
SGMS	Servopack SGDC-		---	10DSA	15DSA	20DSA	30DSA	50DSA	
	Motor	Type SGMS-	---	10V□D	15V□D	20V□D	30V□D	40V□D	50V□D
		Capacity kW	---	1.0	1.5	2.0	3.0	4.0	5.0
		Rated/Max. Motor Speed r/min	3000/4500						
	Applicable Encoder		Standard: Incremental encoder (4096 P/R)						
	Continuous Output Current A (rms)		---	2.8	4.7	6.2	8.9	12.2	13.8
	Max. Output Current A (rms)		---	8.5	14	19.5	28	38	42
	Allowable Load Inertia* J_L kg·m$^2\times10^{-4}$ (lb in s$^2\times10^{-3}$)		---	8.7 (7.7)	12.4 (11.0)	16.0 (14.2)	35.0 (31.0)	48.0 (42.5)	61.5 (54.4)

*Allowable load inertia is five times the motor inertia for SGMG and SGMS.

4.3.2 Ratings and Specifications

1) The ratings and specifications of the SGDC Servopack are shown below. Refer to them as required when selecting a Servopack.

2) Ratings and Specifications of SGDC Servopack

SERVOPACK Type: SGDC-			05DSA	10DSA	15DSA	20DSA	30DSA	50DSA
Servomotor		SGMG- (1500 r/min)	05V	09V	13V	20V	30V	44V
		SGMS-	–	10V	15V	20V	30V	40V/50V
Basic Specifications	Input Power Supply	Main Circuit	560 to 650 VDC +10% to –15%					
		Control Circuit	24 VDC 0.5 A					
	Control Mode		Three-phase, full-wave rectification IGBT PWM (sine-wave driven)					
	Feedback		Incremental encoder, absolute encoder					
	Location	Ambient/Storage Temp.*1	Base mount tupe: 0 to 45°C Duck ventilation type: 0 to 55°C in panel 0 to 45°C at duct side out of panel					
		Storage temperature	–20 to 70°C					
		Ambient/Storage Humidity	90% RH or less (no-condensing)					
		Vibration/Shock Resistance	4.9 m/s^2 /19.6 m/s^2					
		Cooling Condition	Forced air cooling at heatsink section Velocity of wind: 2.5 m/s or more					
	Structure		Duct ventilatoin type (base mounted available as option)					
	Applicable Load GD^2		5 times of motor GD^2 or less					
	Approx. mass	kg	3.5			3.7		4.3
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*2	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		150 Hz (at $J_L=J_M$)					
	Accel/Decel Time Setting		0 to 10 s					
Input Signal	Speed Reference	Reference Voltage*3	±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*3	±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					
	Contact Speed Reference	Rotation Direction Selection	Uses P control signal					
		Speed Selection	Forward/reverse rotation current control signals are used (1st to 3rd speed selection).When both signals are OFF, the motor stops or enters another control mode.					

4.3.2 Ratings and Specifications cont.

SERVOPACK Type: SGDC-			05DSA	10DSA	15DSA	20DSA	30DSA	50DSA
I/O Signals	Position Output	Output Form	Phases A, B and C: Line driver output					
		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, reverse rotation current limit (or contact input speed control mode)					
	Sequence Output		Servo alarm, alarm code (3-bits)					
		Any 2 of those signals	Positioning complete (speed coincidence), TGON, servo ready, current limit, brake release, overload detected, overload alarm					

Converter Type: JUSP-ACP			08GD	15GD	30GD
Basic Specifications	Input Power Supply	Main Circuit	Three-phase 400 to 460 VAC +10 to –15% 50/60 Hz		
		Control Circuit	Single-phase 200 to 230 VAC +10 to –15% 50/60 Hz		
		Capacity*1 KVA	4.7	9.4	18.8
	Main Circuit	Continuous Output Voltage	560 to 650 VDC +10 to –15%		
		Continous Output Current A	8	15	30
	Control Circuit	Continous Output	24 VDC 3.5 A		
	Location	Ambient Temperature*2	Base mount type: 0 to 45°C Duct ventilation type: 0 to 55°C in panel 0 to 45°C at duct side out of panel		
		Storage Temperature	–20 to 70°C		
		Ambient/Storage Humidity	90% RH or less (non-condensing)		
		Vibration/Shock Resistance	4.9 m/s²/19.6 m/s²		
		Cooling Conditoin	Forced air cooling at heatsink section Velocity of wind: 2.5 m/s or more		
	Structure		Duct ventilation type (base mounted available as option)		
	Approx. Mass kg		2.8	5	9
Built-in Functions	Regenerative Processing		Incorporated (30 Ω)	External regenerative resister must be mounted (16 Ω)	External regenerative resister must be mounted (8 Ω)
	Protection		Regenerative error, main circuit voltage error, power lines open phase		
	LED Display		CHARGE, READY		
	Analog Monitor (5CN)		Same analog monitor signal as 1CN is available.		
Applicable Range*3	Max. Axes Number		Max. 6 axes SERVOPACK can be connected.		
	Approx. Total Connected Motor Capacity kW		3.5	7	14
	Standard for Safety		UL508C (Open type, contaminated rank 2) EC machine instructions, EMC directives		

*1 Capacity is at rated output.

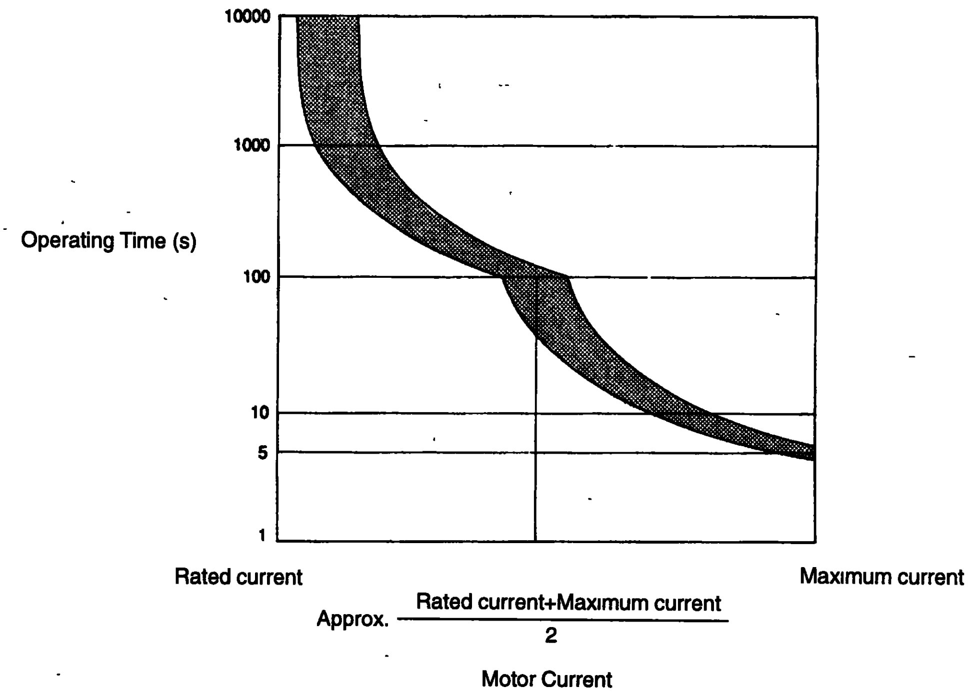
*2 The ambient temperature must be within the specified range. Even if the Converter is installing in the panel, the temperature inside the panel must not exceed the range.

*3 Determined at 70% continous output of total connected motor capacity.

4.3.3 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

Hot Start

Indicates that both Servopack and Servomotor have run long enough at rated load to be thermally saturated.

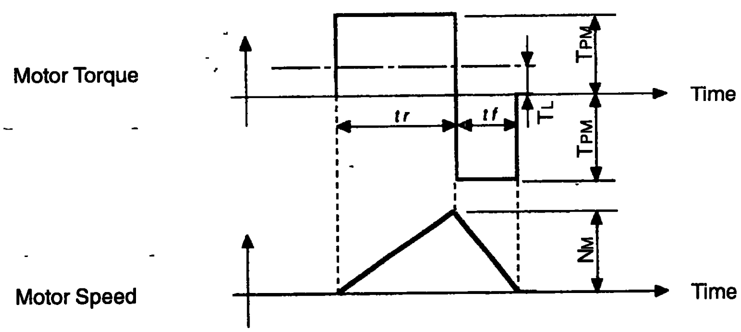
4.3.4 Starting Time and Stopping Time

1) 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]

N_M: Motor speed used (r/min.)
J_M: Motor moment of inertia (kg·m^2) .... ($GD^2{}_M/4$)
J_L: Load converted to shaft moment of inertia (kg·m^2) .... ($GD^2{}_L/4$)
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

4.3.5 Load Inertia

1) The larger the load inertia becomes, the worse the movement response of the load. The size of the load inertia (J_L) allowable when using a Servomotor must not exceed five times the motor inertia (J_M).
If the load inertia exceeds five times the motor inertia, an overvoltage alarm may arise during deceleration. To prevent this, take one of the following actions:

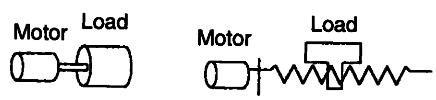
   1) Reduce the torque limit value.

   2) Reduce the slope of the deceleration curve.

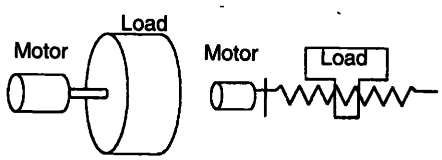
   3) Reduce the maximum motor speed.

   4) Consult your Yaskawa representative.

- Small Load Inertia



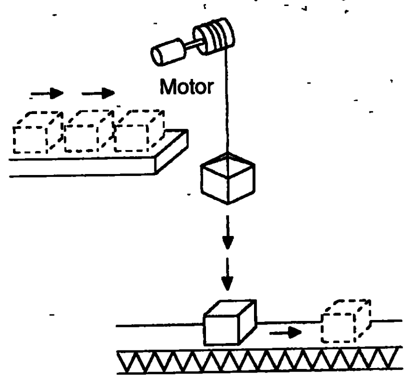
- Large Load Inertia



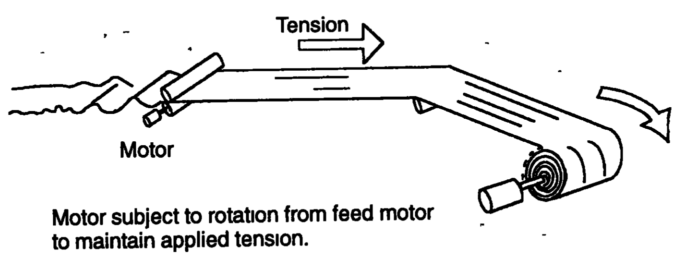
4.3.6 Overhanging Loads

1) A Servomotor may not be operated under an overhanging load, that is a load which tends to continually rotate the motor.
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 SGDC 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



4.4 Σ-Series Dimensional Drawings

This section presents dimensional drawings of the Σ-Series Servomotor, Servopack, and Digital Operator.

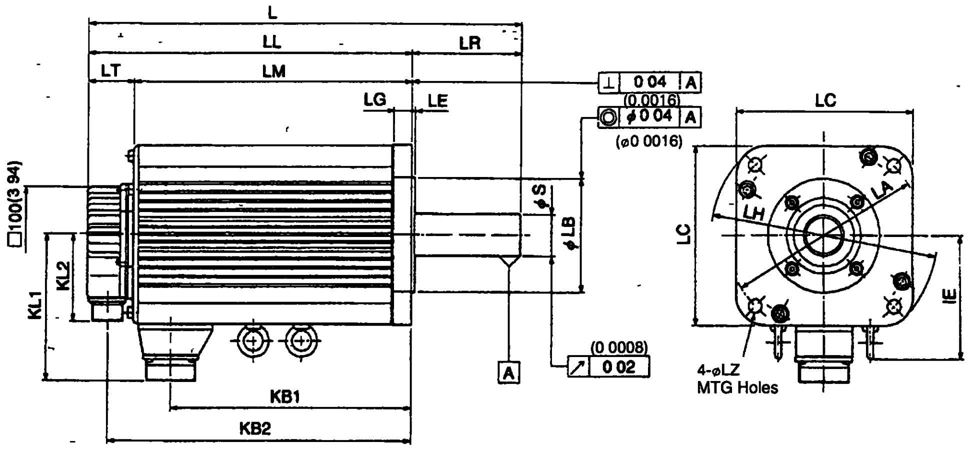
4.4.1 Servomotor Dimensional Drawings

The dimensional drawings of the SGMG and SGMS Servomotors are shown on the following pages.
The dimensional drawings of each Servomotor series are broadly divided into two types, according to the detector type (incremental or absolute encoder) and the presence or absence of a brake.

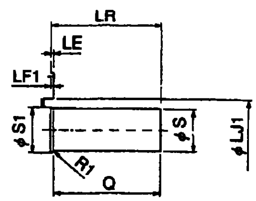
4

1) SGMG-□□V□D Servomotor (1500 r/min)

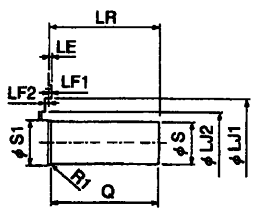
(1) Incremental encoder (8192 P/R)



Detailed View of Shaft End for SGMG-05V2D to -13V2D



Detailed View of Shaft End for SGMG-20V2D to -44V2D



in mm (inches)

Type SGMG-	L	LL	LM	LR	LT	KB1	KB2	IE	KL1	KL2
05V2D	196 (7.72)	138 (5.43)	92 (3.62)	58 (2 28)	46 (1.81)	65 (2.56)	117 (4.61)	–	109 (4.29)	88 (3.46)
09V2D	219 (8.62)	161 (6.34)	115 (4.53)	58 (2.28)	46 (1.81)	88 (3.46)	140 (5.51)	–	109 (4.29)	88 (3.46)
13V2D	243 (9.57)	185 (7.28)	139 (5.47)	58 (2.28)	46 (1.81)	112 (4.41)	164 (6.46)	–	109 (4.29)	88 (3.46)
20V2D	245 (9.65)	166 (6.54)	119 (4.69)	79 (3.11)	47 (1.85)	89 (3.50)	145 (5.71)	–	140 (5.51)	88 (3.46)
30V2D	271 (10.67)	192 (7.56)	145 (5.71)	79 (3.11)	47 (1.85)	115 (4.53)	171 (6.73)	–	140 (5.51)	88 (3.46)
44V2D	305 (12.01)	226 (8.90)	179 (7.05)	79 (3.11)	47 (1.85)	149 (5.87)	205 (8.07)	–	140 (5.51)	88 (3.46)

in mm (inches)

Type SGMG-	Flange dimensions										
	LA	LB	LC	LE	LF1	LF2	LG	LH	LJ1	LJ2	LZ
05V2D	145 (5.71)	$110^{\ 0}_{-0.035}$ ($4.33^{\ 0}_{-0.0014}$)	130 (5.12)	6 (0.24)	6 (0.24)	–	12 (0.47)	165 (6.50)	45 (1.77)	–	9 (0.35)
09V2D	145 (5.71)	$110^{\ 0}_{-0.035}$ ($4.33^{\ 0}_{-0.0014}$)	130 (5.12)	6 (0.24)	6 (0.24)	–	12 (0.47)	165 (6.50)	45 (1.77)	–	9 (0.35)
13V2D	145 (5.71)	$110^{\ 0}_{-0.035}$ ($4.33^{\ 0}_{-0.0014}$)	130 (5.12)	6 (0.24)	6 (0.24)	–	12 (0.47)	165 (6.50)	45 (1.77)	–	9 (0.35)
20V2D	200 (7.87)	$114.3^{\ 0}_{-0.025}$ ($4.50^{\ 0}_{-0.0010}$)	180 (7.09)	3.2 (0.13)	3 (0.12)	0.5 (0.0197)	18 (0.71)	230 (9.06)	76 (2.99)	62 (2.44)	13.5 (0.53)
30V2D	200 (7.87)	$114.3^{\ 0}_{-0.025}$ ($4.50^{\ 0}_{-0.0010}$)	180 (7.09)	3.2 (0.13)	3 (0.12)	0.5 (0.0197)	18 (0.71)	230 (9.06)	76 (2.99)	62 (2.44)	13.5 (0.53)
44V2D	200 (7.87)	$114.3^{\ 0}_{-0\ 025}$ ($4.50^{\ 0}_{-0.0010}$)	180 (7.09)	3.2 (0.13)	3 (0.12)	0.5 (0.0197)	18 (0.71)	230 (9.06)	76 (2.99)	62 (2.44)	13.5 (0.53)

in mm (inches)

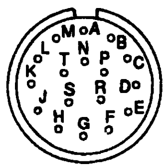
Type SGMG-	Shaft end dimensions S	S1	Q	Approx. mass kg (lb)
05V2D	$19^{\ 0}_{-0.013}$ ($0.75^{\ 0}_{-0.0005}$)	30 (1.18)	40 (1.57)	5.5 (12.12)
09V2D	$19^{\ 0}_{-0.013}$ ($0.75^{\ 0}_{-0.0005}$)	30 (1.18)	40 (1.57)	7.6 (16.75)
13V2D	$22^{\ 0}_{-0.013}$ ($0.87^{\ 0}_{-0.0005}$)	30 (1.18)	40 (1.57)	9.6 (21.16)
20V2D	$35^{+0.01}_{\ 0}$ ($1.38^{+0.0004}_{\ 0}$)	45 (1.77)	76 (2.99)	14 (30.86)
30V2D	$35^{+0.01}_{\ 0}$ ($1.38^{+0.0004}_{\ 0}$)	45 (1.77)	76 (2.99)	18 (39.68)
44V2D	$35^{+0.01}_{\ 0}$ ($1.38^{+0.0004}_{\ 0}$)	45 (1.77)	76 (2.99)	23 (50.69)

Note 1) Incremental encoder (8192 P/R) is used as a detector.

2) These Servomotors do not contain eyebolts.

- Connector Wiring on Detector Side

Receptacle: 97F3102E20-29
Plug (To be prepared by customer): JA08A-20-29S-J1-EB
Cable Clamp (To be prepared by customer): JL04-2022CKE(□□)

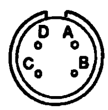


Encoder Wiring Specifications

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	0V	S	
H	+5V DC	T	
J	FG (Frame Ground)		

Note These are general specifications when an incremental encoder is used.

- Connector Wiring on Motor Side



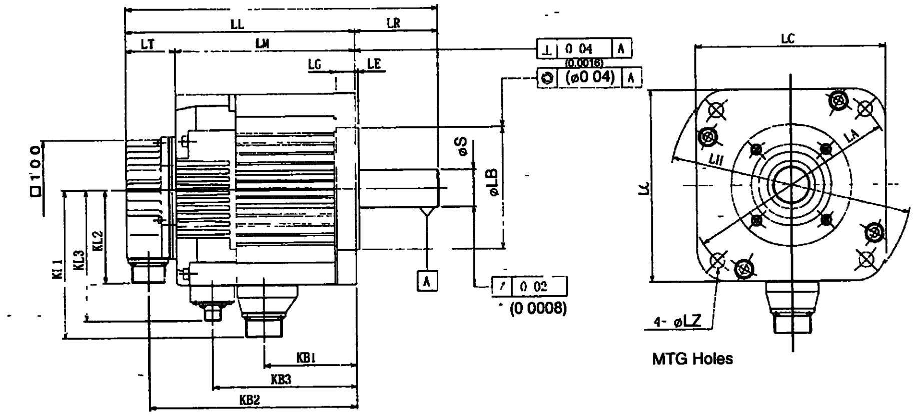
Motor Wiring Specifications

A	U phase
B	V phase
C	W phase
D	FG (Frame Ground)

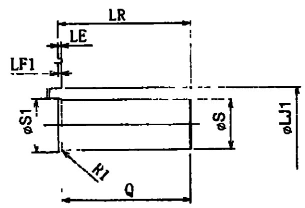
Note Receptacle, plug and cable clamp differ depending on the capacity. Refer to 3) Connectors on Detector and Motor Sides (page 210).

(2) Incremental encoder (8192 P/R) with brake

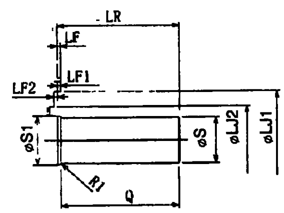
- 0.5 to 4.4kW



Detailed View of Shaft End for SGMG-05V2DAB to -13V2DAB



Detailed View of Shaft End for SGMG-20V2DAB to -44V2DAB



in mm (inches)

Type SGMG-	L	LL	LM	LR	LT	KB1	KB2	KB3	KL1	KL2	KL3
05V2DAC	234 (9.21)	176 (6.93)	129 (5.08)	58 (2.28)	47 (1.85)	65 (2.56)	155 (2.20)	109 (4.29)	109 (4.29)	88 (3.46)	98 (3.86)
09V2DAC	257 (10.12)	199 (7.83)	152 (5.98)	58 (2.28)	47 (1.85)	88 (3.46)	178 (7.01)	132 (5.20)	109 (4.29)	88 (3.46)	98 (3.86)
13V2DAC	281 (11.06)	223 (8.78)	176 (6.93)	58 (2.28)	47 (1.85)	112 (4.41)	202 (7.95)	156 (6.14)	109 (4.29)	88 (3.46)	98 (3.86)
20V2DAC	296 (11.65)	217 (8.54)	170 (6.69)	79 (3.11)	47 (1.85)	89 (3.50)	196 (7.72)	137 (5.39)	140 (5.51)	88 (3.46)	123 (4.84)
30V2DAC	322 (12.68)	243 (9.57)	196 (7.72)	79 (3.11)	47 (1.85)	115 (4.53)	222 (8.74)	163 (6.42)	140 (5.51)	88 (3.46)	123 (4.84)
44V2DAC	356 (14.02)	277 (10.91)	230 (9.06)	79 (3.11)	47 (1.85)	149 (5.87)	256 (10.08)	196 (7.72)	140 (5.51)	88 (3.46)	123 (4.84)

in mm (inches)

Type SGMG-	Flange dimensions									
	LA	LB	LC	LE	LF1	LF2	LG	LH	LJ1	LJ2	LZ
05V2DAC	145 (5.71)	$110^{\ 0}_{-0.035}$ ($4.33^{\ 0}_{-0.0014}$)	130 (5.12)	6 (0.24)	6 (0.24)	–	12 (0.47)	165 (6.5)	45 (1.77)	–	9 (0.35)
09V2DAC	145 (5.71)	$110^{\ 0}_{-0.035}$ ($4.33^{\ 0}_{-0.0014}$)	130 (5.12)	6 (0.24)	6 (0.24)	–	12 (0.47)	165 (6.5)	45 (1.77)	–	9 (0.35)
13V2DAC	145 (5.71)	$110^{\ 0}_{-0.035}$ ($4.33^{\ 0}_{-0.0014}$)	130 (5.12)	6 (0.24)	6 (0.24)	–	12 (0.47)	165 (6.5)	45 (1.77)	–	9 (0.35)
20V2DAC	200 (7.87)	$114.3^{\ 0}_{-0.025}$ ($4.50^{\ 0}_{-0.0010}$)	180 (7.09)	3.2 (0.13)	3 (0.12)	0.5 (0.0197)	18 (0.71)	230 (9.06)	76 (2.99)	62 (2.44)	13.5 (0.53)
30V2DAC	200 (7.87)	$114.3^{\ 0}_{-0.025}$ ($4.50^{\ 0}_{-0.0010}$)	180 (7.09)	3.2 (0.13)	3 (0.12)	0.5 (0.0197)	18 (0.71)	230 (9.06)	76 (2.99)	62 (2.44)	13.5 (0.53)
44V2DAC	200 (7.87)	$114.3^{\ 0}_{-0.025}$ ($4.50^{\ 0}_{-0.0010}$)	180 (7.09)	3.2 (0.13)	3 (0.12)	0.5 (0.0197)	18 (0.71)	230 (9.06)	76 (2.99)	62 (2.44)	13.5 (0.53)

in mm (inches)

Type SGMG-	Shaft end dimensions			Approx. mass kg (lb)
	S	S1	Q	
05V2DAC	$19^{\ 0}_{-0.013}$ $(0.75^{\ 0}_{-0.0005})$	30 (1.18)	40 (1.57)	7.5 (16.53)
09V2DAC	$19^{\ 0}_{-0.013}$ $(0.75^{\ 0}_{-0.0005})$	30 (1.18)	40 (1.57)	9.6 (21.16)
13V2DAC	$22^{\ 0}_{-0.013}$ $(0.87^{\ 0}_{-0.0005})$	30 (1.18)	40 (1.57)	12 26.45)
20V2DAC	$35^{+0.01}_{\ 0}$ $(1.38^{+0.0004}_{\ 0})$	45 (1.77)	76 (2.99)	19 (41.88)
30V2DAC	$35^{+0.01}_{\ 0}$ $(1.38^{+0.0004}_{\ 0})$	45 (1.77)	76 (2.99)	23.5 (51.79)
44V2DAC	$35^{+0.01}_{\ 0}$ $(1.38^{+0.0004}_{\ 0})$	45 (1.77)	76 (2.99)	28.5 (62.81)

Note Incremental encoder (8192 P/R) is used as a detector.

- Motor Connector Wiring

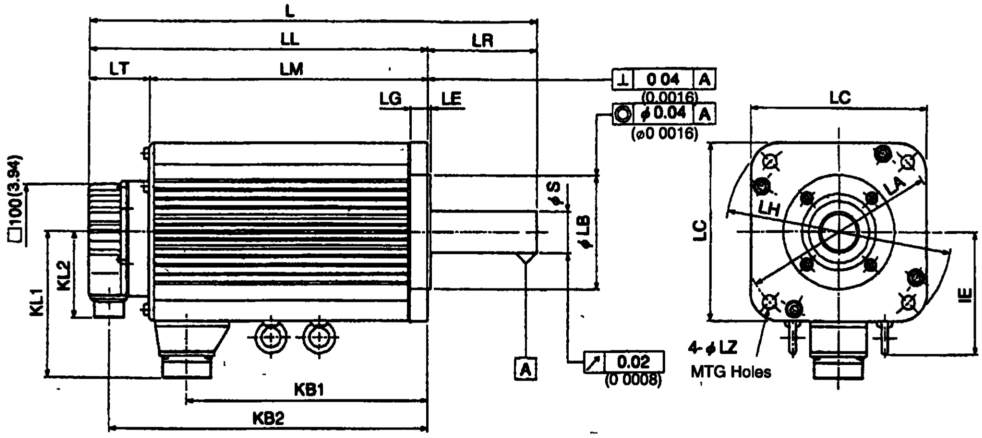
A	U phase
B	V phase
C	W phase
D	Frame ground (FG)

- Brake Connector Wiring

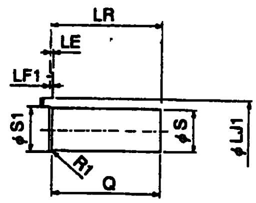
A	Brake terminal
B	Brake terminal
C	

- As for connector wiring on detector side, refer to page 185.

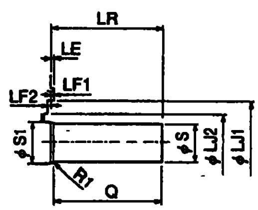
(3) Absolute encoder (15bit : 8192 P/R)



Detailed View of Shaft End for SGMG-05VSD to -13VSD



Detailed View of Shaft End for SGMG-20VSD to -44VSD



in mm (inches)

Type SGMG-	L	LL	LM	LR	LT	KB1	KB2	IE	KL1	KL2
05VSD	210 (8.27)	152 (5.98)	92 (3.62)	58 (2.28)	60 (2.36)	65 (2.56)	131 (5.16)	–	109 (4.29)	88 (3.46)
09VSD	233 (9.17)	175 (6.89)	115 (4.53)	58 (2.28)	60 (2.36)	88 (3.46)	154 (6.06)	–	109 (4.29)	88 (3.46)
13VSD	257 (10.12)	199 (7.83)	139 (5.47)	58 (2.28)	60 (2.36)	112 (4.41)	178 (7.01)	–	109 (4.29)	88 (3.46)
20VSD	259 (10.20)	180 (7.09)	119 (4.69)	79 (3.11)	61 (2.40)	89 (3.50)	159 (6.26)	–	140 (5.51)	88 (3.46)
30VSD	285 (11.22)	206 (8.11)	145 (5.71)	79 (3.11)	61 (2.40)	115 (4.53)	185 (7.28)	–	140 (5.51)	88 (3.46)
44VSD	319 (12.56)	240 (9.45)	179 (7.05)	79 (3.11)	61 (2.40)	149 (5.87)	219 (8.62)	–	140 (5.51)	88 (3.46)

4.4.1 Servomotor Dimensional Drawings cont.

in mm (inches)

Type SGMG-	Flange dimensions										
	LA	LB	LC	LE	LF1	LF2	LG	LH	LJ1	LJ2	LZ
05VSD	145 (5.71)	$110^{0}_{-0.035}$ ($4.33^{0}_{-0.0014}$)	130 (5.12)	6 (0.24)	6 (0.24)	–	12 (0.47)	165 (6.50)	45 (1.77)	–	9 (0.35)
09VSD	145 (5.71)	$110^{0}_{-0.035}$ ($4.33^{0}_{-0.0014}$)	130 (5.12)	6 (0.24)	6 (0.24)	–	12 (0.47)	165 (6.50)	45 (1.77)	–	9 (0.35)
13VSD	145 (5.71)	$110^{0}_{-0.035}$ ($4.33^{0}_{-0.0014}$)	130 (5.12)	6 (0.24)	6 (0.24)	–	12 (0.47)	165 (6.50)	45 (1.77)	–	9 (0.35)
20VSD	200 (7.87)	$114.3^{0}_{-0.025}$ ($4.50^{0}_{-0.0010}$)	180 (7.09)	3.2 (0.13)	3 (0.12)	0.5 (0.0197)	18 (0.71)	230 (9.06)	76 (2.99)	62 (2.44)	13.5 (0.53)
30VSD	200 (7.87)	$114.3^{0}_{-0.025}$ ($4.50^{0}_{-0.0010}$)	180 (7.09)	3.2 (0.13)	3 (0.12)	0.5 (0.0197)	18 (0.71)	230 (9.06)	76 (2.99)	62 (2.44)	13.5 (0.53)
44VSD	200 (7.87)	$114.3^{0}_{-0.025}$ ($4.50^{0}_{-0.0010}$)	180 (7.09)	3.2 (0.13)	3 (0.12)	0.5 (0.0197)	18 (0.71)	230 (9.06)	76 (2.99)	62 (2.44)	13.5 (0.53)

4

in mm (inches)

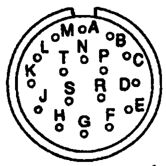
Type SGMG-	Shaft end dimensions S	S1	Q	Approx. mass kg (lb)
05VSD	$19^{\ 0}_{-0.013}$ $(0.75^{\ 0}_{-0.0005})$	30 (1.18)	40 (1.57)	5.9 (13.00)
09VSD	$19^{\ 0}_{-0.013}$ $(0.75^{\ 0}_{-0.0005})$	30 (1.18)	40 (1.57)	8.0 (17.63)
13VSD	$22^{\ 0}_{-0.013}$ $(0.87^{\ 0}_{-0.0005})$	30 (1.18)	40 (1.57)	10 (22.04)
20VSD	$35^{+0.01}_{\ 0}$ $(1.38^{+0.0004}_{\ 0})$	45 (1.77)	76 (2.99)	14 (30.86)
30VSD	$35^{+0.01}_{\ 0}$ $(1.38^{+0.0004}_{\ 0})$	45 (1.77)	76 (2.99)	18.5 (40.77)
44VSD	$35^{+0.01}_{\ 0}$ $(1.38^{+0.0004}_{\ 0})$	45 (1.77)	76 (2.99)	24 (52.90)

Note 1) Absolute encoder (15bit : 8192 P/R) is used as a detector.

2) These Servomotors do not contain eyebolts.

- Connector Wiring on Detector Side

Receptacle: 97F3102E20-29P
Plug (To be prepared by customer): JA08A-20-29S-J1-EB
Cable Clamp (To be prepared by customer): JL04-2022CKE(□□)

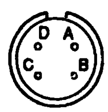


Encoder Wiring Specifications

A	A channel output	K	
B	/A channel output	L	
C	B channel output	M	
D	/B channel output	N	
E	Z (C) channel output	P	
F	/Z (C) channel output	R	Reset
G	0V	S	0V (battery)
H	+5V DC	T	3.6V (battery)
J	FG (Frame Ground)		

Note These are general specifications when an absolute encoder is used.

- Connector Wiring on Motor Side



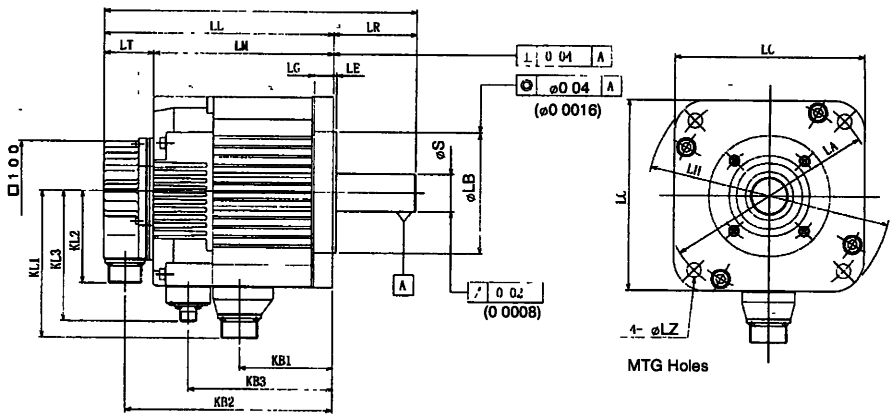
Motor Wiring Specifications

A	U phase
B	V phase
C	W phase
D	FG (Frame Ground)

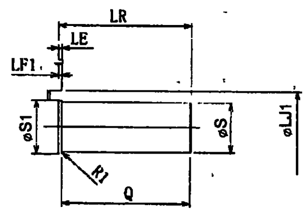
Note Receptacle, plug and cable clamp differ depending on the capacity. Refer to 3) Connectors on Detector and Motor Sides (page 210).

(4) Absolute encoder (15bit : 8192 P/R), with brake

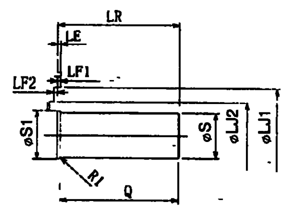
- 0.5 to 4.4kW



Detailed View of Shaft End for SGMG-05VSDAC to -13VSDAC



Detailed View of Shaft End for SGMG-20VSDAC to -44VSDAC



4.4.1 Servomotor Dimensional Drawings cont.

in mm (inches)

Type SGMG-	L	LL	LM	LR	LT	KB1	KB2	KB3	KL1	KL2	KL3
05VSDAC	248 (9.76)	190 (7.48)	129 (5.08)	58 (2.28)	61 (2.40)	65 (2.56)	169 (6.65)	109 (4.29)	109 (4.29)	88 (3.46)	98 (3.86)
09VSDAC	271 (10.67)	213 (8.39)	152 (5.98)	58 (2.28)	61 (2.40)	88 (3.46)	192 (7.56)	132 (5.20)	109 (4.29)	88 (3.46)	98 (3.86)
13VSDAC	295 (11.61)	237 (9.33)	176 (6.93)	58 (2.28)	61 (2.40)	112 (4.41)	216 (8.50)	156 (6.14)	109 (4.29)	88 (3.46)	98 (3.86)
20VSDAC	310 (12.20)	231 (9.09)	170 (6.69)	79 (3.11)	61 (2.40)	89 (3.50)	210 (8.27)	137 (5.39)	140 (5.51)	88 (3.46)	123 (4.84)
30VSDAC	336 (13.23)	257 (10.12)	196 (7.72)	79 (3.11)	61 (2.40)	115 (4.53)	236 (9.29)	163 (6.42)	140 (5.51)	88 (3.46)	123 (4.84)
44VSDAC	370 (14.57)	291 (11.46)	230 (9.06)	79 (3.11)	61 (2.40)	149 (5.87)	270 (10.63)	196 (7.72)	140 (5.51)	88 (3.46)	123 (4.84)

in mm (inches)

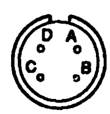
Type SGMG-	Flange dimensions										
	LA	LB	LC	LE	LF1	LF2	LG	LH	LJ1	LJ2	LZ
05VSDAC	145 (5.71)	$110^{\ 0}_{-0.035}$ ($4.33^{\ 0}_{-0.0014}$)	130 (5.12)	6 (0.24)	6 (0.24)	–	12 (0.47)	165 (6.50)	45 (1.77)	–	9 (0.35)
09VSDAC	145 (5.71)	$110^{\ 0}_{-0.035}$ ($4.33^{\ 0}_{-0.0014}$)	130 (5.12)	6 (0.24)	6 (0.24)	–	12 (0.47)	165 (6.50)	45 (1.77)	–	9 (0.35)
13VSDAC	145 (5.71)	$110^{\ 0}_{-0.035}$ ($4.33^{\ 0}_{-0.0014}$)	130 (5.12)	6 (0.24)	6 (0.24)	–	12 (0.47)	165 (6.50)	45 (1.77)	–	9 (0.35)
20VSDAC	200 (7.87)	$114.3^{\ 0}_{-0.025}$ ($4.50^{\ 0}_{-0.0010}$)	180 (7.09)	3.2 (0.13)	3 (0.12)	0.5 (0.0197)	18 (0.71)	230 (9.06)	76 (2.99)	62 (2.44)	13.5 (0.53)
30VSDAC	200 (7.87)	$114.3^{\ 0}_{-0.025}$ ($4.50^{\ 0}_{-0.0010}$)	180 (7.09)	3.2 (0.13)	3 (0.12)	0.5 (0.0197)	18 (0.71)	230 (9.06)	76 (2.99)	62 (2.44)	13.5 (0.53)
44VSDAC	200 (7.87)	$114.3^{\ 0}_{-0.025}$ ($4.50^{\ 0}_{-0.0010}$)	180 (7.09)	3.2 (0.13)	3 (0.12)	0.5 (0.0197)	18 (0.71)	230 (9.06)	76 (2.99)	62 (2.44)	13.5 (0.53)

in mm (inches)

Type SGMG-	Shaft end dimensions			Approx. mass kg (lb)
	S	S1	Q	
05VSDAC	$19^{\ 0}_{-0.013}$ $(0.75^{\ 0}_{-0.0005})$	30 (1.18)	40 (1.57)	7.9 (17.41)
09VSDAC	$19^{\ 0}_{-0.013}$ $(0.75^{\ 0}_{-0.0005})$	30 (1.18)	40 (1.57)	10 (22.04)
13VSDAC	$22^{\ 0}_{-0.013}$ $(0.87^{\ 0}_{-0.0005})$	30 (1.18)	40 (1.57)	12 (26.45)
20VSDAC	$35^{+0.01}_{\ 0}$ $(1.38^{+0.0004}_{\ 0})$	45 (1.77)	76 (2.99)	19.5 (42.98)
30VSDAC	$35^{+0.01}_{\ 0}$ $(1.38^{+0.0004}_{\ 0})$	45 (1.77)	76 (2.99)	23.5 (51.79)
44VSDAC	$35^{+0.01}_{\ 0}$ $(1.38^{+0.0004}_{\ 0})$	45 (1.77)	76 (2.99)	29 (63.92)

Note Absolute encoder (15bit : 8192 P/R) is used as a detector.

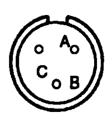
- Motor Connector Wiring



Motor Wiring Specifications

A	U phase
B	V phase
C	W phase
D	Frame ground (FG)

- Brake Connector Wiring



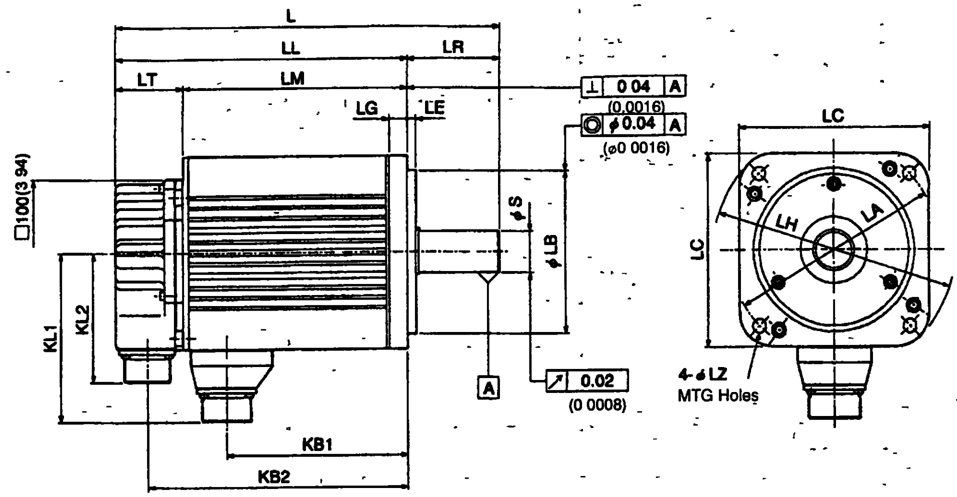
Brake Wiring Specifications

A	Brake terminal
B	Brake terminal
C	

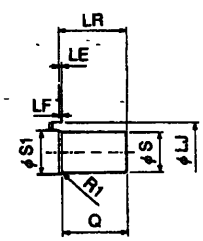
- As for connector wiring on detector side, refer to page 192.

2) SGMS-□□V□D Servomotor

(1) Incremental encoder (4096 P/R)



Detailed View of Shaft End



in mm (inches)

Type SGMS-	L	LL	LM	LR	LT	KB1	KB2	KL1	KL2
10V6D	194 (7.64)	149 (5.87)	103 (4.06)	45 (1.77)	46 (1.81)	76 (2.99)	128 (5.04)	96 (3.78)	87 (3.43)
15V6D	220 (8.66)	175 (6.89)	129 (5.08)	45 (1.77)	46 (1.81)	102 (4.02)	154 (6.06)	96 (3.78)	87 (3.43)
20V6D	243 (9.57)	198 (7.80)	152 (5.98)	45 (1.77)	46 (1.81)	125 (4.92)	177 (6.97)	96 (3.78)	87 (3.43)
30V6D	262 (10.31)	199 (7.83)	153 (6.02)	63 (2.48)	46 (1.81)	122 (4.80)	178 (7.01)	114 (4.49)	87 (3.43)
40V6D	299 (11.77)	236 (9.29)	190 (7.48)	63 (2.48)	46 (1.81)	159 (6.26)	215 (8.46)	114 (4.49)	87 (3.43)
50V6D	339 (13.35)	276 (10.87)	230 (9.06)	63 (2.48)	46 (1.81)	199 (7.83)	255 (10.04)	114 (4.49)	87 (3.43)

in mm (inches)

Type SGMS-	Flange dimensions								
	LA	LB	LC	LE	LF	LG	LH	LJ	LZ
10V6D	115 (4.53)	$95^{\ 0}_{-0.035}$ ($3.74^{\ 0}_{-0.0014}$)	100 (3.94)	3 (0.12)	3 (0.12)	10 (0.39)	130 (5.12)	45 (1.77)	7 (0.28)
15V6D	115 (4.53)	$95^{\ 0}_{-0.035}$ ($3.74^{\ 0}_{-0.0014}$)	100 (3.94)	3 (0.12)	3 (0.12)	10 (0.39)	130 (5.12)	45 (1.77)	7 (0.28)
20V6D	115 (4.53)	$95^{\ 0}_{-0.035}$ ($3.74^{\ 0}_{-0.0014}$)	100 (3.94)	3 (0.12)	3 (0.12)	10 (0.39)	130 (5.12)	45 (1.77)	7 (0.28)
30V6D	145 (5.71)	$110^{\ 0}_{-0.035}$ ($4.33^{\ 0}_{-0.0014}$)	130 (5.12)	6 (0.24)	6 (0.24)	12 (0.47)	165 (6.50)	45 (1.77)	9 (0.35)
40V6D	145 (5.71)	$110^{\ 0}_{-0.035}$ ($4.33^{\ 0}_{-0.0014}$)	130 (5.12)	6 (0.24)	6 (0.24)	12 (0.47)	165 (6.50)	45 (1.77)	9 (0.35)
50V6D	145 (5.71)	$110^{\ 0}_{-0.035}$ ($4.33^{\ 0}_{-0.0014}$)	130 (5.12)	6 (0.24)	6 (0.24)	12 (0.47)	165 (6.50)	45 (1.77)	9 (0.35)

4

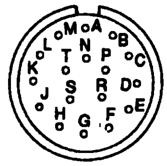
in mm (inches)

Type SGMS-	Shaft end dimensions S	S1	Q	Approx. mass kg (lb)
10V6D	$24^{\ 0}_{-0.013}$ $(0.94^{\ 0}_{-0.0005})$	30 (1.18)	40 (1.57)	4.6 (10.14)
15V6D	$24^{\ 0}_{-0.013}$ $(0.94^{\ 0}_{-0.0005})$	30 (1.18)	40 (1.57)	5.8 (12.78)
20V6D	$24^{\ 0}_{-0.013}$ $(0.94^{\ 0}_{-0.0005})$	30 (1.18)	40 (1.57)	7.0 (15.43)
30V6D	$28^{\ 0}_{-0.013}$ $(1.10^{\ 0}_{-0.0005})$	30 (1.18)	55 (2.17)	11 (24.24)
40V6D	$28^{\ 0}_{-0.013}$ $(1.10^{\ 0}_{-0.0005})$	30 (1.18)	55 (2.17)	14 (30.86)
50V6D	$28^{\ 0}_{-0.013}$ $(1.10^{\ 0}_{-0.0005})$	30 (1.18)	55 (2.17)	17 (37.47)

Note Incremental encoder (4096 P/R) is used as a detector.

• Connector Wiring on Detector Side

Receptacle: 97F3102E20-29P
Plug (To be prepared by customer): JA08A-20-29S-J1-EB
Cable Clamp (To be prepared by customer): JL04-2022CKE(□□)

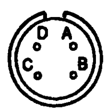


Encoder Wiring Specifications

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	0V	S	
H	+5V DC	T	
J	FG (Frame Ground)		

Note These are general specifications when an incremental encoder is used.

• Connector Wiring on Motor Side



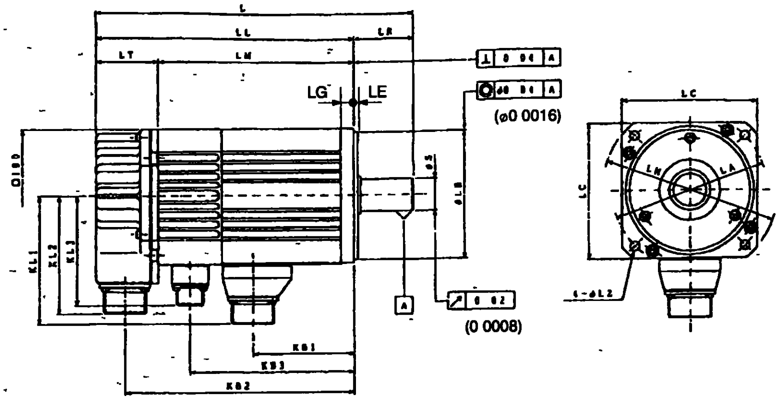
Motor Wiring Specifications

A	U phase
B	V phase
C	W phase
D	FG (Frame Ground)

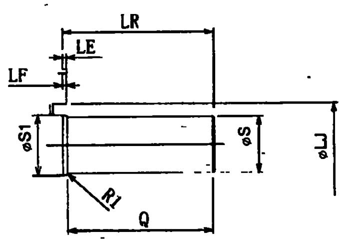
Note Receptacle, plug and cable clamp differ depending on the capacity. Refer to 3) Connectors on Detector and Motor Sides (page 210).

4.4.1 Servomotor Dimensional Drawings cont.

(2) Incremental encoder (4096 P/R), with brake



Detailed View of Shaft End



in mm (inches)

Type SGMS-	L	LL	LM	LR	LT	KB1	KB2	KB3	KL1	KL2	KL3
10V6DAC	238 (9.37)	193 (7.60)	147 (5.79)	45 (1.77)	46 (1.81)	76 (2.99)	172 (6.77)	120 (4.72)	96 (3.78)	87 (3.43)	85 (3.35)
15V6DAC	264 (10.39)	219 (8.62)	173 (6.81)	45 (1.77)	46 (1.81)	102 (4.02)	198 (7.80)	146 (5.75)	96 (3.78)	87 (3.43)	85 (3.35)
20V6DAC	287 (11.30)	242 (9.53)	196 (7.72)	45 (1.77)	46 (1.81)	125 (4.92)	221 (8.70)	169 (6.65)	96 (3.78)	87 (3.43)	85 (3.35)
30V6DAC	300 (11.81)	237 (9.33)	191 (7.52)	63 (2.48)	46 (1.81)	122 (4.80)	216 (8.50)	170 (6.69)	114 (4.49)	87 (3.43)	98 (3.86)
40V6DAC	337 (13.27)	274 (10.79)	228 (8.98)	63 (2.48)	46 (1.81)	159 (6.26)	253 (9.96)	207 (8.15)	114 (4.49)	87 (3.43)	98 (3.86)
50V6DAC	377 (14.84)	314 (12.36)	268 (10.55)	63 (2.48)	46 (1.81)	199 (7.83)	293 (11.54)	247 (9.72)	114 (4.49)	87 (3.43)	98 (3.86)

in mm (inches)

Type SGMS-	Flange dimensions								
	LA	LB	LC	LE	LF	LG	LH	LJ	LZ
10V6DAC	115 (4.53)	$95^{\ 0}_{-0.035}$ ($3.74^{\ 0}_{-0.0014}$)	100 (3.94)	3 (0.12)	3 (0.12)	10 (0.39)	130 (5.12)	45 (1.77)	7 (0.28)
15V6DAC	115 (4.53)	$95^{\ 0}_{-0.035}$ ($3.74^{\ 0}_{-0.0014}$)	100 (3.94)	3 (0.12)	3 (0.12)	10 (0.39)	130 (5.12)	45 (1.77)	7 (0.28)
20V6DAC	115 (4.53)	$95^{\ 0}_{-0.035}$ ($3.74^{\ 0}_{-0.0014}$)	100 (3.94)	3 (0.12)	3 (0.12)	10 (0.39)	130 (5.12)	45 (1.77)	7 (0.28)
30V6DAC	145 (5.71)	$110^{\ 0}_{-0.035}$ ($4.33^{\ 0}_{-0.0014}$)	130 (5.12)	6 (0.24)	6 (0.24)	12 (0.47)	165 (6.50)	45 (1.77)	9 (0.35)
40V6DAC	145 (5.71)	$110^{\ 0}_{-0.035}$ ($4.33^{\ 0}_{-0.0014}$)	130 (5.12)	6 (0.24)	6 (0.24)	12 (0.47)	165 (6.50)	45 (1.77)	9 (0.35)
50V6DAC	145 (5.71)	$110^{\ 0}_{-0.035}$ ($4.33^{\ 0}_{-0.0014}$)	130 (5.12)	6 (0.24)	6 (0.24)	12 (0.47)	165 (6.50)	45 (1.77)	9 (0.35)

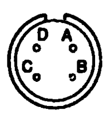
4

in mm (inches)

Type SGMS-	Shaft end dimensions S	S1	Q	Approx. mass kg (lb)
10V6DAC	$24^{\ 0}_{-0.013}$ ($0.94^{\ 0}_{-0.0005}$)	30 (1.18)	40 (1.57)	6.0 (13.22)
15V6DAC	$24^{\ 0}_{-0.013}$ ($0.94^{\ 0}_{-0.0005}$)	30 (1.18)	40 (1.57)	7.5 (16.53)
20V6DAC	$24^{\ 0}_{-0.013}$ ($0.94^{\ 0}_{-0.0005}$)	30 (1.18)	40 (1.57)	8.5 (18.73)
30V6DAC	$28^{\ 0}_{-0.013}$ ($1.10^{\ 0}_{-0.0005}$)	30 (1.18)	55 (2.17)	14 (30.86)
40V6DAC	$28^{\ 0}_{-0.013}$ ($1.10^{\ 0}_{-0.0005}$)	30 (1.18)	55 (2.17)	17 (37.47)
50V6DAC	$28^{\ 0}_{-0.013}$ ($1.10^{\ 0}_{-0.0005}$)	30 (1.18)	55 (2.17)	20 (44.08)

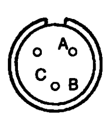
Note Incremental encoder (4096 P/R) is used as a detector.

- Motor Connector Wiring Specifications



A	U phase
B	V phase
C	W phase
D	Frame ground (FG)

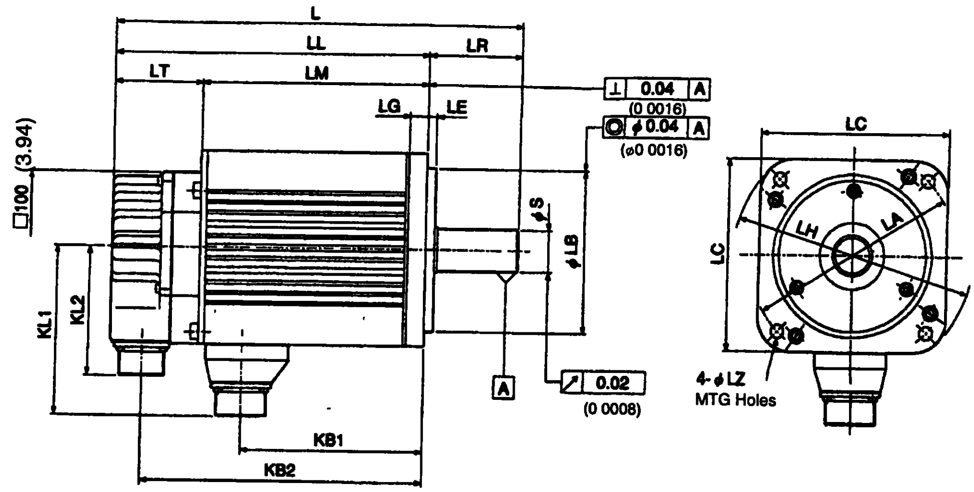
- Brake Connector Wiring



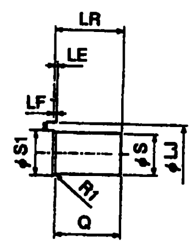
A	Brake terminal
B	Brake terminal
C	

- As for connector wiring on detector side, refer to page 199.

(3) Absolute encoder (15 bit : 8192 P/R)



Detailed View of Shaft End



in mm (inches)

Type SGMS-	L	LL	LM	LR	LT	KB1	KB2	KL1	KL2
10VSD	208 (8.19)	163 (6.42)	103 (4.06)	45 (1.77)	60 (2.36)	76 (2.99)	142 (5.59)	96 (3.78)	87 (3.43)
15VSD	234 (9.21)	189 (7.44)	129 (5.08)	45 (1.77)	60 (2.36)	102 (4.02)	168 (6.61)	96 (3.78)	87 (3.43)
20VSD	257 (10.12)	212 (8.35)	152 (5.98)	45 (1.77)	60 (2.36)	125 (4.92)	191 (7.52)	96 (3.78)	87 (3.43)
30VSD	276 (10.87)	213 (8.39)	153 (6.02)	63 (2.48)	60 (2.36)	122 (4.80)	192 (7.56)	114 (4.49)	87 (3.43)
40VSD	313 (12.32)	250 (9.84)	190 (7.48)	63 (2.48)	60 (2.36)	159 (6.26)	229 (9.02)	114 (4.49)	87 (3.43)
50VSD	353 (13.90)	290 (11.42)	230 (9.06)	63 (2.48)	60 (2.36)	199 (7.83)	269 (10.59)	114 (4.49)	87 (3.43)

in mm (inches)

Type SGMS-	Flange dimensions								
	LA	LB	LC	LE	LF	LG	LH	LJ	LZ
10VSD	115 (4.53)	$95^{\ 0}_{-0.035}$ ($3.74^{\ 0}_{-0.0014}$)	100 (3.94)	3 (0.12)	3 (0.12)	10 (0.39)	130 (5.12)	45 (1.77)	7 (0.28)
15VSD	115 (4.53)	$95^{\ 0}_{-0.035}$ ($3.74^{\ 0}_{-0.0014}$)	100 (3.94)	3 (0.12)	3 (0.12)	10 (0.39)	130 (5.12)	45 (1.77)	7 (0.28)
20VSD	115 (4.53)	$95^{\ 0}_{-0.035}$ ($3.74^{\ 0}_{-0.0014}$)	100 (3.94)	3 (0.12)	3 (0.12)	10 (0.39)	130 (5.12)	45 (1.77)	7 (0.28)
30VSD	145 (5.71)	$110^{\ 0}_{-0.035}$ ($4.33^{\ 0}_{-0.0014}$)	130 (5.12)	6 (0.24)	6 (0.24)	12 (0.47)	165 (6.50)	45 (1.77)	9 (0.35)
40VSD	145 (5.71)	$110^{\ 0}_{-0.035}$ ($4.33^{\ 0}_{-0.0014}$)	130 (5.12)	6 (0.24)	6 (0.24)	12 (0.47)	165 (6.50)	45 (1.77)	9 (0.35)
50VSD	145 (5.71)	$110^{\ 0}_{-0.035}$ ($4.33^{\ 0}_{-0.0014}$)	130 (5.12)	6 (0.24)	6 (0.24)	12 (0.47)	165 (6.50)	45 (1.77)	9 (0.35)

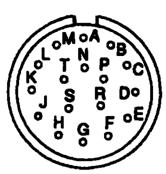
in mm (inches)

Type SGMS-	Shaft end dimensions S	S1	Q	Approx. mass kg (lb)
10VSD	$24^{\ 0}_{-0.013}$ ($0.94^{\ 0}_{-0.0005}$)	30 (1.18)	40 (1.57)	5.0 (11.02)
15VSD	$24^{\ 0}_{-0.013}$ ($0.94^{\ 0}_{-0.0005}$)	30 (1.18)	40 (1.57)	6.2 (13.66)
20VSD	$24^{\ 0}_{-0.013}$ ($0.94^{\ 0}_{-0.0005}$)	30 (1.18)	40 (1.57)	7.4 (16.31)
30VSD	$28^{\ 0}_{-0.013}$ ($1.10^{\ 0}_{-0.0005}$)	30 (1.18)	55 (2.17)	11.5 (25.35)
40VSD	$28^{\ 0}_{-0.013}$ ($1.10^{\ 0}_{-0.0005}$)	30 (1.18)	55 (2.17)	14.5 (31.96)
50VSD	$28^{\ 0}_{-0.013}$ ($1.10^{\ 0}_{-0.0005}$)	30 (1.18)	55 (2.17)	17.5 (38.57)

Note Absolute encoder (15bit : 8192 P/R) is used as a detector.

- Connector Wiring on Detector Side

Receptacle: 97F3102E20-29P
Plug (To be prepared by customer): JA08A-20-29S-J1-EB
Cable Clamp (To be prepared by customer): JL04-2022CKE(□□)

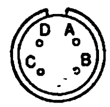


Encoder Wiring Specifications

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	0V	S	0V (battery)
H	+5V DC	T	3.6V (battery)
J	FG (Frame Ground)		

Note These are the general specifications when an absolute encoder is used.

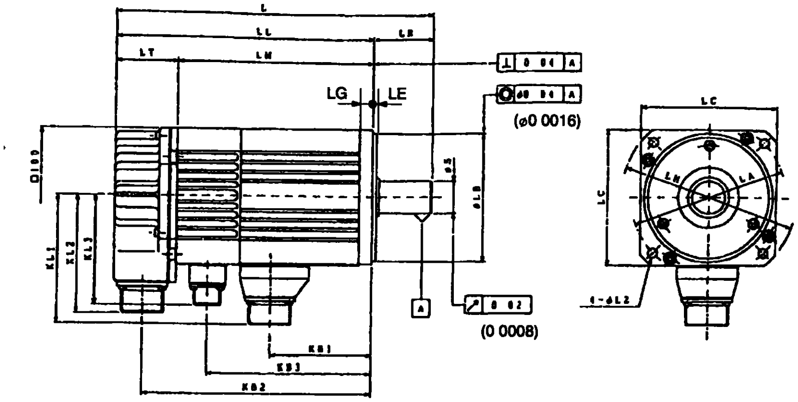
• Connector Wiring on Motor Side



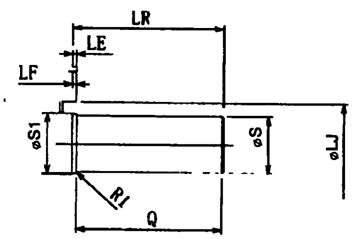
A	U phase
B	V phase
C	W phase
D	FG (Frame Ground)

Note Receptacle, plug and cable clamp differ depending on the capacity. Refer to 3) Connectors on Detector and Motor Sides (page 210).

(4) Absolute encoder (15bit : 8192 P/R), with brake



Detailed View of Shaft End



in mm (inches)

Type SGMS-	L	LL	LM	LR	LT	KB1	KB2	KB3	KL1	KL2	KL3
10VSDAC	252 (9.92)	207 (8.15)	147 (5.79)	45 (1.77)	60 (2.36)	76 (2.99)	186 (7.32)	120 (4.72)	96 (3.78)	87 (3.43)	85 (3.35)
15VSDAC	278 (10.94)	233 (9.17)	173 (6.81)	45 (1.77)	60 (2.36)	102 (4.02)	212 (8.35)	146 (5.75)	96 (3.78)	87 (3.43)	85 (3.35)
20VSDAC	301 (11.85)	256 (10.08)	196 (7.72)	45 (1.77)	60 (2.36)	125 (4.92)	235 (9.25)	169 (6.65)	96 (3.78)	87 (3.43)	85 (3.35)
30VSDAC	314 (12.36)	251 (9.88)	191 (7.52)	63 (2.48)	60 (2.36)	122 (4.80)	230 (9.06)	170 (6.69)	114 (4.49)	87 (3.43)	98 (3.86)
40VSDAC	351 (13.82)	288 (11.34)	228 (8.98)	63 (2.48)	60 (2.36)	159 (6.26)	267 (10.51)	207 (8.15)	114 (4.49)	87 (3.43)	98 (3.86)
50VSDAC	391 (15.39)	328 (12.91)	268 (10.55)	63 (2.48)	60 (2.36)	199 (7.83)	307 (12.09)	247 (9.72)	114 (4.49)	87 (3.43)	98 (3.86)

in mm (inches)

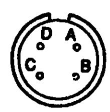
Type SGMS-	Flange dimensions								
	LA	LB	LC	LE	LF	LG	LH	LJ	LZ
10VSDAC	115 (4.53)	$95^{\,0}_{-0.035}$ $(3.74^{\,0}_{-0.0014})$	100 (3.94)	3 (0.12)	3 (0.12)	10 (0.39)	130 (5.12)	45 (1.77)	7 (0.28)
15VSDAC	115 (4.53)	$95^{\,0}_{-0.035}$ $(3.74^{\,0}_{-0.0014})$	100 (3.94)	3 (0.12)	3 (0.12)	10 (0.39)	130 (5.12)	45 (1.77)	7 (0.28)
20VSDAC	115 (4.53)	$95^{\,0}_{-0.035}$ $(3.74^{\,0}_{-0.0014})$	100 (3.94)	3 (0.12)	3 (0.12)	10 (0.39)	130 (5.12)	45 (1.77)	7 (0.28)
30VSDAC	145 (5.71)	$110^{\,0}_{-0.035}$ $(4.33^{\,0}_{-0.0014})$	130 (5.12)	6 (0.24)	6 (0.24)	12 (0.47)	165 (6.50)	45 (1.77)	9 (0.35)
40VSDAC	145 (5.71)	$110^{\,0}_{-0.035}$ $(4.33^{\,0}_{-0.0014})$	130 (5.12)	6 (0.24)	6 (0.24)	12 (0.47)	165 (6.50)	45 (1.77)	9 (0.35)
50VSDAC	145 (5.71)	$110^{\,0}_{-0.035}$ $(4.33^{\,0}_{-0.0014})$	130 (5.12)	6 (0.24)	6 (0.24)	12 (0.47)	165 (6.50)	45 (1.77)	9 (0.35)

in mm (inches)

Type SGMS-	Shaft end dimensions			Approx. mass kg (lb)
	S	S1	Q	
10VSDAC	$24^{\ 0}_{-0.013}$ $(0.94^{\ 0}_{-0.0005})$	30 (1.18)	40 (1.57)	6.5 (14.33)
15VSDAC	$24^{\ 0}_{-0.013}$ $(0.94^{\ 0}_{-0.0005})$	30 (1.18)	40 (1.57)	8.0 (17.63)
20VSDAC	$24^{\ 0}_{-0.013}$ $(0.94^{\ 0}_{-0.0005})$	30 (1.18)	40 (1.57)	9.0 (19.84)
30VSDAC	$28^{\ 0}_{-0.013}$ $(1.10^{\ 0}_{-0.0005})$	30 (1.18)	55 (2.17)	14.5 (31.96)
40VSDAC	$28^{\ 0}_{-0.013}$ $(1.10^{\ 0}_{-0.0005})$	30 (1.18)	55 (2.17)	17.5 (38.57)
50VSDAC	$28^{\ 0}_{-0.013}$ $(1.10^{\ 0}_{-0.0005})$	30 (1.18)	55 (2.17)	20.5 (45.18)

Note Absolute encoder (15bit : 8192 P/R) is used as a detector.

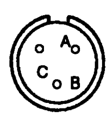
- Motor Connector Wiring



Motor Wiring Specifications

A	U phase
B	V phase
C	W phase
D	Frame ground (FG)

- Brake Connector Wiring



Brake Wiring Specifications

A	Brake terminal
B	Brake terminal
C	

- As for connector wiring on detector side, refer to page 205.

3) Connectors for Detectors, Motors, and Brakes

There are two types of Connectors for Detectors, Motors, and Brakes; Standard Connectors and Connectors based on IP67. Standard Connectors are non-dripproof.

Standard Connectors (Not based on IP67)

A Brake Connector is necessary for Servomotors with Holding Brake.

Connectors for SGM□ Servomotors

Motor Type	Connectors on Motor Side				
	Receptacle Type	Plug Type		Cable Clamp Type*	Manufacturer
		Angle (L-shaped)	Straight		
SGMS- 10V□D 15V□D 20V□D	CE05-2A18-10PD-B	CE05-8A18-10SD-B-BAS	CA05-6A18-10SD-B-BSS	CE3057-10A-✻	DDK LTD
SGMS- 30V□D 40V□D 50V□D	JL04HV-2E22-22PE-B	JL04V-8A22-22SE-EB	JL04V-6A22-22SE-EB	JL04-2022CK (✻✻)	Japan Aviation Electronics Industry, Ltd
SGMG- 05V□D 09V□D 13V□D	CE05-2A18-10PD-B	CE05-8A18-10SD-B-BAS	CE05-6A18-10SD-B-BSS	CE3057-10A-✻	DDK LTD
SGMG- 20V□D 30V□D 44V□D	JL04HV-2E22-22PE-B	JL04V-8A22-22SE-EB	JL04V-6A22-22SE-EB	JL04-2022CK (✻✻)	Japan Aviation Electronics Industry, Ltd
Detector	97F3102E20-29P	JA08A-20-29S-J1-EB	JA06A-20-29S-J1-EB	JL04-2022CK (✻✻)	Receptacle: DDK LTD. Plug, cable clamp: Japan Aviation Electronics Industry, Ltd
	Connector on motor side already provide.	To be provided by customer.			

* See the table "Cable clamp types classified according to lead wire diameter" on page 212.

SGM□ Holding Brake Connectors

Motor Type	Receptacle Type	Plug Type		Cable Clamp Type	Manufacturer
		Angle (L-shaped)	Straight		
All Brake	CE05-2A10SL-3PC-B (Brake side)	CE05-8A10SL-3SC-B-BAS	CE05-6A10SL-3SC-B-BSS	CE3057-4A-1 (D265) (Applicable cable diameter: φ3.6 to φ5.6)	DDK LTD
	Connector on motor side already provide.	To be provided by customer			

Note 1) The connectors for a detector are the same regardless of the motor type being used.

Note 1) The connectors for a detector are the same regardless of the motor type being used.

2) Select an appropriate cable clamp type.

IP67-based Connectors

A Brake Connector is necessary for Servomotors with Holding Brake.

SGM□ Servomotor Connectors

	Motor Type		Receptacle	Plug	End Bell: Manufactured by Japan Aviation Electronics Industry, Ltd. Back Shell: Manufactured by Daiichi Denshi Kogyo K.K.		Cable Clamp	Manufacturer
					Angle (L-Shaped)	Straight		
Motor	SGMS-	10V□D 15V□D 20V□D	CE05-2A18-10PD (MS3102A18-10P)	MS3106A18-10S(D190)	CE-18BA-S	CE02-18BS-S	CE3057-10A-✻	Daiichi Denshi Kogyo K.K
		30V□D 40V□D 50V□D	JL04HV-2E22-22PE-B (MS3102A22-22P)	JL04V-6A22-22SE	JL04-22EBL	JL04-22EB	JL04-2022CK (✻✻)	Japan Aviation Electronics Industry, Ltd.
	SGMG-	05V□D 09V□D 13V□D	CE05-2A18-10PD (MS3102A18-10P)	MS3106A18-10S(D190)	CE-18BA-S	CE02-18BS-S	CE3057-10A-✻	Daiichi Denshi Kogyo K.K
		20V□D 30V□D 44V□D	JL04HV-2E22-22PE-B (MS3102A22-22P)	JL04V-6A22-22SE	JL04-22EBL	JL04-22EB	JL04-2022CK (✻✻)	Japan Aviation Electronics Industry, Ltd.
Detector			97F3102E20-29P (MS3102A20-29P)	MS3106A20-29S(D190)	CE-20BA-S	CE02-20BS-S	CE3057-12A-✻	Daiichi Denshi Kogyo K K

Receptacle: Connector on motor side already provided

Plug: To be selected if flexible conduit is used

End Bell and Cable Clamp: Not required if flexible conduit is used

Plug through Cable Clamp: To be prepared by customer

SGM☐ Holding Brake Connectors

	Receptacle	Plug	End Bell: Manufactured by Japan Aviation Electronics Industry, Ltd. Back Shell: Manufactured by Daiichi Denshi Kogyo K.K.		Cable Clamp	Manufacturer
			Angle (L-Shaped)	**Straight**		
Brake	CE05-2A10SL-3PC (MS3102A10SL-3P)	MS3106A10SL-3S (D190)	CE-10SLBA-S	CE-10SLBS-S	CE3057-4A-1	Daiichi Denshi Kogyo K K

Connector on motor side already provided

To be selected if flexible conduit is used

Not required if flexible conduit is used

To be prepared by customer

Note

1) The connectors for a detector are the same regardless of the motor type being used.

2) To ensure compliance with IP67, always use the plug, End Bell, Back Shell and cable clamp specified above.

3) End Bell is a product of Japan Aviation Electronics Industry, Ltd. Back Shell is a product of Daiichi Denshi Kogyo K.K.

4) Select an appropriate cable clamp type (mark ✱✱) according to the lead wire diameter. See Table below.

5) ( ) in the receptacle column shows the standard (non-dripproof) type. However, both are actually the same receptacles.

• Cable clamp types classified according to lead wire diameter

Cable Clamp Type	Lead Wire Diameter Range
CE3057-10A-1	ϕ10.5 to ϕ14.1
CE3057-10A-2	ϕ8.5 to ϕ11.0
CE3057-10A-3	ϕ6.5 to ϕ8.7
CE3057-12A-1	ϕ12.5 to ϕ16.0
CE3057-12A-2	ϕ9.5 to ϕ13.0
CE3057-12A-3	ϕ6.8 to ϕ10.0
JL04-2022CK (09)	ϕ6.5 to ϕ9.5
JL04-2022CK (12)	ϕ9.5 to ϕ13.0
JL04-2022CK (14)	ϕ12.9 to ϕ16.0
JL04-2428CK (11)	ϕ9.0 to ϕ12.0
JL04-2428CK (14)	ϕ12.0 to ϕ15.0
JL04-2428CK (17)	ϕ15.0 to ϕ18.0
JL04-2428CK (20)	ϕ18.0 to ϕ20.0

4.4.2 SGDC Servopack and JUSP Converter Dimensional Drawings

1) The dimension drawings of the SGDC Servopack and JUSP Converter are broadly grouped according to capacity into the following five categories.

Servopack

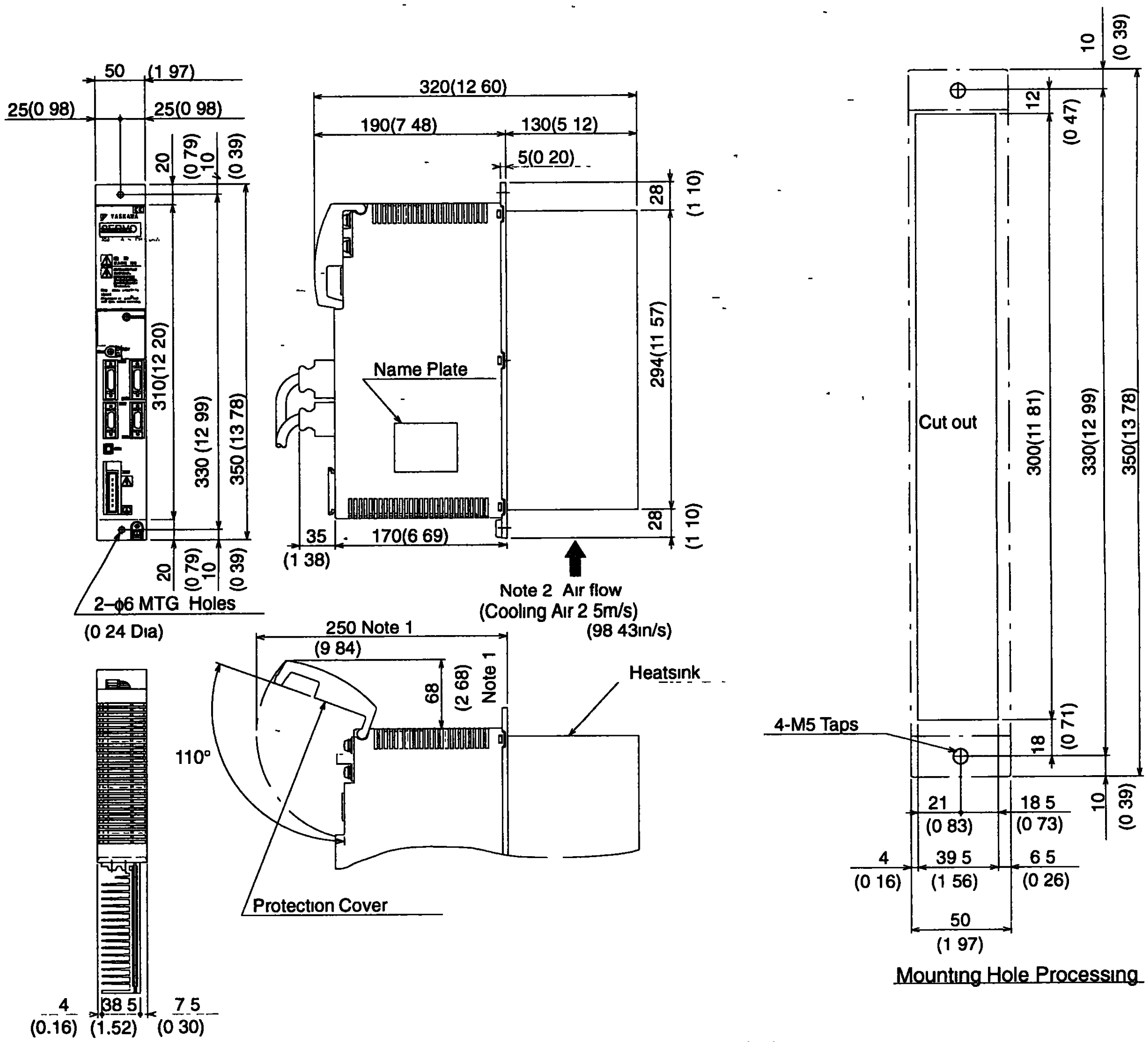
(1) 0.5 to 3.0 kW (0.7 to 4.0 HP)	(Type: SGDC-05DSA to 30DSA)
(2) 5.0 kW (6.7 HP)	(Type: SGDC-50DSA)

Converter

(3) 8 A	(Type: JUSP-ACP08GD)
(4) 15 A	(Type: JUSP-ACP15GD)
(5) 30 A	(Type: JUSP ACP30GD)

Servopack

(1) 0.5 to 3.0 kW (SGDC-05DSA to 30DSA)



Dimensions in mm (in.)

Approx Mass: 3.5 kg (7 72 lb) (SGDC-05 to 15DSA)
3 7 kg (8.16 lb) (SGDC-20 to 30DSA)

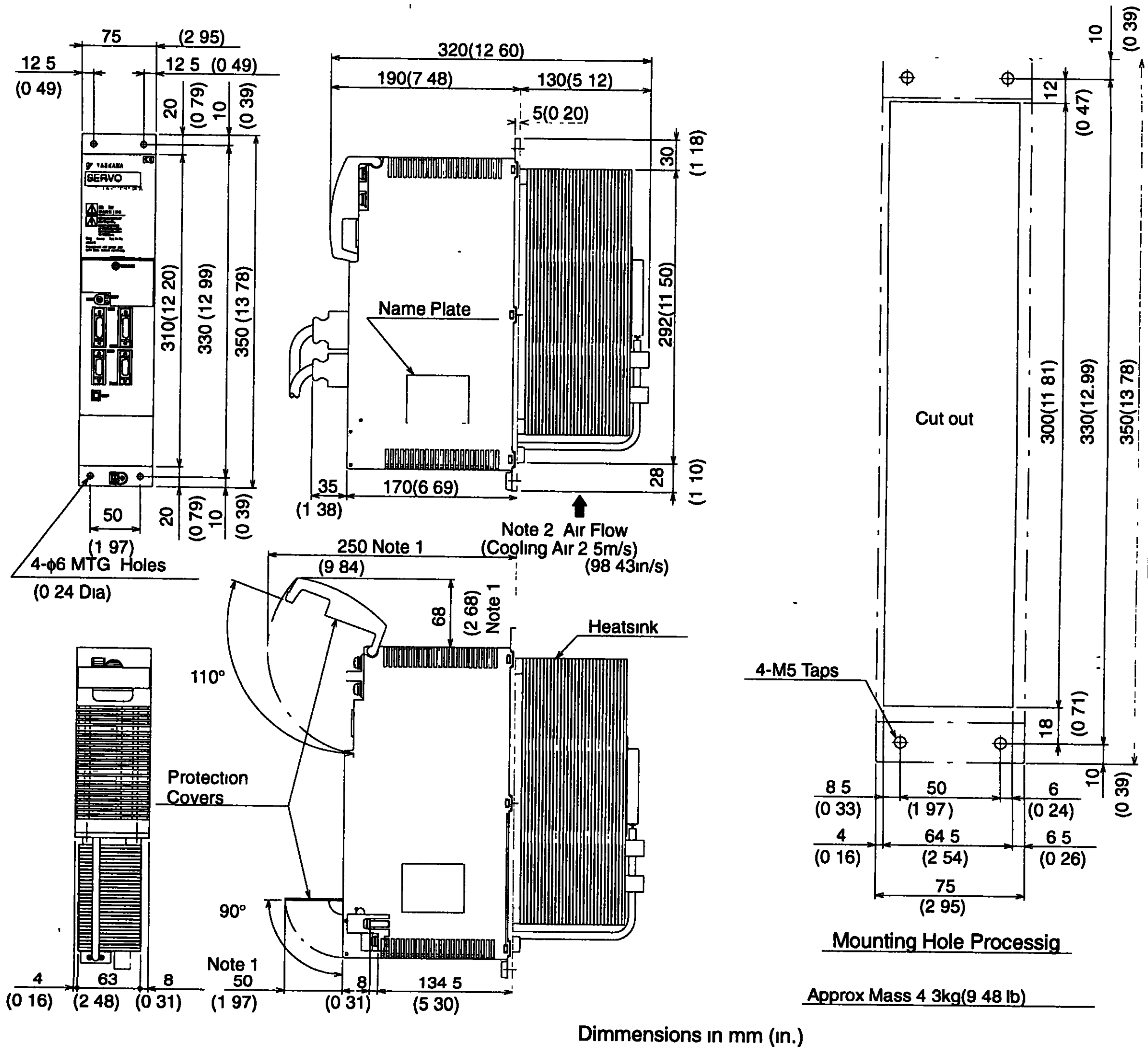
Note 1) Keep the space for the protection cover.

2) This unit is forced cooling air system. This heatsink needs cooling air 2.5 m/s and over.

- SGDC-05DSA to 30DSA

Symbols	Connector on Servopack side	Note
1CN, 6CN	10226-52A2JL	Manufactured by 3M
2CN	10220-52A2JL	
3CN	1-316131-2	Manufactured by AMP
7CN	10214-52A2JL	Manufactured by 3M
8CN	DE11-4DP-2DS(52)	Manufactured by HIROSE

(2) 5.0 kW (SGDC-50DSA: 6.7 HP)



Note 1) Keep the space for the protection covers.

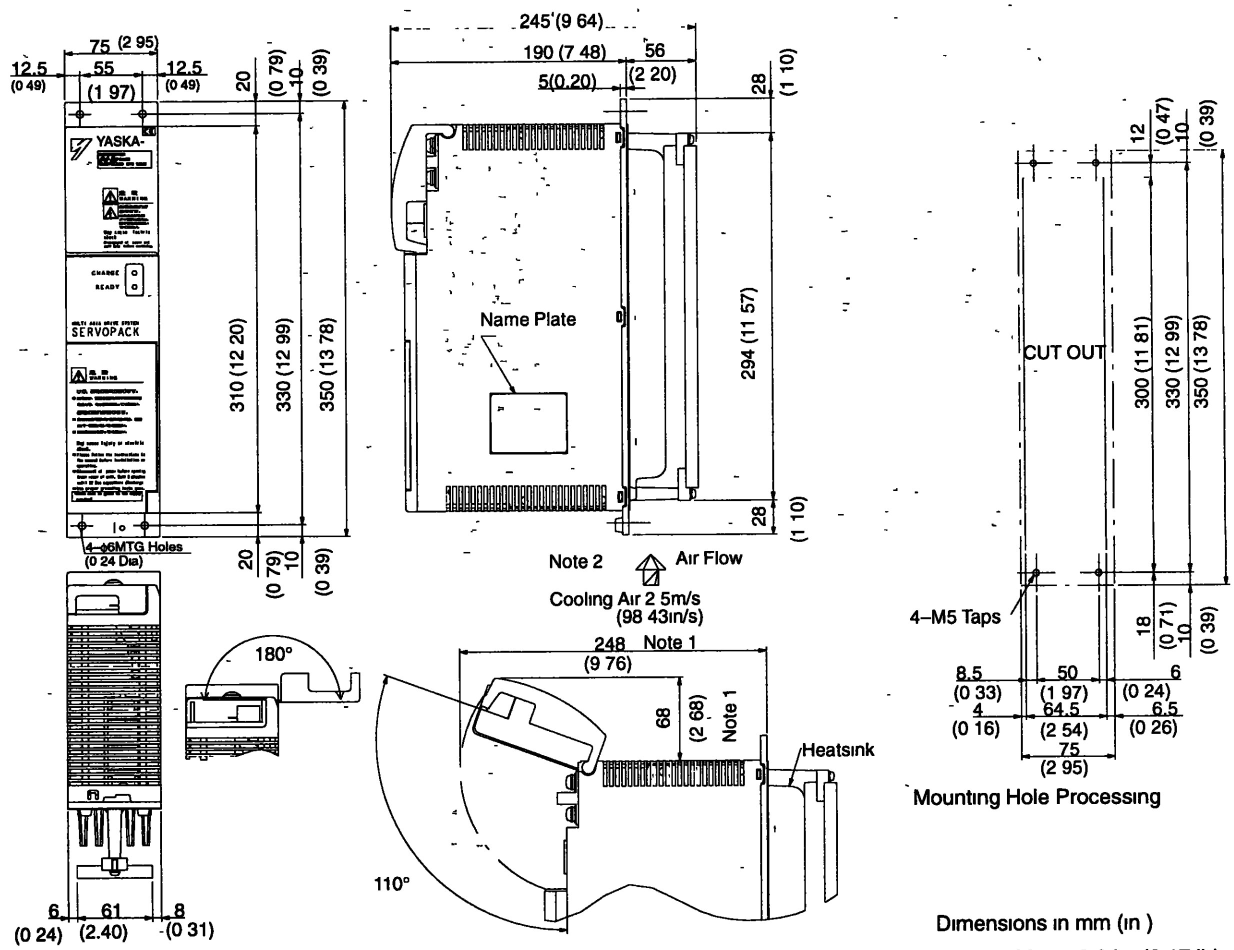
2) This unit is forced cooling air system. This heatsink needs cooling air 2.5 m/s and over.

- SGDC-50DSA

Symbols	Connector on Servopack side	Note
1CN, 6CN	10226-52A2JL	Manufactured by 3M
2CN	10220-52A2JL	
7CN	10214-52A2JL	
8CN	DE11-4DP-2DS(52)	Manufactured by HIROSE

Converter

(3) 8 A (JUSP-ACP08GD)



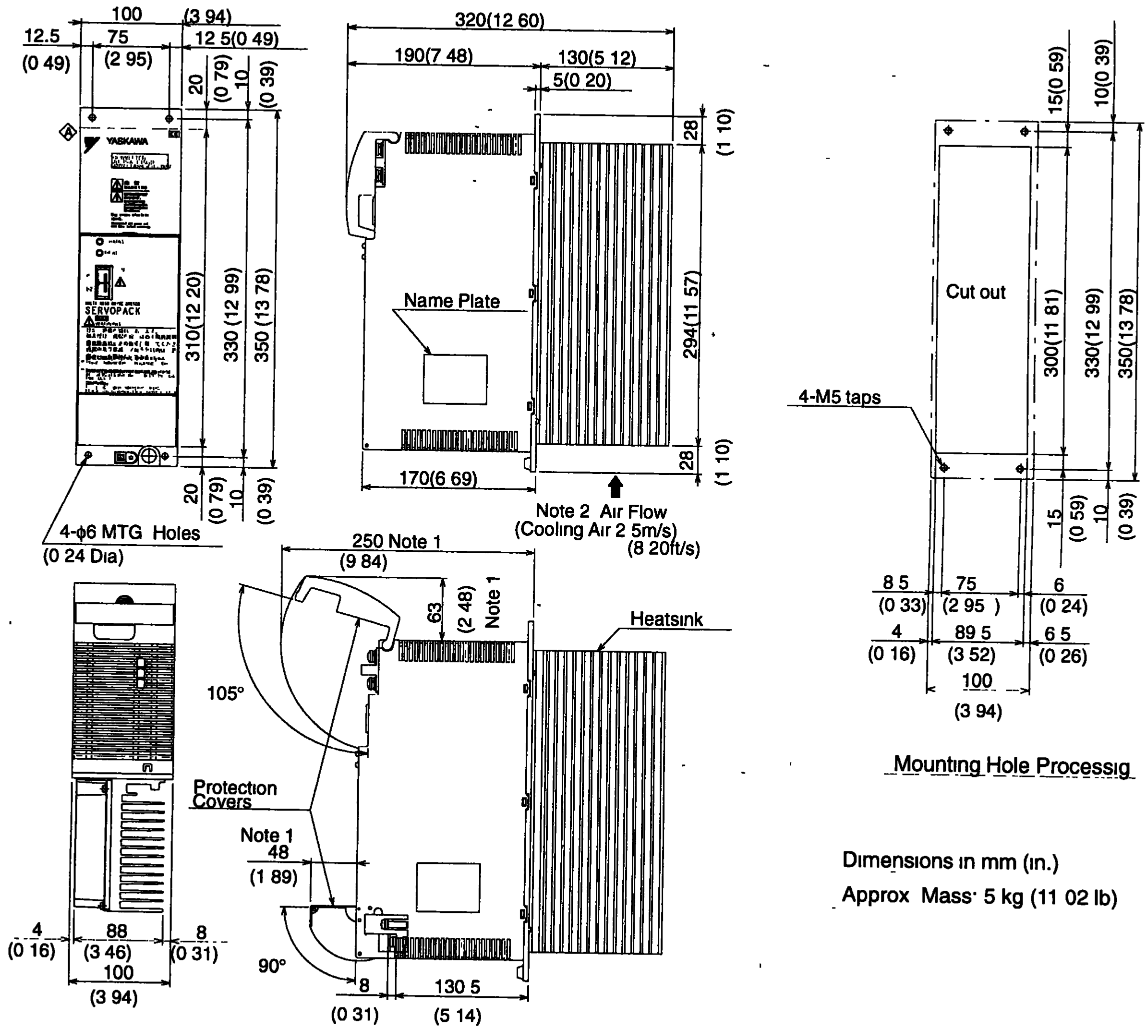
Dimensions in mm (in)

Approx Mass 2 8 kg (6.17 lb)

Note 1) Keep the space for the protection cover.

2) This unit is forced cooling air system. This heatsink needs cooling air 2.5 m/s and over.

(4) 15 A (JUSP-ACP15GD)



Dimensions in mm (in.)

Approx Mass: 5 kg (11 02 lb)

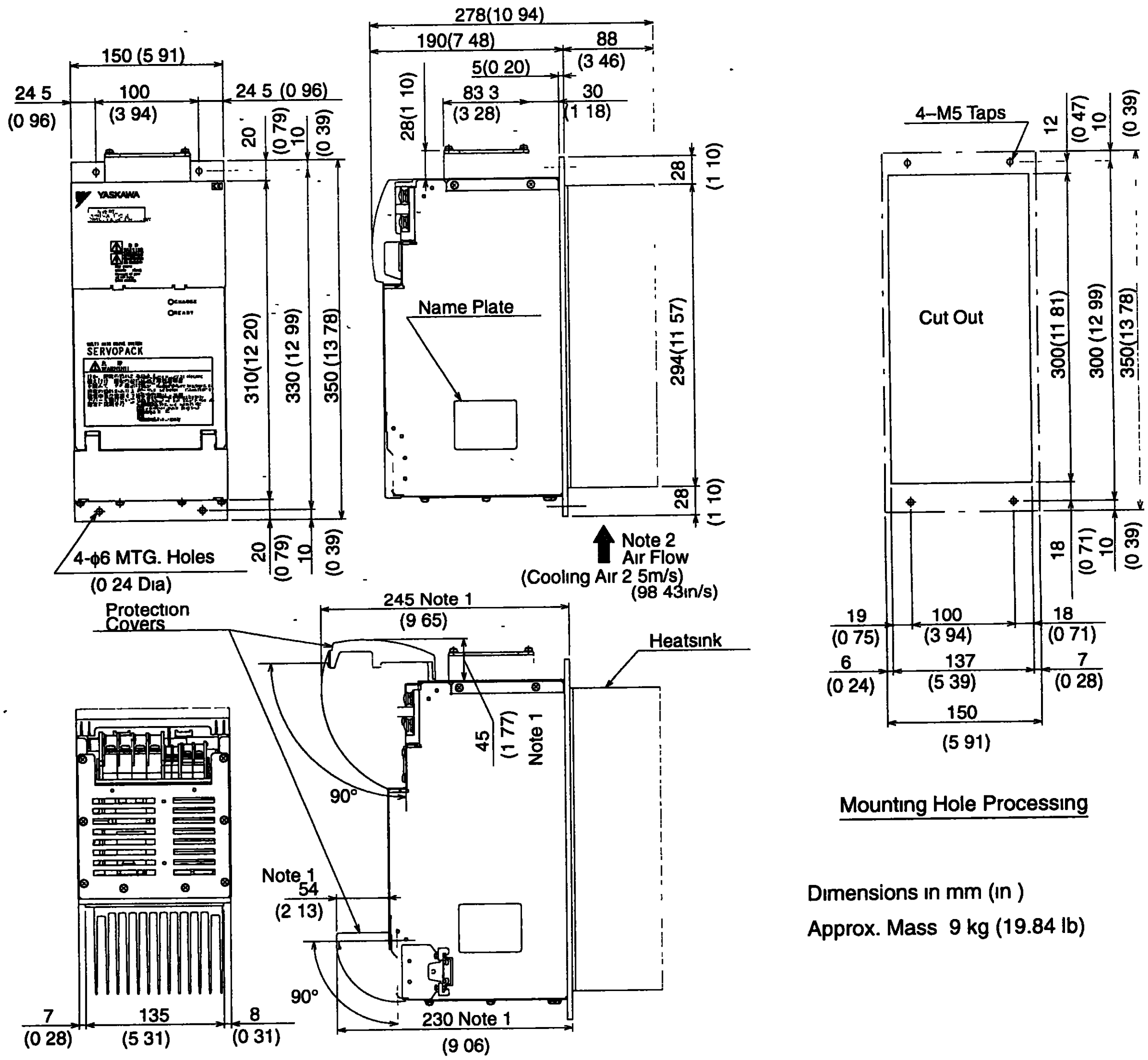
Note 1) Keep the space for the protection covers.

2) This unit is forced cooling air system. This heatsink needs cooling air 2.5 m/s and over.

- JUSP-ACP15GD

Symbols	Connector on Servopack side	Note
1CN	1-353079-2	Manufactured by AMP

(5) 30 A (JUSP-ACP30GD)



Mounting Hole Processing

Dimensions in mm (in)
Approx. Mass 9 kg (19.84 lb)

Note

1) Keep the space for the protection covers.

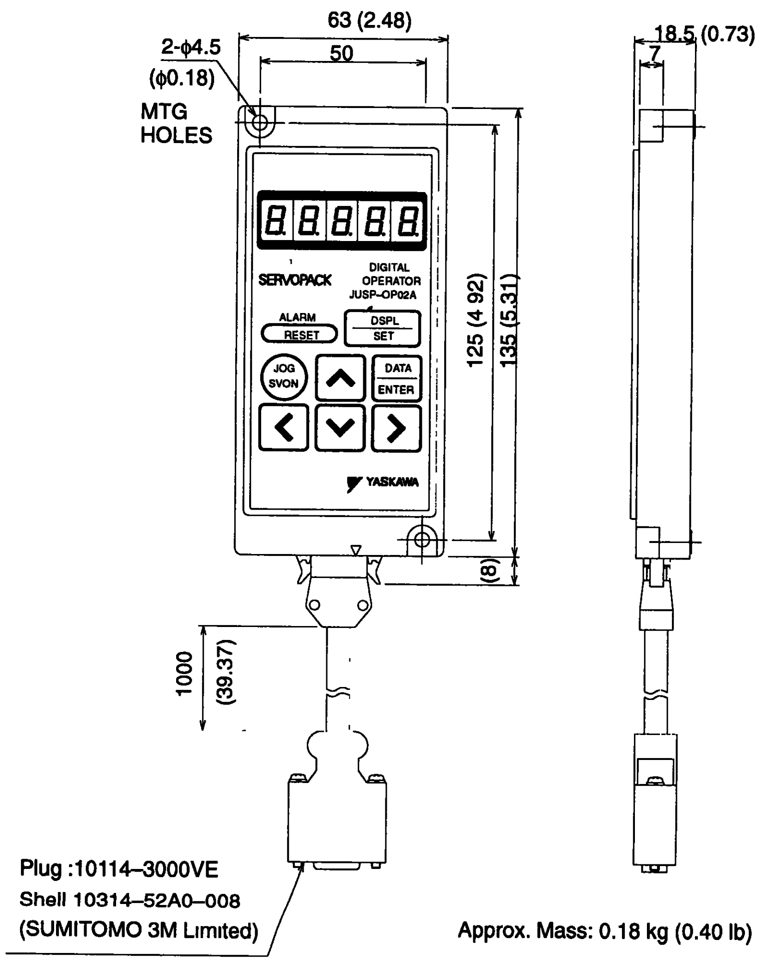
2) This unit is forced cooling air system. This heatsink needs cooling air 2.5 m/s and over.

3) Keep the another unit 50 mm and over apart from the fan for the cooling air.

4.4.3 Digital Operator Dimensional Drawings

1) The following Digital Operator is available.

JUSP-OP02A-2 (Hand-held Type)



Approx. Mass: 0.18 kg (0.40 lb)

Dimensions in mm (in.)

4.5 Selecting Peripheral Devices

This section shows how to select peripheral devices using flowcharts. Order lists for Servomotors, Servopacks, digital operators, and peripheral devices are also included.

4.5.1 Selecting Peripheral Devices

Select the peripheral devices using the flowcharts on the subsequent pages.

The items below are not included in the flowcharts. Refer to *Section 4.6 Specifications and Dimensional Drawings of Peripheral Devices.*

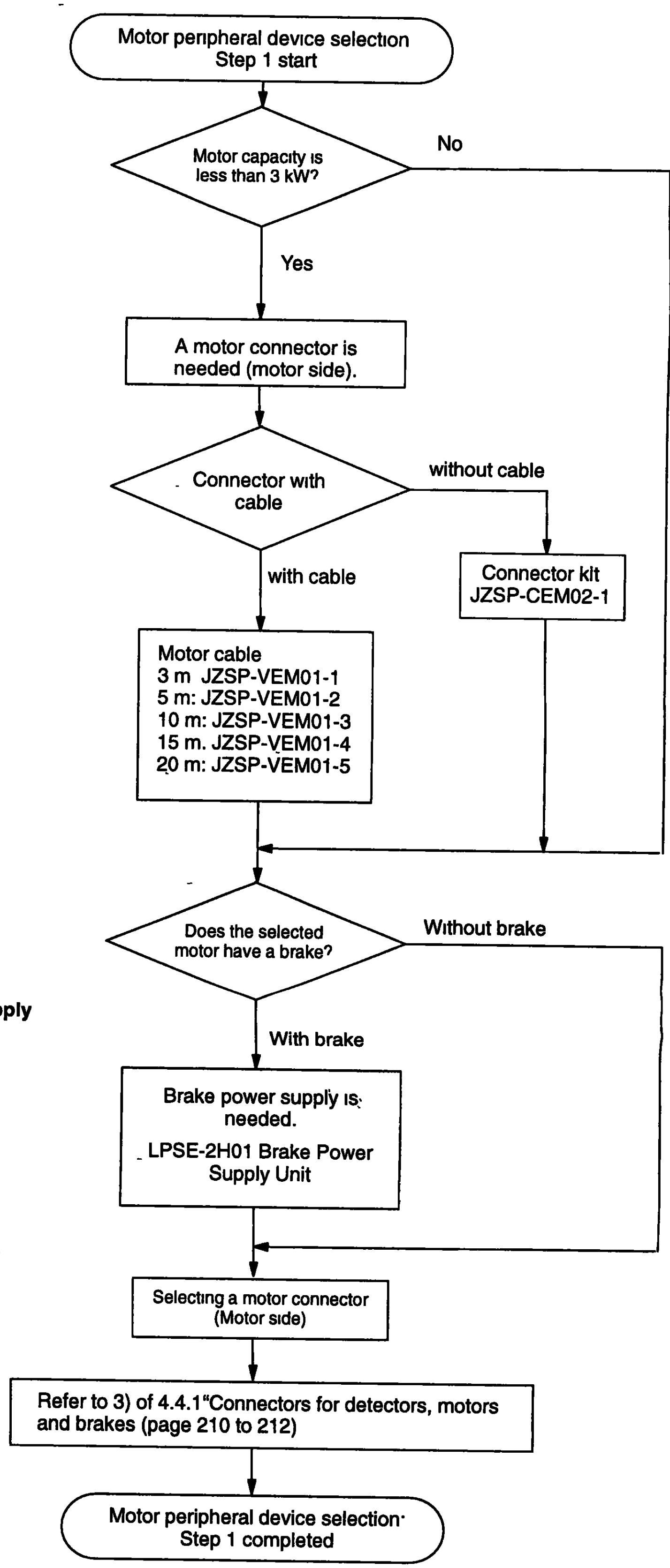
- Variable resistors for speed setting
- Encoder signal converter units
- Cables for connecting PC and Servopack

<Flowchart for Peripheral Device Selection>

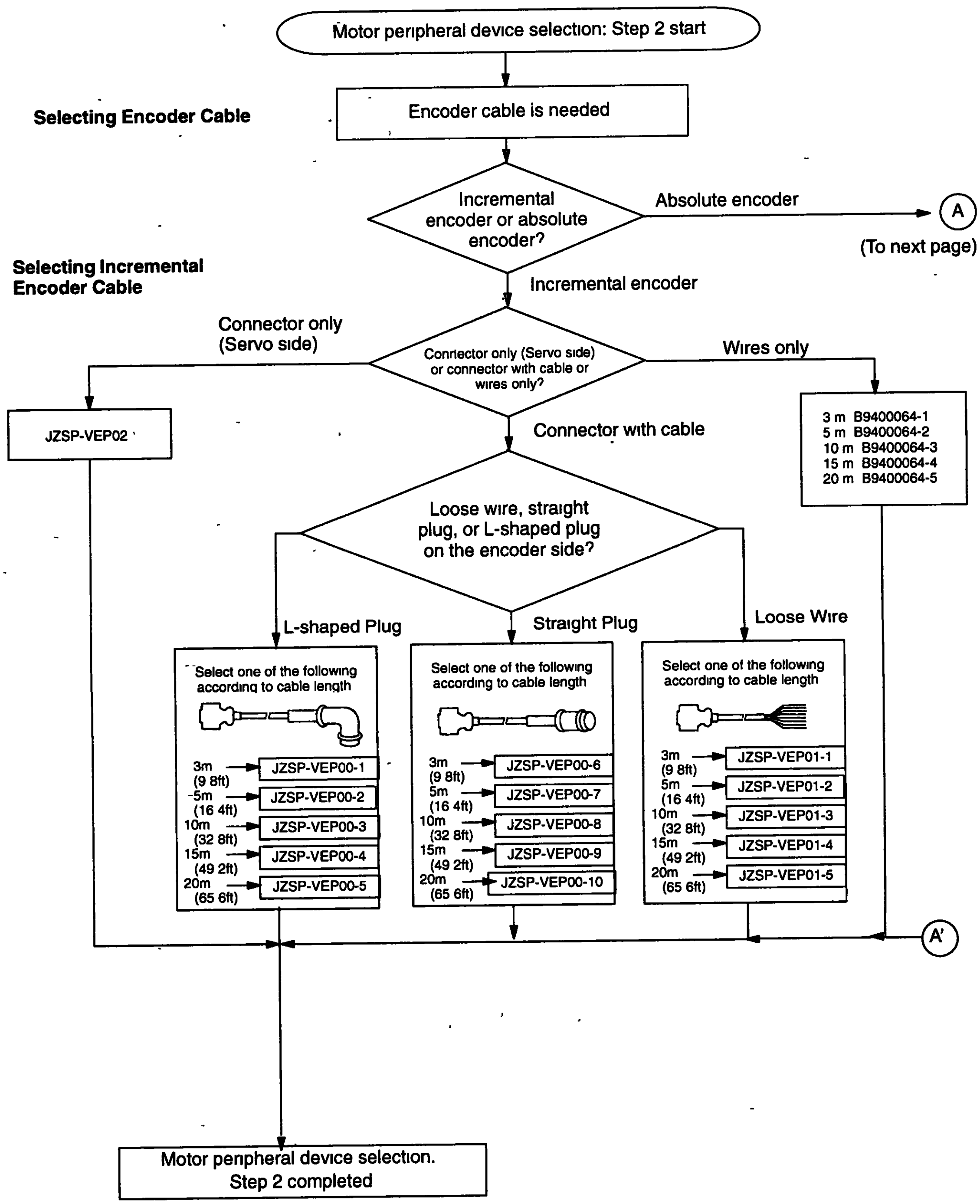
Selecting a motor connector (Servo side)

Selecting a brake power supply

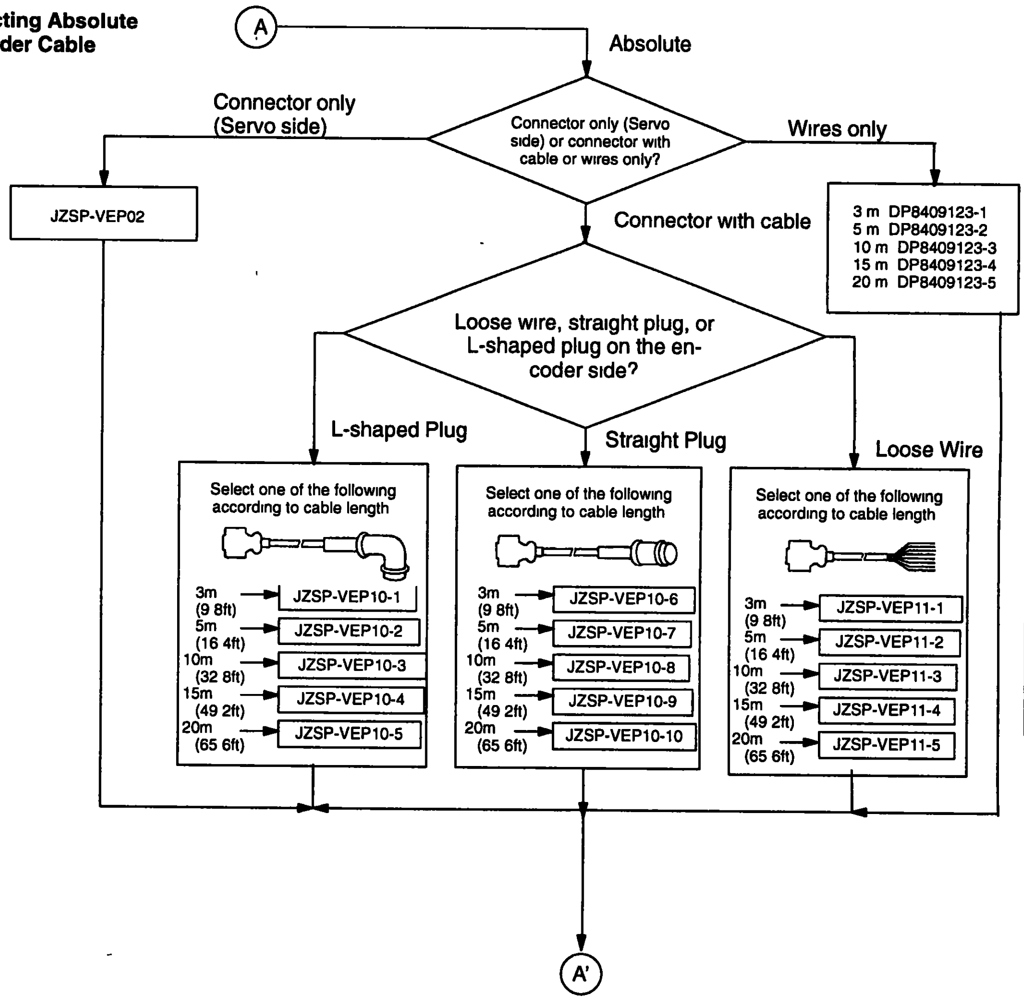
Selecting a connector motor (Motor side)



4.5.1 Selecting Peripheral Devices cont.



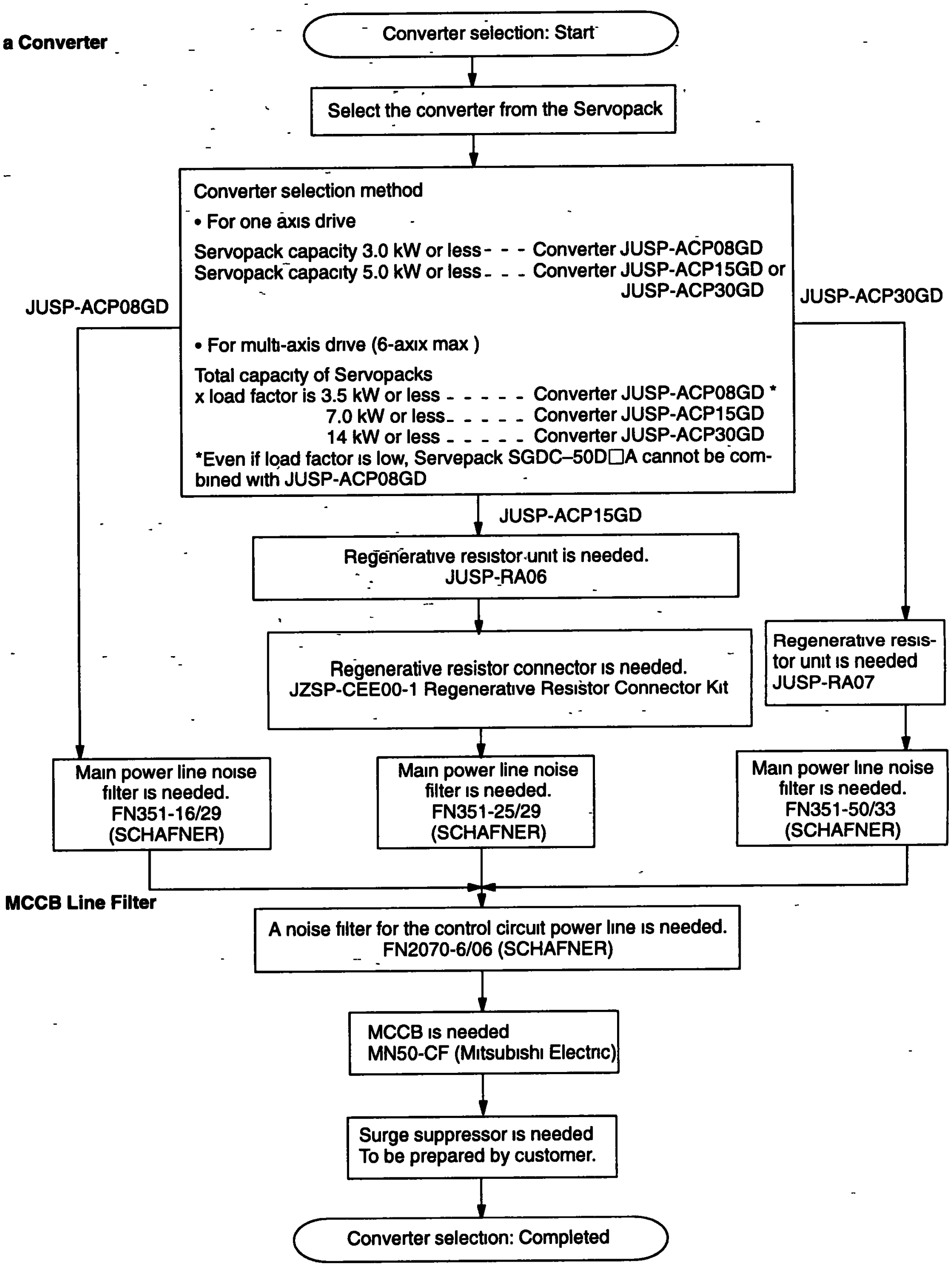
Selecting Absolute Encoder Cable



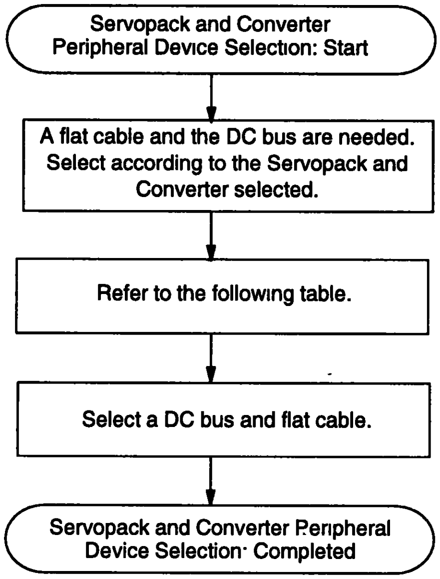
4

4.5.1 Selecting Peripheral Devices cont.

Selecting a Converter



Selecting MCCB Line Filter



DC bus and flat cable should be selected in accordance with the width of JUSP-converter and Servopack. Use the table below to specify the Unit to be combined.

	Converter	Servopack A	(1) DC Bus	(2) Flat Cable
For Connecting Converter with Servopack	JUSP-ACP08GD	SGDC-05DSA to SGDC-30DSA	JZSP-CEB02-3	JZSP-CEC02-1
		SGDC-50DSA	JZSP-CEB02-6	
	JUSP-ACP15GD	SGDC-05DSA to SGDC-30DSA	JZSP-CEB02-2	JZSP-CEC02-2
		SGDC-50DSA	JZSP-CEB02-7	
	JUSP-ACP30GD	SGDC-05DSA to SGDC-30DSA	JZSP-CEB02-8	
		SGDC-50DSA	JZSP-CEB02-5	
	Servopack A	**Servopack B**	**(1) DC Bus**	**(2) Flat Cable**
For Connecting between Servopack	SGDC-05DSA to SGDC-30DSA	SGDC-05DSA to SGDC-30DSA	JZSP-CEB02-6	JZSP-CEC02-1
		SGDC-50DSA	JZSP-CEB02-9	
	SGDC-50DSA	SGDC-05DSA to SGDC-30DSA	JZSP-CEB02-5	JZSP-CEC02-4
		SGDC-50DSA	JZSP-CEB02-4	

4.6 Specifications and Dimensional Drawings of Peripheral Devices

This section shows the specifications and dimensional drawings of the peripheral devices required for the Σ-Series servo system. The sequence of peripheral devices is given by the Flowchart for Peripheral Device Selection in *Section 4.5.1 Selecting Peripheral Devices.*

4.6.1 Cable Specifications and Peripheral Devices

1) The cable sizes and peripheral devices for SGDC 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.

External Terminal Name		Converter Type / Terminal Symbol	Cable Size (mm^2)		
			JUSP-ACP08GD	JUSP-ACP15GD	JUSP-ACP30GD
On-line Terminal	Main Circuit Power Input Terminal	L1, L2, L3	HIV 3.5 or more	HIV 5.5 or more	HIV 14 or more
	Control Power Input Terminal	A1, A2	HIV 1.25 or more		
Off-line Terminal	Ground Terminal	⏚	HIV 2.0 or more		

External Terminal Name		Servopack Type / Terminal Symbol	Cable Size (mm^2)					
			05	10	15	20	30	50
On-line Terminal	Motor Connection Terminal	3CN (for 05 to 30) U, V, W (for 50)	HIV 1.25 or more		HIV 2.0 or more	HIV 3.5 or more		
Off-line Terminal	Control I/O Signal Connector	1CN, 6CN	Core of twisted pair or twisted pair shield wires: 0.12 mm^2 or more Outside dimensions of tinned annealed copper twisted wires: max. ø16 (for 1CN, 6CN), max. ø11 (for 2CN)					
	PG Signal Connector	2CN						
	Ground Terminal	⏚	HIV 2.0 or more					

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 subject to heat deterioration and become unusable in a short period of time. To prevent this, always use heat resistant cables.

• Peripheral Devices

Converter type	MCCB or fuse capacity*1	Main power inrush current (peak value)	Recommended line filter*2	Power ON/OFF switch
JUSP-ACP08GD	10 A	80 A	FN-351-16/29 (16 A)	HI-15E5 (30 A)
JUSP-ACP15GD	24 A	70 A	FN-351-25/29 (25 A)	HI-18E (35 A)
JUSP-ACP30GD	41 A	112 A	FN-351-50/33 (50 A)	HI-30E (65 A)

*1 Braking characteristics (at 25°C): 200% for 2 s min., 700% for 0.01 s min.

*2 Yaskawa recommends noise filters manufactured by SHAFFNER.

4

NOTE

• 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.

2) 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

• Use cable with 600 V min. rating for main circuits.

• Consider allowable current reduction ratio if cables are bundled in PVC or metal ducts.

• Use temperature-resistant cable under high ambient or panel temperature where normal vinyl cables rapidly deteriorate.

3) The appropriate cables for Servopack connectors 1CN, 6CN and 2CN are shown in the table below.

Control I/O Signal Connector	**1CN, 6CN**	Cable	Use twisted-pair cable or twisted-pair shielded cable.
		Applicable Cable	AWG24,26,28,30
		Finished Cable Dimensions	ø16.0 mm (ø 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	ø11.6 mm (ø0.46 in.) MAX.

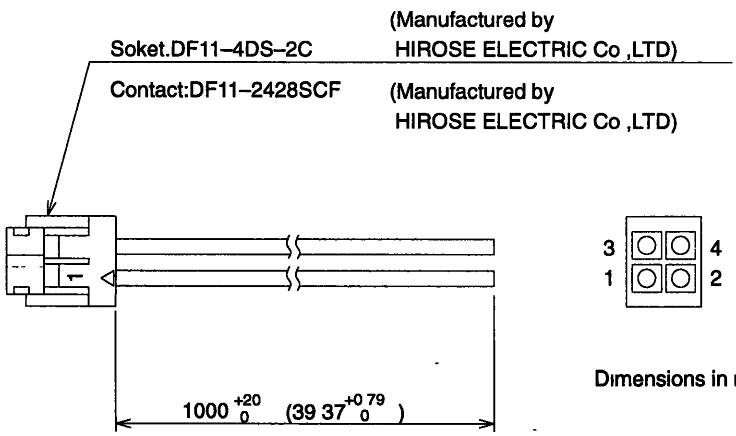
Note Cable selection conditions: three cables per bundle at 40 °C ambient temperature, with the rated current flowing.

4.6.2 Motor Cables

Select an appropriate motor cable that meets the customer's service conditions by referring to the cable specifications described in *Section 4.6.1 Cable Specifications and Peripheral Devices.*

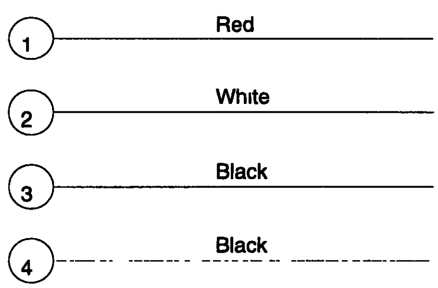
Monitor cable connector

Type	Contain Parts			
	Socket		Contact	
	Type	Quantity	Type	Quantity
JZSP-CA01	DF11-4DS-2C	1	DF11-2428SCF	4



Dimensions in mm (inches)

1) Details of lead (pin number and color)

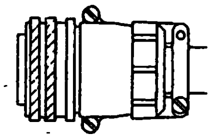


2) Wire style
UL STYLE 1007 AWM E74037 AWG24 VW-1

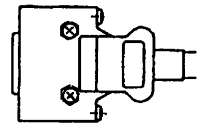
4.6.3 Connector

1) Connectors are divided into the three types shown in the figure: one encoder connector at both the motor and Servopack ends of the cable and a motor connector at the motor end of the cable. These connectors are common to both encoder types (incremental and absolute encoders).

Encoder Connector at Motor End of Cable



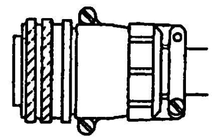
Encoder Connector at Servopack End of Cable



The connector type to be used differs according to the following items:

- Straight plug or L-shaped plug
- Motor with or without brake
- Standard specifications or IP67 specifications

Main circuit (Power Line) Connector at Motor End of Cable



When ordering connectors, also check the motor type and capacity as they affect the connector type to be used.

To connect the motor at the Servopack end of the cable, use the crimp terminals (to be prepared by the customer).

Always order the connectors under the following conditions:

a) Connectors for all cables (required regardless of whether the motor has brake or not)

b) Connectors for encoder cables with a connector only on the Servopack end of the cable or for encoder cables without connector (required regardless of the encoder type (incremental or absolute))

c) Connectors for encoders (on the motor and Servopack ends of the cable) when IP 67 specifications are used

2) Encoder cable connectors are divided into four types according to the following items:

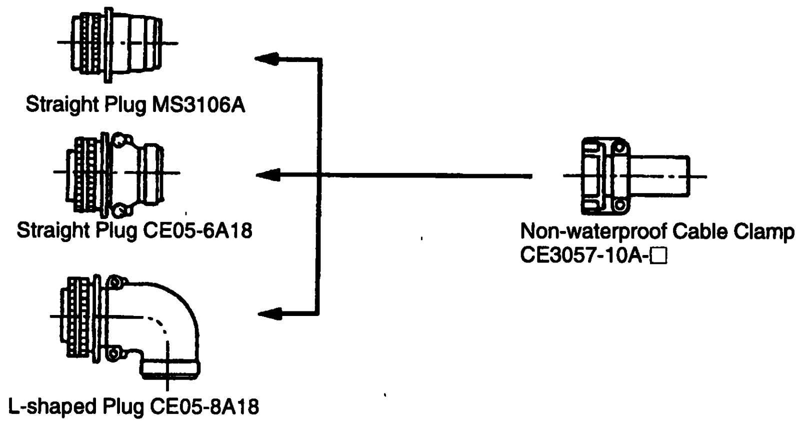
- Standard specifications or IP 67 specifications
- Straight plug or L-shaped plug

			Straight Type	L-shaped (Angle) Type	Manufacturer
Standard Environment		Plug	JA06A-20-29S-J1-EB	JA08-20-29S-J1-EB	DDK Ltd.
		Cable Clamp	JL04-2022CKE (□□)		
IP67-based Environment	Flexible Conduit Used	Plug Only	MS3106A20-29S (D190)	---	
	Flexible Conduit Not Used	Plug Only	MS3106A20-29S(D190)		
		Back Shell	CE02-20BS-S	CE-20BA-S	
		Cable Clamp	CE3057-12A-✱		

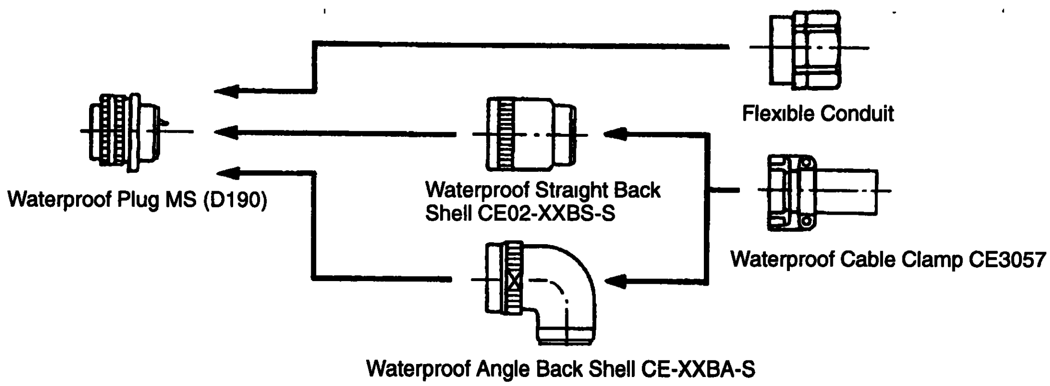
- Examples of Connector Combination

  The following examples show how to combine connectors manufactured by Daiichi Denshi Kogyo K.K.

  - Standard Environment



  - IP67-based Environment



3) The motor cable connectors to be used depend on the presence or absence of brake, motor type and capacity, and specifications (standard or IP67).

   To connect the motor cable on the Servopack side, use the crimp terminals (to be prepared by the customer).

4.6.3 Connector cont.

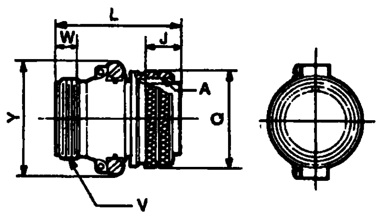
a) Standard Environment

• When using Standard Motor (without Brake)

Motor Type		Receptacle Type	Plug Type		Cable Clamp Type*	Manufacturer
			Angle (L-shaped)	Straight		
SGMS-	10V□D 15V□D 20V□D	CE05-2A18-10PD-B	CE05-8A18-10SD-B-BAS	CA05-6A18-10SD-B-BSS	CE3057-10A-1 (D265) CE3057-10A-2 (D265) CE3057-10A-3 (D265)	DDK Ltd.
	30V□D 40V□D 50V□D	JL04HV-2E22-22PE-B	JL04V-8A22-22SE-EB	JL04V-6A22-22SE-EB	JL04-2022CK (09) JL04-2022CK (12) JL04-2022CK (14)	Japan Aviation Electronics Industry, Ltd.
SGMG-	05V□D 09V□D 13V□D	CE05-2A18-10PD-B	CE05-8A18-10SD-B-BAS	CE05-6A18-10SD-B-BSS	CE3057-10A-1 (D265) CE3057-10A-2 (D265) CE3057-10A-3 (D265)	DDK Ltd.
	20V□D 30V□D 44V□D	JL04HV-2E22-22PE-B	JL04V-8A22-22SE-EB	JL04V-6A22-22SE-EB	JL04-2022CK (09) JL04-2022CK (12) JL04-2022CK (14)	Japan Aviation Electronics Industry, Ltd.
		Connector on motor side already provide.	To be provided by customer			

* See the table "Cable clamp type classified according to lead wire diameter" on page 212.

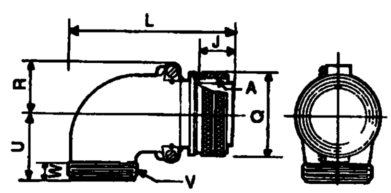
CE05-6A Straight Plug Shell



Dimensions in mm (inches)

Shell Size	Joint Screw A	Length of Joint Portion J±0.12 (±0.0047)	Overall Length L or less	Outside Diameter of Joint Nut $\varnothing Q\ ^{+0}_{-0.38}$ (−0.0150)	Cable Clamp Set Screw	Effective Screw Length W or more	Maximum Width Y or less
18	1 1/8-18UNEF	18.26 (0.72)	52.37 (2.06)	34.13 (1.34)	1-20UNEF	9.53 (0.38)	42 (1.65)
20	1 1/4-18UNEF	18.26 (0.72)	55.57 (2.19)	37.28 (1.47)	1 3/16-18UNEF	9.53 (0.38)	47 (1.85)
22	1 3/8-18UNEF	18.26 (0.72)	55.57 (2.19)	40.48 (1.59)	1 3/16-18UNEF	9.53 (0.38)	50 (1.97)
24	1 1/2-18UNEF	18.26 (0.72)	58.72 (2.31)	43.63 (1.72)	1 7/16-18UNEF	9.53 (0.38)	53 (2.09)
32	2-18UNS	18.26 (0.72)	61.92 (2.44)	56.33 (2.28)	1 3/4-18UNS	11.13 (0.44)	66 (2.60)

CE05-8A L-Plug Shell

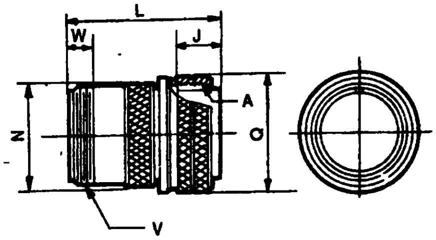


Dimensions in mm (inches)

Shell Size	Joint Screw A	Length of Joint Portion J±0.12 (±0.0047)	Overall Length L or less	Outside Diameter of Joint Nut $\varnothing Q\ ^{+0}_{-0.38}$ (−0.0150)	R±0.5 (0.02)	U±0.5 (0.02)	Cable Clamp Set Screw V	Effective Screw Length W or more
10SL								
18	1 1/8-18UNEF	18.26 (0.72)	68.27 (2.69)	34.13 (1.34)	20.5 (0.81)	30.2 (1.19)	1-20UNEF	9.53 (0.38)
20	1 1/4-18UNEF	18.26 (0.72)	76.98 (3.03)	37.28 (1.45)	22.5 (0.89)	33.3 (1.31)	1 3/16-18UNEF	9.53 (0.38)
22	1 3/8-18UNEF	18.26 (0.72)	76.98 (3.03)	40.48 (1.59)	24.1 (0.95)	33.3 (1.31)	1 3/16-18UNEF	9.53 (0.38)
24	1 1/2-18UNEF	18.26 (0.72)	86.51 (3.41)	43.63 (1.72)	25.6 (1.01)	36.5 (1.44)	1 7/16-18UNEF	9.53 (0.38)
32	2-18UNS	18.26 (0.72)	95.25 (3.75)	56.33 (2.22)	32.8 (1.29)	44.4 (1.75)	1 3/4-18UNS	11.13 (0.44)

4.6.3 Connector cont.

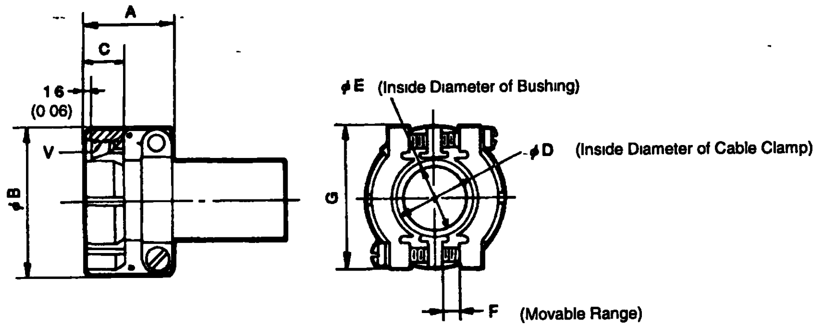
MS3106A Straight Plug Shell



Dimensions in mm (inches)

Shell Size	Joint Screw A	Length of Joint Portion J±0.12 (±0.0047)	Overall Length L±1.5 (±0.00591)	Outside Diameter of Joint Nut øQ $^{+0}_{-0.38}$ (−0.0150)	ϕN ± 0.5 (± 0.0197)	Cable Clamp Set Screw V	Effective Screw Length W or more
10SL	5/8-24UNEF	13.49 (0.53)	34.9 (1.37)	22.22 (0.87)	19.12 (0.75)	5/8-24UNEF	9.53(0.38)

MS3057-XXA Cable Clamp (with Rubber Bushing)



Dimensions in mm (inches)

Part Number	Shell Size of Connector	Overall Length A±0.7 (±0.0276)	Outside Diameter øB±0.7 (±0.0276)	Cable Clamp C	øD	øE	F	G ± 0.7 (±0.03)	Set Screw V	Attached Bushing
CE3057-10A	18	23.8 (0.94)	30.1 (1.19)	10.3 (0.41)	15.9 (0.63)	14.3 (0.56)	3.2 (0.13)	31.7 (1.25)	1-20UNEF	AN3420-10
JL04-2022	20, 22	23.8 (0.94)	35.0 (1.38)	10.3 (0.41)	19.0 (0.75)	15.9 (0.63)	4.0 (0.16)	37.3 (1.49)	13/16-18UNEF	AN3420-12
MS3057-16A	24, 28	26.2 (1.03)	42.1 (1.66)	10.3 (0.41)	23.8 (0.94)	15.9 (0.63) 19.1 (0.75)	4.8 (0.19)	42.9 (1.69)	17/16-18UNEF	AN3420-12 AN3420-16
MS3057-20A	32	27.8 (1.09)	51.6 (2.03)	11.9 (0.47)	31.7 (1.25)	19.1 (0.75) 23.8 (0.94)	6.3 (0.25)	51.6 (2.03)	13/4-18UNS	AN3420-16 AN3420-20

• When using Brake Connector

Motor Type	Receptacle Type	Plug Type: Angle (L-shaped)	Plug Type: Straight	Cable Clamp Type	Manufacturer
All Brake	CE05-2A10SL-3PC-B (Brake side)	CE05-8A10SL-3CS-B-BSS	CE05-6A10SL-3SV-B-BSS	CE3057-4A-1 (D265) (Applicable cable diameter: ϕ3.6 to ϕ5.6)	DDK Ltd.

b) IP67-based Environment

• When Using IP67-based Motor (without Brake)

	Motor Type		Receptacle	Plug	End Bell: Manufactured by Japan Aviation Electronics Industry, Ltd. Back Shell: Manufactured by Daiichi Denshi Kogyo K.K.		Cable Clamp	Manufacturer
					Angle (L-shaped)	Straight		
Motors	SGMS-	10V□D 15V□D 20V□D	CE05-2A18-10PD	MS3106A18-10S(D190)	CE-18BA-S	CE02-18BS-S	CE3057-10A-*	Daiichi Denshi Kogyo K.K
		30V□D 40V□D 50V□D	JL04HV-2E22-22PE-B	JL04V-6A22-22SE	JL04-22EBL	JL04-22EB	JL04-2022CK (**)	Japan Aviation Electronics Industry, Ltd.
	SGMG-	05V□D 09V□D 13V□D	CE05-2A18-10PD	MS3106A18-10S(D190)	CE-18BA-S	CE02-18BS-S	CE3057-10A-*	Daiichi Denshi Kogyo K.K
		20V□D 30V□D 44V□D	JL04HV-2E22-22PE-B	JL04V-6A22-22SE	JL04-22EBL	JL04-22EB	JL04-2022CK (**)	Japan Aviation Electronics Industry, Ltd.

Connector on motor side already provided (Receptacle)

To be prepared by customer (Plug through Manufacturer)

Note

1) To ensure compliance with IP67, always use correct combinations of receptacles and plugs.

2) Select an appropriate cable clamp type (mark **) according to the lead wire diameter.

3) When flexible conduit is used, select plug only.

• When Using Brake Connectors

	Receptacle	Plug	End Bell: Manufactured by Japan Aviation Electronics Industry, Ltd. Back Shell: Manufactured by Daiichi Denshi Kogyo K.K.		Cable Clamp	Manufacturer
			Angle (L-shaped)	Straight		
All Brake	CE05-2A10SL-3PC	MS3106A10SL-3S (D190)	CE-10SLBA-S	CE-10SLBS-S	CE3057-4A-1	Daiichi Denshi Kogyo K.K.

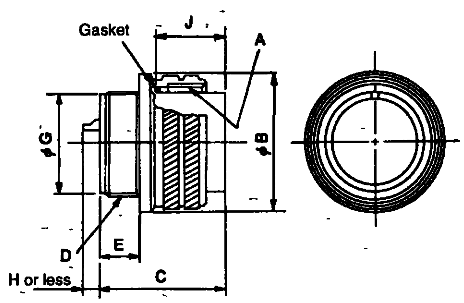
Connector on motor side already provided (Receptacle)

To be prepared by customer (Plug through Cable Clamp)

Note 1) To ensure compliance with IP67, always use correct combinations of receptacles and plugs.

2) When flexible conduit is used, select plug only.

MS(D190) Series: Plug for Conduit
MS3106A20-29S (D190)

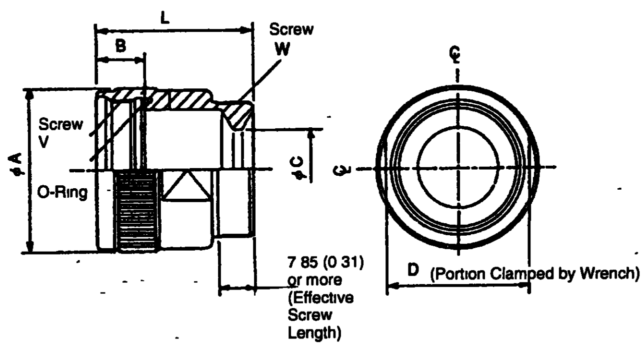


Dimensions in mm (inches)

Shell Size	A	B +0 −0.38 (−0.0150)	C±0.5 (±0.0197)	D	E±0.3 (±0.0118)	G +0.05 (+0.0020) −0.25 (−0.0098)	J±0.12 (±0.0047)
10SL	5/8-24UNEF-2B	22.22 (0.87)	23.3 (0.92)	9/16-24UNEF-2A	7.5 (0.30)	12.5 (0.49)	13.49 (0.53)
20	11/4-18UNEF-2B	37.28 (1.47)	34.11 (1.34)	11/18-18UNEF-2A	12.16 (0.48)	26.8 (1.06)	18.26 (0.72)

Made by Daiichi Denshi Kogyo K.K.

CE02-XXBS-S
Straight Back Shell (for MS(D190))



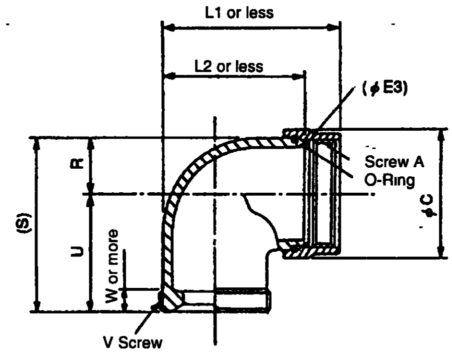
Dimensions in mm (inches)

Shell Size	Part Number	L	A	B	C	D	V	W
18	CE02-18BS-S	31 (1.22)	30.5 (1.20)	10.5 (0.41)	16.3 (0.64)	26.7 (1.05)	1-20UNEF-2B	1-20UNEF-2A
20	CE02-20BS-S	35 (1.38)	35 (1.38)	10.9 (0.41)	17.8 (0.70)	31.6 (1.24)	1 1/8-18UNEF-2B	1 3/16-18UNEF-2A

Made by Daiichi Denshi Kogyo K.K.

4

CE-XXBA-S (XXX)
Angle Back Shell (for MS(D190))

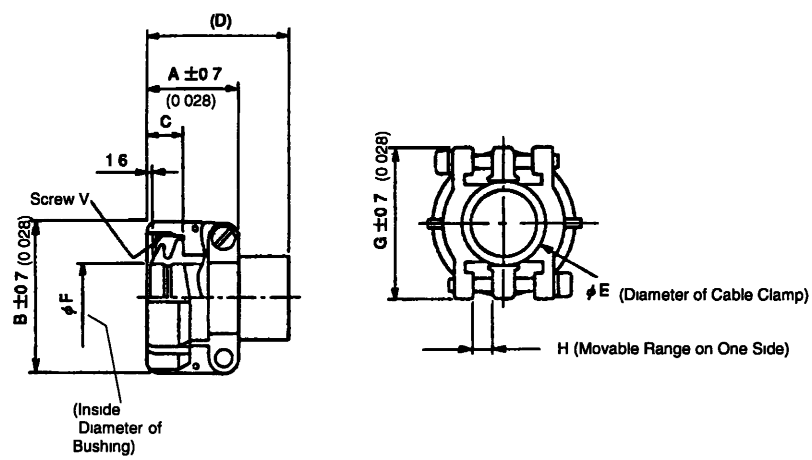


Dimensions in mm (inches)

Part Number	Shell Size	Joint Screw A	Overall Length L1	Overall Length of Angle Body L2	Outside Diameter of Coupling C	R	V	(S)	Cable Clamp Set Screw V	Effective Screw Length W
CE-10SLBA-S	10SL	9/16-24UNEF-2B	30.6 (1.20)	22.5 (0.89)	21.7 (0.85)	7.9 (0.31)	21 (0.83)	(28.9) (1.14)	5/8-24UNEF-2A	7.5 (0.30)
CE-18BA-S	18	1-20UNEF-2B	44.6 (1.76)	34 (1.34)	32.4 (1.28)	13.2 (0.52)	30.2 (1.19)	(43.4) (1.71)	1-20UNEF-2A	7.5 (0.30)
CE-20BA-S	20	1 1/18UNEF-2B	50.5 (1.99)	39.6 (1.56)	36 (1.42)	15 (0.59)	33.3 (1.31)	(48.3) (1.90)	1 3/16-UNEF-2A	7.5 (0.30)

Made by Daiichi Denshi Kogyo K.K.

CE3057-XXA (for MS(D190))
Waterproof Cable Clamp (with Rubber Bushing)



Dimensions in mm (inches)

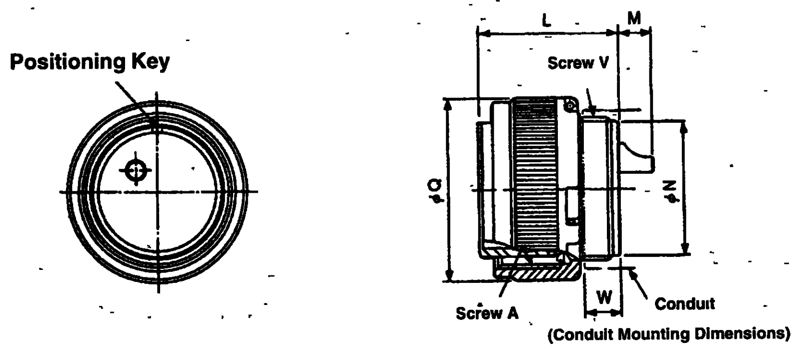
Part Number	Shell Size	Overall Length A	Outside Diameter B	Effective Screw Length C	(D)	E	F	G	H	Set Screw V	At-tached Bushing	Cable Size (for refer-ence)
CE3057 -4A-1	10SL	20.6 (0.81)	20.6 (0.81)	10.3 (0.41)	(41.3) (1.63)	7.9 (0.31)	5.6 (0.22)	22.2 (0.87)	1.6 (0.06)	5/8-24U NEF-2B	CE3420- 4-1	ø3.6 (0.14) ~ø5.6 (0.22)
CE3057 -10A-1	18	23.8 (0.94)	30.1 (1.19)	10.3 (0.41)	(41.3) (1.63)	15.9 (0.63)	14.1 (0.56)	31.7 (1.25)	3.2 (0.13)	1-20UN EF-2B	CE3420- 10-1	ø10.5 (0.41) ~ø14.1 (0.56)
CE3057 -10A-2							11.6 (0.46)				CE3420- 10-2	ø8.5 (0.25) ~ø11 (0.43)
CE3057 -10A-3							8.7 (0.34)				CE3420- 10-3	ø6.5 (0.22) ~ ø8.7 (0.38)
CE3057 -12A-1	20 22	23.8 (0.94)	35 (1.38)	10.3 (0.41)	(41.3) (1.63)	19 (0.75)	16 (0.63)	37.3 (1.47)	4 (0.16)	1 3/16-18U NEF-2B	CE3420- 12-1	ø12.5 (0.49) ~ø16 (0.63)
CE3057 -12A-2							13 (0.51)				CE3420- 12-2	ø9.5 (0.37) ~ ø13 (0.51)
CE3057 -12A-3							10 (0.38)				CE3420- 12-3	ø6.8 (0.27) ~ ø10 (0.39)
CE3057 -16A-1	24 28	26.2 (1.03)	42.1 (1.66)	10.3 (0.41)	(41.3) (1.63)	23.8 (0.94)	19.1 (0.75)	42.9 (1.69)	4.8 (0.19)	1 7/16-18U NEF-2B	CE3420- 16-1	ø15 (0.59) ~ø19.1 (0.75)
CE3057 -16A-2							15.5 (0.61)				CE3420- 16-2	ø13 (0.51) ~ø15.5 (0.61)

Made by Daiichi Denshi Kogyo K.K.

4.6.3 Connector cont.

4

Plug: JL04-6A

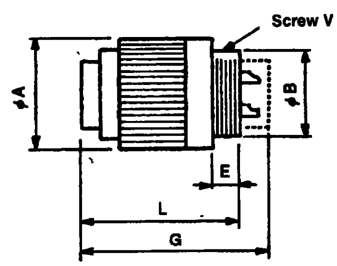


Dimensions in mm (inches)

Shell Size	No. of Cores	Parts Name	Joint Screw	L±0.4 (0.0157)	M±0.8 (0.0315)	N±0.2 (0.0079)	Q±0.8 (0.0315)	Screw V	W (max)
22	4	JL04-6A22-22S	1 3/8-18UNEF-2B	31.5 (1.24)	7.6 (0.30)	29 6 (1.17)	40.5 (1.59)	1 1/4-18UNEF-2A	8 (0.31)
24	7	JL04-6A24-10S	1 1/2-18UNEF-2B	35 (1.38)	5.9 (0.23)	32.8 (1.29)	43.7 (1.72)	1 3/8-18UNEF-2A	10 (0.39)

Made by Japan Aviation Electronics Industry, Ltd.

Plug: JL04V-6A

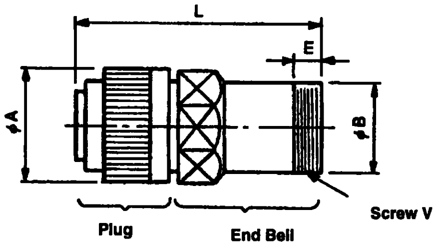


Dimensions in mm (inches)

Shell Size	Screw V	ΦA	ΦB	L	E (max)	G
20	11/8-18UNEF-2A	37.3±0.8 (1.47±0.0315)	27±0.2 (1.06±0.0079)	31.5±0.4 (1.24±0.0157)	8 (0.32)	---
32	17/8-16UN-2A	56.3±0.8 (22.2±0.0315)	45.4±0.2 (1.79±0.0079)	35.8±0.4 (1.41±0.0157)	10 (0.39)	---

Made by Japan Aviation Electronics Industry, Ltd.

End Bell (Straight): JL04-□□EB

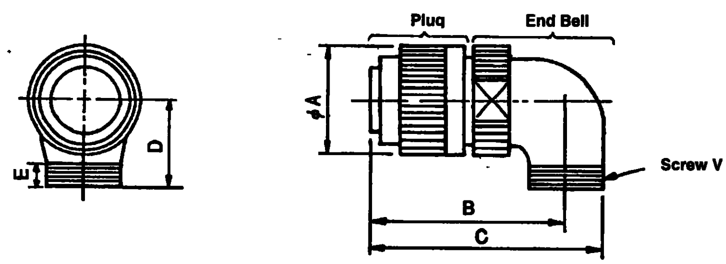


Dimensions in mm (inches)

Shell Size	Screw V	øA	øB	L	E (min)
20	13/16-18UNEF-2A	37.3±0.8 (1.47±0.0315)	30.05±0.2 (1.18±0.0079)	67.9±0.8 (2.67±0.0315)	8 (0.32)
22	13/16-18UNEF-2A	40.5±0.8 (1.59)(0.0315)	30.05±0.2 (1.18)(0.0079)	67.63±0.8 (2.66±0.0315)	8 (0.32)
24	17/16-18UNEF-2A	43.7±0.8 (1.72±0.0315)	36.4±0.2 (1.43±0.0079)	71±0.8 (2.80±0.0315)	8 (0.32)

Made by Japan Aviation Electronics Industry, Ltd.

End Bell (L-shaped): JL04-□□EBL

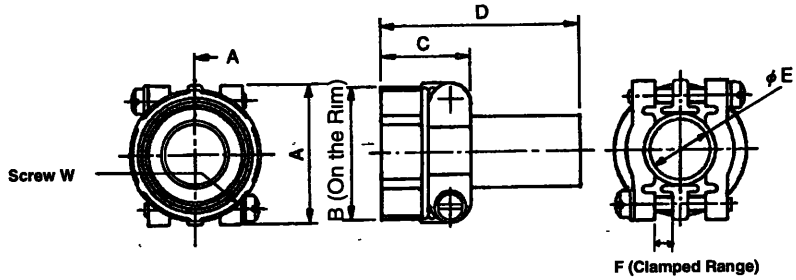


Dimensions in mm (inches)

Shell Size	Screw V	øA	B	C	D	E
20	13/16-18UNEF-2A	37.3±0.8 (1.47±0.0315)	60.5±0.8 (2.38±0.0315)	74.2±0.8 (2.92±0.0315)	32±0.8 (1.26±0.0315)	10±0.5 (0.39±0.0197)
22	13/16-18UNEF-2A	40.5±0.8 (1.59±0.0315)	60.23±0.8 (2.37±0.0315)	73.93±0.8 (2.91±0.0315)	32±0.8 (1.26±0.0315)	10±0.5 (0.39±0.0197)
24	17/16-18UNEF-2A	43.7±0.8 (1.72±0.0315)	65±0.8 (2.56±0.0315)	82±0.8 (3.23±0.0315)	38±0.8 (1.50±0.0315)	10±0.5 (0.39±0.0197)

4.6.3 Connector cont.

Cable Clamp: JL04-□CK(✻✻)



Dimensions in mm (inches)

Parts Name/Size	A±0.8 (±0.0315)	B±0.8 (±0.0315)	C±0.8 (±0.0315)	D±0.8 (±0.0315)	ØE±0.8 (±0.0315)	F	Screw W	Cable Size
JL04-2022CK(14)	37.3 (1.47)	34.9 (1.37)	24.3 (0.96)	53.8 (2.11)	15.9 (0.63)	4 (0.16)	13/16-18UNEF-2B	Ø12.9 (0.51) ~Ø15.9 (0.63)
JL04-2428CK(17)	42.9 (42.9)	42.1 (1.66)	26.2 (1.03)	56.2 (2.21)	18 (0.71)	4.8 (0.19)	17/16-18UNEF-2B	Ø15 (0.59)~ Ø18 (0.71)

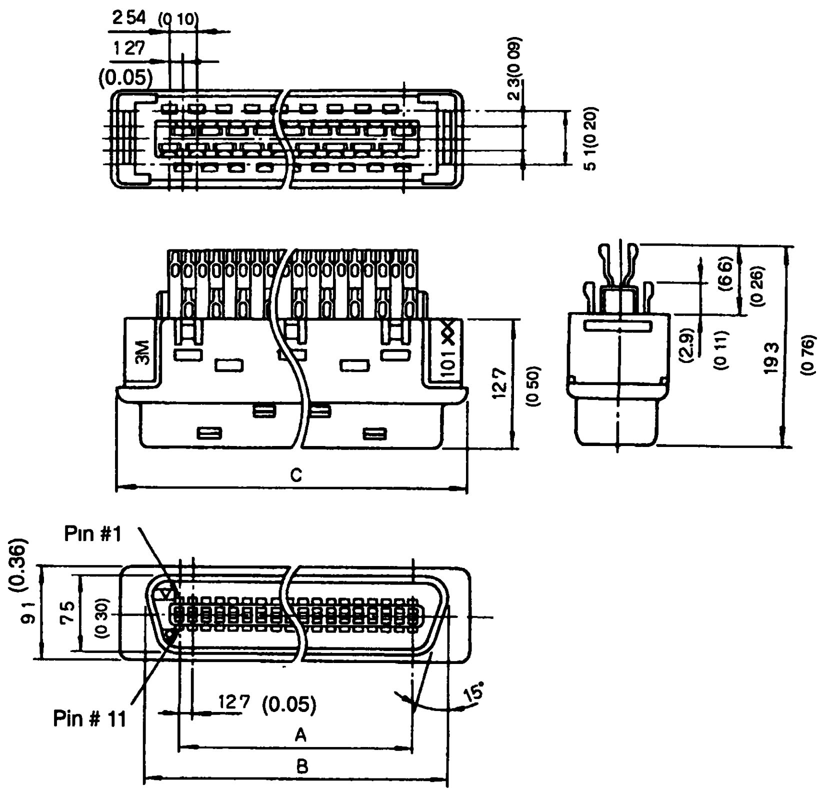
- Common to the SGMG, SGMS Types (2CN)

4) Only one type of encoder connector is available for the Servopack end of the cable.

- PG connector kit

Type	Contain Parts			
	Connector		Case	
	Type	Quantity	Type	Quantity
JZSP-VEP02	10120-3000VE	1	10320-52S0-00S	1 set

• Connector



Units: mm (inches)

Connector Type	A	B	C
10120-3000VE	11.43 (0.45)	17.6 (0.69)	22.0 (0.87)

Manufactured by 3M.

• Case

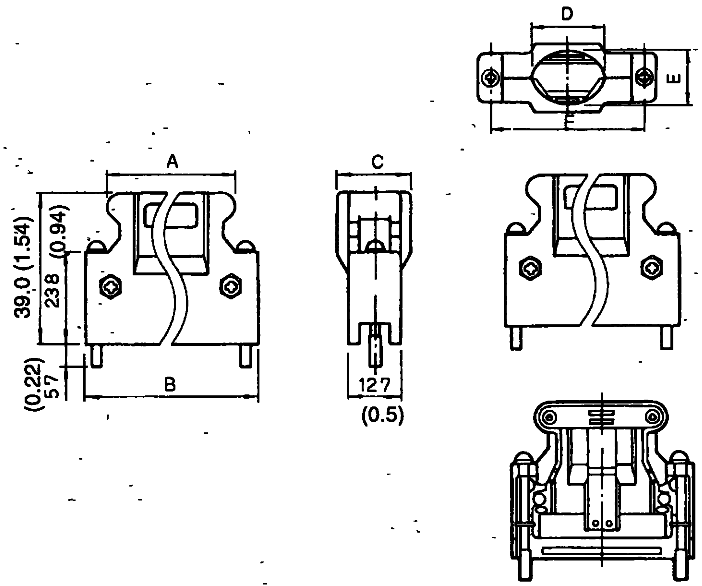


Diagram of Assembled Connector (for reference)

Units: mm (inches)

Connector Kit Type	Connector	Case	A	B	C	D	E	F
JZSP-VEP02	10120-3000VE	10320-52S0-00S	22.0 (0.87)	33.3 (1.31)	14.0 (0.55)	12.0 (0.47)	10.0 (0.39)	27.4 (1.08)

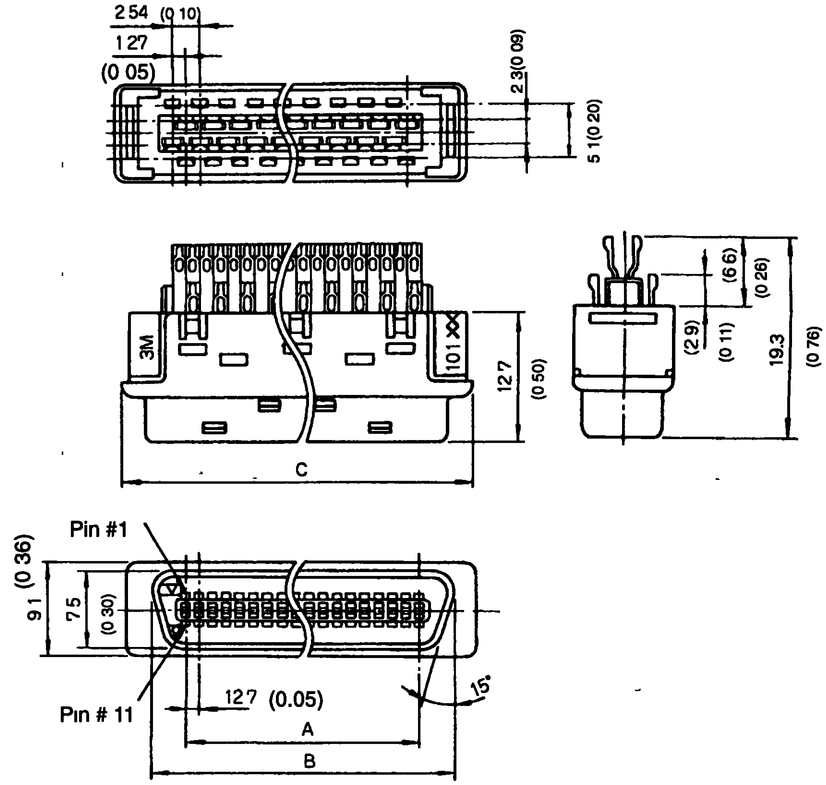
Manufactured by 3M.

• I/O connector for servopack (1, 6CN)

• I/O connector kit

Type	Contain Parts			
	Connector		Case	
	Type	Quantity	Type	Quantity
JZSP-VEI02	10126-3000VE	1	10326-52S0-00S	1

• Connector



Units: mm (inches)

Connector Type	A	B	C
10126-3000VE	15.24 (0.6)	21.5 (0.85)	25.8 (1.02)

Manufactured by 3M.

• Case

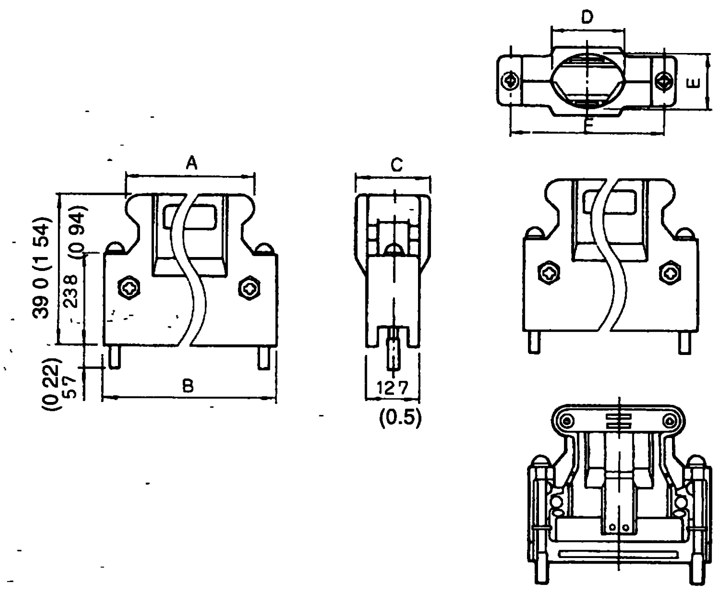


Diagram of Assembled Connector (for reference)

Units: mm (inches)

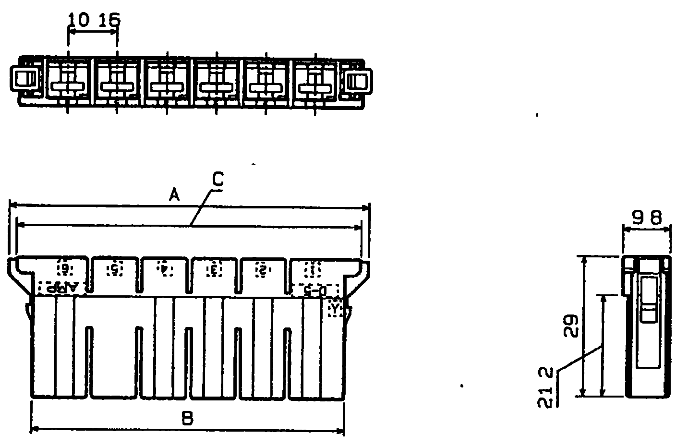
Connector Kit Type	Connector	Case	A	B	C	D	E	F
JZSP-VEI02	10126-3000VE	10326-52S0-00S	25.8 (1.02)	37.2 (1.46)	14.0 (0.55)	12.0 (0.47)	10.0 (0.40)	31.3 (1.23)

Manufactured by 3M.

• Regenerative resistor connector for converter JUSP-ACP15GD (1CN)

• Regenerative resistor connector kit

Type	Contain Parts			
	Housing		Contact	
	Type	Quantity	Type	Quantity
JZSP-CEE00-1	1-179958-2	2	316041-2	2

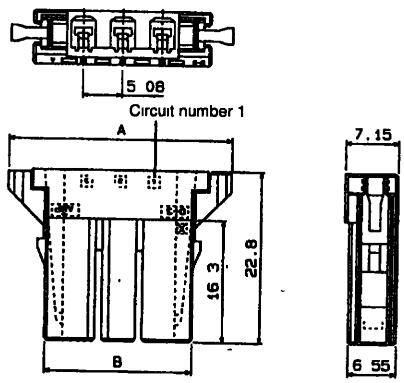


Pos.	Model Number	Dimensions in mm	
		A	B
2	□-179958-2	53.76	23.76

- Motor connector for Servopack end of cable (3CN) (For SGDC-05DSA to 30DSA)

  - Motor connector kit (SERVOPACK side)

Type	Contain Parts			
	Housing		Contact	
	Type	Quantity	Type	Quantity
JZSP-CEM02-1	1-178128-6	1	1-917511-2	6

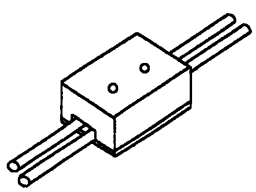


Pos.	Model Number	Dimensions in mm	
		A	B
6	□-178128-6	44.94	34.48

4.6.4 Brake Power Supply

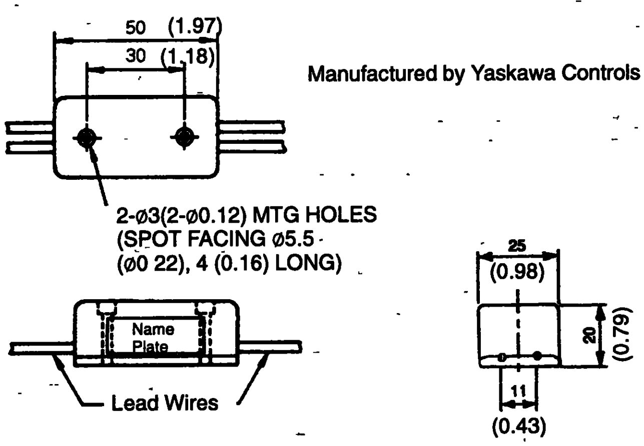
1) Brake power supplies are available for 200 V input.

200 VAC Input: LPSE-2H01



Use for Servomotor with brake.

• Dimensional Drawings



• Lead Wire Length: 500 mm each (19.69 in.)

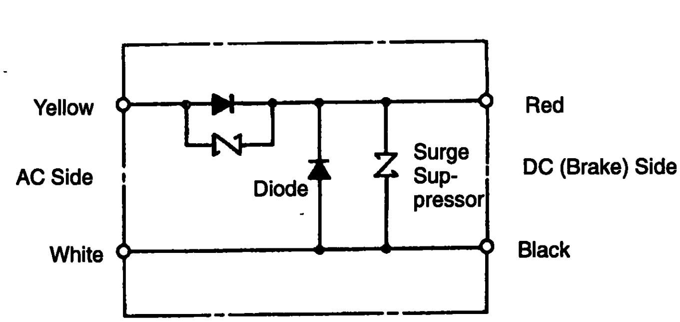
• Max. Ambient Temperature: 60°C

• Lead Wires: Color Code

AC Input	Brake
200V	
Yellow/White	Red/Black

NOTE 2) 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 "2.4.4 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)

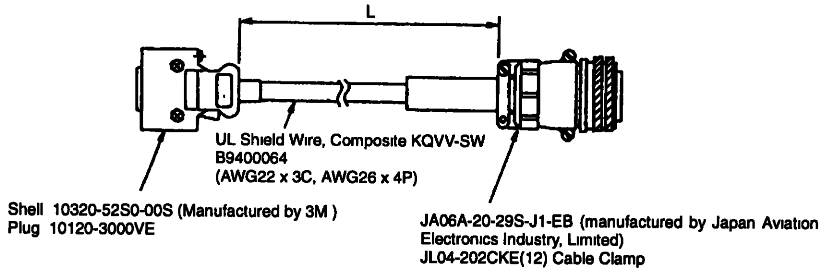


4.6.5 Encoder Cables

The dimensions and appearance of the encoder cables are shown below. Specify the cable type when ordering.

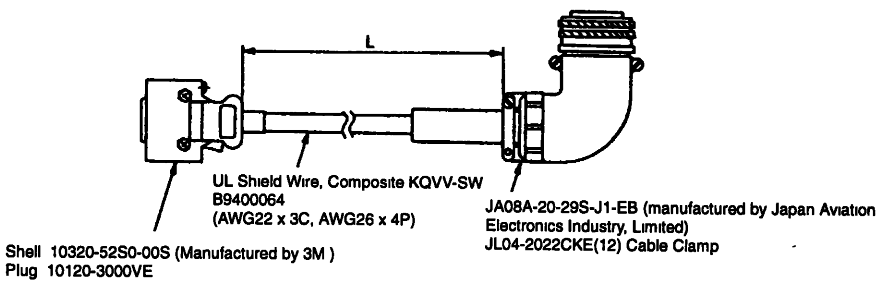
1) For the SGMG, SGMS Types

a) Cables for Incremental Encoder (with Straight Plug)



Type	L in mm (feet)
JZSP-VEP00-6	3000^{+100}_{0} ($10^{+0.33}_{0}$)
JZSP-VEP00-7	5000^{+100}_{0} ($16.7^{+0.33}_{0}$)
JZSP-VEP00-8	10000^{+500}_{0} ($33.3^{+1.67}_{0}$)
JZSP-VEP00-9	15000^{+500}_{0} ($50^{+1.67}_{0}$)
JZSP-VEP00-10	20000^{+500}_{0} ($66.7^{+1.67}_{0}$)

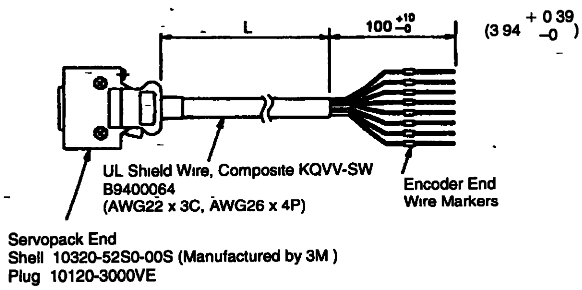
b) Cables for Incremental Encoder (with L-shaped Plug)



4.6.5 Encoder Cables cont.

Type	L in mm (feet)
JZSP-VEP00-1	3000^{+100}_{0} $(10^{+0.33}_{0})$
JZSP-VEP00-2	5000^{+100}_{0} $(16.7^{+0.33}_{0})$
JZSP-VEP00-3	10000^{+500}_{0} $(33.3^{+1.67}_{0})$
JZSP-VEP00-4	15000^{+500}_{0} $(50^{+1.67}_{0})$
JZSP-VEP00-5	20000^{+500}_{0} $(66.7^{+1.67}_{0})$

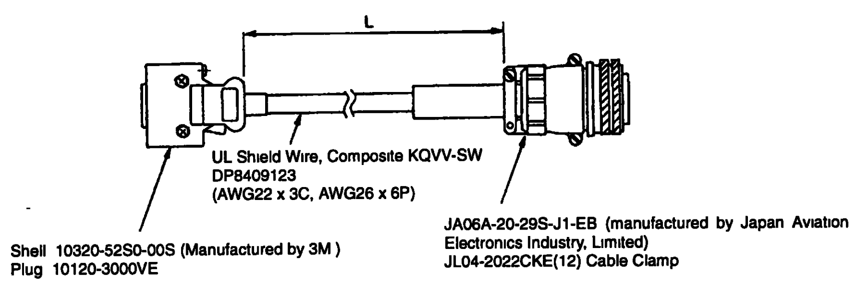
c) Cables for Incremental Encoder (without Connector on Encoder End)



Type	L in mm (feet)
JZSP-VEP01-1	3000^{+100}_{0} $(10^{+0.33}_{0})$
JZSP-VEP01-2	5000^{+100}_{0} $(16.7^{+0.33}_{0})$
JZSP-VEP01-3	10000^{+500}_{0} $(33.3^{+1.67}_{0})$
JZSP-VEP01-4	15000^{+500}_{0} $(50^{+1.67}_{0})$
JZSP-VEP01-5	20000^{+500}_{0} $(66.7^{+1.67}_{0})$

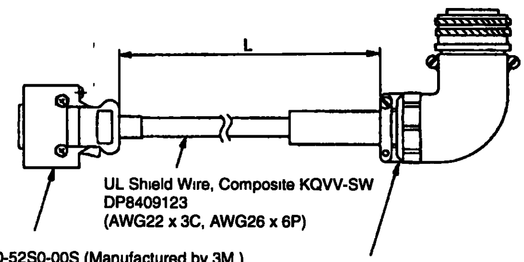
Purchase cases and connectors separately. Refer to *Section 4.6.3 Connector* for details.

d) Cables for Absolute Encoder (with Straight Plug)



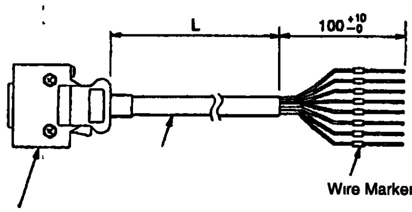
Type	L in mm (feet)
JZSP-VEP10-6	3000^{+100}_{0} $(10^{+0.33}_{0})$
JZSP-VEP10-7	5000^{+100}_{0} $(16.7^{+0.33}_{0})$
JZSP-VEP10-8	10000^{+500}_{0} $(33.3^{+1.67}_{0})$
JZSP-VEP10-9	15000^{+500}_{0} $(50^{+1.67}_{0})$
JZSP-VEP10-10	20000^{+500}_{0} $(66.7^{+1.67}_{0})$

e) Cables for Absolute Encoder (with L-shaped Plug)



Type	L in mm (feet)
JZSP-VEP10-1	3000^{+100}_{0} $(10^{+0.33}_{0})$
JZSP-VEP10-2	5000^{+100}_{0} $(16.7^{+0.33}_{0})$
JZSP-VEP10-3	10000^{+500}_{0} $(33.3^{+1.67}_{0})$
JZSP-VEP10-4	15000^{+500}_{0} $(50^{+1.67}_{0})$
JZSP-VEP10-5	20000^{+500}_{0} $(66.7^{+1.67}_{0})$

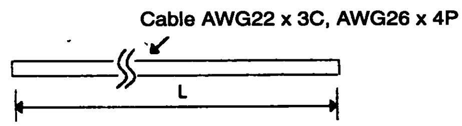
f) Cables for Absolute Encoder (without Connector on Encoder End)



Type	L in mm (feet)
JZSP-VEP11-1	3000^{+100}_{0} $(10^{+0.33}_{0})$
JZSP-VEP11-2	5000^{+100}_{0} $(16.7^{+0.33}_{0})$
JZSP-VEP11-3	10000^{+500}_{0} $(33.3^{+1.67}_{0})$
JZSP-VEP11-4	15000^{+500}_{0} $(50^{+1.67}_{0})$
JZSP-VEP11-5	20000^{+500}_{0} $(66.7^{+1.67}_{0})$

Purchase cases and connectors separately. Refer to *Section 4.6.3 Connector* for details.

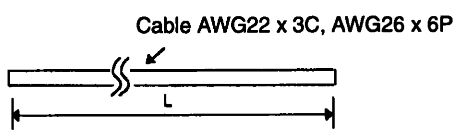
g) Cables for Incremental Encoder (without Connector on Both Ends)



Type	L in mm (feet)
B9400064-1	3000^{+100}_{0} $(10^{+0.33}_{0})$
B9400064-2	5000^{+100}_{0} $(16.7^{+0.33}_{0})$
B9400064-3	10000^{+500}_{0} $(33.3^{+1.67}_{0})$
B9400064-4	15000^{+500}_{0} $(50^{+1.67}_{0})$
B9400064-5	20000^{+500}_{0} $(66.7^{+1.67}_{0})$

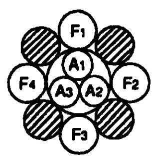
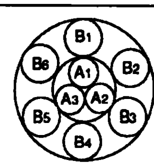
Purchase caps, sockets, cases, and connectors separately. Refer to *Section 4.6.3 Connector* for details.

h) Cables for Absolute Encoder (Cable Only)



Type	L in mm (feet)
DP8409123-1	3000^{+100}_{0} $(10^{+0.33}_{0})$
DP8409123-2	5000^{+100}_{0} $(16.7^{+0.33}_{0})$
DP8409123-3	10000^{+500}_{0} $(33.3^{+1.67}_{0})$
DP8409123-4	15000^{+500}_{0} $(50^{+1.67}_{0})$
DP8409123-5	20000^{+500}_{0} $(66.7^{+1.67}_{0})$

Purchase caps, sockets, cases, and connectors separately. Refer to *Section 4.6.3 Connector* for details.

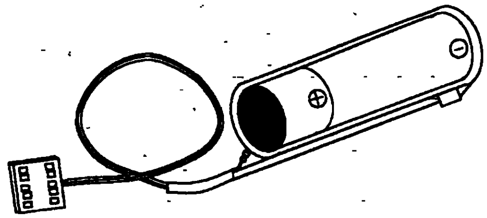
Cable Specification	Incremental Encoder (Yaskawa Drg. #B9400064)	Absolute Encoder (Yaskawa Drg. #DP8409123)
Basic Specifications	Compound KQVV-SW AWG22 x 3C, AWG26 x 4P	Compound KQVV-SW AWG22 x 3C, AWG26 x 6P
Finished Dimension	ø7.5 mm (ø0.30)	ø8.0 mm (ø0.31)
Internal Structure and Lead Colors	 A_1 Red 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 appropriate cable is used, the allowable wiring distance between Servopack and Servomotor (PG) is 20 m (65.6) max.

Note See items 1) a) to f) in this section for details about cables with connectors.

4.6.6 Battery for Absolute Encoder

1) Purchase the following battery if using an absolute encoder. (Manufactured by Toshiba Battery Co., Ltd.)

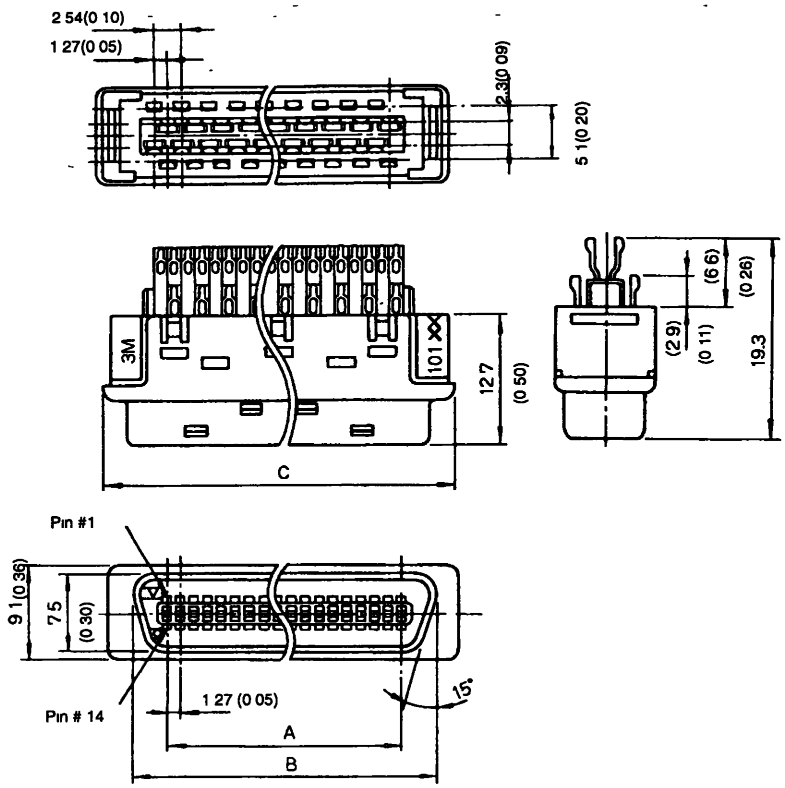


- Lithium Battery: ER 6 V C3
- Nominal Voltage: 3.6 V
- Standard Capacity: 2000 mAh

4.6.7 1CN, 6CN Connector

1) This connector is required to connect the host controller to 1CN, 6CN on the Servopack.

- Connector



Units: mm (inches)

Connector Type	A	B	C
10126-3000VE	15.24 (0.60)	21.5 (0.85)	25.8 (1.02)

Manufactured by 3M.

• Case

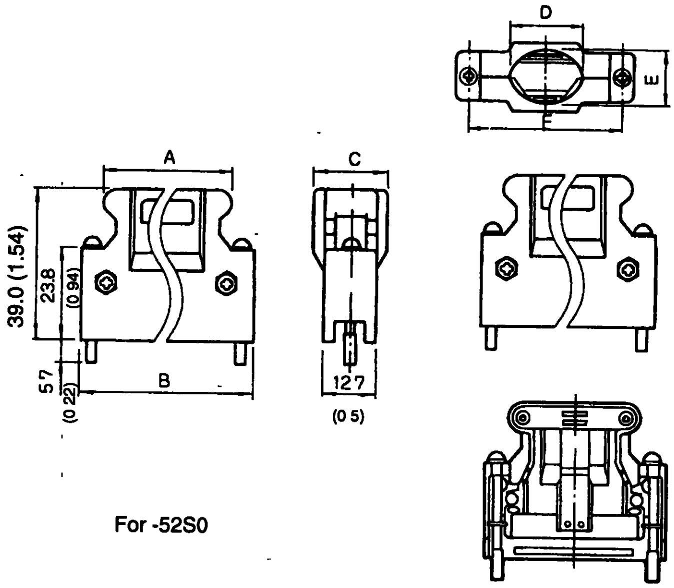


Diagram of Assembled Connector (for reference)

Units: mm (inches)

Connector Type	Case Type	A	B	C	D	E	F
10126-3000 VE	10326-5 2S0-00S	25.8 (1.02)	37.2 (1.46)	14.0 (0.55)	12.0 (0.47)	10.0 (0.39)	31.3 (1.23)

Manufactured by 3M.

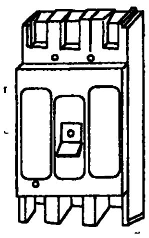
2) The 1CN, 6CN connector type is shown below.

Connector Type	Application	Connector Part List			
		Connector		Case	
		Type	Qty	Type	Qty
JZSP-VEI02	I/O connector for 1CN, 6CN	10126-3000VE*	1	10326-52S0-00S	1

* Manufactured by 3M.

4.6.8 Circuit Breaker

1) The customer should purchase a circuit breaker (MCCB) of appropriate capacity.



- Recommended Product

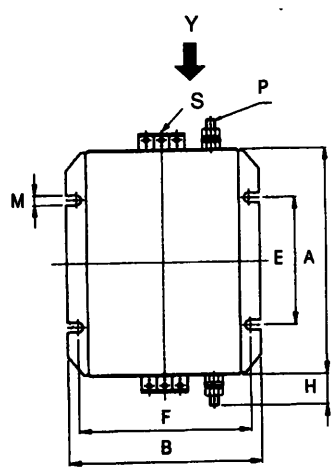
  Ground fault detector for motor protection manufactured by Mitsubishi Electric Co Ltd.
  Type: MN50-CF

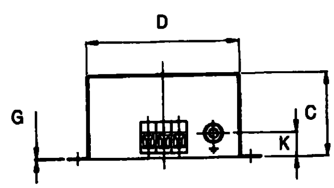
Use to protect the power lines.

4.6.9 Noise Filter

1) Select the noise filter from the following types according to the Converter capacity. *Section 4.6.1 Cable Specifications and Peripheral Devices* provides a summary list showing the relationship between Converter capacity and noise filter type.

- **For main power line**

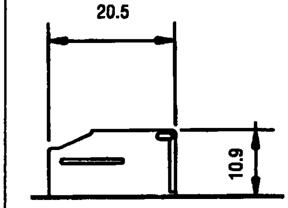
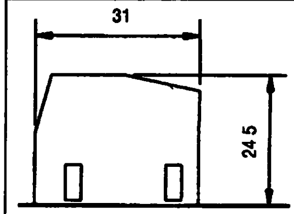




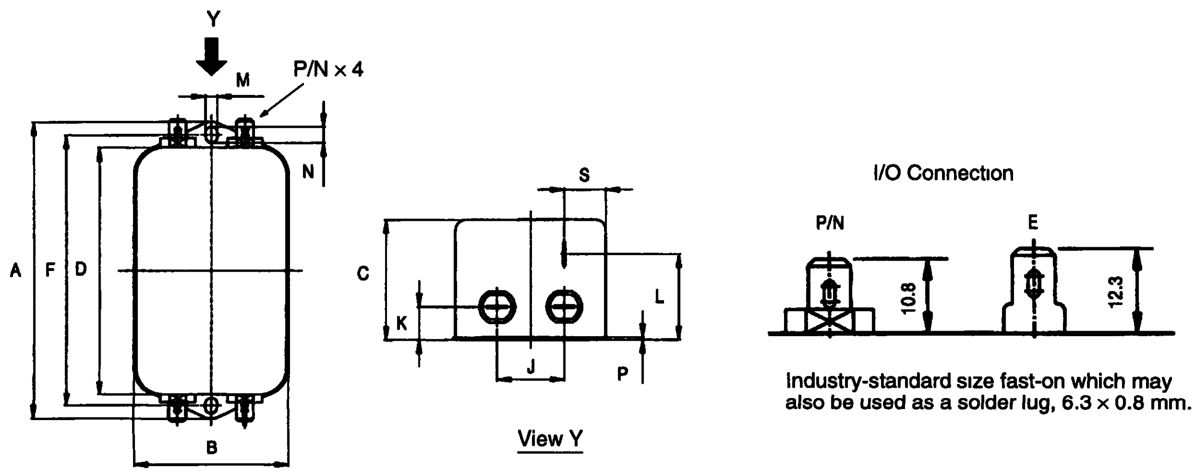
View Y (Top view)

in mm (inches)

Parts Name	A	B	C	D	E	F	G
FN351-16/29	200 (7.87)	150 (5.91)	65 (2.56)	120 (4.72)	115 (4.53)	136 (5.35)	0.75 (0.03)
FN351-25/29							
FN351-50/33							

Parts Name	H	K	M	P	S
FN351-16/29	20 (0.79)	17 (0.67)	64 (0.25)	M6	
FN351-25/29					Safety terminal block for 6 mm^2 or AWG 10 cables
FN351-50/33					 Safety terminal block for 10 mm^2 or AWG 6 cables

• **For Control Power Line**



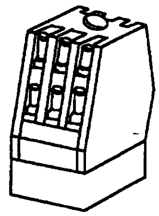
in mm (inches)

Parts Name	A	B	C	D	F	J
FN2070-6/06	113.5 (4.47)	57.5 (2.26)	45.4 (1.79)	94 (3.70)	103 (4.06)	25 (0.98)

Parts Name	K	L	M	N	P	S
FN2070-6/06	124 (0.49)	32.4 (1.28)	44 (0.17)	6 (0.24)	0.9 (0.04)	15.5 (6.10)

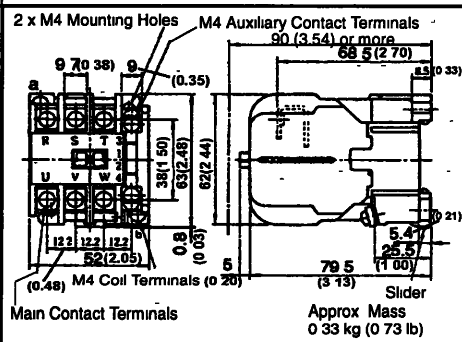
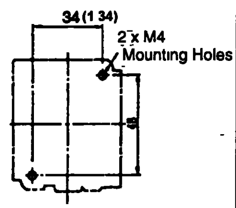
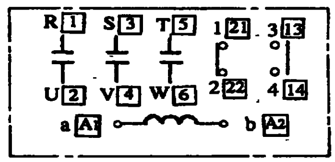
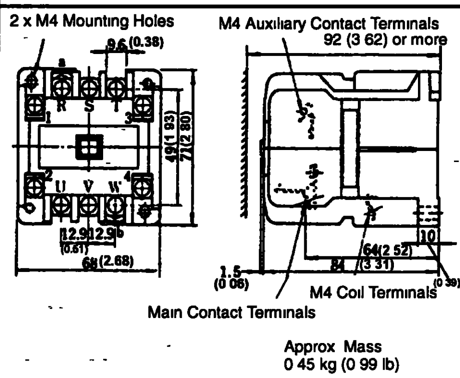
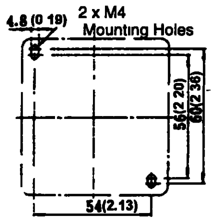
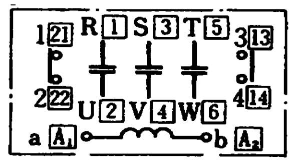
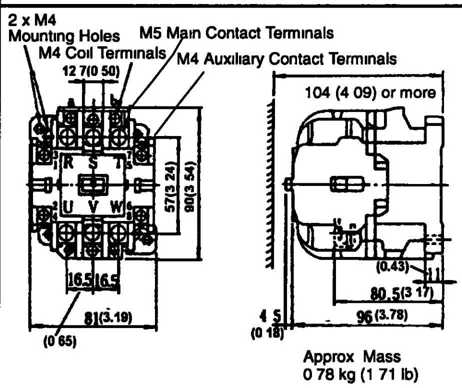
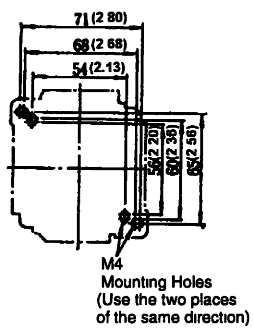
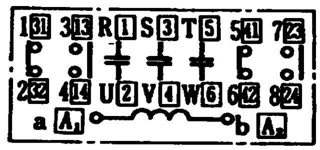
4.6.10 Magnetic Contactor

1) Select an appropriate magnetic contactor according to the JUSP Converter capacity.



Turns servo ON and OFF.

(Note) Attach an appropriate surge suppressor to the magnetic contactor.

Type	Outside Dimensions	Mounting Holes	Terminal Symbols
HI-15E5			
HI-18E			
HI-30E			

4.6.11 Surge Suppressor

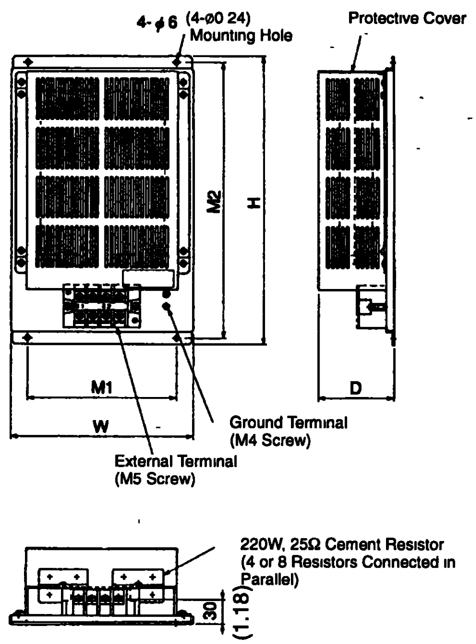
1) Attach a surge suppressor to the magnetic contactor to prevent power supply noise and protect contacts.

4.6.12 Regenerative Resistor Unit

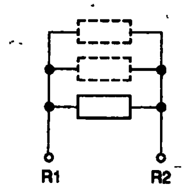
1) Use one of the following regenerative resistor units according to the Converter type:

Converter Type	Regenerative Resistor Unit Type
JUSP-ACP08GD	Not required
JUSP-ACP15GD	JUSP-RA06
JUSP-ACP30GD	JUSP-RA07

• Dimensional Drawings



• Terminal Numbers



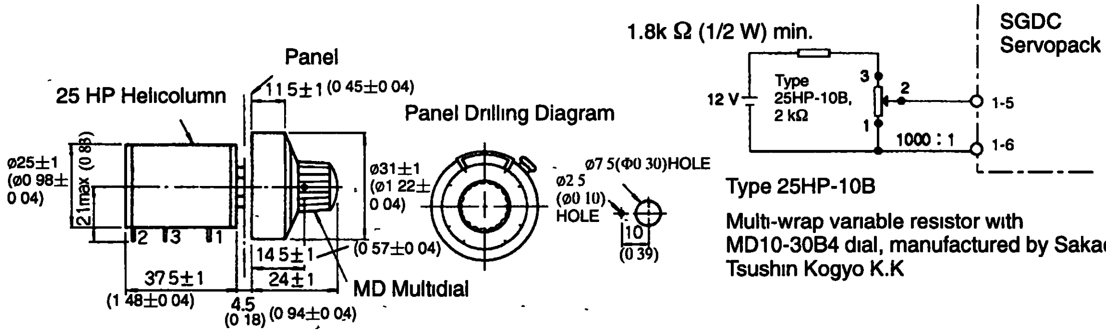
Units: mm (inches)

Type	W	H	D	M1	M2	Approx. mass
JUSP-RA06	220 (8.66)	350 (13.78)	92 (3.62)	180 (7.09)	335 (13.19)	4 kg
JUSP-RA07	300 (11.81)	350 (13.78)	95 (3.74)	250 (9.84)	335 (13.19)	7 kg

4.6.13 Variable Resistor for Speed Setting

1) This variable resistor is used to give speed references by applying the speed reference voltage from an external power supply across 1CN pins #3 and #4.

• Dimensional Drawings

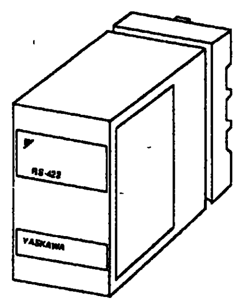


Type 25HP-10B

Multi-wrap variable resistor with MD10-30B4 dial, manufactured by Sakae Tsushin Kogyo K.K

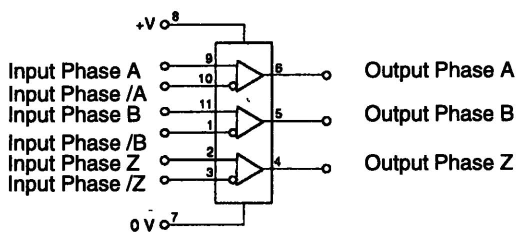
4.6.14 Encoder Signal Converter Unit

1) Unit to convert the encoder signal output from the line driver to an open collector output or voltage pulse output.

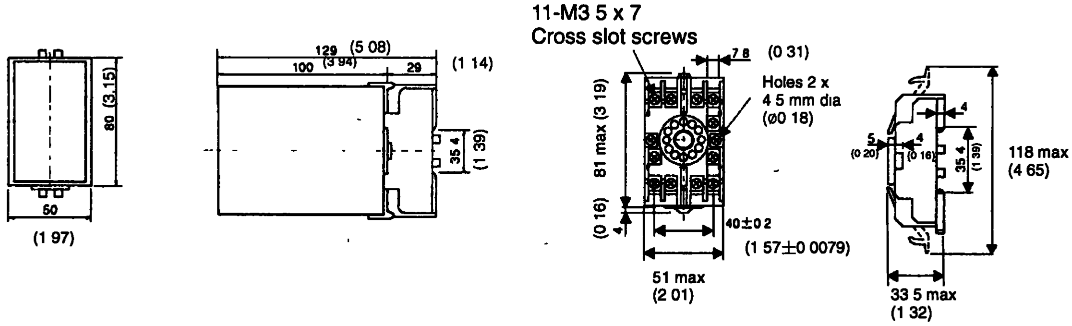


Line Receiver Unit

• Terminal Numbers



• Dimensional Drawings



2) The encoder signal converter unit specifications are as follows:

Type	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			

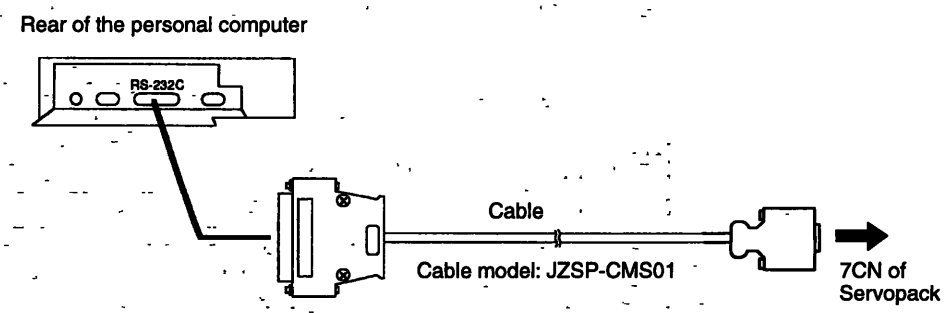
4.6.15 Cables for Connecting PC and Servopack

Special cables are used to connect a PC to a Servopack. With these cables, user constants can be monitored and set with a PC.

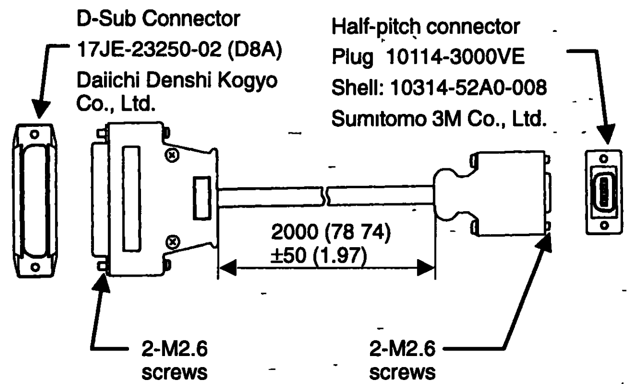
Communications software that controls the Servodrive from a PC is available from Yaskawa. Contact your Yaskawa representative for more details, and operate the software as described in the manual supplied.

■ D-sub, 25-pin Connector Cable

Connecting a Personal Computer to a Servopack



Cable Configuration



Communications Specifications

The communications specifications are as follows:

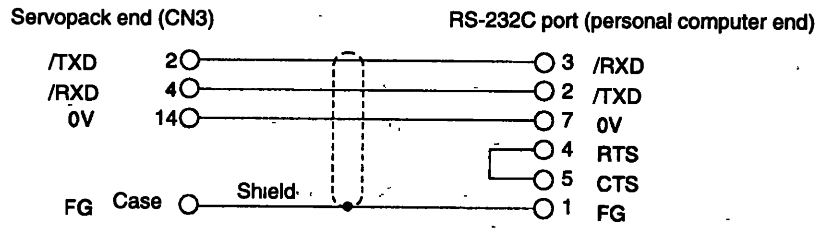
- Baud Rate: 9600 bps
- Number of Bits: Start: 1 bit
  Data: 7 bits
  Stop: 1 bit
  Parity: 1 bit (even)

- Synchronization Method: Start-Stop
- XON/XOFF Control: None
- Shift Control: None
- Communications Method: Semi-duplex

Connection Circuits

- **With an RS-232C Port**

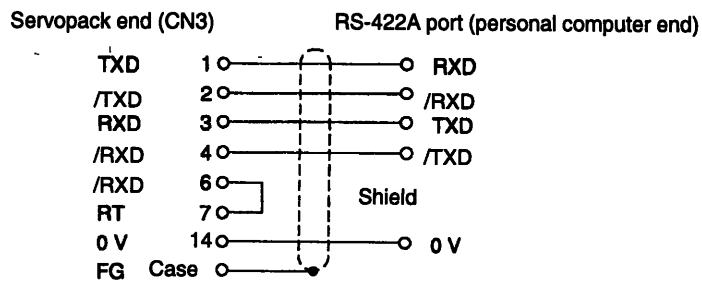
Maximum cable length is 2 m (6.56 ft). In this case, the connection circuit is as follows:



- **With an RS-422A Port**

The Servopack can also be connected to an 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 the Servopack End**

Connector Pin Numbers and Signal Names

Pin No.	Signal Name	Signal Circuit Name	Signal Direction
1	TXD	Transmit data (not inverted)	P *1 ← S *2
2	/TXD	Transmit data (inverted)	P ← S
3	RXD	Receive data (not inverted)	P → S
4	/RXD	Receive data (inverted)	P → S
5	OPH	Reserved pin	–
6	/RXD	Short pins 6 and 7 to insert a 220 Ω terminating resistance between RXD and /RXD.	
7	RT		
8	TXD	Transmit data (not inverted)	P ← S
9	/TXD	Transmit data (inverted)	P ← S
10	RXD	Receive data (not inverted)	P → S
11		Reserved pin	# *3
12		Reserved pin	# *3
13	5VPP	Reserved pin	–
14	GND	Signal ground: 0 V	–

*1 P: Personal computer

*2 S: Servopack

*3 #: Reserved terminal (Leave open.)

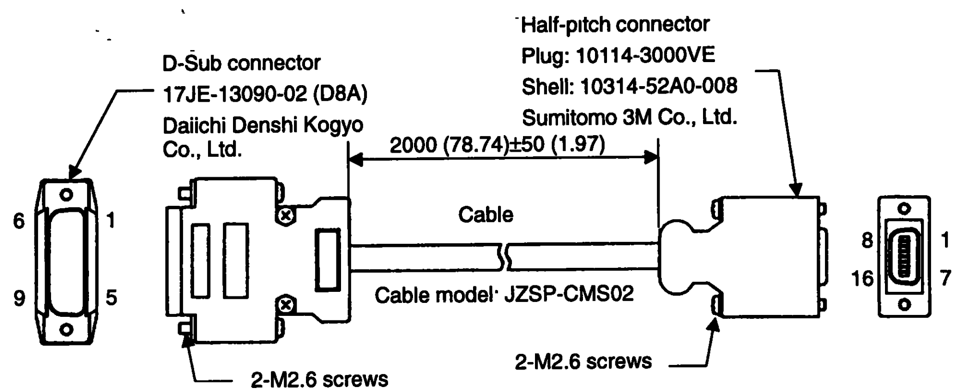
Note Fold back and clamp the cable shield at both ends.

■ Other Cables for Connecting Personal Computers

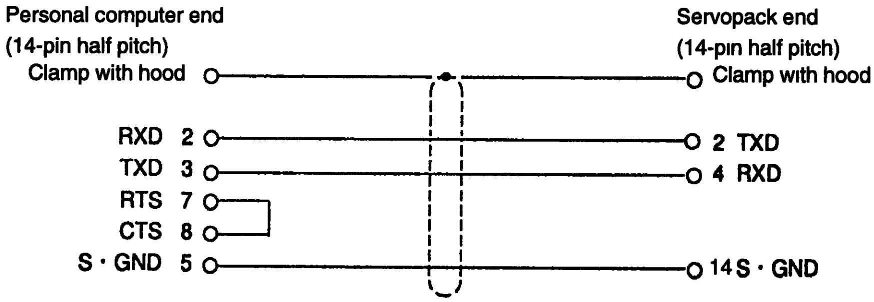
Yaskawa also provides cables for connecting NEC PC98 Series and IBM PC compatible to a Servopack.

D-sub, 9-pin Connector Cable for IBM PC Compatible

• **Cable Configuration**

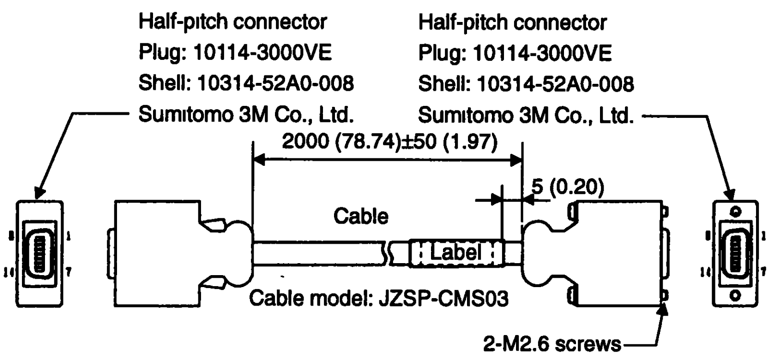


- **Connecting Circuit**

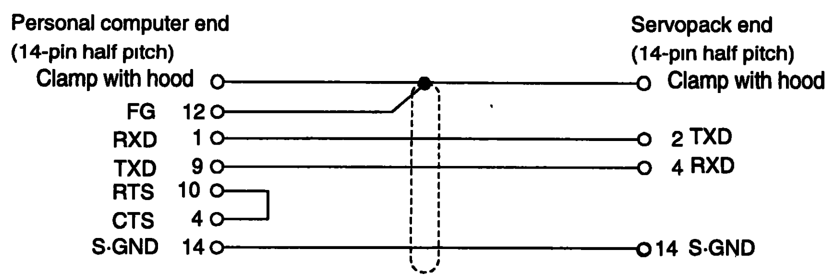


14-pin Half-pitch Connector Cable for NEC PC-98 Series PC

- **Cable Configuration**



- **Connecting Circuit**



INSPECTION, MAINTENANCE, AND TROUBLESHOOTING

5

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.

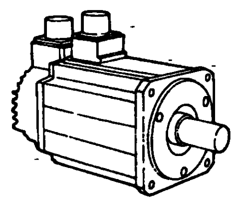
5.1 Inspection and Maintenance

This section describes the basic inspections and maintenance for Σ-Series servo drives.

5.1.1 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	Yearly	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	Every 5,000 hours	Remove servomotor from machine and replace oil seal.	Applies only to motors with oil seal.
Overhaul	Every 20,000 hours or 5 years	Contact your Yaskawa representative.	The customer should not disassemble and clean the servomotor.

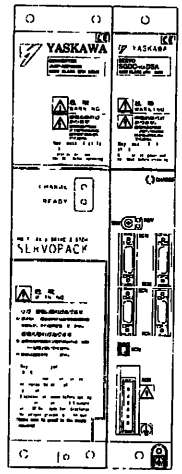
Note Measure across the servomotor FG and the U-phase, V-phase, or W-phase power lead.

During inspection and maintenance, do not disassemble the servomotor.
If disassembly of the servomotor is required, contact your Yaskawa representative.

5.1.2 Servopack and Converter

For inspection and maintenance of the Servopack and Converter, follow the inspection procedures in the table below at least once every year.

The Servopack and Converter contain highly reliable parts and daily inspection is not required. Carry out the inspections and maintenance in the table below once every year.



Converter Servopack

Item	Frequency	Procedure	Remedy
Clean unit interior and circuit boards	Yearly	Check for dust, dirt, and oil on the surfaces.	Clean with compressed air.
Loose screws	Yearly	Check for loose terminal block and connector screws.	Tighten any loose screws.
Defective parts in unit or on circuit boards.	Yearly	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.

Note Operating Conditions:

- Ambient Temperature: annual average 30°C

- Load Factor: 80% max.
- Operation Rate: 20 hours/day max.

If the Servopack and the Converter has been already overhauled at YASKAWA, its user constants are set back to the standard settings on shipment. Always check the user constants before operating the motor.

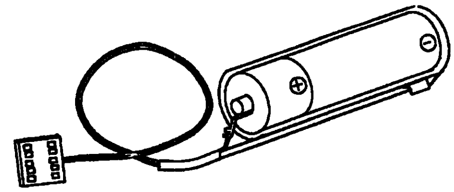
5

5.1.3 Replacing Battery for Absolute Encoder

Battery replacement is only required for servo systems using an absolute encoder.

The battery type 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

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.

Note After completing step 1 above, the absolute encoder will function normally for up to 2 days with no battery.

5.2 Troubleshooting

This section describes causes and remedies for problems which cause an alarm display and for problems which result in no alarm display.

5.2.1 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.

1. 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

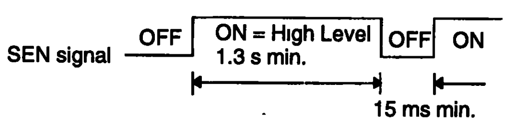
Status When Alarm Occurred

	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 below.) • If Cn-01 Bit 1 = 1, turn Servopack power OFF and back ON.
D	Incorrect user constant 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.

NOTE **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 User constants 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 User constant 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 user constant was previously set or loaded.	Reset all user constants in range. Otherwise, re-load correct user constants.
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 U, V, or W phase 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.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

Occurred when the control power turned ON. — D

Occurred approximately 0.6 second after the main circuit power turned ON. — A, C

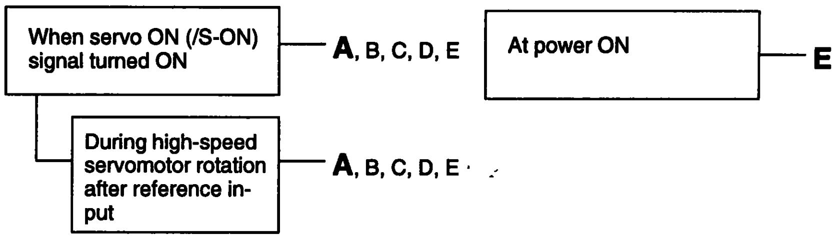
	Cause	Remedy
A	The power supply voltage is not within the range of specifications.	Check power supply.
B	Load exceeds capacity of the regenerative unit.	Check specifications of load inertia and overhanging load.
C	Fuse blown.	Replace Servopack.
D	Servopack defective.	

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



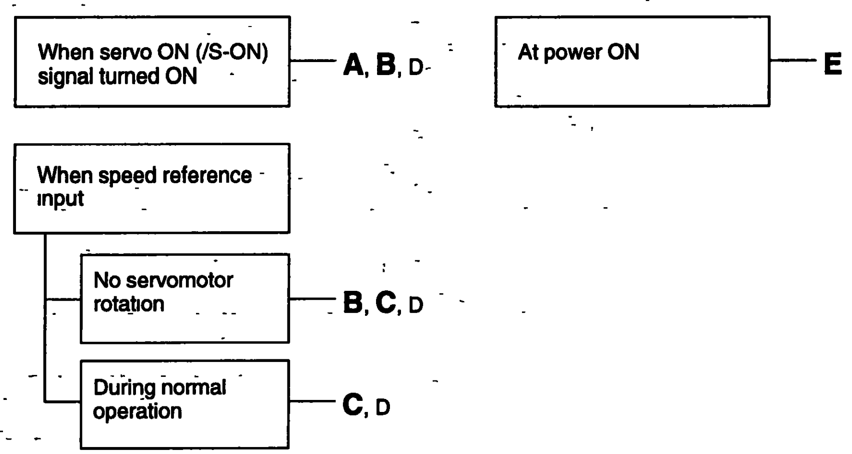
	Cause	Remedy
A	• Servomotor wiring incorrect. • Encoder wiring incorrect (disconnection, short-circuit, power supply, etc.)	Check and correct wiring. (Check A-, B-, C-phase pulses correct at 2CN.)
B	Incremental encoder power not supplied from Servopack.	Use the Servopack power supply for the encoder.
C	Noise in encoder wiring.	Separate encoder wiring from main wiring circuits.
D	Incorrect user constant (number of encoder pulses) setting.	Set user constant 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



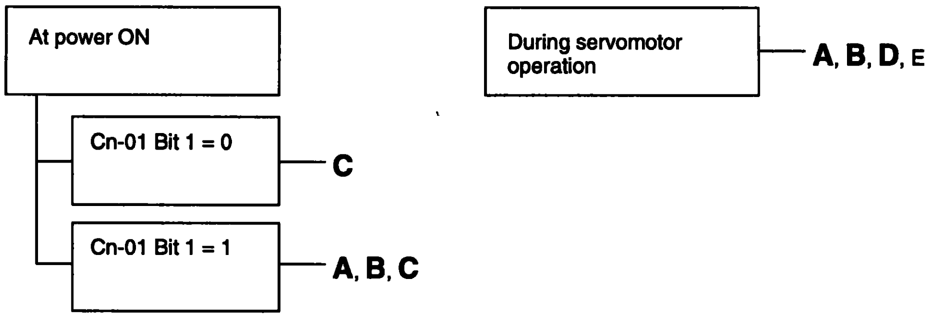
	Cause	Remedy
A	Servomotor wiring incorrect or disconnected	Check wiring and connectors at servomotor.
B	Encoder wiring incorrect or disconnected	Check wiring and connectors at encoder.
C	Load greatly exceeds rated torque	Reduce load torque and inertia. Otherwise, replace with larger capacity servomotor.
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



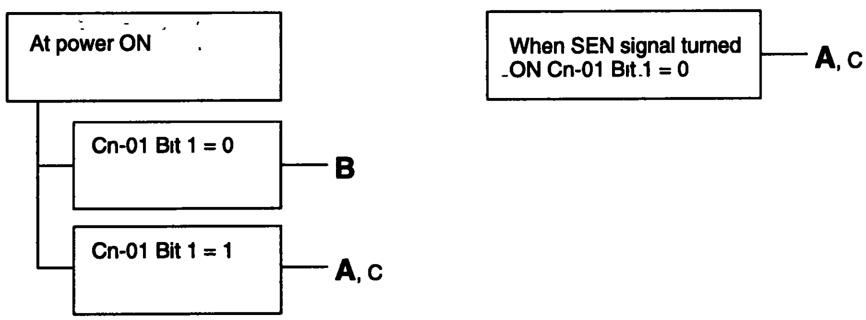
	Cause	Remedy
A	Incorrect absolute encoder wiring (PA, PB, RESET, SEN signal etc.)	Check and correct the absolute encoder wiring.
B	Absolute encoder malfunctioned	• At Cn-01 Bit 1 = 0, turn SEN signal OFF then back ON. • At Cn-01 Bit 1 = 1, turn Servopack power OFF then back ON.
C	Circuit board (1PWB) 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



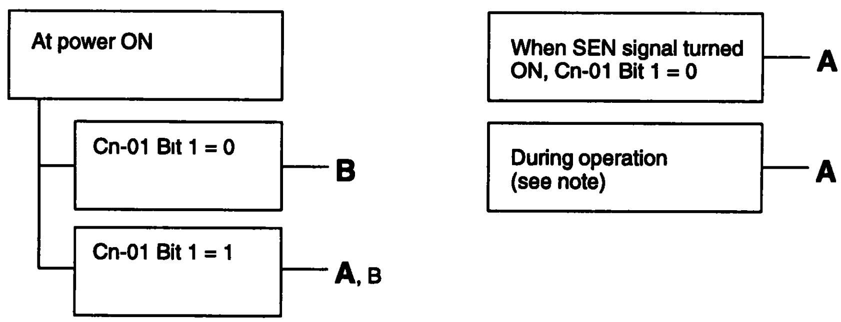
	Cause	Remedy
A	The following power supplied to the absolute encoder all failed: • +5 V supply • Battery (ER6V C3) • Internal capacitor	Follow absolute encoder set-up procedures.
B	Circuit board (1PWB) defective	Replace Servopack.
C	Absolute encoder malfunctioned	Replace servomotor.

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



	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.

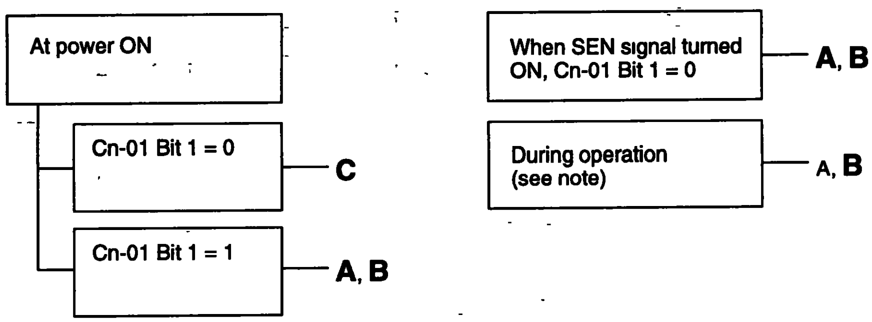
Note An absolute encoder error (A.80) is given initially if a sum-check error (A.82) is generated during operation.
The sum-check error (A.82) occurs after turning the SEN signal (or Servopack power supply) OFF and back ON.
However, the sum-check error (A.82) does occur during operation if the host controller is receiving the S-phase 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 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



	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.

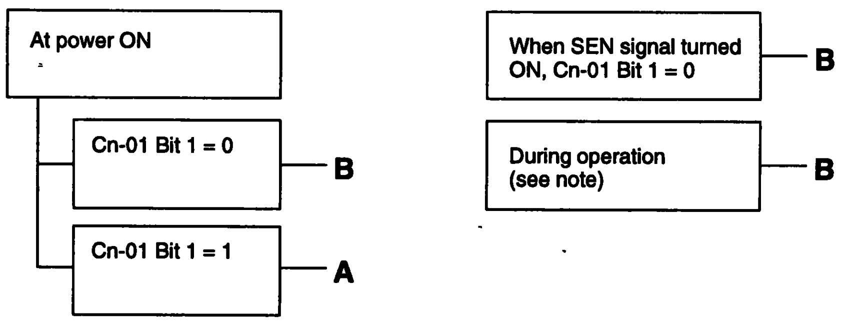
Note No alarm occurs at the Servopack when a battery error (A.83) is generated. The battery error (A.83) occurs the next time the SEN signal (or Servopack) turns ON.
However, the battery error (A.83) can be read during operation if the host controller is receiving the S-phase signal (serial data).

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



	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.

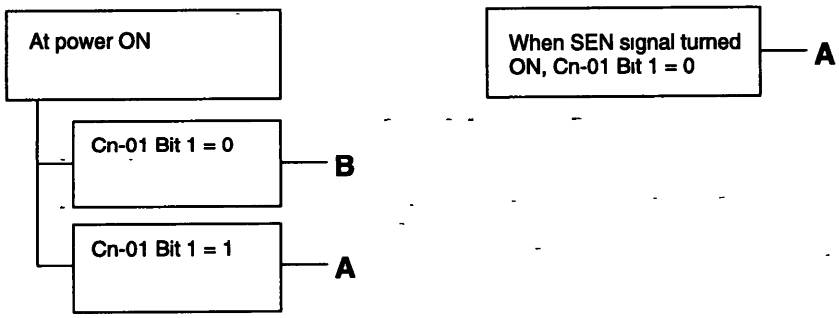
Note No alarm occurs at the Servopack when a data error (A.84) is generated. The data error (A.84) occurs the next time the SEN signal (or Servopack) turns ON.
However, the data error (A.84) can be read during operation if the host controller is receiving the S-phase signal (serial data).

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
  - User constant Cn-01 Bit 0 = 0 — E
- Occurred 1 to 3 seconds after power ON
  - User constant 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 A-, B-phase disconnection	ON	OFF	ON	OFF

OFF: Output transistor is OFF
ON: Output transistor is ON

Status When Alarm Occurred

- At power ON
  - User constant Cn-01 Bit 0 = 0 — **D**
- Occurred 1 to 3 seconds after power ON
  - User constant 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

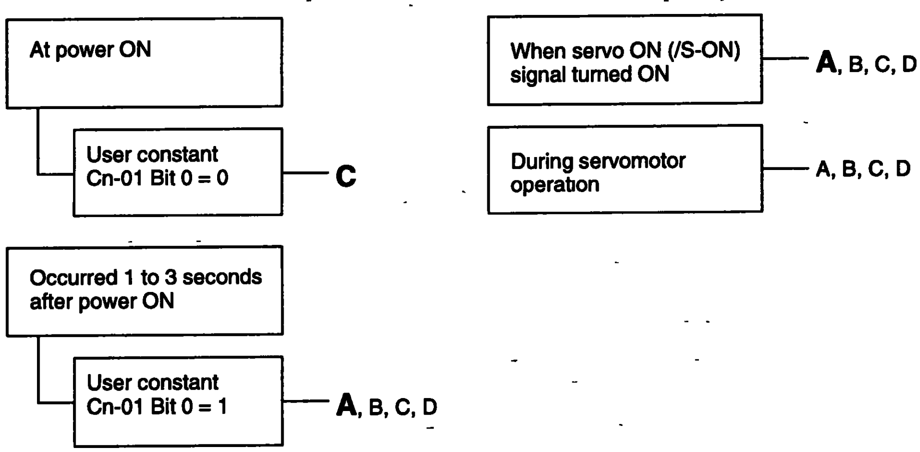
	Cause	Remedy
A	Encoder wiring incorrect or poor connection	Check wiring and connectors at encoder.
B	Noise in encoder wiring.	Separate encoder wiring from main wiring circuits.
C	Encoder defective	Replace servomotor.
D	Circuit board (1PWB) defective	Replace Servopack.

Display and Outputs

Digital Operator Display and Alarm Name	Alarm Output			
	Alarm Code Output			Alarm Output
	ALO1	ALO2	ALO3	
A.C4 Encoder C-phase 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.F4 Converter error	OFF	ON	OFF	OFF

OFF: Output transistor is OFF
ON: Output transistor is ON

Status When Alarm Occurred

During servomotor operation.	D, E, F
Occurred when the control power turned ON.	H
At main circuit power supply ON.	A, B, C
Occurred approximately 1 second after the main circuit power ON	E, F, G

	Cause	Remedy
A	One phase (L1, L2, L3) 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	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 then 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.
D	The power supply voltage is not within the range of specifications.	Check power supply.
E	• Rectifying diode defective • Fuse blown. • Inrush current-limited resistor disconnected. • Regenerative transistor is abnormal.	Replace converter.
F	Disconnection of the regenerative resistor unit.	Replace converter or regenerative resistor unit.
G	Regenerative resistor unit disconnected (for more than 15 type)	Check wiring of regenerative resistor unit.
H	Converter defective.	Replace converter.

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			

Note This alarm is not stored in alarm trace-back function memory.

Status When Alarm Occurred

Status	Cause
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			

Note 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.

5

5.2.2 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, 6CN, 2CN).	Tighten any loose parts.
	Connector (1CN, 6CN) external wiring incorrect	Check connector (1CN, 6CN) 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 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 user constant Cn-2B.	Refer to *Section 2.2.1* and set user constants to match application.
	Encoder type differs from user constant setting.	Incremental or absolute encoder?	Set user constants 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.
	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 user constant setting.		Set the user constant (Cn-11) to match the number of encoder pulses.
	Servomotor or encoder wiring incorrect.		Refer to *Section 2.8.7* 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 (U, V, and W phase) and encoder connectors.	Tighten any loose terminals or connectors.
Servomotor vibrates at approximately 200 to 400 Hz.	Speed loop gain value too high.		Reduce speed loop gain (Cn-04) preset value.
	Speed reference input lead too long.		Minimize length of speed/position reference input lead, with impedance not exceeding several hundred ohms.
	Speed reference input lead is bundled with power cables.		Separate reference input lead at least 30 cm from power cables.

5.2.2 Troubleshooting Problems With No Alarm Display cont.

Symptom	Cause	Inspection	Remedy
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 3.2.4* and *3.2.5* and adjust reference offset.

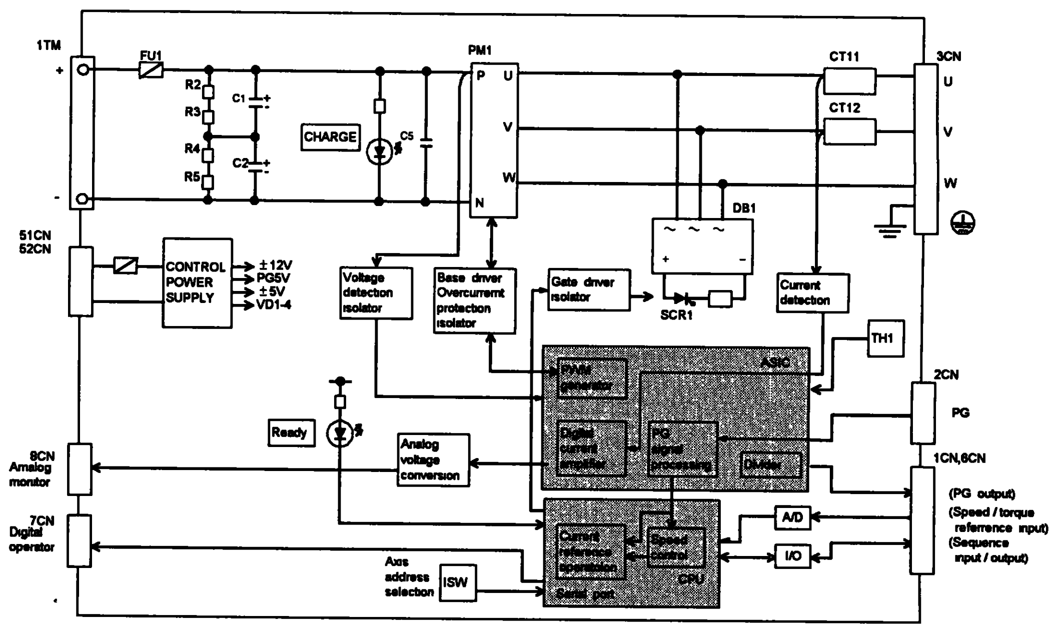
5

5.2.3 Internal Connection Diagram and Instrument Connection Examples

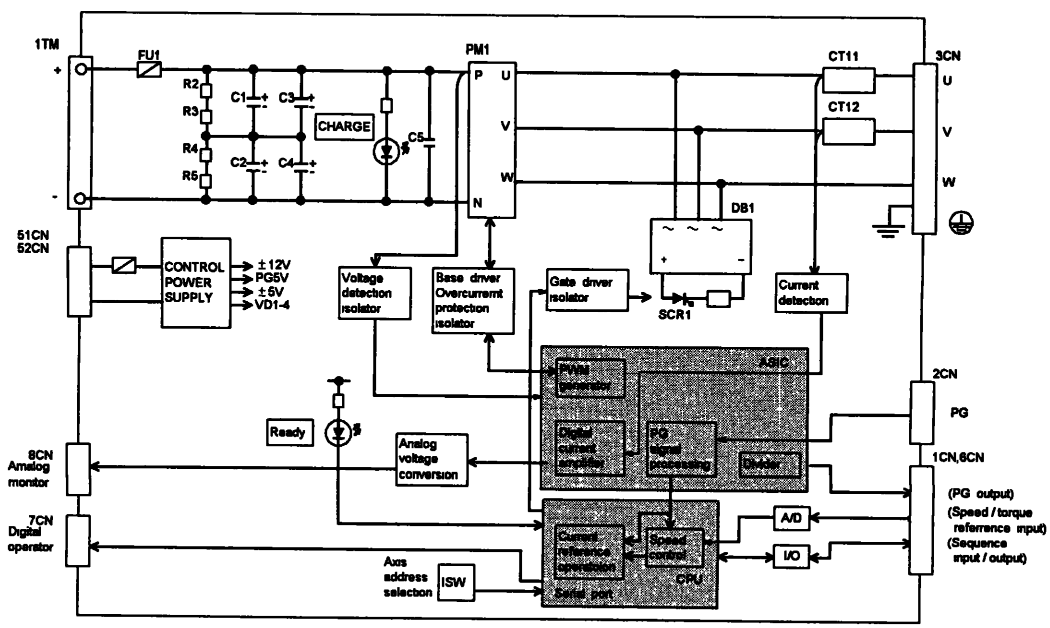
1) The SGDC Servopack and Converter internal connection diagrams are given below. Refer to these diagrams during inspection and maintenance.

2) Internal Connection Diagram

• For Servopack Model SGDC-05DSA to -15DSA

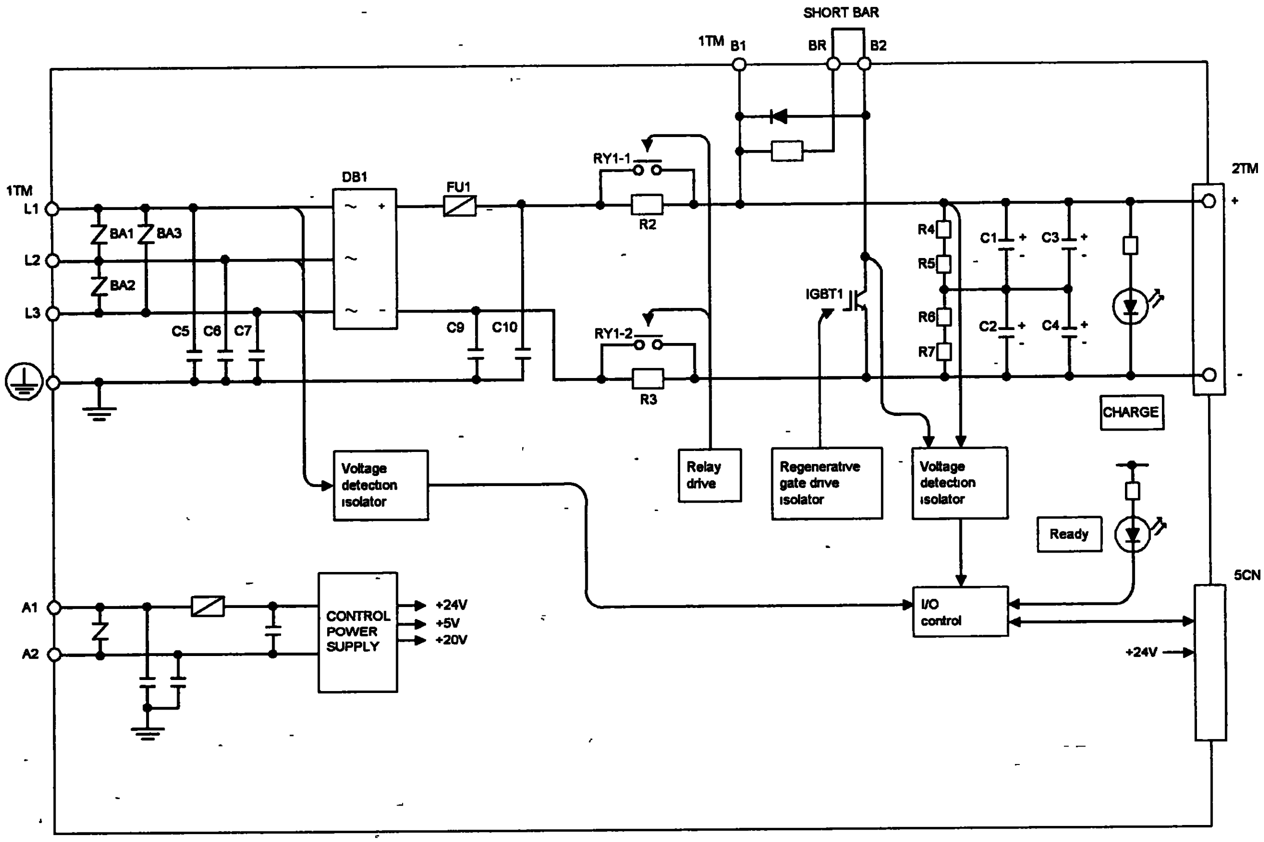


• For Servopack Model SGDC-20DSA to -50DSA

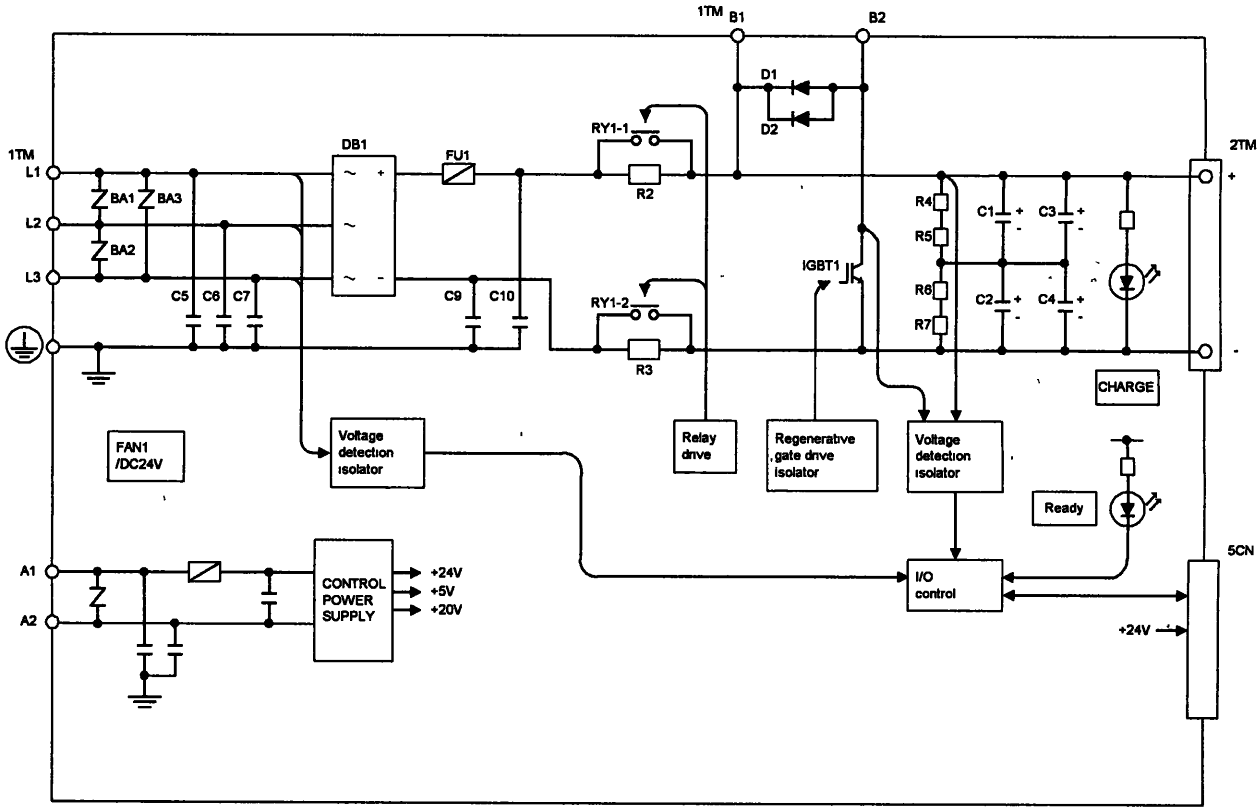


5.2.3 Internal Connection Diagram and Instrument Connection Examples cont.

• For Converter Model JUSP-ACP08GD

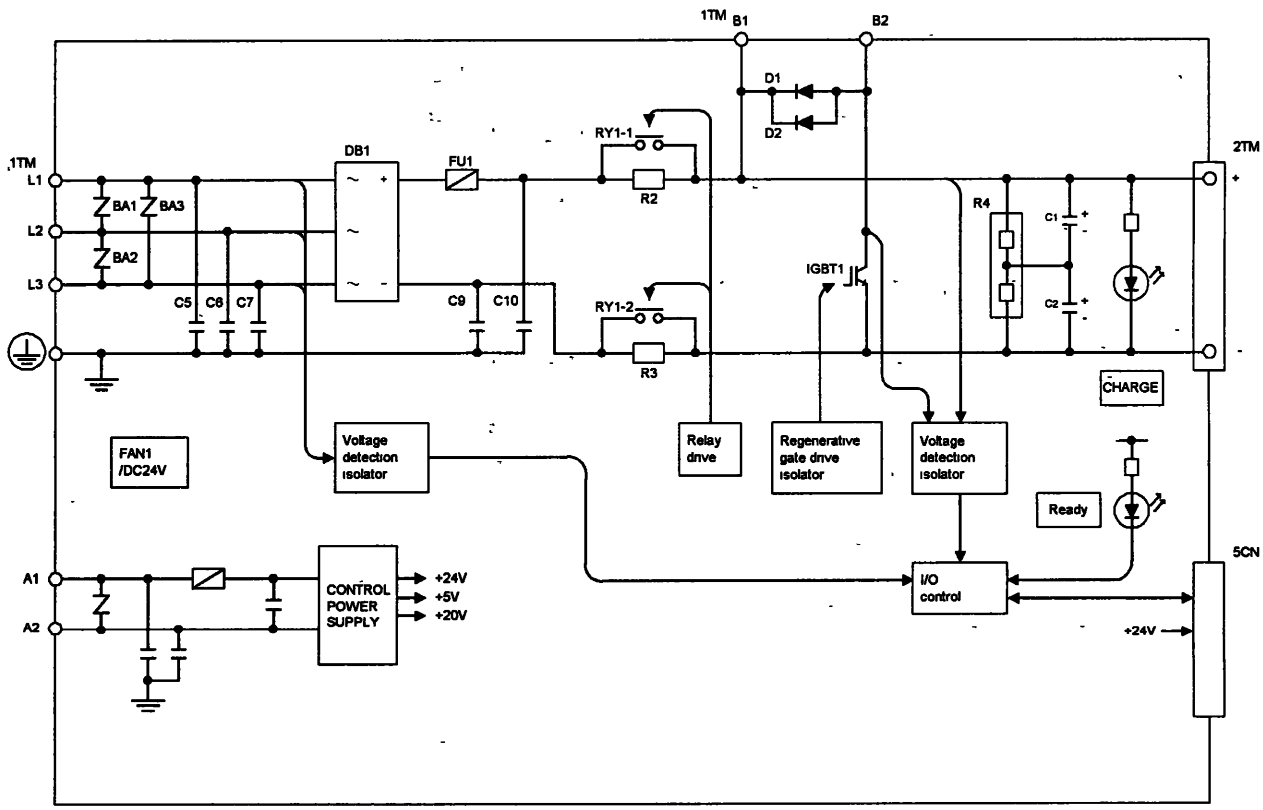


• For Converter Model JUSP-ACP15GD

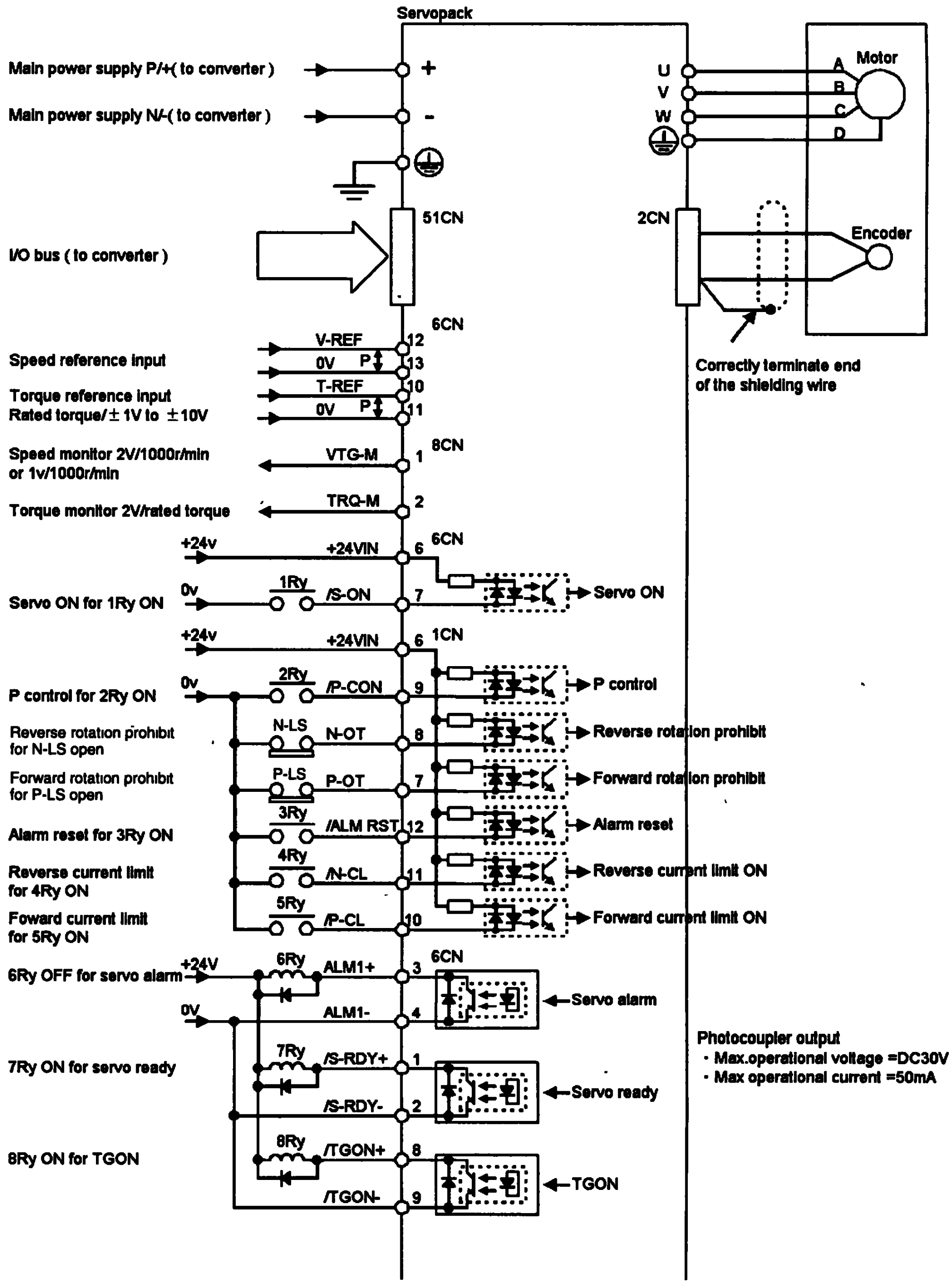


5.2.3 Internal Connection Diagram and Instrument Connection Examples cont.

• For Converter Model JUSP-ACP30GD



3) Connector 1CN, 6CN Connection of SERVOPACK



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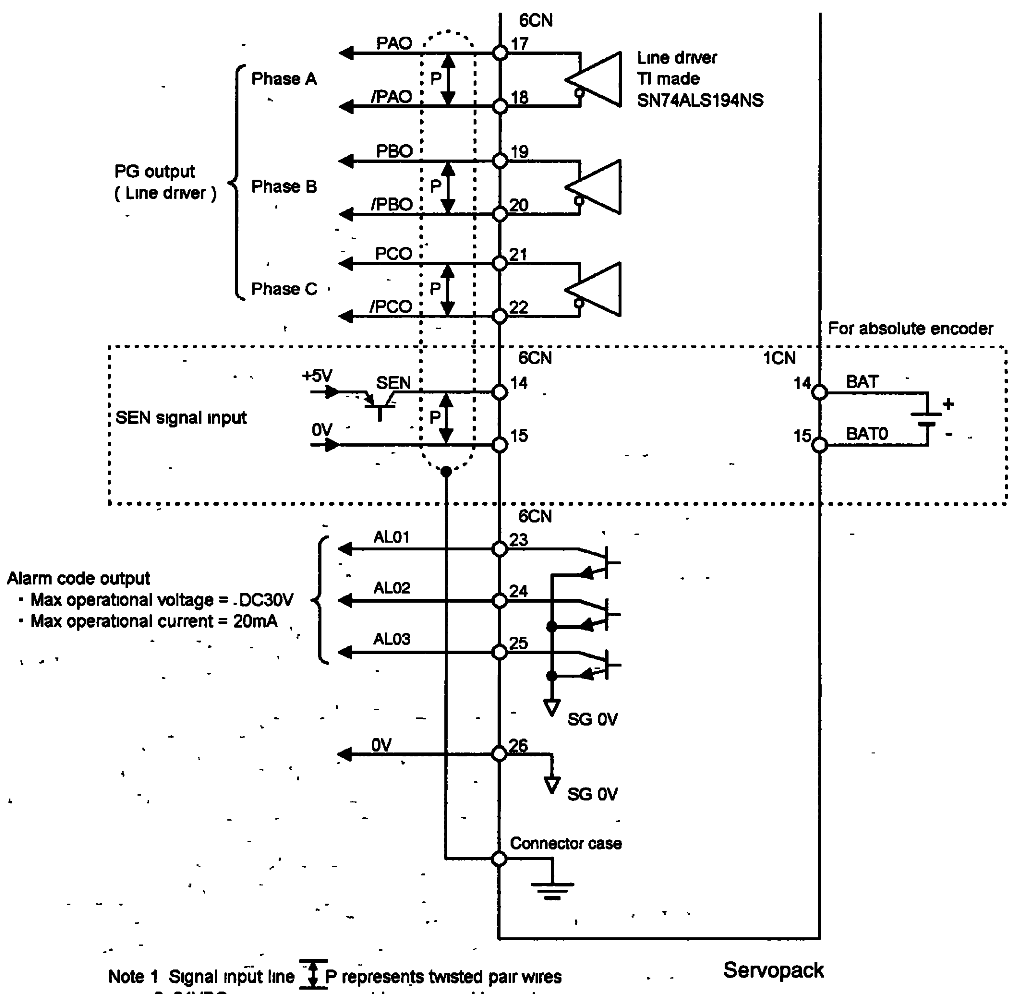
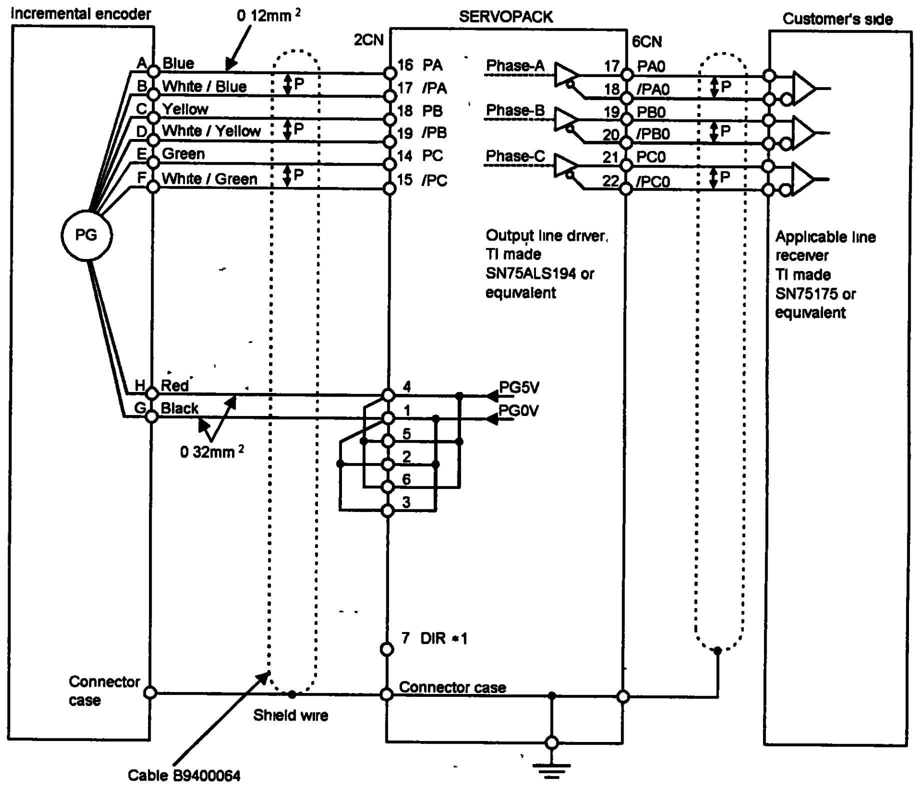


Note 1 Signal input line P represents twisted pair wires
2 24VDC power suppy must be prepared by customers

4) Connection method of 2CN and Encoder

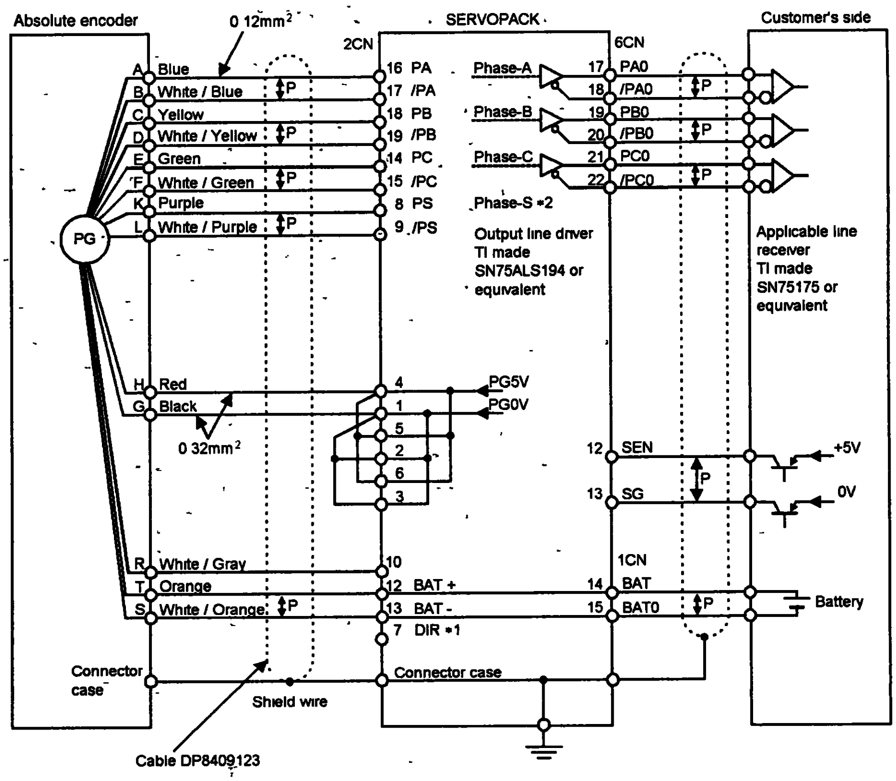
a) In case of incremental encoder



Note P represents twisted pair wires.

*1 By connecting DIR (2CN-7) to PG0V, the motor will be in reverse connection (motor reversed by forwared reference.)

b) In case of absolute encoder



Note P represents twisted pair wires.

*1 By connecting DIR (2CN-7) to PG0V, the motor will be in reverse connection (motor reversed by forward reference).

*2 S phase signal is valid only when 12-bit absolute encoder is used.

Appendix 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

1) The Servopacks allow both manual adjustment by the conventional method of observing the machine response and automatic adjustment using the internal auto-tuning function.

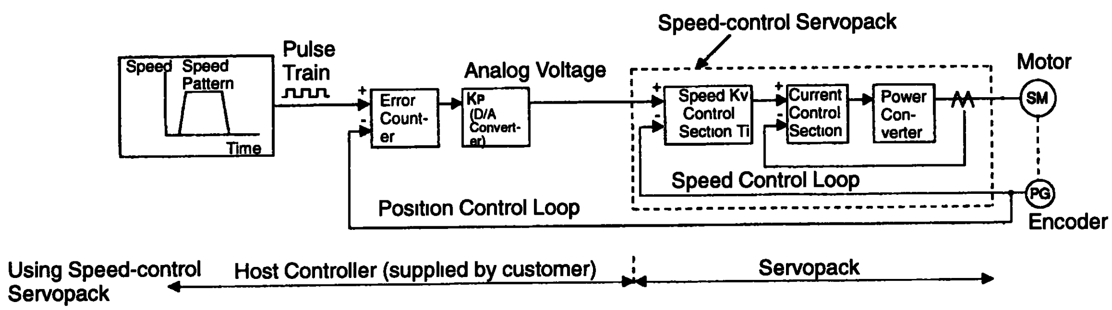
2) The main user constants changed by the customer to adjust the servo system include the following:

- 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 user constant.

A simple block diagram of the servo system is shown below.

Servo System Block Diagram



A.1.2 Basic Rules for Gain Adjustment

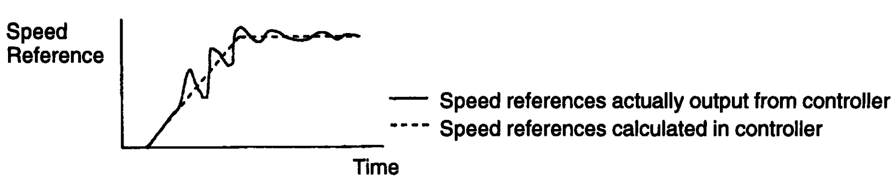
1) The servo system comprises three feedback systems: position loop, speed loop, and current loop. The response must increase from outer loop to inner loop (see Servo System Block Diagram, above). The response deteriorates and oscillates if this principle is not obeyed.
The customer cannot adjust the 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.

2) 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.

3) 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.

4) 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

1) Important Points About Auto-tuning

a) 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 user constant Cn-10 (Jog speed).

b) Selecting Machine Rigidity
If the machine rigidity is unknown, select the rigidity according to the following standards.

Drive Method	Machine Rigidity
Ball screw, direct	3 (C-003) to 7 (C-007)
Ball screw, with reduction gears	2 (C-002) to 3 (C-003)
Timing belt	1 (C-001) to 3 (C-003)
Chain	1 (C-001) to 2 (C-002)
Wave reduction gears*	1 (C-001) to 2 (C-002)

* Product name: Harmonic Drive

Select the machine rigidity level for SGDC 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.

2) 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.

3) 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

1) The role of each user constant is briefly described below.

a) Speed Loop Gain (Cn-04)
This user constant is used for determining the response speed of the speed loop. The response speed increases if the constant is set to a large value provided that the mechanical system does not vibrate. The value of speed loop gain is the same as the set value of Cn-04 if the inertia ratio set in Cn-28 is correct.

Speed loop gain Kv = Set value of Cn-04 (Hz)

Set Cn-28 to the following value.

$$\text{Cn-28 set value} = \frac{\text{Motor axis conversion load inertia } (J_Z)}{\text{Servomotor rotor inertia } (J_M)} \times 100\ (\%)$$

b) 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 vibration.
The following formula calculates a guideline value.

$$Ti \geq 2.3 \times \frac{1}{2\pi \times Kv}$$

Ti: Integration Time Constant (sec)
Kv: Speed Loop Gain (Hz) (calculated above)

c) 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.

d) 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 user constant (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.

NOTE For a SGDC Servopack used for speed control, the position loop gain (Cn-1A) is valid in zero-clamp mode only.
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.

2) Adjustment Procedure

a) 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).

b) 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).

c) 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.

d) 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.

e) 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 Gain Setting References

This section presents tables of load inertia values for reference when adjusting the gain.

A.3.1 Guidelines for Gain Settings According to Load Inertia Ratio

1) 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.

a) Machines with High Rigidity

Ball Screw, Direct Drive Machines
Example: Chip mounter, IC bonder, precision machine tools

Load/Inertia Ratio (GD_L^2/GD_M^2)	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.

b) 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

A.3.1 Guidelines for Gain Settings According to Load Inertia Ratio cont.

Load/Inertia Ratio (GD_L^2/GD_M^2)	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
3 x		60 to 100	Slightly increase for inertia ratio of 20 x, or greater.
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.

c) 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 (GD_L^2/GD_M^2)	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
3 x		20 to 40	Slightly increase for inertia ratio of 20 x, or greater.
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.

2) 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.

$$K_P = \frac{V_S}{\epsilon}$$

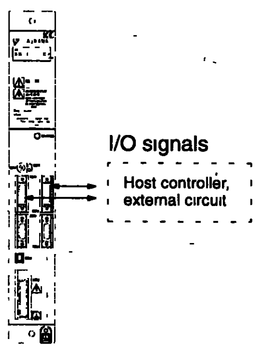
K_P [1/s]: Position loop gain
V_S [PPS]. Steady speed reference
ε: (pulse): Steady error
(The number of pulses in the error counter at steady speed.)

Appendix B

List of I/O Signals

B

This appendix lists I/O signal terminals (connector 1CN, 6CN) on Servopacks which connect to a host controller or external circuit.



NOTE 1) Refer to *Chapter 2* 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.

1CN Terminal Number	Abbreviated symbol	Signal name		
1	BK+	Break output		
2	BK	Break output		
3	ALM2+	Servo alarm 2 output		
4	ALM2–	Servo alarm 2 output		
5	N.C.	No connected		
6	+24VIN	External power supply input	See 2.2.4	
7	P-OT	Forward prohibit input	See 2.1.2	
8	N-OT	Reverse prohibit input	See 2.1.2	
9	P-CON	P control input	See 2.2.1	*4
10	P-CL	Forward current limit ON input	See 2.1.3	*4
11	N-CL	Reverse current limit ON input	See 2.1.3	*4
12	ALMRST	Alarm reset input	See 2.7.1	
13	N.C.	No connected		
14	BAT	Battery (+) (for absolute only)	See 2.8.5	*5
15	BATO	Battery (–) (for absolute only)	See 2.8.5	
16	N.C.	No connected		
17	N.C.	No connected		
18	ESPO	Does not use		
19	ALMC	Servo alarm 2 output		
20	N.C.	No connected		
21	N.C.	No connected		
22	N.C.	No connected		
23	N.C.	No connected		
24	N.C.	No connected		
25	N.C.	No connected		
26	N.C.	No connected		

6CN Terminal Number	Abbreviated symbol	Signal name		
1	S-RDY+	Servo ready output	See 2.7.6	*3
2	S-RDY–			
3	ALM1+	Servo alarm 1 output	See 2.7.1	
4	ALM1–			
5	N.C.	No connected		
6	+24VIN	External power supply input		
7	S-ON	Servo ON input	See 2.7.2	

6CN Terminal Number	Abbreviated symbol	Signal name		
8	TGON+	TGON output		*3
9	TGON–	TGON output		
10	T-REF	Torque reference input	See 2.2.7	*1
11	SG	0 V		
12	V-REF	Speed reference input	See 2.2.1	*1
13	SG	0 V		
14	SEN	SEN signal input	See 2.8.5	*5
15	SG	0 V		
16	SG	0 V		
17	PAO	Encoder output phase-A	See 2.2.3	
18	/PAO			
19	PBO	Encoder output phase-B	See 2.2.3	
20	/PBO			
21	PCO	Encoder output phase-C	See 2.2.3	
22	/PCO			
23	ALO1	Alarm code output (open corrector)	See 2.7.1	
24	ALO2			
25	ALO3			
26	SG	0 V		

*1 Used for analog reference .... See page 318
*2 Specifications vary depending on bits 6, 7 of Cn-02 .... refer to page 318
*3 Specifications vary according to setting values of Cn-2D ... refer to Appendix D (page 323)
*4 Specifications vary according to setting values of Cn-2B .... refer to page 319
*5 Used only for absolute encoder (used only when bit E of Cn-01 equal to 1)

*1 Signals used for analog reference

For signal control

Specifications	Speed control		Speed control with torque limit by analog voltage reference		Speed control with torque feed-forward	
Setting / 6CN Terminal number	Cn-02 Bit 8 = 0 Bit 9 = 0		Cn-02 Bit 8 = 1 Bit 9 = 0		Cn-02 Bit 8 = 0 Bit 9 = 1	
10	V-REF	Speed reference	V-REF	Speed reference	V-REF	Speed reference
12	---	Terminal unused	T-REF	Torque limit input (See 2.2.7)	T-REF	Torque feed forward reference (See 2.2.6)

For torque control

Specifications	Torque control		Torque control with speed limit by analog voltage reference	
Setting / 6CN Terminal number	Cn-02 Bit 2= 0		Cn-02 Bit 2= 1	
10	---	Terminal unused	V-REF	Speed limit value (See 2.1.3)
12	T-REF	Torque reference	T-REF	Torque reference

*3 Analog monitor signals

Control mode	———		Speed mode		Torque control
Setting / 8CN Terminal number	Cn-02 Bit 6 = 0		Cn-02 Bit 6 = 1		
2	TRQ-M	Torque monitor	TRQ-M	Speed reference monitor	×
Setting / 8CN Terminal number	Cn-02 Bit 7 = 0		Cn-02 Bit 7 = 1		
1	VTG-M	Speed monitor	VTG-M	×	×

Note ↘× means don't care for voltage values.

*5

Specifications / Setting / 1CN Terminal number	Speed control		Torque control		Speed control (contact reference)	
	Cn-2B = 0		Cn-2B = 2		Cn-2B = 3, 4, 6	
9	/P-CON	Proportional control reference	---	Terminal unused	/P-CON	Rotation direction reference for contact input speed selection
10	/P-CL	Forward (Reverse) torque limit	/P-CL	Forward (Reverse) torque limit	/P-CL	Contact input speed selection (control mode switching)
11	/N-CL		/N-CL		/N-CL	

Specifications / Setting / 1CN Terminal number	Torque ←→ Speed		Speed control with zero clamp	
	Cn-2B = 9		Cn-2B = 10	
9	/P-CON	Control mode switching signal	/P-CON	Zero clamp operation reference
10	/P-CL	Forward (Reverse) torque limit	/P-CL	Forward (Reverse) torque limit
11	/N-CL		/N-CL	

B

Appendix C

List of User Constants

- Σ-Series Servopacks provide many functions, and have parameters called "user constants" to allow the user to select each function and perform fine adjustment. This appendix lists these user constants.

- User constants are divided into the following two types:

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

NOTE 1) Refer to *Chapter 2* for details of how to use user constants.

2) For details of how to set user constants, refer to *Section 3.1.5 Operation in User Constant Setting Mode.*

List of User Constants (User Constant Setting)

Category	User Constant No.	Code	Name	Unit	Lower Limit	Upper Limit	Factory Setting	Re-marks
	Cn-00	Not a user constant. (Cn-00 is used to select a special mode for digital operator)						
	Cn-01	Memory switch						*2
	Cn-02	Memory switch (See page 325)						
Basic Constants	Cn-11	PULSNO	Number of encoder pulses	P/R	513	32768	8192	*1, *2, *3
	Cn-2B	CTLSEL	Control method selection	–	0	10	0	*2
	Cn-2A	MTRSEL	Motor selection	–	0	254	*2	*1, *2, *3
Gain Related Constants	Cn-03	VREFGN	Speed reference adjustment gain	(r/min)/V	10	2000	250	*2, *3
	Cn-04	LOOPHZ	Speed loop gain	Hz	1	2000	80	
	Cn-05	PITIME	Speed loop integration time constant	0.01 ms	200	51200	2000	
	Cn-1A	POSGN	Position loop gain	1/s	1	1000	40	
	Cn-17	TRQFIL	Torque reference filter time constant	0.1 ms	0	250	4	
	Cn-28	JLOAD	Load inertia	%	0	65535	100	
	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	
Reference related constants	Cn-0A	PGRAT	PG dividing ratio	P/R	16	32768	8192	
	Cn-07	SFSACC	Soft start acceleration time	ms	0	10000	0	*4
	Cn-23	SFSDEC	Soft start deceleration time	ms	0	10000	0	*4
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	

Category	User Constant No.	Code	Name	Unit	Lower Limit	Upper Limit	Factory Setting	Re-mar ks
Sequence Related Constants	Cn-2D	OUTSEL	Output signal selection	–	00	66	12	
	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-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	SPEED1	1st speed (contact input speed control)	r/min	0	10000	100	
	Cn-20	SPEED2	2nd speed (contact input speed control)	r/min	0	10000	200	
	Cn-21	SPEED3	3rd speed (contact input speed control)	r/min	0	10000	300	
	Cn-2C	PGPWR	PG power supply voltage change	0.1 mV	52000	58000	52500	

Note *1 User constants must be set and checked before turning the motor power ON.

*2 After changing the setting, always turn the power OFF, then ON. This makes the new setting valid.

*3 Refer to page 141.

*4 To use soft start function, always set both Cn-07 and Cn-23.

List of User Constants (Memory Switch Setting) (1)

	User Constant No.	Bit No.	Setting				Factory Setting
Input signal enable/disable	Cn-01	0	0		1		0
			Uses servo ON input (/S-ON).		Does not use servo ON input (/S-ON). Servo is always ON.		
		1	0		1		0
			Uses SEN signal input (SEN) when absolute encoder is used.		Does not use SEN signal input (SEN) when absolute encoder is used. Servopack automatically treats signal voltage as high level.		
		2	0		1		0
			Uses forward rotation prohibited input (P-OT).		Does not use forward rotation prohibited input (P-OT). Forward rotation is always possible.		
		3	0		1		0
			Uses reverse rotation prohibited input (N-OT).		Does not use reverse rotation prohibited input (N-OT). Reverse rotation is always possible.		
Reserved		4	Reserved : Setting = 0 (do not change the setting)				0
		5					0
Sequence selection at alarm condition		6	0		1		0
			Stops the motor by applying dynamic brake (DB)at base block.		Makes the motor coast to a stop at base block.		
		7	0		1		0
			At base block, stops the motor by applying dynamic brake (DB)and then release DB.		At base block, stops the motor by applying dynamic brake (DB)but does not release DB.		
		8	0		1		0
			Stops the motor according to bit 6 setting when overtravel is detected (P-OT, N-OT).		Decelerates the motor to a stop by applying the torque specified in Cn-06 when overtravel is detected (P-OT, N-OT).		
		9	0		1		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 turns the zero-clamp.		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.		
Reserved		A	Reserved: Setting = 0 (Do not change the setting.)				0
Mode switch selection		B	0		1		0
			Uses mode switch function. Follows Cn-01 bits D, C		Does not use mode switch function.		
		D·C	00	01	10	11	0
			Uses internal torque reference as a condition (Level setting : Cn-0C)	Uses speed reference as a condition (Level setting : Cn-0D)	Uses acceleration as a condition (Level setting : Cn-0E)	Do not use.	

	User Constant 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

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 User Constants (Memory Switch Setting) (2)

	User Constant 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	
Reserved		3, 4, 5	Reserved: Setting = 0 (do not change the setting)		0, 0, 0
Analog monitor selection		6	0	1	0
			Outputs torque to TRQ-M	Outputs reference speed to TRQ-M	
		7	0	1	0
			Outputs reference speed to VTG-M	Does not use.	
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	
Reserved		A	Reserved : Setting = 0 (do not change the setting)		0
		B			0
Torque filter		C	0	1	0
			Uses torque filter as primary filter	Uses torque filter as secondary filter	
Reserved		D	0	1	0
			Reserved: Setting = 0 (do not change the setting)		
		E	0	1	0
			Reserved: Setting = 0 (do not change the setting)		
		F	0	1	0
			Reserved: Setting = 0 (do not change the setting)		

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)	
2	Torque control (analog reference)	
3	Speed control (contact reference)	↔Speed control (0 reference)
4	Speed control (contact reference)	↔Speed control (analog reference)
6	Speed control (contact reference)	↔Torque control (analog reference)
9	Torque control (analog reference)	↔Speed control (analog reference)
10	Speed control (analog reference)	↔Zero clamp control

- Outputs signal selection (CN-2D) setting values
  Selects which function of signal sent to output signal of 6CN.

1st decimal digit	to select function of 6CN-1, -2 (/S-RDY)
2nd decimal digit	to select function of 6CN-8, -9 (/TGON)

Setting value	Function
0	/V-CMP
1	/TGON
2	/S-RDY
3	/CLT
4	/BK
5	OL warning
6	OL alarm

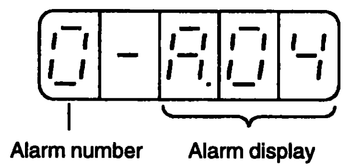
- Factory settings

SERVOPACK type	Applicable motor type	Cn-2A	Cn-11, Cn-0A	Cn-03
SGDC-05DSA	SGMG-05□□D	181	8192	250
SGDC-10DSA	SGMG-09□□D	182		
SGDC-15DSA	SGMG-13□□D	183		
SGDC-20DSA	SGMG-20□□D	184		
SGDC-30DSA	SGMG-30□□D	185		
SGDC-50DSA	SGMG-44□□D	186		
SGDC-10DSA	SGMS-10□□D	201	4096	500
SGDC-15DSA	SGMS-15□□D	202		
SGDC-20DSA	SGMS-20□□D	203		
SGDC-30DSA	SGMS-30□□D	204		
SGDC-50DSA	SGMS-40□□D	205		
	SGMS-50□□D	206		

Appendix D

List of Alarm Displays

- SGDC 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 3.2.1 Operation in Alarm Trace-back Mode

- For the cause of each alarm and the action to be taken, refer to the following section:
  Section 5.2.1 Troubleshooting Problems with Alarm Display

List of Alarm Displays

Alarm Display or Digital Operator	Alarm Output				Alarm Name	Meaning	Remarks
	Alarm Code Output			ALM Output			
	ALO1	ALO2	ALO3				
A.00	×	×	×	×	Absolute data error	Absolute data fails to be received, or received absolute data is abnormal.	For absolute encoder only
A.02	×	×	×	×	User constant breakdown	Checksum results of user constants are abnormal.	
A.04	×	×	×	×	User constant setting error	User constant setting is outside the allowable setting range.	
A.05	×	×	×	×	Alarm traceback error	Checksum results of user constants are abnormal.	
A.10	○	×	×	×	Overcurrent	Overcurrent flowed through the power transistor.	
A.20	×	○	×	×	Blown fuse	Fuse is blown.	
A.40	×	×	○	×	Overvoltage	Main circuit voltage for motor operation has become too high.	
A.51	○	×	○	×	Overspeed	Rotation speed of the motor has exceeded detection level.	Detection level = Max. rotation speed x 1.1 or x1.2
A.71	○	○	○	×	Overloaded (high load)	Motor was running for several seconds to several tens of seconds under torque largely exceeding ratings.	
A.72	○	○	○	×	Overloaded (low load)	Motor was running continuously under torque largely exceeding ratings	
A.80	×	×	×	×	Absolute encoder error	Number of pulses per absolute encoder revolution is abnormal.	For absolute encoder only
A.81	×	×	×	×	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	×	×	×	×	Absolute encoder checksum error	Checksum results of absolute encoder memory is abnormal.	

TERMS

Checksum

An automatic check function for a set of data such as user constants. It stores the sum of user constant 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 or Digital Operator	Alarm Output				Alarm Name	Meaning	Remarks
	Alarm Code Output			ALM Output			
	ALO1	ALO2	ALO3				
A.83	×	×	×	×	Absolute encoder battery error	Battery voltage for absolute encoder is abnormal.	For 12 bit absolute encoder only
A.84	×	×	×	×	Absolute encoder data error	Received absolute data is abnormal.	
A.85	×	×	×	×	Absolute encoder overspeed	Motor was running at a speed exceeding 400 r/min when the absolute encoder was turned ON.	
A.A1	○	○	○	×	Heat sink overheated	Heat sink of Servopack was overheated.	
A.b1	×	×	×	×	Reference input read error	Servopack input read error	
A.C1	○	×	○	×	Servo overun detected	Servomotor (encoder) runs out of control.	
A.C2	○	×	○	×	Encoder output phase error	Phases -A, -B and -C output by encoder are abnormal.	
A.C3	○	×	○	×	Encoder A, B phase disconnection	Wiring in encoder phase -A or -B is disconnected.	
A.C4	○	×	○	×	Encoder C phase disconnection	Wiring in encoder phases-C is disconnected.	
A.F4	×	○	×	×	Converter error	Detection of regenerative error. Main circuit voltage error. Power lines open phase.	
CPF00	Undefined				Digital operator transmission error 1	Digital operator fails to communicate with Servopack even 5 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 5 consecutive times.	
A.99	×	×	×	○	Not an error	Normal operation status.	

○: Output transistor is ON
×: Output transistor is OFF

Σ Series SGM□/SGDC

USER'S MANUAL

TOKYO OFFICE
New Pier Takeshiba South Tower, 1-16-1, Kaigan, Minatoku, Tokyo 105-6891 Japan
Phone 81-3-5402-4511 Fax 81-3-5402-4580

YASKAWA ELECTRIC AMERICA, INC.
2121 Norman Drive South, Waukegan, IL 60085, U S A
Phone 1-847-887-7000 Fax 1-847-887-7370

MOTOMAN INC. HEADQUARTERS
805 Liberty Lane West Carrollton, OH 45449, U S A
Phone 1-937-847-6200 Fax 1-937-847-6277

YASKAWA ELÉTRICO DO BRASIL COMÊRCIO LTDA.
Avenida Fagundes Filho, 620 Bairro Saude-Sao Pàulo-SP, Brazil CEP 04304-000
Phone 55-11-5071-2552 Fax 55-11-5581-8795

YASKAWA ELECTRIC EUROPE GmbH
Am Kronberger Hang 2, 65824 Schwalbach, Germany
Phone 49-6196-569-300 Fax 49-6196-888-301

Motoman Robotics AB
Box 504 S38525 Torsås, Sweden
Phone 46-486-48800 Fax 46-486-41410

Motoman Robotec GmbH
Kammerfeldstraβe1, 85391 Allershausen, Germany
Phone 49-8166-900 Fax 49-8166-9039

YASKAWA ELECTRIC UK LTD.
1 Hunt Hill Orchardton Woods Cumbernauld, G68 9LF, United Kingdom
Phone 44-1236-735000 Fax 44-1236-458182

YASKAWA ELECTRIC KOREA CORPORATION
Kfpa Bldg #1201, 35-4 Youido-dong, Yeongdungpo-Ku, Seoul 150-010, Korea
Phone 82-2-784-7844 Fax 82-2-784-8495

YASKAWA ELECTRIC (SINGAPORE) PTE. LTD.
151 Lorong Chuan, #04-01, New Tech Park Singapore 556741, Singapore
Phone 65-282-3003 Fax 65-289-3003

YATEC ENGINEERING CORPORATION
Shen Hsiang Tang Sung Chiang Building 10F 146 Sung Chiang Road, Taipei, Taiwan
Phone 886-2-2563-0010 Fax 886-2-2567-4677

BEIJING OFFICE
Room No 301 Office Building of Beijing International Club, 21
Jianguomenwai Avenue, Beijing 100020, China
Phone 86-10-6532-1850 Fax 86-10-6532-1851

SHANGHAI OFFICE
27 Hui He Road Shanghai 200437 China
Phone 86-21-6553-6600 Fax 86-21-6531-4242

YASKAWA JASON (HK) COMPANY LIMITED
Rm 2909-10, Hong Kong Plaza, 186-191 Connaught Road West, Hong Kong
Phone 852-2803-2385 Fax 852-2547-5773

TAIPEI OFFICE
Shen Hsiang Tang Sung Chiang Building 10F 146 Sung Chiang Road, Taipei, Taiwan
Phone 886-2-2563-0010 Fax 886-2-2567-4677

SHANGHAI YASKAWA-TONGJI M & E CO., LTD.
27 Hui He Road Shanghai China 200437
Phone 86-21-6531-4242 Fax 86-21-6553-6060

BEIJING YASKAWA BEIKE AUTOMATION ENGINEERING CO., LTD.
30 Xue Yuan Road, Haidian, Beijing P R China Post Code 100083
Phone 86-10-6233-2782 Fax 86-10-6232-1536

SHOUGANG MOTOMAN ROBOT CO., LTD.
7, Yongchang-North Street, Beijing Economic Technological Investment & Development Area, Beijing 100076, P R China
Phone 86-10-6788-0551 Fax 86-10-6788-2878

YASKAWA ELECTRIC CORPORATION

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