GE Fanuc Automation

Motion Solutions Products

Servo Product Specification Guide

GFH – 001C *October 2004*

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Warning

Warning notices are used in this publication to emphasize that hazardous voltages, currents, temperatures, or other conditions that could cause personal injury exist in this equipment or may be associated with its use.

In situations where inattention could cause either personal injury or damage to equipment, a Warning notice is used.

Caution

Caution notices are used where equipment might be damaged if care is not taken.

Note: Notes merely call attention to information that is especially significant to understanding and operating the equipment.

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CIMPLICITY	Helpmate	PowerTRAC	Series Three
	Logicmaster	ProLoop	VersaMax
CIMSTAR	Modelmaster	PROMACRO	VersaPoint
Field Control	Motion Mate	Series Five	VersaPro
GEnet	PACSystems	Series 90	VuMaster
		Series One	Workmaster

Contents

GE Fanuc

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β Series Servo

Introduction

Reliability

The α and β Series Servo systems offer high reliability and performance. In addition, high-speed serial encoders and high efficiency Integrated Power Modules further enhance the performance of the servo systems.

The servo systems' digital control loops (current, velocity, and position) are closed in the controller. This feature reduces setup time and delivers significant performance gains even in the most challenging applications.

Features

Additional features of the servo systems include the following:

- The systems' plug-and-play connectivity makes them cost-effective to integrate and maintain.
- The all-digital systems provide the greatest possible stability in a changing environment.
- There are no "personality" modules.
- The servos have a broad application range including a wide load inertia range, flexible acceleration/deceleration, and position feedback configurations.
- Extensive software customization features are available to optimize performance and overcome machine limitations.

α and β Servo Motors

The α and β Series Servo motors offer superior performance with reduced size and cost.

The β Series motors feature an improved insulation system on the windings and an overall sealing coating helps protect the motor from the environment.

The α and β Series motors conform to international IEC standards. A motor protection level of IP65 is standard with all α and β Series motors, and optional IP67 sealing is available on α Series motors. Torque ratings of 0.5, 2, 6, and 12 Nm are available on β Series motors, and torque ratings of 6, 12, 22, 30, and 40 Nm are available on α Series motors.

A 32K counts /revolution absolute mode digital encoder is standard with each β Series servo motor. A 64K absolute encoder is standard on α Series motors. An optional electrically released holding brake is also available on all α and β Series motors.

α and β Amplifiers

The α and β Series Servo amplifiers integrate a power supply with the PWM switching circuitry, making the amplifier compact and very efficient. The amplifier is built to conform to these international standards:

- European CE (EMC and Low Voltage directives)
- IEC Standards
- UL/CUL on α Series

Pulse Width Modulated Interface

The Pulse Width Modulated (PWM) interface uses the standard GE Fanuc digital servo communication protocol.

The α and β Series amplifiers can communicate with a wide variety of GE Fanuc controllers, including the Power Mate D, Power Mate H, and DSM 300 Series, plus many of the GE Fanuc CNC systems.

The βi Series amplifiers can communicate with the DSM324 controller.

Part I:
α Servo System

Section 1: α SVU Series Servo System Block Diagram

The following block diagram shows the interconnections of a typical α Series servo system:

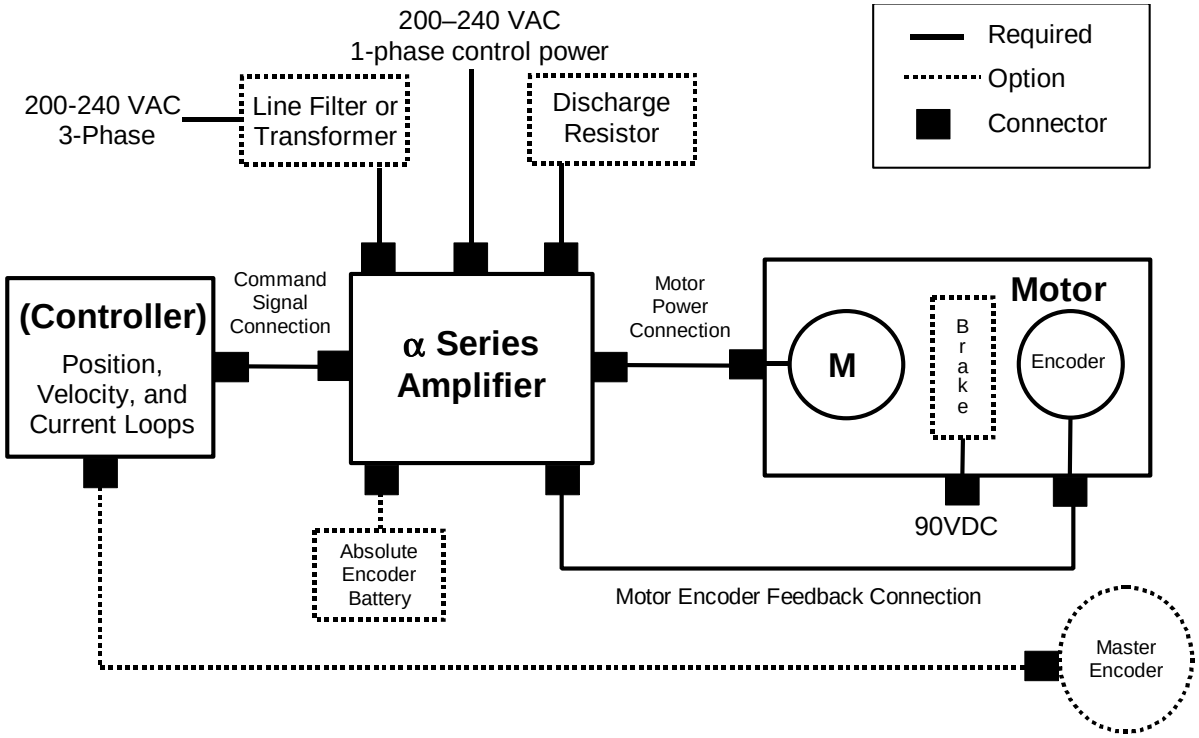


Figure I-1. α SVU Series servo block diagram

> **NOTE**
>
> The 200–240 VAC control power inputs are jumpered to the three-phase bus power inputs (L1C to L1 and L2C to L2) when delivered from the factory. If a separate control power source is desired to maintain alarm status during E-stop removal of main bus power, remove the jumper links and connect the separate control power.

Section 2: α Series Servo Product Overview

2.1 α Series Motors

The α Series servo motors include built-in serial encoders with 64K PPR (pulses per revolution) resolution. All α Series motors are available with an optional holding brake, and most are available with an optional IP67 sealing. A fan package is standard on the α40/2000 servo motor. The servo motors must be used with the designated amplifier package and a GE Fanuc motion controller such as the Motion Mate DSM300 Series.

Table I-1 provides a summary of the α Series servos. See Section 3: for more detailed motor specifications.

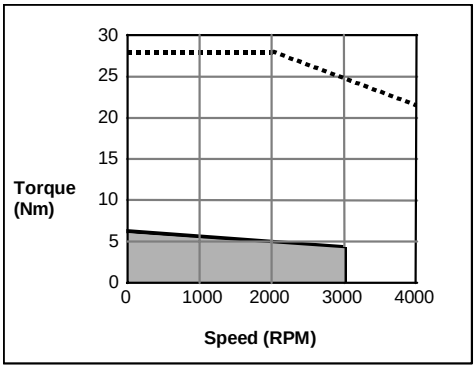
Table I-1. α Series Servo Motors

Motor	Rated Torque	Power Rating	Required Amplifier Kit	Motor Catalog #
α6/3000	6 Nm (53 in-lbs) continuous stall torque; 3000 RPM (max)	1.4 kW	80 Amp (IC800APK080)	Motor Only: A06B-0128-B575#7008 w/ IP67 Sealing: A06B-0128-B575#7076 w/ Brake: A06B-0128-B675#7008 w/ IP67 Sealing & Brake: A06B-0128-B675#7076
α12/3000	12 Nm (106 in-lbs) continuous stall torque; 3000 RPM (max)	2.8 kW	80 Amp (IC800APK080)	Motor Only: A06B-0143-B075#7008 w/ IP67 Sealing: A06B-0143-B075#7076 w/ Brake: A06B-0143-B175#7008 w/ IP67 Sealing & Brake: A06B-0143-B175#7076
α22/2000	22 Nm (195 in-lbs) continuous stall torque; 2000 RPM (max)	3.7 kW	80 Amp (IC800APK080)	Motor Only: A06B-0147-B075#7008 w/ IP67 Sealing: A06B-0147-B075#7076 w/ Brake: A06B-0147-B175#7008 w/ IP67 Sealing & Brake: A06B-0147-B175#7076
α30/3000	30 Nm (265 in-lbs) continuous stall torque; 3000 RPM (max)	5.2 kW	130 Amp (IC800APK130)	Motor Only: A06B-0153-B075#7008 w/ IP67 Sealing: A06B-0153-B075#7076 w/ Brake: A06B-0153-B175#7008 w/ IP67 Sealing & Brake: A06B-0153-B175#7076
α40/2000 w/ fan package	40 Nm (494 in-lbs) continuous stall torque; 2000 RPM (max)	7.2 kW	130 Amp (IC800APK130)	Motor w/ Fan Package: A06B-0158-B075#7008 w/ Fan Package & Brake: A06B-0158-B175#7008

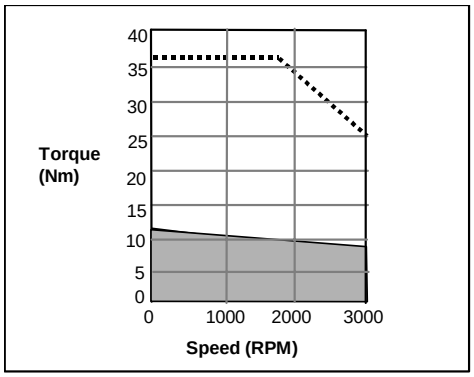
2.2 α Series Motor –Torque Curves

The curves shown below illustrate the relationship between the speed of the motor and the output torque. The motor can operate continuously at any combination of speed and torque within the prescribed continuous operating zone. The limit of the continuous operating zone is determined with the motor's ambient temperature at 40°C and its drive current as pure sine wave. Actual operation is limited by the current of the servo drive unit.

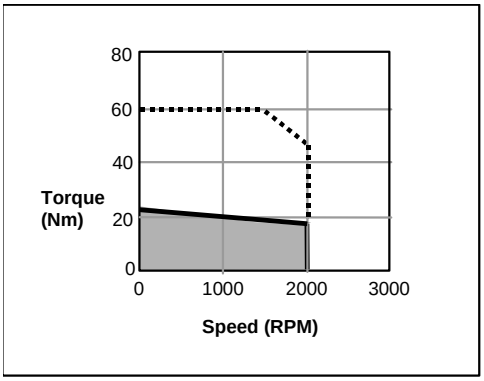
α6/3000



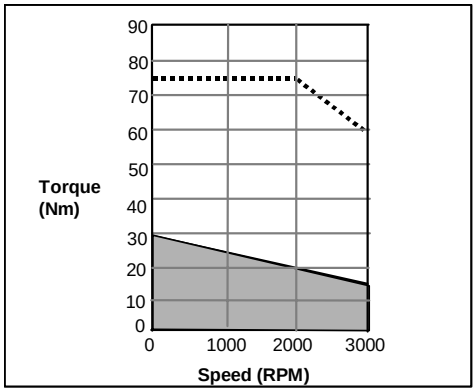
α12/3000



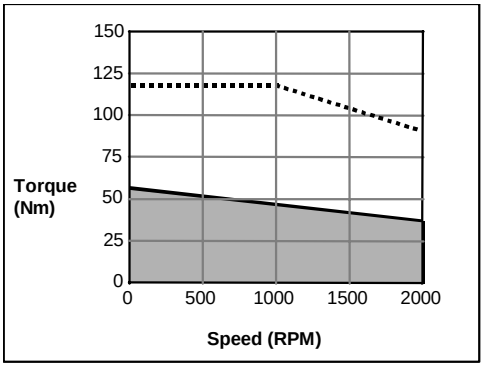
α22/2000



α30/3000



α40/2000



KEY: - - - - = Intermittent operating

= Continuous operating

Figure I-2. α Series Motor Speed-Torque Curves

2.3 α Series motor holding brake

Any of the servo motors can be ordered with a holding brake. The brake is used to prevent movement on horizontal axes or falling along the vertical axis when the servo motor control is turned off.

Brakes are spring-set and electrically released and are designed for holding stationary loads only. Using the holding brake to stop a moving axis may damage the motor or severely reduce its service life.

The specifications of the built-in brakes are listed in Table I-2:

Table I-2. Brake specifications

Parameter	SERVO PACKAGE				
	α6/3000	**α12/2000**	**α22/2000**	**α30/3000**	**α40/2000**
Brake torque	71 in-lb 8 Nm 82 kgf-cm	310 in-lb 35 Nm 357 kgf-cm	310 in-lb 35 Nm 357 kgf-cm	310 in-lb 35 Nm 357 kgf-cm	310 in-lb 35 Nm 357 kgf-cm
Release Response Time	80 msec	150 msec	150 msec	150 msec	150 msec
Brake Response Time	40 msec	20 msec	20 msec	20 msec	20 msec
Supply Voltage and Current	90 VDC (±10%) 0.4 A or less	90 VDC (±10%) 0.6 A or less	90 VDC (±10%) 0.6 A or less	90 VDC (±10%) 0.6 A or less	90 VDC (±10%) 0.6 A or less
Weight Increase	Approx. 5 lb Approx. 2.3 kg	Approx. 13.8 lb Approx. 6.3 kg	Approx. 13.8 lb Approx. 6.3 kg	Approx. 13.8 lb Approx. 6.3 kg	Approx. 22 lb Approx. 10 kg
Inertia Increase	0.00061 in-lb-s^2 0.00007 kg m^2 0.0007 kgf-cm-s^2	0.0052 in-lb-s^2 0.0006 kg m^2 0.006 kgf-cm-s^2	0.0052 in-lb-s^2 0.0006 kg m^2 0.006 kgf-cm-s^2	0.0052 in-lb-s^2 0.0006 kg m^2 0.006 kgf-cm-s^2	0.0087 in-lb-s^2 0.0010 kg m^2 0.010 kgf-cm-s^2

An example of a typical ***user-supplied*** brake power supply is shown below:

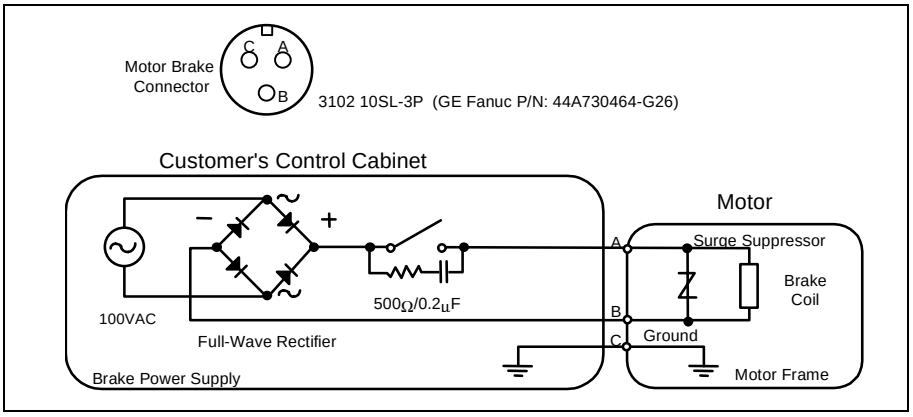


Figure I-3. Typical User-Supplied Brake Power Supply

2.4 α SVU Series Servo Amplifiers

The α SVU Series amplifiers must be matched to the corresponding α Series motor. Because motor characteristics are closely related to amplifier ratings, GE Fanuc restricts the allowable motor/amplifier combinations to those shown in Table **I-3** below.

GE Fanuc offers α SVU Series amplifiers either separately, for replacement and spare parts, or as preconfigured packages that include the connectors and spare fuses necessary for most new installations. The catalog numbers for both options and package contents are shown in the following tables.

Table I-3. α SVU Series models

Motor	Amplifier Model	Amplifier Catalog #	Amplifier Package Catalog #
α6/3000	SVU1-80	A06B-6089-H105	IC800APK080
α12/3000	SVU1-80	A06B-6089-H105	IC800APK080
α22/2000	SVU1-80	A06B-6089-H105	IC800APK080
α30/3000	SVU1-130	A06B-6089-H106	IC800APK130
α40/2000	SVU1-130	A06B-6089-H106	IC800APK130

Table I-4. α SVU Series packages

Description	Package Contents*	Catalog #
80 Amp α Series Amplifier Package	• 1 SVU1-80 Amp (A06B-6093-H105) • 1 Fuse (A06B-6089-K250) • 1 External MCC Connector (A06B-6089-K201) • 1 E-Stop Connector (A02B-0120-K321)	IC800APK080
130 Amp α Series Amplifier Package	• 1 SVU1-130 Amp (A06B-6093-H106) • 1 External MCC Connector (A06B-6089-K201) • 1 E-Stop Connector (A02B-0120-K321) • 2 Fuses (A06B-6089-K250)	IC800APK130

* If required, amplifier package components can be ordered separately.

Section 3: α Series Servo System

The α Series Servo system consists of a motor and its corresponding amplifier. GE Fanuc offers several servo systems, which are identified in Table I-5 below.

Table I-5. Identification of servo systems

Parameter (Unit)	SERVO SYSTEM				
	α6/3000	***α12/3000***	***α22/2000***	***α30/3000***	***α40/2000 (w/fan)***
MOTOR					
Rated output power (kW)	1.4	2.8	3.8	4.8	7.3
Rated torque at stall (Nm) *	6.0	12	22	30	56
Rated torque at stall (in-lb) *	53	106	195	265	495
Rated torque at stall (kgf-cm) *	61	122	225	306	571
Rated output speed (RPM)	4000	3000	2000	3000	2000
Rotor inertia (kg m^2)	0.002646	0.006272	0.01176	0.01666	0.02254
Rotor inertia (in-lb-s^2)	0.02343	0.0555	0.1041	0.1475	0.1996
Rotor inertia (kg-cm-s^2)	0.027	0.064	0.12	0.17	0.23
Continuous RMS current at stall A (rms)	10.0	15.5	18.7	33.7	40.1
Torque constant (Nm/A [rms]) *	0.60	0.77	1.17	0.89	1.40
Torque constant (in-lb/A [rms]) *	5.3	6.8	10.4	7.9	12.4
Torque constant (kgf-cm/A [rms]) *	6.1	7.9	12.0	9.1	14.3
Back EMF constant (V/1000 RPM) *	21	27	41	31	49
Back EMF constant (Vsec/rad) *	0.20	0.26	0.39	0.30	0.47
Armature resistance (Ω) *	0.18	0.17	0.140	0.046	0.080
Mechanical time constant (s) *	0.004	0.005	0.004	0.003	0.003
Thermal time constant (min)	50	60	65	70	30
Static friction (Nm)	0.3	0.8	1.2	1.8	1.8
Static friction (in-lb)	2.7	7.1	10.6	15.9	15.9
Static friction (kgf-cm)	3	8	12	18	18
Maximum allowable current (A [peak])	132	120	160	320	270
Maximum theoretical torque (Nm) **	56	66	130	200	270
Maximum theoretical torque (in-lb) **	496	584	1150	1770	2390
Maximum theoretical torque (kgf-cm) **	571	670	1400	2100	2800
Weight (kg)	13	18	29	41	55
Weight (lb)	28.6	39.6	63.8	90.2	121
AMPLIFIER					
Amplifier model	SVU1-80	SVU1-80	SVU1-80	SVU1-130	SVU1-130
Rated output current (rms amps)	18.7	18.7	18.7	52.2	52.2
Current limit (Peak amps)	80	80	80	130	130
Heat loss (watts)	37.7	47.3	54	70.9	80.7
230 VAC 1ϕ control power current (A)	0.13	0.13	0.13	0.26	0.26
Weight (kg)	4.9	4.9	4.9	9.9	9.9
Weight (lb)	10.8	10.8	10.8	21.8	21.8

* These values are standard values at 20°C with a tolerance of ±10%. The speed-torque characteristics vary, depending on the type of software, parameter setting, and input voltage of the digital servo amplifier. (The above figures show average values.) These values may be changed without prior notice.
** Theoretical values. The actual maximum torque is restricted by the current limit values of the drive amplifier.

Section 4: α Servo System Options

Designing a servo control system requires that you understand how the electrical and mechanical aspects of your system interact. GE Fanuc application engineers are available to help you determine your control system requirements.

Table I-6 will help you select which servo options your system requires. Further details for each option are located in the sections indicated.

Table I-6. α Series servo package options

Servo Option	*Consider Selecting When*	*Catalog #*	*Section #*
Motor Holding Brake	the system design includes an axis that must hold its position when power is removed	Motor option (see p. I-4 for motor catalog #)	2.3
IP67 Sealing	to enable the motor to meet IEC standards for protection from solid objects and water	Motor option (see p. I-4 for motor catalog #)	4.1
Absolute Encoder Battery Packs	you would like to avoid having to re-reference the position when power is restored to the control	IC800ABK001	4.2
AC Line Filters	200—240 VAC is already available to the control cabinet and no transformer is used. Line filters reduce harmonic noise into the servo power supply.	**5.4 kW, 3-phase:** A81L-0001-0083#3C **10.5 kW, 3-phase:** A81L-0001-0101#C	6.2
Prefinished Cables	the cable lengths available from GE Fanuc are appropriate for your application	Refer to the “Cable Connection” table on p. I-43	7.2
External Discharge Resistor	the internal regenerative discharge resistor is insufficient for the application. If required, the regen resistor must be ordered separately.	**16 Ohm 200 Watt:** A06B-6089-H500 **16 Ohm 800 Watt:** A06B-6089-H713 **8 Ohm 800 Watt:** A06B-6089-H711	6.6

4.1 IP67 Sealing Option on α Series Servo Motors

Most of the α Series servo motors can be ordered with IP67 Sealing. Motors with the IP67 Sealing meet the IEC standards regarding protection from solid objects and water, as described below:

Standard IP6*x*: Protection from Solid Objects

- Protected against solid objects greater than 1 mm thickness or diameter
- Dust tight. “No ingress of dust.”

Standard IP*x*7: Protection from Water

- Protected against dripping water, rate equivalent to 3–5 mm of rain per minute
- Protected against splashing water from any direction
- Protected from harmful damage due to water jets, according to the following test:
  - Spray from all angles of 12.5 liters/minute (3.3 gal/min)
  - Nozzle diameter = 6.3 mm (0.248 in)
  - Pressure = 30 kN/m^2 (0.3 bar)
  - Distance = 3 m (118 in)
  - Duration = 3 minutes
- Protected from harmful Protected against the effects of immersion, according to the following test:
  - Surface of the water level shall be at least 150 mm (5.9 in) above the highest point of the machine
  - Lowest point of the machine must be at least 1 m (39.4 in) below the surface of the water
  - Duration of the test must be at least 30 minutes
  - Water temperature must not differ from that of the machine by more than 5° C

For more information, refer to CEI/IEC 34–5; 1991 and the GE Fanuc document *Servo and Spindle Motors Exposed to Liquids* (GFK-1046).

4.2 Absolute Encoder Battery Packs

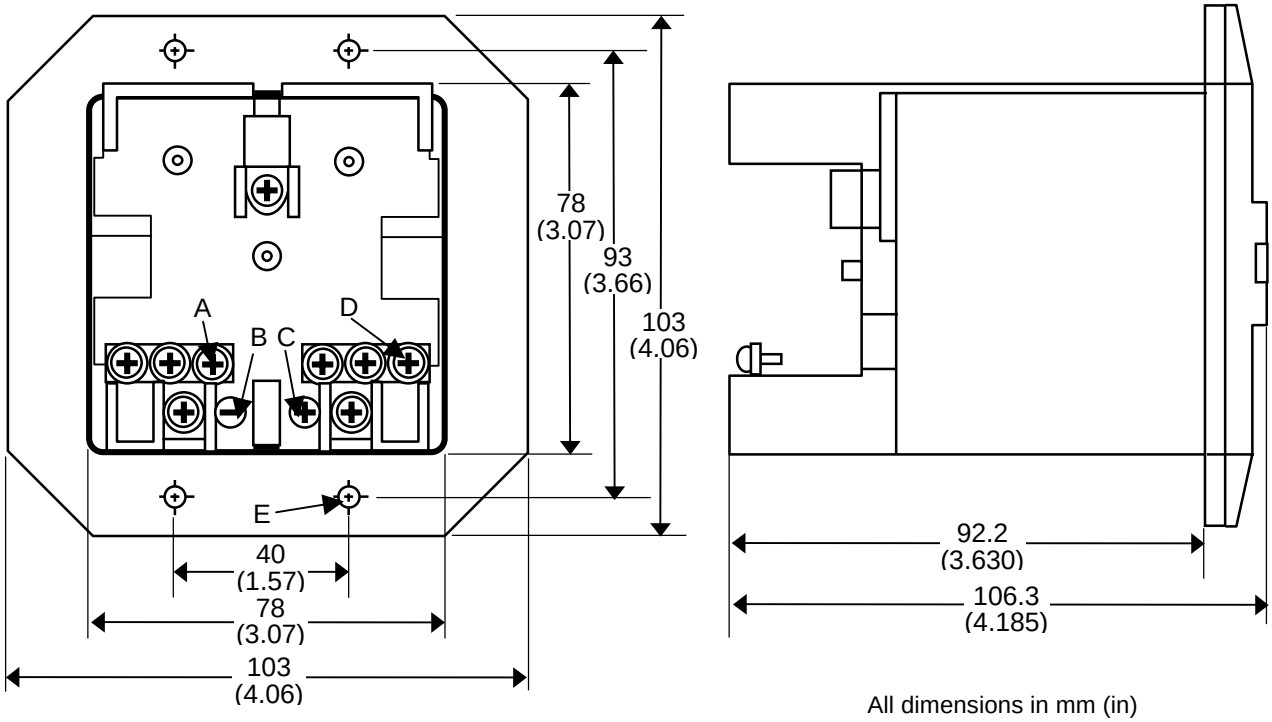
All α Series servo motors feature a built-in serial encoder that can be used in either incremental or absolute mode. To utilize the absolute capability, an optional encoder battery pack (IC800ABK001) must be installed. This pack makes the encoder's position information non-volatile so that the machine does not need to be re-referenced to a home position every time power is restored to the servo system.

The Absolute Encoder Battery Kit (IC800ABK001) contains the following:

- One battery holder (A06B-6050-K060)
- Four D-cell, alkaline batteries (A98L-0031-0005)

One kit provides battery backup for up to four absolute encoders. A two-meter-long cable (44C741863-001) must be ordered separately for each servo axis connected to the battery pack. Kit components cannot be ordered separately.

The battery pack is panel-mounted and requires a cutout in the mounting surface. Mounting dimensions and terminal designations are shown below:



All dimensions in mm (in)

A	3-M3 negative terminal
B	Negative terminal indication
C	Positive terminal indication
D	3-M3 positive terminal
E	4-∅4.3 (0.169) mounting holes

Note: Current drain (per encoder) from battery:
- 20μA with amplifier power ON
- 200μA with amplifier power OFF

Figure I-4. Absolute encoder battery pack

Section 5: Installation Guidelines

This section includes environmental requirements, motor and amplifier dimension drawings and information on ensuring noise protection and selecting a ground fault interrupter.

5.1 Motor Environmental Requirements

The servo motor must be installed in a location that satisfies the following environmental conditions:

Table I-7. Servo amplifier environmental conditions

Condition	Description
Ambient temperature	The ambient temperature should be -10°C to 40°C. When operating the machine at a temperature higher than 40°C (55°C max), it is necessary to derate the output power so that the motor's temperature rating is not exceeded.
Vibration	When installed in a machine, the vibration applied to the motor must not exceed 5G.
Altitude	No more than 1,000 m (3,300 ft) above sea level.
Drip-Proof Environment	The motors have a drip-proof structure that complies with IP65 of the IEC standard. Optional IP67 Sealing, available on most α Series servo motors, offers further protection from liquids (see Section 4.1 for more details). Nevertheless, to ensure long-term performance, the motor surface should be protected from solvents, lubricants, and fluid spray. A cover should be used when there is a possibility of wetting the motor surface. Also, to prevent fluid from being led to the motor through the cable, put a drip loop in the cable when the motor is mounted. Finally, turn the motor connector sideways or downward as far as possible. If the cable connector will be subjected to moisture, it is recommended that an R class or waterproof plug be used.

For additional information, see GE Fanuc publication *Servo and Spindle Motors Exposed to Liquids*, GFK-1046.

5.2 Servo Amplifier Environmental Requirements

The servo amplifier must be installed in a location that satisfies the environmental conditions identified in Table 8 below.

Table I-8. Servo amplifier environmental conditions

Condition	***Description***
Ambient temperature	0°C to 55°C (operating). -20°C to 60°C (storage and transportation).
Temperature fluctuation	Within 1.1°C/min.
Humidity	30% to 95% RH (no condensation).
Altitude	No more than 1000 m (3,300 ft) above sea level.
Vibration	No more than 0.5 G during operation.
Atmosphere	The circuitry and heat sink must not be exposed to any corrosive and conductive vapor or liquid.

The amplifier must be installed in a cabinet that protects it from contaminants such as dust, coolant, organic solvents, acid, corrosive gas, and salt. Adequate protection must also be provided for applications where the amplifier could be exposed to radiation, such as microwave, ultraviolet, laser light, or x-rays.

To adequately protect the amplifier, you must ensure that:

- Contaminants such as dust and coolant, cannot enter through the air inlet or outlet.
- The flow of cooling air is not obstructed.
- The amplifier can be accessed for inspection.
- The amplifier can be disassembled for maintenance and later reinstalled.
- There is sufficient separation between the power and signal lines to avoid interference. Noise protection should be provided.

5.3 α SVU Series servo amplifier heat Dissipation

To determine the heat generated by an α Series SVU amplifier with a particular motor, use the table that follows. The α SVU Series amplifiers are mounted with their heat sink extending through a panel cut out in the control enclosure. This design eliminates most of the heat dissipation inside the control cabinet.

Table I-9. Servo amplifier heat dissipation

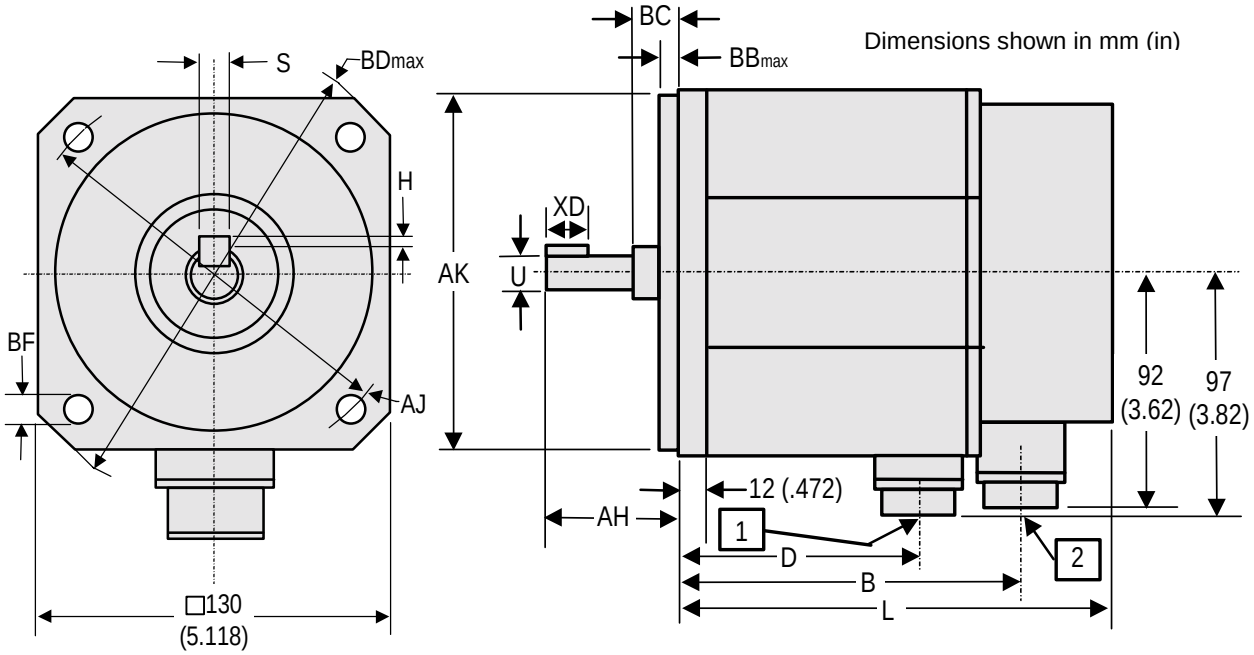
Motor Model	*Amplifier Model*	*Total Dissipation*	*Dissipation Inside Cabinet*
α6/3000	α SVU1-80	73 W	38 W
α12/3000	α SVU1-80	106 W	47 W
α22/2000	α SVU1-80	127 W	54 W
α30/3000	α SVU1-130	228 W	71 W
α40/2000 w/ Fan	α SVU1-130	276 W	81 W

The following notes apply to the heat values:

- The heat dissipation values are worst case values when motors are run at their continuous output ratings.
- If the heat sink of the amplifier is installed outside the cabinet or if a separate regenerative resistor is installed outside the cabinet, it is unnecessary to add the heat generated by the regenerative resistor to the total heat generated by the cabinet. If the heat sink of a built-in or separate regenerative resistor is installed inside the cabinet, it is necessary to add the heat generated by the regenerative resistor to the heat generated by the cabinet. See Section 6.6 for more information.

5.4 α Series Motor Dimensions

α6/3000



Dim.	MOTOR α6/3000
S	$6\ ^{+0}_{-0.030}$ mm (0.2362/0.235 in)
H	$2.5\ ^{+0}_{-0.013}$ (0.0984/0.0933)
BD	165 (6.496)
AJ (dia)	145 (5.709)
BF (dia)	9 (0.354)

Dim.	MOTOR α6/3000
BB	6 mm (.236 in)
XD	36 (1.417)
AK	$110\ ^{+0}_{-0.035}$ (4.331/4.329)
U	$19\ ^{+0}_{-0.013}$ (0.7480/0.7475)
BC	15±0.5 (0.610/0.571)
AH	55 (2.165)
D	176 (6.93)
B	221 (8.70)
L	259 (10.20)

Connector	Description
1	Motor AC Power Connector
2	Motor Encoder Feedback Connector

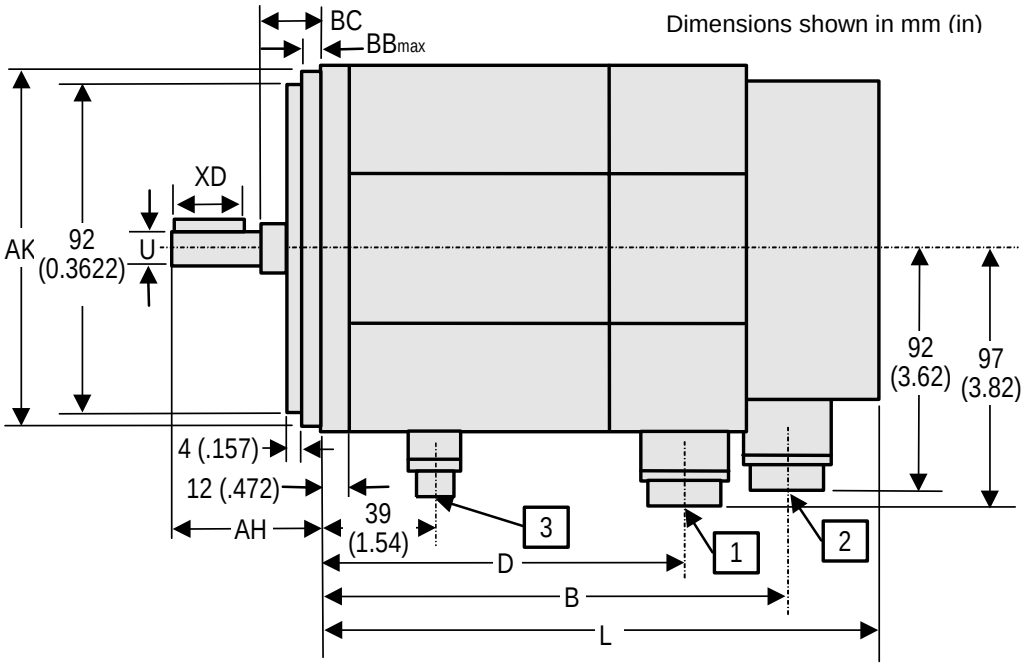
NOTES

1. See the α Connection section (0) for more information about motor cables.
2. Shaft diameter runout = 0.02 mm max (0.00079 in).
3. Flange surface runout = 0.06 mm max (0.00236 in).
4. Rabbet diameter eccentricity = 0.02 mm max (0.00079 in).
5. Maximum radial load for output shaft is 70 kgf (31.8 lb).

Figure I-5. α 6/3000 motor, front and side views

α6/3000 with Brake, Side View

(Front view same as α6/3000 without brake)



Dim.	MOTOR α6/3000 w/ brake
BB	6 mm (0.236 in)
XD	36 (1.917)
AK	$110^{+0}_{-0.035}$ (4.331/4.329)
U	$19^{+0}_{-0.013}$ (0.7480/0.7475)
BC	221 (8.70)
AH	55 (2.165)
D	225 (8.858)
B	270 (10.63)
L	309 (12.17)

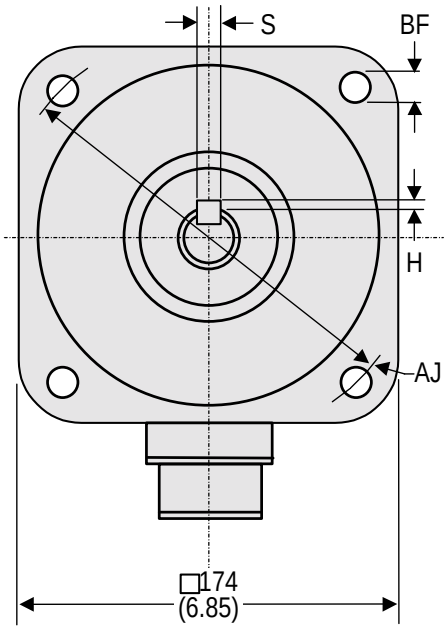
Connector	Description
1	Motor AC Power Connector
2	Motor Encoder Feedback Connector
3	Brake Connector

NOTES

1. See the α Connection section (0) for more information about motor cables.
2. Shaft diameter runout = 0.02 mm max (0.00079 in).
3. Flange surface runout = 0.06 mm max (0.00236 in).
4. Rabbet diameter eccentricity = 0.04 mm max (0.00157 in).
5. Maximum radial load for output shaft is 70 kgf (31.8 lb).

Figure I-6. α 6/3000 motor with brake, side view

α12/3000, α22/2000, and α30/3000, Front View



Dimensions shown in mm (in)

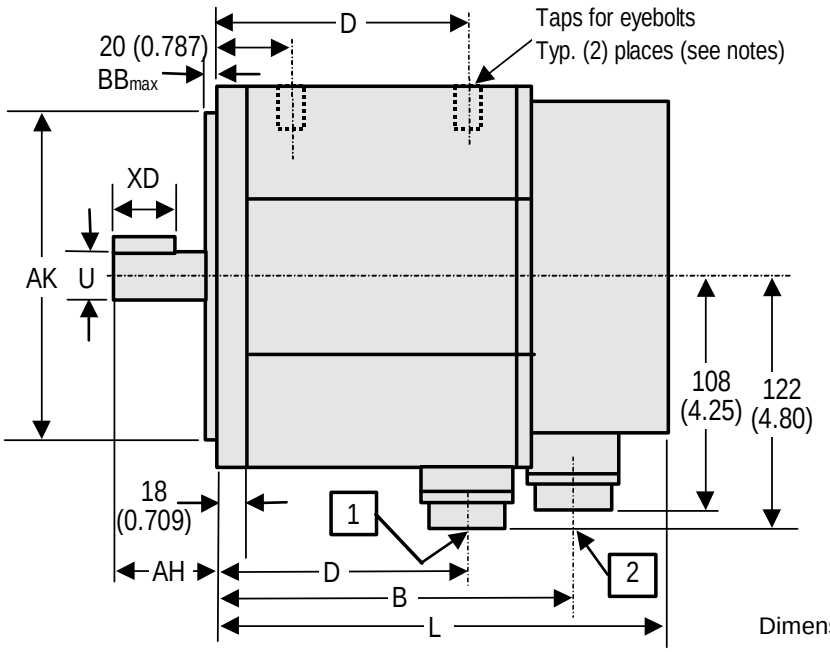
Dim.	MOTOR		
	α12/2000	α22/2000	α30/3000
S	$10^{+0}_{-0.036}$ mm (0.3937/0.3923 in)	$10^{+0}_{-0.036}$ mm (0.3937/0.3923 in)	$10^{+0}_{-0.036}$ mm (0.3937/0.3923 in)
H	$3^{+0}_{-0.30}$ (0.1181/0.1063)	$3^{+0}_{-0.30}$ (0.1181/0.1063)	$3^{+0}_{-0.30}$ (0.1181/0.1063)
BF	13.5 (0.532)	13.5 (0.532)	13.5 (0.532)
AJ	200 (7.874)	200 (7.874)	200 (7.874)

NOTES FOR ALL VIEWS (see Section 0 for side view and Section 0 for side view with brake)

1. See the α Connection section (Section 7.2) for more information about motor cables.
2. Shaft diameter runout = 0.05 mm max (0.00197 in).
3. Flange surface runout = 0.10 mm max (0.00394 in).
4. Rabbet diameter eccentricity = 0.07 mm (0.00276 in).
5. Maximum radial load for output shaft is 450 kgf (204 lb).
6. Taps for eyebolts are M8 by 15 mm (.591 in) deep; eyebolts are not attached.

Figure I-7. α 12/3000, α22/2000, and α30/3000 motors, front view

α12/3000, α22/2000, and α30/3000, Side View



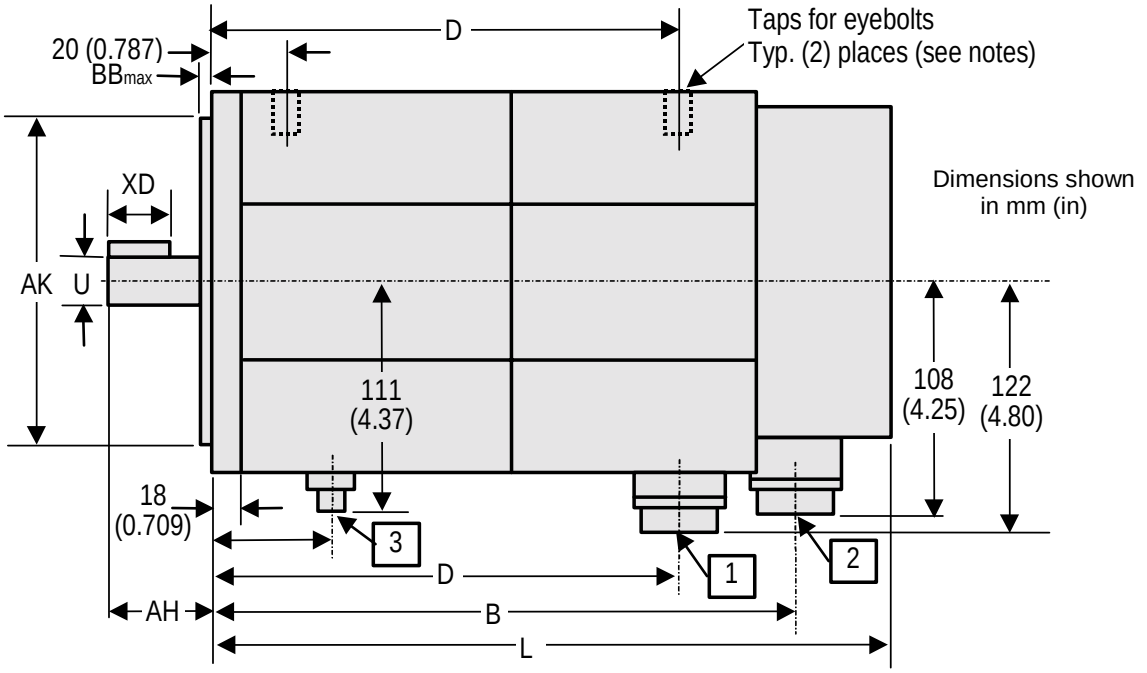
Dimen.	MOTOR		
	α12/2000	**α22/2000**	**α30/3000**
BB	3.2 mm (0.126 in)	3.2 mm (0.126 in)	3.2 mm (0.126 in)
XD	70 (2.756)	70 (2.756)	70 (2.756)
AK	$114.3^{+0}_{-0.025}$ (4.50/4.499)	$114.3^{+0}_{-0.025}$ (4.50/4.499)	$114.3^{+0}_{-0.025}$ (4.50/4.499)
U	$35^{+0.01}_{-0}$ (1.3784/1.3779)	$35^{+0.01}_{-0}$ (1.3784/1.3779)	$35^{+0.01}_{-0}$ (1.3784/1.3779)
AH	79 (3.11)	79 (3.11)	79 (3.11)
D	166 (6.535)	240 (9.449)	314 (12.362)
B	215 (8.465)	289 (11.378)	363 (14.291)
L	240 (9.45)	314 (12.36)	388 (15.28)

Connector	Description
1	Motor AC Power Connector
2	Motor Encoder Feedback Connector

Figure I-8. α 12/3000, α22/2000, and α30/3000 motors, side view

α12/3000, α22/2000, and α30/3000 with Brake, Side View

(Front view same as α12/3000, α22/2000, and α30/3000 without brake; see also Notes in Section 0)

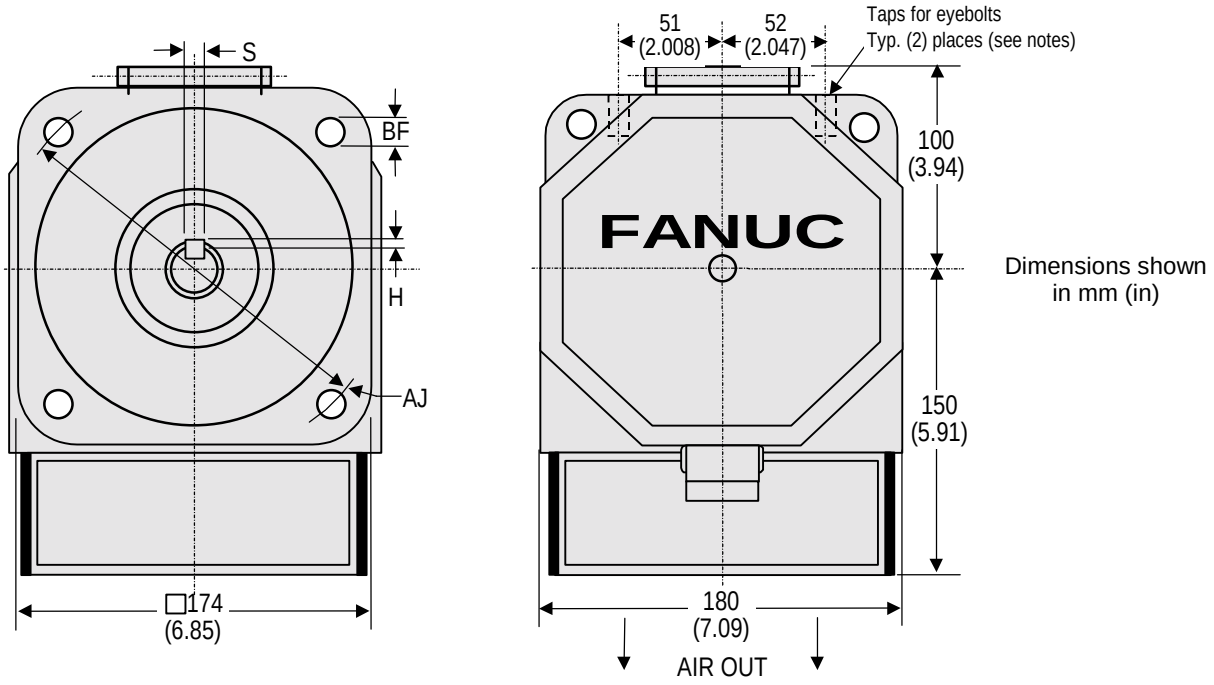


Dimension	MOTOR		
	α12/2000 w/brake	α22/2000 w/brake	α30/3000 w/brake
BB	3.2 mm (0.126 in)	3.2 mm (0.126 in)	3.2 mm (0.126 in)
XD	70 (2.756)	70 (2.756)	70 (2.756)
AK	$114.3\,^{+0}_{-0.025}$ (4.50/4.499)	$114.3\,^{+0}_{-0.025}$ (4.50/4.499)	$114.3\,^{+0}_{-0.025}$ (4.50/4.499)
U	$35\,^{+0.01}_{-0}$ (1.3784/1.3779)	$35\,^{+0.01}_{-0}$ (1.3784/1.3779)	$35\,^{+0.01}_{-0}$ (1.3784/1.3779)
AH	79 (3.11)	79 (3.11)	79 (3.11)
D	238 (9.37)	312 (12.28)	386 (15.20)
B	287 (11.30)	361 (14.21)	435 (17.13)
L	312 (12.28)	386 (15.20)	460 (18.11)

Connector	Description
1	Motor AC Power Connector
2	Motor Encoder Feedback Connector
3	Brake Connector

Figure I-9. α 12/3000, α22/2000, and α30/3000 motors with brake, side view

α40/2000 with Fan, Front And Rear Views



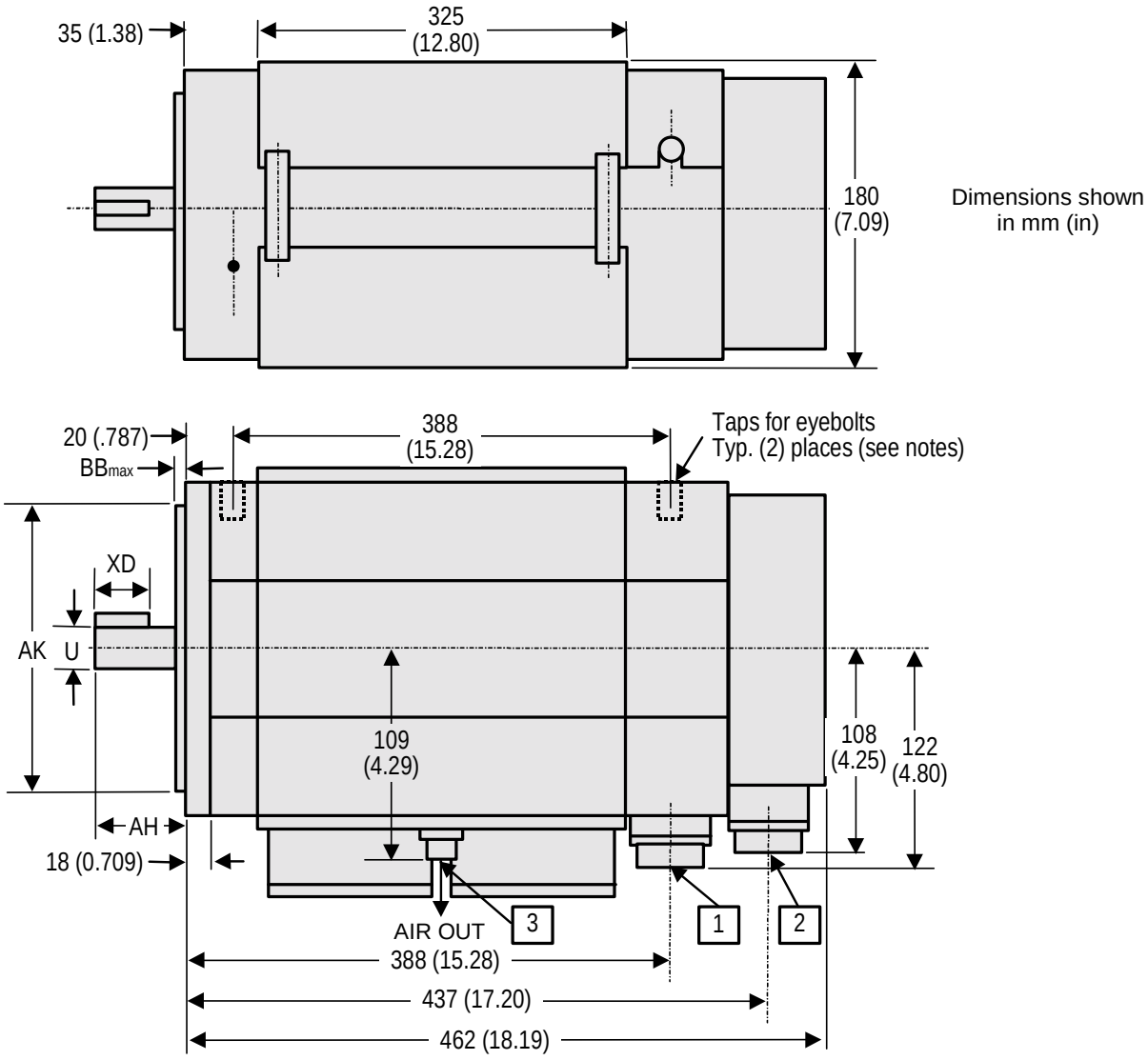
Dim.	MOTOR α40/2000 w/fan
S	$10^{+0}_{-0.036}$ mm (0.3937/0.3923 in)
H	$3^{+0}_{-0.30}$ (0.1181/0.1063)
BF (dia.)	13.5 mm (0.531 in)
AJ (dia.)	200 (7.874)

NOTES FOR ALL VIEWS (see Sections 0 and 0 for top and side views)

1. See Section 7.2 for more information about motor cables.
2. Shaft diameter runout = 0.05 mm max (0.00197 in).
3. Flange surface runout = 10.10 max (0.00394 in).
4. Maximum radial load for output shaft is 450 kgf (990 lb).
5. Taps for eyebolts are M8 by 15 mm (.591 in) deep; eyebolts are not attached.
6. Rabbet diameter eccentricity = 0.07 mm max (0.00276 in).
7. Direction of air flow is downward only.

Figure I-10. α 40/2000 with fan, front and rear views

α40/2000 with fan, top and side views



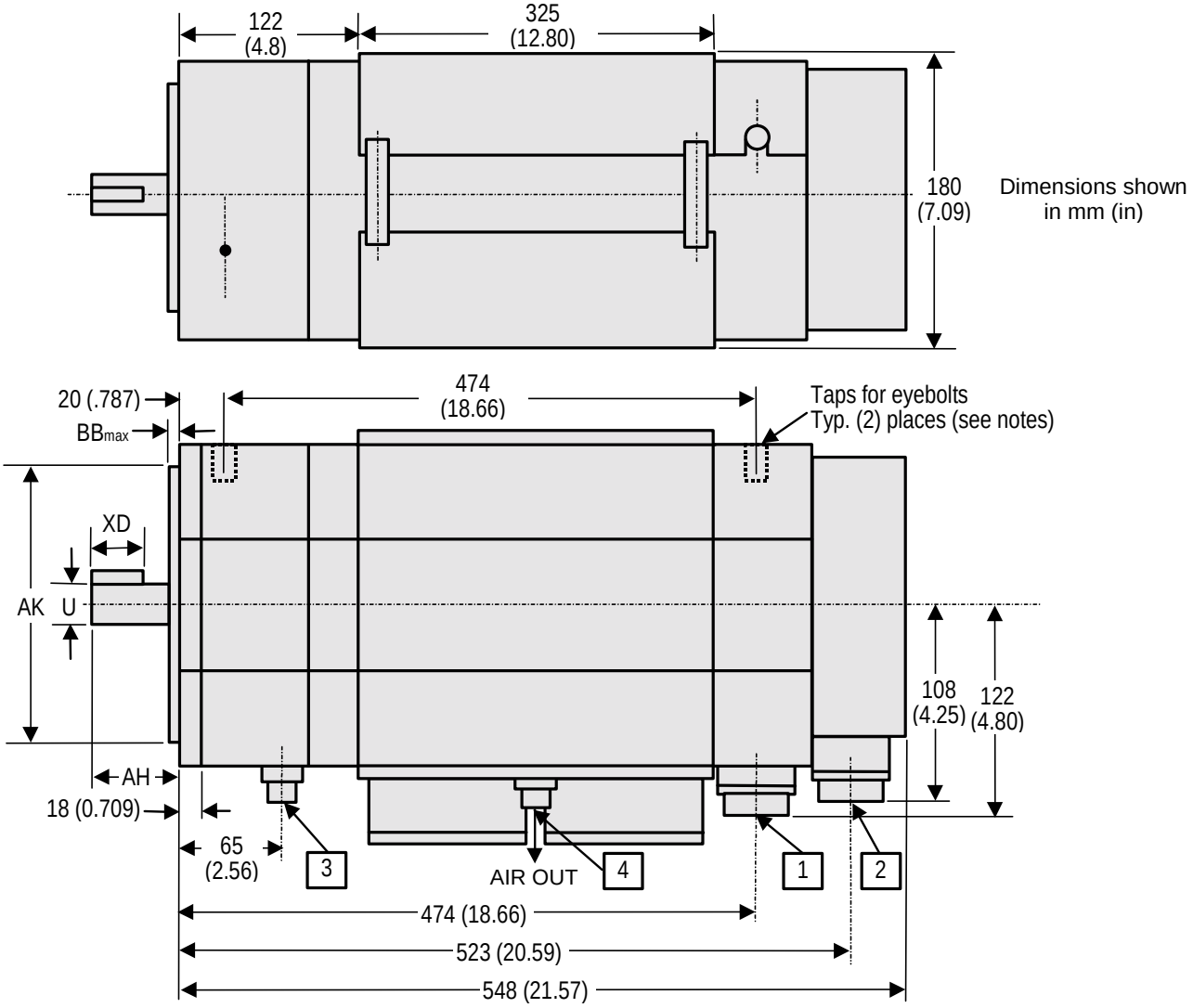
Dim.	MOTOR α40/2000 w/fan
BB	3.2 mm (0.126 mm)
XD	70 (2.756)
AK	$114.3^{+0}_{-0.025}$ (4.50/4.499)
U	$35^{+0.01}_{-0}$ (1.3784/1.3779)
AH	79 (3.11)

Connector	Description
1	Motor AC Power Connector
2	Motor Encoder Feedback Connector
3	Fan Connector

Figure I-11. α 40/2000 motor with fan, top and side views

α40/2000 with Fan and Brake, Top and Side Views

(Front and rear views same as α40/2000 with fan and without brake)



Dim.	MOTOR α40/2000 w/fan
BB	3.2 mm (0.126 in)
XD	70 (2.756)
AK	$114.3^{+0}_{-0.025}$ (4.50/4.499)
U	$35^{+0.01}_{-0}$ (1.3784/1.3779)
AH	79 (3.11)

Connector	Description
1	Motor AC Power Connector
2	Motor Encoder Feedback Connector
3	Brake Connector
4	Fan Connector

Figure I-12. α 40/2000 motor with fan and brake, top and side views

5.5 Shaft Loading:

The allowable load of the motor shaft is as follows:

Table I-10. Allowable motor shaft load

Motor Model	*Radial Load*	*Axial Load*	*Front Bearing Type*
α6/3000	70 kg (31.8 lb)	20 kg (9.1 lb)	6205
α12/3000, α22/2000, α30/3000, α40/2000 w/ fan	450 kg (204 lb)	135 kg (61.4 lb)	6208

NOTES:

- The allowable radial load is the value when a load is applied to the shaft end. It indicates the total continuous force applied to the shaft in some methods of mounting (for example, belt tension) and the force by load torque (for example, moment/pulley radius).
- The belt tension is critical particularly when a timing belt is used. Belts that are too tight may cause breakage of the shaft or premature bearing failure. Belt tension must be controlled so as not to exceed the limits calculated from the permissible radial load indicated above.
- In some operating conditions, the pulley diameter or gear size needs to be checked. For example, when using the model α6/3000 with a pulley/gear with a radius of 1.5 cm (2 in) or less, the radial load when 230 in-lb of peak torque is provided by the motor will exceed the 154 lb maximum rating. In the case of the timing belt, the belt tension is added to this value, making it necessary to support the shaft end.
- When using a timing belt, shaft failure or bearing overload can be minimized by positioning the pulley as close to the bearing as possible.
- Since a standard single row, deep-groove ball bearing is used for the motor bearing, a very large axial load cannot be used. Particularly when using a worm gear and a helical gear, it is necessary to provide another bearing to isolate the thrust load from the searing.
- The motor bearing is generally fixed with a C-snap ring, and there is a small play in the axial direction. When this play influences the positioning in the case of using a worm gear and a helical gear, for example, it is necessary to use an additional bearing support.

5.6 α SVU1 Series Amplifier and Panel Cutout Dimensions

The α SVU Series amplifiers are designed with a rear-mounted heat sink that extends through a hole in the mounting plate. This design eliminates most of the heat dissipation inside the control cabinet reducing the temperature rise in the cabinet and the load on cabinet cooling equipment.

This section contains front and side views as well as the panel cutout drawings for the SVU1-80 and SVU1-130 servo amplifier units.

α SVU1-80 and SVU1-130 Dimension Drawings

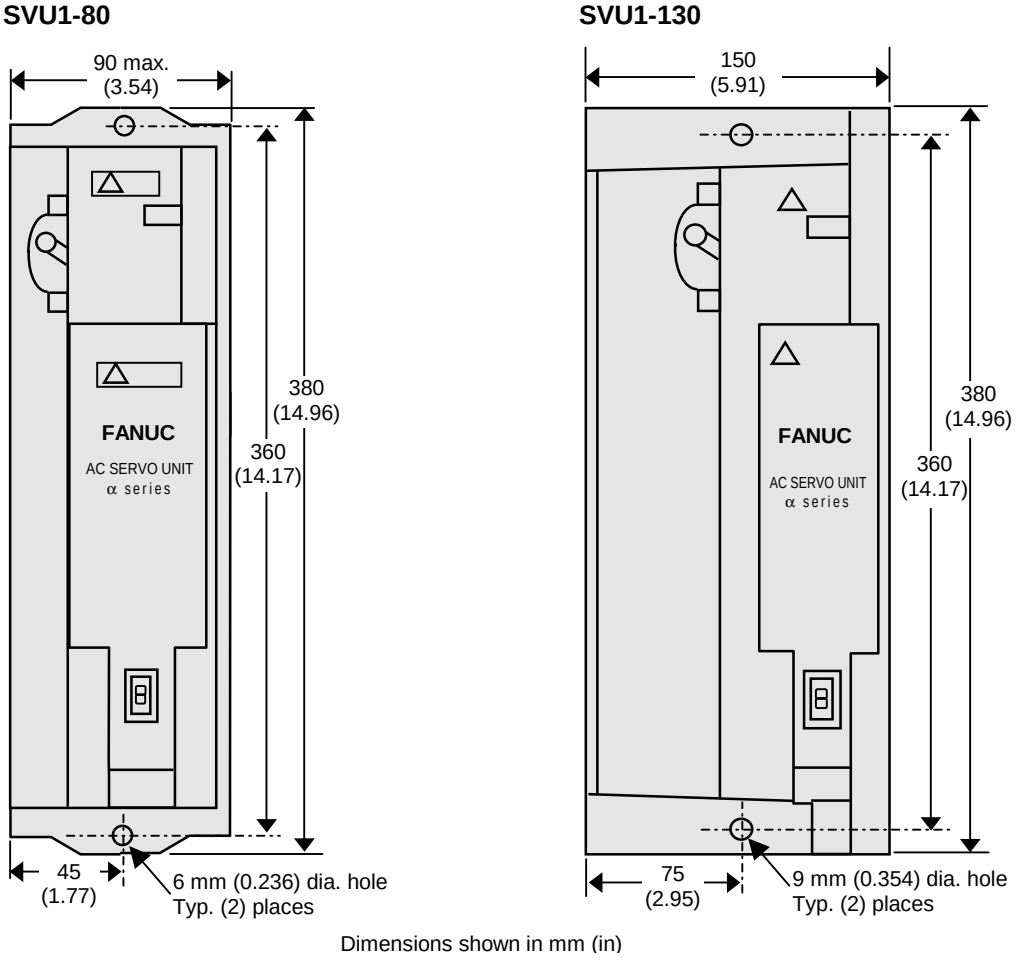
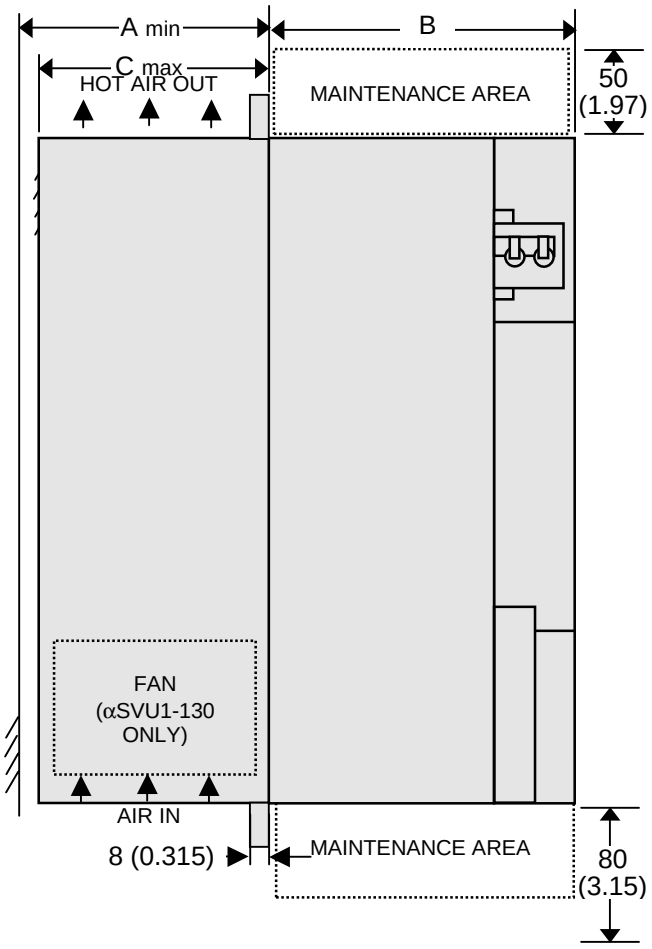


Figure I-13. Front view of αSVU1-80 and αSVU1-130 servo amplifiers



Dim.	SVU1-80	SVU1-130
A	135 mm (5.31 in)	135 mm (5.31 in)
B	165 (6.50)	175 (6.89)
C	120 (4.72)	130 (5.12)

Dimensions shown in mm (in)

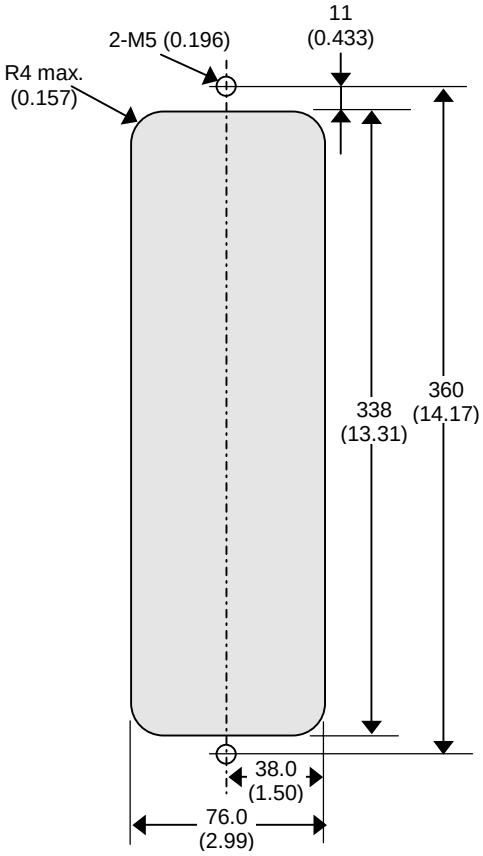
Figure I-14. Side view of αSVU1-80 and αSVU1-130 servo amplifiers

NOTE

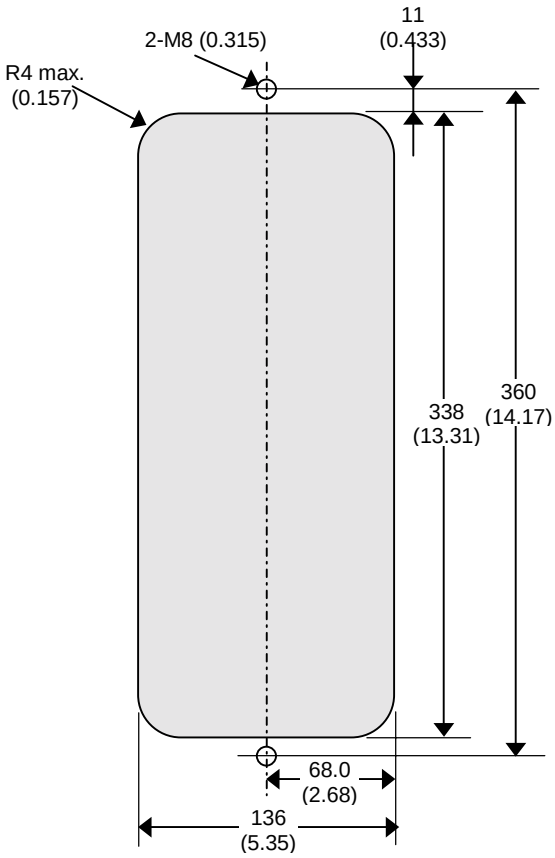
The α SVU Series amplifiers and regenerative discharge units have rear heat sink extensions designed to protrude through the customer's control cabinet. This design allows the amplifier's heat to be dissipated outside the control cabinet, reducing the load on enclosure cooling equipment. Panel cut out drawings are shown on the next page.

α SVU1-80 and SVU1-130 Panel Cutout Drawings

SVU1-80



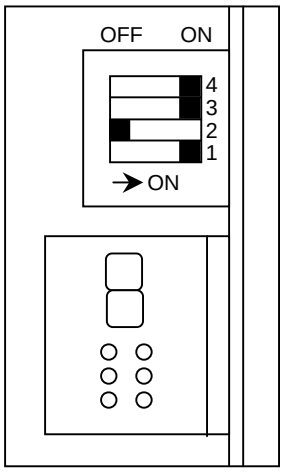
SVU1-130



Dimensions shown in mm (in)

Figure I-15. Panel cut out drawings of α SVU1-80 and α SVU1-130 servo amplifiers

5.7 α SVU Series Switch Settings



There are four channel switches located above the 7-segment LED and behind the terminal board cover on the front of the α Series servo amplifiers. These switches should be set as described below before use of the α SVU series servo amplifiers.

Figure I-16. α SVU Series channel switches

Positions:

The switches are sequentially numbered 1, 2, 3, and 4 with the one at the bottom as switch 1. The OFF position is on the left, and the ON position is on the right.

Switch 1 Setting:

Always set to ON.

Switch 2 Setting:

Always set to OFF for α SVU1 Series.

NOTE: If the switch 2 setting is incorrect, the VRDY OFF alarm may occur.

Switch 3 and 4 Setting:

The setting of these switches depends on the regenerative discharge resistance used:

Table I-11. Switch 3 and 4 setting for α SVU1 Series amplifiers

SVU1-80		
Regen. Discharge Unit	**SW3**	**SW4**
Built-in (100 W)	ON	ON
Separate A06B-6089-H500 (200 W)	ON	OFF
Separate A06B-6089-H713 (800 W)	OFF	OFF

SVU1-130		
Regen. Discharge Unit	**SW3**	**SW4**
Built-in (400 W)	ON	ON
Separate A06B-6089-H711 (800 W)	ON	OFF

5.8 Noise Protection

Separation of Signal and Power Lines

When routing signal and power lines, the signal lines must be separated from the power lines to ensure best noise immunity. Table I-12 below lists the types of cables used:

Table I-12. Servo amplifier signal line separation

Group	Signal	Action
A	Amplifier input power line, motor power line, MCC drive coil	Separate these cables from those of group B by bundling them separately* or by means of electromagnetic shielding**. Attach a noise preventer or suppressor, such as a spark arrester, to the MCC drive coil.
B	Cable connecting control unit with servo amplifier and serial encoder feedback cable	Separate these cables from those of group A by bundling them separately or by means of electromagnetic shielding**. In addition, shielding must be provided.

* The bundle of group A cables must be separated from the bundle of group B cables by at least 10 cm.
** Electromagnetic shielding involves shielding groups from each other by means of a grounded metal (steel) plate.

Grounding

A typical machine has three separate grounds:

- **Signal Ground:** Provides the reference potential (0 V) for the electrical signal system.
- **Frame Ground:** Ensures safety and shields external and internal noise.
- **System Ground:** Connects each unit and the inter-unit frame ground system to earth ground.

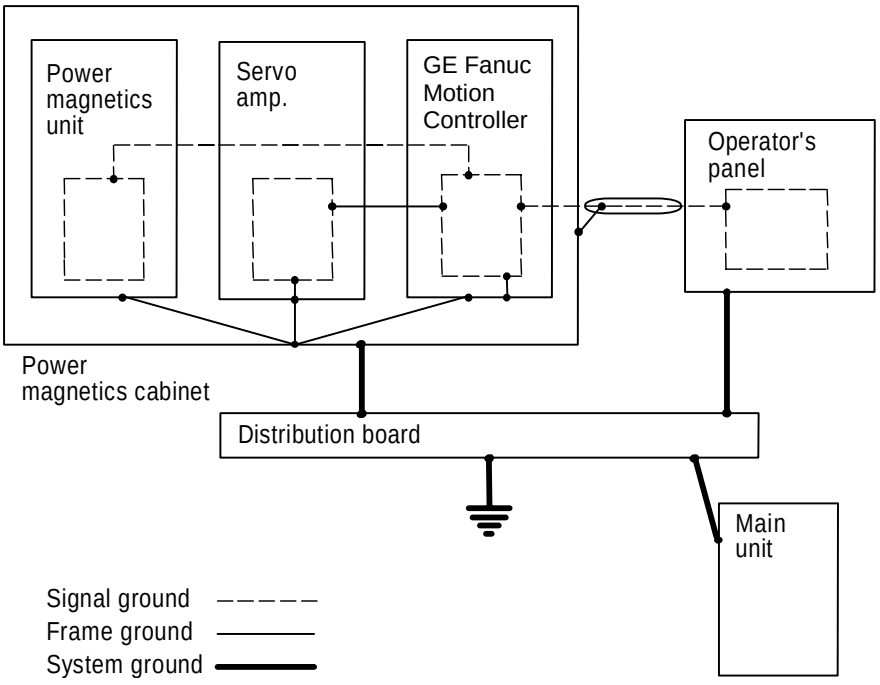


Figure I-17. Ground system

Notes on the ground system wiring for α SVU1 Series amplifiers:

- The ground resistance of the system ground must not exceed 100 ohms (Class-3 ground).
- System ground connection cables must have a sufficiently large cross-sectional area to enable them to safely carry the current that will arise in the event of a problem such as a short-circuit (in general, a cross-sectional area no less than that of the AC power line must be provided).
- The system ground connection cable must be integrated with the AC power line such that power cannot be supplied if the ground wire is disconnected.

5.9 Command Cable Grounding

The GE Fanuc controller cables that require shielding should be clamped by the method shown below. This cable clamp treatment provides both cable support (strain relief) and proper grounding of the shield. To ensure stable system operation, the cable clamp method is recommended. Partially peel back the cable sheath to expose the shield. Push the clamp (A99L-0035-0001) over the exposed shield and insert the clamp hooks into slots on the grounding bar (44B295864-001). Tighten the clamp to secure cable and complete the ground connection. The grounding bar must be attached to a low impedance earth ground.

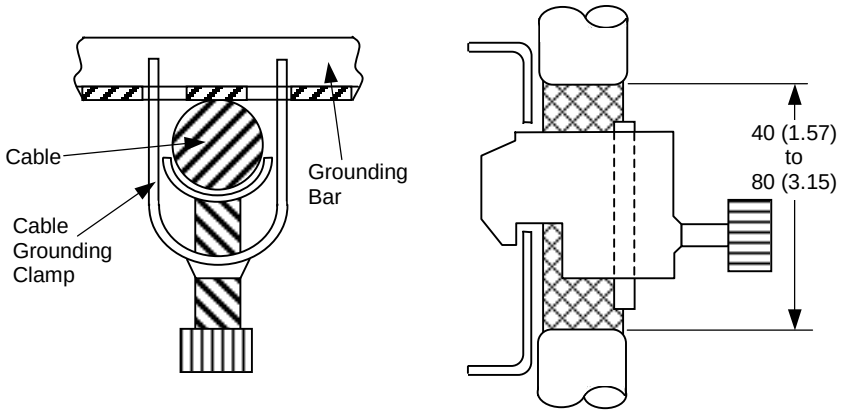


Figure I-18. Cable grounding clamp detail

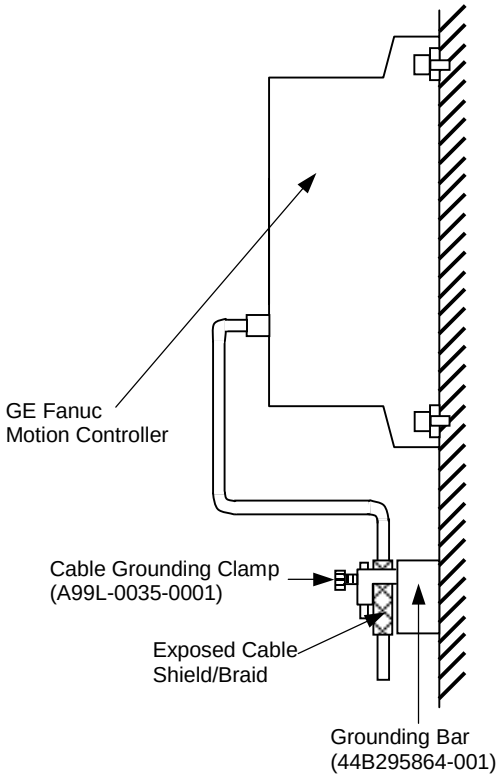


Figure I-19. Command cable shield grounding system

5.10 Selecting a Ground Fault Interrupter

The α Series servo amplifier drives a motor by means of the transistor-based PWM inverter method, in which a high-frequency leakage current flows to ground through the stray capacitance of the motor windings, power cable, and amplifier. A ground fault interrupter or leakage-protection relay, which is installed on the power supply side, can malfunction if such a leakage current should flow. Therefore, you should select an inverter-compatible ground fault interrupter capable of handling the approximate leakage currents shown below to protect against the occurrence of this malfunction:

- **α6/3000:** choose a 1.8 mA commercial frequency component.
- **α12/3000, α22/2000:** choose a 2.0 mA commercial frequency component.
- **α30/3000, α40/2000:** choose a 2.5 mA commercial frequency component.

Section 6: α Servo System Power Requirements

This section provides information about AC amplifier power as well as the discharge of regenerative power.

6.1 Power Line Protection

A circuit breaker, electromagnetic contactor and AC line filter or transformer should be installed as part of your α Series Servo system. GE Fanuc provides the AC line filter as an option. The transformer, circuit breaker, and electromagnetic contactor, however, are user-supplied components. In European countries where power sources are 380 to 400 VAC and neutral grounded, it is necessary to install a transformer.

The same incoming AC control components can be used to provide power to multiple amplifiers, as long as the components are rated for the current and power drawn by the sum of all of the amplifiers.

6.2 AC Line Filter

An AC line filter is recommended to suppress the influences of high-frequency input line noise on the drive power supply. When an isolation-type power transformer is used because a power supply voltage within the specified range is not available, an AC line filter is not required.

If two or more servo amplifiers are connected to one AC line filter, the total continuous output rating of all connected servo amplifiers should be kept below the continuous output rating of the AC line filter. The continuous output rating for the various servos are shown below.

Table I-13. α servo motor continuous output rating

Motor	Cont. Output Rating
α6/3000	1.4 kW
α12/3000	2.8 kW
α22/2000	3.8 kW
α30/3000	4.8 kW
α40/2000 with fan	7.3 kW

If your installation must be EMC compliant, verify that the use of an AC line filter fully satisfies the EMC requirements. You may need to select and install a user-supplied noise filter to meet EMC requirements.

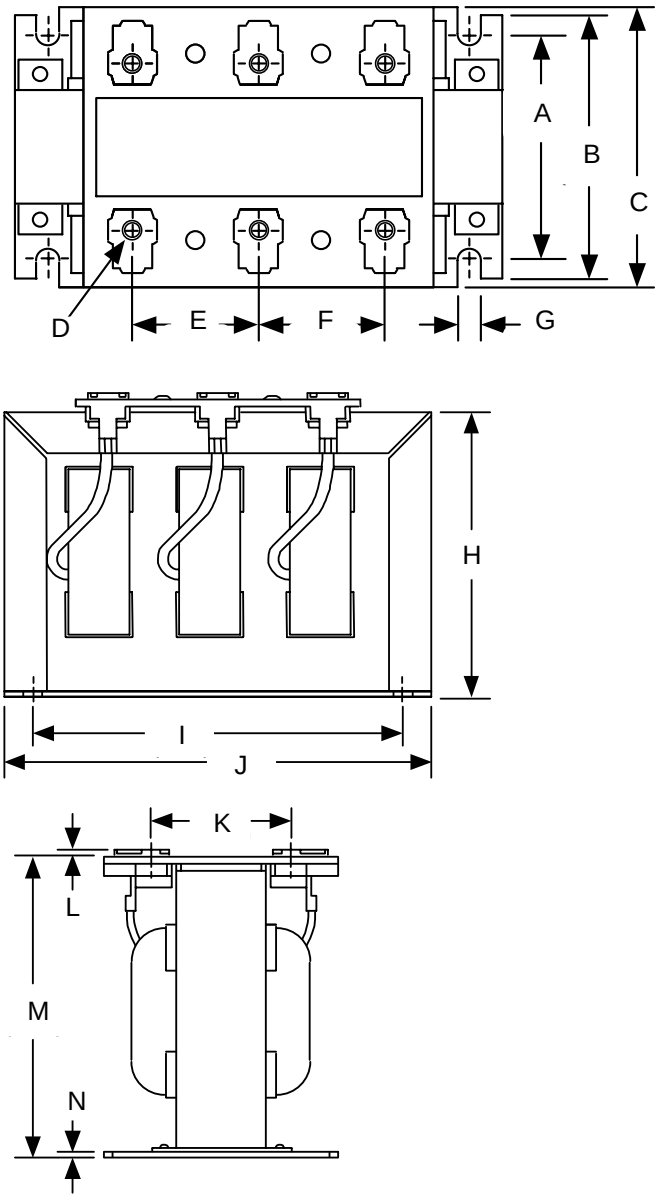
GE Fanuc offers two AC line filters from GE Fanuc:

- 5.4 kW, 3-phase (A81L-0001-0083#3C)
- 10.5 kW, 3-phase (A81L-0001-0101#C)

Table I-14. AC line filter specifications

Specification	5.4 kW	10.5 kW
Continuous rated current	24A	44A
Max. continuous rated power	5.4kW	10.5kW
Heat dissipation	20W	70W
Weight	1.1 kg (2.4 lb)	3.0 kg (6.6 lb)
Catalog Number	(A81L-0001-0083#3C)	(A81L-0001-0101#C)

The dimensions of the AC line filters are as follows



Dim.	*AC LINE FILTER*	
	5.4 kW	**10.5 kW**
A	50 mm (1.97in)	65 (2.56)
B	56 (2.20)	76 (2.99)
C	60 (2.36)	80 (3.15)
D	6-M4 x 0.7 deep	6-M5
E	30 (1.18)	35 (1.38)
F	30 (1.18)	35 (1.38)
G	5 (.197)	5.5 (.217)
H	73.6 (2.89)	98.5 (3.86)
I	95 (3.74)	114 (4.49)
J	110 (4.33)	126 (4.96)
K	35 (1.38)	63 (2.48)
L	1.6 (.062)	2 (.079)
M	78.5 (3.09)	113 (4.45)
N	1.6 (.062)	2 (.079)

Figure I-20. AC line filter dimension drawing

6.3 Circuit Breaker Selection

To provide proper protection for the amplifier, use a circuit breaker rated at no more than 20 Amps (10A for VDE 1601 compliance for CE marking). Table I-15 will help you select the appropriate circuit breaker for your motion application.

Table I-15. Currents drawn at continuous rated output

Motor	Input Current 3-phase*
α6/3000	6 A (rms)
α12/3000	11 A (rms)
α22/2000	15 A (rms)
α30/3000	21 A (rms)
α40/2000	29 A (rms)

NOTE

When multiple amplifiers are connected to a single circuit breaker, select a breaker by multiplying the sum of the currents listed in Table I-15 by 0.6.*

During rapid motor acceleration, a current that is three times the continuous rating flows. Select a circuit breaker that does not trip when a current that is three times the continuous rating flows for two seconds.

*This factor attempts to compensate for applications where all axes are not demanding full power at the same time. For applications where all axes are running continuously or with high duty cycles, this factor must be increased to 1.

6.4 Electromagnetic Contactor (MCC) Rating

To prepare for incoming AC power, you must also select and install an appropriate electromagnetic contactor (MCC), based on the peak currents for the motors in your system. A contactor is typically required on systems approved to display the CE marking (Machinery Directive). When multiple amplifiers are connected to a single circuit breaker, select a breaker based on the sum of the currents in Table I-15.

6.5 Incoming AC Power

The α SVU Series servo amplifiers require a three-phase AC input for main bus power and a single-phase AC input for control power. Two terminals of the three-phase input (L1 and L2) are connected with the terminals for the single-phase input by jumper bars on terminal board T1 at the factory. If you want to separate the two power supplies, remove the jumper bars. The power requirements for these supplies are shown below:

Table I-16. AC and control power

Specification	Description
Voltage: 3-phase	200 VAC to 240 VAC
Frequency	50 Hz, 60Hz ±2 Hz
Voltage fluctuation during acceleration/deceleration	7% or less

Table I-17. Control power current

Amplifier Model	Control Power Current
α SVU1-80	150 mA
α SVU1-130	300 mA

AC Power Ratings

The power supply rating required when using multiple servo motors can be determined by summing the requirements of the individual motors.

The power supply ratings listed in Table I-18 are sufficient as continuous ratings. Note, however, that servo motor acceleration causes a current to momentarily flow that is approximately three times the continuous flow rating.

When the power is turned on, a surge current of about 37A (when 264VAC is applied) flows for 20 msec.

Table I-18. Three-phase power supply ratings

Motor	Power Supply Rating	Current @ 230 VAC
α6/3000	2.2 kVA	6 A
α12/3000	4.3 kVA	11 A
α22/2000	5.9 kVA	15 A
α30/3000	8.2 kVA	21 A
α40/2000 with fan	11.3 kVA	29 A

6.6 Discharging Regenerative Energy

Regenerative energy is normally created in applications with a high load inertia or frequent acceleration and deceleration. When decelerating a load, the stored kinetic energy of the load causes generator action in the motor causing energy to be returned to the α Series amplifier.

The α SVU amplifiers have a regenerative discharge resistor built in to dissipate this energy. For light loads, low acceleration rates, or low speed machines, the amplifier may be able to handle the regenerated energy. Some applications may require the assistance of a separately mounted external regenerative discharge unit. Vertical axes with no counter balance may generate excessive regenerative energy. These units comply with VDE 0160, European Safety Standards for CE marking.

Three separate regenerative discharge units are available for the α SVU Series amplifiers:

- 16 Ω, 200 W (A06B-6089-H500) for the SVU1-80 (weight of 2.2 Kg [4.8 lb])
- 16 Ω, 800 W (A06B-6089-H713) for the SVU1-80 (weight of 5 Kg [11 lb])
- 8 Ω, 800 W (A06B-6089-H711) for the SVU1-130 (weight of 5 Kg [11 lb])

Calculations to determine if a separate regenerative discharge unit is required are shown in Section 0.

If the regenerative discharge unit overheats, a built-in thermostat is tripped, the external overheat alarm is issued, and the motor is stopped. If an external regenerative discharge unit is required, a separate unit must be installed for each amplifier. This component cannot be daisy-chained. The dimensions for these units are shown in Section 0. Connections for cables K7 and K8 are shown on p. 52 of this document.

Calculating the Average Regenerative Energy

Use the following calculation to determine the average regenerative power that will be released in your application (ambient temperature is assumed not to exceed 55°C). Based on the calculations, a separate regenerative discharge unit may be required. If this is the case, select either the 200 W or 800 W regenerative discharge unit as appropriate for the amplifier model. The watt rating of the selected unit must exceed the average calculated regenerative power.

Average Amount of Regenerative Discharge (W)	**=**	**Rotational Power Released During Deceleration (P_1) (STEP 1)**	**–**	**Power Consumed through Axis Friction (P_2) (STEP 2)**	**+**	**Vertical Power Released During Downward Motion (P_3) (STEP 3)**

STEP 1—Rotational power released during deceleration (P_1)

P_1 = $(6.19x10^{-4}) \times (J_m + J_L) \times \omega_m^2 / F$ **watts**

where:

F	Deceleration duty (Example: deceleration once per 5 second cycle, F=5)	(sec)
J_m	Motor rotor inertia α6/3000 = 0.0174 α12/3000 = 0.0555 α22/2000 = 0.1041 α30/3000 = 0.1475 α40/2000 = 0.1996	(lb-in-s^2)
J_L	Load inertia converted to motor shaft inertia	(lb-in-s^2)
ω_m	Maximum motor speed at time of deceleration	(rpm)

STEP 2—Power consumed through axis friction (P_2)

P_2 = $(5.91x10^{-3}) \times t_a \times \omega_m \times T_L / F$ **Watts**

where:

ω_m	Maximum motor speed at time of deceleration	(rpm)
t_a	Worst case/deceleration time (shortest time)	(sec)
T_L	Machine friction torque	(in-lb)
F	Deceleration duty	(sec)

STEP 3—Vertical power released during downward motion (P_3)
(this term applies only for vertical axis operation)

P3 = $(1.182x10^{-2}) \times T_h \times \omega_m \times \frac{D}{100}$ **Watts**

where:

ω_m	Motor speed during rapid traverse	(rpm)
T_h	Upward supporting torque applied by the motor during downward motion	(sec)
D	Duty cycle of downward operation (Note: The maximum value of D is 50%)	(%)

STEP 4—Determine if a separate regenerative discharge unit is required

When the average regenerative power produced never exceeds the values indicated in Table I-19, a separate regenerative discharge unit is **NOT** required:

$$\text{Average Regenerative Power} = P_1 - P_2 + P_3$$

Table I-19. Maximum allowable regenerative energy for amplifiers

Amplifier	Max. Allowable Regen. Power	Used with Motors
αSVU1-80	100 watts	α6/3000, α12/3000, α22/2000
αSVU1-130	400 watts	α30/3000, α40/2000 w/fan

If the average regenerative power exceeds the value for the amplifier, only then is a separate regenerative discharge unit required. Select a unit from Table I-20 that exceeds the calculated power value.

Table I-20. Regenerative discharge capacity

Amplifier Model	Unit	Catalog #	No Air Flow	Air Velocity 2m/sec	Air Velocity 4m/sec
αSVU1-80	16 Ω, 200 W	A06B-6089-H500	200 W (as shipped)	400 W*	600 W*
αSVU1-130	8 Ω, 800 W	A06B-6089-H711	Forced cooling fan is installed		800 W
αSVU1-80	16 Ω, 800 W	A06B-6089-H713	Forced cooling fan is installed		800 W

*GE Fanuc does not supply a cooling fan for this unit. These values are supplied for reference only (customer-supplied fan).

EXAMPLE:

Assume a vertical axis using an α12/3000 motor (J_m = 0.0555 lb-in-s^2) that decelerates once every 4 seconds (F = 4) for 0.10 seconds (t_a) from a maximum speed of 2500 rpm (ω_m). The machine load inertia reflected to the motor shaft (J_L) is 0.05 lb-in-s^2. The torque (max) required to support the load during a downward move (T_h) is 100 in-lb, and the downward motion is 20% of the cycle (D). Axis friction (T_L) is 35 in-lb.

STEP 1:

P_1 = Rotational Power $= (6.19 \times 10^{-4}) \times (0.0555 + 0.05) \times 2000^2/4$

$= 65.3$ Watts

STEP 2:

P_2 = Friction Power $= (5.91 \times 10^{-3}) \times 0.10 \times 2000 \times 35/4$

$= 10.3$ Watts

STEP 3:

P_3 = Vertical Power $= (1.182 \times 10^{-2}) \times 100 \times 2000 \times \frac{20}{100} = 472.8$ Watts

STEP 4:

Average Power $= P_1 – P_2 + P_3$

$= 65.3 – 10.3 + 472.8$

$= 527.8$ Watts

(Note the large value associated with the non-counterbalanced vertical load)

Since this value is larger than the 100 W internal capacity of the αSVU1-80 amplifier used with this motor, a separate regenerative discharge unit is required. The A06B-6089-H713 unit is adequate since its 800 W rating exceeds the 539.1 W average for the application. With a customer-supplied fan with at least a 4 m/sec flow rate, the A06B-6089-H500 unit could also be used.

Regenerative Discharge Unit Dimensions

The separate regenerative discharge units are designed with a rear-mounted heat sink that extends through a hole in the mounting plate. This design eliminates most of the heat inside the control cabinet. This section contains the dimensions for the units, and Section 0 shows the necessary panel cutouts to properly mount the units in an enclosure.

A06B-6089-H500 (200 W) for the α SVU1-80

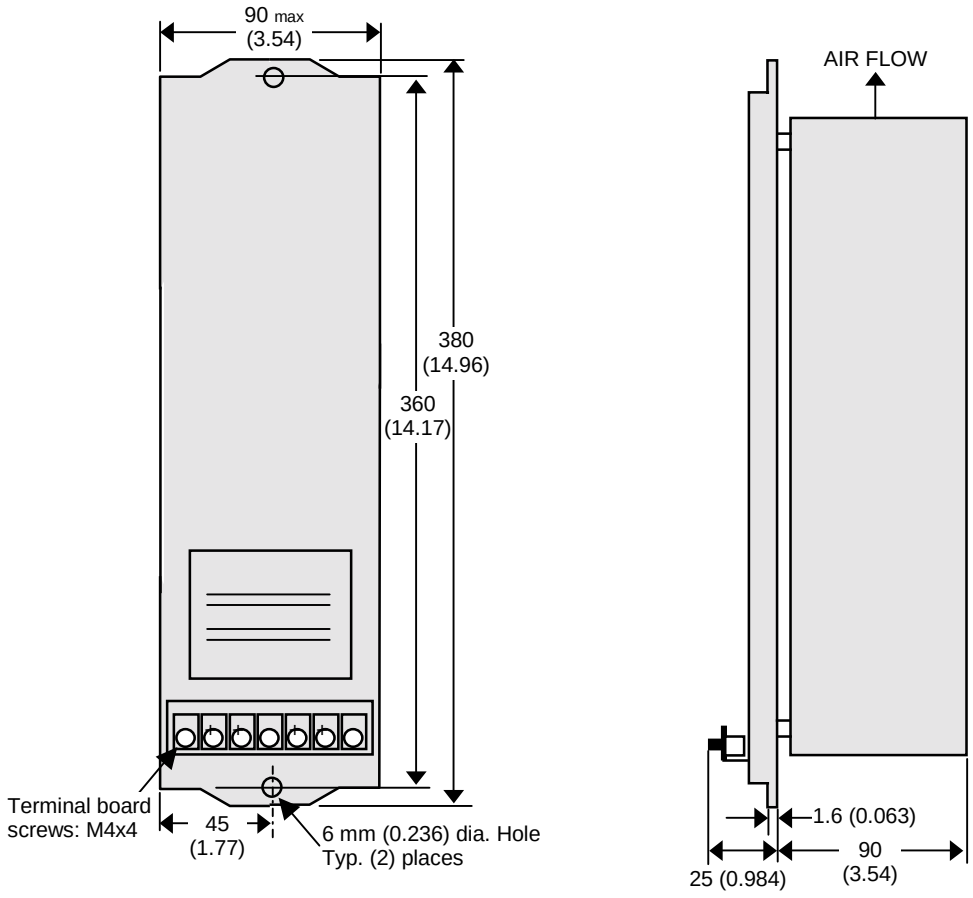


Figure I-21. 200 W Regenerative discharge unit (A06B-6089-H500), front, side, and end views

A06B-6089-H711 (800 W) for the α SVU1-130 and A06B-6089-H713 (800W) for the α SVU1-80

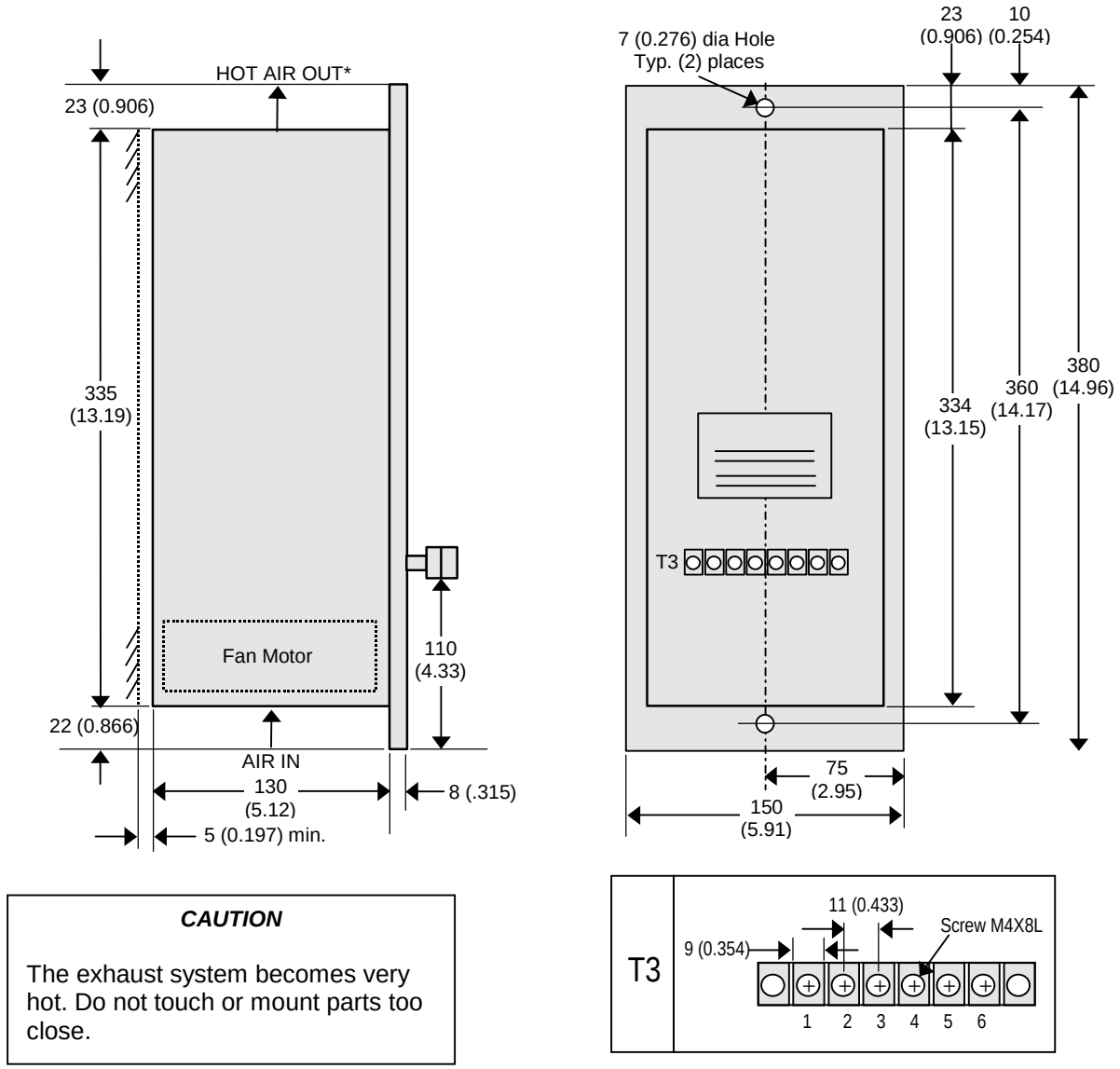


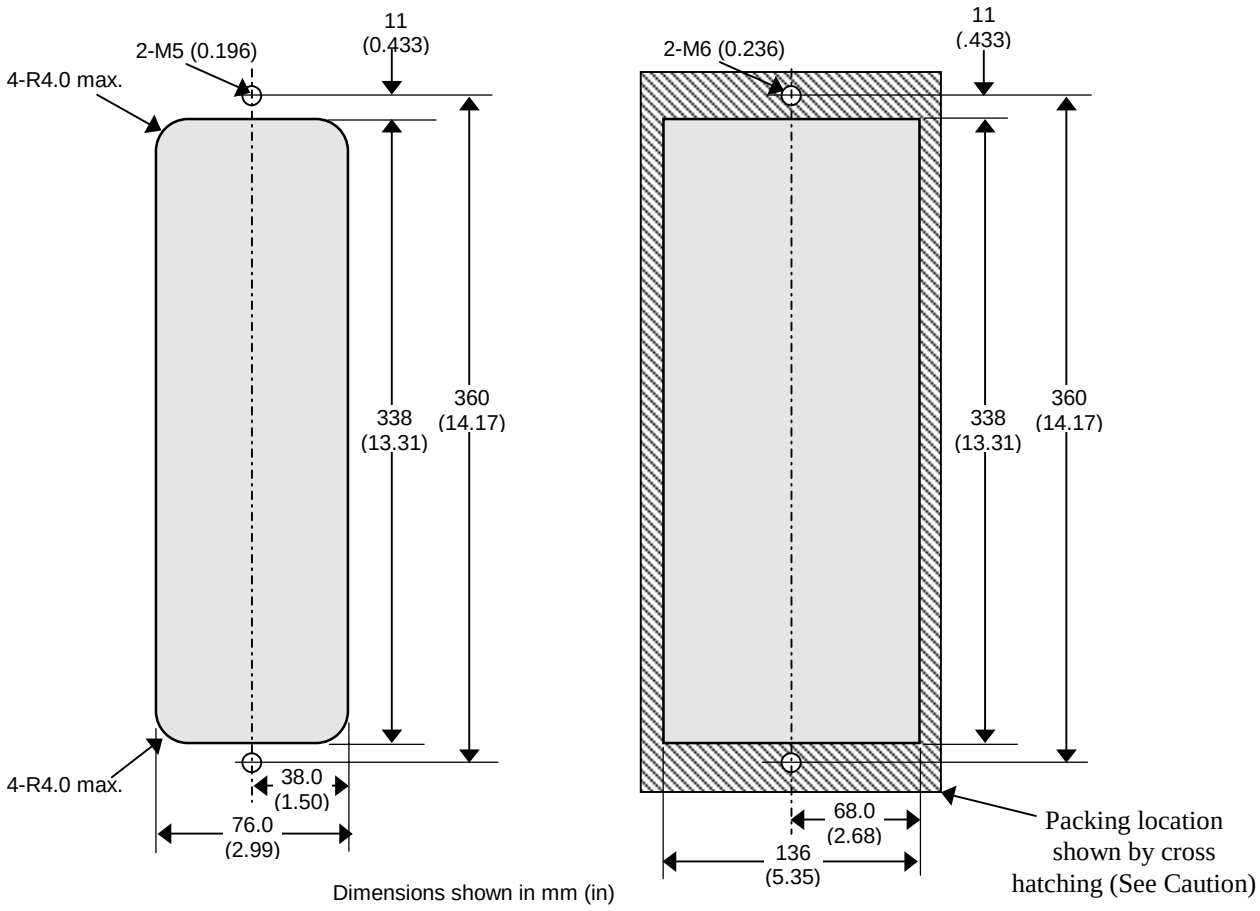
Figure I- 22. 800 W Regenerative discharge unit (A06B-6089-H711, A06B-6089-H713), front, side, and end views and T3 terminal detail

Regenerative Discharge Unit Panel Cutout Dimensions

The panel cutouts necessary to mount the separate regenerative discharge units are shown below.

A06B-6089-H500 (200 W) for the α SVU1-80

A06B-6089-H711 (800 W) for the α SVU1-130
A06B-6089-H713 (800 W) for the α SVU1-80



CAUTION:
Attach packing (acrylonitrile-butadiene rubber or soft NBR) around the cutout to keep out oil and dust.

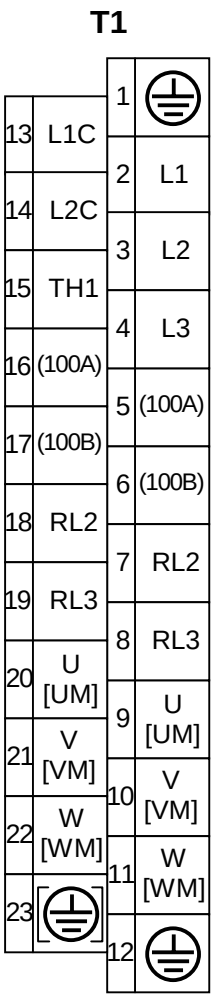
Figure I-23. Regenerative discharge unit panel cutout dimensions

Section 7: α Servo System Connection

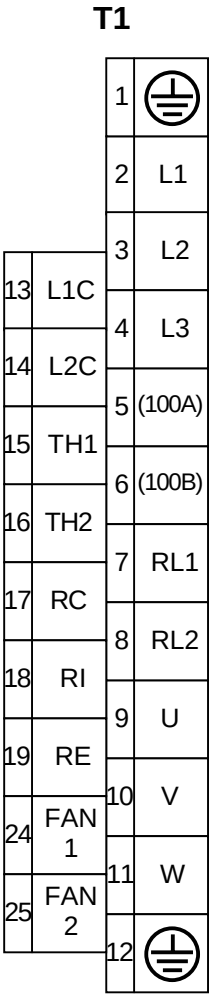
7.1 α SVU1 Amplifier Connections

Power terminations are connected to the αSVU amplifiers on Terminal Board T1 located on the front of the amplifier. The terminals are shielded by a hinged cover that includes a convenient label indicating the terminal designations, as shown in Figure **I-24.** Terminals are M4 screws and will accept stripped wire, spring spade, or ring terminals.

α SVU1-80
(A06B-6089-H105)



α SVU1-130
(A06B-6089-H106)

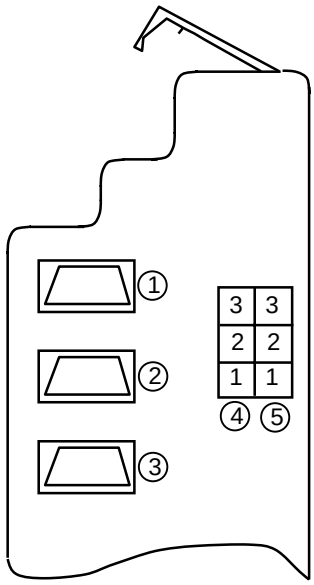


NOTE

5 and 6 on terminal board T1 are not used with the α SVU1 Series.

Figure I-24. αSVU amplifier terminal designations

Signal and control cables are interfaced to the amplifiers using connectors on the bottom of the unit. Location and designation of each connector is shown in Figure **I-25.**



#	Connector Description	Connector Label	Remarks	See Section 7.4
1	Connector for GE Fanuc Motion Controller or CNC Interface	JS1B	N/A	K1 cable
2	Connector for Serial Encoder	JF1	N/A	K2 cable
3	Connector for Serial Encoder Battery	JA4	N/A	K9 cable
4	Connector for 24V power supply (connector keyed for Y position)	CX3	pin 1 pin 3	K10 cable
5	Connector for E-Stop input signal (connector keyed for X position)	CX4	pin 2; ESP pin 3; 24V	K5 cable

Figure I-25. Bottom view of αSVU amplifier

7.2 α System Connections

When planning your system, it is important to determine how the different parts of the system connect together. Cable reference numbers K1 through K15 on the α Servo Connection Diagram in Section 7.3 and in Table I-22 indicate the required and optional system connections.

The α Series motor and amplifier connectors required for the system are available from GE Fanuc.

GE Fanuc supplies connectors to allow you to manufacture cables to the specific length required by your system design. GE Fanuc does offer finished cables as options for many connections. See the Cable Connections chart that follows for more information.

An external contactor (MCC) connector (A06B-6089-K201) and E-Stop connector (A02B-0120-K321) are shipped with each α Series servo amplifier package.

Optional As are also available for the various and feedback cables.

Table I-21. Available motor cable connectors for α Servo systems

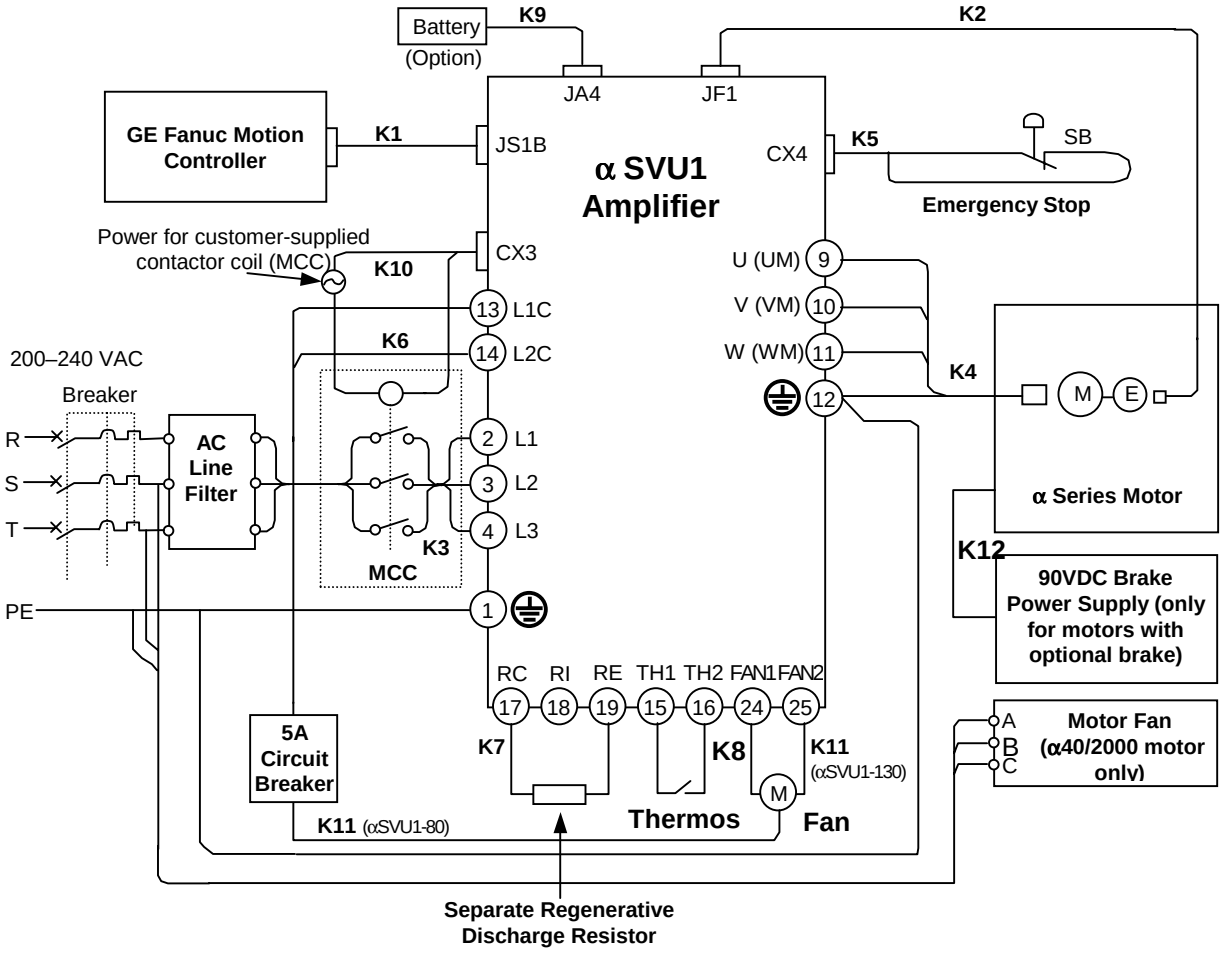
Part Number	Description
44A730464-G18	Motor Power Connector Kit, α6/3000
44A730464-G20	Motor Power Connector Kit, α12/3000 and α22/2000
44A730464-G21	Motor Power Connector Kit, α30/3000 and α40/2000
A06B-6050-K115	Motor Encoder Connector Kit, α 6/3000
44A730464-G24	Motor Encoder Connector Kit, α12/3000, α22/2000, α30/3000, and α40/2000
44A730464-G26	Motor Brake Connector Kit, all α Series motors

Table I-22. Cable Connections

Ref.	Connects	Prefinished Cable Part Number	Connection Type	When Required
K1	DSM302 to Amplifier (JS1B)	IC800CBL001 (1m) IC800CBL002 (3m)	Servo Command Signal	always
K1	All Other Controllers to Amplifier (JS1B)	IC800CBL003 (2m)	Servo Command Signal	always
K2	Built in Serial Encoder to Amplifier (JF1)	CF3A-2MPB-0140-AZ	Motor Encoder Feedback	always
K3	AC Power Supply to Amplifier	N/A	3-Phase Servo Power	always
K4	Amplifier to Motor (Prefinished cables include separate cable to connect motor frame ground to customer's earth ground.)	IC800CBL061 (α6/3000) [14m] IC800CBL062 (α12/3000, α22/2000) [14m] IC800CBL063 (α30/3000, α40/2000) [14m]	Motor Power	always
K5	Amplifier E-stop contact (CX4) to machine E-stop contact	N/A	Emergency Stop	always
K6	AC Control Power Supply to Amplifier	N/A	Amplifier Control Power	always
K7	Amplifier to Regenerative Discharge Unit	N/A	Separate Regenerative Discharge Unit	in some cases[1]
K8	Regenerative Discharge Unit Over Temperature Switch to Amplifier	N/A	Separate Regenerative Discharge Unit	in some cases[1]
K9	Amplifier (JA4) to Encoder Backup Battery Unit	44C741863-001	Absolute Encoder Battery	with battery option[2]
K10	Control to MCC Coil Connector (CX3) on Amplifier	N/A	Emergency Stop/Power Enable	control-dependent; consult your control documentation
K11	Amplifier to Regenerative Discharge Unit Cooling Fan	N/A	Separate Regenerative Discharge Unit Fan Supply Cable	in some cases[1]
K12	90 VDC Brake Power Supply to Motor Brake	44C742238-004 (14m)	Motor Brake Power	with brake option
K13	Motor Cooling Fan to Fan Power Supply	44C742238-004 (14m)	Motor Fan Power	α40/2000 with fan only

[1] See the Discharging Regenerative Energy section in Section 6.6
[2] Prefinished cable is provided as a part of a battery pack option

7.3 α SERIES Servo Connection Diagram

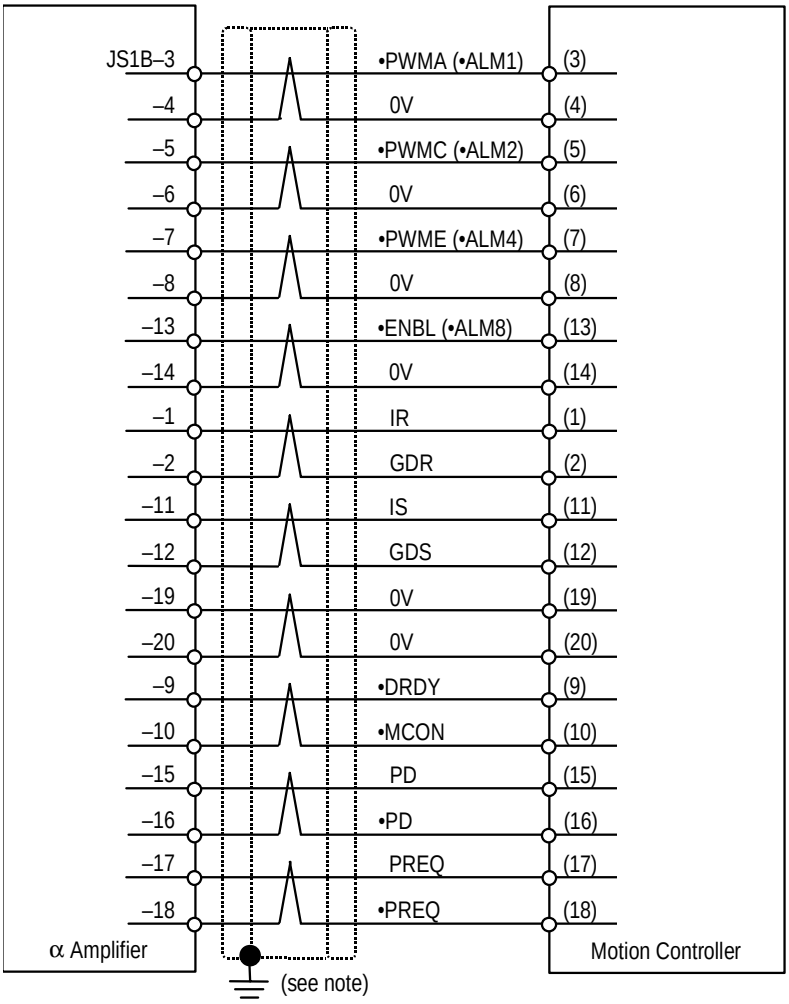


NOTES

- An AC line filter is recommended (unless an isolation transformer is provided) to reduce the effect of harmonic noises to the power supply. Two or more αSVU amplifiers can be connected to one AC line filter if its power capacity is not exceeded.
- RC and RI were connected to each other through a jumper bar at the factory. If a separate regenerative discharge unit will be used, the jumper bar must be removed.
- TH1 and TH2 were connected to each other through a jumper bar at the factory. Remove the jumper bar and connect these terminals to the separate regenerative discharge unit and resistor thermal switch.
- Only the αSVU1-130 (A06B-6089-H106) has FAN1 and FAN2 terminals. Connect the terminals to the fan motor (K11 cable) of the separate regenerative discharge unit (other than the A06B-6089-H106). If a fan is to be used with the aSVU1-80 the fan power should be connected to L1C and L2C through a 5-amp circuit breaker as shown.
- For CE Mark applications, an MCC that complies with European standards should be selected. The user should determine details of the use of the MCC.

7.4 Connection Details

K1—Servo Command Signal Cable (α6/3000, α12/3000, α22/2000, α30/3000, α40/2000)

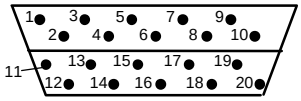
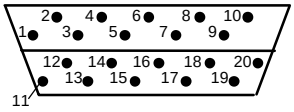


NOTES

The servo command cables for the DSM300 Series controller (IC800CBL001 and IC800CBL002) must be purchased from GE Fanuc. Proper tooling is required to assemble the connectors. For custom length cables, contact your GE Fanuc Distributor or GE Fanuc Sales Engineer.

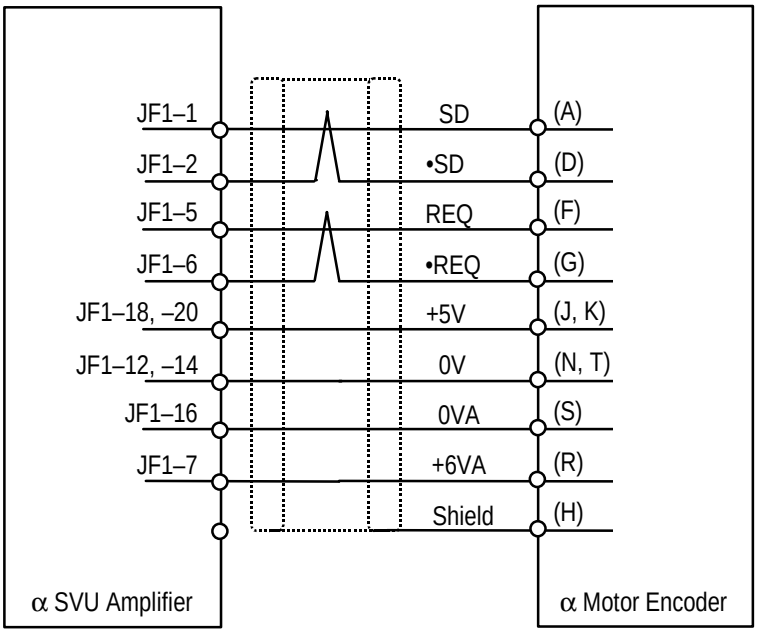
Grounding the cable shield using the grounding bar (44B295864-001) and cable grounding clamp (A99L-0035-0001) will provide greater noise immunity.

- Wire: 0.08mm^2 twisted pair group shielded cable (10 pairs). The following wire is recommended for the K1 cable: 28 AWG x 10 pairs (20 conductors).

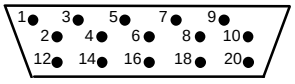
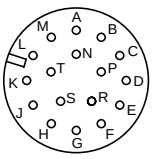
Cable (K1)	*GE Fanuc Part No.*	*Connector Manufacturer*
DSM300 Controller to Servo Amplifier (JS1B)	IC800CBL001 (1 meter) IC800CBL002 (3 meter)	Cable must be purchased from GE Fanuc (connectors not sold separately)*
GE Fanuc controller other than DSM302 to Servo Amplifier (JS1B)	IC800CBL003 (2 meter)	Hirose Electric Co., Ltd.  Honda Tsushin Kogyo Co., Ltd. (PCR-E20FA)  *Connectors viewed from back (solder/crimp side).*

***NOTE:** DSM302 cables cannot be customer-manufactured and uses a 36-pin connector on its end. The DSM302 module requires IC693ACC355 Axis Terminal Board and either IC693CBL324 (1 meter) or IC693CBL325 (3 meter) Terminal Board Cable to access axis I/O such as Home Switch Input, Over Travel Inputs, or Strobe (registration) Inputs.

K2—Motor Encoder Feedback Cable (α6/3000, α12/3000, α22/2000, α30/3000, α40/2000)

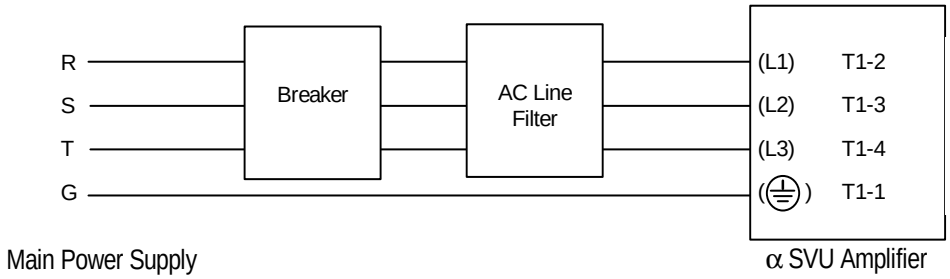


- Prefinished 14m Cable, Part number: CF3A-2MPB-0140-AZ (severe duty)
- Wire: for +5V, 0V use two parallel conductors of 0.5mm^2 (20 AWG) or larger when the wire length does not exceed 14m. When the wire length exceeds 14m, wire gauge must be increased to ensure that the sum of the electrical resistance of 0V and 5V circuit does not exceed 0.5 ohms. For 6VA, 0VA use 0.5mm^2 (20 AWG) or larger; for SD, *SD, REQ, *REQ use 0.18mm^2 (24 AWG) or larger twisted pair with 60% braid shield.

Connector	*GE Fanuc Part No.*	*Manufacturer*
Servo Amplifier (JF1)	A06B-6073-K214	Hirose Electric Co., Ltd. (F140-2015S) [connector cover: FI-20-CV]  *Connector viewed from back (solder/crimp side).*
Servo Motor Encoder	44A730464-G38 (CE EXT GND pin type) Alpha 6 A06B-6050-K115	Hirose Electric Co., Ltd. (MS3106A 20-29SW, straight) (MS3108B 20-29SW, elbow) 

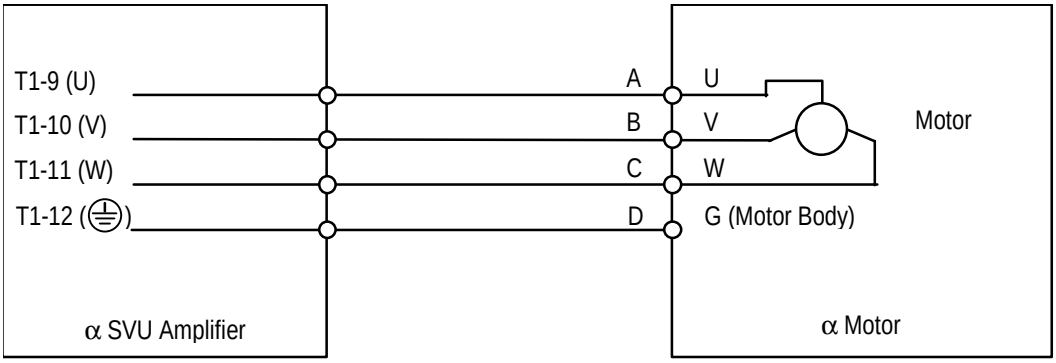
K3—Three-Phase Servo Power Cable

For a power supply voltage of 200–240 VAC 50/60 Hz

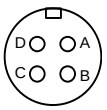


- For αSVU1-80, use 600 V, 4-conductors (JIS C 3312) of 3.5mm^2 (12 AWG) or larger, heat-resistive vinyl cable (nonflammable polyflex cable with a max. conductor temperature of 105º C) of 3.5mm^2 (12 AWG) or more.
- For αSVU1-130, use 600 V, 4-conductors (JIS C 3312) of 5.5mm^2 (10 AWG) or larger.
- Use M4 terminal board screws on α SVU amplifier

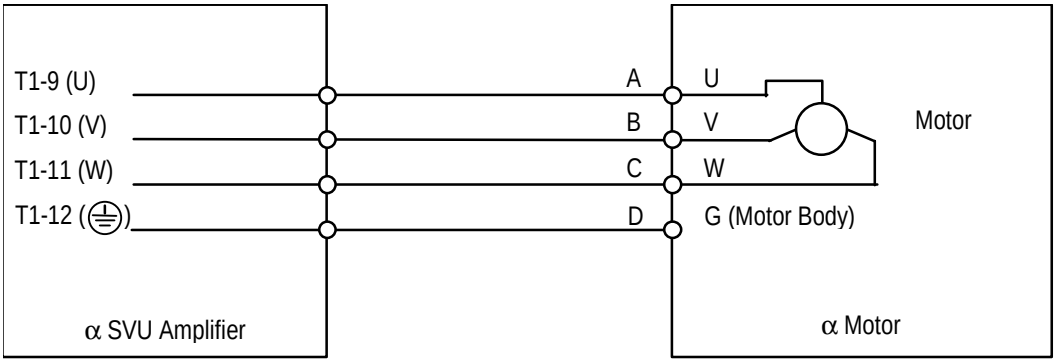
K4—Motor Power Cable (α6/3000)



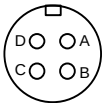
- Prefinished 14m Cable, Part number: IC800CBL061 (severe duty)
- Wire: 4-conductor, 12 AWG, Type S0 power cord, PUR (polyurethane) jacket

Connector	*Part No.*	*Maker*
Servo Amplifier T1 Terminal Board	N/A (M4 Spring Spade)	N/A
Servo Motor	44A730464-G20 (CE EXT GND pin)	DDK CE Series (CE02-6A22-22DS) 

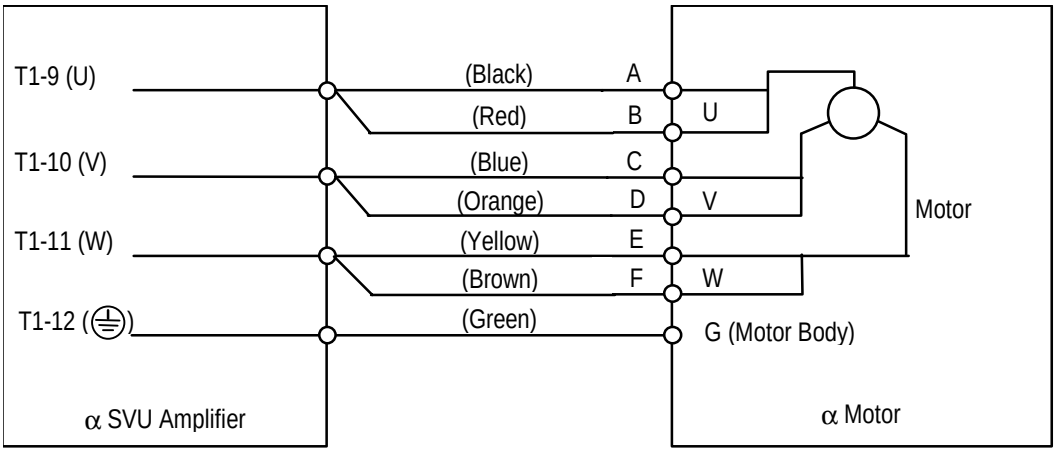
K4—Motor Power Cable (α12/3000, α22/2000)



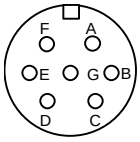
- Prefinished 14m Cable, Part number: IC800CBL061 (severe duty)
- Wire: 4-conductor, 12 AWG, Type S0 power cord, PUR (polyurethane) jacket

Connector	*Part No.*	*Maker*
Servo Amplifier T1 Terminal Board	N/A (M4 Spring Spade)	N/A
Servo Motor	44A730464-G20 (CE EXT GND pin)	DDK CE Series (CE02-6A22-22DS) 

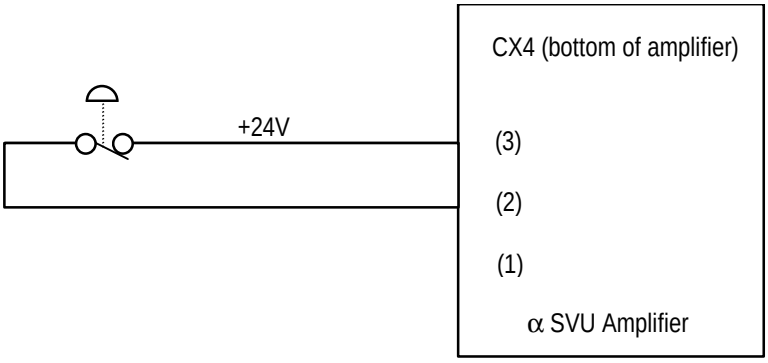
K4—Motor Power Cable (α30/3000, α40/2000)



- Prefinished 14m Cable, Part number: IC800CBL063 (severe duty)
- Wire: 7-conductor, 12 AWG, Type SO power cord, PUR (polyurethane) jacket

Connector	*Part No.*	*Maker*
Servo Amplifier T1 Terminal Board	N/A (M4 Spring Spade)	N/A
Servo Motor	44A730464-G21 (CE EXT GND pin)	DDK CE Series (CE02-6A24-10GS) 

K5—Amplifier Emergency Stop Connection

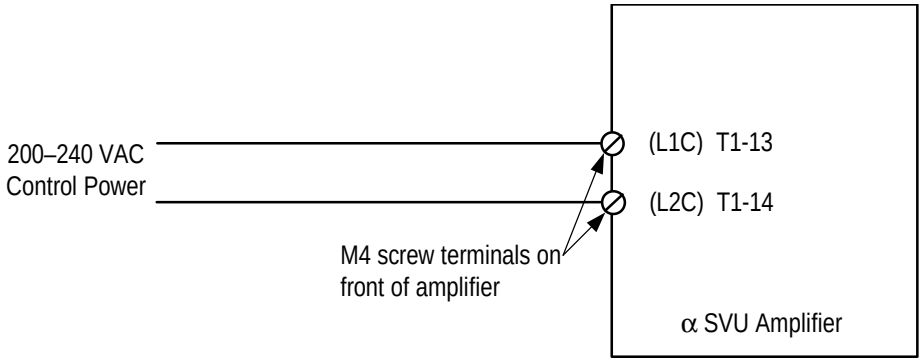


NOTE
Up to six amplifiers can be daisy chained to the same E-Stop circuit

- Wire: 2-conductor 0.75mm^2 (20 AWG)

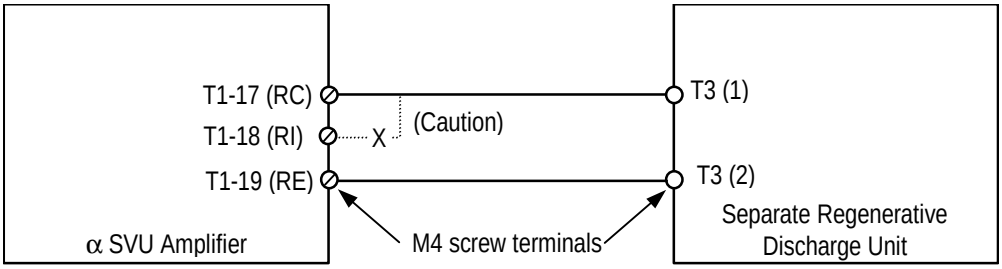
Connector	*GE Fanuc Part No.*	*Manufacturer*
Servo Amplifier CX4	A06B-0120-K321 (included with amplifier packages)	AMP Housing: 1-178128-3; Contact: 1-175218-2 (crimp terminal) 1 2 3 Connector viewed from wire insertion side.

K6—Amplifier Control Power Connection



- Wire: 300V, 2-conductor 1.25mm^2 (16 AWG) or larger

K7—Separate Regenerative Discharge U nit Power Cable (α6/3000, α12/3000, α22/2000, α30/3000, α40/2000)

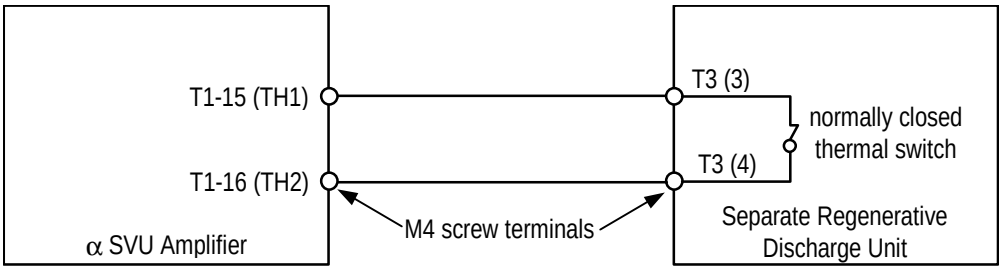


CAUTION

When a separate regenerative discharge unit is connected, remove the factory-installed shorting bar between terminals T1-17 (RC) and T1-18 (RI).

- Wire: 600 V, 2-conductor, 2.0mm^2 (14 AWG) or larger

K8— Separate Regenerative Discharge Unit Thermal Protection Cable (α6/3000, α12/3000, α22/2000, α30/3000, α40/2000)

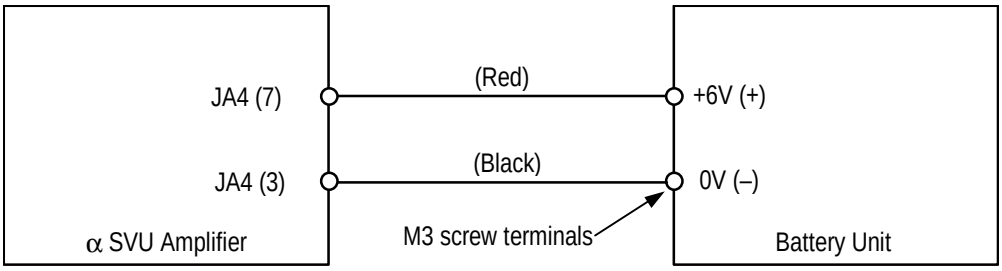


CAUTION

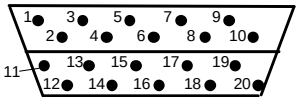
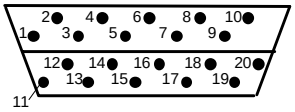
When a separate regenerative discharge unit is connected, the DIP switches on the front of the amplifier must be set for the proper unit. See Section 5.7 for more information.

- Wire: 600 V, 2-conductor, 0.75mm^2 (18 AWG) or larger

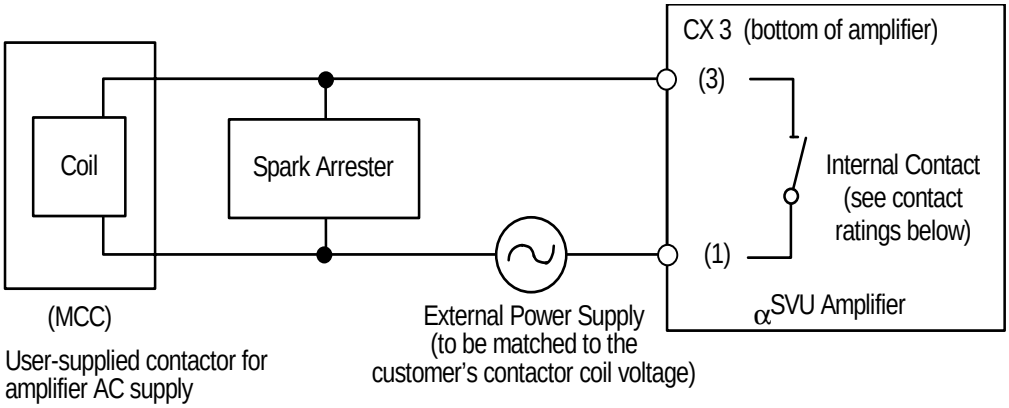
K9—Optional Absolute Encoder Battery Cable (α6/3000, α12/3000, α22/2000, α30/3000, α40/2000)



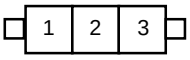
- Prefinished 2m Cable: 44C741863-001 (supplied as a part of α SVU Series Battery Backup Kit IC800ABK001)
- Wire: 2-conductor, 0.75mm^2 (20 AWG)

Cable	*GE Fanuc Part No.*	*Connector Manufacturer*
Servo Amplifier JA4	A02B-0120-K301	Hirose Electric Co., Ltd.  Honda Tsushin Kogyo Co., Ltd. (PCR-E20FA)  *Connectors viewed from back (solder/crimp side).*

K10—Emergency Stop/Power Enable Cable (α6/3000, α12/3000, α22/2000, α30/3000, α40/2000)



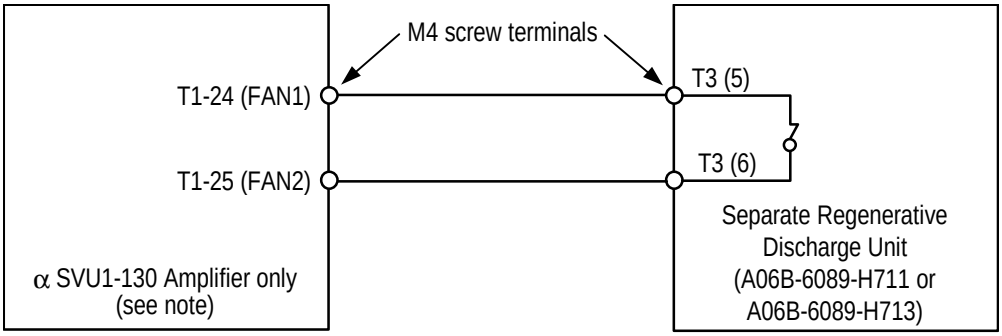
- Wire: 2-conductor, 1.25mm^2 (16 AWG) or larger

Connector	*GE Fanuc Part No.*	*Manufacturer*
Servo Amplifier CX3	A06B-6089-K201 (included with α Series amplifier packages IC800APK080 and IC800 APK130)	AMP Housing: 1-178128-3; Contact: 1-175218-2 (crimp terminal)  Connector viewed from wire insertion end

Contactor Ratings:

Specification of internal contact	*Resistor load (cosϕ=1)*	*Inductance load (cosϕ=0.4, L/R=7msec)*
Rated load	250 VAC, 5A 30VDC, 5A	250 VAC, 2A 30 VDC, 2A
Max. current	5A	5A

K11—Separate Regenerative Discharge Unit Fan Supply Cable (A06B-6089-H711 or A06B-6089-H713)

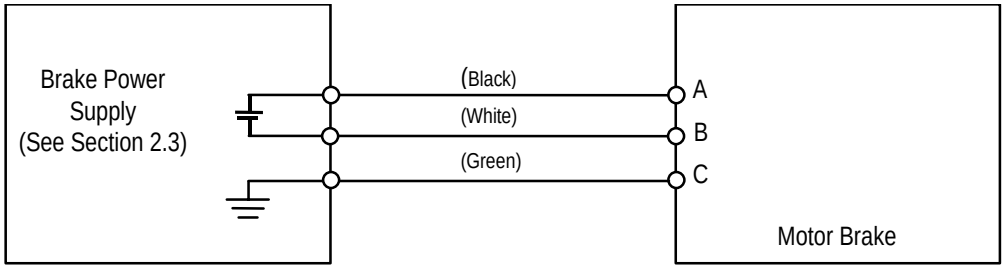


NOTE

Only the α SVU1-130 amplifier has separate fan power supply terminals. When using the A06B-6089-H713 unit with the α SVU1-80 amplifier, connect the fan power to terminals T1-13 (L1C) and T1-14 (L2C) through a 5A circuit breaker.

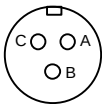
- Wire: 300 V, 2-conductor, 2.0mm^2 (16 AWG) or larger

K12—Motor Brake Power Connection

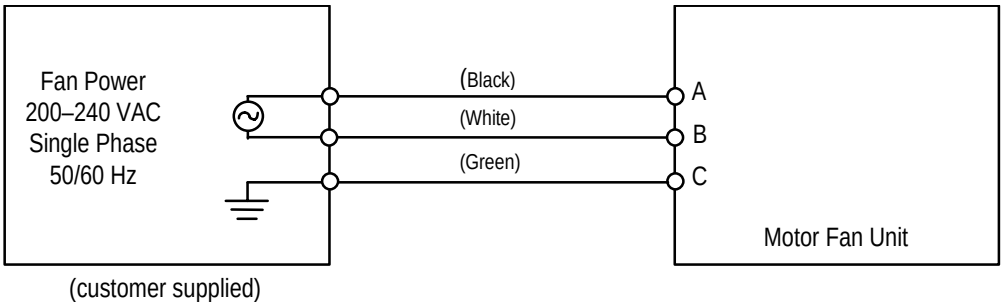


(customer supplied)

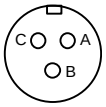
- Prefinished 14m Cable, Part number: 44C742238-004 (severe duty)
- Wire: 330 V, 3-conductor, 20 AWG, 80 °C, PUR (polyurethane) jacket

Connector	*GE Fanuc Part No.*	*Manufacturer*
Servo Motor Brake	44A730464-G26	AMP 3102A-10SL-3P  Connector viewed from solder side

K13—Cooling Fan Power Connection (α 40/2000)



- Prefinished 14m Cable, Part number: 44C742238-004 (severe duty)
- Wire: 330 V, 3-conductor, 20 AWG, 80 °C, PUR (polyurethane) jacket

Connector	*GE Fanuc Part No.*	*Manufacturer*
Servo Motor Fan	44A730464-G26	AMP 3102A-10SL-3P  Connector viewed from solder side

Fan Voltage/Current Specifications:

Input voltage	*Steady-state current*	*Surge current*
200V	Approx. 0.85Arms	Approx. 1.60Arms
230V	Approx. 0.98Arms	Approx. 1.84Arms

Section 8: *α SVU Series Protection* and Alarm Functions

The Servo Amplifier Unit can detect error conditions and provide alarm information.

The LEDs on the front of the amplifier provide a visual cue to the status of the system by indicating, for example, when the motor and amplifier are ready to function. A built-in, seven-segment LED display indicates when an alarm condition is detected. When an alarm is detected, power is dropped and the motor is stopped by dynamic braking action. Alarm information is displayed as diagnostic data in the GE Fanuc controller. TableI-23 details the alarm conditions the α SVU Series Servo Amplifier System can detect. Table I-24 shows the LED indication for normal operating mode.

Table I-23. α SVU1 Series servo amplifier alarm system

Alarm Type	*LED Ind.*	*Description*
Over-voltage alarm (HV)	1	Occurs if the DC voltage of the main circuit power supply is abnormally high.
Low control power voltage alarm (LV)	2	Occurs if the control power voltage is abnormally low.
Low DC link voltage alarm (LVDC)	3	Occurs if the DC voltage of the main circuit power supply is abnormally low or if the circuit breaker trips.
Regenerative discharge control circuit failure alarm (DCSW)	4	Occurs if the short-time peak regenerative discharge energy is too high or if the regenerative discharge circuit is abnormal.
Over-regenerative discharge alarm (DCOH)	5	Occurs if the average regenerative discharge energy is too high (too frequent acceleration/deceleration) or the regeneration resistor overheats.
Dynamic brake circuit failure (DBRLY)	7	Occurs if the relay contacts of the dynamic brake fuse together.
Over-current alarm	8	Occurs if an abnormally high current flows through the motor.
IPM alarm	8■	The Intelligent Power Module (IPM) has detected an alarm due to over-current, overheating, or a drop in IPM control power voltage.
Circuit breaker	(trips)	The circuit breaker trips if an abnormally high current (exceeding the working current of the circuit breaker) flows through it.

Table I-24. α SVU1 Series servo amplifier alarm system

Type	*LED Ind.*	*Description*
Amplifier not ready	—	The servo amplifier is not ready to drive the motor.
Amplifier ready	0	The servo amplifier is ready to drive the motor.

Part II:
β Servo System

Section 9: β Servo System Block Diagram

The following block diagram shows the interconnections of a typical β Series servo system:

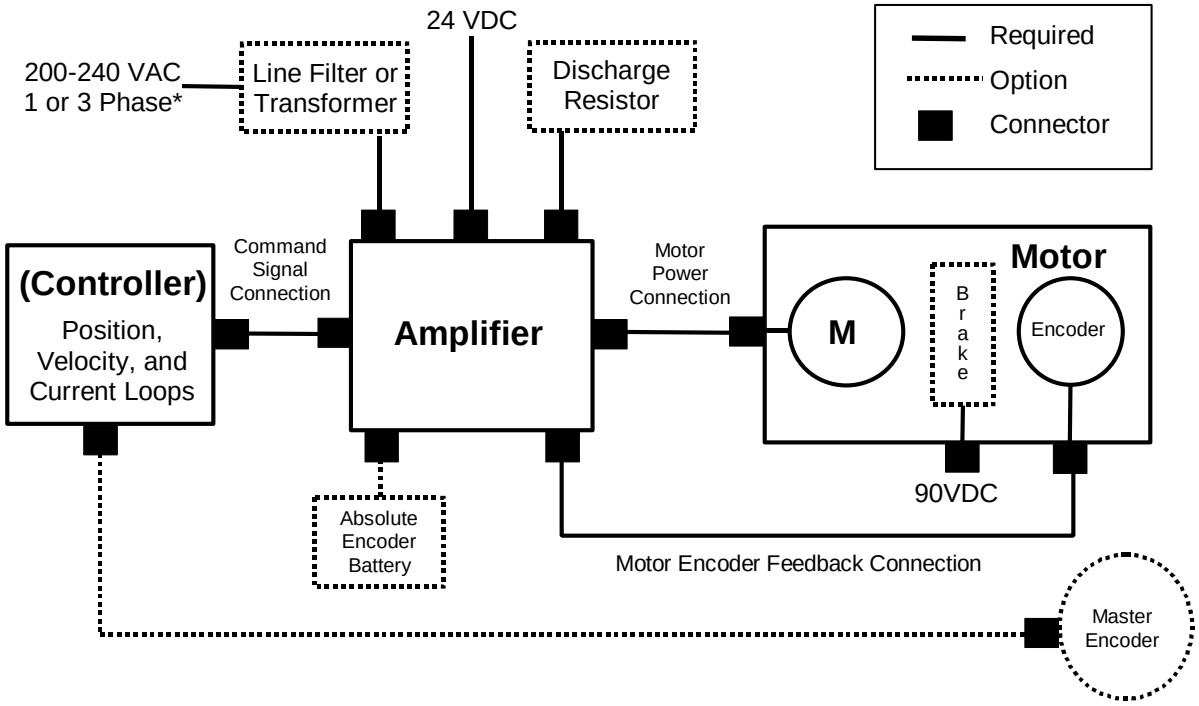


Figure 1. β Series servo block diagram

NOTE

A 24 VDC power supply, circuit breaker, electromagnetic contactor, surge suppresser, and transformer or line filter should be user-installed as part of the system. See β Servo System Package Options in Section 12: and β Servo Installation in Section 13:of this document for more information.

- For single phase input, the lifetime of the amplifier is reduced because of higher input current. For operation of β6/2000 or αC12/2000 motors at acceleration/deceleration duty cycles greater than 1 cycle/20 seconds, 3-phase input is recommended. The output power of these motors when operated in ambient temperatures greater than 40°C must be derated linearly at 1%/°C above 40°C up to a maximum ambient temperature of 55°C.

Section 10: β Series Servo Product Overview

10.1 β Series Motors

The β Series servo motors are all digital systems with built-in 32K serial encoders. All β Series motors are available with an optional holding brake. The servo motors must be used with the designated amplifier package and a GE Fanuc motion controller such as the Motion Mate™ DSM 300.

Table II-1 provides a summary of the β Series servo motors. See Section 11:for more detailed motor specifications.

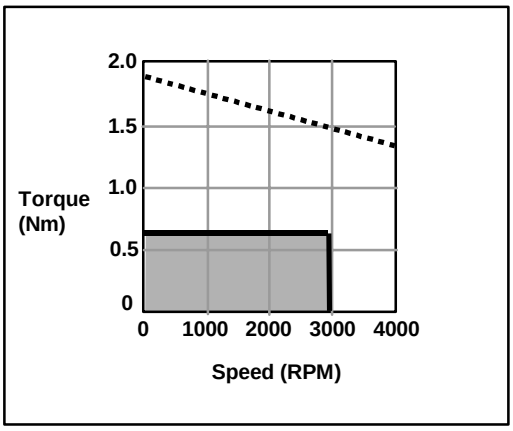
Table II-1. β Series Servo Motors

Motor	Rated Torque	Power Rating	Required Amplifier Kit	Motor Catalog #
β0.5/3000	0.5 Nm (5.6 in-lbs) continuous stall torque; 3000 RPM	0.2 kW	12 Amp (IC800BPK012)	Motor Only: A06B-0113-B075#7008 Motor w/ Brake: A06B-0113-B175#7008
β2/3000	2 Nm (17 in-lbs) continuous stall torque; 3000 RPM	0.5 kW	12 Amp (IC800BPK012)	Motor Only: A06B-0032-B075#7008 Motor w/ Brake: A06B-0032-B175#7008
β6/2000	6 Nm (53 in-lbs) continuous stall torque; 2000 RPM	0.9 kW	20 Amp (IC800BPK020)	Motor Only: A06B-0034-B075#7008 Motor w/ Brake: A06B-0034-B175#7008
αC12/2000	12 Nm (106 in-lbs) continuous stall torque; 2000 RPM	1.0 kW	20 Amp (IC800BPK020)	Motor Only: A06B-0141-B075#7008 Motor w/ Brake: A06B-0141-B175#7008

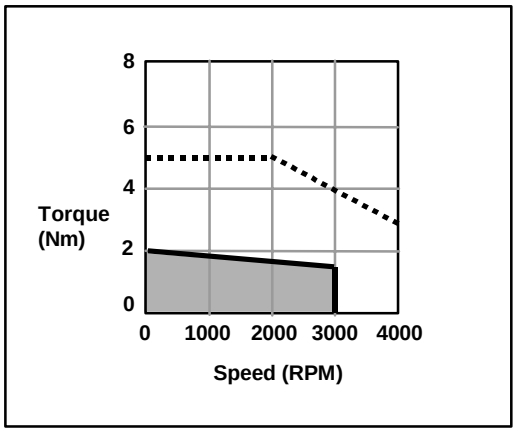
10.2 β Series Motor Speed–Torque Curves

The curves shown below illustrate the relationship between the speed of the motor and the output torque. The motor can operate continuously at any combination of speed and torque within the prescribed continuous operating zone. The limit of the continuous operating zone is determined with the motor's ambient temperature at 40°C and its drive current as pure sine wave. Actual operation is limited by the current of the servo drive unit.

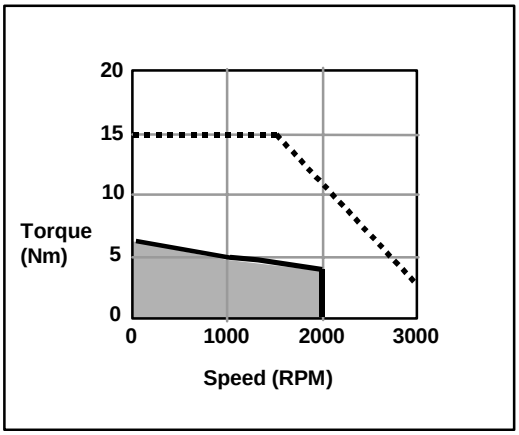
β0.5/3000



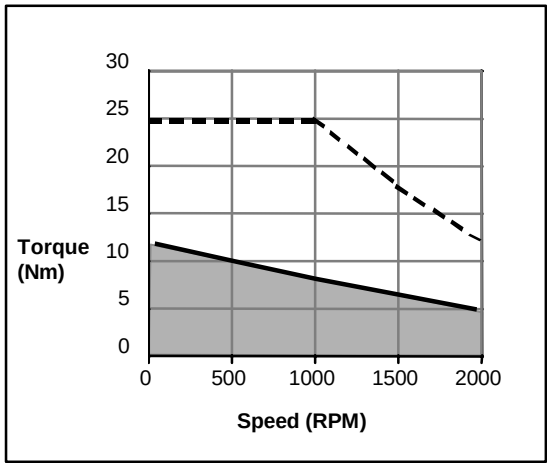
β2/3000



β6/2000



αC12/2000



KEY: - - - - = Intermittent operating

= Continuous operating

Figure 2. β Series motor speed-torque curves

10.3 β Series Motor Holding Brake

Any of the servo motors can be ordered with a holding brake. The brake is used to prevent movement on horizontal axes or falling along the vertical axis when the servo motor control is turned off.

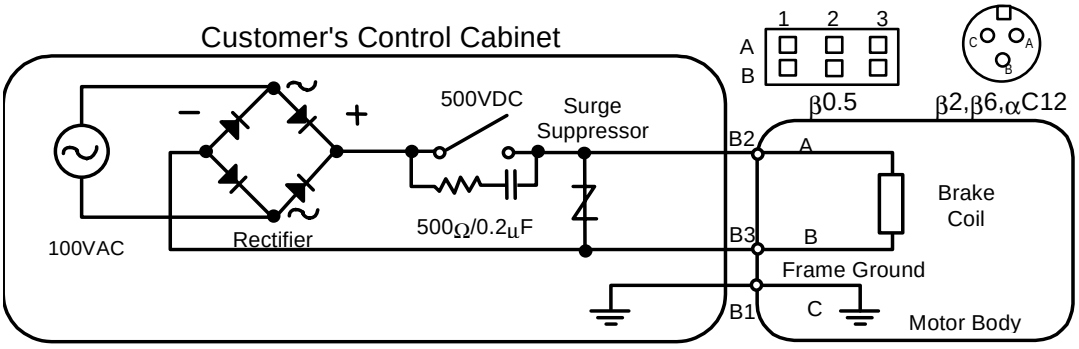
Brakes are spring-set and electrically released and are designed for holding stationary loads only. Using the holding brake to stop a moving axis may damage the motor or severely reduce its service life.

The specifications of the built-in brakes are listed in Table II-2.

Table II-2. Brake Specifications

Parameter	SERVO PACKAGE			
	β0.5/3000	**β2/3000**	**β6/2000**	**αC12/2000**
Brake torque	5.75 in-lb 0.65 Nm 6.6 kgf-cm	17.7 in-lb 2 Nm 20 kgf-cm	71 in-lb 8 Nm 82 kgf-cm	310 in-lb 35 Nm 357 kgf-cm
Release Response Time	40 msec	60 msec	80 msec	150 msec
Brake Response Time	20 msec	10 msec	40 msec	20 msec
Supply Voltage and Current	90 VDC (±10%) 0.1 A or less	90 VDC (±10%) 0.3 A or less	90 VDC (±10%) 0.4 A or less	90 VDC (±10%) 0.6 A or less
Weight Increase	Approx. 0.88 lb Approx. 0.4 kg	Approx. 3.3 lb Approx. 1.5 kg	Approx. 5.1 lb Approx. 2.3 kg	Approx. 13.9 lb Approx. 6.3 kg
Inertia Increase	0.00008 in-lb-s^2 0.000009 kg m^2 0.00009 kgf-cm-s^2	0.00017 in-lb-s^2 0.00002 kg m^2 0.0002 kgf-cm-s^2	0.00061 in-lb-s^2 0.00007 kg m^2 0.0007 kgf-cm-s^2	0.0052 in-lb-s^2 0.0006 kg m^2 0.006 kgf-cm-s^2

An example of a typical ***user-supplied*** brake power supply is shown below:



Surge Suppressor: Manufactured by Matsushita Electronic Parts, Ltd.
ERZ-C20DK221, ERZ-C10DK221 or equivalent

B1–B3 apply to β0.5 motors;
A–C apply to all other motors

Figure 3. Typical user-supplied brake power supply

NOTE

Use a full-wave rectified 100VAC or 90VDC as a power supply. Do not use a half-wave rectified 200 VAC, which may damage the surge suppressor. Use a rectifier with a dielectric strength of 400V or higher. Connect RC filter as shown in the above drawing to protect the contact of the switch.

10.4 β Series Servo Amplifiers

The following table shows which amplifier model is included in each β Series servo package:

Table II-3. β Series Servo Amplifier Models

Motor	Amplifier Model	Amplifier Catalog #	Amplifier Package Catalog #
β0.5/3000	β12	A06B-6093-H101	IC800BPK012
β2/3000	β12	A06B-6093-H101	IC800BPK012
β6/2000	β20	A06B-6093-H102	IC800BPK020
αC12/2000	β20	A06B-6093-H102	IC800BPK020

As a convenience, amplifiers can also be ordered as a package containing all of the components required to operate the amplifier in a servo system, as detailed in the following table:

Table II-4. β Series Servo Amplifier Packages

Description	Package Contents*	Catalog #
12 Amp β Series Amplifier Package	Contains 1 of each of the following: • SVU1-12 Amp (A06B-6093-H101) • Fuse (A06B-6073-K250) • Connector Kit (A06B-6093-K305) • E-Stop Connector (A02B-0120-K301) • 100 Watt Discharge Resistor (A06B-6093-H402)	IC800BPK012
20 Amp β Series Amplifier Package	Contains 1 of each of the following: • SVU1-20 Amp (A06B-6093-H102) • Fuse (A06B-6073-K250) • Connector Kit (A06B-6093-K305) • E-Stop Connector (A02B-0120-K301) • 100 Watt Discharge Resistor (A06B-6093-H402)	IC800BPK020

* If required, amplifier package components can be ordered separately.

Section 11: β Series Servo System Specifications

The β Series Servo system consists of a motor and its corresponding amplifier. GE Fanuc offers several servo systems, which are identified in Table II-5 below.

Table II-5. Identification of Servo Systems

	SERVO SYSTEM			
Parameter (Unit)	***β0.5/3000***	***β2/3000***	***β6/2000***	***αC12/2000***
MOTOR				
Rated output power (kW)	0.2	0.5	0.9	1.0
Rated torque at stall (Nm) *	0.6	2	6	12
Rated torque at stall (in-lb) *	5.3	17	53	105
Rated torque at stall (kgf-cm) *	6.1	20	60	122
Rated output speed (RPM)	4000	4000	3000	2000
Rotor inertia (kg m^2)	0.00001764	0.0006566	0.00392	0.006272
Rotor inertia (in-lb-s^2)	0.00016	0.00581	0.0347	0.0555
Rotor inertia (kg-cm-s^2)	0.00018	0.0067	0.040	0.064
Continuous current at stall A(rms)	2.8	3.2	5.6	5.9
Torque constant (Nm/A [rms]) *	0.23	0.61	1.05	2.04
Torque constant (in-lb/A [rms]) *	2.0	5.4	9.3	18
Torque constant (kgf-cm/A [rms]) *	2.3	6.2	10.7	20.8
Back EMF constant (V/1000 RPM) *	7.9	21.4	37.0	71
Back EMF constant (Vsec/rad) *	0.08	0.20	0.35	0.68
Armature resistance (Ω) *	0.80	1.4	0.85	1.092
Mechanical time constant (s) *	0.0007	0.008	0.009	0.005
Thermal time constant (min)	10	20	40	60
Static friction (Nm)	0.04	0.1	0.3	0.8
Static friction (in-lb)	0.35	0.89	2.7	7
Static friction (kgf-cm)	0.4	1.0	3	8
Maximum allowable current (A [peak])	19	18	30	46
Maximum theoretical torque (Nm) **	3.4	11	32	66
Maximum theoretical torque (in-lb) **	30	97	283	584
Maximum theoretical torque (kgf-cm) **	35	112	321	670
Maximum winding temperature rise (°C)	125	125	125	125
Weight (kg)	1.0	3.5	8.5	18
Weight (lb)	2.2	7.2	18.7	39.6
AMPLIFIER				
Model	β SVU-12	β SVU-12	β SVU-20	β SVU-20
Rated output current (rms amps)	3.2	3.2	5.9	5.9
Current limit (Peak amps)	12	12	20	20
AC Power	200–240 VAC (3-phase), 220–240 VAC (1-phase) 50/60 Hz ± 2 Hz			
DC Power	24 VDC ± 10% @ 0.4 Amp per amplifier			
Heat loss (watts)	17.5	17.5	33.3	33.3

* These values are standard values at 20°C with a tolerance of ±10%. The speed-torque characteristics vary, depending on the type of software, parameter setting, and input voltage of the digital servo amplifiers. (The above figures show average values.) These values may be changed without prior notice.

** Theoretical values. The actual maximum torque is restricted by the current limit values of the drive amplifier.

Section 12: β Servo System Options

Designing a servo control system requires that you understand how the electrical and mechanical aspects of your system interact. GE Fanuc application engineers are available to help you determine your servo control system requirements.

Table II-6 will help you select which servo options your system requires:

Table II-6. β Servo Package Options

Servo Option	*Consider Selecting When*	*Catalog #*	*Section #*
Motor Holding Brake	the system design includes an axis that must hold its position when power is removed	Refer to Table II-2	10.3
Absolute Encoder Battery Backup Kit	you would like to avoid having to re-reference the position when power is restored to the control	IC800BBK021	12.1
AC Line Filters	200—240 VAC is already available to the control cabinet and no transformer is used	**5.4 kW, 3-phase:** A81L-0001-0083#3C **10.5 kW, 3-phase:** A81L-0001-0101#C	14.2
Prefinished Cables	the cable lengths available from GE Fanuc are appropriate for your application	Refer to the “Cable Connection” Table II-21	15.1
Discharge Resistor	see “Discharging Regenerative Power” section; The 100 Watt discharge resistor is included in all β Series Amplifier Packages	**20 Watt Resistor:** A06B-6093-H401 **100 Watt Resistor:** A06B-6093-H402	14.7

12.1 Absolute Encoder Battery Packs

All β Series servo motors feature a built-in encoder that can be used in either incremental or absolute mode. To utilize the absolute capability, an optional encoder battery pack (IC800BBK021) for the β Series amplifier must be installed. This pack allows the encoder's position information to be backed up so that the machine does not need to be re-referenced to a home position every time power is restored to the servo system.

For optimal panel space utilization, a small lithium battery pack is available that snaps onto the underside of the β amplifier. An integral pigtail cable plugs directly into the CX5 connector. One battery is required for each amplifier.

Absolute Encoder Battery Kit (IC800BBK021) contains the following:

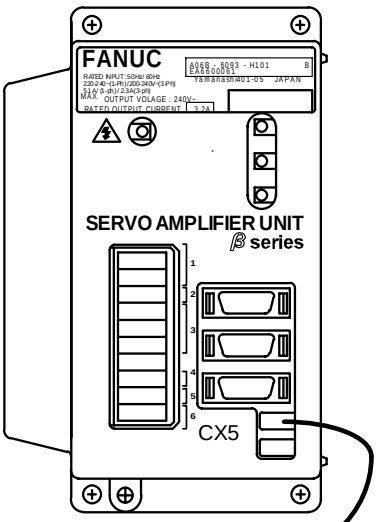
- Battery (A06B-6093-K001)
- Battery Holder (A06B-6093-K002)

Note: Current drain (per encoder) from battery:

- 20µA with amplifier power ON
- 200µA with amplifier power OFF

Connection Method

(for use with a single amplifier)



NOTE

Do not attempt to connect multiple amplifiers to one IC800BBK021 battery kit. If you wish to daisy chain multiple β Series amplifiers to one battery you must use the IC800ABK001 battery kit shown in Section 4.2 and the following cables:

- 44C742433-001 2m, battery to amplifier cable (1 per battery required)
- 44C742433-002 250mm, amplifier to amplifier cable (1 for each daisy chained amplifier required)

Battery (A06B-6093-K001)

Battery Holder (A06B-6093-K002)

Snap in place on bottom of amplifier

Figure 4. Connecting a single β Series amplifier to an absolute encoder battery pack

Section 13: Installation Guidelines

This section includes environmental requirements, motor and amplifier dimension drawings and information on ensuring noise protection and selecting a ground fault interrupter.

13.1 Motor Environmental Requirements

The servo motor must be installed in a location that satisfies the following environmental conditions:

Table II-7. Servo amplifier environmental conditions

Condition	Description
Ambient temperature	The ambient temperature should be -10°C to 40°C. When operating the machine at a temperature higher than 40°C), it is necessary to derate the output power so that the motor's temperature rating is not exceeded.
Vibration	When installed in a machine, the vibration applied to the motor must not exceed 5G.
Altitude	No more than 1,000 m (3,300 ft) above sea level.
Drip-Proof Environment	The motors have a drip-proof structure that complies with IP65 of the IEC standard. Nevertheless, to ensure long-term performance, the motor surface should be protected from solvents, lubricants, and fluid spray. A cover should be used when there is a possibility of wetting the motor surface. Also, to prevent fluid from being led to the motor through the cable, put a drip loop in the cable when the motor is mounted. Finally, turn the motor connector sideways or downward as far as possible. If the cable connector will be subjected to moisture, it is recommended that an R class or waterproof plug be used.

For additional information, see GE Fanuc publication *Servo and Spindle Motors Exposed to Liquids*, GFK-1046.

13.2 Servo Amplifier Environmental Requirements

The servo amplifier must be installed in a location that satisfies the environmental conditions identified in Table II-8 below.

Table II-8. Servo Amplifier Environmental Conditions

Condition	*Description*
Ambient temperature	0°C to 55°C (operating). -20°C to 60°C (storage and transportation).
Temperature fluctuation	Within 1.1°C/min.
Humidity	30% to 95% RH (no condensation).
Altitude	No more than 1000 m (3,300 ft) above sea level.
Vibration	No more than 0.5 G during operation.
Atmosphere	The circuitry and cooling fins must not be exposed to any corrosive and conductive vapor or liquid.

The amplifier must be installed in a cabinet that protects it from contaminants such as dust, coolant, organic solvents, acid, corrosive gas, and salt. Adequate protection must also be provided for applications where the amplifier could be exposed to radiation, such as microwave, ultraviolet, laser light, or x-rays.

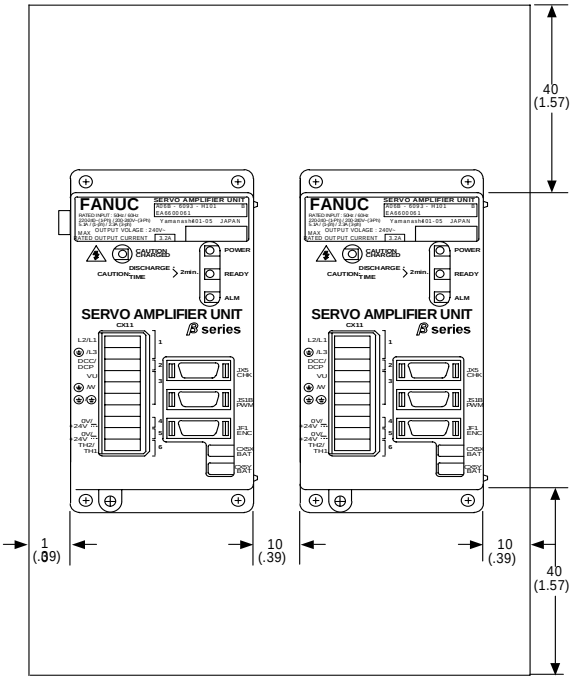
To adequately protect the amplifier, you must ensure that:

- Contaminants such as dust and coolant, cannot enter through the air inlet or outlet.
- The flow of cooling air is not obstructed.
- The amplifier can be accessed for inspection.
- The amplifier can be disassembled for maintenance and later reinstalled.
- There is sufficient separation between the power and signal lines to avoid interference. Noise protection should be provided.

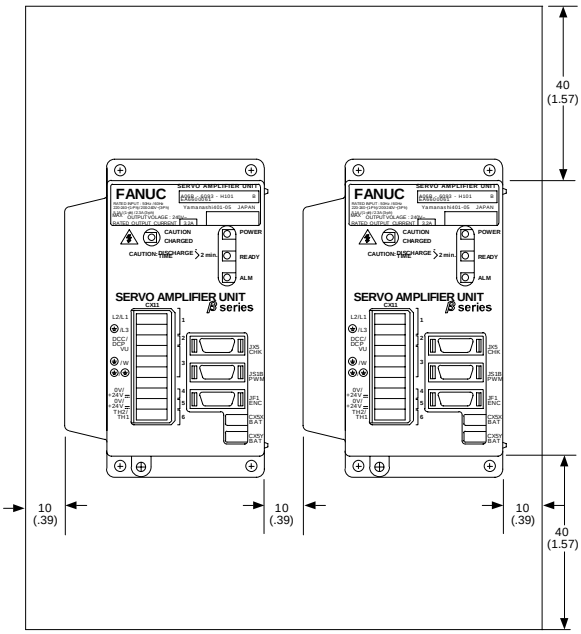
13.3 β servo Amplifier heat dissipation and maintenance

The amplifier contains a cooling fan that forces air through the unit. Allow for adequate clearance for airflow when installing the amplifier using the recommended distances shown in the drawings below. If possible, do not mount amplifiers one above the other unless they are staggered to prevent the heated exhaust of the lower unit from flowing over the upper unit.

βSVU-12 Maintenance Clearances



βSVU-20 Maintenance Clearances



Dimensions shown in mm (in)

Figure 5. β Series amplifier maintenance clearances

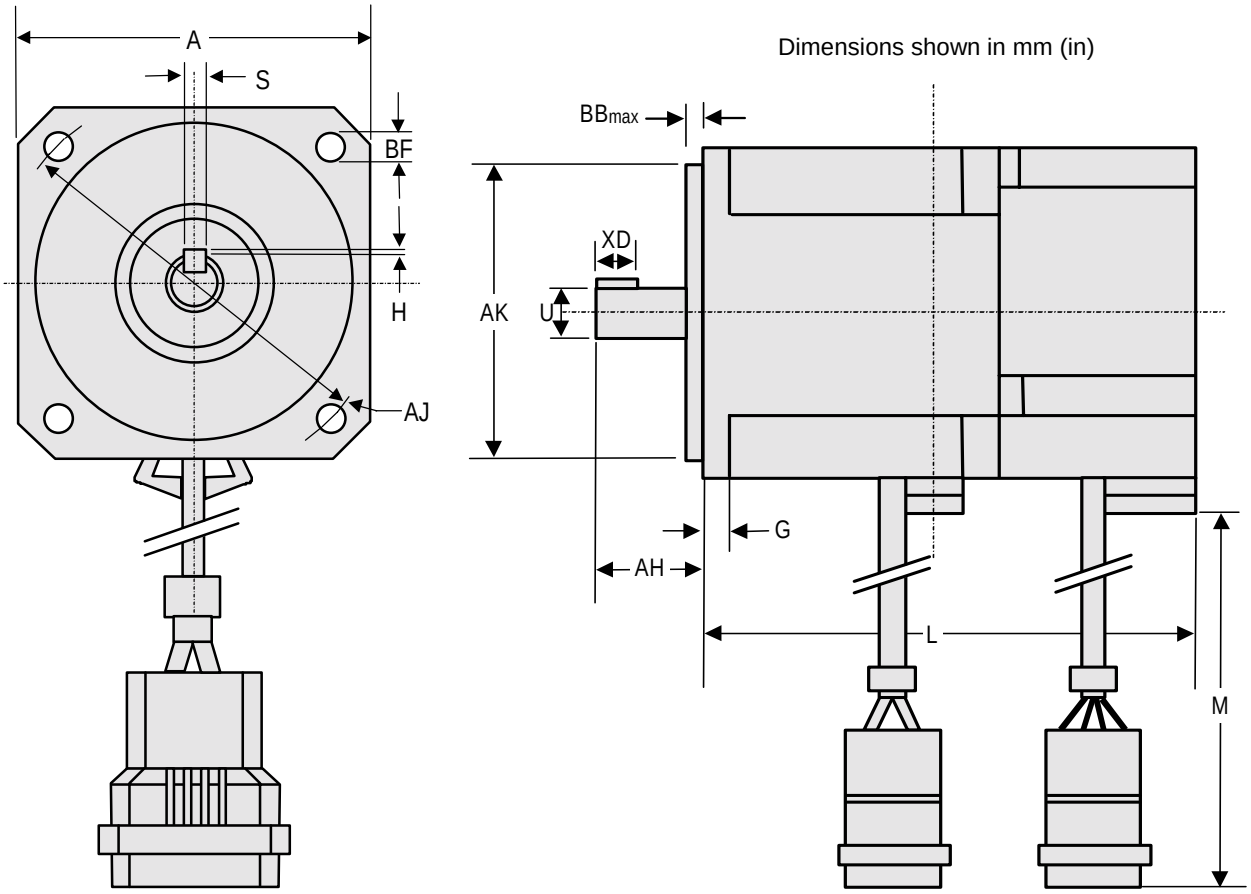
Table II-9 identifies worst-case heat dissipation values for each amplifier. These values may be used to determine heat load for sizing enclosures and cooling equipment. Heat dissipation for external regeneration resistors depends on the application and is calculated in Section 0, Step 5.

Table II-9. Heat Dissipation

Amplifier	*Total Heat Dissipation*	*Catalog #*
βSVU-12	17.5 watts	A06B-6093-H101
βSVU-20	33.3 watts	A06B-6093-H102

13.4 β Series Motor Dimensions

β0.5/3000 Motor, Front and Side Views



Dim.	MOTOR
	β0.5/3000
A	60 mm (2.36 in)
S	$3^{+0}_{-0.025}$ (0.1181/0.1191)
H	$1.2^{+0}_{-0.125}$ (0.0472/0.0423)
AJ (dia.)	70 (2.76)
BF (dia.)	5.5 (.2165)

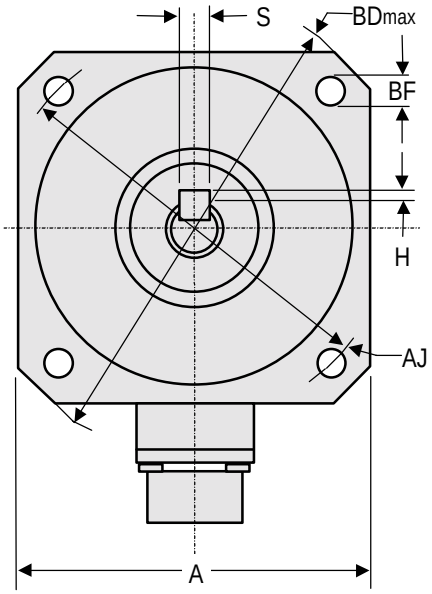
Dim.	MOTOR	
	β0.5/3000	β0.5/3000 with brake
BB	3 mm (.118 in)	3 mm (.118 in)
XD	20 (.787)	20 (.787)
AK	$50^{+0}_{-0.025}$ (1.9685/1.9675)	$50^{+0}_{-0.025}$ (1.9685/1.9675)
U	$9^{+0}_{-0.009}$ (0.3543/0.3539)	$9^{+0}_{-0.009}$ (0.3543/0.3539)
G	6 (.236)	6 (.236)
AH	25 (.984)	25 (.984)
L	100 (3.94)	128 (5.04)
M	~ 300 (11.81)	~ 300 (11.81)

NOTES

1. Shaft diameter runout = 0.02 mm max (0.00079 in).
2. Flange surface runout = 0.06 mm max (0.00236 in).
3. Maximum radial load for output shaft is 20 kgf (44 lb).

Figure 6. β0.5/3000 motor, front and side views

β2/3000, β6/2000, and αC12/2000 Motors, Front View



Dimensions shown in mm (in)

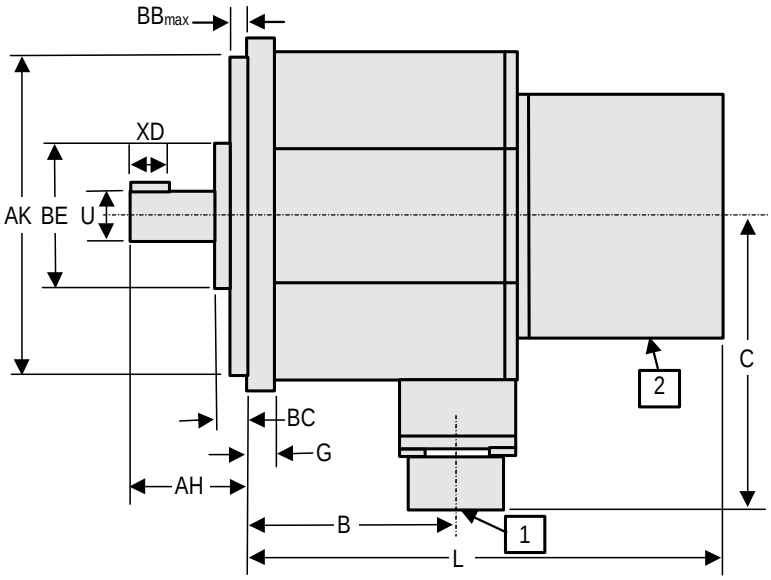
Dimension	Motor		
	β2/3000	β6/2000	αC12/2000
A	105 mm(4.13 in)	142 mm(5.59 in)	174 mm (6.85 in)
S	$5^{+0}_{-0.03}$ (.1969/.1957)	$6^{+0}_{-0.03}$ (.236/.235)	$10^{+0}_{-0.036}$ (.394/.392)
H	$2^{+0}_{-0.13}$ (.0787/.0736)	$2.5^{+0}_{-0.13}$ (.0984/.0933)	$3^{+0}_{-0.29}$ (.118/.107)
AJ (dia.)	115 (4.53)	165 (6.50)	200 (7.87)
BF (dia.)	9 (.354)	11 (.433)	13.5 (.532)
BD	134 (5.38)	190 (7.48)	240 (9.45)

NOTES FOR ALL VIEWS (see Section 0 for side view)

1. See the β Connection section (p. 28) for more information about motor cables.
2. Shaft diameter runout = 0.02 mm max (0.00079 in) for β2/3000 and β6/2000; 0.05 mm (0.00197 in) for αC12/2000.
3. Flange surface runout = 0.06 mm max (0.00236 in) for β2/3000 and β6/2000; 0.10 mm (0.00394 in) for αC12/2000.
4. Maximum radial load for output shaft is 25 kgf (55 lb) for β2/3000; 70 kgf (154 lb) for β6/2000; 450 kgf (990 lb) for αC12/2000.

Figure 7. β2/3000, β6/2000, and αC12/2000 motors, front view

β2/3000, β6/2000, and αC12/2000 Motors, Side View



Dimensions shown in mm (in)

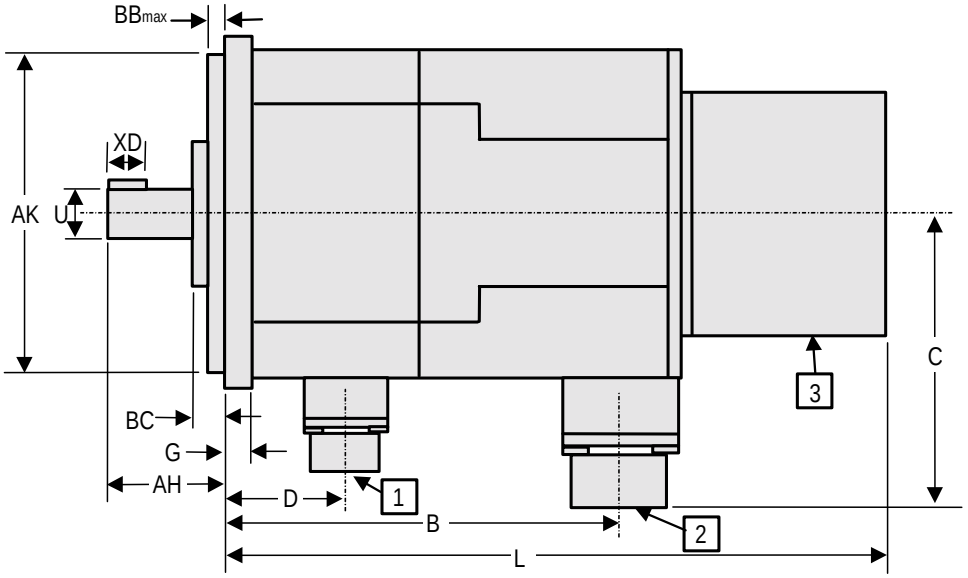
Dimension	Motor		
	β2/3000	β6/2000	αC12/2000
BB	5 mm (.196 in)	5 mm (.196 in)	3.2 mm (.126 in)
XD	20 (0.787)	28 (1.10)	70 (2.76)
AK	$95^{+0}_{-0.035}$ (3.740/3.739)	$130^{+0}_{-0.035}$ (5.118/5.117)	$114.3^{+0}_{-0.025}$ (4.50/4.499)
U	$14^{+0}_{-0.011}$ (0.5512/0.5507)	$19^{+0}_{-0.013}$ (0.7480/0.7475)	$35^{+0.01}_{-0}$ (1.3783/1.3780)
BC	10 (0.394)	12 (0.472)	N/A
C	88 (3.46)	110 (4.33)	122 (4.80)
G	8 (0.315)	10 (0.394)	18 (0.709)
AH	36 (1.42)	46 (1.81)	79 (3.11)
B	93 (3.66)	117 (4.61)	166 (6.54)
L	174 (6.85)	203 (7.99)	240 (9.45)
BE	43 (1.69)	90 (3.54)	N/A

Connector	Description
1	Motor AC Power
2	Motor Encoder Feedback

Figure 8. β2/3000, β6/2000, and αC12/2000 motors, side view

β2/3000, β6/2000, and αC12/2000 Motors with Brake

(Front view same as β2/3000, β6/2000, and αC12/2000 without brake)



Dimension	*Motor*		
	β2/3000	*β6/2000*	*αC12/2000*
BB	5 mm (0.196 in)	5 mm (0.196 in)	3.2 mm (0.126 in)
XD	20 (0.787)	28 (1.10)	70 (2.76)
AK	$95^{+0}_{-0.035}$ (3.740/3.739)	$130^{+0}_{-0.035}$ (5.118/5.117)	$114.3^{+0}_{-0.025}$ (4.50/4.499)
U	$14^{+0}_{-0.011}$ (0.5512/0.5507)	$19^{+0}_{-0.013}$ (0.74801/0.74751)	$35^{+0.01}_{-0}$ (1.37831/1.3780)
BC	11 (0.433)	12 (0.472)	N/A
C	88 (3.46)	110 (4.33)	122 (4.80)
G	8 (0.315)	10 (0.394)	18 (0.709)
AH	36 (1.42)	46 (1.81)	79 (3.11)
D	31 (1.22)	28 (1.10)	65 (2.56)
B	149 (5.87)	169 (6.65)	238 (9.37)
L	230 (9.06)	255 (10.04)	312 (12.28)

Connector	*Description*
1	Brake
2	Motor AC Power
3	Motor Encoder Feedback

Figure 9. β2/3000, β6/2000, and αC12/2000 motors with brake, side view

NOTES

1. See the Connection section of the manual (p. 28) for more information about motor cables.
2. Shaft diameter runout = 0.02 mm max (0.00079 in) for β2/3000 and β6/2000; 0.05 mm (0.00197 in) for αC12/2000.
3. Flange surface runout = 0.06 mm max (0.00236 in) for β2/3000 and β6/2000; 0.10 mm (0.00394 in) for αC12/2000.
4. Maximum radial load for output shaft is 25 kgf (55 lb) for β2/3000; 70 kgf (154 lb) for β6/2000; 450 kgf (990 lb) for αC12/2000.

13.5 Shaft Loading

The allowable load of the motor shaft is as follows:

Table II-10. Allowable motor shaft load

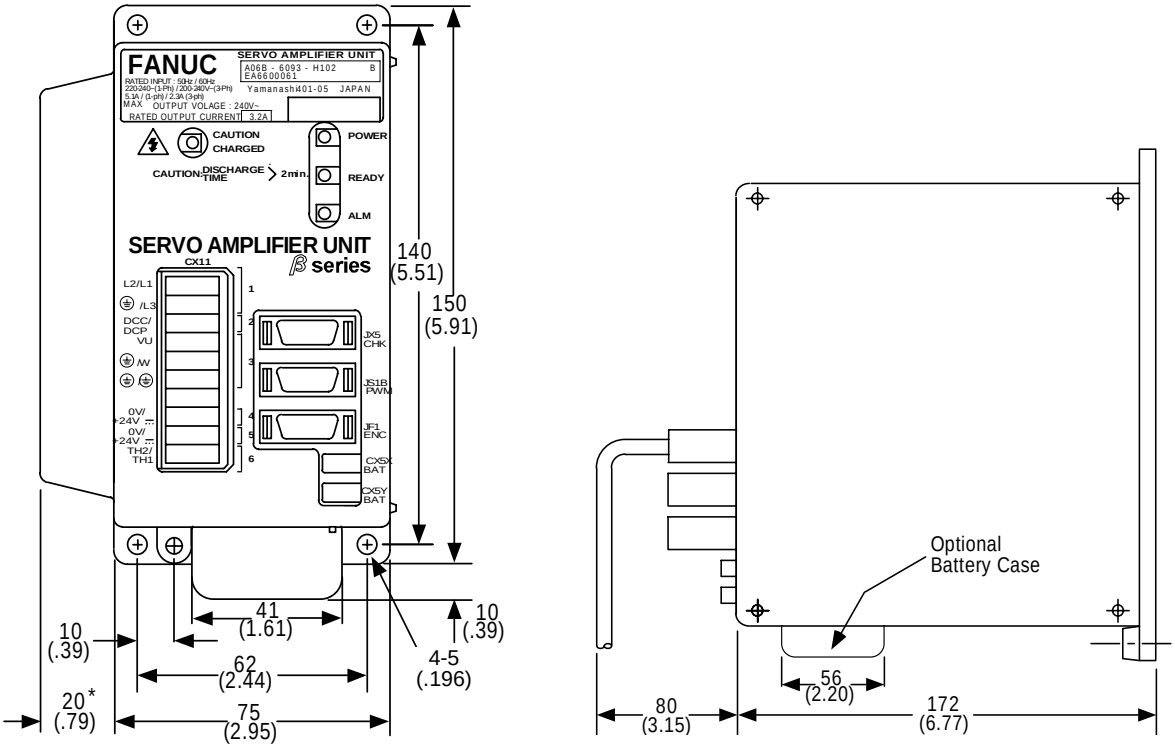
Motor Model	*Radial Load*	*Axial Load*	*Front Bearing (type reference)*
β0.5/3000	20 kg (44 lb)	5 kg (11 lb)	6902
β2/3000	25 kg (55 lb)	8 kg (17.6 lb)	6003 (without brake)
			6202 (with brake)
β6/2000	70 kg (154 lb)	20kg (44 lb)	6205
αC12/2000	450 kg (990 lb)	135 kg (297 lb)	6208

NOTES:

- The allowable radial load is the value when a load is applied to the shaft end. It indicates the total continuous force applied to the shaft in some methods of mounting (for example, belt tension) and the force by load torque (for example, moment/pulley radius).
- The belt tension is critical particularly when a timing belt is used. Belts that are too tight may cause breakage of the shaft or premature bearing failure. Belt tension must be controlled so as not to exceed the limits calculated from the permissible radial load indicated above.
- In some operating conditions, the pulley diameter or gear size needs to be checked. For example, when using the model β6/2000 with a pulley/gear with a radius of 1.5 inches (3.8 cm) or less, the radial load when 230 in-lb of peak torque is provided by the motor will exceed the 154 lb maximum rating. In the case of the timing belt, the belt tension is added to this value, making it necessary to support the shaft end.
- When using a timing belt, shaft failure or bearing overload can be minimized by positioning the pulley as close to the bearing as possible.
- Since a standard single row, deep-groove ball bearing is used for the motor bearing, a very large axial load cannot be used. Particularly when using a worm gear and a helical gear, it is necessary to provide another bearing to isolate the thrust load from the gearing.
- The motor bearing is generally fixed with a C-snap ring, and there is a small play in the axial direction. When this play influences the positioning in the case of using a worm gear and a helical gear, for example, it is necessary to use an additional bearing support.

13.6 β Series Amplifiers Dimensions

The β Series amplifiers are panel mounted devices with dimensions as shown in Figure 10. When installing the amplifiers make sure the clearances as shown in Section 13.3.



* Measurement applies to the β20 amplifier only. The β12 amplifier does not include the heat sink extension. Dimensions shown in mm (in).

Figure 10. β Series servo amplifier unit, front and side views

13.7 Noise Protection

Separation of Signal and Power Lines

When routing signal and power lines, the signal lines must be separated from the power lines to ensure best noise immunity. The table below lists the types of cables used:

Table II-11. Servo amplifier signal line separation

Group	Signal	Action
A	Amplifier input power line, motor power line, MCC drive coil	Separate these cables from those of group B by bundling them separately* or by means of electromagnetic shielding**. Attach a noise preventer or suppressor, such as a spark arrester, to the MCC drive coil.
B	Cable connecting control unit with servo amplifier and serial encoder feedback cable	Separate these cables from those of group A by bundling them separately or by means of electromagnetic shielding**. In addition, shielding must be provided.

* The bundle of group A cables must be separated from the bundle of group B cables by at least 10 cm.
** Electromagnetic shielding involves shielding groups from each other by means of a grounded metal (steel) plate.

Grounding

A typical machine has three separate grounds:

- **Signal Ground:** Provides the reference potential (0 V) for the electrical signal system.
- **Frame Ground:** Ensures safety and shields external and internal noise.
- **System Ground:** Connects each unit and the inter-unit frame ground system to earth ground.

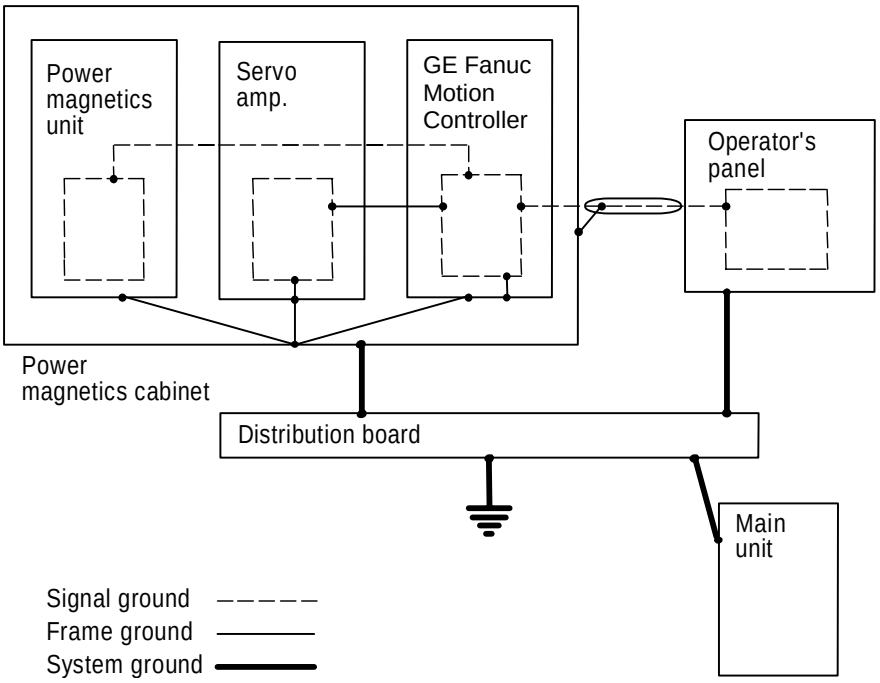


Figure 11. Ground system

Notes on the ground system wiring:

- The ground resistance of the system ground must not exceed 100 ohms (Class-3 ground).
- System ground connection cables must have a sufficiently large cross-sectional area to enable them to safely carry the current that will arise in the event of a problem such as a short-circuit (in general, a cross-sectional area no less than that of the AC power line must be provided).
- The system ground connection cable must be integrated with the AC power line such that power cannot be supplied if the ground wire is disconnected.
- The CX11-3 grounding connector is supplied to provide the servo motor frame ground connection and should always be installed. A separate 1 meter long cable for this connection is included with the optional GE Fanuc prefinished motor power cables.

13.8 Command Cable Grounding

The GE Fanuc controller cables that require shielding should be clamped by the method shown below. This cable clamp treatment provides both cable support (strain relief) and proper grounding of the shield. To ensure table system operation, the cable clamp method is recommended. Partially peel back the cable sheath to expose the shield. Push the clamp (A99L-0035-0001) over the exposed shield and insert the clamp hooks into slots on the grounding bar (44B295864-001). Tighten the clamp to secure cable and complete the ground connection. The grounding bar must be attached to a low impedance earth ground.

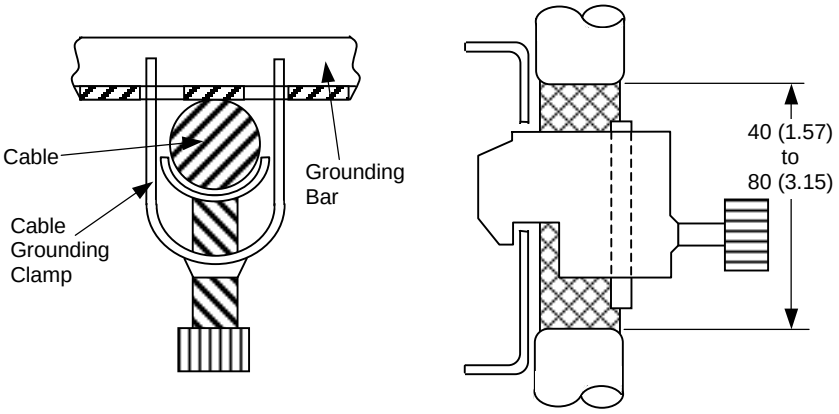


Figure 12. Cable grounding clamp detail

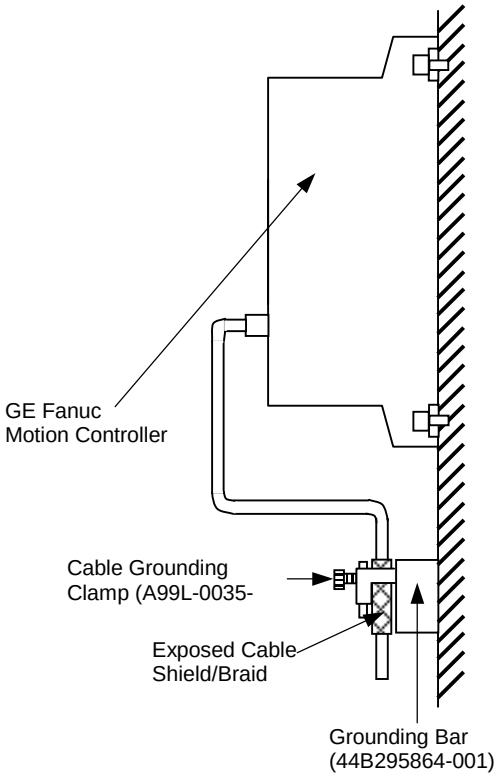


Figure 13. Command cable shield grounding system

13.9 Selecting a Ground Fault Interrupter

The β Series servo amplifier drives a motor by means of the transistor-based PWM inverter method, in which a high-frequency leakage current flows to ground through the stray capacitance of the motor windings, power cable, and amplifier. A ground fault interrupter or leakage-protection relay, which is typically installed on the power supply side, can malfunction if such a leakage current should flow. Therefore, you should select an inverter-compatible ground fault interrupter with the following ratings to protect against the occurrence of this malfunction:

- **β0.5/3000, β2/3000, β6/2000:** choose a 1.8 mA commercial frequency component.
- **αC12/2000:** choose a 2.0 mA commercial frequency component.

Section 14: β Servo System Power Requirements

This section provides information about AC and DC amplifier power as well as the discharge of regenerative power.

14.1 Power Line Protection

A circuit breaker, electromagnetic contactor, and AC line filter or transformer should be installed as part of your β Series Servo system. GE Fanuc provides the AC line filter as an option. The transformer, circuit breaker, and electromagnetic contactor, however, are user-supplied components. In European countries where power sources are 380 to 400 VAC and neutral grounded, it is necessary to install a transformer or supply single-phase power.

The same incoming AC control components can be used to provide power to multiple amplifiers, as long as the components are rated for the current and power drawn by the sum of all of the amplifiers.

14.2 AC Line Filter

An AC line filter is recommended to suppress the influences of high-frequency input line noise on the drive power supply. When an isolation-type power transformer is used because a power supply voltage within the specified range is not available, an AC line filter is not required.

If two or more servo amplifiers are connected to one AC line filter, the total continuous output rating of all connected servo amplifiers should be kept below the continuous output rating of the AC line filter. The continuous output rating for the various servos are shown below.

Table II-12. β Servo Motor Continuous Output Rating

Motor	*Cont. Output Rating*
β0.5/3000	0.2 kW
β2/3000	0.5 kW
β6/2000	0.9 kW
αC12/2000	1.0 kW

If your installation must be EMC compliant, verify that the use of an AC line filter fully satisfies the EMC requirements. You may need to select and install a user-supplied noise filter to meet EMC requirements.

Two AC line filters are available:

- 5.4 kW, 3-phase (A81L-0001-0083#3C)
- 10.5 kW, 3-phase (A81L-0001-0101#C)

For AC line filter specifications and dimension drawings, refer to Section 6.2.

14.3 Circuit Breaker Selection

To provide proper protection for the amplifier, use a circuit breaker rated at no more than 20 Amps (10A for VDE 1601 compliance for CE marking). Table II-13 will help you select the appropriate circuit breaker for your motion application.

Table II-13. Currents Drawn at Continuous Rated Output

Motor	*Input Current 3-phase*	*Input Current single phase*
β0.5/3000	1.9 A (rms)	3.2 A (rms)
β2/3000	3.2 A (rms)	5.1 A (rms)
β6/2000	6.3 A (rms)	10.1 A (rms)
αC12/2000	6.3 A (rms)	10.1 A (rms)

NOTE

When multiple amplifiers are connected to a single circuit breaker, select a breaker by multiplying the sum of the currents listed in Table II-13 by 0.6.*

Example: Connecting two β6/2000 motors operating on 3-phase power:

(6.3 + 6.3) x 0.6 = 7.6 Arms

A standard 10 Amp circuit breaker can be used.

During rapid motor acceleration, a peak current that is three times the continuous rating flows. Select a circuit breaker that does not trip when a current that is three times the continuous rating flows for two seconds.

***This factor attempts to compensate for applications where all axes are not demanding full power at the same time. In applications where all axes are running continuously or with high duty cycles, this factor must be increased by 1.**

14.4 Electromagnetic Contactor Rating

To prepare for incoming AC power, you must also select and install an appropriate electromagnetic contactor, based on the peak currents for the motors in your system. When multiple amplifiers are connected to a single circuit breaker, select a breaker based on the sum of the currents in Table II-13.

14.5 Incoming AC Power

Table II-14. AC Power

Specification	Description
Voltage: 3-phase 1-phase*	200 VAC to 240 VAC 220 VAC to 240 VAC
Frequency	50 Hz, 60Hz ± 2 Hz
Voltage fluctuation during acceleration/deceleration	7% or less

* Single-phase operation reduces the lifetime of the servo amplifier. For β6/2000 and αC12/2000 motors with acceleration/deceleration duty cycles greater than once every 20 seconds, 3-phase power is recommended.

AC Power Ratings

The power supply rating required when using multiple servo motors can be determined by summing the requirements of the individual motors.

The power supply ratings listed in Table II-15 are sufficient as continuous ratings. Note, however, that servo motor acceleration causes a current to momentarily flow that is approximately three times the continuous current rating.

When the power is turned on, a surge current of about 37A (when 264VAC is applied) flows for 20 msec.

Table II-15. Three-Phase Power Supply Ratings

Motor	*Power Supply Rating*
β0.5/3000	0.4kVA
β2/3000	0.77kVA
β6/2000	1.4kVA
αC12/2000	1.6kVA

14.6 Incoming DC Power

The amplifier requires a 24 VDC power supply for amplifier control power. This DC power supply must be supplied by the user.

The information in Table II-16 below will help you select the appropriate DC power supply for your motion application.

The same external DC power supply can be used to provide power to multiple amplifiers as long as the supply is rated for the sum of power drawn by all of the amplifiers. To daisy chain the amplifiers, add connection K13 between amplifiers (see the connection diagram in Section 15.3 for more details).

Table II-16. DC Amplifier Control Power Specifications

Specification	Description
Input voltage	24V DC (±10%)
Power supply rating (per amplifier)	0.4 amps

NOTE

The 24 VDC input is fused to protect the amplifier. The fuse labeled F600 is located below the CX11 connector when the amplifier plastic cover is removed. The replacement fuse part number is A06B-6073-K250 (Manufacturer: Daito LM32, DC48V, F3.2A).

A spare fuse is included with each β amplifier package (IC800BPK012 or IC800BPK020)

14.7 Discharging Regenerative Energy

Regenerative energy is normally created in applications with a high load inertia or frequent acceleration and deceleration. When decelerating a load, the stored kinetic energy of the load causes generator action in the motor causing energy to be returned to the β Series amplifier. For light loads and low acceleration rates, the amplifier may be able to absorb this energy. Otherwise, an optional external regenerative discharge unit must be installed.

Two separate 30 Ohm regenerative discharge units are available with ratings of 100 W and 20 W. The 100 W unit (A06B-6093-H402) is panel-mounted, whereas the 20 W unit (A06B-6093-H401) mounts to the tapped holes on the side of the amplifier heat sink. Calculations shown later in this section can be used to determine the need for an external unit.

If the regenerative discharge unit overheats, a built-in thermostat is tripped, the external overheat alarm is issued, and the motor is stopped. If an external regenerative discharge unit is required, a separate unit must be installed for each amplifier. This component cannot be daisy-chained. The dimensions for these units are shown in the following drawings. Connections are shown for cables K7 and K8 in Section 15.3 of this document.

Calculating the Average Regenerative Energy

Use the following calculation to determine the average regenerative energy that will be released in your application (ambient temperature is assumed not to exceed 55°C). Based on the calculations select either the 20 W or 100 W regeneration resistor. The wattage rating of the selected resistor must exceed the average calculated regenerative energy from the equation below:

Average Regenerative Energy (Joules)	=	**Rotational Energy to be Released during Deceleration (STEP 1)**	–	**Energy to be Consumed Through Axis Friction (STEP 2)**	+	***(only in vertical axis operation)* Vertical Energy to be Released During Downward Motion (STEP 3)**

STEP 1: Rotational Energy to be Released during Deceleration

$= \left(6.19\times10^{-4}\right)\times\left(J_m + J_L\right)\times\omega_m^{\,2}$ Joules

where:

J_m	Motor rotor inertia β0.5 = 0.00016 β2 = 0.00581 β6 = 0.0347 αC12 = 0.0555	(lb-in-s^2)
J_L	Load inertia converted to motor shaft inertia	(lb-in-s^2)
ω_m	Maximum motor speed at time of deceleration	(rpm)

STEP 2: Energy to be Consumed through Axis Friction

$= \left(5.91\times10^{-3}\right)\times t_a\times\omega_m\times T_L$ where:

ω_m	Motor speed during rapid traverse	(rpm)
t_a	Acceleration/deceleration duration during rapid traverse	(sec)
T_L	Axis friction torque (converted to motor shaft torque)	(lb-in)

STEP 3: Vertical Energy to be Released During Downward Motion

(This term applies only in vertical axis operation)

$= \left(1.182\times10^{-2}\right)\times T_h\times\omega_m\times\frac{D}{100}$ where:

T_h	Upward supporting torque applied by the motor during downward rapid traverse	(lb-in)
ω_m	Motor speed during rapid traverse	(rpm)
D	Duty cycle of downward vertical operation during rapid traverse (Note: the maximum value of D is 50%. D assumes a smaller value)	(%)

STEP 4: Determine if a Regenerative Discharge Unit Is Required

Determine the Average Regenerative Energy using the equation in the beginning of this section.

When the average regenerative energy produced never exceeds the amounts that is indicated in Table II-17 below, a separate regenerative discharge unit is **not** required:

Table II-17. Maximum Allowable Regenerative Energy for Amplifiers

Amplifier	*Max. Allowable Regen. Energy*	*Used with Motors*
βSVU-12	13 Joules	β0.5, β2
βSVU-20	16 Joules	β6, αC12

If the calculated value exceeds the storage capability of the amplifier, then an external regenerative discharge unit is required (see Step 5).

STEP 5: Selecting a Regenerative Discharge Unit

If a separate regenerative discharge unit is required, the following calculation will determine whether the 20 W or 100 W unit is required:

Average Regenerative Power (W) = Average Regenerative Energy (Joules) x $\frac{1}{F}$ where:

F = Deceleration duty (seconds) Example: deceleration once per 5 second cycle, F=5

Select a regenerative resistor with a rating that exceeds the average regenerative power. If this value is greater than 100 W, contact GE Fanuc for assistance.

Example:

Assume a horizontal axis using a β2 motor (J_m = 0.00581 lb-in-s^2) that decelerates once every 6 seconds (F) for 0.2 seconds (t_a) with a maximum speed of 2000 RPM (ω_m). The machine inertia (J_L) is 0.0139 lb-in-s^2.

STEP 1: Rotational Energy = $(6.19 \times 10^{-4}) \times (0.00581+0.0139) \times 2000^2$ = 54.4 Joules

STEP 2: Assuming T_L = 10 in-lb:
Friction Energy = $(5.91 \times 10^{-3}) \times 0.2 \times 2000 \times 10$ = 23.64 Joules

Therefore:

STEP 4: Average Regenerative Energy = 54.4–23.64 = 30.76 Joules
Because the 30.76 Joules required is more than the 13 Joules allowed by the βSVU-12 amplifier used with the β2 motor, a regenerative resistor is required.

STEP 5: Since the application requires decelerations every 6 seconds, $\frac{1}{F} = \frac{1}{6}$

Average Regenerative Power = 30.76 Joules/6 seconds = 5.13 W
Therefore, the 20 W resistor (A06B-6093-H401) is adequate for this application.

Section 15: β Servo System Connection

When planning your system, it is important to determine how the different parts of the system connect together. Cable reference numbers K1 through K15 on the β Servo Connection Diagram on p. 31. Details for each connection are shown in Section 15.3.

15.1 System Connections

β Series motor and amplifier connectors required for the system are available from GE Fanuc.

GE Fanuc supplies connectors to allow you to manufacture cables to the specific length required by your system design. GE Fanuc does offer finished cables as options for many connections. See the Cable Connections chart on p. 28 for more information.

A connector kit (Part number A06B-6093-K305) and an E-Stop connector (A02B-0120-K321) are shipped with each β Series servo amplifier package. Kit components are not sold separately. The contents of the connector kits are described below:

Table II-18. β Connector Kit Contents, A06B-6093-K301 (Amplifier Version G or Lower)

Qty.	*FANUC Part Number*	*Description*	*Wire Gauge*
3	A63L-0001-0460/025KD	CX11-3 (Ground), CX11-4, -5 (24 VDC) single wide connectors	NA
2	A63L-0001-0460/045KD	CX11-1 (Power), CX11-3 (Motor Power) double wide connectors	NA
10	A63L-0001-0456/ASL	CX11 contacts	18—16 AWG ($0.12mm^2$—$0.5mm^2$)
4	A63L-0001-0456/ASM	CX11 contacts	18—16 AWG ($0.12mm^2$—$0.5mm^2$)
1	A660-8011-T604	CX11-6 prewired jumper for discharge resistor thermal switch (must be used when external discharge resistor is not installed)	NA

Table II-19. β Connector Kit Contents, A06B-6093-K305 (Amplifier Version H or Higher)

Qty.	*Tyco Electronics AMP Part Number*	*Description*	*Wire Gauge*
1	175363-3	CX11-1 (Power) double wide connector	NA
1	1318182-2	CX11-2 (Dummy housing for applications when no regenerative discharge resistor is used) single wide connector	NA
1	1318095-2	CX11-3 (Motor Power) triple wide connector	N/A
2	175362-1	CX11-4 & CX11-5 (24VDC Power) two single wide connectors	N/A
10	A63L-0001-0456/ASL	CX11 contacts	18—16 AWG ($0.12mm^2$—$0.5mm^2$)
4	A63L-0001-0456/ASM	CX11 contacts	18—16 AWG ($0.12mm^2$—$0.5mm^2$)
1	A660-8011-T604 (FANUC p/n)	CX11-6 prewired jumper for discharge resistor thermal switch (must be used when external discharge resistor is not installed)	NA

Caution

When no regenerative discharge resistor is used, installation of a dummy housing (1318182-2) is recommended for prevention of wrong insertion. Do not make a connection between the pins (A and B) of CX11-2. Otherwise, the amplifier can be damaged.

Note: The following hand tool, which is available from Tyco Electronics (http://www.tycoelectronics.com), is required for installing the connectors:
Crimp Tool 58571-1 with die 58571-2 (die is installed in the tool at factory).

.Optional connectors are also available for the various motor power and feedback cables.

Table II-20. Available Motor Power and Feedback Cable Connectors for β Servo Systems

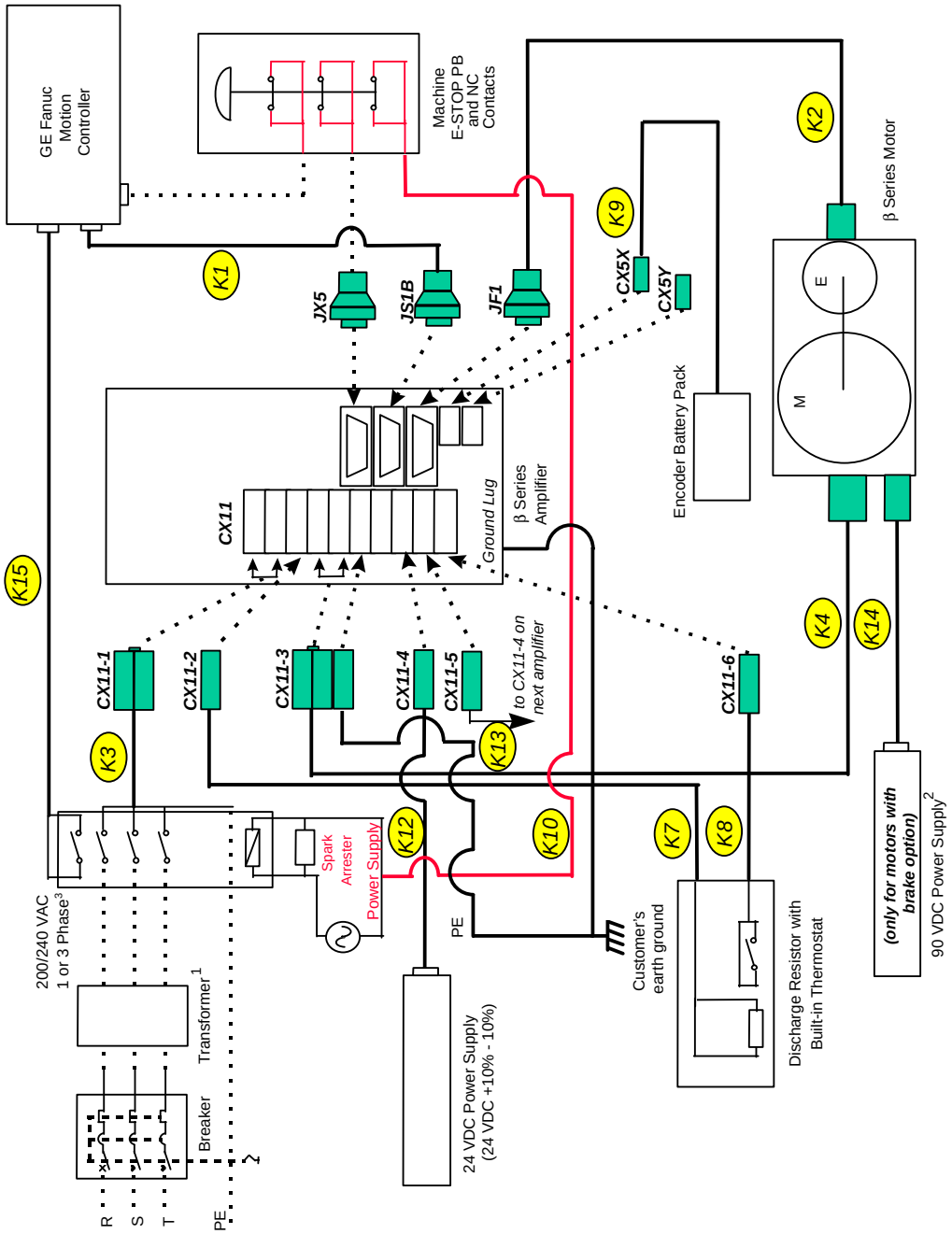
Part Number	*Description*
A06B-6050-K119	Motor Power Connector Kit, β0.5/3000
44A730464-G18	Motor Power Connector Kit, β2/3000 and β6/2000
A06B-6050-K120	Motor Encoder Connector Kit, β0.5/3000
A06B-6050-K115	Motor Encoder Connector Kit, β2/3000 and β6/2000
A06B-6050-K214	β Series Amplifier Encoder Feedback Connector Kit (JF1)
44A730464-G26	Motor Brake Connector Kit (not required for β0.5 motor with brake)

Table II-21. Cable Connections

Ref.	Connects	Prefinished Cable Part Number	Connection Type	When Required
K1	DSM302 to Amplifier (JS1B)	IC800CBL001 (1m) IC800CBL002 (3m)	Servo Command Signal	always
K1	All Other GE Fanuc Controllers to Amplifier (JS1B)	IC800CBL003 (2m)	Servo Command Signal	
K2	Built in Serial Motor Encoder to Amplifier (JF1)	IC800CBL022 severe duty, 14m (β0.5/3000) IC800CBL023 severe duty, 14m (β2/3000, β6/2000) CF3A-2MPB-0140-AZ severe duty, 14m (αC12/2000)	Motor Encoder Feedback	always
K3	AC Power Components to Amplifier	N/A	3 Phase Servo Power	always
K4	Amplifier to Motor (Prefinished cable includes separate cable to connect motor frame ground to customer's earth ground.)	IC800CBL067, 14m (β0.5/3000) IC800CBL068, 14m (β2/3000, β6/2000) CP4B-1MPB-0140-AZ, 14m (αC12/2000)	Motor Power	always
K5	Servo Amplifier Emergency Stop Input (JX5) to Machine E-Stop Contact	N/A	Emergency Stop	always
K7	Amplifier to Regenerative Discharge Unit	N/A (included with regenerative discharge unit)	Regenerative Power Discharge	in most cases[1]
K8	Regenerative Discharge Unit Over Temperature Switch to Amplifier	N/A (included with regenerative discharge unit)	Regenerative Power Discharge	in most cases[1]
K9	Amplifier (CX5) to Backup Battery Holder	N/A	Absolute Encoder Battery	with battery option[2]
K10	Control to MCC Coil	N/A	Emergency Stop/Power Enable	control-dependent; consult your control documentation
K12	External 24 VDC Power Supply to Amplifier	N/A	24 VDC Amplifier Power	always
K13	Amplifier to Second Amplifier	N/A	24 VDC Amplifier Power	when daisy chaining amplifiers
K14	90 VDC Brake Power Supply to Motor Brake	44C742238-004. 14m (β2/3000, β6/2000, αC12/2000)	Motor Brake Power	with brake option[3]
K15	MCC Contact to Control	N/A	Control Enable	always

[1] See Discharging Regenerative Energy in Section 14.7
[2] Prefinished cable is provided as a part of a battery pack option
[3] Prefinished motor power cables supplied by GE Fanuc for β 0.5/3000 motor includes brake wiring.

15.2 β Series Connection Diagram



KEY:

—— available GE Fanuc cable

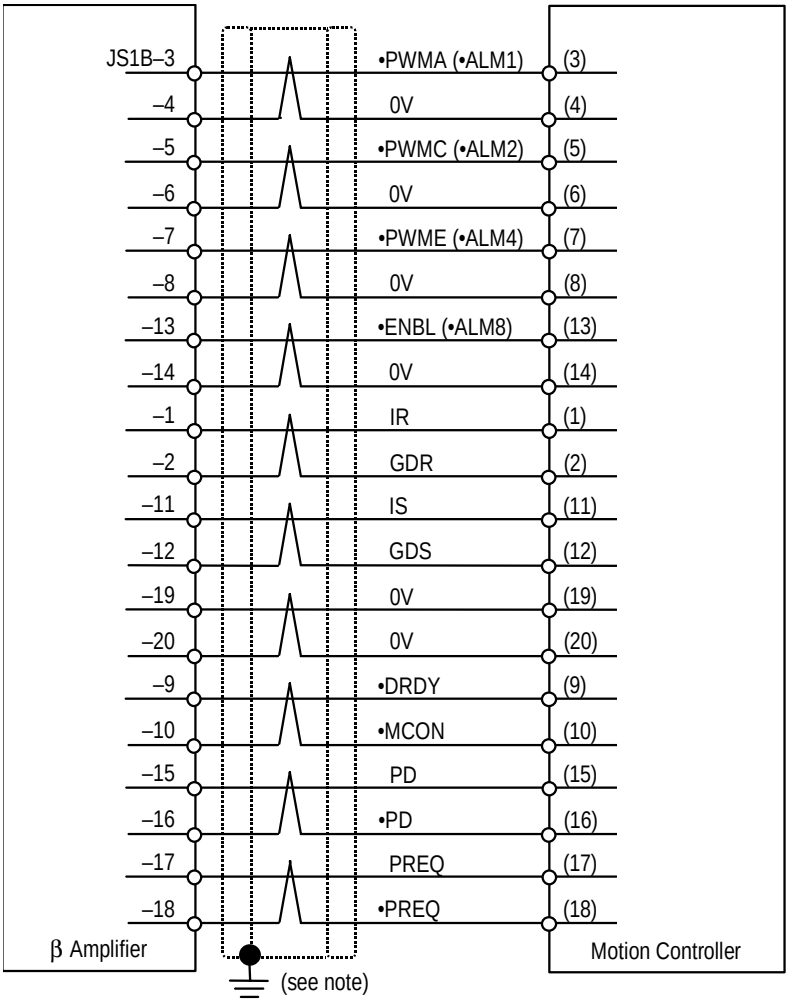
.... user-supplied cable

Figure 14. Cable connection diagram

[1] Line filter and lightning surge absorber can be used in place of a transformer when 200–240 VAC is available to the cabinet.
[2] Refer to the note in Section 0 regarding the motor holding brake.
[3] For single-phase operation, AC line phase T is not connected. Refer to the Servo System Specifications in Section 11:for output current derating.

15.3 Connection Details

K1— Servo Command Signal Cable (β0.5/3000, β2/3000, β6/2000, αC12/2000)

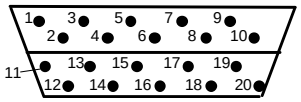
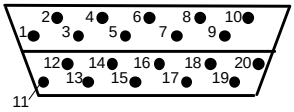


NOTES

The servo command cables for the DSM302 and DSM314 controllers (IC800CBL001 and IC800CBL002) must be purchased from GE Fanuc. Proper tooling is required to assemble the connectors. For custom length cables, contact your GE Fanuc Distributor or GE Fanuc Sales Engineer.

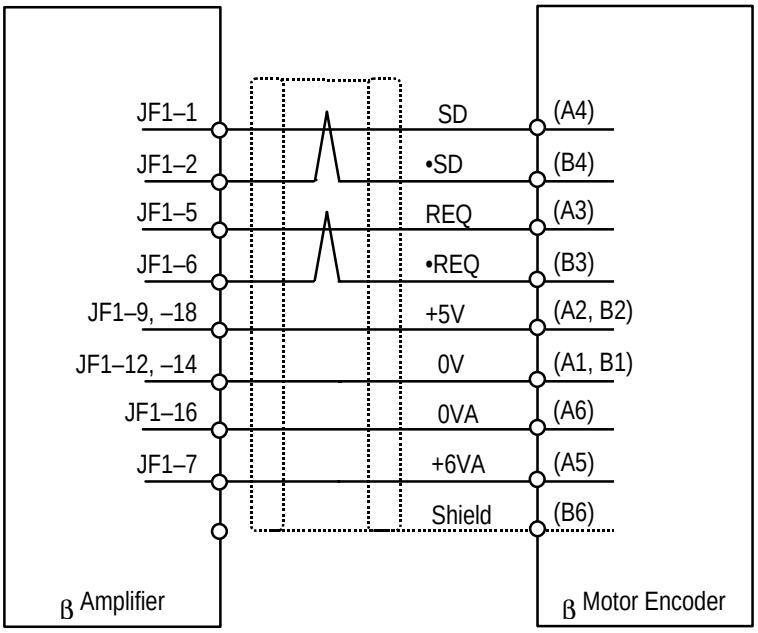
Grounding the cable shield using the grounding bar (44B295864-001) and cable grounding clamp (A99L-0035-0001) will provide greater noise immunity.

- Wire: 0.08mm^2 twisted pair group shielded cable (10 pairs). The following wire is recommended for the K1 cable: 28 AWG x 10 pairs (20 conductors).

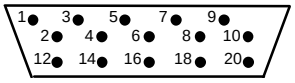
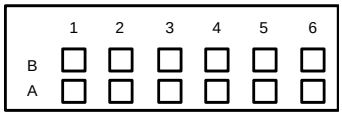
Cable (K1)	*GE Fanuc Part No.*	*Connector Manufacturer*
DSM302 to Servo Amplifier (JS1B)	IC800CBL001 (1 meter) IC800CBL002 (3 meter)	Cable must be purchased from GE Fanuc (connectors not sold separately)*
GE Fanuc controller other than DSM302 to Servo Amplifier (JS1B)	IC800CBL003 (2 meter)	Hirose Electric Co., Ltd.  Honda Tsushin Kogyo Co., Ltd. (PCR-E20FA)  *Connectors viewed from back (solder/crimp side).*

***NOTE:** DSM302 cables cannot be customer-manufactured and uses a 36-pin connector on its end. The DSM302 module requires IC693ACC355 Axis Terminal Board and either IC693CBL324 (1 meter) or IC693CBL325 (3 meter) Terminal Board Cable to access axis I/O such as Home Switch Input, Over Travel Inputs, or Strobe (registration) Inputs.

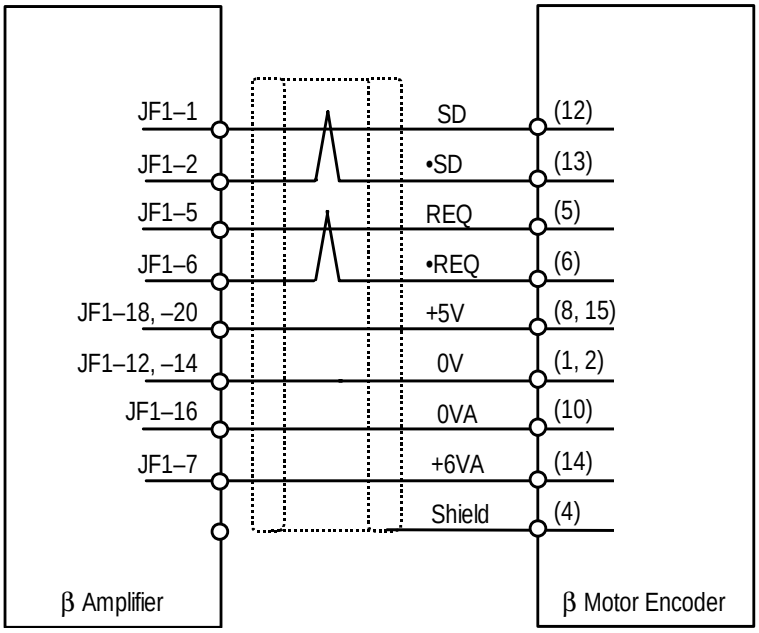
K2—Motor Encoder Feedback Cable (β0.5/3000)



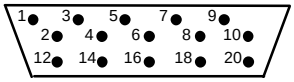
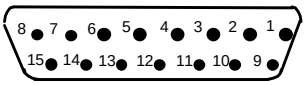
- Prefinished 14m Cable, Part number: IC800CBL022
- Wire: for +5V, 0V use two parallel conductors of 0.5mm^2 (20 AWG) or larger when the wire length does not exceed 14m. When the wire length exceeds 14m, wire gauge must be increased to ensure that the sum of the electrical resistance of 0V and 5V circuit does not exceed 0.5 ohms. For 6VA, 0VA use 0.5mm^2 (20 AWG) or larger; for SD, *SD, REQ, *REQ use 0.18mm^2 (24 AWG) or larger twisted pair with 60% braid shield.

Connector	*GE Fanuc Part No.*	*Manufacturer*
Servo Amplifier (JF1)	A06B-6073-K214	Hirose Electric Co., Ltd. (connector:FI40-2015S) (connector cover: F1-20-CV)  *Connector viewed from back (solder/crimp) side.*
Servo Motor Encoder	A06B-6050-K120	AMP (connector: 178289-6 pin: AMP 1-175217-2) 

K2—Motor Encoder Feedback Cable (β2/3000, β6/2000)



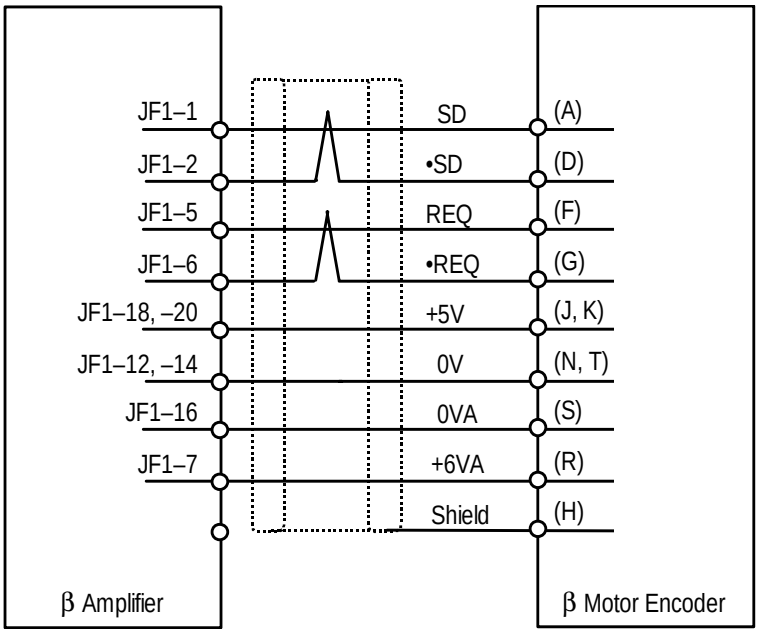
- Prefinished 14m Cable, Part number: IC800CBL023 (severe duty)
- Wire: for +5V, 0V use two parallel conductors of 0.5mm^2 (20 AWG) or larger when the wire length does not exceed 14m. When the wire length exceeds 14m, wire gauge must be increased to ensure that the sum of the electrical resistance of 0V and 5V circuit does not exceed 0.5 ohms. For 6VA, 0VA use 0.5mm^2 (20 AWG) or larger; for SD, *SD, REQ, *REQ use 0.18mm^2 (24 AWG) or larger twisted pair with 60% braid shield.

Connector	*GE Fanuc Part No.*	*Manufacturer*	
Servo Amplifier (JF1)	A06B-6073-K214	Hirose Electric Co., Ltd. (connector: FI40-2015S) (connector cover: FI-20-CV)	
Servo Motor Encoder	A06B-6050-K115	Hirose Electric Co., Ltd. (HDAB-15S) [connector cover: HDAW-15-CV (waterproof), HAD-CTH]	
Connectors viewed from back (solder/crimp side).			

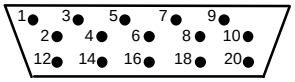
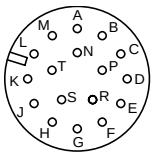
NOTE

Cable includes two M4 x 12mm screws and captive lock washers for securing connector to motor encoder housing.

K2—Motor Encoder Feedback Cable (αC12/2000)

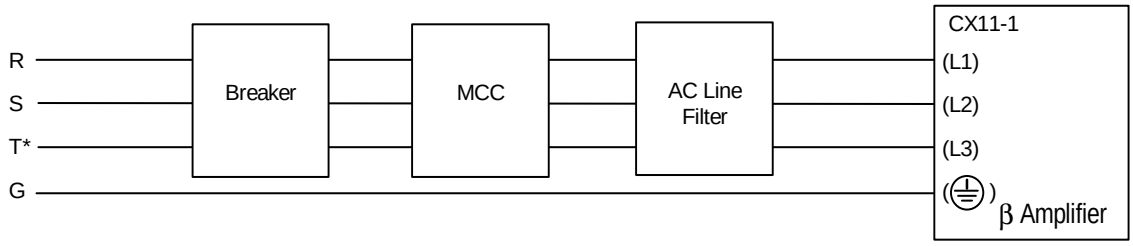


- Prefinished 14m Cable, Part number: IC800CBL021 (severe duty)
- Wire: for +5V, 0V use two parallel conductors of 0.5mm^2 (20 AWG) or larger when the wire length does not exceed 14m. When the wire length exceeds 14m, wire gauge must be increased to ensure that the sum of the electrical resistance of 0V and 5V circuit does not exceed 0.5 ohms. For 6VA, 0VA use 0.5mm^2 (20 AWG) or larger; for SD, *SD, REQ, *REQ use 0.18mm^2 (24 AWG) or larger twisted pair with 60% braid shield.

Connector	*GE Fanuc Part No.*	*Manufacturer*
Servo Amplifier (JF1)	A06B-6073-K214	Hirose Electric Co., Ltd. (F140-2015S) [connector cover: FI-20-CV]  *Connector viewed from back (solder/crimp side).*
Servo Motor Encoder	44A730464-G38 (CE EXT GND pin type)	Hirose Electric Co., Ltd. (MS3106A 20-29SW, straight) (MS3108B 20-29SW, elbow) 

K3—Three-Phase Servo Power Cable (user-supplied)

For a power supply voltage of 200/220/230/240 VAC 50/60 Hz (220 VAC minimum for single-phase)



Main Power Supply

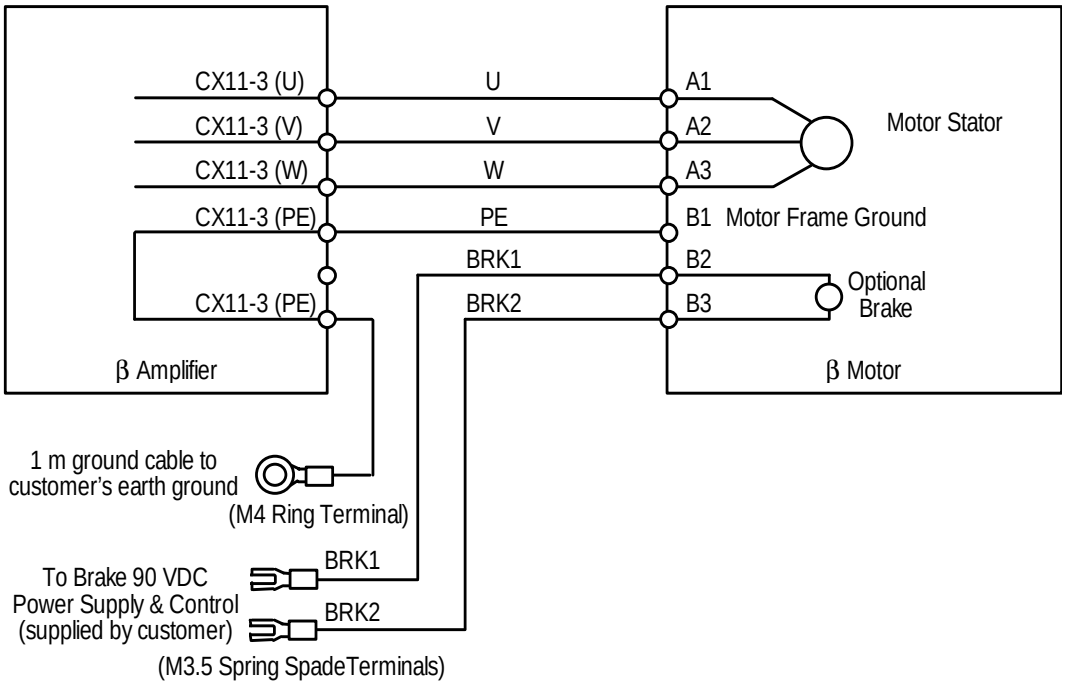
* For single-phase operation, phase T is not connected

- Wire: 600V, 4-conductor, 1.0mm2 (18 AWG) or larger. For sourcing multiple amplifiers from the same AC supply, size conductors based on the sum of the current for all amplifiers (see specifications in Section 11:

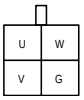
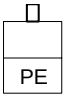
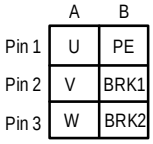
Connector	*GE Fanuc Part No.*	*Manufacturer*
Servo Amplifier (Version G or lower) CX11-1	Part of Kit A06B-6093-K301	Nihon AMP (175363-1 Housing; 1-175218-2 Contact)
Servo Amplifier (Version H or higher) CX11-1*	Part of Kit A06B-6093-K305	Nihon AMP (175363-3 Housing; 1-75218-2 Contact)

* The CX11-1 connector contained in the K305 kit is not compatible with β Series amplifiers prior to revision letter H.

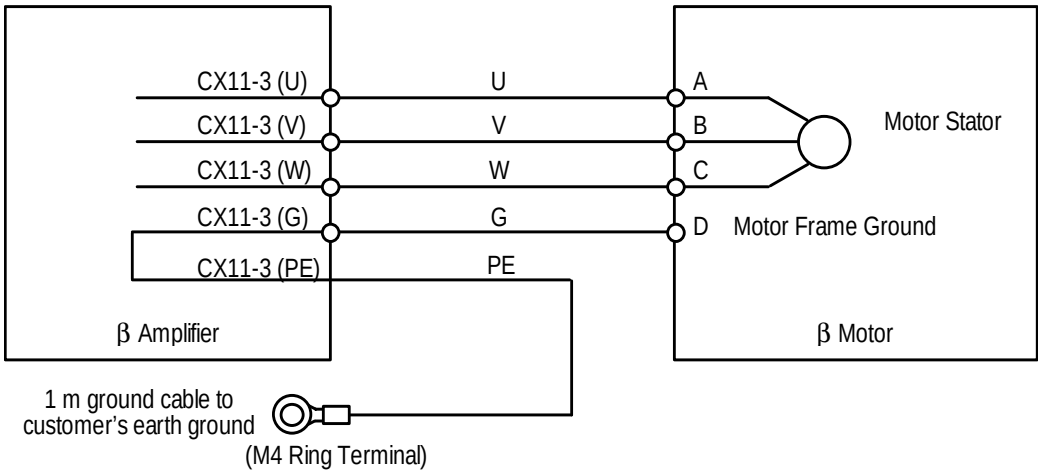
K4—Motor AC Power Cable (β0.5/3000)



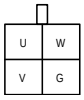
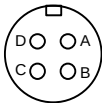
- Prefinished 14m Cable, Part number: IC800CBL064 (severe duty)
- Wire: 300V, 6-conductor, 20 AWG (finestrand) 80°C, polyurethane jacket with PVC conductors (nominal cross-sectional area 0.75mm^2). Ground wire is 18 AWG, 300 V, 1-conductor, 80°C, PVC, green with yellow stripe.

Connector	*GE Fanuc Part No.*	*Manufacturer*
Servo Amplifier CX11-3 (motor power)	Part of Kit A06B-6093-K301 (AMP version G or lower) A06B-6093-K305 (AMP version H or higher)	Nihon AMP (Housing: 175363-1; Contact: 1-175218-2) 
Servo Amplifier CX11-3 (ground)	Part of Kit A06B-6093-K301 (AMP version G or lower) A06B-6093-K305 (AMP version H or higher)	Nihon AMP (Housing: 175362-1; Contact: 1-175218-2) 
Servo Motor	A06B-6050-K119	Nihon AMP (Housing: 3-178129-6; Contact: 1-175217-2) 

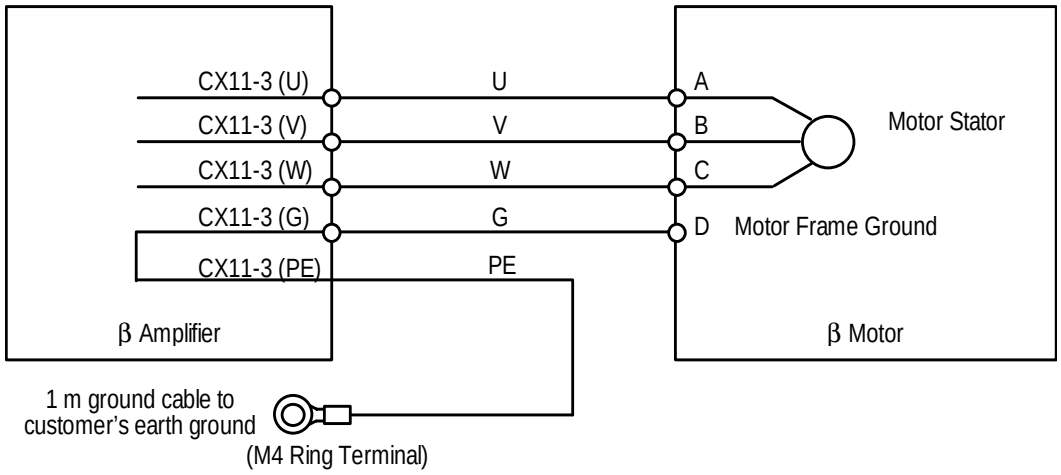
K4—Motor AC Power Cable (β2/3000, β6/2000)



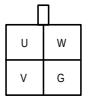
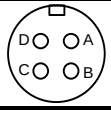
- Prefinished 14m Cable, Part number: IC800CBL065 (severe duty)
- Wire: 300V, 4-conductor, 18 AWG (finestrand) 80°C, polyurethane jacket (PUR) with PVC conductors (nominal cross-sectional area 0.75mm^2). Ground wire is 18 AWG, 300 V, 1-conductor, 80°C, PVC, green with yellow stripe.

Connector	*GE Fanuc Part No.*	*Manufacturer*
Servo Amplifier CX11-3 (motor power)	Part of Kit A06B-6093-K301 (AMP version G or lower) A06B-6093-K305 (AMP version H or higher)	Nihon AMP (Housing: 175363-1; Contact: 1-175218-2) 
Servo Amplifier CX11-3 (ground)	Part of Kit A06B-6093-K301 (AMP version G or lower) A06B-6093-K305 (AMP version H or higher)	Nihon AMP (Housing: 175362-1; Contact: 1-175218-2) 
Servo Motor	Customer-made cable: 44A730464-G18 (CE EXT GND pin)	

K4—Motor AC Power Cable (αC12/2000)

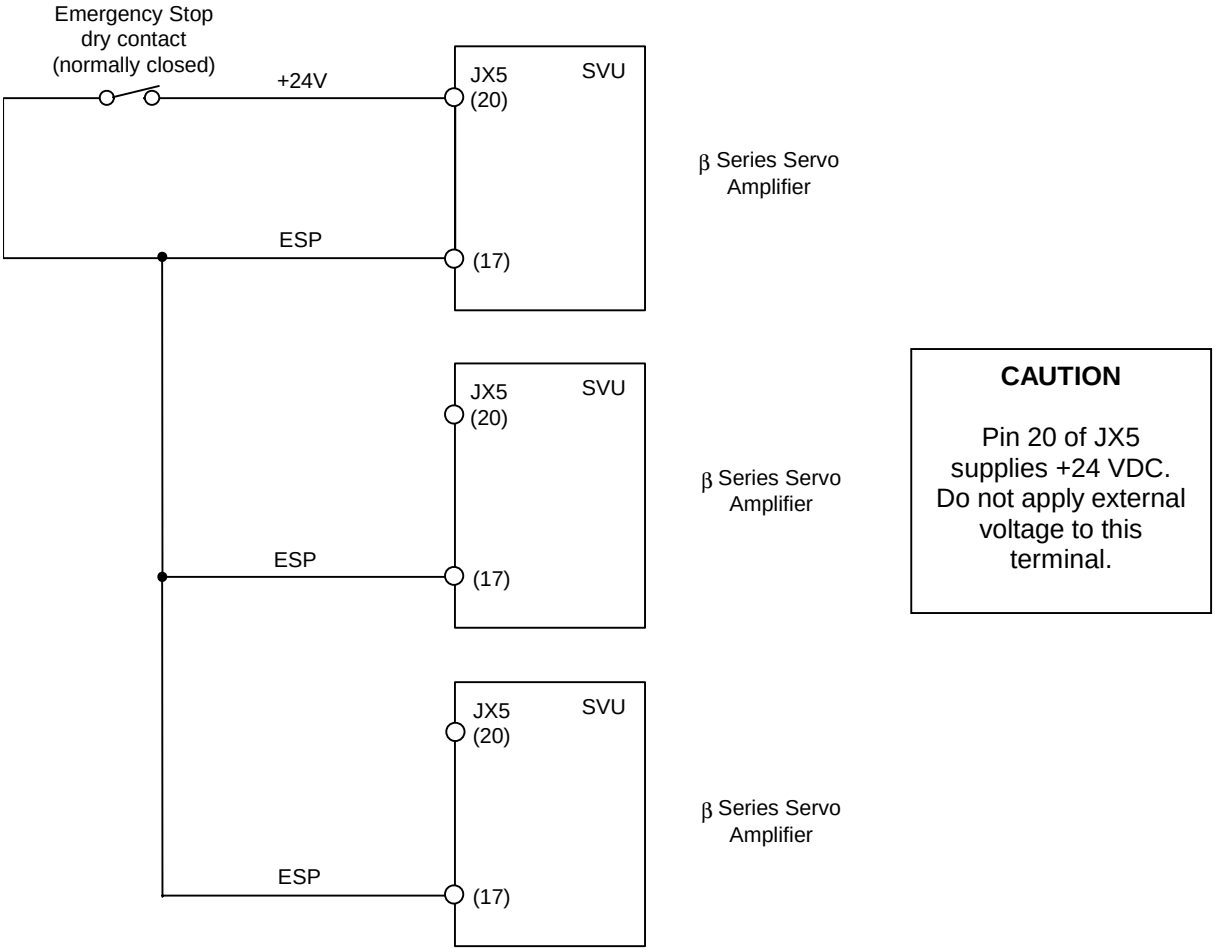


- Prefinished 14m Cable, Part number: IC800CBL066
- Wire: 300V, 4-conductor, 18 AWG (finestrand) 80°C, polyurethane jacket with PVC conductors (nominal sectional area 0.75mm^2). Ground wire is 18 AWG, 300 V, 1-conductor, 80°C, PVC, green with yellow stripe.

Connector	*Part No.*	*Maker*
Servo Amplifier CX11-3 (motor power)	Part of Kit A06B-6093-K301 (AMP version G or lower) A06B-6093-K305 (AMP version H or higher)	Nihon AMP (Housing: 175363-1; Contact: 1-175218-2) 
Servo Amplifier CX11-3 (ground)	Part of Kit A06B-6093-K305 (AMP version G or lower) A06B-6093-K305 (AMP version H or higher)	Nihon AMP (Housing: 175362-1; Contact: 1-175218-2) 
Servo Motor	Customer-made cable: 44A730464-G20 (CE EXT GND pin)	

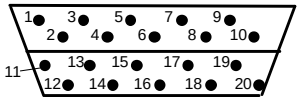
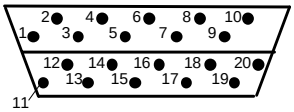
K5—Servo Amplifier Emergency Stop Connection

If two to six amplifier units are used in the same system, the emergency stop signal must be connected as shown below:



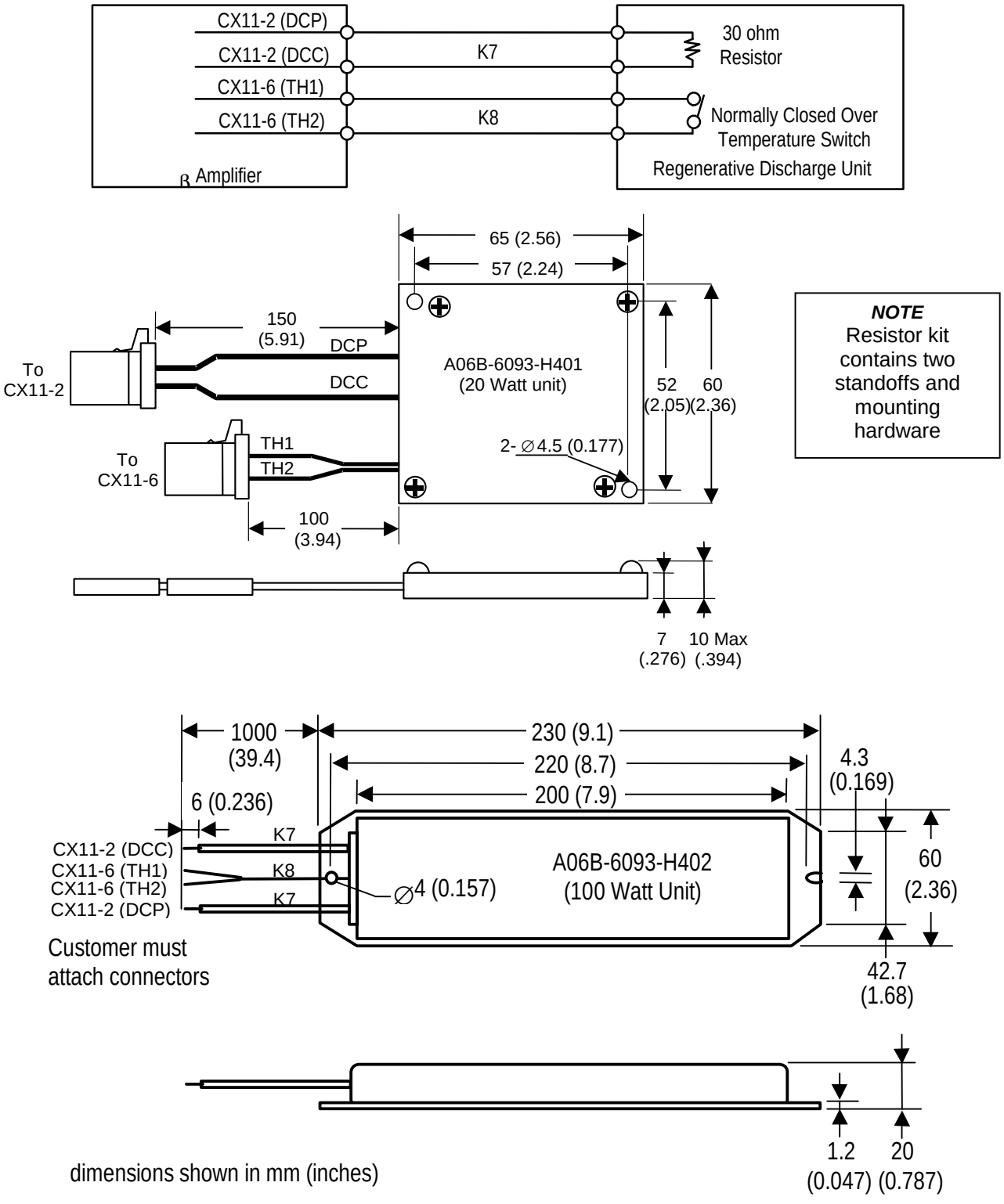
CAUTION

Pin 20 of JX5 supplies +24 VDC. Do not apply external voltage to this terminal.

Connector	*GE Fanuc Part No.*	*Manufacturer*
JX5	A02B-0120-K301	Hirose Electric Co., Ltd. (F140-2015S; F1-20-CV cover)  Honda Tsushin Kogyo Co., Ltd. (PCR-E20FA)  Connectors viewed from back (solder/crimp side).

K7—Regenerative Power Discharge Cable (β2/3000, β6/2000, αC12/2000)
K8—Regenerative Power Discharge Thermal Protection Cable

(Resistor includes amplifier connectors and contacts)



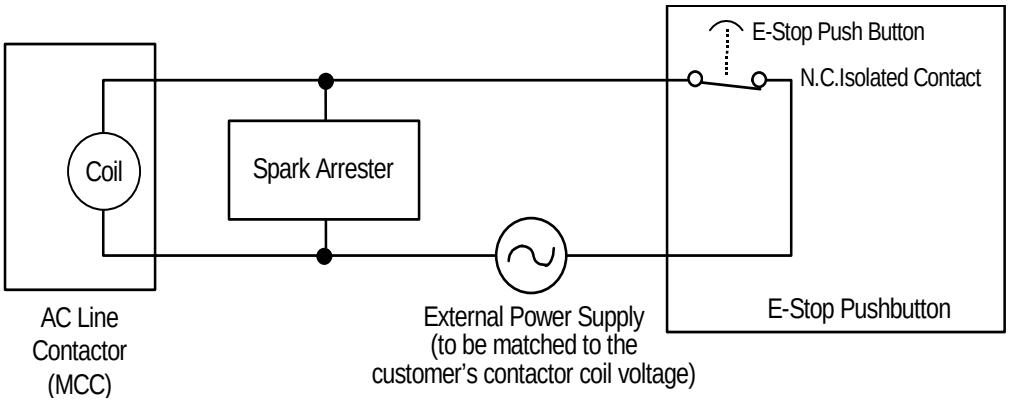
Connector	*GE Fanuc Part No.*	*Manufacturer*
Servo Amplifier CX11-2, -6	Included with Resistor Kit	Nihon AMP (Housing: 175362-1; Contact: 1-175218-2) DCP TH1 DCC TH2

K9—Absolute Encoder Battery Cable (β0.5/3000, β2/3000, β6/2000, αC12/2000)

- Wire: Nominal sectional area 0.32mm^2 (24 AWG) or less

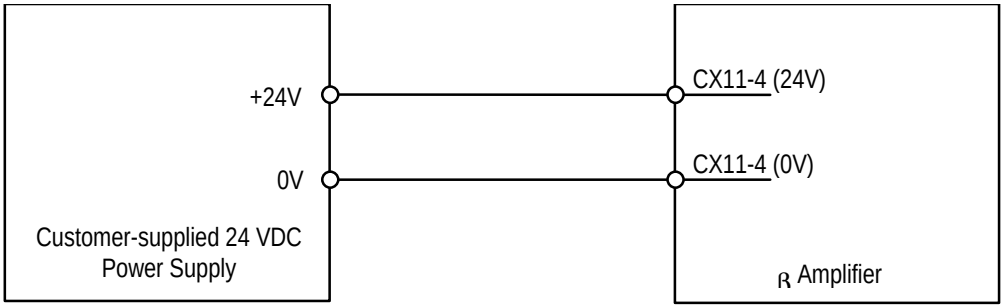
Connector	*GE Fanuc Part No.*	*Manufacturer*
Servo Amplifier (CX5X)	A06B-6093-K303	Japan Aviation Electronics Industry (Housing: IL-L2S-S3L-B(N); Contact: IL-C2-1-00001)

K10—Emergency Stop/Power Enable Cable (β0.5/3000, β2/3000, β6/2000, αC12/2000)



- Cable Specification: Heavy-duty vinyl power cord, 2-conductor 0.5mm^2 (20 AWG)
- Spark Arrester: To protect internal contacts, always use a spark arrester appropriate for the contactor you select.

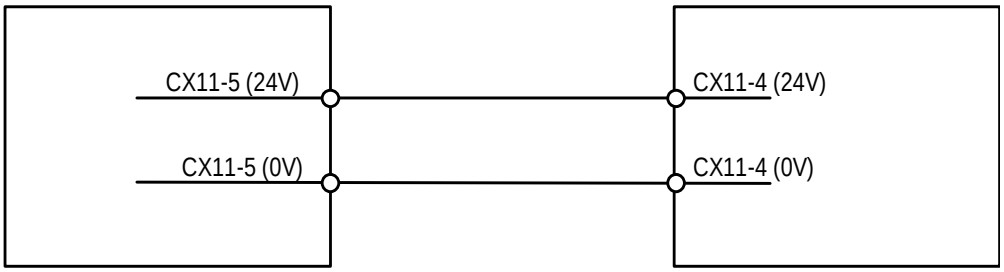
K12—24 VDC Amplifier Power Cable (β0.5/3000, β2/3000, β6/2000, αC12/2000)



- Wire: Nominal sectional area 0.5mm^2 (20 AWG)

Connector	*GE Fanuc Part No.*	*Manufacturer*
DC Power Supply	N/A	N/A
Servo Amplifier CX11-4	Part of Kit A06B-6093-K301 (AMP version G or lower) A06B-6093-K305 (AMP version H or higher)	Nihon AMP (Housing: 175362-1; Contact: 1-175217-2)

K13—24 VDC Amplifier Power Daisy Chain Cable (β0.5/3000, β2/3000, β6/2000, αC12/2000)

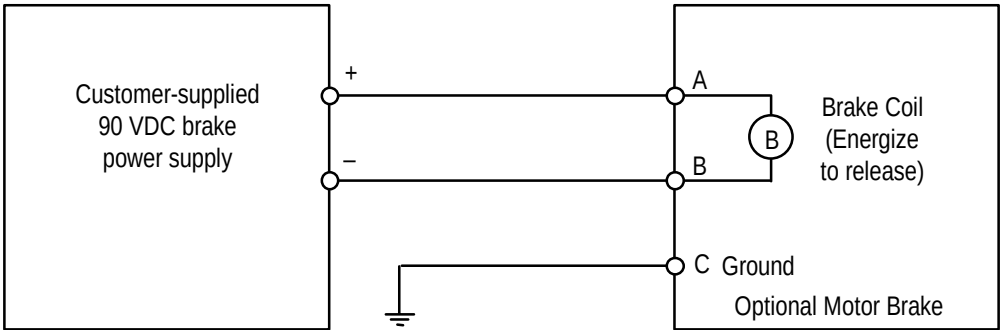


- Wire: Nominal sectional area 0.5mm^2 (20 AWG)

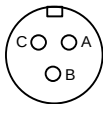
Connector	*GE Fanuc Part No.*	*Manufacturer*
DC Power Supply	N/A	N/A
Servo Amplifier CX11-5	Part of Kit A06B-6093-K301 (AMP version G or lower) A06B-6093-K305 (AMP version H or higher)	Nihon AMP (Housing: 175362-1; Contact: 1-175217-2)

K14—Motor Brake Power Cable (β2/3000, β6/2000, αC12/2000)

(β0.5/3000 brake wiring is include in power cable K4)



- Prefinished 14m Cable, Part number: 44C742238-004 (severe duty)
- Wire: 300V, 3-conductor, 20 AWG (0.5mm^2), finestrand, 80 °C, polyurethane (PUR) jacket

Connector	*GE Fanuc Part No.*	*Manufacturer*
Motor Brake	Customer-made cable: 44A730464-G26 GE Fanuc cable: 44A739012-G08	DDK CE Series (CE02-6A10SL-3CS) with Raychem Boot (222A-32-25142) 

15.4 β Series Amplifier Protection and Alarm Functions

The Servo Amplifier Unit can detect error conditions and provide alarm information.

The LEDs on the front of the amplifier provide a visual cue to the status of the system by indicating, for example, when the motor and amplifier are ready to function. The ALM LED is turned ON when an alarm condition is detected. When an alarm is detected, power is dropped and the motor is stopped by dynamic braking action. Alarm information is displayed as diagnostic data in the GE Fanuc controller. Table II-22 details the alarm conditions the β Series Servo Amplifier System can detect.

Table II-22. β Series Servo Amplifier Alarm System

Alarm Condition	*Description*
Over-voltage	Issued when the DC voltage in the main circuit power supply is abnormally high.
DC link under-voltage	Issued when the DC voltage in the main circuit power supply is abnormally low or when the circuit breaker has tripped.
Regenerative overheat	Issued when the average regenerative discharge energy is excessively high, such as when acceleration/deceleration is performed too frequently.
Overheat	Issued when the temperature inside the amplifier becomes so high that the thermostat trips.
Fan failure	Issued when the fan unit built into the amplifier fails.
Over-current	Issued when an abnormally high current is detected in the main circuit.

Part III:

βi

Series Servo System

Section 16: βi Series Servo Overview

16.1 βi Series Servo Systems

β*is* Series servomotors are high performance, low inertia servomotors with built-in serial encoders. All β*is* Series servomotors are available with an optional 24VDC holding brake. Each β*is* Series servomotor must be used with the designated amplifier and a GE Fanuc DSM324i motion controller.

Table **III-1** provides a summary of βis Series servo motors. See Section 18:for more detailed motor specifications.

Table III-1. βis Series Servo Systems

Motor	*Rated Torque*	*Encoder*	*Required Amplifier*	*Motor Catalog #*
β0.4/5000*is*	0.4 Nm (3.5 lbf-in) continuous stall torque; 5000 RPM	β64ia (64K)	βSVM1-20*i* A06B-6130-H002	Motor Only: A06B-0114-B203 Motor w/ Brake: A06B-0114-B503
β0.5/5000*is*	0.65 Nm (5.8 lbf-in) continuous stall torque; 5000 RPM	β64ia (64K)	βSVM1-20*i* A06B-6130-H002	Motor Only: A06B-0115-B203 Motor w/ Brake: A06B-0115-B503
β1/5000*is*	1.2 Nm (10.6 lbf-in) continuous stall torque; 5000 RPM	β64ia (64K)	βSVM1-20*i* A06B-6130-H002	Motor Only: A06B-0116-B203 Motor w/ Brake: A06B-0116-B503
β2/4000*is*	2 Nm (17.7 lbf-in) continuous stall torque; 4000 RPM	β128ia (128K)	βSVM1-20*i* A06B-6130-H002	Motor Only: A06B-0061-B203 Motor w/ Brake: A06B-0061-B503
β4/4000*is*	3.5 Nm (31.0 lbf-in) continuous stall torque; 4000 RPM	β128ia (128K)	βSVM1-20*i* * A06B-6130-H002	Motor Only: A06B-0063-B203 Motor w/ Brake: A06B-0063-B503
β8/3000*is*	7 Nm (62.0 lbf-in) continuous stall torque; 3000 RPM	β128ia (128K)	βSVM1-20*i* ** A06B-6130-H002	Motor Only: A06B-0075-B203 Motor w/ Brake: A06B-0075-B503
β12/3000*is*	11 Nm (97.4 lbf-in) continuous stall torque; 3000 RPM	β128ia (128K)	βSVM1-40*i* A06B-6130-H003	Motor Only: A06B-0078-B203 Motor w/ Brake: A06B-0078-B503
β22/2000*is*	20 Nm (177.0 lbf-in) continuous stall torque; 2000 RPM	β128ia (128K)	βSVM1-40*i* A06B-6130-H003	Motor Only: A06B-0085-B203 Motor w/ Brake: A06B-0085-B503

* Requires Fan Kit (A06B-6134-K003) for single-phase mains power.
** Fan Kit (A06B-6134-K003) always required.

16.2 βi Series Servo Amplifier Packages

The following table shows which amplifier model is included in each β*i* Series servo package:

Table III-2. β*i* Series Servo Amplifiers and Packages

Motor	*Amplifier Model*	*Amplifier Catalog #*	*Amplifier Package Catalog #*
β0.4/5000is	βSVM1-20i	A06B-6130-H002	IC800BIK020
β0.5/500is	βSVM1-20i	A06B-6130-H002	IC800BIK020
β1/5000is	βSVM1-20i	A06B-6130-H002	IC800BIK020
β2/4000is	βSVM1-20i	A06B-6130-H002	IC800BIK020
β4/4000is	βSVM1-20i	A06B-6130-H002	IC800BIK020
β8/3000is	βSVM1-20i	A06B-6130-H002	IC800BIK020
β12/3000is	βSVM1-40i	A06B-6130-H003	IC800BIK040
β22/2000is	βSVM1-40i	A06B-6130-H003	IC800BIK040

As a convenience, amplifiers can also be ordered as a package containing all of the components required to operate the amplifier in a servo system, as detailed in the following table:

Table III-3. β*i* Series Servo Amplifier Packages

Description	*Package Contents**	*Catalog #*
20 Amp β*i*-Series Amplifier Package	Contains the following: ■ βSVM1-20i 20A amplifier (A06B-6130-H002) – Qty 1 ■ Spare 24 VDC Fuse (A06B-6073-K250) – Qty 1 ■ 20 Watt Discharge Resistor (A06B-6130-H401) – Qty 1 ■ CZ7 Power Connector Kit (A06B-6130-K200) – Qty1 ■ CXA19 24 VDC Connector Kit (A06B-6130-K201) – Qty 2 ■ CXA20 Discharge Thermostat Connector Kit (A06B-6130-K202) – Qty 1 ■ CX29 MCC Connector Kit (A06B-6130-K203) – Qty 1 ■ CX30 E-stop Connector Kit (A06B-6130-K204) – Qty 1	IC800BIK020
40 Amp β*i*-Series Amplifier Package	Contains the following: ■ βSVM1-40i 40A amplifier (A06B-6130-H003) – Qty 1 ■ Spare 24 VDC Fuse (A06B-6073-K250) – Qty 1 ■ 20 Watt Discharge Resistor (A06B-6130-H401) – Qty 1 ■ CZ4 Power Connector Kit (A06B-6110-K200#XXS) – Qty1 ■ CZ5 Motor Power Connector Kit (A06B-6110-K202#YYS) – Qty 1 ■ CZ6 Discharge Resistor Connector Kit (A06B-6110-K201#XYM) – Qty 1 ■ CXA19 24 VDC Connector Kit (A06B-6130-K201) – Qty 2 ■ CXA20 Discharge Thermostat Connector Kit (A06B-6130-K202) – Qty 1 ■ CX29 MCC Connector Kit (A06B-6130-K203) – Qty 1 ■ CX30 E-stop Connector Kit (A06B-6130-K204) – Qty 1	IC800BIK040

* Amplifier package components can also be ordered separately.

Section 17: βi Servo System Options

Designing a servo control system requires that you understand how the electrical and mechanical aspects of your system interact. The table below will help you select which servo options your system requires.

Table III-4. β*is* Servo System Options

Servo Option	*Consider Selecting When*	*Catalog #*	*Section #*
Motor Holding Brake	The system design includes an axis that must hold its position when power is removed	Refer to Table III-1	18.4
Absolute Encoder Battery Backup Kit	You would like to avoid having to re-reference the position when power is restored to the control	IC800BBK021 (1-axis) IC800ABK001 (4-axis)	19.5
AC Line Filters	200—240 VAC is already available to the control cabinet and no isolation transformer is used	**5.4 kW, 3-phase:** A81L-0001-0083#3C **10.5 kW, 3-phase:** A81L-0001-0101#C	23.2
Pre-finished Cables	The cable lengths available from GE Fanuc are appropriate for your application	Refer to “Cable Connections” Table	24
Discharge Resistor	See “Discharging Regenerative Energy;” The 20 Watt discharge resistor is included in all 20 amp β*i* Series Amplifier Packages. The 40 amp amplifier includes an integral discharge resistor. The external 100 W discharge resistor offers additional capacity when required.	A06B-6130-H401 A06B-6130-H402 A06B-6089-H500 A06B-6089-H713	23.7
Ground Clamp	CE Installation or high electrical noise environment.	A99L-0035-0001, Clamp 44B295864-001, Bar	22.3

Section 18: Servo Motors

18.1 Servo Motor Specifications

The β*i* Series Servo system consists of a servomotor and its corresponding amplifier and cables. GE Fanuc offers several β*is* series servo motors, which are identified below.

Table III-5. Specifications of β*is* Servo Motors

	Unit	β0.4/5000is	β0.5/5000is	β 1/5000is	β 2/4000is	β 4/4000is	β 8/3000is	β 12/3000is	β 22/2000is
Rated torque at stall *	Nm	0.4	0.65	1.2	2.0	3.5	7.0	11.0	20.0
	lbf-in	3.5	5.8	10.6	17.7	31.0	62.0	97.4	177.0
Stall Current *	A (rms)	3.6	2.9	2.7	3.3	4.7	6.0	10.2	11.3
Rated Output *	kW	0.13	0.2	0.4	0.5	0.75	1.2	1.8	2.5
	HP	0.17	0.27	0.54	0.67	1.0	1.6	2.4	3.4
Rating Speed	RPM	4000	4000	4000	4000	3000	2000	2000	2000
Max. Speed	RPM	5000	5000	5000	4000	4000	3000	3000	2000
Peak Torque *	Nm	1.0	2.5	5.0	7.0	10.0	15.0	27.0	45.0
	lbf-in	8.9	22.1	44.3	62.0	88.5	132.8	239.0	398.3
Rotor Inertia	Kgm^2	0.00001	0.000018	0.000034	0.000291	0.000515	0.00117	0.00228	0.00527
	$lbf\text{-}ft\text{-}s^2$ $*(10^{-6})$	7.3756215	13.276118	25.07711	214.6305	379.8445	862.9477	1681.6417	3886.9525
Rotor Inertia (with brake)	Kgm^2	0.000019	0.000027	0.000043	0.000311	0.000535	0.00124	0.00235	0.00587
Torque Constant *	Nm/A	0.112	0.223	0.45	0.62	0.75	1.16	1.08	1.77
	Lbf-in/A								
Back EMF Const. (1 phase) *	Vsec/rad (rms)	0.038	0.074	0.14	0.21	0.25	0.39	0.36	0.59
Resistance (1 phase) *	ohm	0.55	0.85	1.5	1.6	0.94	1.00	0.39	0.44
Mechanical Time Constant	sec	0.001	0.0009	0.0007	0.004	0.003	0.003	0.002	0.002
Thermal time Constant	min	8	10	15	15	20	20	25	30
Static friction	Nm	0.04	0.04	0.04	0.1	0.2	0.3	0.4	0.8
Weight	kg	0.8	1.0	1.5	2.8	4.3	7.4	11.9	17.0
	lb								
Weight (with brake)	kg	1.2	1.4	1.9	3.8	5.3	9.6	14.1	23.0
	lb								
Max Current	A (peak)	20	20	20	20	20	20	40	40

* These values are standard values at 20°C with a tolerance of ±10%. The speed-torque characteristics vary, depending on the type of software, parameter setting, and input voltage of the digital servo amplifiers. (The above figures show average values.) These values may be changed without prior notice.

18.2 βis Series Motor Speed–Torque Curves

The curves shown in the following figure illustrate the relationship between the speed of the motor and the output torque. The motor can operate continuously at any combination of speed and torque within the prescribed continuous operating zone. The limit of the continuous operating zone is determined with the motor's ambient temperature at 20°C and its drive current as pure sine wave. The curves reflect peak torque limits based on maximum current of the servo amplifier unit.

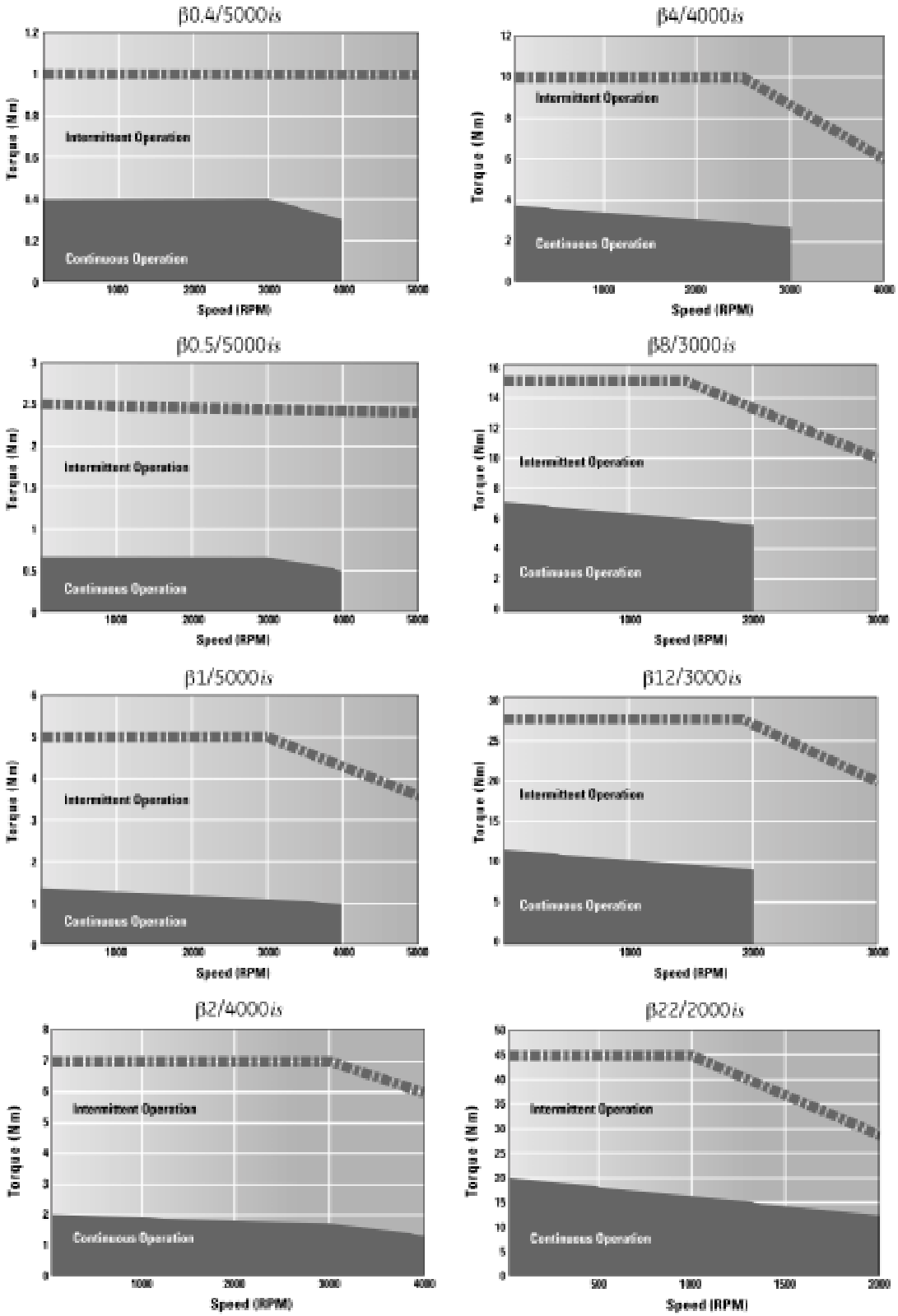
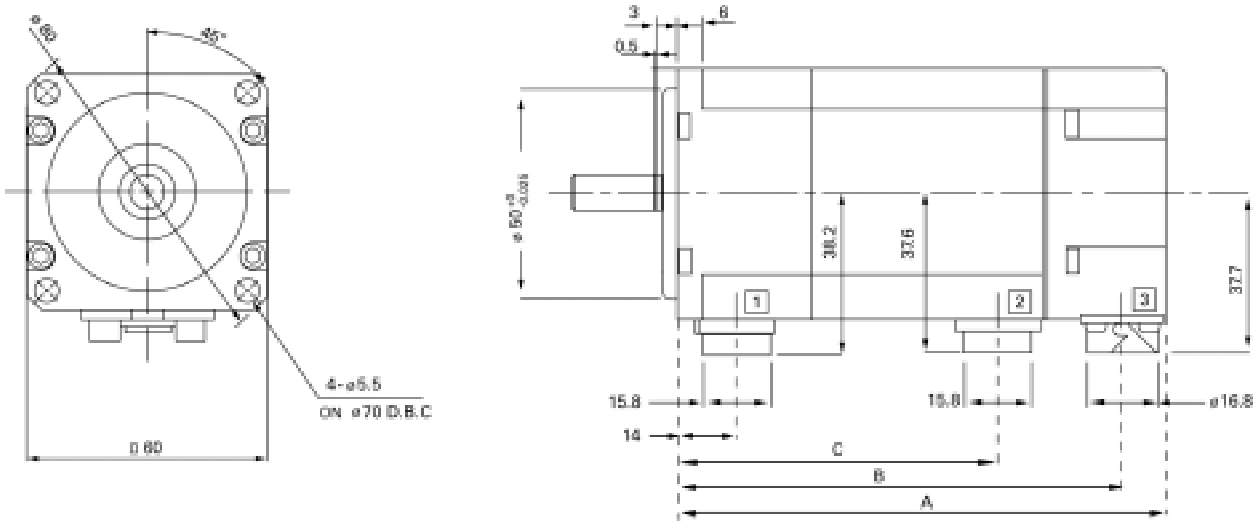
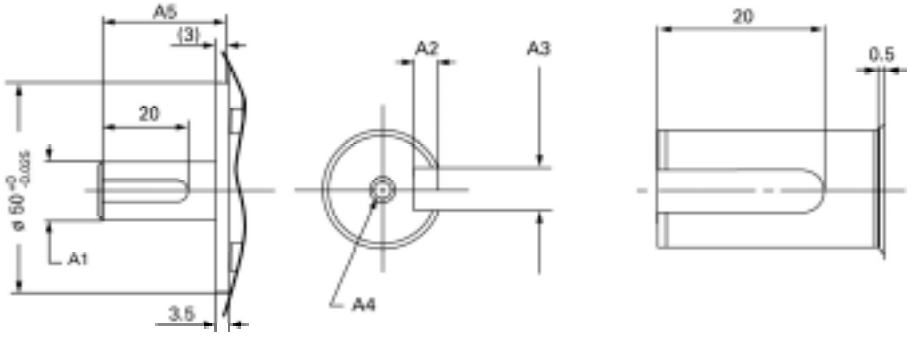


Figure III-1. β0.4/5000*is* Series servo motor speed-torque curve.

18.3 Motor Outline Drawings



Motor



Shaft Detail

Dimensions shown mm

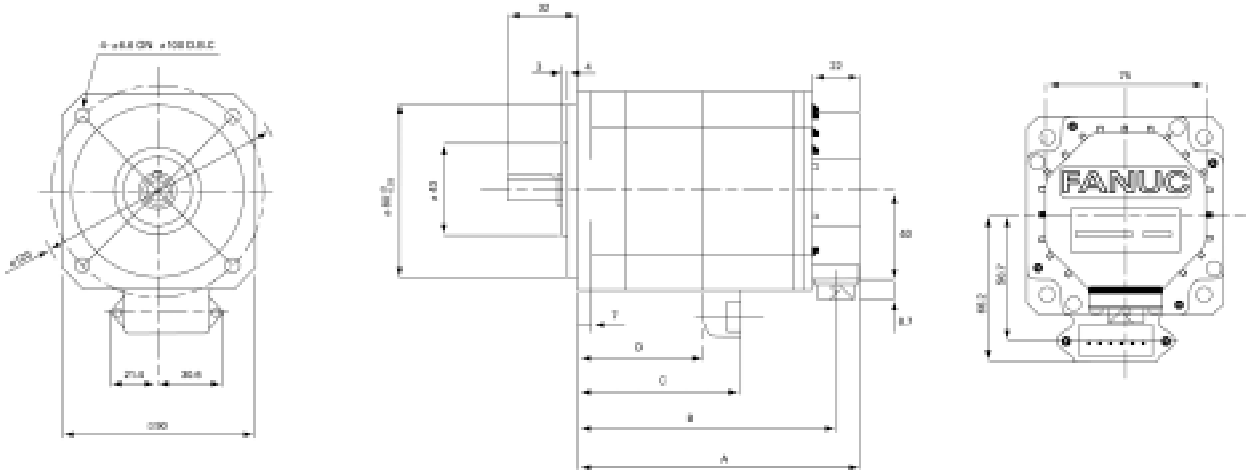
Dimension	*β0.4/5000is*	*β0.5/5000is*	*β1/5000is*
A	75	89.5	118.5
A with brake	101.5	116	145
A1	$\Phi 9^{+0.000}_{-0.009}$	$\Phi 9^{+0.000}_{-0.009}$	$\Phi 14^{+0.000}_{-0.011}$
A2	$1.2^{+0.0}_{-0.1}$	$1.2^{+0.0}_{-0.1}$	$2^{+0.0}_{-0.1}$
A3	$3^{+0.000}_{-0.025}$	$3^{+0.000}_{-0.025}$	$5^{+0.00}_{-0.33}$
A4	M3 Depth 6	M3 Depth 6	M4 Depth 10
A5	25	25	30
B	65	79.5	108.5
B with brake	91.5	106	135
C	34.5	49	78
C with brake	61	75.5	104.5

Connector	*Description*
1	Brake (optional)
2	Power
3	Encoder

Notes:

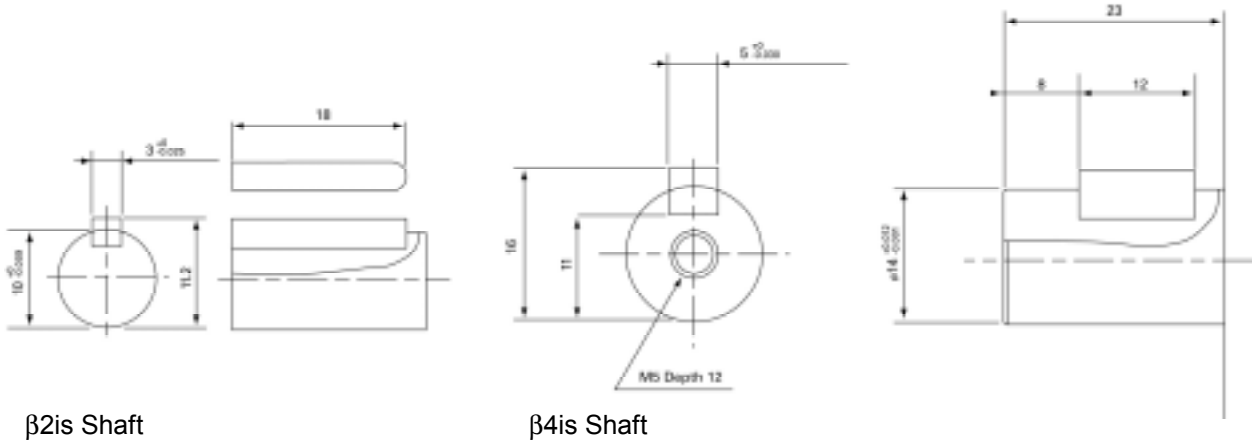
1. Shaft diameter runout = 0.02mm max
2. Flange surface runout = 0.06mm max
3. Maximum radial load for output shaft is 20kgf (44lb)

Figure III-2. β0.4*is*, β0.5*is* and β1*is* Series Servo Motor Outline Drawing



Power/Brake Connections					
1	2	3	4	5	6
U	V	W	G	B	B

Motor



β2is Shaft β4is Shaft

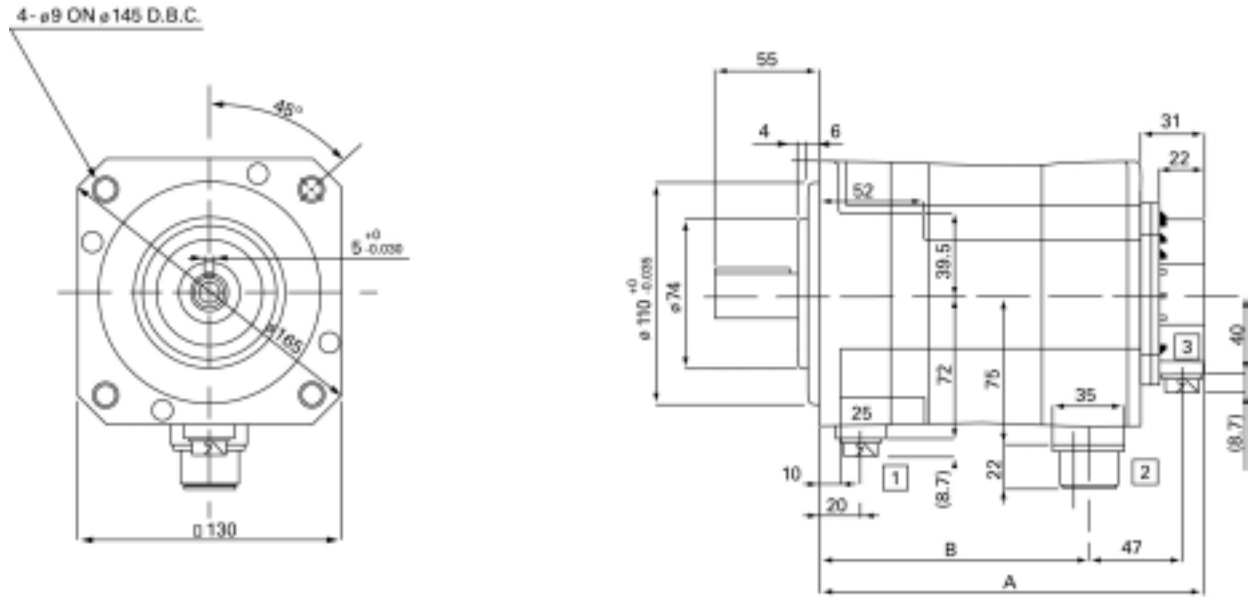
Shaft Detail

Dimensions shown mm

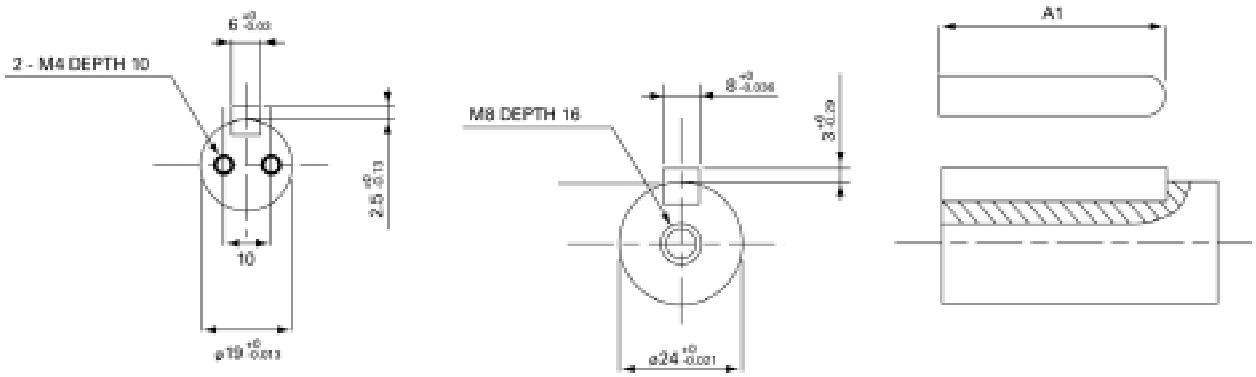
Dimension	*β2/4000is*	*B4/4000is*
A	130	166
A with brake	159	195
B	119	155
B with brake	148	184
C	75	111
C with brake	75	111
D	59	95
D with brake	59	95

Notes: 1. Shaft diameter runout = 0.02mm max
2. Flange surface runout = 0.06mm max
3. Maximum radial load for output shaft is 25kgf (55lb)

Figure III-3. β2*is* and β4*is* Series Servo Motor Outline Drawing



Motor



B8/3000is

B12/3000is

Shaft Detail

Dimensions shown mm

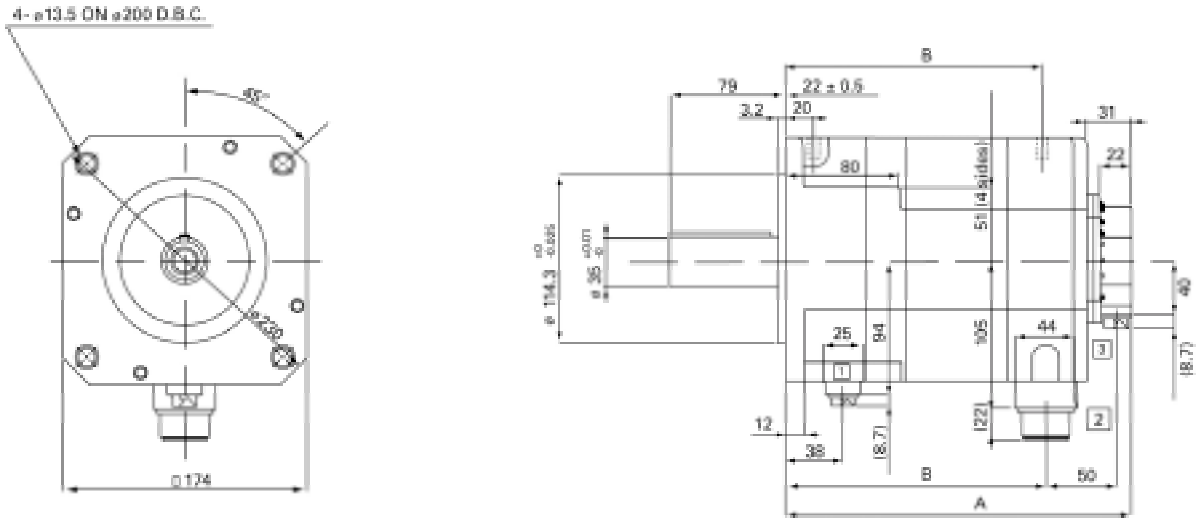
Dimension	*β8/3000is*	*β12/3000is*
A	166	222
A with brake	191	247
A1	36	45
B	108	164
B with brake	133	189

Connector	*Description*
1	Brake (optional)
2	Power
3	Encoder

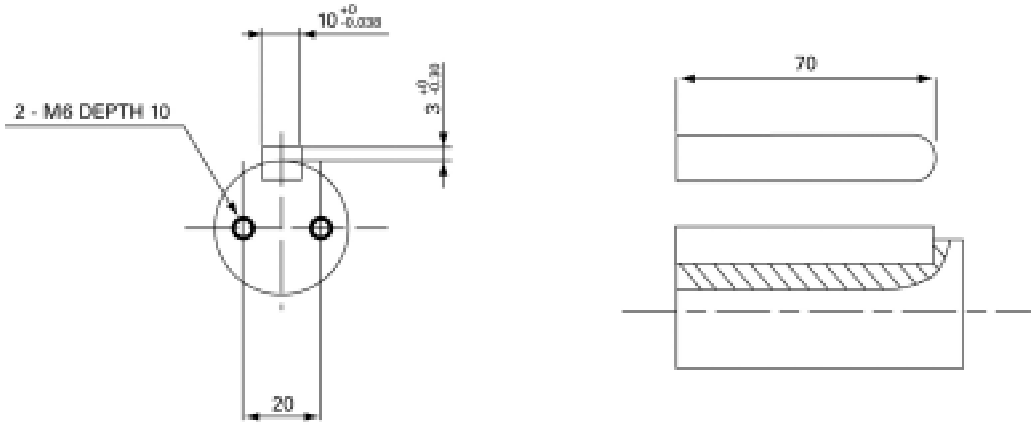
Notes:

1. Shaft diameter runout = 0.02mm max
2. Flange surface runout = 0.05mm max
3. Maximum radial load for output shaft is 70kgf (154lb)

Figure III-4. β8*is* and β12*is* Series Servo Motor Outline Drawing



Motor



Shaft Detail

Dimensions shown mm

Dimension	*β22/2000is*
A	202
A with brake	243
B	141
B with brake	182

Connector	*Description*
1	Brake (optional)
2	Power
3	Encoder

Notes:

1. Shaft diameter runout = 0.03mm max
2. Flange surface runout = 0.06mm max
3. Maximum radial load for output shaft is 200kgf (440lb)

Figure III-5. β22*is* Series Servo Motor Outline Drawing

18.4 βis Series Servo Motor Holding Brake

The holding brake is used to prevent movement on horizontal axes or falling along the vertical axis when the servo motor control is turned off. Brakes are spring-set and electrically released and are designed for holding stationary loads only. Using the holding brake to stop a moving axis may damage the brake or severely reduce its service life.

The specifications of the built-in brakes are listed in the following table.

Table III-6. β*is* Motor Holding Brake Specifications

Motor Model		*Unit*	*β0.4is β0.5is*	*β1is*	*β2is β4is*	*β8is β12is*	*β22is*
Brake Holding Torque		Nm	0.65	1.2	3	8	35
		lbf-in	5.8	10.6	26.6	70.8	309.8
Response Time	Release	msec	40	40	60	160	160
	Brake	msec	20	20	10	30	30
Power Supply	Voltage	VDC	24 (± 10%)				
	Current	A	0.5	0.5	0.9	1.1	1.2
	Wattage	W	12	12	22	26	29
Weight Increase		kg	0.4	0.4	1.0	2.2	6.0
Inertia Increase		kg-m^2	0.000009	0.000009	0.00002	0.00007	0.0006
		lbf-in-s^2	0.0000797	0.0000797	0.000177	0.0006195	0.000531

The values shown above are standard values at 20°C.

18.5 Brake Power Supply Circuit

The following table lists the recommended parts and their specifications to be used as components of a user-built brake circuit. Configure a brake circuit by referencing the following brake connection diagram and the recommended parts as shown below.

Table III-7. βis Holding Brake Circuit Components

Name	*Model No.*	*Name of Manufacturer*	*Specifications*
Rectifier	D3SB60	Shindengen Electric Mfg. Co., Ltd.	Withstand voltage 400V min. Maximum output current: 2.3 A (with no fins)
Switch	N/A	N/A	Rated load capacity (resistance load) 250VAC 10A / 30VDC 10A or more
Spark Killer	XEB0471	Okaya Electric Ind. Co., ltd.	47 ohm/0.1 µF Withstand voltage 400V min
Surge Absorber	ERZV10D820	Matsusihita Electric Industrial Co., Ltd.	Varistor voltage 82V Max allowable voltage 50 VAC

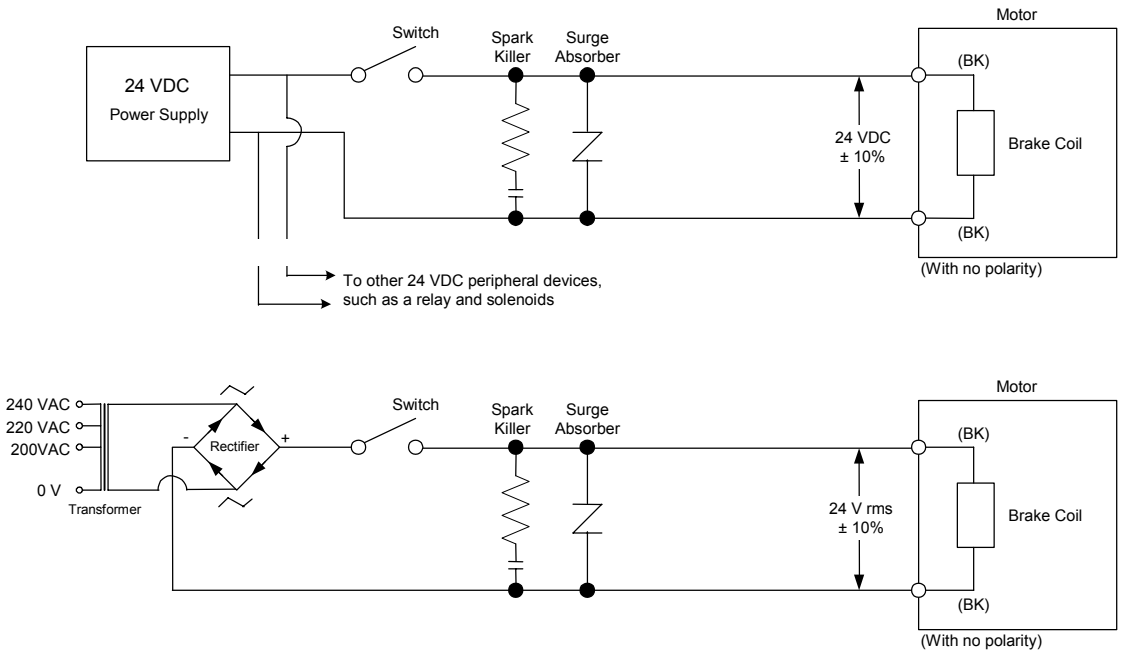


Figure III-6. Connecting Motor Holding Brake Control and Power Circuit

Option 1: Use a commercial 24 VDC power supply as the power supply for the β*i*s series servo motor brake. To prevent amplifier malfunction or damage do not use the same 24V power supply for the amplifier control logic circuitry as the power supply for the brake. The power supply for a relay, solenoid, or another peripheral device can be used for the brake. Be careful of the power capacity and changes in voltage due to load changes.

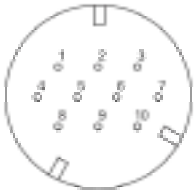
Option 2: Alternately you may build a power supply for the brake circuit (equivalent to 24 Vrms) produced by full-wave rectification after transforming commercial power (50 Hz/60 Hz). For user built full-wave rectification, transform the secondary voltage into approximately 29 VAC by taking voltage drop in the rectifier or cable into account. Check to make sure the power capacity and power voltage fluctuations of the voltage applied to the brake falls within 24 Vrms ±10%.

If the brake switching contact is installed on the DC side (at the position shown in the figure), the life of the contact is generally shortened due to the surge voltage when the brake is turned off. Provide an adequate contact capacity and always use a surge absorber and spark killer for protecting the contact. Installing the switching contact on the DC side of the power provides the fastest brake operation time.

18.6 Motor Connections

Connections

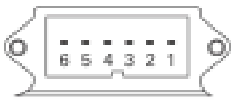
Serial Encoder Connections



All β*is* Motors

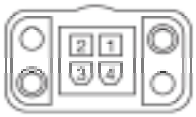
Description	βis Motors	βis Series Amplfier JF1 Connector
N/C	2	1
N/C	1	2
RD	6	5
$\overline{RD}$	5	6
+5 VDC	8,9	9,20
0 VDC	7,10	12,14
+6 VA (battery)	4	7
Frame Ground	3	16
Cable Shield	3	16
GE Fanuc Mating Connector: A06B-6114-K204#E (90 degree) A06B-6114-K204#S (straight)		

Power and Brake Connections



β2is& β4*is* Motor Power/Brake

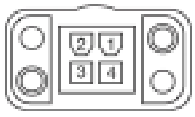
β8*is*, β12*is* & β22*is*
Motor Power



β0.4*is*, β0.5*is* & β1*is*
Motor Power

Description	β0.4is, β0.5is & β1is Motor Connector	β2is & β4is Motor Connector	β8is, β12is & β22is Motor Connector	βis Series Amplfier Motor Connector
Phase U	2	1	A	U
Phase V	2	2	B	V
Phase W	3	3	C	W
Earth (case)	4	4	D	PE
Brake VDC	n/a	5	n/a	n/a
Brake VDC	n/a	6	n/a	n/a
GE Fanuc Mating Connector: A06B-6114-K220#E (90 degree) (β2*is*, β4*is*) A06B-6114-K220#S (straight) (β2*is*, β4*is*) 44A730464-G18 (β*is*, β12*is*) A06B-6114-K230#E (β0.4*is*, β0.5*is*, β1*is*) 44A730464-G20 (β22*is*)				

β8*is*, β12*is* & β22*is* Brake



β0.4*is*, β0.5*is* & β1*is* Brake

Description	β0.4is, β0.5is & β1is Motor Connector	β8is, β12is & β22is Motor Connector
Brake VDC	1	1
Brake VDC	2	2
Earth (case)	4	4
GE Fanuc Mating Connector: A06B-6114-K213#E (90 degree) (β8*is*, β12*is*, β22*is*) A06B-6114-K213#S (straight) (β8*is*, β12*is*, β22*is*) A06B-6114-K232#E (β0.4*is*, β0.5*is*, β1*is*)		

Brake power connections are not polarized 24VDC.

Section 19: β SVM-20i and SVM-40i Amplifiers

19.1 Amplifier Electrical Specifications

Item	SVM-20i	SVM-40i
Power Supply Voltage (amplifier)	3-Phase 200-240VAC [1] 1-Phase 200-240VAC [2]	3-Phase 200-240VAC
Power Supply Voltage (control)	24 VDC /0.9A	24 VDC /0.9A
Dynamic Brake Function [3]	Built In	Built In
Built In Regeneration Capacity	16 joule (capacitor energy storage)	50 watt (internal resistor)
External Regeneration Options	20 watt, 30 ohm – A06B-6130-H401 100 watt, 30 ohm - A06B-6130-H402	200 watt, 16 ohm - A06B-6089-H500 800 watt, 16 ohm – A06B-6089-H713

Notes:

1. 8Nm motor always requires amplifier fan kit A06B-6134-K003.
2. 4Nm motor requires amplifier fan kit A06B-6134-K003 for single-phase operation only.
3. Dynamic braking activates during servo alarms to stop the motor more quickly than coasting to a stop.

19.2 Amplifier Environmental Specifications

Item	Specification
Ambient Temperature Operation Storage	 0 to 55 °C -20 to 60 °C
Humidity	90% RH or below (non-condensing)
Vibration	Below 0.5 G

19.3 βi Series Amplifier Status LED and Alarm Functions

The Servo Amplifier Unit can detect error conditions and provide alarm information.
The LEDs on the front of the amplifier provide a visual cue to the status of the system by indicating, for example, when the motor and amplifier are ready to function.

- POWER LED (green) indicates the logic 24 VDC power is present.
- DC LINK CHARGED LED (red) indicates that the amplifier has high (motor) voltage DC present.
- LINK LED (green) indicates that the FSSB (fiber optic) interface is functioning.
- ALM LED (yellow) is turned ON when an alarm condition is detected. When an alarm is detected, power is dropped and the motor is stopped by dynamic braking action. Alarm information is additionally displayed as diagnostic data in the GE Fanuc DSM324i motion controller. The amplifier control power must be cycled to reset this alarm state. The table below details the alarm conditions the βi Series Servo Amplifier System can detect.

Table III-8. βi Series Servo Amplifier Alarm System

Alarm Condition	Description
DC Link Under-Voltage	Issued when the DC voltage in the main circuit power supply is abnormally low. Indicates low AC mains power dip or hardware problem. Make sure the plug-in (gray faceplate) circuit board is securely seated in the amplifier base. Replace amplifier.
DC Link Over-Voltage	Issued when the DC voltage in the main circuit power supply is abnormally high. Indicates high AC mains power or hardware problem. Make sure the plug-in (gray faceplate) circuit board is securely seated in the amplifier base. May also be caused by excessive regenerated power. Increase acceleration/deceleration time and/or add additional regenerative discharge capacity. Replace amplifier.
Excessive Deceleration Power	If no external regeneration resistor is used, the discharge resistor thermal sensor jumper is missing on connector CXA20. This input requires a normally closed contact for normal operation. When using an external regeneration resistor, the thermal sensor in the regeneration resistor has tripped. Indicating excessive regenerated power load to the regeneration resistor. Use a meter to confirm an open circuit on the thermal sensor leads. Make sure the plug-in (gray faceplate) circuit board is securely seated in the amplifier base. Increase capacity of external regeneration resistor or decrease deceleration rate or frequency, and/or the top speed from which the axis must decelerate.
Control Power Under-Voltage	The 24 VDC control power is below 21.6 VDC. Check the supply voltage level and make sure the CXA19A and CXA19B connectors are secure and associated cables are wired correctly. Replace amplifier.
Internal Cooling Fan Stopped	Fan is jammed, has failed or is not connected. Check for foreign material in fan blades. Make sure fan is plugged in. Make sure the plug-in (gray faceplate) circuit board is securely seated in the amplifier base. Replace amplifier.
IPM Alarm	Excessive current in the power transistors. Phase to phase or phase to ground short circuit on motor power output. Make sure the plug-in (gray faceplate) circuit board is securely seated in the amplifier base. Possible incorrect phase connection of the motor power wiring. Motor type code must be configured correctly in the GE Fanuc controller. Disconnect motor power leads from amplifier and reset E-stop condition. If IPM alarm occurs replace amplifier. If no IPM alarm the problem is in the motor or motor power cable. Check for electrical shorts in the motor power cable or motor winding shorted to frame ground.
IPM Overheat	Issued when the temperature inside the amplifier becomes so high that the thermostat trips. Make sure the plug-in (gray faceplate) circuit board is securely seated in the amplifier base. Check that the heat sink cooling fan (if applicable) is running. Make sure the ambient temperature around the amplifier is 55^{o}C or lower. Check that the motor load is within the rating of the motor.
Motor Over-current	Issued when an abnormally high current is detected in the main circuit. Make sure the plug-in (gray faceplate) circuit board is securely seated in the amplifier base. Check for electrical shorts in the motor power cable or motor winding shorted to frame ground. Possible incorrect phasing on motor power wiring. Motor type code may be configured incorrectly in the DSM324 controller. Possible excessive force loading on motor.
FSSB Communication Error	FSSB connector or cable failure. Check the connections to the COP10A and COP10B connectors. Try replacing the optical cable. Replace amplifier.

19.4 Amplifier External Dimensions

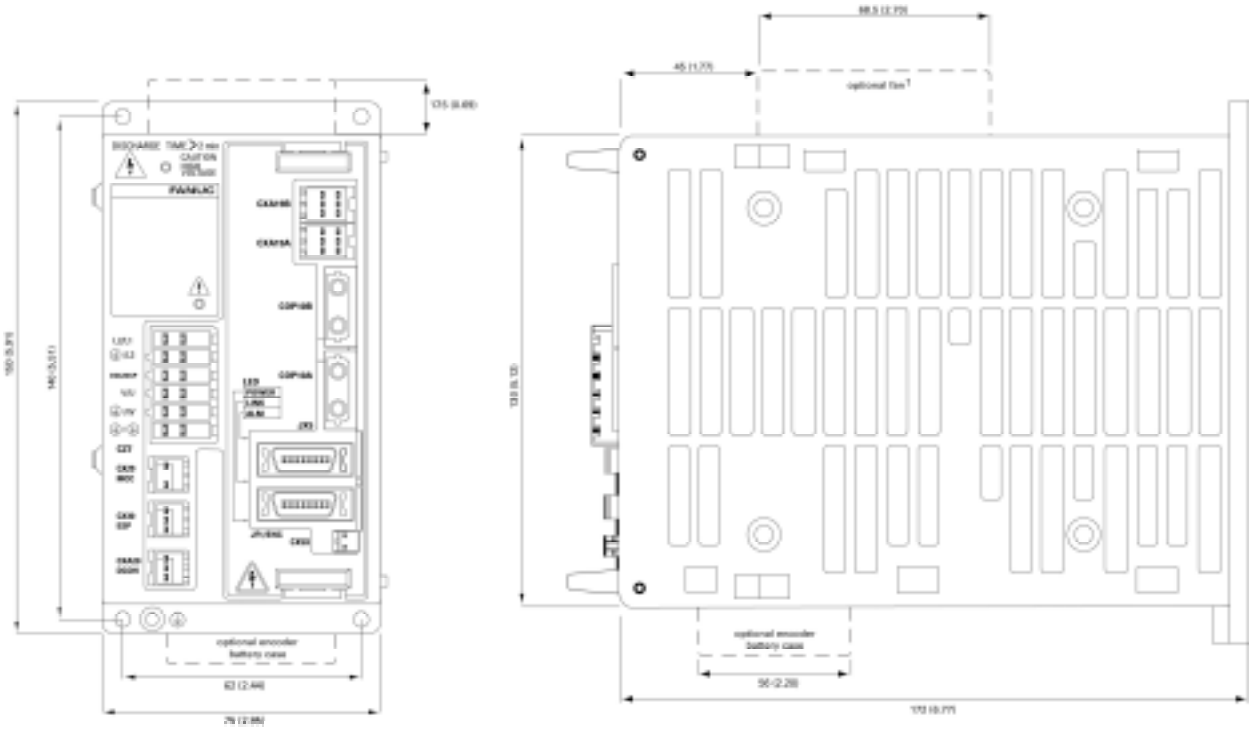
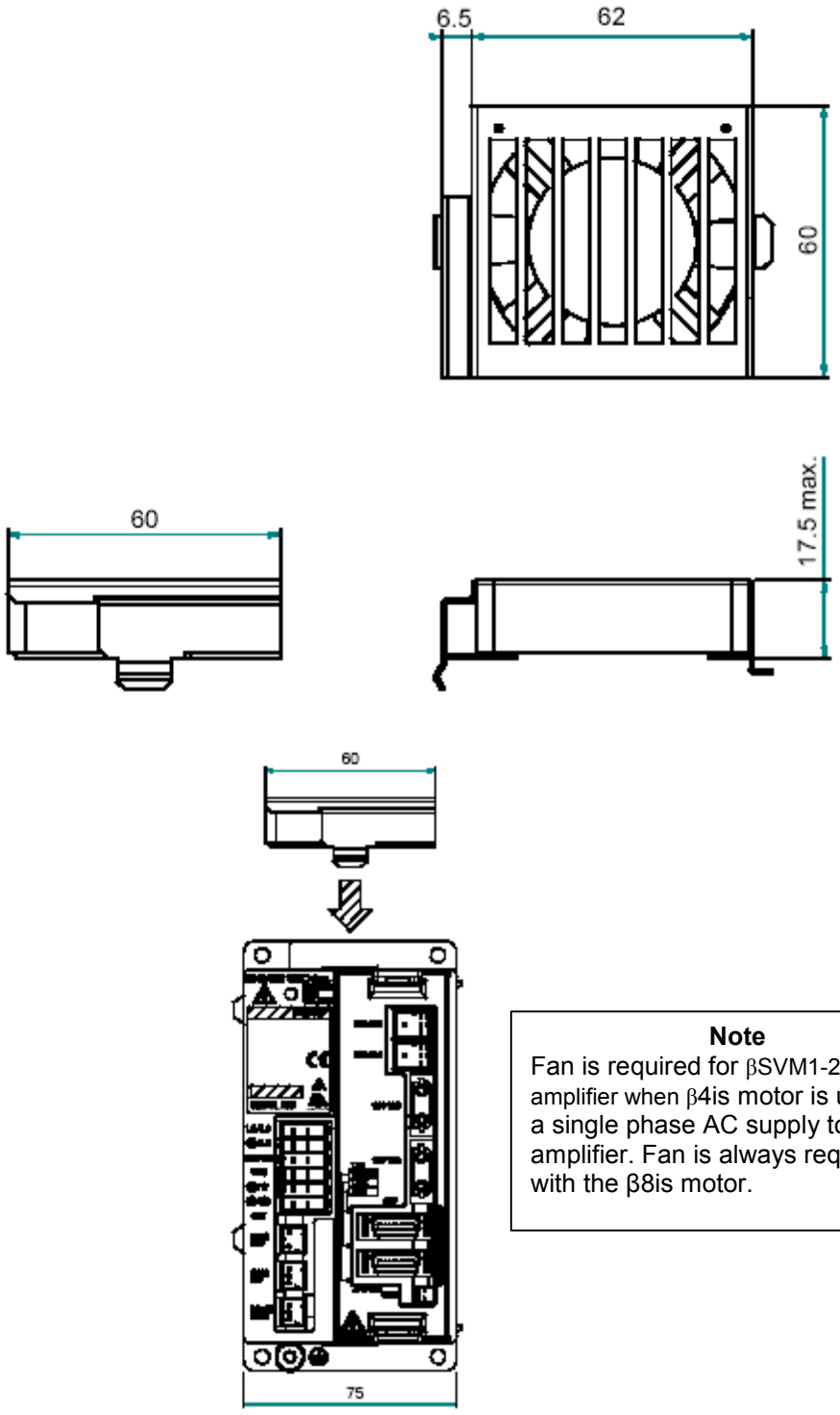


Figure III-7. External Dimensions of βSVM-20i Amplifier



Note
Fan is required for βSVM1-20i amplifier when β4is motor is used with a single phase AC supply to the amplifier. Fan is always required with the β8is motor.

Figure III-8. External Dimensions of Optional Cooling Fan Unit (A06B-6134-K003)

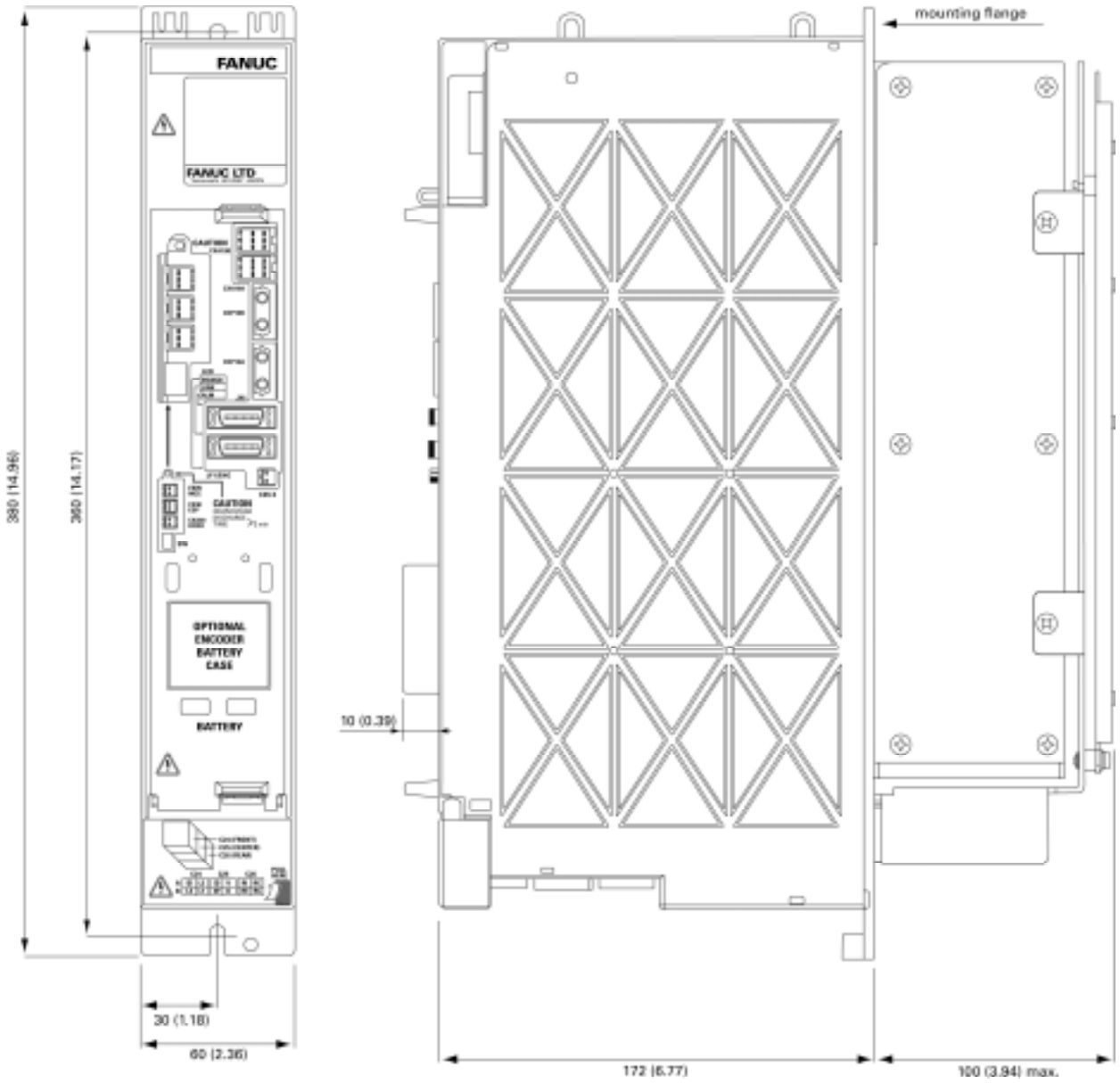


Figure III-9. External Dimensions of βSVM1-40i Amplifier

19.5 Absolute Encoder Battery Options

All βis Series servomotors feature a built-in encoder that can be used in either incremental or absolute mode. To utilize the absolute capability, an optional encoder battery pack must be installed. This pack allows the encoder's position information to be maintained so that the machine does not need to be re-referenced to a home position every time power is restored to the servo system.

The βis 0.4 to 22 Nm motor encoders contain an integral capacitor that will maintain the encoder backup voltage for approximately 10 minutes. This allows battery change without loss of absolute position data.

There are two encoder battery backup options for the βi Series amplifiers. A snap-on lithium battery pack that will support a single amplifier or a panel mounted battery pack for up to four amplifiers that uses standard D cell alkaline batteries.

For optimal panel space utilization, a small lithium battery pack IC800BBK021 is available that snaps onto the βi Series amplifiers housing (see figure below). An integral pigtail cable plugs directly into the CX5X connector on the faceplate of the amplifier. One battery is required for each βi Series amplifier. The lithium battery service life is approximately 2 years.

The Absolute Encoder Battery Kit (IC800BBK021) contains the following:

- Qty 1 - Battery (A06B-6093-K001)
- Qty 1 - Battery Holder (A06B-6093-K002)

Connection Method for Single Amplifiers

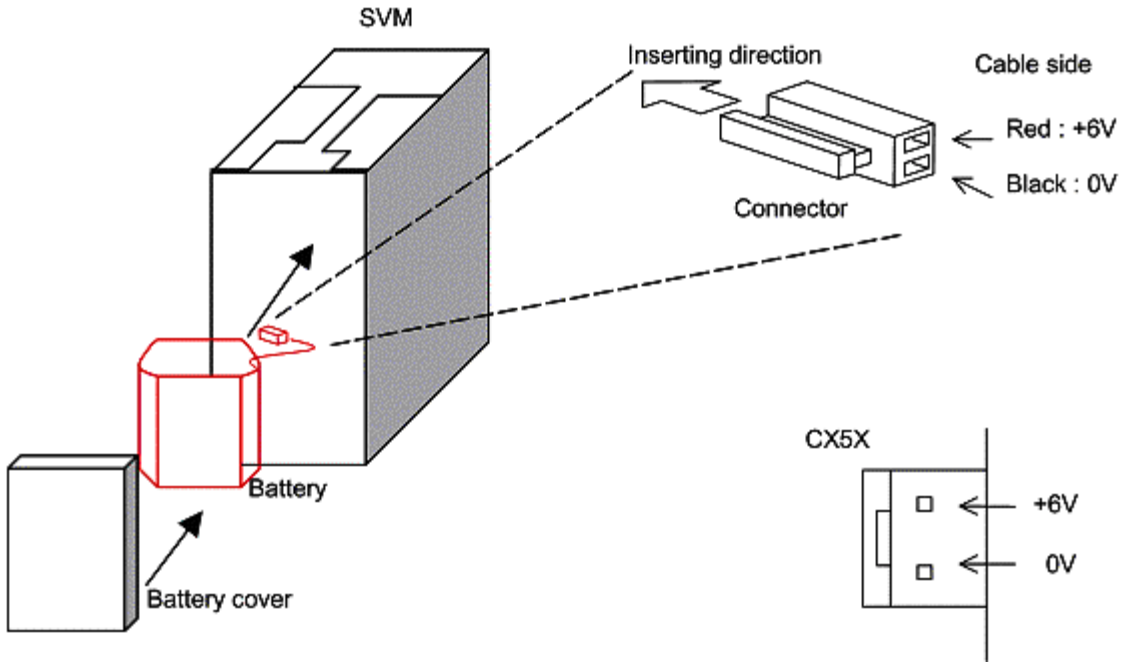
(IC800BBK021 for use with a single amplifier)

Installation

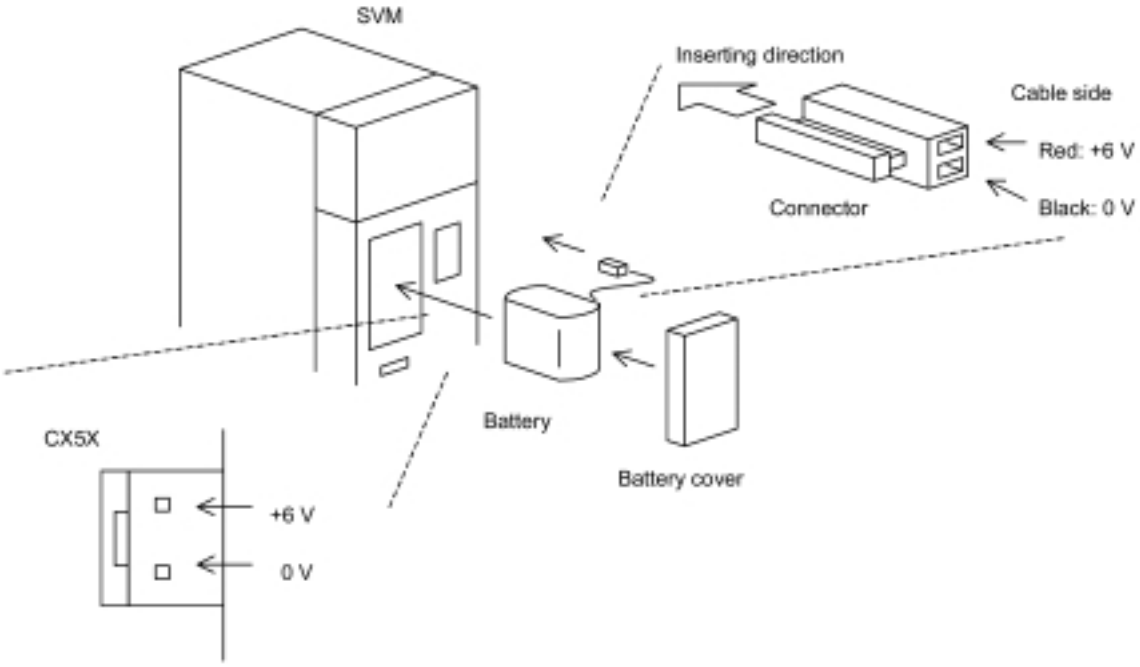
1. Make sure 24V control power is applied to the amplifier (if trying to hold position on an existing system)
2. Place system in an E-stop condition
3. Remove AC power from the amplifier
4. Remove the old battery (if applicable)
5. Place battery into plastic cover
6. Snap cover onto amplifier housing
7. Attach battery cable to amplifier CX5X connector as indicated in diagram making sure polarity is correct.

Note

- **Do not attempt to connect multiple amplifiers to one IC800BBK021 battery kit.**
- **Replacement CX5 battery connectors are available as kit number A06B-6093-K303**



βSVM1-20i Amplifier



βSVM1-40i Amplifier

Figure III-10. Installing the IC800BBK021 Absolute Encoder Battery Pack (One-Axis)

Connection Method for Multiple Amplifiers

To utilize the absolute capability for multiple amplifiers (SVM-20i or SVM-40i), the IC800ABK001 panel mounted battery pack must be installed.

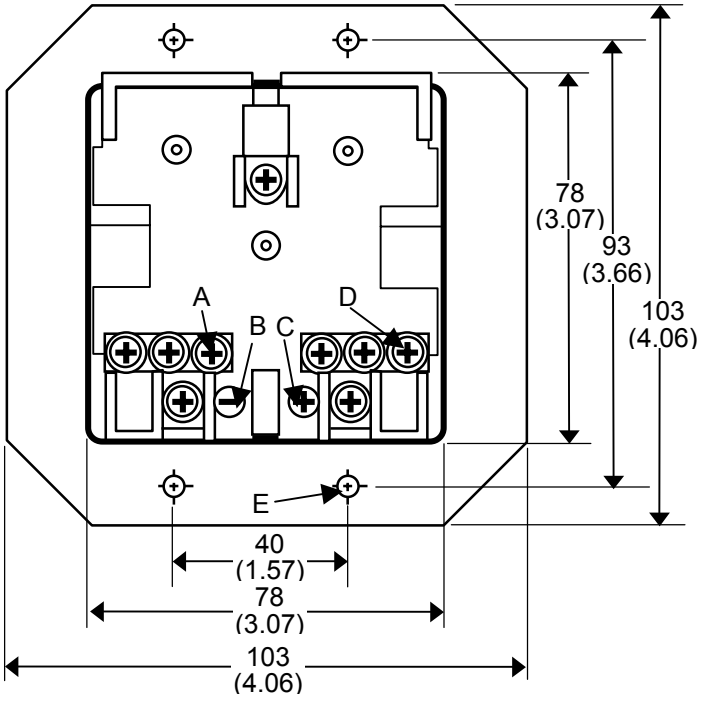
The Absolute Encoder Battery Kit (IC800ABK001) contains the following:

- One battery holder (A06B-6050-K060)
- Four D-cell, alkaline batteries (A98L-0031-0005)

One kit provides battery backup for up to four absolute encoders. The user is responsible for manufacturing the cable used to connect the battery pack to the amplifier. The battery connection is made to the CXA19B connector on the last amplifier in the sequence supported by the battery pack. Terminals CXA19B-B3 (6V) and CXA19B-A2 (0V) are used and wire should be 0.3 mm^2 minimum cross sectional area. The battery power is distributed to the other amplifiers in the sequence by daisy chaining the CXA19A connections to the CXA19B connections on adjacent amplifiers. See Section 24:βi Series Servo System Connection for more detail.

The battery service life is approximately one year and we recommend a yearly replacement schedule.

The IC800ABK001 battery pack is panel-mounted and requires a cutout in the mounting surface. Mounting dimensions and terminal designations are shown below.



All dimensions in mm (in)

A	3-M3 negative terminal
B	Negative terminal indication
C	Positive terminal indication
D	3-M3 positive terminal
E	4-∅4.3 (0.169) mounting holes

Figure III-11. Absolute Encoder Battery Pack IC800ABK001 (up to Four Axes)

Section 20: Installation Guidelines

This section includes environmental requirements, motor and amplifier dimension drawings and information on ensuring noise protection and selecting a ground fault interrupter.

20.1 βis Motor Environmental Requirements

The servomotor must be installed in a location that satisfies the following environmental conditions:

Table III-9. Servo Motor Environmental Conditions

Condition	*Description*
Ambient temperature	The ambient temperature should be 0°C to 40°C. When operating the motor at a temperature higher than 40°C, it is necessary to de-rate the output power so that the motor's and the encoder's temperature rating is not exceeded.
Ambient humidity	Should be 80% RH (relative humidity) or less, non-condensing
Vibration	When installed in a machine, the vibration applied to the motor must not exceed 5G.
Altitude	No more than 1,000 m (3,300 ft) above sea level.
Drip-Proof Environment	The motors have a drip-proof structure that complies with IP65 of the IEC standard. Nevertheless, to ensure long-term performance, the motor surface should be protected from solvents, lubricants, and fluid spray. A cover should be used when there is a possibility of wetting the motor surface. Also, to prevent fluid from being led to the motor through the cable, put a drip loop in the cable when the motor is mounted. Finally, turn the motor connector sideways or downward as far as possible. If the cable connector will be subjected to moisture, it is recommended that an R class or waterproof plug be used. For additional information, see GE Fanuc publication *Servo and Spindle Motors Exposed to Liquids*, GFK-1046.

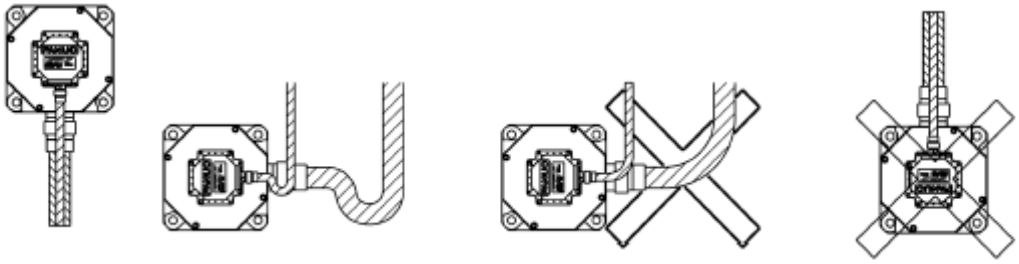


Figure III-12. Motor Installation for Drip-Proof environment

20.2 βis Servo Amplifier Environmental Requirements

The servo amplifier must be installed in a location that satisfies the environmental conditions identified in the table below.

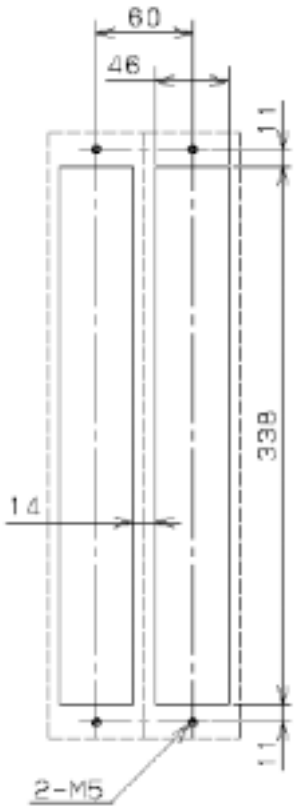
Table III-10. Servo Amplifier Environmental Conditions

Condition	*Description*
Ambient temperature	0°C to 55°C (operating). -20°C to 60°C (storage and transportation).
Temperature fluctuation	Within 1.1°C/min.
Humidity	90% RH (non-condensing) or lower.
Altitude	No more than 1000 m (3,300 ft) above sea level.
Vibration	No more than 0.5 G during operation.
Atmosphere	The circuitry and cooling fins must not be exposed to any corrosive and conductive vapor or liquid.

The amplifier must be installed in a cabinet that protects it from contaminants such as dust, coolant, organic solvents, acid, corrosive gas, and salt. Adequate protection must also be provided for applications where the amplifier could be exposed to radiation, such as microwave, ultraviolet, laser light, or x-rays.

To adequately protect the amplifier, you must ensure that:

- Contaminants such as dust and fluid cannot enter through the air inlet or outlet.
- The flow of cooling air is not obstructed.
- The amplifier can be accessed for inspection.
- The amplifier can be disassembled for maintenance and later reinstalled.
- There is sufficient separation between the power and signal lines to avoid interference. Noise protection should be provided.



NOTE
Attach the accompanying gasket around the panel cutout to prevent oil and dust from getting in. Reinforce the right and left sides of the panel cutout by using fittings such as angles to maintain satisfactory contact between the cabinet and the amplifier.

Figure III-13. Panel Cut-out Drawing for Through-Cabinet Mounting of the βSVM-40*i* Amplifier

20.3 βis Amplifier Heat Dissipation and Maintenance Clearance

The amplifier may contain a cooling fan that forces air through the unit. Allow for adequate clearance for airflow when installing the amplifier using the recommended distances shown in the drawings below. If possible, do not mount amplifiers one above the other unless they are staggered to prevent the heated exhaust of the lower unit from flowing over the upper unit.

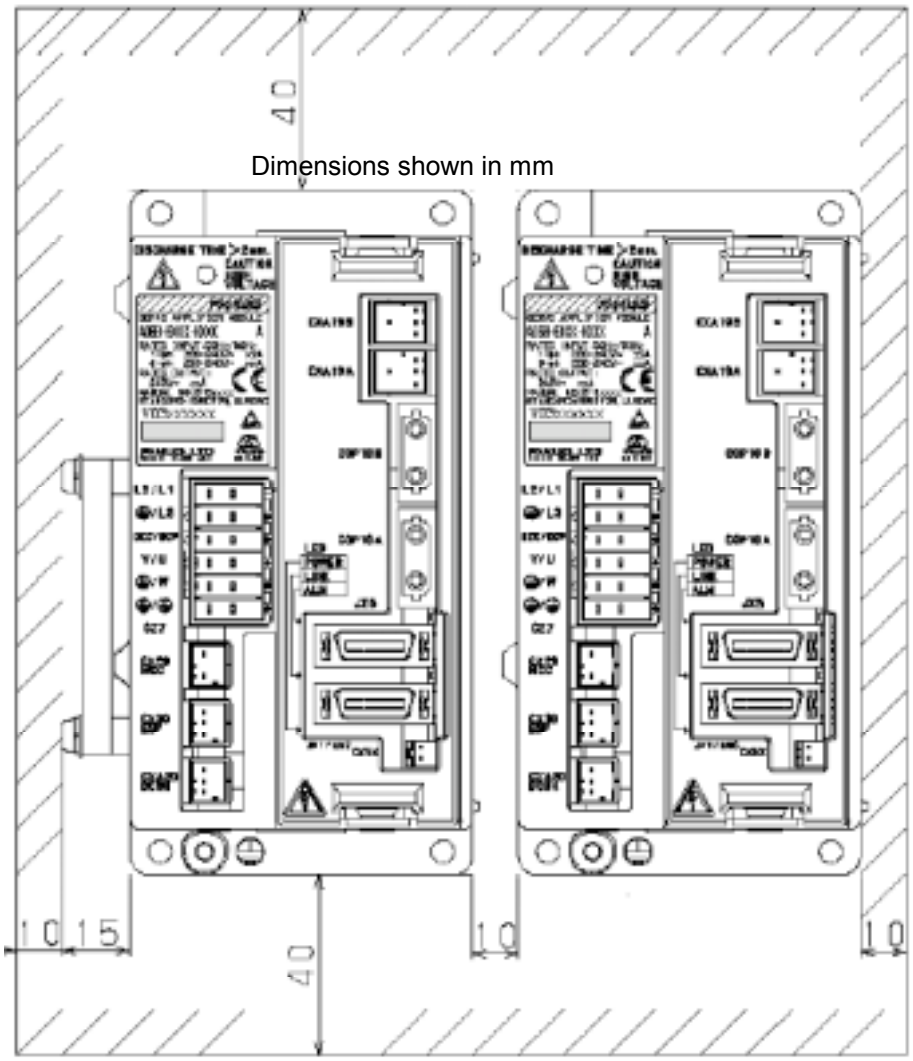


Figure III-14. Maintenance Clearance for Amplifier βSVM-20i

Dimensions shown in mm

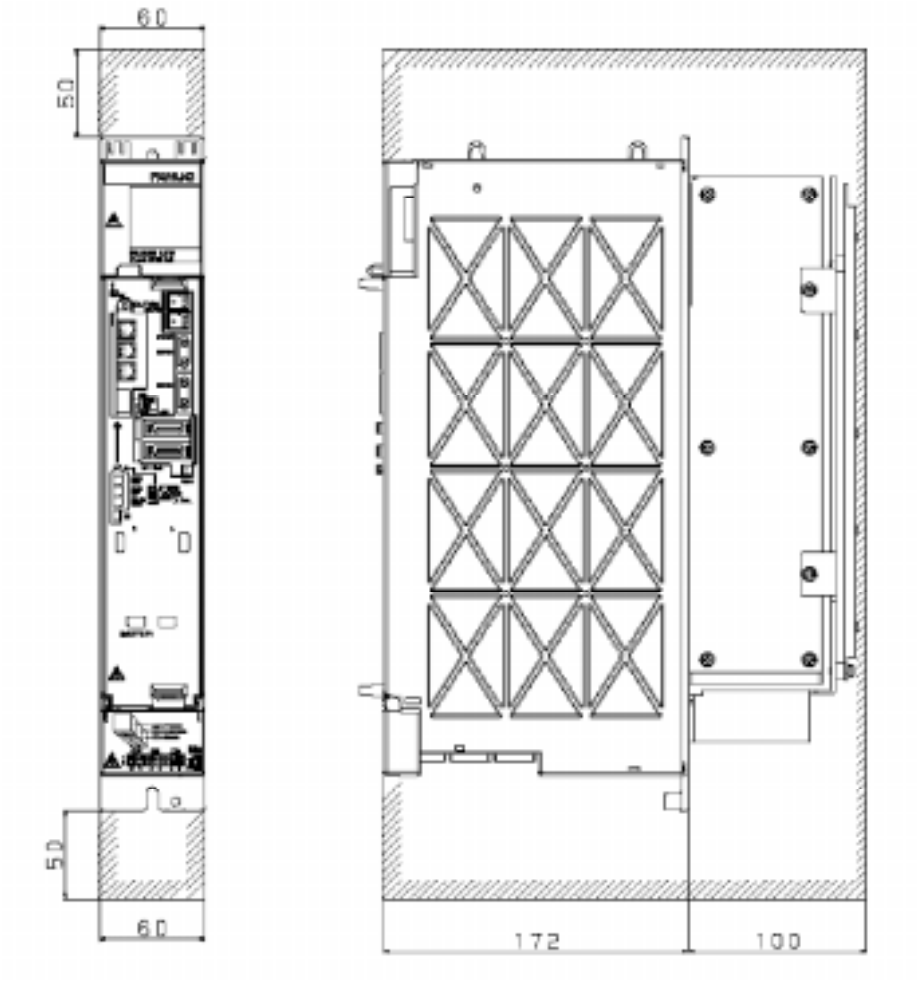


Figure III-15. βi Series βSVM1-40i Amplifier Maintenance Clearances

Section 21: Heat Dissipation

Table III-11 identifies worst-case heat dissipation values for each amplifier. These values may be used to determine heat load for sizing enclosures and cooling equipment. Heat dissipation for external regeneration resistors depends on the application and is calculated in 23.7, Step 5.

The total heat dissipation is a function of the amplifier base dissipation (a) plus the amplifier heat coefficient (K) times the heat generated by RMS stall current flowing through the servo motor (b).

Total heat dissipation Watts = a + (K * b)

Table III-11. In Cabinet Heat Dissipation

Amplifier	*Catalog #*	*Amplifier base heat dissipation (a)*	*Amplifier heat coefficient (K)*	*Motor Model*	*Motor Current (b) [Arms]*	*Total heat dissipation [Watts]*
βSVM1-20i	A06B-6130-H002	20 watt	7.7	β0.4/5000is	3.6	47.7
				β0.5/5000is	2.9	42.3
				β1/5000is	2.7	40.8
				β2/4000is	3.3	45.4
				β4/4000is	4.7	56.2
				β8/3000is	6	66.2
βSVM1-40i	A06B-6130-H003	20 watt	7.1 (heat sink in cabinet)	β12/3000is	10.2	92.4
				β22/2000is	11.3	100.2
			1.4 (heat sink external to cabinet)	β12/3000is	10.2	34.2
				β22/2000is	11.3	35.8

Section 22: Noise Protection

22.1 Separation of Signal and Power Lines

When routing signal and power lines, the signal lines must be separated from the power lines to ensure best noise immunity. The table below lists the types of cables used:

Table III-12. Servo amplifier signal line separation

Group	*Signal*	*Action*
A	Amplifier input power line, motor power line, MCC drive coil	Separate these cables from those of group B by bundling them separately* or by means of electromagnetic shielding**. Attach a noise suppressor (spark arrester) to the MCC drive coil.
B	Cable connecting control unit with servo amplifier and serial encoder feedback cable	Separate these cables from those of group A by bundling them separately or by means of electromagnetic shielding**. In addition, shielding must be provided.

* The bundle of group A cables must be separated from the bundle of group B cables by at least 10 cm.
** Electromagnetic shielding involves shielding groups from each other by means of a grounded metal (steel) plate.

22.2 Grounding

A typical machine has three separate grounds:

- **Signal Ground:** Provides the reference potential (0 V) for the electrical signal system.
- **Frame Ground:** Ensures safety and shields external and internal noise.
- **System Ground:** Connects each unit and the inter-unit frame ground system to earth ground.

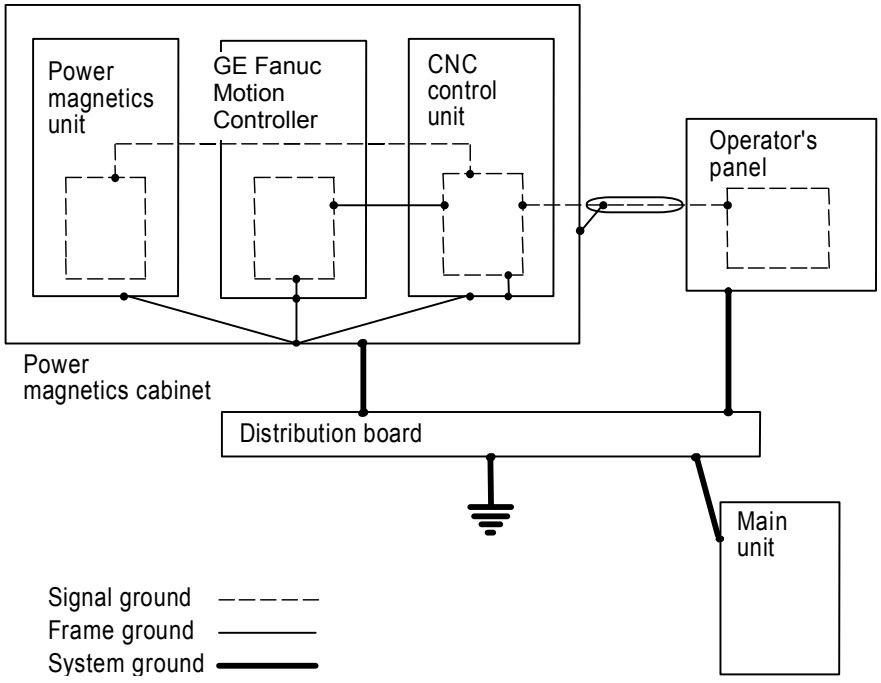


Figure III-16. Ground System

Notes on the ground system wiring:

- The ground resistance of the system ground must not exceed 100 ohms (Class-3 ground).
- System ground connection cables must have a sufficiently large cross-sectional area to enable them to safely carry the current that will arise in the event of a problem such as a short-circuit (in general, a cross-sectional area no less than that of the AC power line must be provided).
- The system ground connection cable must be integrated with the AC power line such that power cannot be supplied if the ground wire is disconnected.
- The SVM1-20*i* CZ7-3 motor power connector servo motor frame ground connection on pin A2 should always be installed.

22.3 Encoder Feedback Cable Grounding

The βis Series motor encoder feedback cable shielding should be grounded by the method shown below. This cable clamp treatment provides both cable support (strain relief) and proper grounding of the shield. To ensure stable system operation, the cable clamp method is recommended. Partially peel back the cable sheath to expose the shield. Push the clamp (A99L-0035-0001) over the exposed shield and insert the clamp hooks into slots on the grounding bar (44B295864-001). Tighten the clamp to secure cable and complete the ground connection. The grounding bar must be attached to a low impedance earth ground.

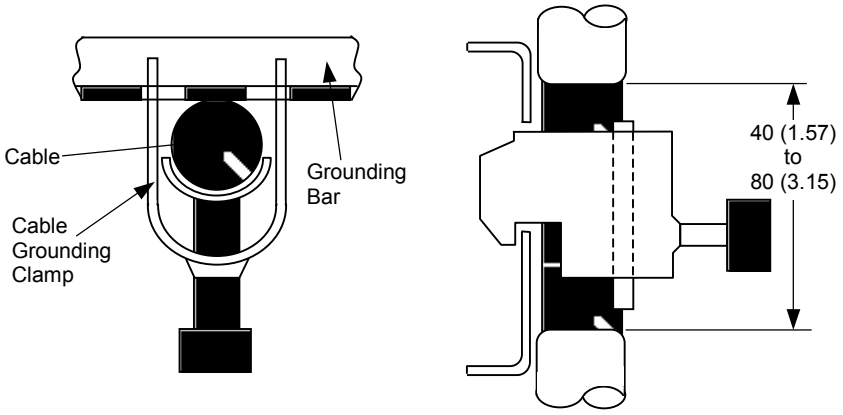


Figure III-17. Cable Grounding Clamp Detail

Note: Grounding bar should be located as close as possible to the amplifier to minimize cable length between amplifier and ground bar. Observe recommended maintenance clearance.

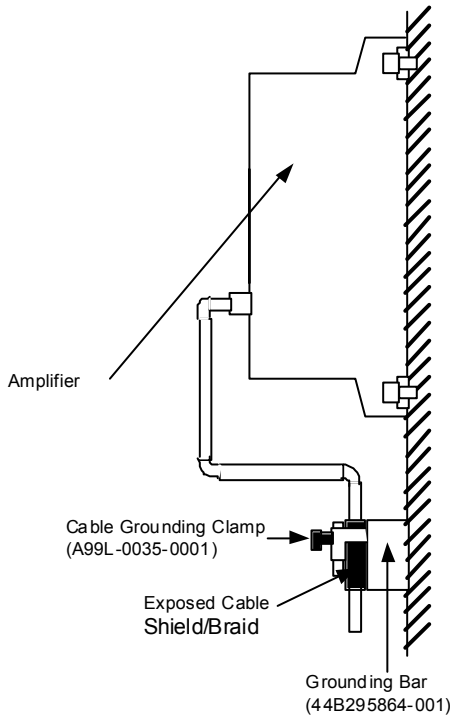


Figure III-18. Feedback Cable Shield Grounding System

Section 23: βi Servo System Power Requirements

This section provides information about AC and DC amplifier power as well as the discharge of regenerative power.

23.1 Power Line Protection

A circuit breaker, electromagnetic contactor, and AC line filter or transformer should be installed as part of your β*i* Series Servo system. GE Fanuc provides the AC line filter as an option. The transformer, circuit breaker, and electromagnetic contactor, however, are user-supplied components. In European countries where power sources are 380 to 400 VAC and neutral grounded, it is necessary to install a transformer or supply single-phase power.

The same incoming AC control components can be used to provide power to multiple amplifiers, as long as the components are rated for the current and power drawn by the sum of all of the amplifiers.

23.2 AC Line Filter

An AC line filter is recommended to suppress the influences of high-frequency input line noise on the drive power supply. When an isolation-type power transformer is used because a power supply voltage within the specified range is not available, an AC line filter is not required.

If two or more servo amplifiers are connected to one AC line filter, the total continuous output rating of all connected servo amplifiers should be kept below the continuous output rating of the AC line filter. The continuous output rating for the various servos are shown below.

Table III-13. β*is* Servo Motor Continuous Output Rating at Low Line of 200 VAC

Motor	*Cont. Output Rating*
β0.4/5000is	0.13 kW
β0.5/5000is	0.2 kW
β1/5000is	0.4 kW
β2/4000is	0.5 kW
β4/4000is	0.75 kW
β8/3000is	1.2 kW
β12/3000is	1.8 kW
β22/2000is	2.5 kW

If your installation must be EMC compliant, verify that the use of an AC line filter fully satisfies the EMC requirements. You may need to select and install a user-supplied noise filter to meet EMC requirements.

Two AC line filters are available for GE Fanuc:

- 5.4 kW, 3-phase (A81L-0001-0083#3C)
- 10.5 kW, 3-phase (A81L-0001-0101#C)

For AC line filter specifications and dimension drawings, refer to Section 6.2.

23.3 Circuit Breaker Selection

To provide proper protection for the amplifier, use a circuit breaker rated at no more than 20 Amps (10A for VDE 1601 compliance for CE marking). Table III-14 will help you select the appropriate circuit breaker for your motion application.

Table III-14. Currents Drawn at Continuous Rated Output at Low Line of 200 VAC

Motor	*Input Current 3-phase (Arms)*	*Input Current Single Phase (Arms)*
β0.4/5000*is*	0.7	1.4
β0.5 /5000*is*	1.1	2.2
β1/5000*is*	2.1	4.3
β2/4000*is*	2.6	5.4
β4/4000*is*	3.9	8.1
β8/3000*is*	6.3	9.7
β12/3000*is*	9.4	-
β22/2000*is*	13.1	-

Note:

When multiple amplifiers are connected to a single circuit breaker, select a breaker by multiplying the sum of the currents listed in Table III-14 by 0.6. (This factor attempts to compensate for applications where all axes are not demanding full power at the same time. In applications where all axes are running continuously or with high duty cycles, this factor must be increased to 1.)

Example: Connecting two β8/3000is motors operating on 3-phase power:

(6.3 + 6.3) x 0.6 = 7.6 Arms

A standard 10 Amp circuit breaker can be used.

During rapid motor acceleration, a peak current that is three times the continuous rating flows. Select a circuit breaker that does not trip when a current that is three times the continuous rating flows for two seconds.

23.4 Electromagnetic Contactor Rating

To prepare for incoming AC power, you must also select and install an appropriate electromagnetic contactor, based on the peak currents for the motors in your system. When multiple amplifiers are connected to a single circuit breaker, select a breaker based on the sum of the motor currents in Table III-14.

23.5 Incoming AC power

Table III-15. AC Power

Specification	*Description*
Voltage: 3-phase 1-phase	200 VAC to 240 VAC 220 VAC to 240 VAC
Frequency	50 Hz, 60Hz ± 2 Hz
Voltage fluctuation during acceleration/deceleration	7% or less

AC Power Ratings

The power supply rating required when using multiple servo motors can be determined by summing the requirements of the individual motors.

The power supply ratings listed in Table III-16 are sufficient as continuous ratings. Note, however, that servo motor acceleration causes a current to momentarily flow that is approximately three times the continuous current rating.

When the power is turned on, a surge current of about 37A (when 264VAC is applied) flows for 20 msec.

Table III-16. Three-Phase Power Supply Ratings

Motor	*Cont. Output Rating*
β0.4/5000is	0.13 kW
β0.5/5000is	0.2 kW
β1/5000is	0.4 kW
β2/4000is	0.5 kW
β4/4000is	0.75 kW
β8/3000is	1.2 kW
β12/3000is	1.8 kW
β22/2000is	2.5 kW

23.6 Incoming DC Power

The amplifier requires a 24 VDC power supply for amplifier control power. The user must supply this DC power supply.

The information in Table III-17 below will help you select the appropriate DC power supply for your motion application.

The same external DC power supply can be used to provide power to multiple amplifiers as long as the supply is rated for the sum of power drawn by all of the amplifiers. To daisy chain the amplifiers, add connections between connector CXA19A and CXA19B on adjacent amplifiers (see the connection diagrams for more details). Up to 8 amplifiers can be daisy chained when using 16 AWG wire or up to 6 amplifiers when using 20 AWG wire.

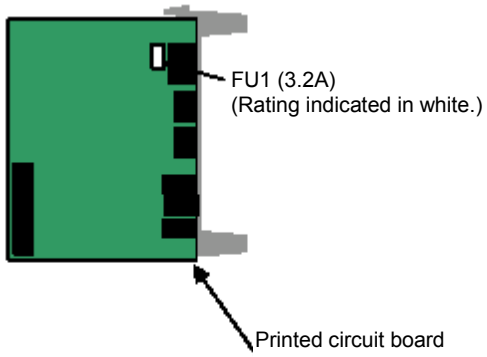
Table III-17. Amplifier DC Control Power Specifications

Specification	*Description*
Input voltage	24V DC (±10%)
Power supply rating (per amplifier)	0.9 amps

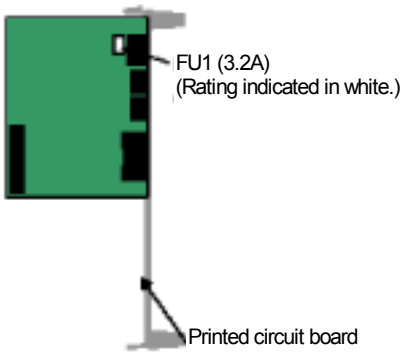
24 VDC Fuse Locations

The 24 VDC input is fused to protect the amplifier. The fuse labeled FU1 is located on the gray control board that plugs into the front of the amplifier. The diagrams below show the location on this board for each amplifier model. The replacement fuse part number is A06B-6073-K250 (Manufacturer: Daito LM32, DC48V, F3.2A).

A spare fuse is included with each βi series amplifier package (IC800BIK020 or IC800BIK040)



SVM1-20i Amplifier



SVM1-40i Amplifier

23.7 Discharging Regenerative Energy

Regenerative energy is normally created in applications with a high load inertia or frequent acceleration and deceleration. When decelerating a load, the stored kinetic energy of the load causes generator action in the motor causing energy to be returned to the β*i* Series amplifier. For light loads and low acceleration rates, the amplifier may be able to absorb this energy. Otherwise, an optional external regenerative discharge unit must be installed. This optional regeneration capability extends the functionality of the amplifier when working with loads and move profiles that require more capacity than is internal. Calculations shown later in this section can be used to determine the need for an external unit.

If the regenerative discharge unit overheats, a built-in thermostat is tripped, the external overheat alarm is issued, and the motor is stopped. If an external regenerative discharge unit is required, a separate unit must be installed for each amplifier. This component cannot be daisy-chained.

β SVM1-20i Amplifier Regeneration Options

For the β SVM-20i amplifier, two optional separate 30-Ohm regenerative discharge units are available with power ratings of 100 W and 20 W. The 100 W unit (A06B-6130-H402) is panel-mounted, whereas the 20 W unit (A06B-6130-H401) mounts to the tapped holes on the side of the amplifier heat sink. The dimensions and connections for both units are shown in the connection section of this document.

NOTE

The amplifiers include an input on connector CXA20 (DCOH) for a normally closed thermal overload switch to protect the external regeneration resistor from overheating. If an external resistor is not used this input must be connected with a wire jumper or the amplifier will generate a fault and will not run.

β SVM1-40i Amplifier Regeneration Options

For the βSVM-40i amplifier, two optional regeneration units are available. Both regeneration kits are panel mounted.

Regenerative Resistor Kit	*No Fan Cooling*	*Fan Cooling (2 meters/sec air flow)*	*Fan Cooling (4 meters/sec air flow)*
A06B-6089-H500	200 watt	400 watt	600 watt
A06B-6089-H713	Incorporates a cooling fan in the kit		800 watt

β SVM1-40i Switch Settings

There are four switches located on the front of the β SVM1-40*i* series servo amplifier that configure the amplifier for the regenerative resistor option used. These switches should be set as described below before use of the β SVM1-40*i* series servo amplifiers.

WARNING:

If the switch settings are not correct it is possible to damage the regenerative resistor and it will be impossible to normally detect a regenerative overheat alarm.

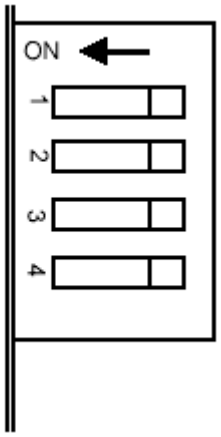


Figure III-19. β SVM1-40*i* Series channel switches

Switch Positions:

The switches are sequentially numbered 1, 2, 3, and 4 with the one at the top as switch 1. The ON position is on the left, and the OFF position is on the right.

Switch 1 Setting: Always set to OFF.

Switch 2 Setting: Always set to OFF.

Switches 3 and 4 Settings: The setting of these switches depends on the regenerative discharge resistance used.

Table III-18. Switch 3 and 4 setting for βSVM-40*i* Series amplifiers

βSVM1-40i		
Regenerative Discharge Unit	SW3	SW4
Built-in (50 W) (Default)	ON	ON
External A06B-6089-H500 (200 W)	OFF	ON
External A06B-6089-H713 (800 W)	OFF	OFF

Regenerative Discharge Unit Dimensions

The separate regenerative discharge units are designed with a rear-mounted heat sink that extends through a hole in the mounting plate. The intent is that the user will construct a control cabinet with an internal air plenum into which the heat sinks for the βSVM1-40i amplifiers and associated regenerative discharge units will be mounted. This design eliminates most of the heat dissipation from these units inside the control cabinet.

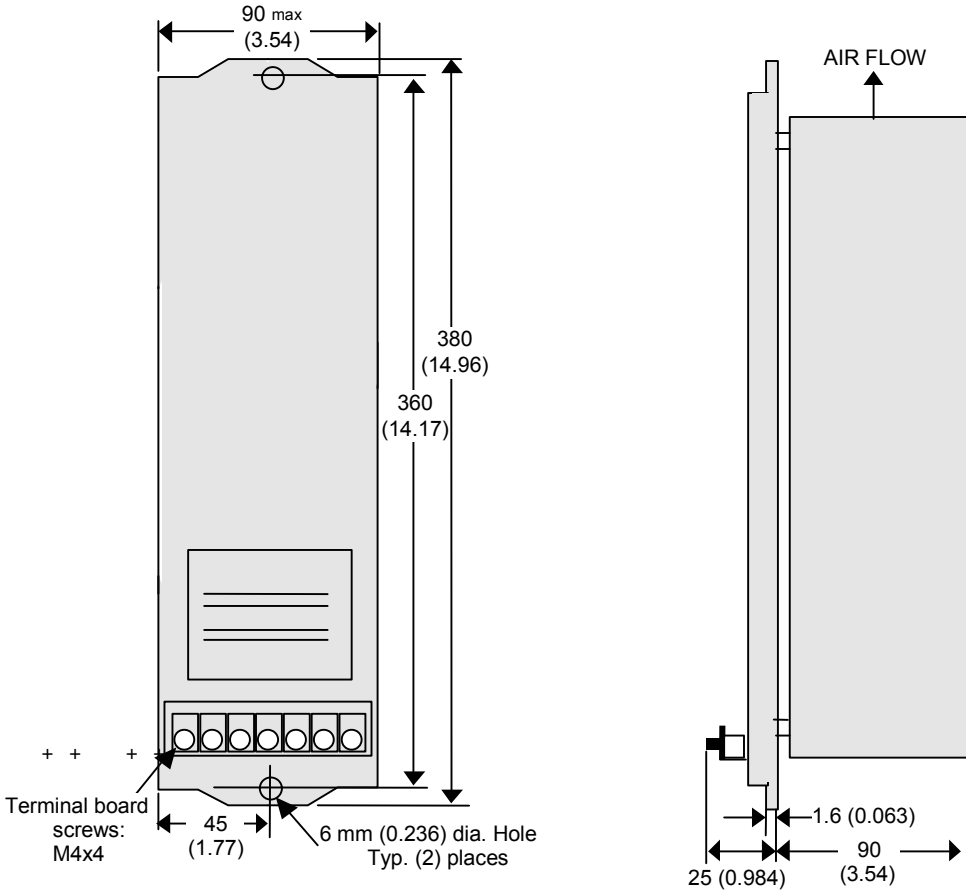


Figure III- 20. 200 W Regenerative discharge unit (A06B-6089-H500), front and side views

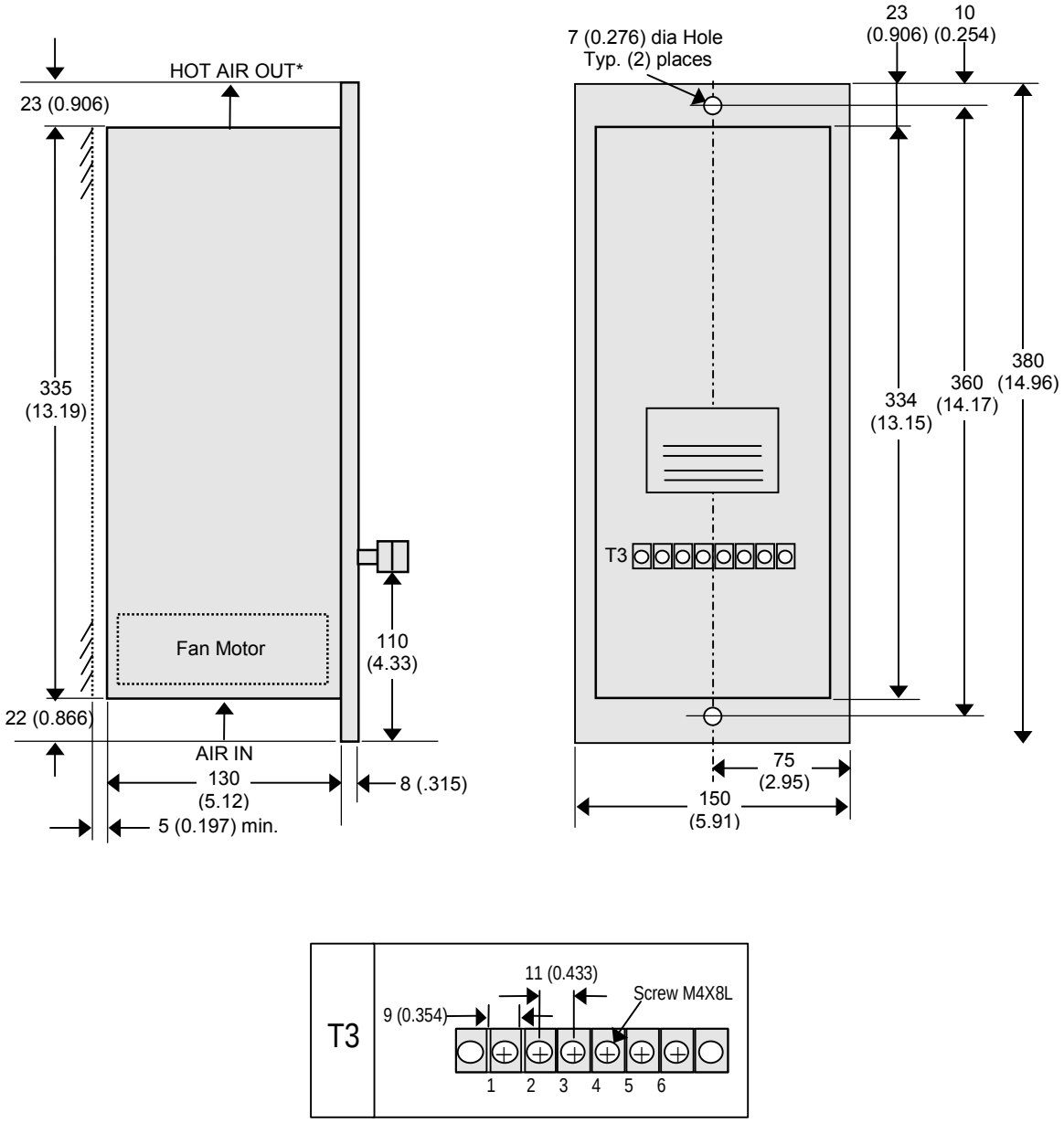
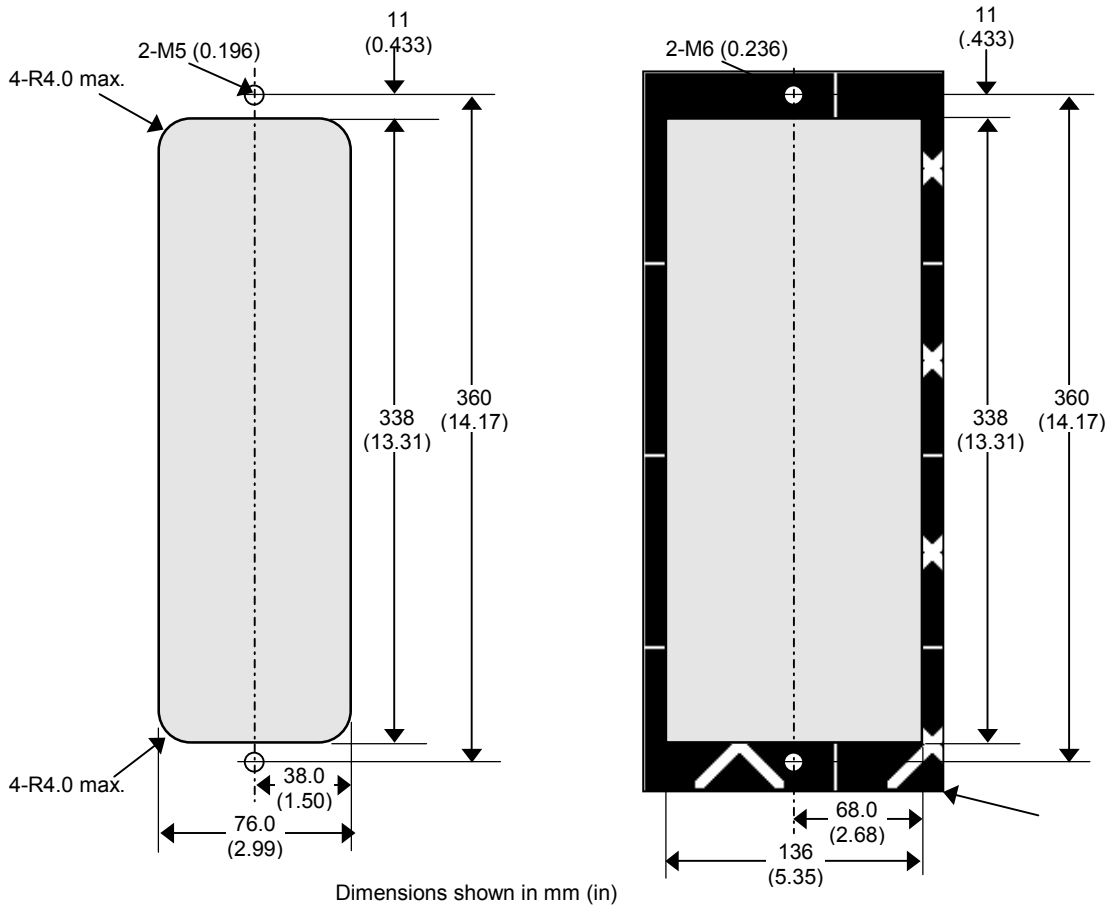


Figure III-21.800 W Regenerative discharge unit (A06B-6089-H713), Front, Side, and End Views with T3 Terminal Detail

Regenerative Discharge Unit Panel Cutout Dimensions

The panel cutouts necessary to mount the separate regenerative discharge units are shown below.

A06B-6089-H500 (200 W) **A06B-6089-H713 (800 W)**



CAUTION:
Attach packing (acrylonitrile-butadiene rubber or soft NBR) around the cutout to keep out oil and dust.

Figure III-22. Regenerative discharge unit panel cutout dimensions

Calculating the Average Regenerative Energy

Use the following calculation to determine the average regenerative energy that will be released in your application (ambient temperature is assumed not to exceed 55°C). Based on the calculations select either the internal regeneration or optional external regeneration resistor. The wattage rating of the selected resistor must exceed the average calculated regenerative energy from the equation below:

Average Regenerative Energy (Joules)	=	**Rotational Energy to be Released during Deceleration (STEP 1)**	–	**Energy to be Consumed Through Axis Friction (STEP 2)**	+	***(only in vertical axis operation)* Vertical Energy to be Released During Downward Motion (STEP 3)**

STEP 1: Rotational Energy to be Released during Deceleration

$= \left(6.19\times10^{-4}\right)\times\left(J_m + J_L\right)\times\omega_m^{\,2}$ Joules

where:

J_m	Motor rotor inertia	(lb-in-s^2)
J_L	Load inertia converted to motor shaft inertia	(lb-in-s^2)
ω_m	Maximum motor speed at time of deceleration	(rpm)

STEP 2: Energy to be consumed through Axis Friction

$= \left(5.91\times10^{-3}\right)\times t_a\times\omega_m\times T_L$ where:

ω_m	Motor speed during rapid traverse	(rpm)
t_a	Acceleration/deceleration duration during rapid traverse	(sec)
T_L	Axis friction torque (converted to motor shaft torque)	(lb-in)

STEP 3: Vertical Energy to be Released During Downward Motion

(This term applies only in vertical axis operation)

$= \left(1.182\times10^{-2}\right)\times T_h\times\omega_m\times\frac{D}{100}$ where:

T_h	Upward supporting torque applied by the motor during downward rapid traverse	(lb-in)
ω_m	Motor speed during rapid traverse	(rpm)
D	Duty cycle of downward vertical operation during rapid traverse (Note: the maximum value of D is 50%. D assumes a smaller value)	(%)

STEP 4: Determine if a Regenerative Discharge Unit Is Required

Determine the Average Regenerative Energy using the equation in the beginning of this section.

When the average regenerative energy produced never exceeds the amounts indicated in the table below, a separate regenerative discharge unit is **not** required:

Table III-19. Maximum Allowable Regenerative Energy for Amplifiers

Amplifier	*Max. Allowable Regen. Energy*
βSVM1-20i	16 Joules
βSVM1-40i	50 Watt

If the calculated value exceeds the storage capability of the amplifier, then an external regenerative discharge unit is required (see Step 5).

STEP 5: Selecting a Regenerative Discharge Unit

If a separate regenerative discharge unit is required, the following calculation will determine the unit required:

Average Regenerative Power (W) = Average Regenerative Energy (Joules) x $\frac{1}{F}$ where:

F = Deceleration duty (seconds) Example: deceleration once per 5 second cycle, F=5

Select a regenerative resistor with a rating that exceeds the average regenerative power.

Example:

Assume a horizontal axis using a β2/4000is motor (J_m = 0.0002146 lb-in-s^2) that decelerates once every 6 seconds (F) for 0.2 seconds (t_a) with a maximum speed of 2000 RPM (ω_m). The machine inertia (J_L) is 0.00139 lb-in-s^2.

STEP 1: Rotational Energy = $(6.19 \times 10^{-4}) \times (0.0002146+0.00139) \times 2000^2$ = 3.97 Joules

STEP 2: Assuming T_L = 10 in-lb:
Friction Energy = $(5.91 \times 10^{-3}) \times 0.2 \times 2000 \times 10$ = 23.64 Joules

Therefore:

STEP 4: Average Regenerative Energy = 3.97–23.64 = 27.61 Joules
Because the 27.61 Joules required is more than the 16 Joules allowed by the βSVM1-20*i* amplifier used with the β2is motor, an external regenerative resistor is required.

STEP 5: Since the application requires decelerations every 6 seconds, $\frac{1}{F} = \frac{1}{6}$

Average Regenerative Power = 27.61 Joules/6 seconds = 4.6 W
Therefore, the 20 W resistor (A06B-6130-H401) is adequate for this application.

Section 24: βi Series Servo System Connection

When planning your motion control system, it is important to determine how the different parts of the system connect together. This section provides information on the various cables and connectors required to connect the motor, amplifier and motion controller.

Many cables required for the system are available from GE Fanuc. Motor cable and connector kit part numbers for each motor and amplifier combination are shown in the table below.

Table III-20. β0.4is to β2is Motor Power, Feedback and Brake Cables and Connector Kits

Motor Model		B0.4/5000is	B0.5/5000is	B1/5000is	B2/4000is
Amplifier Model		βSVM1-20i	βSVM1-20i	βSVM1-20i	βSVM1-20i
Power Cable	7 M	CP8B-1WPB-0070-AZ	CP8B-1WPB-0070-AZ	CP8B-1WPB-0070-AZ	CP9B-0WPB-0070-AZ
	14 M	CP8B-1WPB-0140-AZ	CP8B-1WPB-0140-AZ	CP8B-1WPB-0140-AZ	CP9B-0WPB-0140-AZ
Power Cable (Shielded)	7 M	CP8B-1WEB-0070-AZ	CP8B-1WEB-0070-AZ	CP8B-1WEB-0070-AZ	CP9B-0WEB-0070-AZ
	14 M	CP8B-1WEB-0140-AZ	CP8B-1WEB-0140-AZ	CP8B-1WEB-0140-AZ	CP9B-0WEB-0140-AZ
Feedback Cable (Right Angle)	7 M	CFDA-3WPB-0070-AZ	CFDA-3WPB-0070-AZ	CFDA-3WPB-0070-AZ	CFDA-3WPB-0070-AZ
	14 M	CFDA-3WPB-0140-AZ	CFDA-3WPB-0140-AZ	CFDA-3WPB-0140-AZ	CFDA-3WPB-0140-AZ
Feedback Cable (Straight)	7 M	CFDA-0WPB-0070-AZ	CFDA-0WPB-0070-AZ	CFDA-0WPB-0070-AZ	CFDA-0WPB-0070-AZ
	14 M	CFDA-0WPB-0140-AZ	CFDA-0WPB-0140-AZ	CFDA-0WPB-0140-AZ	CFDA-0WPB-0140-AZ
Brake Power Cable	7 M	CB6N-5WPM-0070-AZ	CB6N-5WPM-0070-AZ	CB6N-5WPM-0070-AZ	Integrated with Power Cable
	14 M	CB6N-5WPM-0140-AZ	CB6N-5WPM-0140-AZ	CB6N-5WPM-0140-AZ	Integrated with Power Cable
Motor Feedback Connector Kit	90 Deg	A06B-6114-K204#E	A06B-6114-K204#E	A06B-6114-K204#E	A06B-6114-K204#E
	Straight	A06B-6114-K204#S	A06B-6114-K204#S	A06B-6114-K204#S	A06B-6114-K204#S
Motor Power/Brake Connector Kit	90 Deg	N/A	N/A	N/A	A06B-6114-K220#E
	Straight	N/A	N/A	N/A	A06B-6114-K220#S
Motor Power Connector Kit	90 Deg	A06B-6114-K230#E	A06B-6114-K230#E	A06B-6114-K230#E	N/A
	Straight	A06B-6114-K230#S	A06B-6114-K230#S	A06B-6114-K230#S	N/A
Motor Brake Connector Kit	90 Deg	A06B-6114-K232#E	A06B-6114-K232#E	A06B-6114-K232#E	N/A
	Straight	A06B-6114-K232#S	A06B-6114-K232#S	A06B-6114-K232#S	N/A

Table III-21. β4is to β22is Motor Power, Feedback and Brake Cables and Connector Kits

Motor Model		B4/4000is	B8/3000is	B12/3000is	B22/2000is
Amplifier Model		βSVM1-20i	βSVM1-20i	βSVM1-40i	βSVM1-40i
Power Cable	7 M	CP9B-0WPB-0070-AZ	CP3B-0WPB-0070-AZ	CP5B-0WPB-0070-AZ	CP6B-0WPB-0070-AZ
	14 M	CP9B-0WPB-0140-AZ	CP3B-0WPB-0140-AZ	CP5B-0WPB-0140-AZ	CP6B-0WPB-0140-AZ
Power Cable (Shielded)	7 M	CP9B-0WEB-0070-AZ	CP3B-0WEB-0070-AZ	CP5B-0WEB-0070-AZ	CP6B-0WEB-0070-AZ
	14 M	CP9B-0WEB-0140-AZ	CP3B-0WEB-0140-AZ	CP5B-0WEB-0140-AZ	CP6B-0WEB-0140-AZ
Feedback Cable (Right Angle)	7 M	CFDA-3WPB-0070-AZ	CFDA-3WPB-0070-AZ	CFDA-3WPB-0070-AZ	CFDA-3WPB-0070-AZ
	14 M	CFDA-3WPB-0140-AZ	CFDA-3WPB-0140-AZ	CFDA-3WPB-0140-AZ	CFDA-3WPB-0140-AZ
Feedback Cable (Straight)	7 M	CFDA-0WPB-0070-AZ	CFDA-0WPB-0070-AZ	CFDA-0WPB-0070-AZ	CFDA-0WPB-0070-AZ
	14 M	CFDA-0WPB-0140-AZ	CFDA-0WPB-0140-AZ	CFDA-0WPB-0140-AZ	CFDA-0WPB-0140-AZ
Holding Brake Power Cable	7 M	Integrated with Power Cable	CB4N-0WPM-0070-AZ	CB4N-0WPM-0070-AZ	CB4N-0WPM-0070-AZ
	14 M	Integrated with Power Cable	CB4N-0WPM-0140-AZ	CB4N-0WPM-0140-AZ	CB4N-0WPM-0140-AZ
Motor Feedback Connector Kit	90 Deg	A06B-6114-K204#E	A06B-6114-K204#E	A06B-6114-K204#E	A06B-6114-K204#E
	Straight	A06B-6114-K204#S	A06B-6114-K204#S	A06B-6114-K204#S	A06B-6114-K204#S
Motor Power/Brake Connector Kit	90 Deg	A06B-6114-K220#E	N/A	N/A	N/A
	Straight	A06B-6114-K220#S	N/A	N/A	N/A
Motor Power Connector Kit	90 Deg	N/A	A06B-6079-K812	A06B-6079-K812	A06B-6079-K815
	Straight	N/A	A06B-6079-K811	A06B-6079-K811	A06B-6079-K814
Motor Brake Connector Kit	90 Deg	N/A	A06B-6114-K213#E	A06B-6114-K213#E	A06B-6114-K213#E
	Straight	N/A	A06B-6114-K213#S	A06B-6114-K213#S	A06B-6114-K213#S

System Connector Locations

Motor and amplifier connector kits required for the system are available from GE Fanuc. The following figures indicate the physical connector locations on the amplifiers, the appropriate connector designations and connector kit part numbers.

No.	Name	Connector Kit	Remarks
1			DC link charge LED
2	CZ7-1	A06B-6130-K200	Main AC power input connector
3	CZ7-2		External regenerative discharge register connector
4	CZ7-2		Motor power connector
5	CX29	A06B-6130-K203	Connector for main power MCC control signal
6	CX30	A06B-6130-K204	Emergency stop (ESP) signal connection connector
7	CXA20	A06B-6130-K202	Regenerative resistor thermal protector connector
8	CXA19B	A06B-6130-K201	24VDC power input
9	CXA19A	A06B-6130-K201	24VDC power input
10	COP10B	N/A	FSSB fiber optic command interface
11	COP10A	N/A	FSSB fiber optic command interface
12	ALM	N/A	Servo alarm status LED
13	JX5	N/A	No Connection (Reserved)
14	LINK	N/A	FSSB communication status LED
15	JF1	A06B-6073-K214	Motor encoder input connector
16	POWER	N/A	24 VDC control power status LED
17	CX5X	A06B-6093-K303	Absolute encoder battery input connector
18	GROUND	N/A	Tapped hole for grounding the amplifier

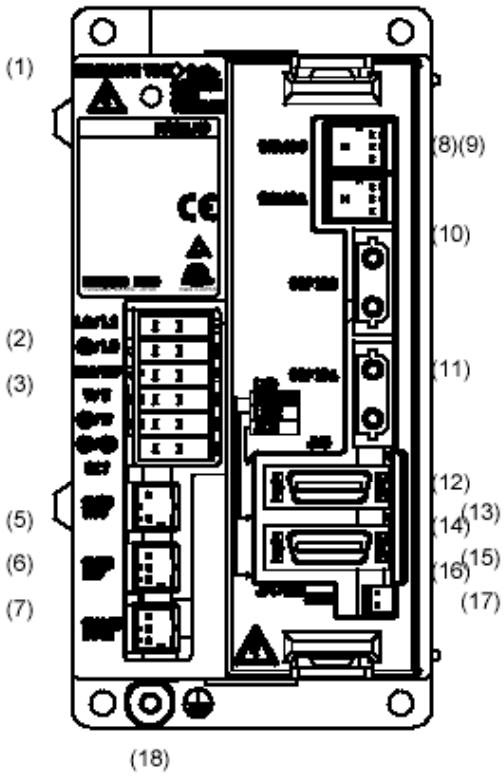


Figure III-23. βSVM1- 20*i* Connector Location Diagram

No.	Name	Connector Kit	Remarks
1			DC link charge LED
2	CX29	A06B-6130-K203	Connector for main power MCC control signal
3	CX30	A06B-6130-K204	Emergency stop (ESP) signal connection connector
4	CXA20	A06B-6130-K202	Regenerative resistor thermal protector connector
5	SW	N/A	Regenerative Discharge Unit Selection Switch
6	CZ4	A06B-6110-K200#XXS	Main AC power input connector
7	CZ5	A06B-6110-K202#YYS	Motor power connector
8	CZ6	A06B-6110-K201#XYM	External regenerative discharge register connector
9	CXA19B	A06B-6130-K201	24VDC power input
10	CXA19A	A06B-6130-K201	24VDC power input
11	COP10B	N/A	FSSB fiber optic command interface
12	COP10A	N/A	FSSB fiber optic command interface
13	ALM	N/A	Servo alarm status LED
14	JX5	N/A	No Connection (Reserved)
15	LINK	N/A	FSSB communication status LED
16	JF1	A06B-6073-K214	Motor encoder input connector
17	POWER	N/A	24 VDC control power status LED
18	CX5X	A06B-6093-K303	Absolute encoder battery input connector
19	GROUND	N/A	Tapped hole for grounding the amplifier

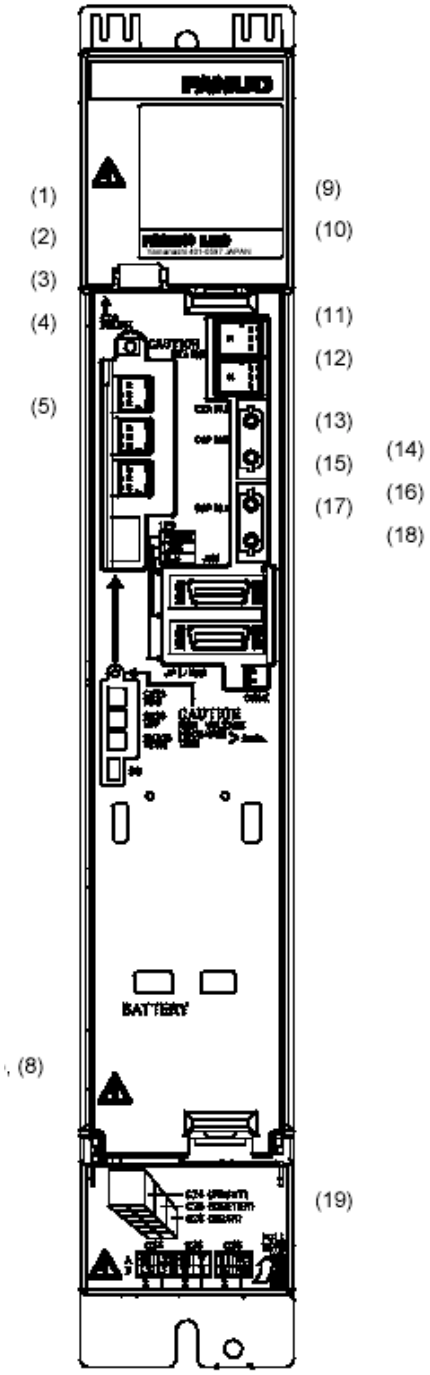
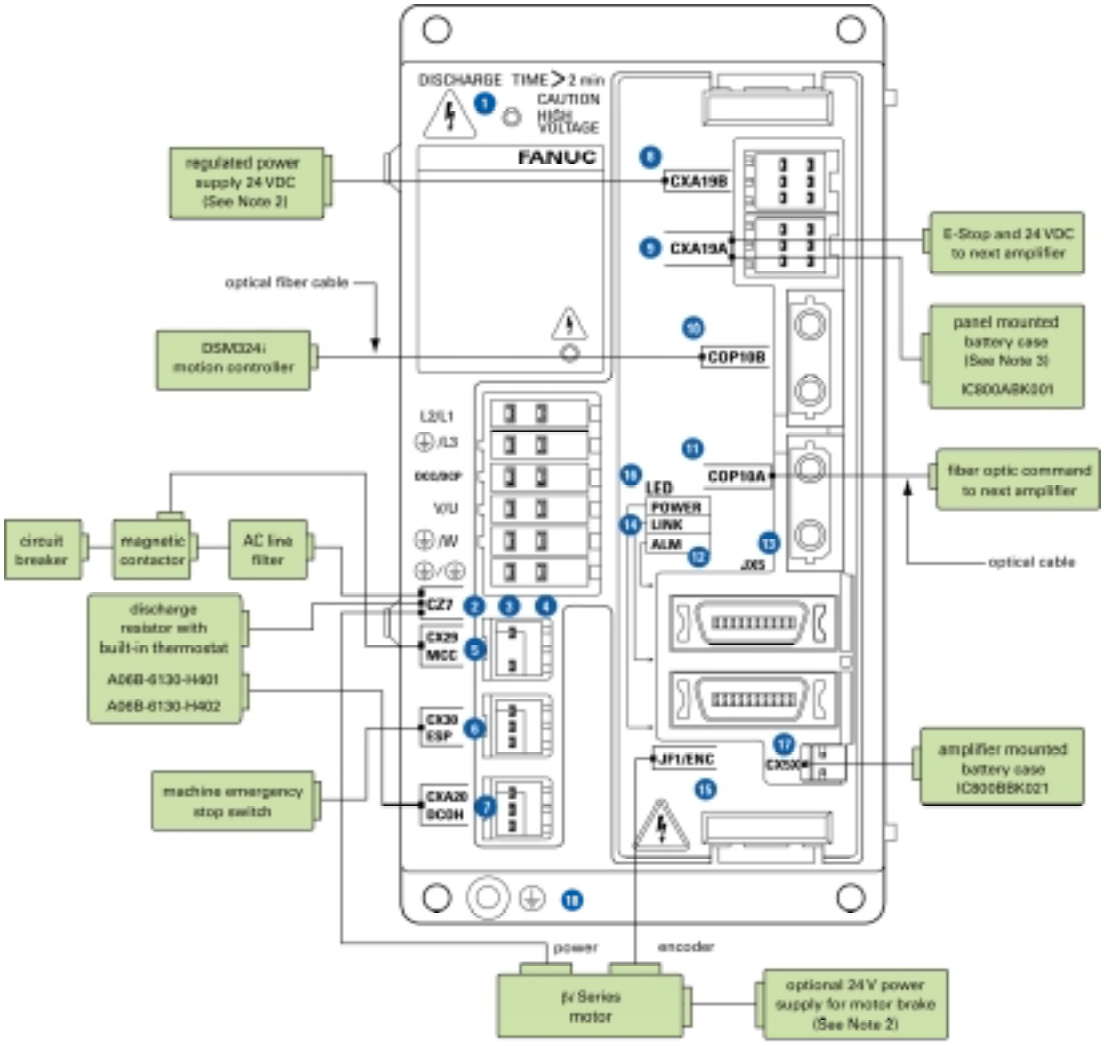


Figure III-24. βSVM1- 40*i* Connector Location Diagram

24.1 System Connection Diagram and Cable Reference

The following diagrams illustrate typical system interconnections. For details on cables and connectors, refer to Table III-22.



Connector Location

No.	*Name*	*Description*	*No.*	*Name*	*Description*	*No.*	*Name*	*Description*
1		DC link charge LED	7	CXA20	Regenerative resistor overtemperature switch connector	13	JX5	Reserved
2	CZ7-1	Main power input connector	8	CXA19B	24 VDC power input	14	LINK	Fiberoptic link status LED
3	CZ7-2	Discharge resistor connector	9	CXA19A	24 VDC power input	15	JF1	Serial encoder feedback
4	CZ7-3	Motor power connector	10	COP10B	Fiber optic servo command	16	POWER	Control power status display LED
5	CX29	Connector for main power MCC control signal	11	COP10A	Fiber optic servo command	17	CX5X	Absolute encoder battery
6	CX30	E-stop signal connector	12	ALM	Servo alarm status LED	18	⏚	Tapped hole for grounding the amplifier

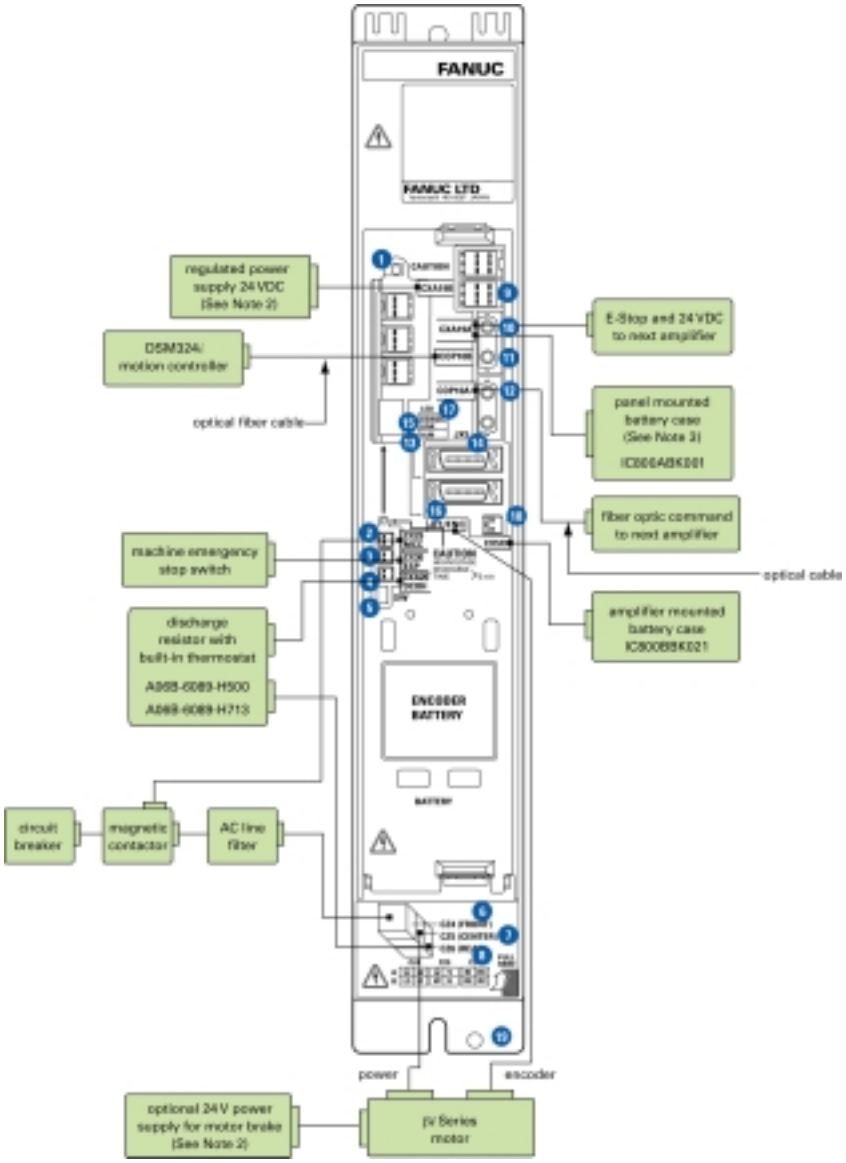
Notes

1: Always install the circuit breakers, magnetic contactor, and AC line filter.

2. User a regulated 24 VDC power supply for the amplifier. The 24 VDC power supply for the amplifier and power supply for the motor brake cannot be shared.

3. The IC800ABK001 encoder battery pack mounts separately on the panel and can power up to four axes. Alternatively, the IC800BBK021 one-axis lithium battery can be snapped onto each amplifier.

Figure III-25. βSVM1- 20*i* Connection Diagram



Connector Location

No.	*Name*	*Description*	*No.*	*Name*	*Description*	*No.*	*Name*	*Description*
1		DC link charge LED	7	CZ5	Main power connector	13	ALM	Servo alarm status LED
2	CX29	Main power input connector MCC control signal	8	CZ6	Discharge resistor connector	14	JX5	Reserved
3	CX30	E-stop signal connector	9	CXA19B	24 VDC power input	15	LINK	Fiberoptic link status LED
4	CXA20	Regenerative resistor overtemperature switch connector	10	CXA19A	24 VDC power input	16	JF1	Serial encoder feedback
5	SW	Setting switch (DC alarm level)	11	COP10B	Fiber optic servo command	17	POWER	Control power status display LED
6	CZ4	Main power input connector	12	COP10A	Fiber optic servo command	18	CX5X	Absolute encoder batter
						19	⏚	Tapped hole for grounding the amplifier

Notes

1: Always install the circuit breakers, magnetic contactor, and AC line filter.

2. User a regulated 24 VDC power supply for the amplifier. The 24 VDC power supply for the amplifier and power supply for the motor brake cannot be shared.

3. The IC800ABK001 encoder battery pack mounts separately on the panel and can power up to four axes. Alternatively, the IC800BBK021 one-axis lithium battery can be snapped onto each amplifier.

Figure III-26. βSVM1- 40*i* Connection Diagram

Table III-22. System Connection Cables Summary

Ref.	*Connects*	*GE Fanuc Cable Part Number*	*When Required*
K1	Built in Serial Motor Encoder to Amplifier (JF1)	See Tables III-20 and III-21.	always
K2	AC Power to Amplifier	Customer Supplied	always
K3	Motor Power to Amplifier	See Tables III-20 and III-21.	always
K4	Amplifier to Regenerative Discharge Unit	N/A (included with regenerative discharge unit)	in most cases[1]
K5	Regenerative Discharge Unit Over Temperature Switch to Amplifier	N/A (included with regenerative discharge unit)	in most cases[1]
K5	Servo Amplifier Emergency Stop Input (CX30) to Machine E-Stop Contact	Customer Supplied	always
K6	Connection of or Daisy Chain to an adjacent amplifier the 24 VDC, E-stop and encoder battery backup signals	Customer Supplied	always
K7	Relay Output to Control the Main AC Power Contactor Coil (MCC)	Customer Supplied	control-dependent; consult your control documentation
K8	Servo Amplifier Emergency Stop Input (CX30) to Machine E-Stop Contact	Customer Supplied	always (When an E-Stop switch is not used a jumper connection must be installed)
K9	Amplifier (CX19B) to Panel Mounted Backup Battery Holder IC800ABK001	Customer Supplied	one cable per four amplifiers when IC800APK001 encoder battery backup option is used

[1] See “Discharging Regenerative Energy” on page III-35.

FSSB Fiber Optic Servo Command Interface Cable

The optical cable is available in various lengths and is used to interface up to four amplifiers to the DSM324i motion controller. Additionally the fiber optic cables come in two styles.

PVC Covered Fiber Cable (use in sealed cabinet only)	ZA66L-6001-0023#L150R0	0.15 meter
	ZA66L-6001-0023#L1R003	1 meter
	ZA66L-6001-0023#L3R003	3 meter
Sheathed Fiber Cable*	ZA66L-6001-0026#L1R003	1 meter
	ZA66L-6001-0026#L5R003	5 meter
	ZA66L-6001-0026#L10R03	10 meter
	ZA66L-6001-0026#L20R03	20 meter

* Longer lengths are available but are not stocked

WARNING

GE Fanuc cannot guarantee the servo performance and reliability unless the fiber optic command interface cable meets or exceeds the stated specifications.

24.2 FSSB Cable Specifications

Connector maker: Tyco Electronics AMP. Parts list:

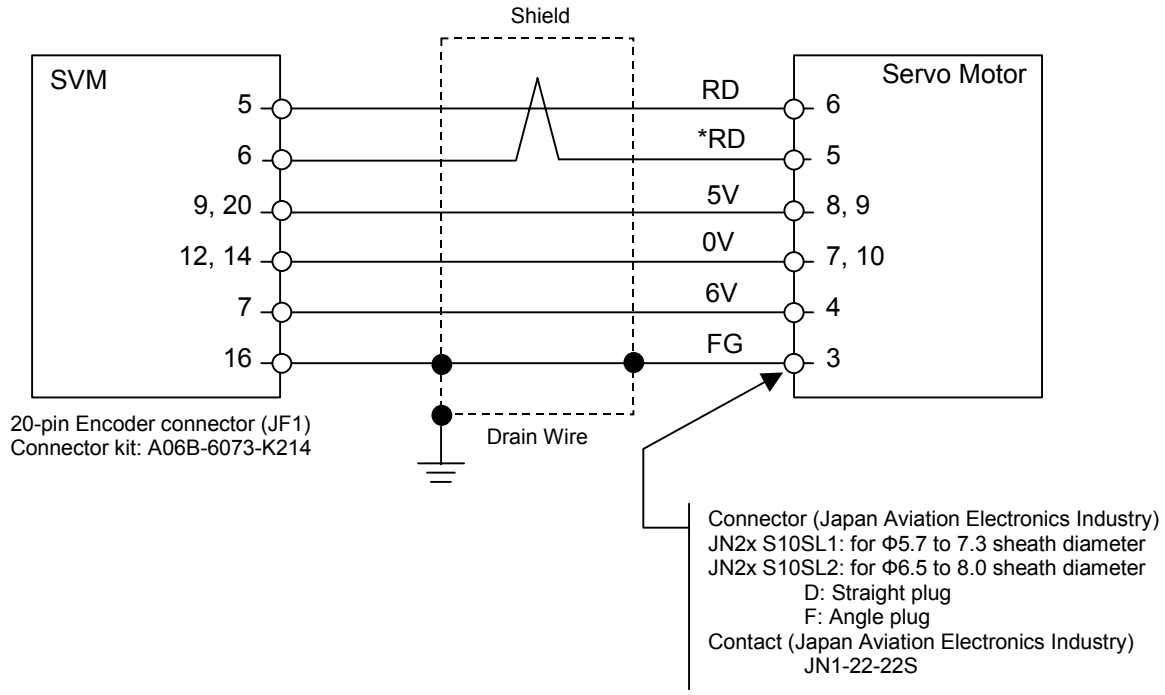
Connector Part	*Vendor Part Number*
Ferrule	316892
Housing	316890
Stopper	316891
Spring	900357

- Cable material must be Multi-mode
- Cable loss (max.): 3dB
- The transmission rate is 25Mbps
- The actual fiber used is the plastic cladding silica fiber
- The core diameter is 200 micrometer, and the plastic clad diameter is 230 micrometer
- The initial loss is 0.015dB per meter (At room temperature)
- The type of light is LED. The wavelength of light is 650nm
- Bend radius min.: 50mm

  Life: ~10 million cycles at 100mm radius, @ +/- 90 degrees
- Twist angle max: 360 degrees

  Life: 900,000 cycles @ +/- 180 degrees twisting
- Cable must be clamped so that no stretching force is applied and no forces within 200mm of connector.

Details of Cable K1- Motor Serial Encoder Feedback



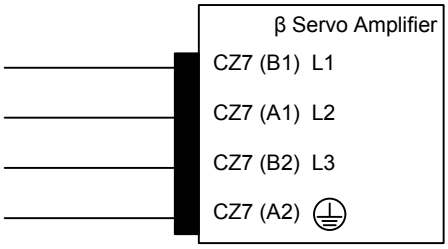
Recommended Cable Conductors

Signal	***Cable Length***	
	28m or Less	***50m or Less***
5V, 0V, 6V	$0.3mm^2$ x 5 Wire construction 12/0.18 or 60/0.08 Insulation outer diameter Φ1.5 or less	$0.5mm^2$ x 5 Wire construction 20/0.18 or 104/0.08 Insulation outer diameter Φ1.5 or less
RD, *RD	$0.18mm^2$ or more Twisted pair wire	$0.18mm^2$ or more Twisted pair wire
Drain wire	0.15 mm^2 or more	0.15 mm^2 or more

Notes:

1. The grounding bar to which the feedback cable shield is connected must be placed as close as possible to the amplifier.
2. Total resistance of the 5V and 0V wire path must be less than 2Ω.
3. Motor encoder connector can accept maximum $0.5mm^2$ wire size (wire construction 20/0.18 or 104/0.08, insulation outer diameter Φ1.5 or less) wire and sheath diameter is Φ 5.7 to Φ 8.0.

Details of Cable K2 – AC Power to βSVM1-20i Amplifier



Receptacle Housing

Use the following receptacle housing.

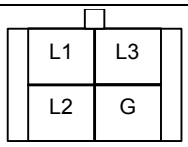
Manufacturer Model Number	*Key Specification*	*Manufacturer*
175363-3	Incorrect-insertion prevent key	Tyco Electronics AMP

Receptacle Contact

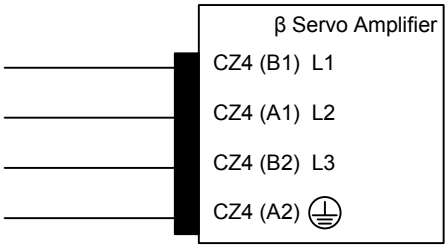
Receptacle Contact Model Number		*Conductor Size*	*Insulation Outer Diameter (mm)*	*Manual Tool Model Number*	*Manufacturer*
L size	1-75218-2	0.5—1.25 mm^2 20/18/16 AWG	1.8—2.8	91558-1	Tyco Electronics AMP

Connector and Tool Ordering Information

Connectors (including housings and contacts) and tools can be purchased directly from Tyco Electronics AMP. Connectors can also be ordered as options from GE Fanuc as listed below.

GE Fanuc Ordering Number	*Description*
A06B-6130-K200	Housing: Incorrect-insertion prevention key 175636-3 (Qty. 1) Incorrect-insertion prevention key 1318095-2 (Qty. 1) Contact: L size, 1-175218-2 (Qty. 10) Applicable wire diameter: 0.5—1.25mm^2, AWG 20/18/16 Applicable tool: 91558-1 (not included in this kit)
	CZ7  Connector pin location as viewed from the (back) wire insertion side.

Details of Cable K2 – AC Power to βSVM1-40i Amplifier



Receptacle Housing

Use the following receptacle housing.

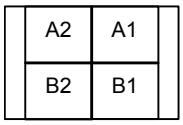
Manufacturer Model Number	*Key Specification*	*Manufacturer*
1-917807-2	XX	Tyco Electronics AMP

Receptacle Contact

Receptacle Contact Model Number		*Conductor Size*	*Insulation Outer Diameter (mm)*	*Manual Tool Model Number*	*Manufacturer*
S size	316040-6	1.25—2.20 mm^2 16/14 AWG	3.0—3.8	234170-1	Tyco Electronics AMP

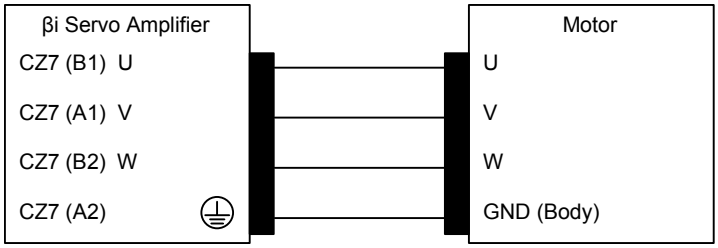
Connector and Tool Ordering Information

Connectors (including housings and contacts) and tools can be purchased directly from Tyco Electronics AMP. Connectors can also be ordered as options from GE Fanuc as listed below.

GE Fanuc Ordering Number	*Description*
A06B-6110-K200#XXS	Housing: XX key 917807-2 (Qty. 1) Contact: S size, 316040-6 (Qty. 4) Applicable wire diameter: 1.25—2.20mm^2, AWG 16/14 Applicable tool: 234170-1 (not included in this kit) ***CZ4***  Connector pin location as viewed from the (back) wire insertion side.

Details of Cable K3 – Motor Power to βSVM1-20i Amplifier

The D-3000 and D-5000 connector series manufactured by Tyco Electronic AMP are used for motor power connections to the βi series amplifiers.



Receptacle Housing

Use the following receptacle housing.

Manufacturer Model Number	*Manufacturer*
1318095-2	Tyco Electronics AMP

Receptacle Contact

Receptacle Contact Model Number		*Conductor Size*	*Insulation Outer Diameter*	*Manual Tool Model Number*	*Manufacturer*
L size	1-75218-2	0.5—1.25 mm^2 20/18/16 AWG	1.8—2.8	91558-1	Tyco Electronics AMP

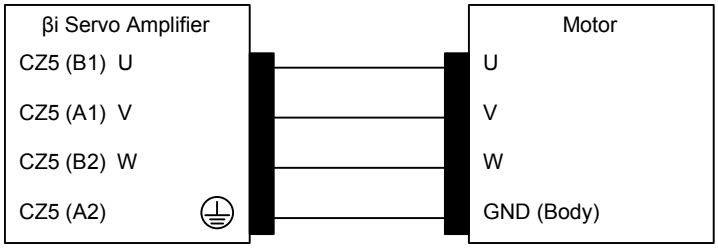
Connector and Tool Ordering Information

Connectors (including housings and contacts) and tools can be purchased directly from Tyco Electronics AMP. Connectors can also be ordered as options from GE Fanuc as listed below.

GE Fanuc Ordering Number	*Description*
A06B-6130-K200	Housing: Incorrect insertion prevent key 175363-3 (Qty. 1) Incorrect insertion prevent key 1318095-2 (Qty. 1) Contact: L size, 1-175218-2 (Qty. 10) Applicable wire diameter: 0.5—1.25mm^2, AWG 20/18/16 Applicable tool: 91558-1 (not included in this kit) **CZ7** U W G V G G Connector pin location as viewed from the (back) wire insertion side.

Details of Cable K3 – Motor Power to βSVM1-40i Amplifier

The D-3000 and D-5000 connector series manufactured by Tyco Electronic AMP are used for motor power connections to the βi series amplifiers.



Receptacle Housing

Use the following receptacle housing.

Manufacturer Model Number	*Key Specification*	*Manufacturer*
2-917807-2	YY	Tyco Electronics AMP

Receptacle Contact

Receptacle Contact Model Number		*Conductor Size*	*Insulation Outer Diameter*	*Manual Tool Model Number*	*Manufacturer*
S size	316040-6	1.25—2.2 mm^2 16/14 AWG	3.0—3.8	234170-1	Tyco Electronics AMP

Connector and Tool Ordering Information

Connectors (including housings and contacts) and tools can be purchased directly from Tyco Electronics AMP. Connectors can also be ordered as options from GE Fanuc as listed below.

GE Fanuc Ordering Number	*Description*
A06B-6110-K202#YYS	Housing: YY key 2-917807-2 (Qty. 1) Contact: S size 316040-6 (Qty. 4) Applicable wire diameter: 1.25—2.20mm^2, AWG 16/14 Applicable tool: 234170-1 (not included in this kit)
	CZ5 G V W U Connector pin location as viewed from the (back) wire insertion side.

Details of Cables K4 and K5 – Regenerative Discharge Resistor

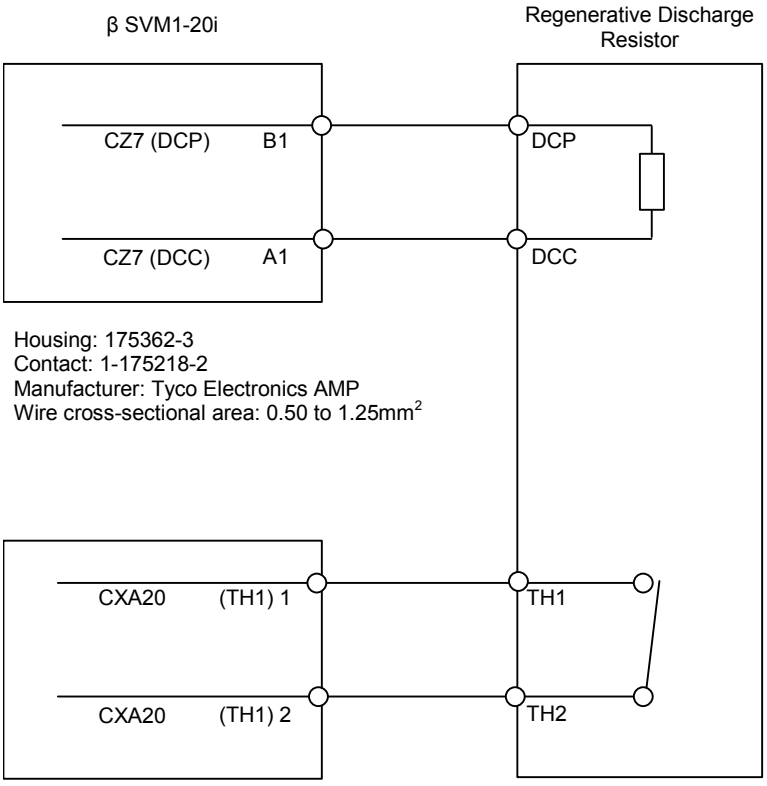
βSVM1-20i

When a Regenerative Discharge Resistor is Used

The following regenerative discharge resistor models are available for the βSVM1-20i amplifier. The housing and contact are connected to the resistor.

A06B-6130-H401 30 ohms, 20 watts

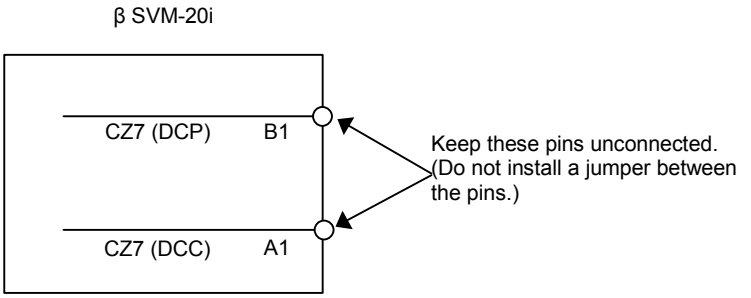
A06B-6130-H402 30 ohms, 100 watts

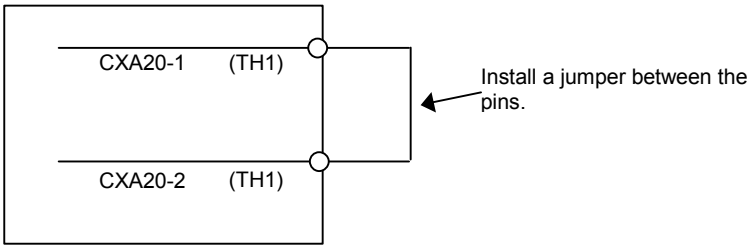


Housing: 175362-3
Contact: 1-175218-2
Manufacturer: Tyco Electronics AMP
Wire cross-sectional area: 0.50 to 1.25mm^2

Housing: 1-1618120-3
Contact: 1318107-1
Manufacturer: Tyco Electronics AMP
Wire cross-sectional area: 0.30 to 0.85mm^2
Connector kit: Not required; connector included on resistor

When no Regenerative Discharge Resistor is Used





Housing: 1-1318120-3
Contact: 1318107-1
Manufacturer: Tyco Electronics AMP
Wire cross-sectional area: 0.30 to 0.85mm^2
Connector Kit: A06B-6130-K202

Caution

Do not connect the DCP and DCC pins to each other.

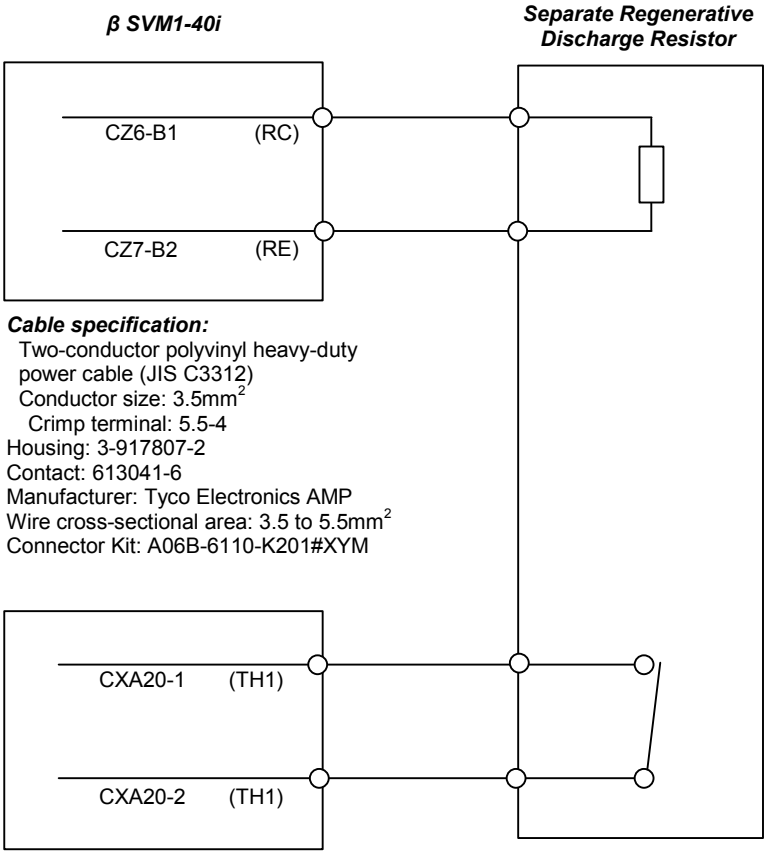
βSVM1-40i

When a Separate Regenerative Discharge Resistor is Used

The following regenerative discharge resistor models are available for the βSVM1-40i amplifier. The users must manufacture the connecting cables.

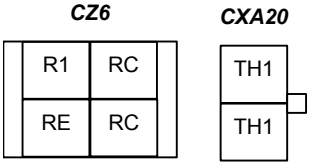
A06B-6089-H500 16 ohms, 200 watts

A06B-6089-H713 16 ohms, 200 watts



Cable specification:
Two-conductor polyvinyl heavy-duty power cable (JIS C3312)
Conductor size: 3.5mm^2
Crimp terminal: 5.5-4
Housing: 3-917807-2
Contact: 613041-6
Manufacturer: Tyco Electronics AMP
Wire cross-sectional area: 3.5 to 5.5mm^2
Connector Kit: A06B-6110-K201#XYM

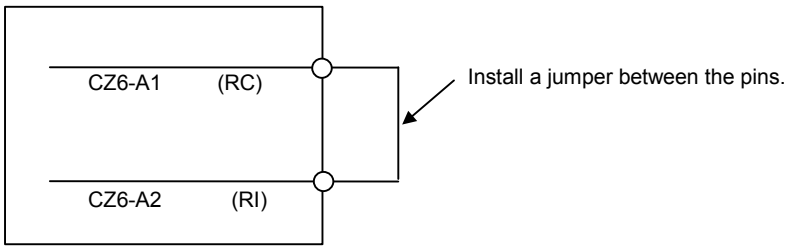
Cable specification:
Two-conductor polyvinyl heavy-duty power cable (JIS C3312)
Conductor size: 0.75mm^2
Crimp terminal: 1.25-4
Housing: 1-1318120-3
Contact: 1318107-1
Manufacturer: Tyco Electronics AMP
Wire cross-sectional area: 0.3 to 0.85mm^2
Connector Kit: A06B-6130-K202



Connector pin location as viewed from the (back) wire insertion side.

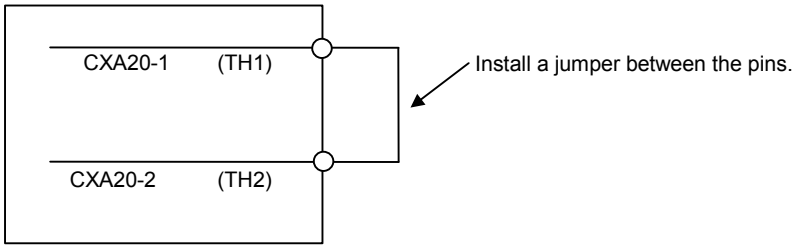
When a Built-in Regenerative Discharge Resistor is Used

βi SVM1-40i



Cable specification:
Two-conductor polyvinyl heavy-duty power cable (JIS C3312)
Conductor size: 3.5mm^2
Crimp terminal: 5.5-4

Housing: 3-917807-2
Contact: 613041-6
Manufacturer: Tyco Electronics AMP
Wire cross-sectional area: 3.5 to 5.5mm^2
Connector Kit: A06B-6110-K201#XYM

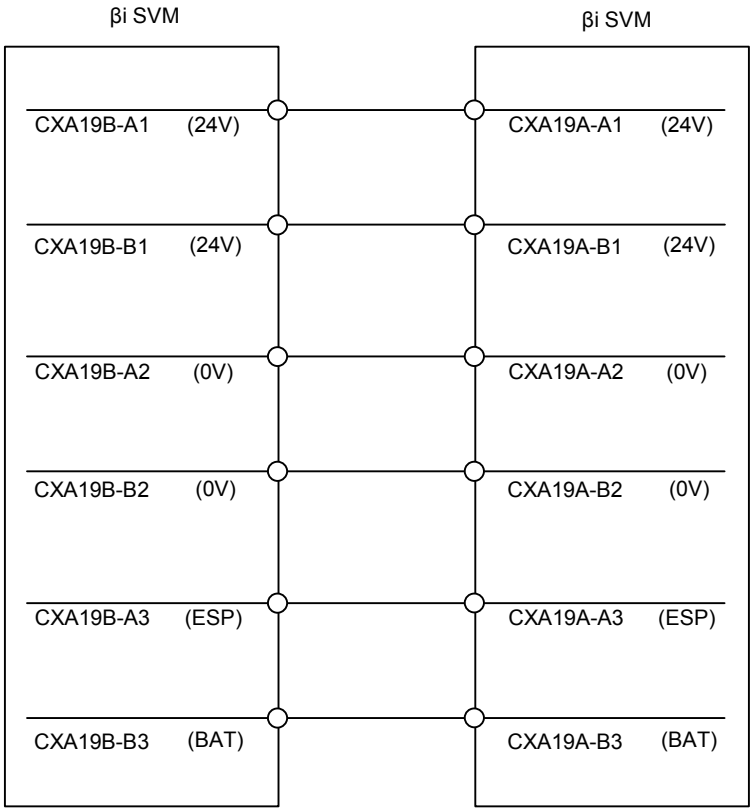


Cable specification:
Two-conductor polyvinyl heavy-duty power cable (JIS C3312)
Conductor size: 0.75mm^2
Crimp terminal: 1.25-4

Housing: 1-1318120-3
Contact: 1318107-1
Manufacturer: Tyco Electronics AMP
Wire cross-sectional area: 0.3 to 0.85mm^2
Connector Kit: A06B-6130-K202

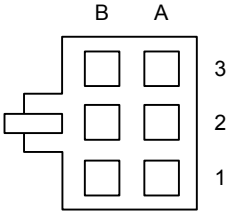
Details of Cable K6 – 24V, E-Stop and Battery Daisy Chain for Multi-Axis Systems

For multi-axis systems, the 24VDC control power, emergency stop, and absolute encoder backup battery signals can be daisy chained from the first amplifier to up to four adjacent amplifiers using the CXA19 connections. The state of the E-stop input signal on connector CX30 on the first amplifier is passed to the other connected amplifiers, allowing an emergency stop condition to be executed on all amplifiers simultaneously. When using this connection for the encoder battery backup, the IC800ABK001 multi-axis battery kit must be connected to the first amplifier. Do not use the IC800BBK021 single-axis battery kit.



Housing: 1-1318119-3
Contact: 1318107-1
Manufacturer: Tyco Electronics AMP
Wire cross-sectional area: 0.3 to 0.85mm^2
Connector Kit: A06B-6130-K201

Housing: 1-1318119-3
Contact: 1318107-1
Manufacturer: Tyco Electronics AMP
Wire cross-sectional area: 0.3 to 0.85mm^2
Connector Kit: A06B-6130-K201



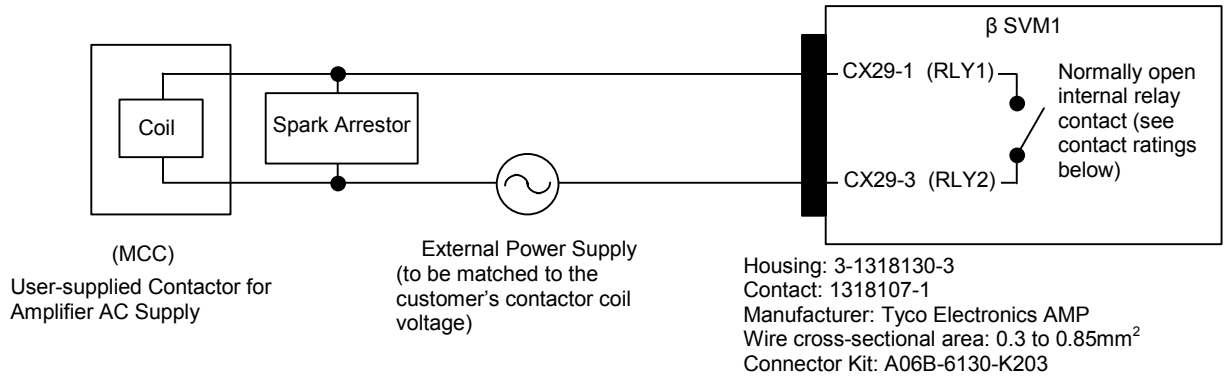
CXA19 connector pin location as viewed from the (back) wire insertion side.

Details of Cable K7 – E-Stop/Power Enable (MCC)

This cable is used to connect the normally open relay contacts on connector CX29 to the power source of the magnetic contactor coil used to interrupt AC power to the amplifier when an amplifier fault occurs or E-stop condition occurs.

The relay contact will close when the amplifier is enabled by the DSM324i controller (MCON signal sent) as long as there are no servo alarms and the E-stop input on connector CX30 is closed. The relay contacts will open when any one or more of the following conditions occurs:

1. 24 VDC power is removed from the amplifier.
2. A servo alarm occurs on the amplifier.
3. The emergency stop input (CX30) to the amplifier is opened.

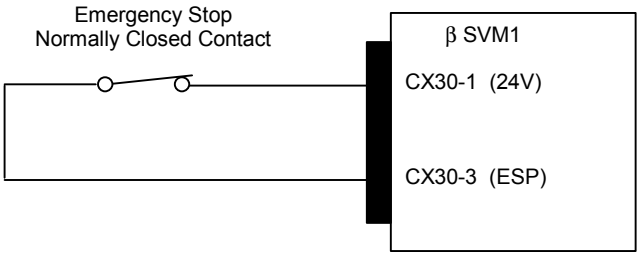


Contact Ratings

Specification of Internal Contact	***Resistor Load (cosΦ=1)***	***Inductance Load (cosΦ=0.4, L/R=7msec)***
Rated load	250 VAC, 5A 30 VDC, 5A	250 VAC, 2A 30 VDC, 2A
Max. current	5A	5A

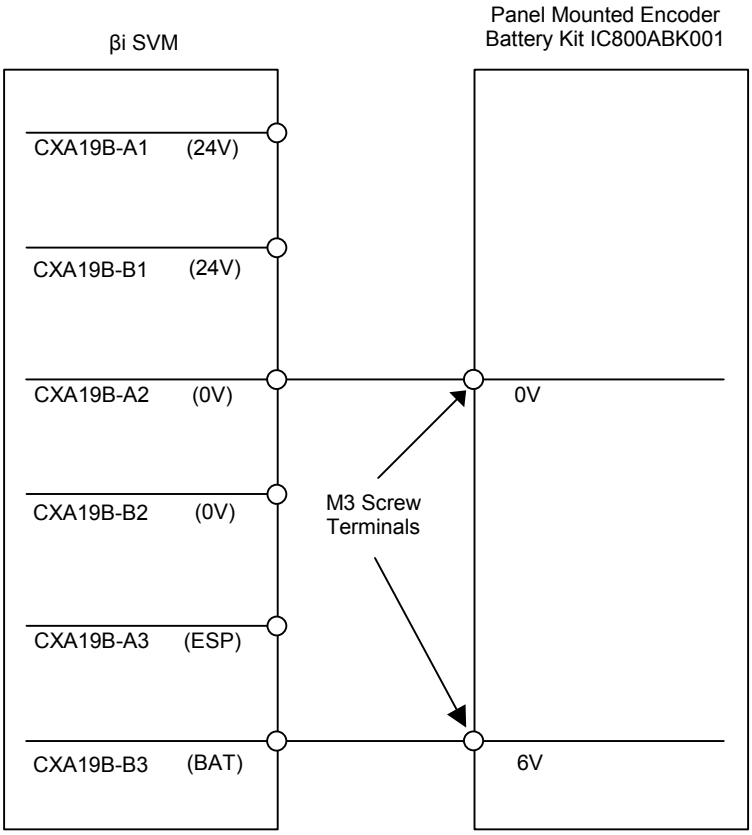
Details of Cable K8 – Servo Amplifier Emergency Stop Connection

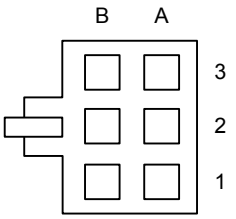
The state of this signal input is reflected on the CXA19 connector pin A3, allowing one E-stop input to be used for all amplifiers in a multi-axis system. When the E-stop input is open, the MCC relay contacts on connector CX29 will open.



Housing: 3-1318120-3
Contact: 1318107-1
Manufacturer: Tyco Electronics AMP
Wire cross-sectional area: 0.3 to 0.85mm^2
Connector Kit: A06B-6130-K204

Details of Cable K9 – Optional External Absolute Encoder Battery Connection





CXA19 connector pin location as viewed from the (back) wire insertion side.

Housing: 1-1318119-3
Contact: 1318107-1
Manufacturer: Tyco Electronics AMP
Wire cross-sectional area: 0.3 to 0.85mm^2
Connector Kit: A06B-3160-K201

Crimp terminal: 1.25-2
Wire cross-sectional area: 0.3 to 0.85mm^2

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