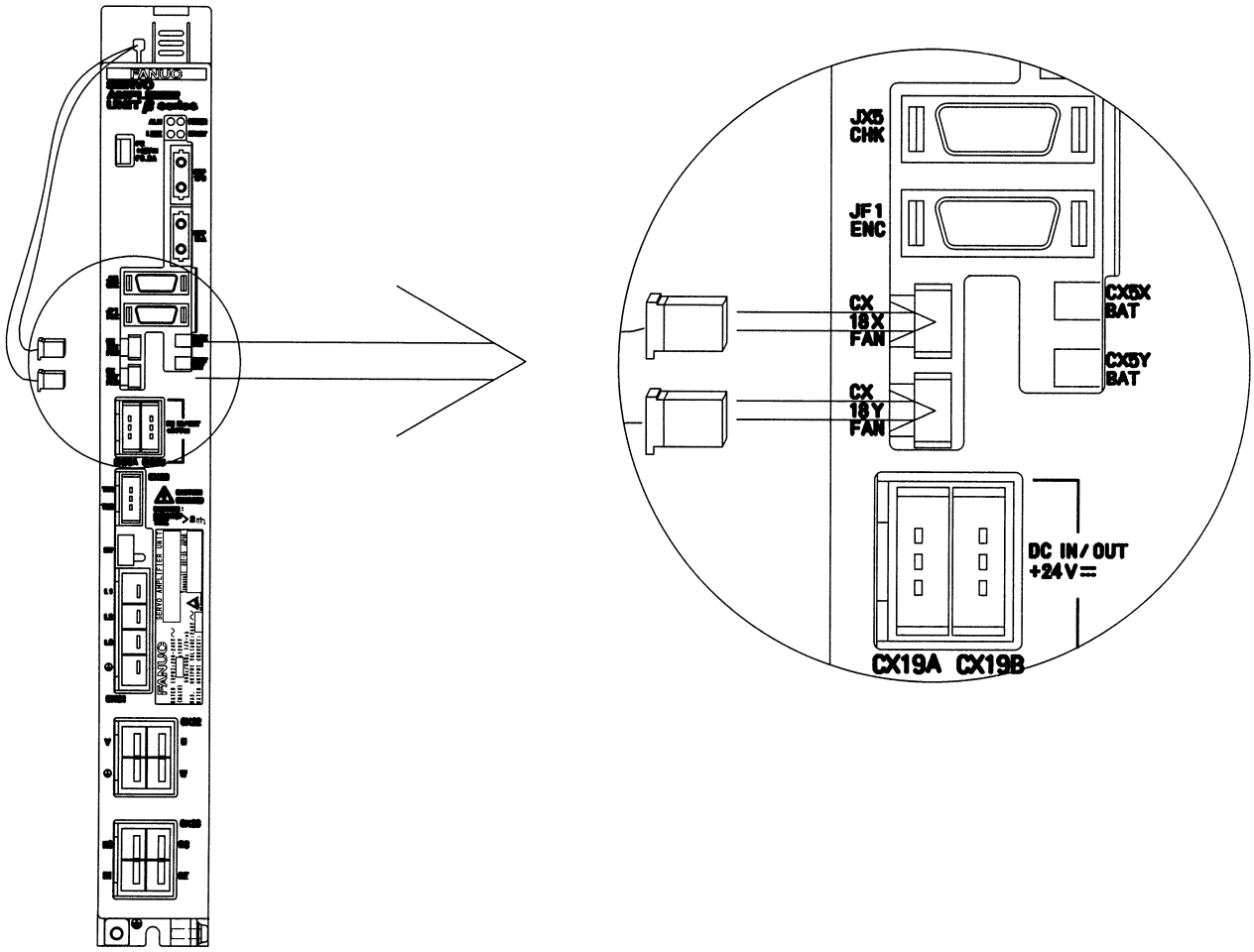
2.4 METHOD OF CONNECTING THE FAN MOTOR

Connect cables of two fan motors to the connector (CX18X, CX18Y) of servo amplifier unit. There is no distinction in CX18X and CX18Y. When the cable is attached or detached to the connector, keep cables loose and not stress to the connector.
Be careful because poor contact may be caused when the fan motor is connected under the condition that the cable spreads.



2.5 UNIT TYPES AND SPECIFICATIONS

Table 2.5(a) Unit types and specifications (1)

Model	Specification	Interface	Application
SVU-4	A06B-6093-H119	FSSB	For a feed axis that requires high precision
	A06B-6093-H159	I/O Link	For positioning that does not require high precision
SVU-12	A06B-6093-H111	FSSB	For a feed axis that requires high precision
	A06B-6093-H151	I/O Link	For positioning that does not require high precision
	A06B-6093-H101	PWM	For a feed axis that requires high precision
SVU-20	A06B-6093-H112	FSSB	For a feed axis that requires high precision
	A06B-6093-H152	I/O Link	For positioning that does not require high precision
	A06B-6093-H102	PWM	For a feed axis that requires high precision
SVU-40	A06B-6093-H113	FSSB	For a feed axis that requires high precision
	A06B-6093-H153	I/O Link	For positioning that does not require high precision
	A06B-6093-H103	PWM	For a feed axis that requires high precision
SVU-80	A06B-6093-H114	FSSB	For a feed axis that requires high precision
	A06B-6093-H154	I/O Link	For positioning that does not require high precision
	A06B-6093-H104	PWM	For a feed axis that requires high precision

Table 2.5(b) Applicable motor (αi series servo motor)

Amplifier model	Motor model	1	2	3	4		8			12		22		
	αi	α1 /5000i (20A)	α2 /5000i (20A)			α4 /4000i (40A)		α8 /3000i (40A)			α12 /3000i (80A)		α22 /3000i (80A)	
	αMi		αM2 /5000i (20A)	αM3 /5000i (20A)					αM8 /4000i (80A)		αM12 /4000i (80A)			
	αCi				αC4 /3000i (20A)		αC8 /2000i (20A)			αC12 /2000i (20A)		αC22 /2000i (40A)		αC30 /1500i (80A)
SVU-20	H112	O	O	O	O		O			O				
	H152													
	H102													
SVU-40	H113					O		O				O		
	H153													
	H103													
SVU-80	H114								O		O		O	O
	H154													
	H104													

Table 2.5(c) Applicable motor (βM, β series servo motor)

Amplifier model	Motor model	0.2	0.3	0.4	0.5	1		2	3	6
	βM	βM0.2 /4000 (4A)	βM0.3 /4000 (4A)	βM0.4 /4000 (20A)	βM0.5 /4000 (20A)	βM1 /4000 (20A)				
	β						β1 /3000	β2 /3000	β3 /3000	β6 /2000
SVU-4	H119	O	O							
	H159									
SVU-12	H111						O	O		
	H151									
	H101									
SVU-20	H112			O	O	O			O	O
	H152									
	H102			O						

Table 2.5(d) Unit types and specifications (2)

Classification	Name	Application		Specification
Basic	AC line filter (Note 1)	Type A: For applications where the sum of the rated motor powers does not exceed 5.4 kW		A81L-0001-0083#3C
		Type B: For applications where the sum of the rated motor powers does not exceed 10.5 kW		A81L-0001-0101#C
		Type C: For applications where the sum of the rated motor powers does not exceed 23 kW		A81L-0001-0102
Option	Power transformer for export (Note 2)	Type SAE : Capacity 2.2kVA		A80L-0022-0005
		Type SBE : Capacity 3.5kVA		A80L-0024-0006
		Type SCE : Capacity 5.0kVA		A80L-0026-0003
		Type SDE : Capacity 7.5kVA		A80L-0028-0001
	Separated regenerative discharge unit (Caution)	30Ω/20W at natural cooling	For SVU-4, SVU-12, SVU-20	A06B-6093-H401
		30Ω/100W at natural cooling	For SVU-4, SVU-12, SVU-20	A06B-6093-H402 (Note 3)
		16Ω/200W at natural cooling	For SVU-40, SVU-80	A06B-6089-H500
		16Ω/800W with cooling fan motor	For SVU-40, SVU-80	A06B-6089-H713
		16Ω/1200W with cooling fan motor	For SVU-40, SVU-80	A06B-6089-H714
	Fan adapter	With forced air cooling (Note 4)	For SVU-40, SVU-80	A06B-6078-K002

⚠ CAUTION

A separated regenerative discharge unit must be used when the amount of regenerative energy produced by the motor exceeds a specified value because of a high load inertia of frequent acceleration/deceleration.
Refer to Chapter 4 "Separated regenerative discharge unit" for details of regenerative discharge unit. For information about connections, see Part V, "CONNECTION". An incorrect connection can damage the amplifier. Care must be taken.

NOTE

1 An AC line filter must be used to suppress the influences of high-frequency noise on the power supply.
When a power transformer (insulation type) is used because a power supply voltage within the specified range is not available, this AC line filter is not necessary. If the use of this AC line filter fails to fully satisfy EMC requirements the use of a commercially available noise filter is recommended.
2 At single-phase power input, it is not necessary.
If the line voltage is higher than 200/220/230 VAC, use a power transformer. When a transformer is used, as AC line filter usually becomes unnecessary, however in case that requirements of EMC standard are still not satisfied, AC line filter will be needed.
3 A06B-6093-H402 contains a connector kit for connection with a β series amplifier as a standard accessory.

Table 2.5(e) Unit types and specifications (for SVU-4, SVU-12, SVU-20)

Classification	Name	Application		Specification
Basic	Connector (PWM)	JX5 : For ESP signal	Solder type	A06B-6073-K212
			Crimp type	A06B-6073-K213
	Connector (PWM)	JS1B : NC-SVU command cable	Solder type	A06B-6073-K212
			Crimp type	A06B-6073-K213
	Connector (I/O Link)	JD1A : For I/O Link	Solder type	A06B-6073-K212
			Crimp type	A06B-6073-K213
	Connector (I/O Link)	JD1B : For I/O Link	Solder type	A06B-6073-K212
			Crimp type	A06B-6073-K213
	Connector (I/O Link)	JA35 : For built-in DI input cable	Solder type	A06B-6073-K212
			Crimp type	A06B-6073-K213
	Connector (common)	JF1 : For pulse coder F/B cables		A06B-6073-K214
	Connector (common)	JA34 : For external pulse input cable		A06B-6073-K214
	Connector (common)	CX11-1, 3, 4, 5 and dummy plug for 6: When a regenerative discharge unit is not used		(Caution) A06B-6093-K305
	Connector (common)	CX11-1, 3, 4, 5: When a regenerative discharge unit is used		(Caution) A06B-6093-K306
	Connector (common) (Note 1)	CX11-4, 5: When the cross-sectional area of wire exceeds 0.5 mm^2		A06B-6093-K304
	Fuse (common)	For protecting control power 24 VDC from a short-circuit		A06B-6073-K250
Option	Connector	CX5X, Y: For battery cable		A06B-6093-K303
	Battery case	For absolute pulse coders. Connection method 1 (Note 2)		A06B-6093-K002
	Battery	For absolute pulse coders. Connection method 1 (Note 2)		A06B-6093-K001
	Battery case	For absolute pulse coders. Connection method 2 (Note 2)		A06B-6050-K060
	Battery	For absolute pulse coders. Connection method 2 (Note 2)		A06B-6050-K061
	Battery case	For absolute pulse coders (Cable length: 5m). Connection method 2 (Note 2)		A06B-6093-K810
	Lightning surge absorber	Not complying with the standard (Warning)		A06B-6077-K141
		Complying with the standard (Warning)		A06B-6077-K142

The terms "PWM," " I/O Link," and "common" used in the Name column indicate what interface to be used.
PWM : The PWM interface is used.
I/O Link : The I/O Link interface is used.
Common : Both PWM and I/O Link interfaces can be used.

⚠ WARNING

At the power input of the power magnetics cabinet, install a surge absorber between the power lines and between each power line and a ground to protect the unit from a voltage surge caused by lightning.
See Section 7.5 for details of the lightning surge absorber.

⚠ CAUTION

Refer to Chapter 4 "Separated regenerative discharge unit" for details of regenerative discharge unit. For information about connections, see Part V, "CONNECTION". An incorrect connection can damage the amplifier. Care must be taken.

NOTE

1 When multiple β series amplifiers are connected, and a wire with a diameter of 0.53 mm^2 or more needs to be used, select this connector. The supply current of the control power supply per β series amplifier is 0.6 A for the FSSB interface, 0.9 A for the I/O Link interface, or 0.4 A for the PWM interface. So, select an appropriate wire according to the number of β series amplifiers to be connected.
2 There are two methods of connecting the batteries for the absolute pulse coder. Specify an appropriate battery case and battery according to the connection method selected.

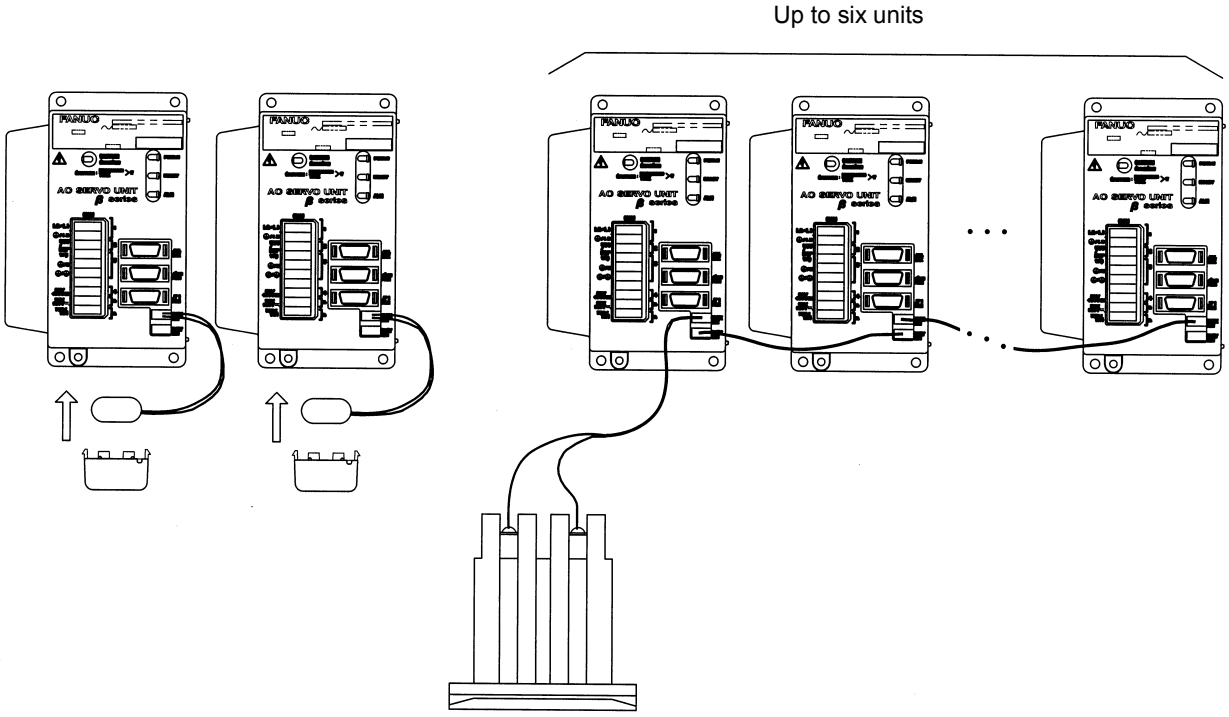


Table 2.5(f) Unit types and specifications (for SVU-40, SVU-80)

Classification	Name	Application		Specification
Basic	Connector (common)	CX21: For input power line	Crimp type	A06B-6093-K311
	Connector (common)	CX22: For motor power line (cross-sectional area of wire is under 3.5 mm^2)	Crimp type	A06B-6093-K312
	Connector (common)	CX22: For motor power line (cross-sectional area of wire is under 3.5 mm^2)	Crimp type	A06B-6093-K313
	Connector (common)	CX20, CX23:For regenerative discharge resistor (When separate regenerative discharge resistor is not used.)	Crimp type	A06B-6093-K314 (Note 1)
	Connector (common)	CX20, CX23: For regenerative discharge resistor (When separate regenerative discharge resistor is used.)	Crimp type	A06B-6093-K315 (Note 1)
	Connector (common)	CX19A/B: For 24 VDC input/output connector	Crimp type	A06B-6093-K316
	Connector (common)	CX19A/B: For 24 VDC input/output connector	Crimp type	A06B-6093-K317 (Note 2)
	Connector (common)	JF1 : For pulse coder F/B cables	Solder type	A06B-6073-K214
	Fuse (common)	For protecting control power 24 VDC from a short-circuit		A06B-6073-K250
	Connector (PWM, FSSB)	JX5 : For ESP signal	Solder type	A06B-6073-K212
			Crimp type	A06B-6073-K213
	Connector (PWM)	JS1B : NC-SVU command cable	Solder type	A06B-6073-K212
			Crimp type	A06B-6073-K213
	Connector (I/O Link)	JD1A : For I/O Link	Solder type	A06B-6073-K212
			Crimp type	A06B-6073-K213
	Connector (I/O Link)	JD1B : For I/O Link	Solder type	A06B-6073-K212
			Crimp type	A06B-6073-K213
	Connector (I/O Link)	JA35 : For built-in DI input cable	Solder type	A06B-6073-K212
			Crimp type	A06B-6073-K213
	Connector (I/O Link)	JA34 : For external pulse input cable		A06B-6073-K214
Option	Connector (common)	CX5X, Y : For battery		A06B-6093-K303
	Battery case (common)	For absolute pulse coders. Connection method 1 (Note 3)		A06B-6093-K002
	Battery (common)	For absolute pulse coders. Connection method 1 (Note 3)		A06B-6093-K001
	Battery case (common)	For absolute pulse coders. Connection method 2 (Note 3)		A06B-6050-K060
	Battery (common)	For absolute pulse coders. Connection method 2 (Note 3)		A06B-6050-K061
	Lightning surge absorber (common)	Not complying with the standard (Note 4)		A06B-6077-K141
		Complying with the standard (Note 4)		A06B-6077-K142

The terms "PWM," " I/O Link," and "common" used in the Name column indicate what interface to be used.
PWM : The PWM interface is used.
I/O Link : The I/O Link interface is used.
Common : The FSSB interface, I/O Link interface, and PWM interface can be used.

⚠ WARNING

At the power input of the power magnetics cabinet, install a surge absorber between the power lines and between each power line and a ground to protect the unit from a voltage surge caused by lightning.
See Section 7.5 for details of the lightning surge absorber.

NOTE

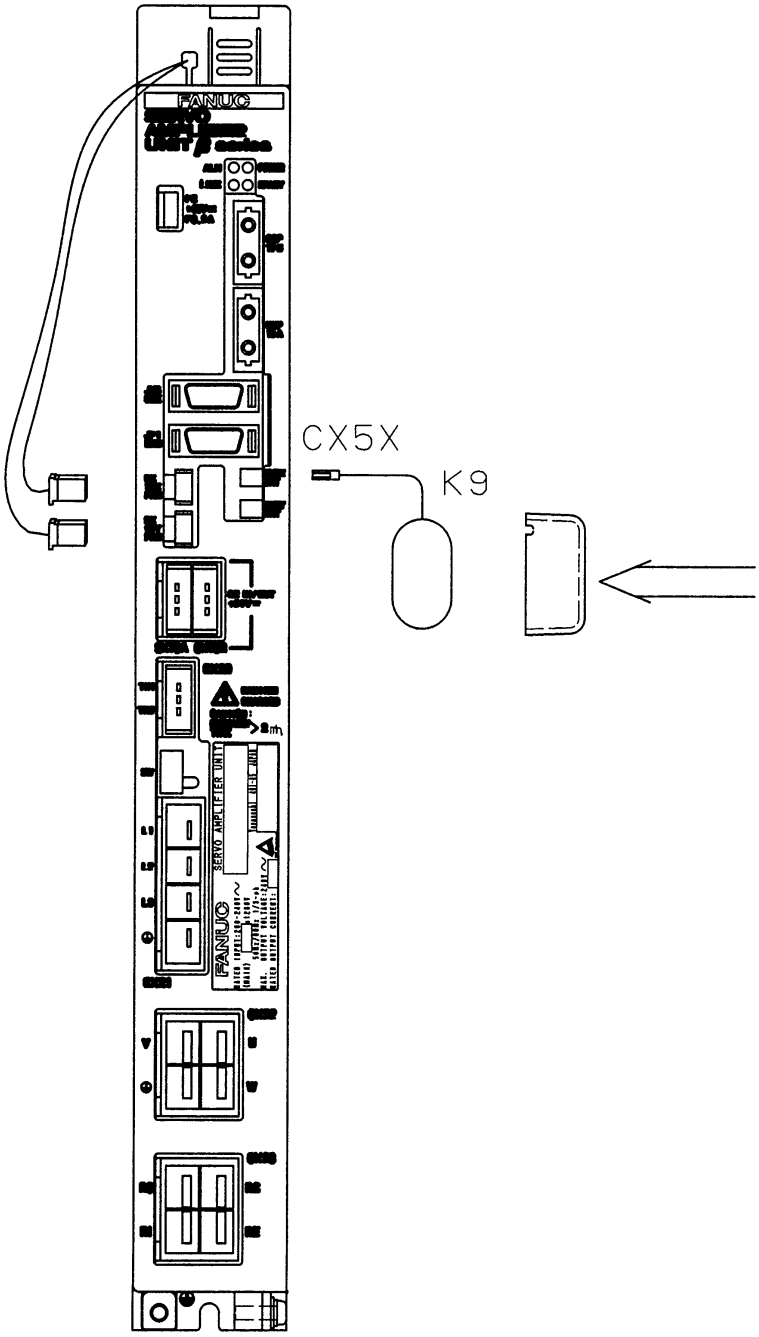
1 When no separate regenerative resistor is used, a dummy connector for connecting the overheat alarm (OH alarm) for separate regenerative resistors and a dummy connector for connecting a resistance wire are required.
Specify the ordering drawing number A06B-6093-K314 when ordering dummy connectors for connecting the OH alarm and resistance wire.
Specify the ordering drawing number A06B-6093-K315 when ordering a housing and contact for connecting a separate regenerative resistor with a β series amplifier.

2 When multiple β series amplifiers are connected, and a wire with a diameter of 0.5 mm^2 or more needs to be used, select this connector. The supply current of the control power supply per β series amplifier is 0.6 A for the FSSB interface, 0.9 A for the I/O Link interface, or 0.4 A for the PWM interface. So, select an appropriate wire according to the number of β series amplifiers to be connected.

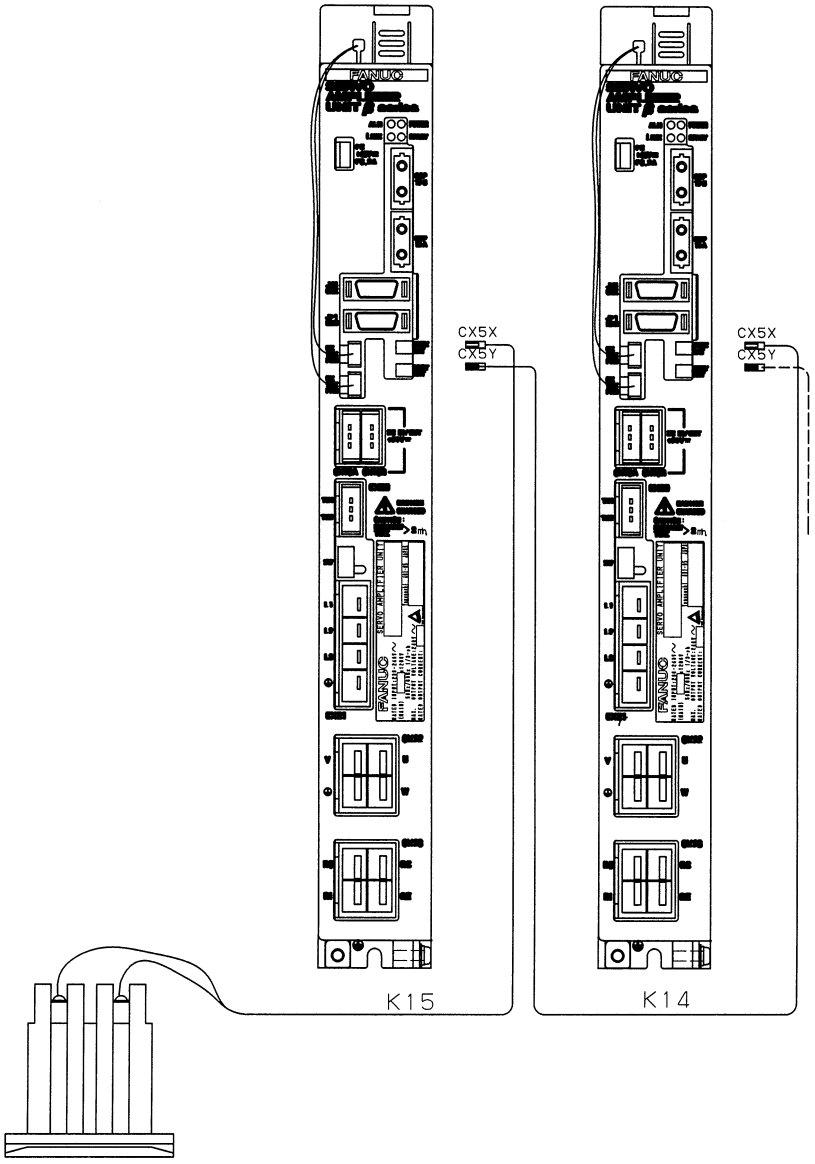
3 There are two methods of connecting the batteries for the absolute pulse coder. Specify an appropriate connection method according to the use environment.

4 See Section 3.2, "DERATING", to choose whether to cool the β series amplifier by natural air cooling or by forced air cooling.
For forced air cooling, a fan motor with a wind speed of 2 m/sec is required.
A desired cooling capability can be obtained by using a fan adapter.
For the attachment of a fan adapter, see Section 9.2, "PANEL CUT-OUT DRAWING" for forced air cooling.
When using forced air cooling, design a power magnetics cabinet so that cooling air from the fan motor does not leak. The fan motor may need to be maintained and replaced, depending on the use environment. So, give a consideration to the installation and structure of a fan motor so that maintenance and replacement work can be performed easily.

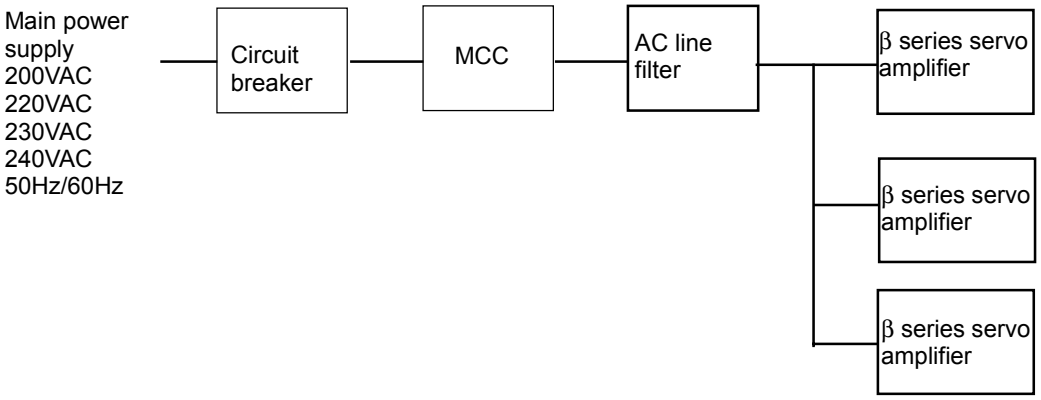
Connection method 1



Connection method 2



2.6 CIRCUIT BREAKER, ELECTROMAGNETIC CONTACTOR, AND AC LINE FILTER



2.6.1 Circuit Breaker Rating

Select an appropriate circuit breaker based on Table 2.6.1. When connecting multiple amplifiers to one circuit breaker, select a circuit breaker according to the sum of the input currents of the individual motors at continuous rated output based on Table 2.6.1.
Note that, during rapid motor acceleration, a current that is roughly triple the continuous rating flows. Therefore, select a circuit breaker that does not trip when a current that is triple the continuous rating flows for 3 seconds.
When certification of the European standard (VDE0160) is to be obtained, the capacity of a circuit breaker needs to be limited for protection of cables such as power input cables.
When connecting multiple amplifiers to one circuit breaker, select a circuit breaker so that the value obtained by multiplying the sum of the input currents of the individual motors at continuous rated output based on Table 2.6.1 by 0.6 does not exceed the rated current of the circuit breaker.

> ⚠ **WARNING**
> For servo amplifier protection, use a correct circuit breaker.
> SVU-4, SVU-20: Circuit breaker of 10 A or less
> SVU-40, SVU-80: Circuit breaker of 20 A or less

Example selection:
EA33 Series manufactured by Fuji Electric Co., Ltd.

Table 2.6.1 Currents drawn by motors operating at continuous rated output

Motor model	Input current (three-phase input) (Arms)	Input current (single-phase input) (Arms)
βM0.2/4000	0.2	0.4
βM0.3/4000	0.4	0.9
βM0.4/4000	0.6	1.1
βM0.5/4000	0.9	1.7
βM1/4000	1.8	3.5
β1/3000	1.3	2.6
β2/3000	2.2	4.3
β3/3000	2.2	4.3
β6/2000	4.0	7.8
α1/5000*i*	2.2	4.3
α2/5000*i*	3.3	6.5
α4/4000*i*	6.2	12.1
α8/3000*i*	7.1	13.8
α12/3000*i*	13.4	19.0 (*1)
α22/3000*i*	17.8	19.0 (*1)
αM2/5000*i*	3.3	10.4
αM3/5000*i*	4.5	8.6
αM8/4000*i*	11.1	19.0 (*1)
αM12/4000*i*	12.0	19.0 (*1)
αC4/3000*i*	4.5	8.6
αC8/2000*i*	5.3	8.6 (*1)
αC12/2000*i*	8.0	8.6 (*1)
αC22/2000*i*	13.4	19.0 (*1)
αC30/1500*i*	18.7	19.0 (*1)

(*1) Depends on the output limit applicable when single-phase input is used.

Example)
Connecting two β6/2000 units operating on three-phase power
Because one β6/2000 unit requires an input current of 4.0 Arms:
$(4.0+4.0) \times 0.6 \fallingdotseq 4.8$ Arms
So, a 10A circuit breaker can be used.

2.6.2 Electromagnetic Contactor Rating

Select an appropriate electromagnetic contactor based on Table 2.6.2. When multiple amplifiers are to be connected to a single electromagnetic contactor (MCC), select an MCC based on the currents on Table 2.4.1.

Table 2.6.2 Recommendation example of electromagnetic contactor

Manufactured by Fuji Electric Co., Ltd.	Rated current
SC-03	11Apeak
SC-4-1	18Apeak
SC-1N	26Apeak

2.6.3 AC Line Filter

When multiple amplifiers are connected to a single AC line filter, select a line filter based on the sum of the currents on Table 2.6.3.
An AC line filter or an EMC noise filter must be used to suppress the influence of high-frequency noise on the power supply unit.
The EMC noise filters of the LF series are available from Tokin Corporation.

Table 2.6.3 AC line filter specifications

AC line filter	Continuous rated current	Continuous rated power	Heat dissipation
Type A:A81L-0001-0083#3C	24A	5.4kW or less	20W
Type B:A81L-0001-0101#C	44A	10.5kW or less	70W
Type C:A81L-0001-0102	100A	23.0kW or less	50W

2.7 CONNECTOR

Specification : A06B-6093-K311

Connector name	Part number	Manufacturer	Use	Quantity	Remarks
CX21	1-179958-4 (housing)	AMP Japan, Ltd.	For input power line (200 VAC input)	1	Crimp type
	316041-2 (contact)			4	

Specification : A06B-6093-K312

Connector name	Part number	Manufacturer	Use	Quantity	Remarks
CX22	1-917807-2 (housing)	AMP Japan, Ltd.	For motor power line	1	Crimp type
	316040-2 (contact)			4	

Specification : A06B-6093-K313

Connector name	Part number	Manufacturer	Use	Quantity	Remarks
CX22	1-917807-2 (housing)	AMP Japan, Ltd.	For motor power line	1	Crimp type
	316041-2 (contact)			4	

Specification : A06B-6093-K315

Connector name	Part number	Manufacturer	Use	Quantity	Remarks
CX20	2-178288-3 (housing)	AMP Japan, Ltd.	For separate regenerative discharge resistor (for OH alarm)	1	Crimp type
	1-175218-5 (contact)			2	
CX23	2-917807-2 (housing)	AMP Japan, Ltd.	For separate regenerative discharge resistor (for resistor)	1	Crimp type
	316041-2 (contact)			2	

Specification : A06B-6093-K316

Connector name	Part number	Manufacturer	Use	Quantity	Remarks
CX19A	1-178288-3 (housing)	AMP Japan, Ltd.	For control unit 24VDC (IN)	1	Crimp type
	1-175217-5 (contact)			2	
CX19B	1-178288-3 (housing)	AMP Japan, Ltd.	For control unit 24VDC (OUT)	1	Crimp type
	1-175217-5 (contact)			2	

Specification : A06B-6093-K317

Connector name	Part number	Manufacturer	Use	Quantity	Remarks
CX19A	1-178288-3 (housing)	AMP Japan, Ltd.	For control unit 24VDC (IN)	1	Crimp type
	1-175218-5 (contact)			2	
CX19B	1-178288-3 (housing)	AMP Japan, Ltd.	For control unit 24VDC (OUT)	1	Crimp type
	1-175218-5 (contact)			2	

3 SPECIFICATIONS

3.1 SPECIFICATIONS

Table 3.1 (a) Specifications (common)

Item		Specifications
Power supply	Three-phase input power supply for motor power	Voltage: 200 VAC to 240 VAC Allowable voltage fluctuation: +10%, -15% (Note) Frequency: 50 Hz, 60 Hz Allowable frequency fluctuation: ±2 Hz Voltage fluctuation during acceleration/deceleration: 7% or less
	Single-phase power supply for motor power (Note)	Voltage: 220 VAC to 240 VAC Allowable voltage fluctuation: +10%, -15% (Note) Frequency: 50 Hz, 60 Hz Allowable frequency fluctuation: ±2 Hz Voltage fluctuation during acceleration/deceleration: 7% or less
	Single-phase input power supply for control power	Voltage: 24 VDC Allowable voltage fluctuation: ±10%
Main circuit control system		Sinusoidal PWM control based on transistor (IGBT) bridge
Alarm protection function		Converter: main circuit overload alarm Converter: control power supply undervoltage alarm Converter: DC link undervoltage alarm Inverter: Abnormal current alarm Converter: DC link undervoltage alarm Converter: excessive deceleration power alarm Converter: cooling fan stopped alarm FSSB disconnection alarm

Table 3.1 (b) Specifications (individual)

Name		Specification	Rated output current (RMS value)	Nominal current limiting (peak value)
SVU-4	FSSB interface	A06B-6093-H119	0.9 Arms	4 Apeak
	I/O Link interface	A06B-6093-H159		
SVU-12	FSSB interface	A06B-6093-H111	3.2 Arms	12 Apeak
	I/O Link interface	A06B-6093-H151		
	PWM interface	A06B-6093-H101		
SVU-20	FSSB interface	A06B-6093-H112	5.9 Arms	20 Apeak
	I/O Link interface	A06B-6093-H152		
	PWM interface	A06B-6093-H102		
SVU-40	FSSB interface	A06B-6093-H113	12 Arms	40 Apeak
	I/O Link interface	A06B-6093-H153		
	PWM interface	A06B-6093-H103		
SVU-80	FSSB interface	A06B-6093-H114	18.9 Arms	80 Apeak
	I/O Link interface	A06B-6093-H154		
	PWM interface	A06B-6093-H104		

NOTE

The allowable voltage fluctuation is a change observed for several minutes. It is not a continuous change.

The rated output is guaranteed provided the rated input voltage is applied. If the input voltage fluctuates, however, the rated output may not be obtained even if the fluctuation falls within the allowable fluctuation range.

3.2 DERATING

Motor current derating or output derating is required, depending on the motor used.

3.2.1 For SVU-20

Output derating is required to drive β6/2000, α2/5000*i*, αM2/5000*i*, αM3/5000*i*, αC4/3000*i*, αC8/2000*i*, and αC12/2000*i* with single-phase input.

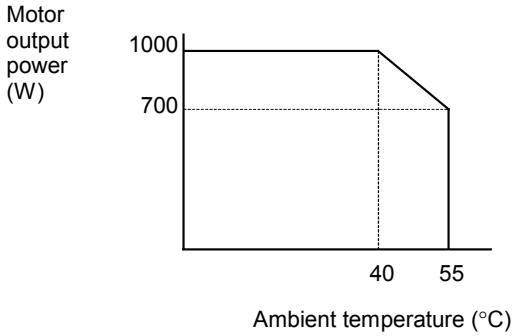


Fig. 3.2.1 Single-phase input time

3.2.2 For SVU-40 and SVU-80

Table 3.2.2(a) Three-phase input time

Motor specifications				Specifications of β series amplifiers SVU-40 and SVU-80		
Motor	**Peak current (Ap)**	**Rated current (Arms)**	**Rated output (kW)**	**Peak current (Ap)**	**Natural air cooling**	**Forced air cooling**
α4/4000*i*	40	7.7	1.4	40	A	A
α8/3000*i*		8.4	1.6		Not usable.	A
αM8/4000*i*		11.1	2.5		Not usable.	A
αC22/2000*i*		12.3	3.0		Not usable.	A
αM8/4000*i*	80	11.1	2.0	80	Not usable.	A
αM12/4000*i*		13.4	2.7		Not usable.	A
α12/3000*i*		18.1	3.0		Not usable.	B (15Arms at 55°C)
α22/3000*i*		18.4	4.0		Not usable.	B (15Arms at 55°C)
αC30/1500*i*		14.2	4.2		Not usable.	A

A : Usable without circuit derating at an ambient temperature of up to 55°C for the amplifier.

B : Requires the current derating shown in the following figure.
Motor output current derating curve

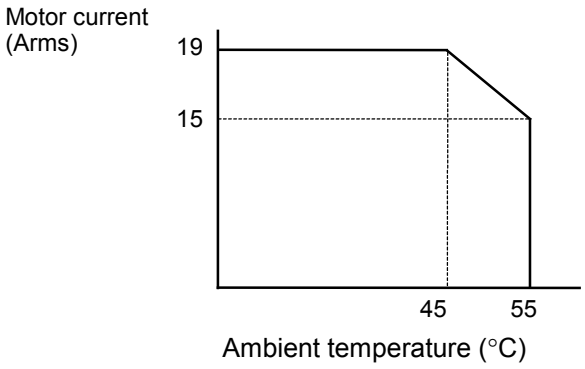


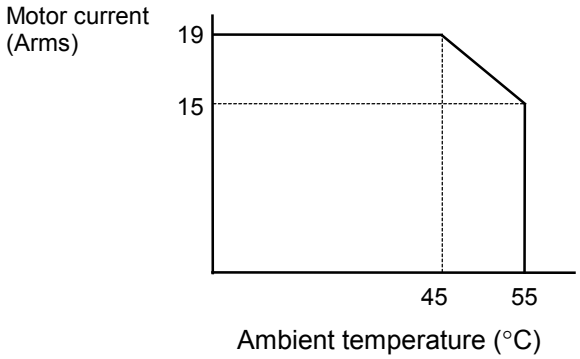
Table 3.2.2(b) Single-phase input time

Motor specifications				Specifications of β series amplifiers SVU-40 and SVU-80		
Motor	**Peak current (Ap)**	**Rated current (Arms)**	**Rated output (kW)**	**Peak current (Ap)**	**Natural air cooling**	**Forced air cooling**
α4/4000*i*	40	7.7	1.4	40	A	A
α8/3000*i*		8.4	1.6		Not usable.	A
αM8/4000*i*		11.1	2.5		Not usable.	C (1.9kW at 55°C)
αM8/4000*i*	80	11.1	2.0	80	Not usable.	C (1.9kW at 55°C)
αM12/4000*i*		13.4	2.7		Not usable.	C (1.9kW at 55°C)

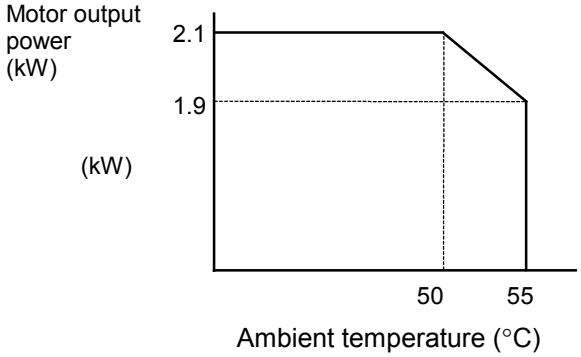
A : Usable without circuit derating at an ambient temperature of up to 55°C for the amplifier.

C : Requires the current derating shown in the following figure.

The α12/3000*i*, α22/3000*i*, αC22/2000*i*, and αC30/1500*i* motors cannot be used with the single phase.



Derating curve of motor output current

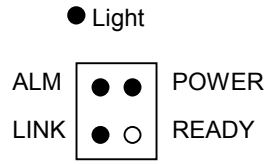
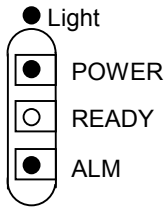


Derating curve of motor output

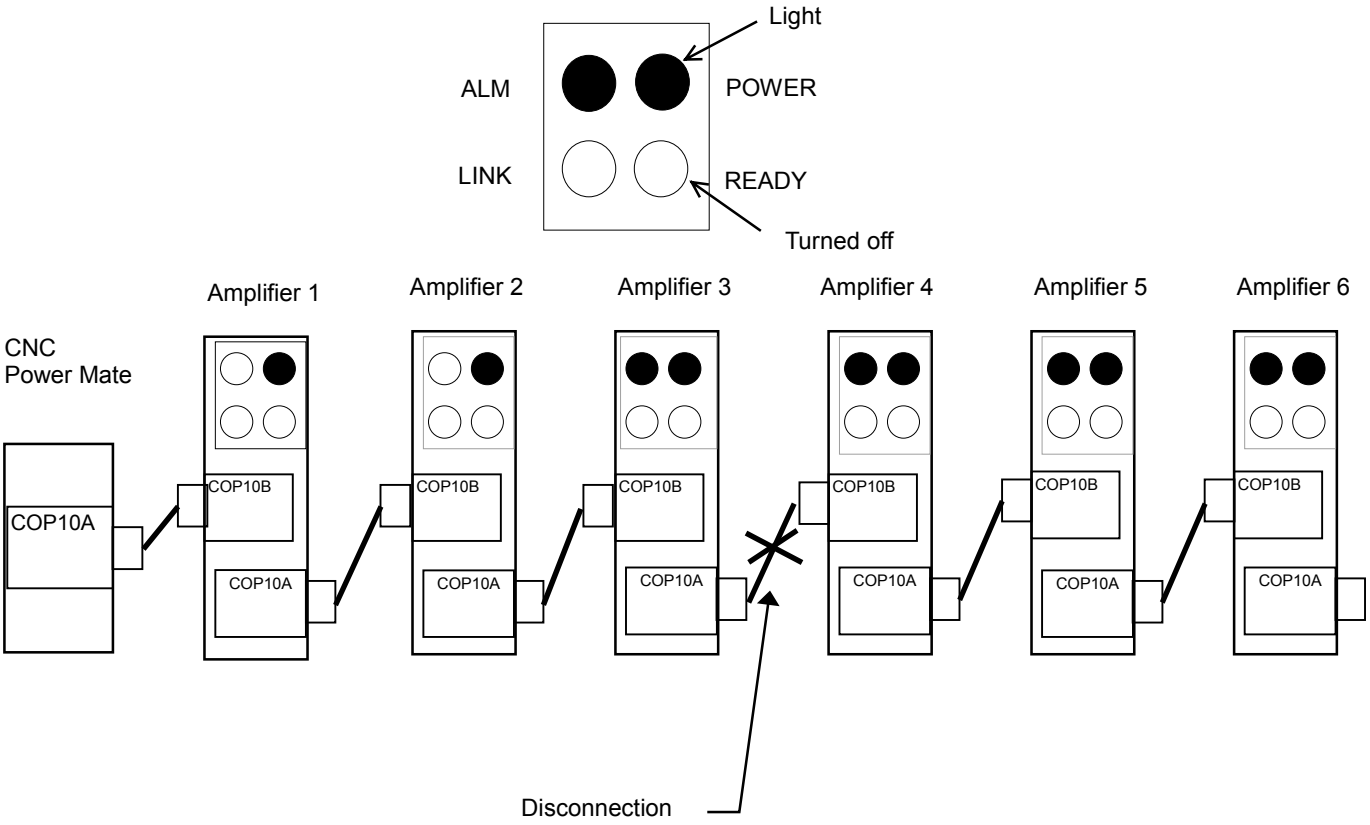
3.3 PROTECTION AND ABNORMALITY DETECTION FUNCTIONS

The servo amplifier is provided with the protection and abnormality detection functions indicated below.
Determine any alarm status from the diagnostic data displayed by the controller.
- Converter: main circuit overload
- Converter: control power supply undervoltage alarm
- Converter: DC link undervoltage alarm
- Inverter: Abnormal current alarm
- Converter: DC link undervoltage alarm
- Converter: excessive deceleration power alarm
- Converter: cooling fan stopped alarm
- FSSB disconnection alarm

When an alarm is issued, the LED "ALM" is turned on with the FSSB interface and PWM interface, and a 7-segment indicator is turned on with the I/O Link interface. For details of the 7-segment interface, refer to "FANUC SERVO MOTOR β series I/O Link Option Maintenance Manual".

FSSB interface	PWM interface	State	Description
		Alarm	Check the details of the alarm with diagnostic data on the controller.

When an FSSB disconnection alarm is issued, the faulty location can be identified using the check method described below.
When an FSSB disconnection alarm is issued, the "LINK" and "READY" LEDs are turned off, and the "ALM" LED is turned on.

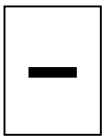
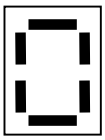


When the optical cable connecting the third β amplifier with the fourth β amplifier, the "ALM" LEDs on the third and subsequent amplifiers are turned on, and the "LINK" LEDs and the "READY" LEDs are turned off.

3.4 NORMAL OPERATING MODE

In normal operating mode, the LEDs located on the front of the servo amplifier light as indicated below.

Table 3.4 Normal Operating Mode

FSSB interface	I/O Link interface LED display	PWM interface	State	Description
● Light ALM ○ ● POWER LINK ○ ○ READY		● Light ● POWER ○ READY ○ ALM	Amplifier NOT READY	Indicates that the control power supply voltage (+24 VDC) is applied.
ALM ○ ● POWER LINK ● ● READY		● POWER ● READY ○ ALM	Amplifier READY	Indicates that the motor has been activated, and that the servo amplifier is ready to accept commands.

4 SEPARATED REGENERATIVE DISCHARGE UNIT

4.1 FOR SVU-4, SVU-12, AND SVU-20

4.1.1 Cases Where a Separated Regenerative Discharge Unit Is Not Required

When the amount of regenerative energy produced [J] never exceeds the amounts indicated in Table 4.1, a separated regenerative discharge unit is not required.

For an external connection to be made when a regenerative discharge unit is not used, see Part V, "CONNECTION", of this manual.

An incorrect connection can damage the amplifier. Care must be taken.

Table 4.1 Maximum allowable regenerative energy for amplifiers

Name	Maximum allowable regenerative energy
SVU-12	13 [J]
SVU-20	16 [J]

Calculating the amount of regenerative energy produced - For horizontal operation

(a) When the SI unit system is used

$$P = (5.48\times10^{-3}\cdot(Jm+JL)\cdot Vm^2 - 5.23\times10^{-2}\cdot ta\cdot Vm\cdot TL)\ [J] \quad \text{(Expression 1)}$$

Jm: Motor rotor inertia [kg·m^2]
JL: Load inertia converted to motor shaft inertia [kg·m^2]
Vm: Motor speed during rapid traverse [min^{-1}]
ta: Acceleration/deceleration duration during rapid traverse [sec]
TL: Machine tool friction torque (in terms of motor) [N·m]

(b) When the CGS unit system is used

$$P = (5.37\times10^{-4}\cdot(Jm+JL)\cdot Vm^2 - 5.13\times10^{-3}\cdot ta\cdot Vm\cdot TL)\ [J] \quad \text{(Expression1)}$$

Jm: Motor rotor inertia [kgf·cm·sec^2]
JL: Load inertia converted to motor shaft inertia [kgf·cm·sec^2]
Vm: Motor speed during rapid traverse [min^{-1}]
ta: Acceleration/deceleration duration during rapid traverse [sec]
TL: Machine tool friction torque (in terms of motor) [kg·cm]

- For vertical operation

(a) When the SI unit system is used

$Q = 1.047 \times 10^{-1} \cdot Th \cdot Vm \cdot ta \ [J]$ (Expression 2)

Th: Upward supporting torque applied by the motor during downward rapid traverse [N·m]
Vm: Motor speed during rapid traverse [min^{-1}]
ta: Acceleration/deceleration duration during rapid traverse [sec]

(b) When the CGS unit system is used

$Q = 1.026 \times 10^{-2} \cdot Th \cdot Vm \cdot ta \ [J]$ (Expression 2)

Th: Upward supporting torque applied by the motor during downward rapid traverse [kg·cm]
Vm: Motor speed during rapid traverse [min^{-1}]
ta: Acceleration/deceleration duration during rapid traverse [sec]

If the operation is vertical, the regenerative energy per operation is a sum of the values of Expressions 1 and 2.

R = P + Q [J] (Expression 3)

4.1.2 Cases Where a Separated Regenerative Discharge Unit Is Required

When the amount of regenerative energy produced [J] exceeds the amounts indicated in Table 4.1, the DC link overvoltage alarm is issued. To prevent this, a separated regenerative discharge unit is required.

For an external connection to be made when a regenerative discharge unit is not used, see Part V, "CONNECTION", of this manual.

An incorrect connection can damage the amplifier. Care must be taken.

Selecting regenerative discharge unit

First, calculate the regenerative energy.

- Servo motor : For horizontal operation

Amount of regenerative discharge (power [W]) when one acceleration/deceleration operation occurs in every F sec during rapid traverse.

(a) When the SI unit system is used

$$w = \frac{1}{F} \times (5.48 \times 10^{-3} \cdot (Jm + JL) \cdot Vm^2 - 5.23 \times 10^{-2} \cdot ta \cdot Vm \cdot TL)\,[W] \quad \text{(Expression 4)}$$

F : Frequency of acceleration/deceleration during rapid traverse [sec/occurrence]
Unless otherwise specified, it is assumed that about one acceleration/deceleration operation occurs in every 5 sec during rapid traverse.

Jm: Motor rotor inertia [kg·m^2]

JL: Load inertia converted to motor shaft inertia [kg·m^2]

Vm: Motor speed during rapid traverse [min^{-1}]

ta: Acceleration/deceleration duration during rapid traverse [sec]

TL: Machine tool friction torque (in terms of motor) [N·m]

(b) When the CGS unit system is used

$$w = \frac{1}{F} \times (5.37 \times 10^{-4} \cdot (Jm + JL) \cdot Vm^2 - 5.13 \times 10^{-3} \cdot ta \cdot Vm \cdot TL)\,[W] \quad \text{(Expression 4)}$$

F : Frequency of acceleration/deceleration during rapid traverse [sec/occurrence]
Unless otherwise specified, it is assumed that about one acceleration/deceleration operation occurs in every 5 sec during rapid traverse.

Jm: Motor rotor inertia [kgf·cm·sec^2]

JL: Load inertia converted to motor shaft inertia [kgf·cm·sec^2]

Vm: Motor speed during rapid traverse [min^{-1}]

ta: Acceleration/deceleration duration during rapid traverse [sec]

TL: Machine tool friction torque (in terms of motor) [kg·cm]

- For vertical operation

Amount of regenerative discharge (power [W]) when the duty cycle of downward vertical operation during rapid traverse is D(%)

(a) When the SI unit system is used

$$w = 1.047 \times 10^{-1} \cdot Th \cdot Vm \times \frac{D}{100} \ [W] \quad \text{(Expression 5)}$$

Th: Upward supporting torque applied by the motor during downward rapid traverse [N·m]

Vm: Motor speed during rapid traverse [min^{-1}]

D : Duty cycle of downward vertical operation during rapid traverse [%]
The maximum value of D is 50%, and D is usually less than 50%.

(b) When the CGS unit system is used

$$w = 1.026 \times 10^{-2} \cdot Th \cdot Vm \times \frac{D}{100} \ [W] \quad \text{(Expression 5)}$$

Th: Upward supporting torque applied by the motor during downward rapid traverse [kg·cm]

Vm: Motor speed during rapid traverse [min^{-1}]

D : Duty cycle of downward vertical operation during rapid traverse [%]
The maximum value of D is 50%, and D is usually less than 50%.

If the operation is vertical, the regenerative energy per operation is a sum of the values of Expressions 4 and 5.

R' = P' + Q' [W] (Expression 6)

From Table 4.2, select a separated regenerative discharge unit having a regenerative discharge rating greater than the value determined in (1).

Table 4.2 Regenerative discharge ratings of separated regenerative discharge unit

Separated regenerative discharge unit	Regenerative discharge rating	Condition
A06B-6093-H401(30Ω)	20W	Air flow = 0m/sec
(Caution) A06B-6093-H402(30Ω)	100W	

⚠ CAUTION
Use a regenerative resistance cable not longer than 1 m. If a cable longer than 1 m is used, the regenerative circuit in the amplifier can malfunction, or the amplifier can be damaged.

NOTE
If a separated regenerative discharge unit is used at a value exceeding the allowable limit, an overheat can occur and activate the built-in thermostat, resulting in an overheat alarm.

4.1.3 For SVU-40 and SVU-80

If the amount of regenerative discharge from a servo motor is so large that it exceeds the regenerative discharge capacity of the regenerative discharge resistor built into the servo amplifier, a separated regenerative discharge unit needs to be used.
When the amount of motor regenerative discharge (R) calculated in Subsection 4.1.2 exceeds the value indicated in Table 4.1.3(a) "Regenerative discharge capacity of the regenerative discharge unit built into a servo amplifier", use a separated regenerative discharge unit.

Table 4.1.3(a) Regenerative discharge capacity of the regenerative discharge unit built into a servo amplifier

Servo amplifier	Capacity
A06B-6093-H103	70W
A06B-6093-H113	
A06B-6093-H153	
A06B-6093-H104	
A06B-6093-H114	
A06B-6093-H154	

NOTE
The capacity is fixed at 70 W, regardless of whether natural air cooling or forced air cooling is used. The user should assume a severer use condition to ensure that the amount of regenerative discharge is less than 70 W.
If 70 W is exceeded, the long-term reliability can degrade.

The separated regenerative discharge units indicated below are available.
Specify a separated regenerative discharge unit to ensure that the amount of regenerative discharge is less than the discharge capacity.

Table 4.1.3(b) Regenerative discharge capacity of a separated regenerative discharge unit for a servo amplifier

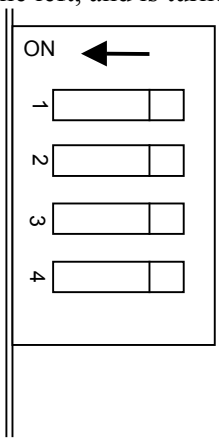
Separated regenerative discharge unit	Wind speed 0 m/sec	Wind speed 2 m/sec	Wind speed 4 m/sec
A06B-6089-H500	R=200W	R=400W	R= 600W
A06B-6089-H713	With a built-in fan motor for forced air cooling		R= 800W
A06B-6089-H714	With a built-in fan motor for forced air cooling		R=1200W

Switch setting (for SVU-40, SVU-80)

With SVU-40 and SVU-80, four switches are provided on the front of the servo amplifier. Be sure to set the switches to match the resistor used.

If the switches are set incorrectly, the regenerative resistor can be damaged.

From top to bottom, switch 1, switch 2, switch 3, and switch 4 are installed in this order. Each switch is turned on when the lever is at the left, and is turned off when the lever is at the right.



(1) Setting of switch 1 and switch 2
The switches need to be set according to the regenerative discharge resistor used.
⇒ If the switches are not set correctly, the regenerative overheat alarm is not detected correctly.

Switch 1	Switch 2	Regenerative discharge resistor
ON	ON	Built-in
ON	OFF	Separate : A06B-6089-H500
OFF	OFF	Separate : A06B-6089-H713, A06B-6089-H714

(2) Setting of switch 3 and switch 4
Switch 3 and switch 4 are not used. Set these switches off.

4.1.4 Notes on Regenerative Discharge Unit Installation

> ⚠ **WARNING**
> 1 A regenerative discharge resistor may be heated to a temperature from 100°C to 200°C. Be careful not to touch the regenerative discharge resistor.
> 2 If a regenerative resistor needs to be touched for a purpose such as maintenance, turn off all the power to the amplifier, wait 30 minutes or more, and check that DC link charge indicator LED (CAUTION CHARGE) is turned off and that the regenerative resistor is sufficiently cooled.
> 3 Install a regenerative resistor sufficiently away from a combustible material.

(1) Drawing numbers

Drawing number of regenerative discharge unit	Resistance value	Capacity			Remark
		Wind speed			
		0m/sec	2m/sec	4m/sec	
A06B-6093-H401	30Ω	20W	-	-	For 12/20A
A06B-6093-H402	30Ω	100W	-	-	For 12/20A
A06B-6089-H500	16Ω	200W	400W	600W	For 40/80A
A06B-6089-H713	16Ω	With cooling fan motor		800W	For 40/80A
A06B-6089-H714	16Ω	With cooling fan motor		1200W	For 40/80A

(2) Installation condition

<1> Cautions on installation

A06B-6093-H401	Install a regenerative discharge unit in a completely closed cabinet.
A06B-6093-H402	
A06B-6089-H500	Install the pin side in a completely closed cabinet, and install the resistor side (heat dissipation portion) in an exhaust duct. (a) Use the delivered packings. (b) Ensure that the pin side and resistor side (heat dissipation portion) are not exposed to coolant, oil mist, cuttings, and so forth. (c) To introduce the open air for the resistor (heat dissipation portion), use an air filter at the inlet. Ensure that the cable inlet and outlet, door, and so forth are sealed.
A06B-6089-H713	
A06B-6089-H714	

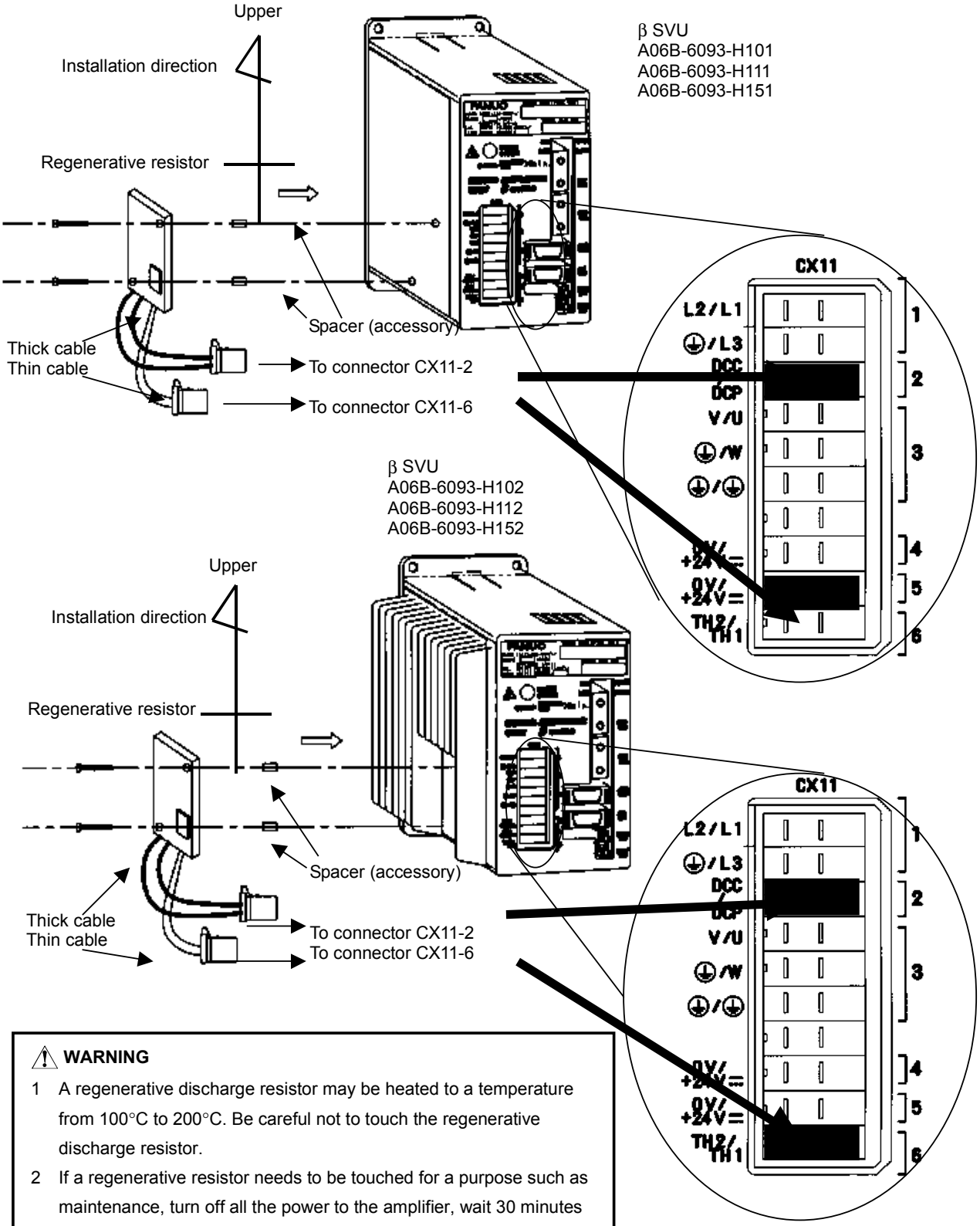
<2> Ambient Temperature
0 to 55 °C (operating)
-20 to 60 °C (storage and transportation)

<3> Humidity
Usually, 95% RH or lower (no condensation)

<4> Vibration
No more than 0.5G during operation

<5> Installation direction
Install a regenerative discharge unit correctly according to the installation drawings that follow.

A06B-6093-H401

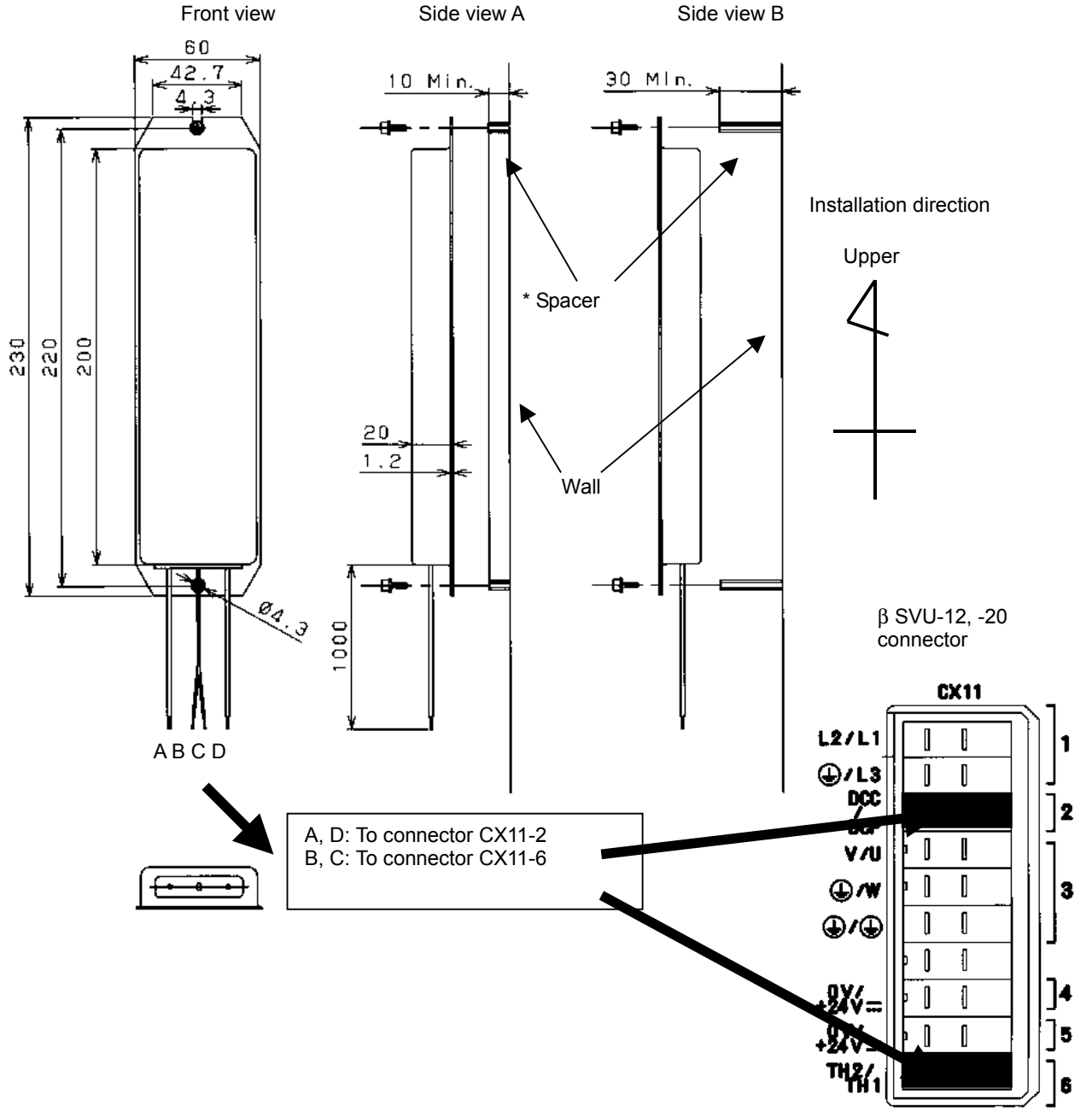


⚠ WARNING

1 A regenerative discharge resistor may be heated to a temperature from 100°C to 200°C. Be careful not to touch the regenerative discharge resistor.

2 If a regenerative resistor needs to be touched for a purpose such as maintenance, turn off all the power to the amplifier, wait 30 minutes or more, and check that DC link charge indicator LED (CAUTION CHARGE) is turned off and that the regenerative resistor is sufficiently cooled.

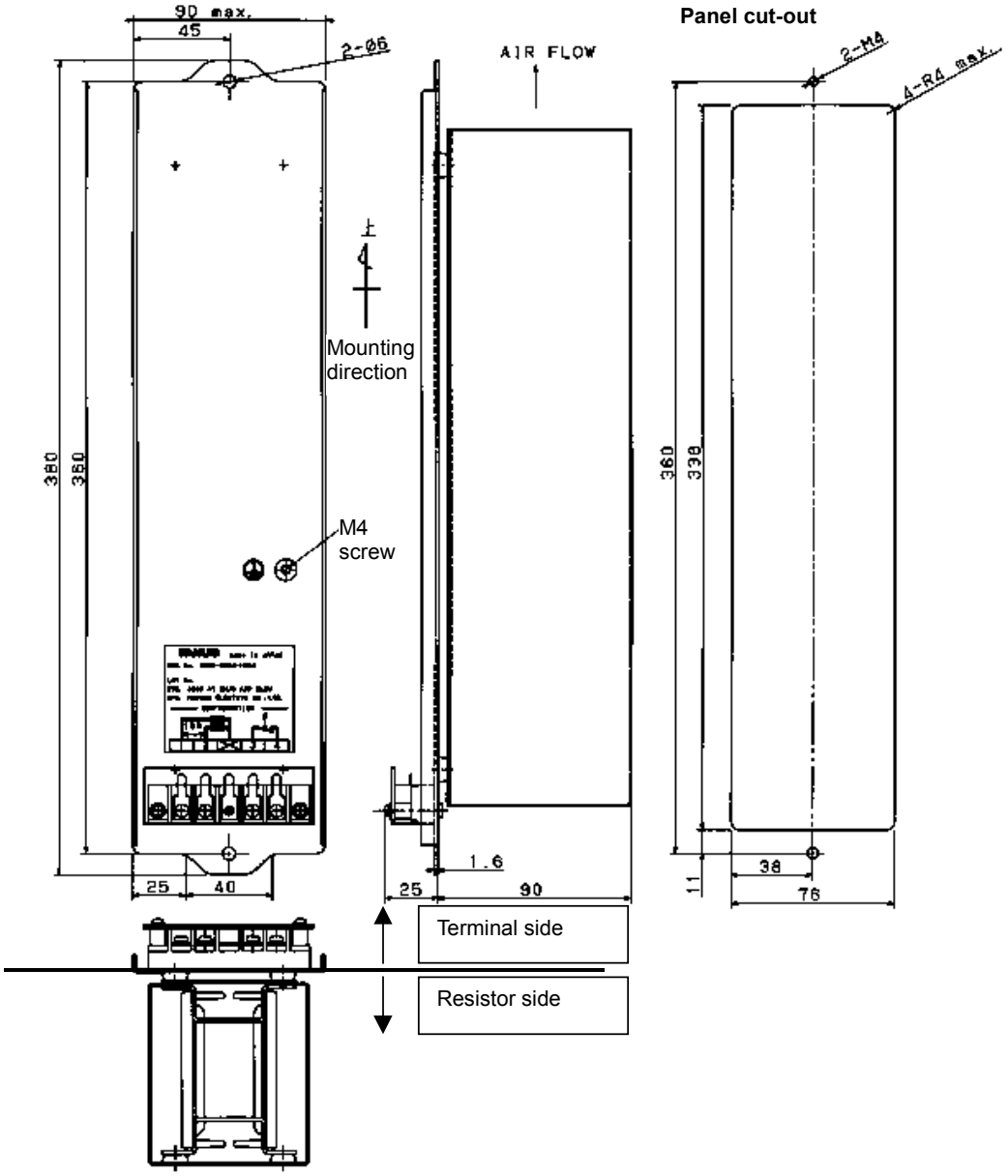
A06B-6093-H402



⚠ WARNING

1 A regenerative discharge resistor may be heated to a temperature from 100°C to 200°C. Be careful not to touch the regenerative discharge resistor.
2 If a regenerative resistor needs to be touched for a purpose such as maintenance, turn off all the power to the amplifier, wait 30 minutes or more, and check that DC link charge indicator LED (CAUTION CHARGE) is turned off and that the regenerative resistor is sufficiently cooled.
3 Install a regenerative resistor sufficiently away from a combustible material.
4 Provide a space of 10 mm or more between a regenerative resistor and the wall.

A06B-6089-H500



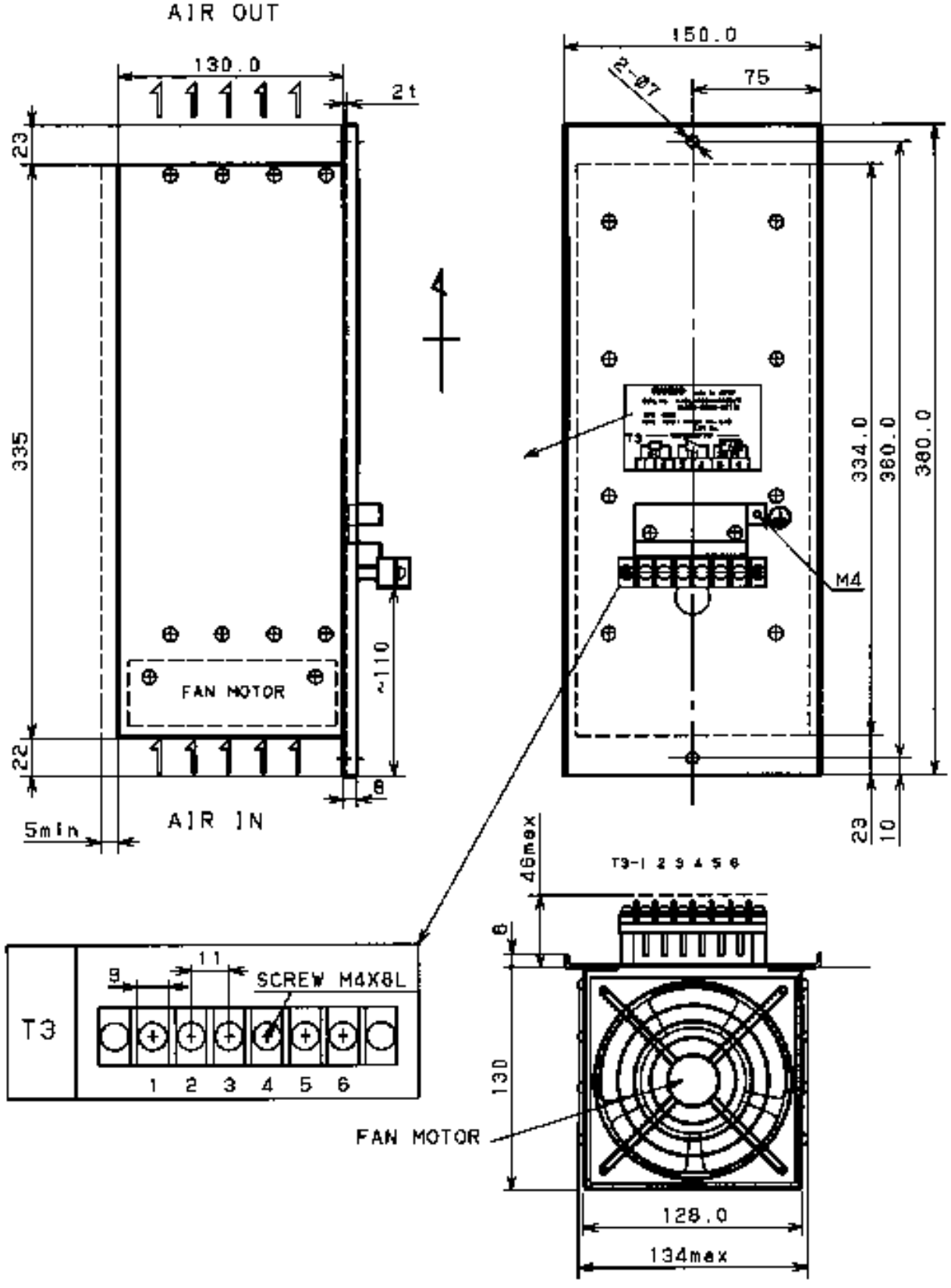
⚠ WARNING

1 A regenerative discharge resistor may be heated to a temperature from 100°C to 200°C. Be careful not to touch the regenerative discharge resistor.
2 If a regenerative resistor needs to be touched for a purpose such as maintenance, turn off all the power to the amplifier, wait 30 minutes or more, and check that DC link charge indicator LED (CAUTION CHARGE) is turned off and that the regenerative resistor is sufficiently cooled.
3 Install a regenerative resistor sufficiently away from a combustible material.

NOTE

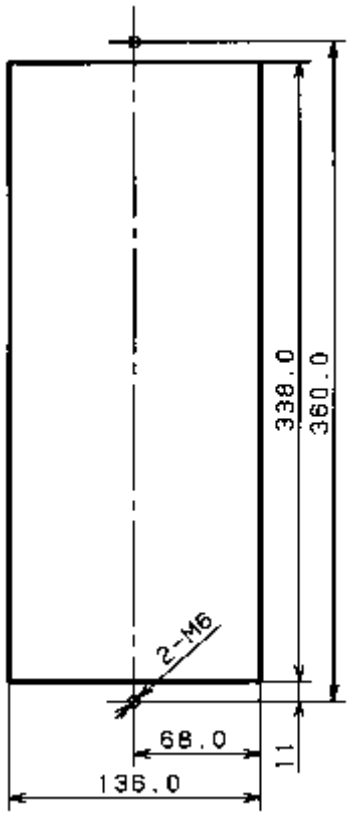
For oil and dust protection, use the delivered packings.

A06B-6089-H713 to -H714



A06B-6089-H713 to -H714

Panel cut-out



⚠ WARNING

1 A regenerative discharge resistor may be heated to a temperature from 100°C to 200°C. Be careful not to touch the regenerative discharge resistor.
2 If a regenerative resistor needs to be touched for a purpose such as maintenance, turn off all the power to the amplifier, wait 30 minutes or more, and check that DC link charge indicator LED (CAUTION CHARGE) is turned off and that the regenerative resistor is sufficiently cooled.
3 Install a regenerative resistor sufficiently away from a combustible material.

NOTE

For oil and dust protection, use the delivered packings.

5 POWER SUPPLY

5.1 INPUT POWER SUPPLY

5.1.1 Three-phase Input Power Supply for Motor Power

- Nominal rated voltage: 200 to 240 VAC
- Allowable voltage fluctuation: -15% to +10%
- Frequency: 50/60 Hz
- Allowable frequency fluctuation: ±2 Hz
- Power supply impedance: Voltage fluctuation cased by load (at maximum output) not to exceed 7%
- Power supply unbalance: Within ±5% of the rated voltage

NOTE
The allowable voltage fluctuation is a change observed for several minutes. It is not a continuous change.

5.1.2 Single-phase Input Power Supply for Motor Power

In European countries, power sources are 380 to 415 VAC and neutral-grounded. To use the β series amplifiers in these European countries, it is necessary to install a power transformer at the input or supply single-phase power.
To use the motors with single-phase power, observe the following:

(1) Power supply specification
- Nominal voltage rating: 220 to 240 VAC
- Allowable voltage fluctuation: -15% to +10%
- Frequency: 50/60 Hz
- Allowable frequency fluctuation: ±2 Hz
- Voltage fluctuation at acceleration/deceleration: 7% or less

NOTE
The allowable voltage fluctuation is a change observed for several minutes. It is not a continuous change.

5.1.3 Single-phase Input for Control Power

- Nominal rated voltage: 24VDC
- Allowable voltage fluctuation: ±10% (including momentary variations)
- Power supply ratings

	Power supply rating per amplifier
FSSB interface	0.6A
I/O Link interface	0.9A
PWM interface	0.4A

5.2 POWER SUPPLY RATINGS

5.2.1 Three-phase Input Power Supply Ratings for Motor Power

(1) The power supply rating necessary when using multiple servo motors can be determined by summing the rating of the power supplies required by the individual motors.

(2) The power supply ratings listed in Table 5.2.1 are sufficient as continuous ratings. Note, however, that servo motor acceleration causes a current that is roughly triple the continuous rating to flow momentarily.

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

Table 5.2.1 Three-phase power supply ratings

Motor model	Power supply rating per motor (three-phase power input) (kVA)	Power supply rating per motor (single-phase power input) (kVA)
βM0.2/4000	0.08	0.10
βM0.3/4000	0.15	0.19
β1/3000	0.46	0.57
β2/3000	0.77	0.95
βM0.4/4000	0.20	0.25
βM0.5/4000	0.31	0.38
βM1/4000	0.62	0.76
β3/3000	0.77	0.95
β6/2000	1.4	1.7
α1/5000*i*	0.77	0.95
α2/5000*i*	1.2	1.4
α4/4000*i*	2.2	2.7
α8/3000*i*	2.5	3.0
α12/3000*i*	4.6	4.2 (*1)
α22/3000*i*	6.2	4.2 (*1)
αM2/5000*i*	1.2	2.3
αM3/5000*i*	1.5	1.9
αM8/4000*i*	3.9	4.2 (*1)
αM12/4000*i*	4.2	4.2 (*1)
αC4/3000*i*	1.5	1.9
αC8/2000*i*	1.9	1.9
αC12/2000*i*	2.8	1.9
αC22/2000*i*	4.6	4.2 (*1)
αC30/1500*i*	6.5	4.2 (*1)

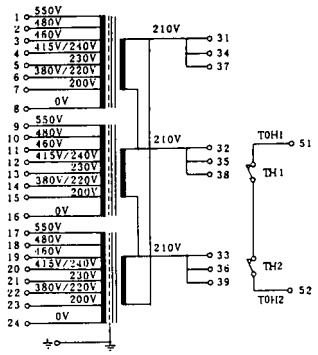
(*1) Depends on the output limit applicable when single-phase input is used.

5.3 POWER TRANSFORMER FOR EXPORTS

Use power transformer for an export when this servo amplifier unit is used at a site where the line voltage is other than 200 to 240 VAC.

5.3.1 Specification

Table 5.3.1 Specification of power transformer

Ordering drawing number	A80L-0022-0005	A80L-0024-0006	A80L-0026-0003	A80L-0028-0001
FANUC drawing number	A80L-0022-0005	A80L-0024-0006	A80L-0026-0003	A80L-0028-0001
Rated capacity	2.2kVA	3.5kVA	5kVA	7.5kVA
Rated primary voltage	200/220/230/240VAC (Δ connection) 380/415/460/480/550VAC (Y connection) ±15%, 50/60Hz±2Hz; 3φ			
Rated secondary voltage	210VAC			
Rated secondary current	6.1A	9.6A	13.7A	20.6A
Voltage regulation at the secondary	2%			
Voltage deviation at the secondary	±3%			
Connection	Δ-Δ connection or Y-Δ connection			
Insulation	Class B (maximum allowable temperature : 130°C)			
Ambient temperature	-20 to 55°C			
Allowable temperature rise	135deg			
Relative humidity	Max. 95%RH			
Type	Dry type, natural air cooling type			
Dielectric withstand voltage	2300VAC, for 1 minute			
Weight	Max. 21kg	Max. 27kg	Max.36kg	Max. 42kg
Outline drawing	Fig. 8.1.3			
Connection diagram				

5.3.2 How to Select a Transformer

Select a transformer according to the load condition and the model of the motor for which the transformer is used. Each transformer has secondary winding taps for three amplifiers so that it can be connected to two or three amplifiers.
For a machine with typical operating conditions, select a transformer according to the following guideline.

(Sum of three-phase power requirements of all models) × 0.6 ≤ transformer rating
Table 5.2.1 Table 5.3.1

> ⚠ **CAUTION**
> When two or more motors are used, the transformer rating obtained using the above expression may be less than the actual power requirements of any one of those motors. Should this occur, use the motors' maximum power requirements as the transformer rating.
> (Example)
> The power requirements of the α22/3000*i* and α2/5000*i* are indicated in Table 5.2.1, as shown below :
> α22/3000*i* : 6.2 kVA
> α2/5000*i* : 1.2 kVA
> Using the expression given above, the transformer rating is calculated as follows :
> (6.2 + 1.2) × 0.6 = 4.4 kVA
> The power requirement of the α22/3000*i* is 6.2 kVA, this being greater than the calculated transformer rating of 4.4 kVA. So, the transformer rating should be 6.2 kVA.

6 HEAT DISSIPATION

Heat dissipation of β series amplifier is as follows :

Table 6.1 Total heat dissipation of each servo amplifier β series

Ordering number	Interface	Total amount of heat dissipation (W)	Residual amount of heat in the cabinet (W)	
			Without forced air cooling	With forced air cooling
A06B-6093-H119	SVU-4 (FSSB interface)	11	11	-
A06B-6093-H159	SVU-4 (I/O Link interface)	12	12	-
A06B-6093-H111	SVU-12 (FSSB interface)	19	19	-
A06B-6093-H151	SVU-12 (I/O Link interface)	20	20	-
A06B-6093-H101	SVU-12 (PWM interface)	18	18	-
A06B-6093-H112	SVU-20 (FSSB interface)	34	34	-
A06B-6093-H152	SVU-20 (I/O Link interface)	35	35	-
A06B-6093-H102	SVU-20 (PWM interface)	33	33	-
A06B-6093-H113	SVU-40 (FSSB interface)	53	20	15
A06B-6093-H153	SVU-40 (I/O Link interface)	53	20	15
A06B-6093-H103	SVU-40 (PWM interface)	53	20	15
A06B-6093-H114	SVU-80 (FSSB interface)	78	27	17
A06B-6093-H154	SVU-80 (I/O Link interface)	78	27	17
A06B-6093-H104	SVU-80 (PWM interface)	78	27	17

7 INSTALLATION CONDITIONS AND NOTES

7.1 ENVIRONMENTAL CONDITIONS

Install a β setting servo amplifier in a completely closed cabinet so that the environment conditions indicated below can be satisfied.

(1) Ambient Temperature
Ambient temperature
0 to 55°C (operating)
-20 to 60°C (storage and transportation)
Ambient temperature of the accommodation cabinet 0 to 45°C

(2) Humidity
Usually, 95% RH or lower (no condensation)

(3) Vibration
No more than 0.5G during operation

(4) Atmosphere
Ensure that the electronic circuits are not exposed to corrosive and conductive mist and waterdrops. (Note)

(5) Notes on installation
When installing an amplifier, consider the following:

(a) Ensure that the heat sink is not exposed to coolant, oil mist, cuttings, and so forth. Otherwise, the cooling efficiency can degrade, resulting in a failure to satisfy the characteristics of the amplifier. Moreover, the life of semiconductors can be adversely affected.
To introduce the open air for the heat sink, use an air filter at the inlet.
Ensure that the cable inlet and outlet, door, and so forth are sealed.

NOTE
The electronic circuits must be installed in an environment of contamination level 2 defined in IEC60664-1.
In order to satisfy contamination level 2 in a severe environment for using machine tools, the servo amplifier β series must be installed in a cabinet that satisfy IP54.

(b) Ensure that dust, coolant, and so forth do not penetrate through the exhaust vent. Moreover, ensure that the flow of cooling wind is not interrupted.

(c) Ensure that the servo amplifier β series can be inspected, removed, and reinstalled easily in maintenance.