

FANUC AC SERVO MOTOR MODEL 120

DESCRIPTIONS

B-65172E/01

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In this manual, we endeavor to include all pertinent matters.

There are, however, a very large number of operations that must not or cannot be performed, and if the manual contained them all, it would be enormous in volume.

It is, therefore, requested to assume that any operations that are not explicitly described as being possible are "not possible".

PREFACE

This manual describes following product:

1) Motor

Series name	Model name
FANUC AC SERVO MOTOR (380/415V input)	MODEL 120.

2) SERVO AMPLIFIER

Series name	Corresponding motor (Note)
FANUC AC SERVO AMPLIFIER (380/415V input)	FANUC AC SERVO MOTOR MODEL 120

Note) Please refer to the text for a concrete correspondence.

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1. AC SERVO MODEL 120 Descriptions (380/415V input)

These specifications relate to the Model 120 AC servo motor, and its servo amplifier.

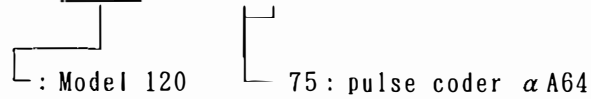
1.1 GENERAL

The Model 120 AC servo motor has been developed for use in the feed axis of large machine tools. It has a static rated torque of 392 Nm and a maximum rated output of 50 kW. It also offers very high acceleration, making it ideal for high-speed, high-precision machining.

1.2 TYPE OF MOTOR AND DESIGNATION

The ordering code for the Model 120 is as follows.

A 0 6 B - 0 3 9 4 - B 0 □ □



1.3 SPECIFICATIONS AND CHARACTERISTICS

1.3.1 Specification

Table3.1 Specification

Item	Unit	Specification
Rated output (Note 1)	KW	50
Static rated torque (Note 2)	Nm (kgf·cm)	392 (4000)
Maximum speed	min ⁻¹	2000
Rotor inertia	Kgm ² (kgf·cm·s ²)	0.25 (2.56)
Cooling method	—	Forced air
Weight	Kg	230

Note 1) The rated output is guaranteed only at the rated input voltage. If the input voltage is subject to variation, even when that variation is within the allowable range, the rated output may not be obtained.

Note 2) Stall torque

1.3.2 Characteristic Curve and Output Data sheet

The following characteristic curve and data sheets quantify the performance of the motor.

(1) Characteristic Curve

① Torque-speed characteristics.

This curve indicates the relationship between the motor speed and output torque. The motor can be run continuously at any combination of motor speed and output torque falling within the continuous operating zone, shown in the figure. Outside this zone, the motor can only be used intermittently.

The continuous operating zone is determined under the following conditions.

- Ambient temperature of 20°C.
- Motor is driven with an ideal sine wave current.

The intermittent operating zone depends on the motor input voltage.

Note that, in practice, the operating zone may be restricted by the characteristics of the amplifier being used.

② Data sheet

Data sheets describe parameters related to the motor performance.

Each parameter is determined under the following conditions.

- Ambient temperature of 20°C.
- Motor is driven with an ideal sine wave current.

(2) Load inertia

Load inertia shall not exceed three times the rotor inertia. When a quick response is required, restrict the load inertia as little as possible. Also, connect loads to the machine to ensure high rigidity.

When the load inertia exceeds three times the rotor inertia, consult with your FANUC representative.

(3) Motor cooling

The motor uses forced-air cooling. The cooling fan motor requires three-phase, 380-V AC power. Cooling air enters from the motor shaft end, exiting to the suction end bell.

(4) Length of motor power cable (K4)

An overly long motor power cable degrades the motor's speed-torque characteristics due to large cable losses (I^2R). Also, if a motor power cable has a very small cross-sectional area, it may overheat and cause an electrical fire.

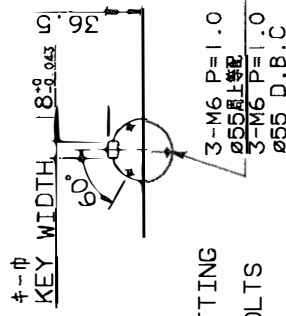
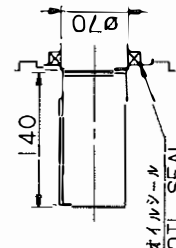
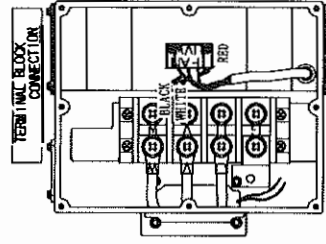
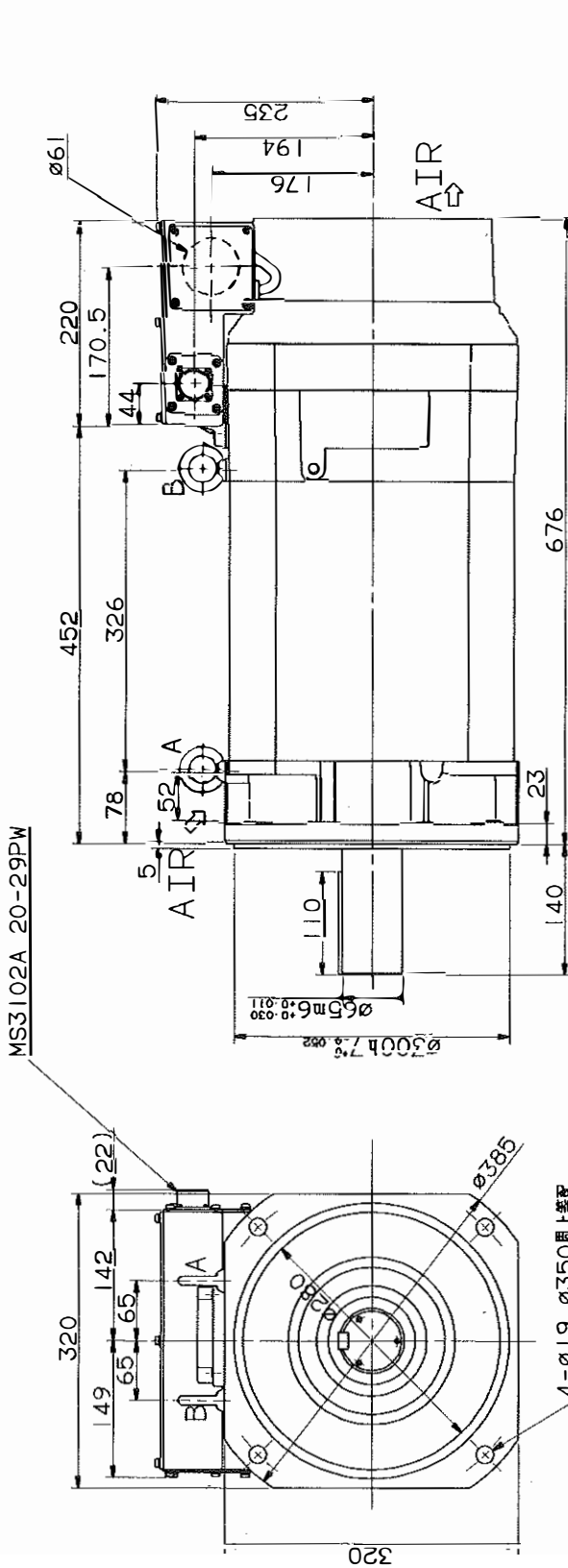
Suitable cable lengths and types for the motor power cable are listed in Item 2.12, Cable connection, in the description of the servo amplifier.

(5) Length of motor feedback cable (K2S)

The length of the motor feedback cable is also critical due to voltage drop caused by the cable resistance and power supply current of the pulse coder.

The specifications for the feedback cable are given in the Connection Manual for each NC.

1.3.3 External Dimension For Model 120

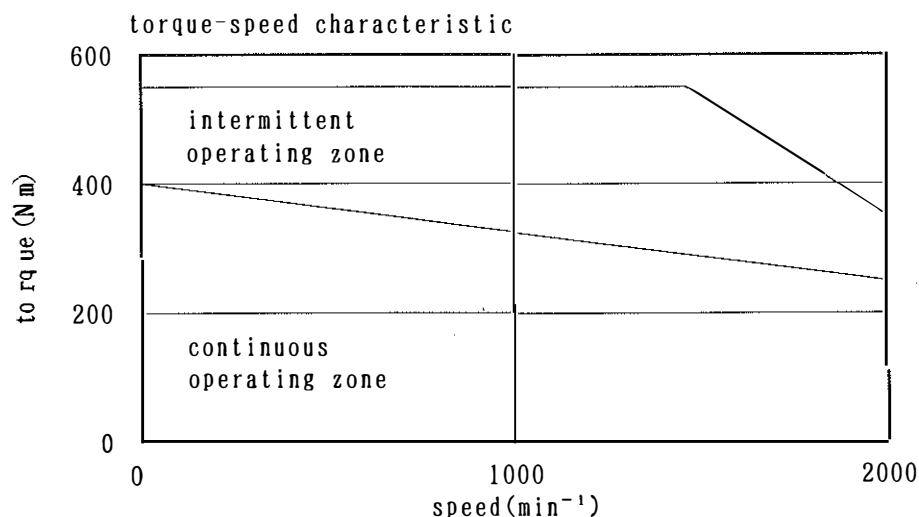


出力軸端詳細
DETAIL OF SHAFT END

(注意) 1. 出力軸は水平または垂直方向にてご使用下さい。
2. 取り付けボルトは六角ボルトM16, 長さ50mm以下をご使用下さい。

NOTICE 1. USE HORIZONTALLY OR VERTICALLY, SETTING THE SHAFT END DOWNWARD.
2. MOUNT WITH M16 SIZE HEXAGON HEAD BOLTS, WHICH LENGTH IS LESS THAN 50mm.

1.3.4 Data sheet



* This torque diagram shows characteristic with FANUC Digital Servo, by using a amplifier for Model 120.

Data sheet

Parameters	Symbol	Value	Unit
Rated torque at stall **	Ts	392 4000	Nm kgf·cm
Rotor inertia	Jm	0.25 2.56	kgm ² kgf·cm·sec ²
Continuous RMS current at stall	Is	168	Arms
Torque constant *	Kt	2.34 23.85	Nm/Arms kgf·cm/Arms
Back EMF constant (RMS voltage per phase) *	Ke kv	81.9 0.78	V/1000min ⁻¹ Vsec/rad
Armature resistance *	Ra	0.0135	Ω
Mechanical time constant *	tm	0.002	s
Thermal time constant	tt	45	min
Static friction torque	Tf	3.92 40	Nm kgf·cm
Max. allowable current	Im	700	A (peak)
Max. torque	Tm	1158 11805	Nm kgf·cm
Max. winding temperature rise	θm	125	°C
Weight		230	kg

* These are the typical value at 20 °C. (±10%) And these specifications are those of motor only, the actual output is also limited by a driver.

** Rated torque is limited by the heat of a motor and a amplifier.

2. TYPE AC SERVO AMPLIFIER FOR MODEL 120

2.1 GENERAL

The Model 120 AC servo motor amplifier has been specially developed to drive the Model 120 AC servo motor. It is used only in digital AC servo systems.

This servo amplifier requires a three-phase 380/415-V AC power supply.

2.2 Configuration

To control the axes of a machine tool using the Model 120 servo amplifier, the following units are usually required.

- Control unit (FANUC Digital AC servo)
- AC servo motor (Model 120)
- AC servo amplifier (for Model 120)
- Dynamic brake unit
- Fan unit (FU1, FU2) (Option)

Fig. 2.2 shows a sample NC system for controlling two axes.

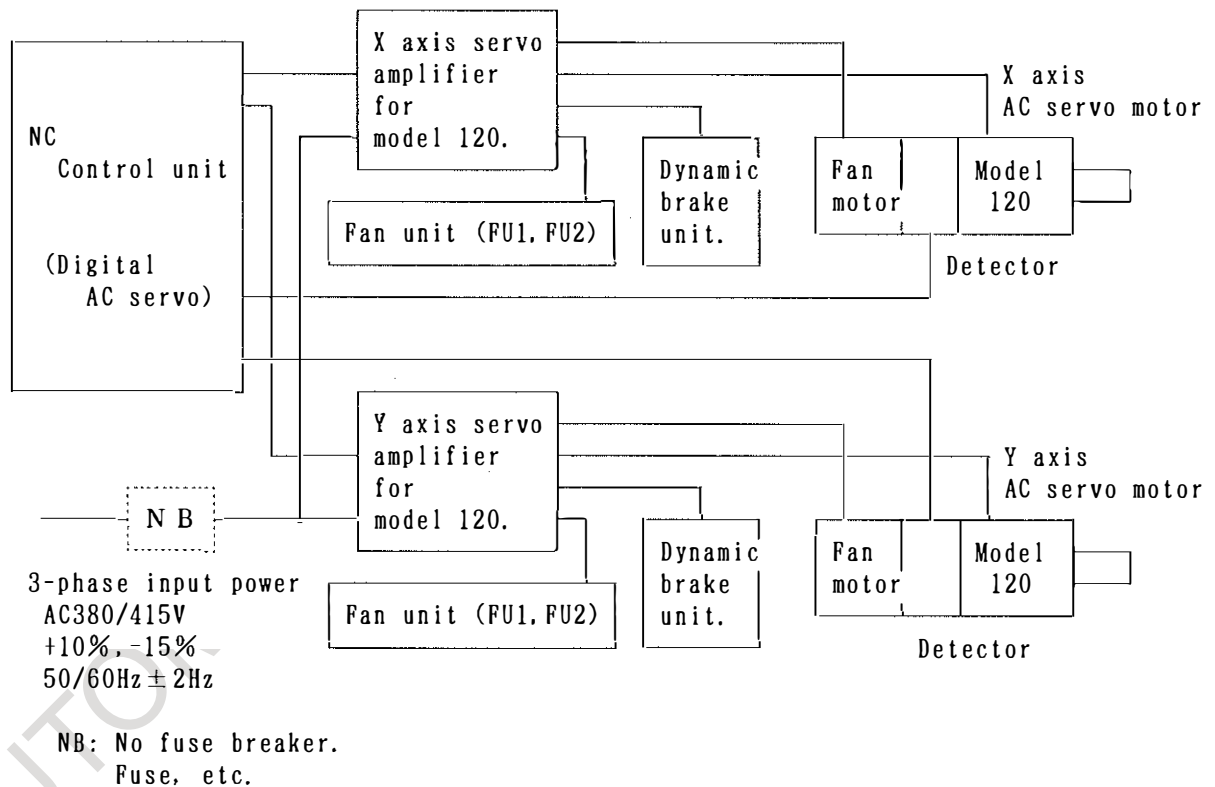


Fig. 2.2 Sample NC System for Controlling Two Axes

2.2.1 Types of Unit and Specifications

Name	Application	Specification
Servo amplifier	Model 120	A06B-6069-H120
Dynamic brake unit (Note 1)	1 unit/axis	A06B-6069-H300
Fan unit (option) (Note 2)	1 unit/axis	A06B-6065-K301
Input connector (Note 3)	Soldering type	A06B-6066-K205
	Crimp type	A06B-6066-K206
Spare fuse (Note 4)	Model 120	A06B-6065-K060

Note 1) This unit is used for applying a dynamic brake to the motor in the event of an emergency stop. One unit is required for each servo amplifier.

The load inertia, applied to the motor axis of the machine, shall not exceed three times that of the motor. If the load inertia applied to the motor axis exceeds three times that of the motor, consult with your FANUC representative.

Note 2) This unit features two cooling fans, FU1 and FU2, used to cool the servo amplifier.

When the user designs a cooling unit, this optional unit is not required. In this case, however, refer to the drawing indicating the typical cooling method, in 2.10.4. (Use the recommended fan motor or equivalent.)

Note 3) This half-pitch (1.27 mm) connector is used for the servo amplifier input signals (CN1B).

Note 4) These fuses protect the control printed circuit board and power circuit of the servo amplifier.

2.3 SPECIFICATIONS

2.3.1 Specifications of Amplifier

Table 2.3.1 Specifications

Item		Specifications
Servo amplifier		Model 120
Rated output current		180 Arms
Power Supply	Three-phase input for power	Voltage: 380/415 VAC Allowable voltage fluctuation: -15% to +10% Frequency: 50 Hz or 60 Hz Allowable frequency fluctuation: ± 2 Hz Number of phases 3
	Capacity of power source	110 KVA
Main circuit control Method		Sine-wave PWM control by transistor bridge
Braking system		Regenerative braking (power supply regenerative method)
Current limit value (Note 1)		360 Ap
Weight		110 kg
Alarm and protection functions		* No fuse breaker (main circuit) * Excessive voltage * Shortage voltage * Excessive regenerative * Overheat * Abnormal current
Cooling system		Forced air
Ambient temperature range		0 °C ~ 55 °C

(Note 1) The current limit value (peak value) of output current is the current control value. The tolerance of rated value due to circuit time constant is approximately $\pm 5\%$.

2.3.2 Dynamic Brake unit

Item	Specification
Allowable operating conditions	Maximum load inertia: Up to three times the motor inertia Emergency stop frequency: Once every three minutes
Weight	10 Kg
Ambient temperature range	0 °C ~ 55 °C
Cooling system	Natural air cooling

2.4 POWER SOURCE

Refer to the table 2.3.1

2.5 HEAT LOSS

The amount of heat generated by a servo amplifier greatly depends on how it is being used, such as the frequency and the time constant of acceleration/ deceleration, load inertia, cutting torque, and friction torque of the connected servo motor.

Design the cabinet for the servo amplifier assuming that each unit generates half the value listed below.

Product name		Maximum heat loss(W)
Servo amplifier (Note 1)	Control circuit side	450
	Heatsink side	1300
Dynamic brake unit	(Note 2)	7

Note 1) Maximum heat loss for rated output.

Note 2) When frequent emergency stops occur, the amount of heat generated will be more than that listed above.

2.6 Installation Conditions

Ambient temperature	0 - 55 degrees
Humidity	95 % RT or less (no dew forming)
Vibration	0.5 G or less
Environment	Not directly subject to cutting liquid, lubrication oil, or cutting dust

2.7 Cautions on Installation

(1) The servo amplifier should be installed in the cabinet such as a power magnetic cabinet. No sealing is provided between the chassis and the heat sink. Thus, keep cutting liquid, lubrication oil, and cutting dust away from the heat sink with the air.

(2) Install the servo amplifier so that the printed board is protected from accidental contact and allocate sufficient space for maintenance.

(3) Wires and the like shall not be routed near the air inlets and outlets used for cooling the servo amplifier. Also, do not install any equipment which would obstruct the air exhaust.

(4) Since the dynamic brake unit is naturally cooled, leave at least 100 mm above and below the unit and do not install any equipment that would obstruct the unit's ventilation.

Very large currents flow through the cable of the dynamic brake unit. Therefore, keep the cables as short as possible.

Also, do not route signal cables near the cable of the dynamic brake unit.

(5) It should be easily inspected, removed or installed on maintenance.

(6) The AC servo amplifier weights approximately 110 kg. Adequate support must be provided for installation.

(7) Route signal cables, such as those used for the motor detector, away from power lines, such as the three-phase power input line and motor power lines.

2.8 When amplifiers are housed in a closed type cabinet

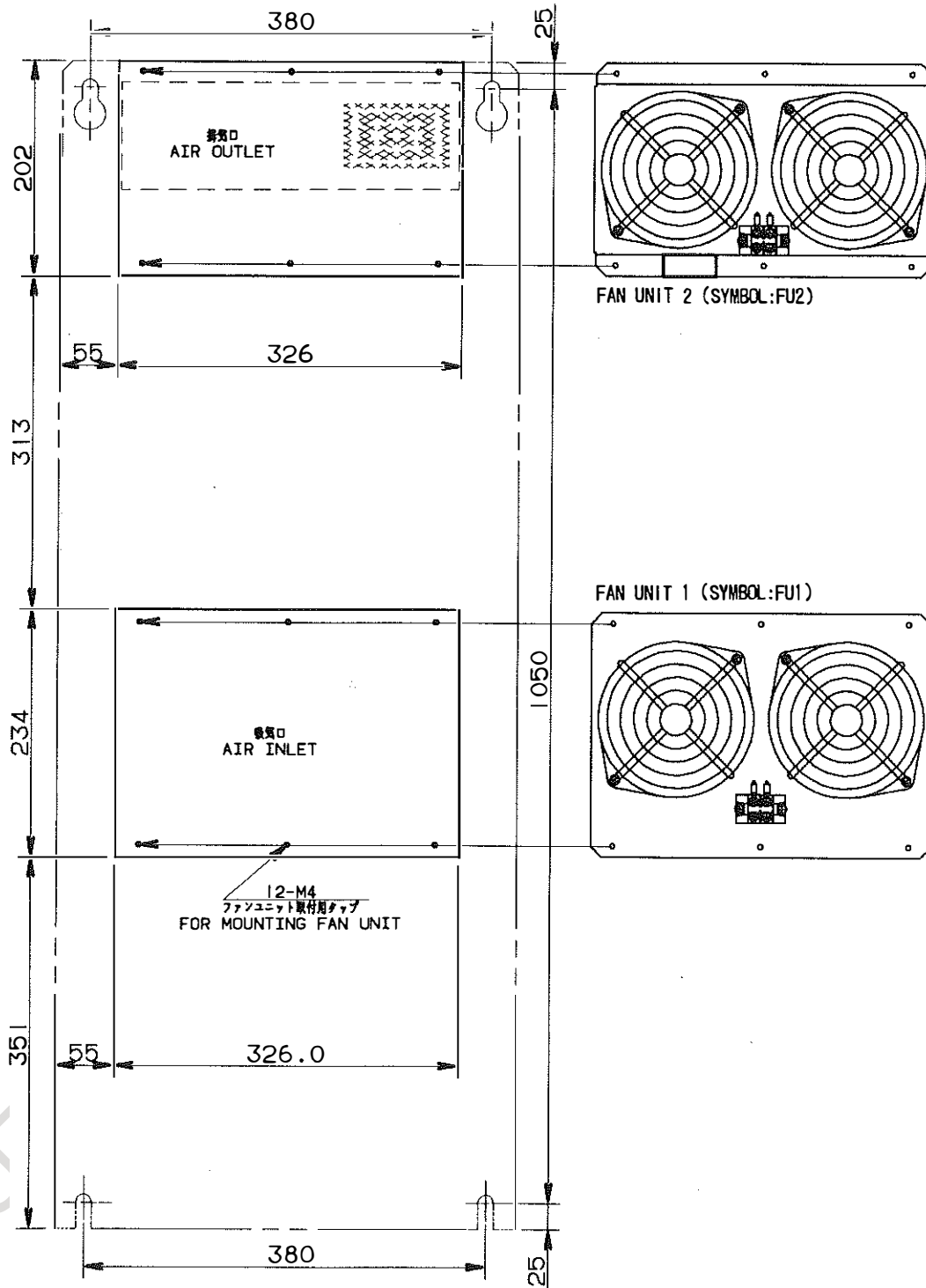
In the case of the closed type cabinet, the internal air temperature increases. Circulate the internal air so the ambient temperature of cabinet is uniform. Air speed should be approximately 1 to 2 m/sec. Install by keeping the fan or blower air away from the unit. Otherwise, dust may be adhered on the unit surface, causing failure.

2.9 When amplifiers are housed in an open-air ventilation cabinet

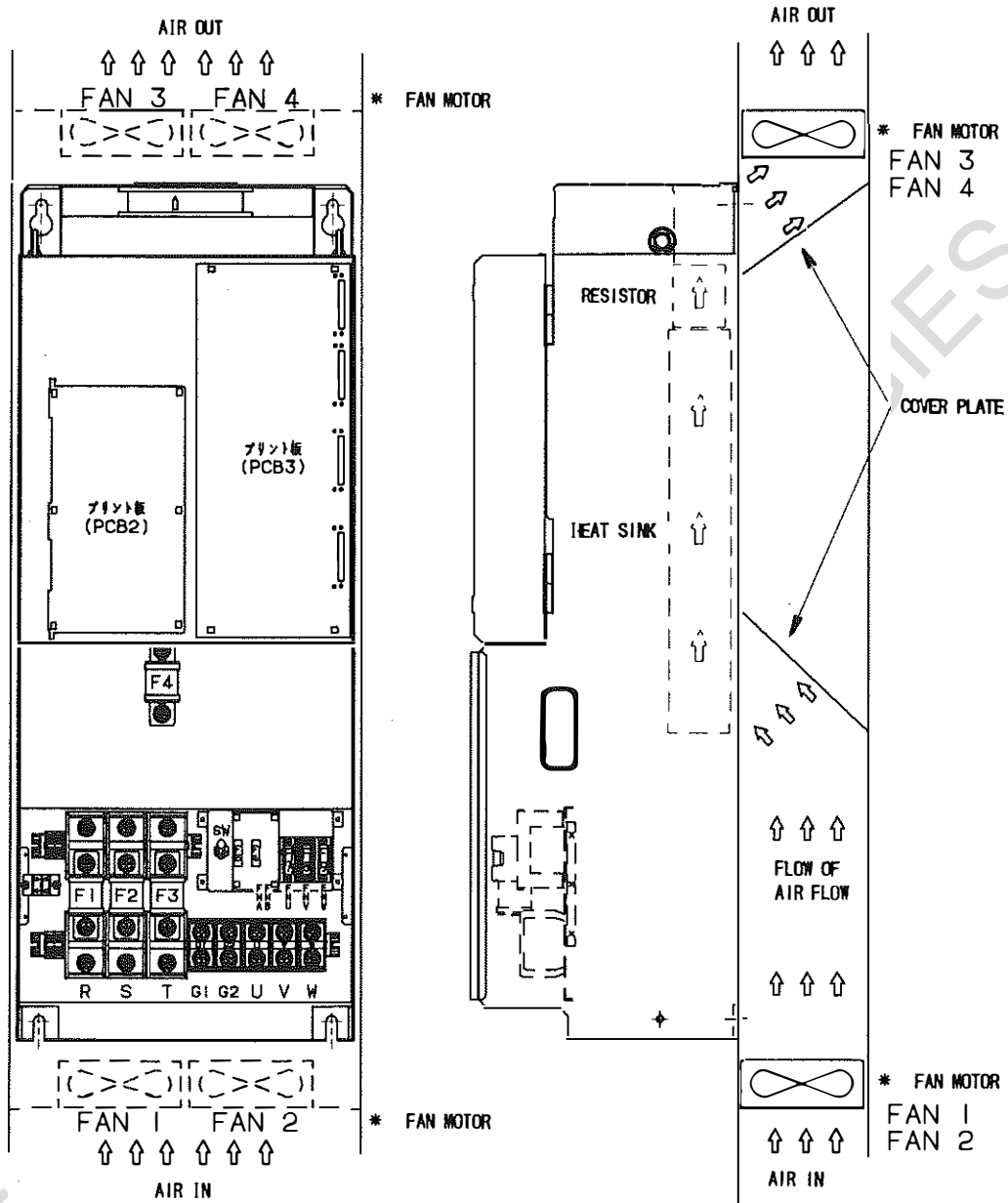
- (1) Use an air filter on the air inlet to prevent cutting-fluid mist and dust from entering the unit.
- (2) Also, ensure that dust or cutting fluid mist cannot enter the unit through the air outlet.
- (3) Install the fan so that the amplifier is not directly subject to blower air. Otherwise, dust may be blown into the amp surface, leading to failure.
- (4) Securely seal the cable entrance and door.

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2.10.2 Panel cutout for installing the servo amplifier
 (when using optional fans FU1 and FU2)



2.10.4 Typical cooling method when the optional fan unit is not used
(for reference)

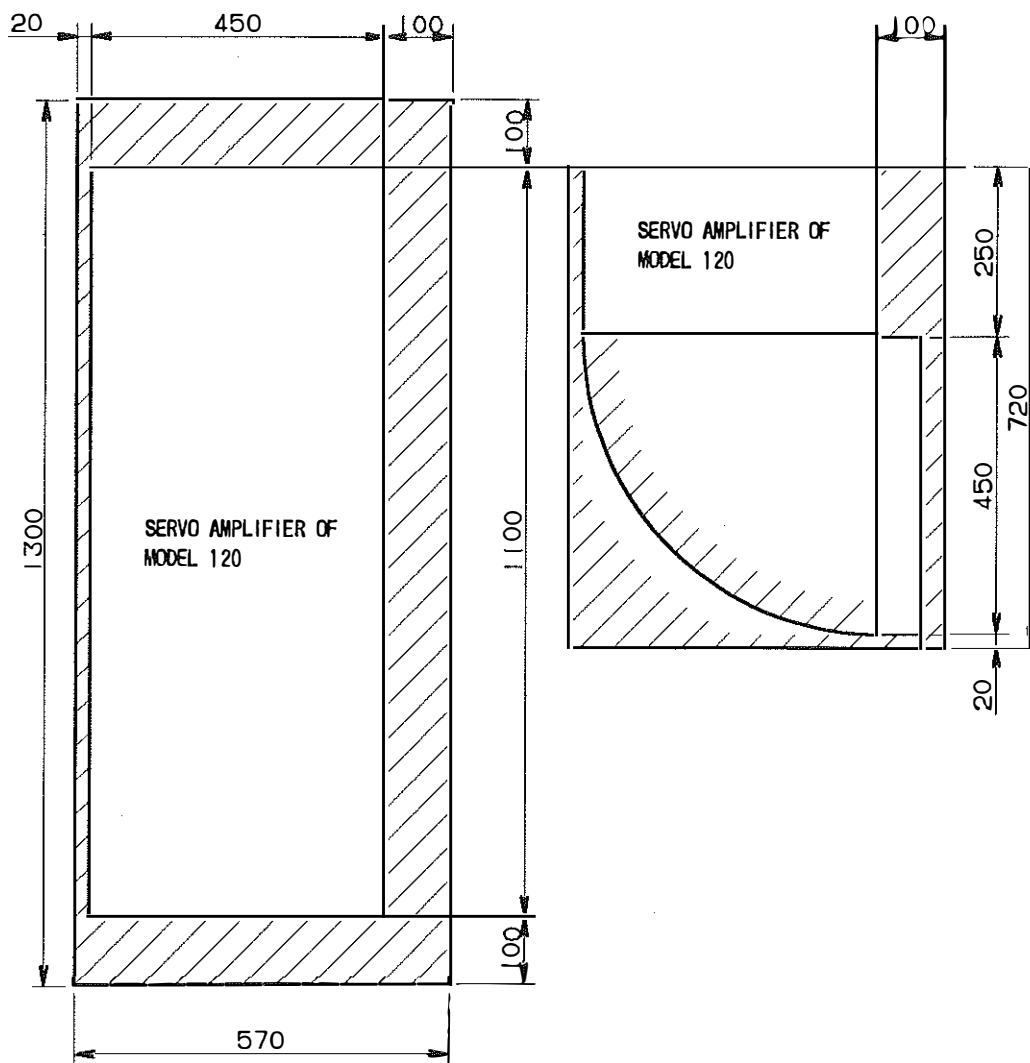


* SPECIFICATION OF FAN MOTOR (FAN 1-4)

VOLTAGE	(V)	200	
FREQUENCY	(Hz)	50	60
INPUT	(W)	43	40
SPEED	(RPM)	2750	3200
MAX. AIR FLOW	(m ³ /min)	6.5	7.5
MAX. AIR PRESSURE	(mm-H ₂ O)	15	16

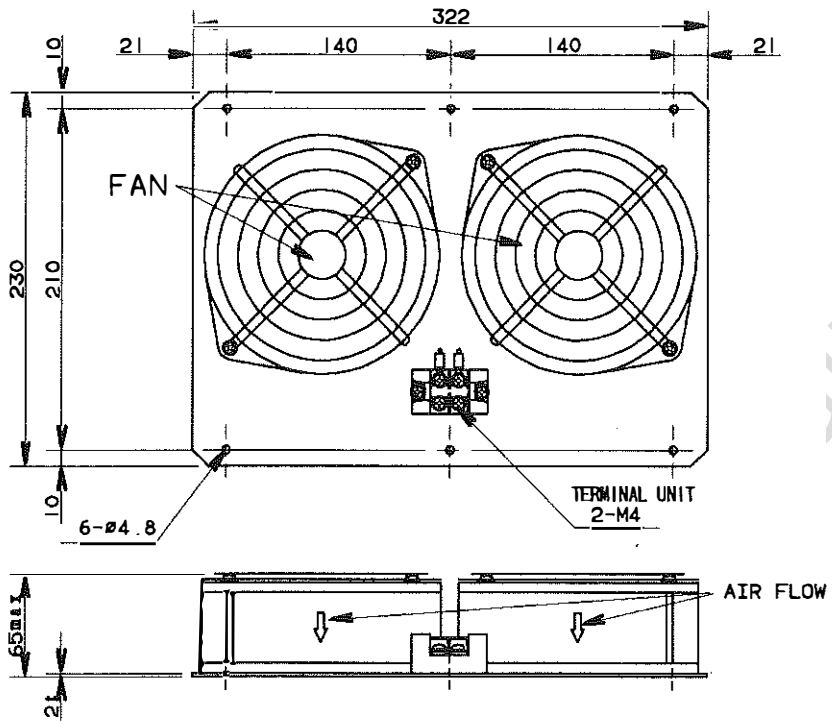
TYPE : T755DX

2.10.5 Servo amplifier maintenance surface and area

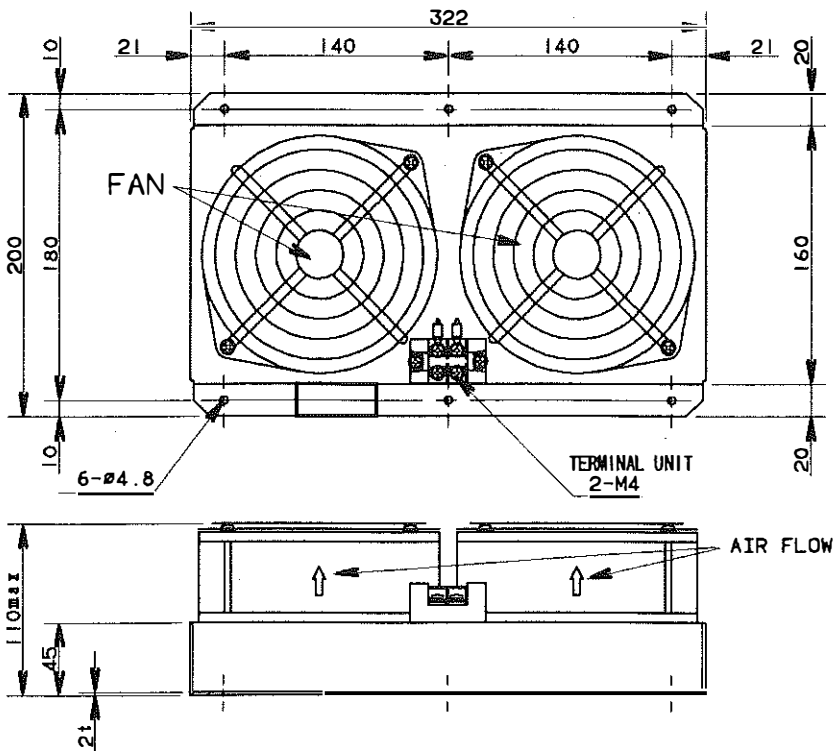


2.10.6 Fan unit

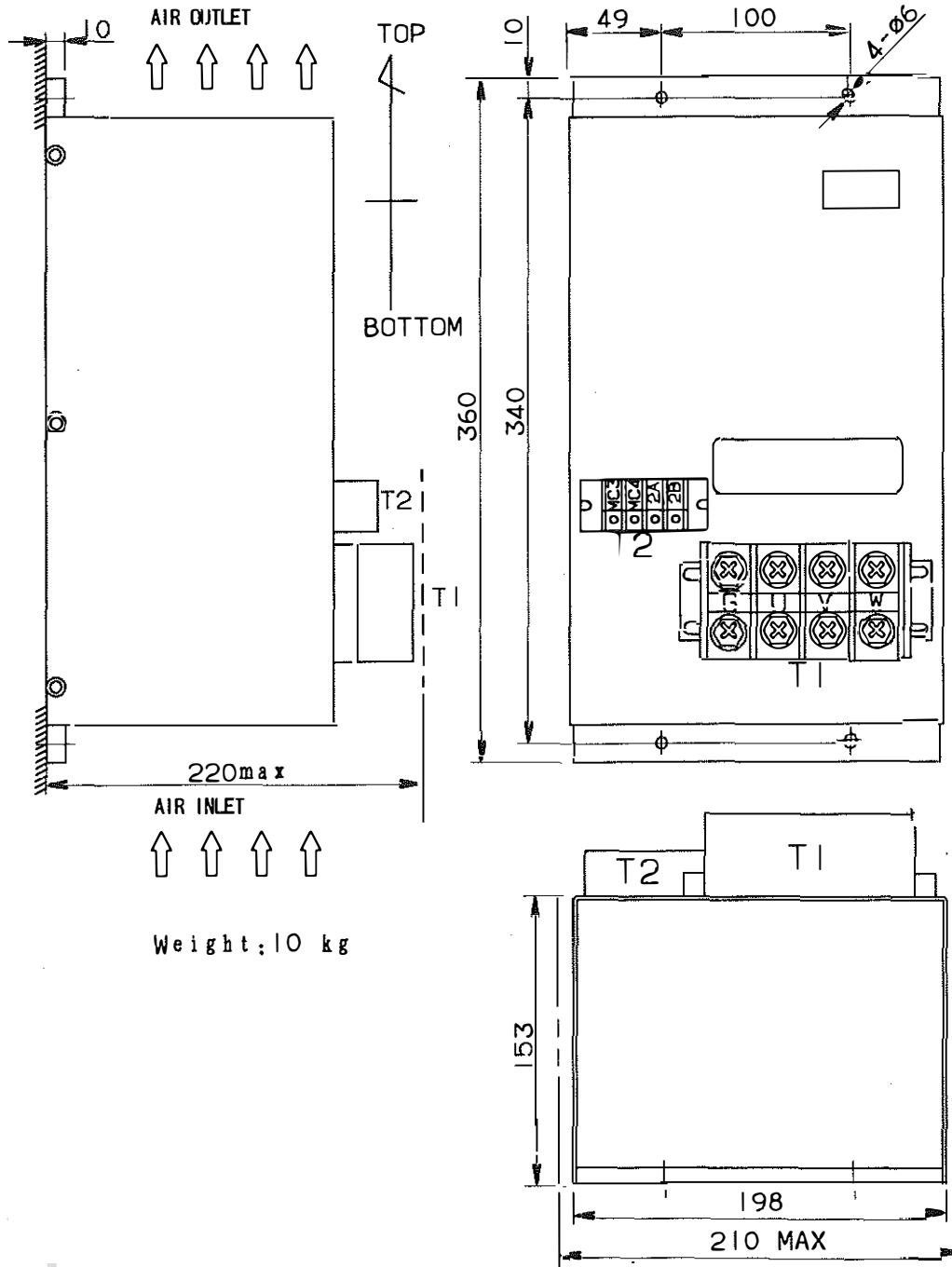
FAN UNIT 1 (SYMBOL:FU1)



FAN UNIT 2 (SYMBOL:FU2)



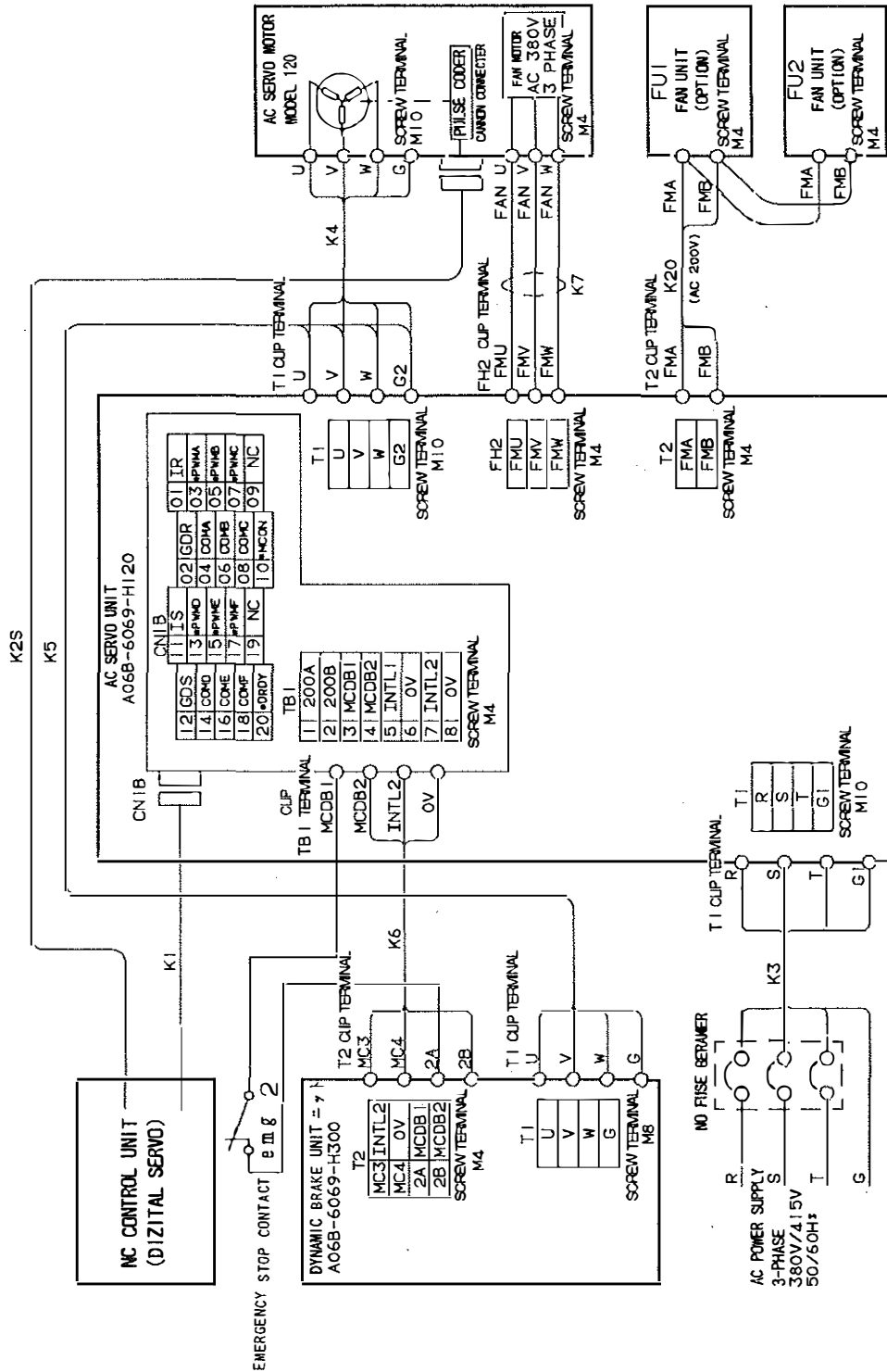
2.10.7 Dynamic Brake unit



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2.11 Connection Diagram



Note 1) Closing the circuit (no-fuse) breaker supplies power to the servo amplifier. The CHARGE LED in the servo amplifier lights.

Fig. 2.11 Connection Diagram

2.12 Connecting Cables

- (1) Cable K1
Refer to the Connection Manual for each NC.
- (2) Cable K3 (AMPLIFIER POWER LINE)

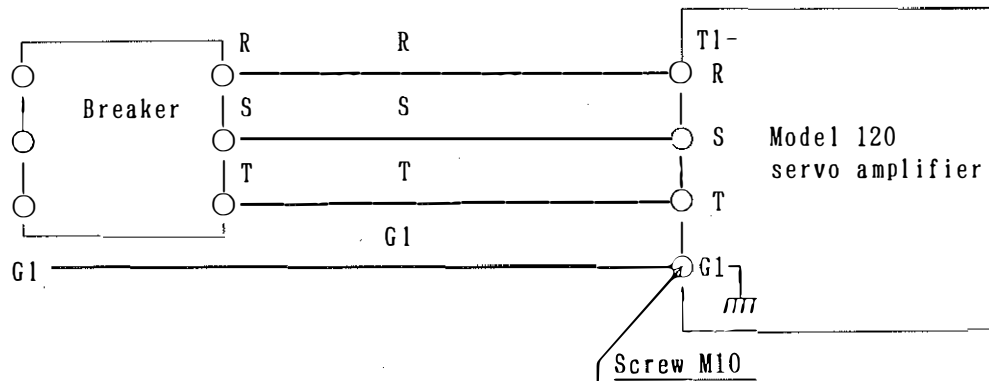


Fig. 2.10(a)

Cable	Symbol	Sectional area	Length	Specification
K3	RST	50mm ² Min.	10m Max.	Cable with a dielectric strength of 600 VAC (LMFC cable, manufactured by Furukawa Electric Co., Ltd., MLFC cable, manufactured by Hitachi Cable, Ltd., or equivalent)
	G1	22mm ² Min.		

- Note 1) Separately consult FANUC if the cable length becomes extremely long.
 Note 2) The number indicates the sectional area per cable used.

- (3) Cable K4 (MOTOR POWER LINE)

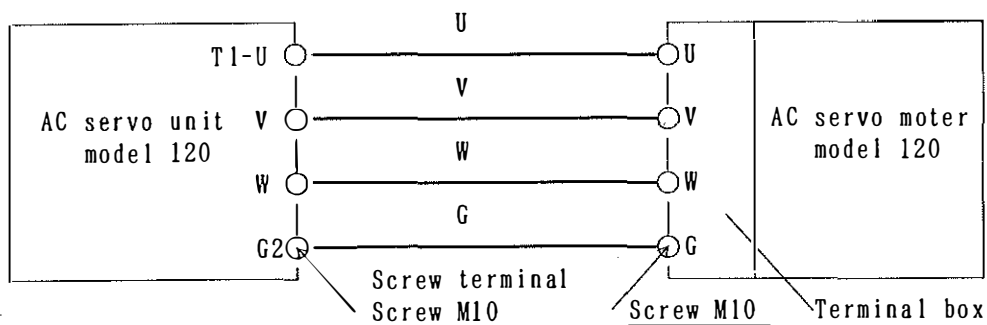


Fig. 2.10(b)

Cable	Symbol	Sectional area	Length	Specification
K4	G(G2)	22mm ² Min.	50m Max.	Cable with a dielectric strength of 600 VAC (LMFC cable, manufactured by Furukawa Electric Co., Ltd., MLFC cable, manufactured by Hitachi Cable, Ltd., or equivalent)
	UVW	30mm ² Min.	14m Max.	
		50mm ² Min.	50m Max.	

- Note 1) Separately consult FANUC if the cable length becomes extremely long.
 Note 2) An overly long cable degrades the output characteristics of the motor.
 Note 3) The number indicates the sectional area per cable used.

(4) Cable K5 (For Dynamic brake)

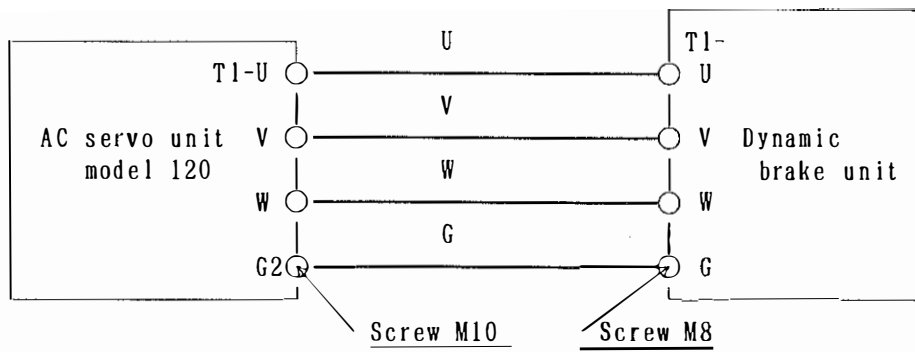


Fig. 2.10(c)

Cable	Symbol	Sectional area	Length	Specification
K5	G(G2) UVW	14mm ² Min.	1m Max.	Cable with a dielectric strength of 600 VAC (LMFC cable, manufactured by Furukawa Electric Co., Ltd., MLFC cable, manufactured by Hitachi Cable, Ltd., or equivalent)

Note 1) The number indicates the sectional area per cable used.

Note 2) Very large currents flow through the cable in the event of an emergency stop. Therefore, keep the cable as short as possible. Also, do not route signal cables near the cable.

(5) Cable K6

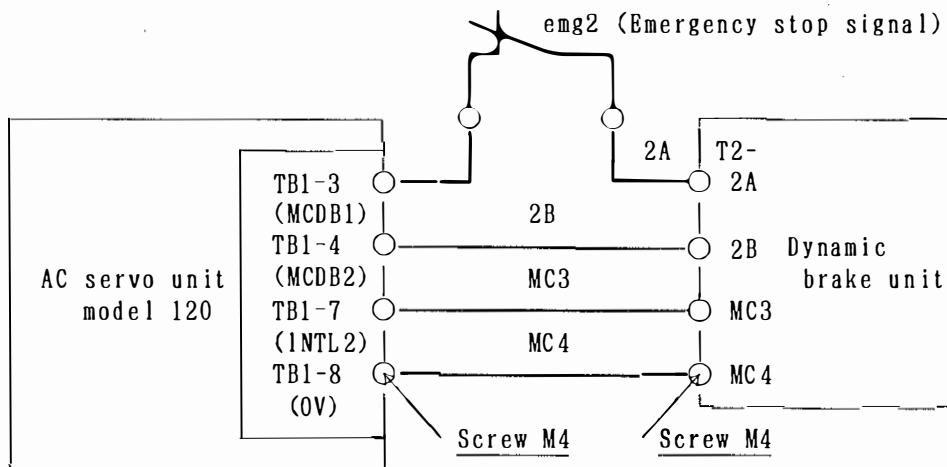


Fig. 2.10(d)

Cable	Symbol	Sectional area	Length	Specification
K6	MC4 MC3 2B	1.25mm ² Min.	1m Max.	Cable with a dielectric strength of 600 VAC (LMFC cable, manufactured by Furukawa Electric Co., Ltd., MLFC cable, manufactured by Hitachi Cable, Ltd., or equivalent)
	2A		10m Max.	

Note 1) The number indicates the sectional area per cable used.
 Note 2) Keep the cable as short as possible. Do not route signal cables near the cable.

The contactor used by emergency stop circuit.

emg2	Contact current		Remark
	Surge current	Rated current	
AC200V	1.1A	0.09A	

(6) Cable K7

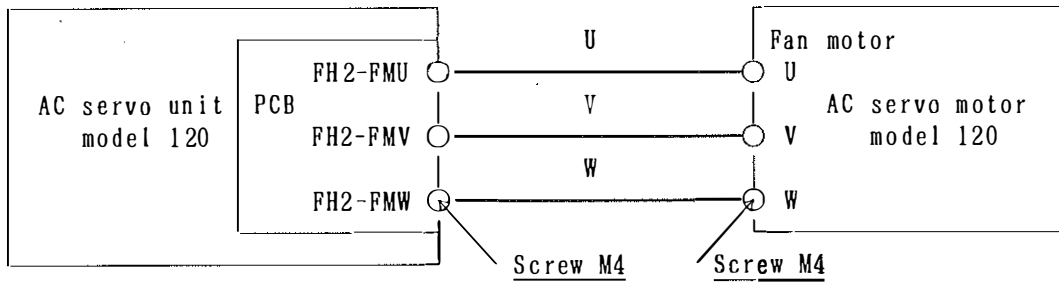


Fig. 2.10(e)

Cable	Symbol	Sectional area	Length	Specification
K7	U (FMU) V (FMV) W (FMW)	2mm ² Mini.	50m Max.	Cable with a dielectric strength of 600 VAC (LMFC cable, manufactured by Furukawa Electric Co., Ltd., MLFC cable, manufactured by Hitachi Cable, Ltd., or equivalent)

Note 1) The number indicates the sectional area per cable used.

(7) Cable K20 (Powerline cable for cooling fan)

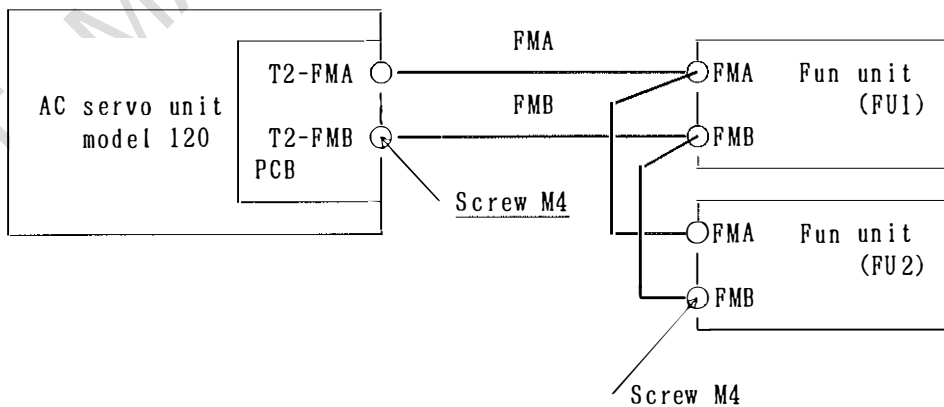


Fig. 2.10(f)

Cable	Symbol	Sectional area	Length	Specification
K20	FMA FMB	2mm ² Mini.	5 m Max.	Cable with a dielectric strength of 600 VAC (LMFC cable, manufactured by Furukawa Electric Co., Ltd., MLFC cable, manufactured by Hitachi Cable, Ltd., or equivalent)

Note 1) The number indicates the sectional area per cable used.

2.13 Digital Servo Parameter

(1) The following ROM version of the digital servo control software is required for the Model 120 motor.

Pulse coder	ROM Version/NC controller unit		
	9046	9060	9070
α A64	FS0/C. FS15A	FS15B. FS16A. FS18. FS20. FS21	FS16B

(2) Setting control parameters

	FS0/C	FS15A FS15B	FS16A. B FS18. 20. 21	Setting parameter	Remark
function bit-Parameter	8*05	1883	2005	00000000	
function bit-Parameter	8*06	1884	2006	01000000	(Compensation for back electromotive force in dec enabled)
Speed control P1/IP	8*03	1808	2003	00001000	(PIENBL=P1 setting)
Control period of velocity loop	8*04	1809	2004	01000110	(TIB0 1=Velocity loop lms Setting)

(3) Setting the servo parameter.

Symbol	FS0/C	FS15A FS15B	FS16A.B FS18.20.21	Setting parameter
PK1	8*40	1852	2040	728
PK2	8*41	1853	2041	-2679
PK3	8*42	1854	2042	-2714
PK1V	8*43	1855	2043	504
PK2V	8*44	1856	2044	-4515
PK3V	8*45	1857	2045	0
PK4V	8*46	1858	2046	-8235
POA1	8*47	1859	2047	841
BLCMP	8*48	1860	2048	0
RESERV	8*49	1861	2049	0
POK1	8*50	1862	2050	956
POK2	8*51	1863	2051	510
RESERV	8*52	1864	2052	0
PPMAX	8*53	1865	2053	21
PDDP	8*54	1866	2054	3787
PHYST	8*55	1867	2055	319
EMFCMP	8*56	1868	2056	11366
PVPA	8*57	1869	2057	3147
PALPH	8*58	1870	2058	64
PPBAS	8*59	1871	2059	20
TQLIM	8*60	1872	2060	7282
EMFLMT	8*61	1873	2061	120
POVC1	8*62	1877	2062	32112
POVC2	8*63	1878	2063	8206
TGALMLV	8*64	1892	2064	4
POVCLMT	8*65	1893	2065	24559
PK2VAUX	8*66	1894	2066	0
FILTER	8*67	1895	2067	0
FALPH	8*68	1961	2068	0
VFFLT	8*69	1962	2069	0
ERBLM	8*70	1963	2070	0
BPLCT	8*71	1964	2071	0
AALPH	8*74	1967	2074	0
MODEL	8*75	1968	2075	0
WKAC	8*76	1969	2076	0
OSCTPL	8*77	1970	2077	0
BLENDL	8*82	1975	2082	0
MOFCTL	8*83	1976	2083	0
SDMR1	8*84	1977	2084	0
SDMR2	8*85	1978	2085	0
RTCURR	8*86	1979	2086	4624
TDPLD	8*87	1980	2087	0

ADDITIONAL INFORMATION

FANUC SERVO MOTOR series
FANUC SPINDLE MOTOR series
FANUC SERVO AMPLIFIER series

SAFETY PRECAUTIONS

B-00200EN/01

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SAFETY PRECAUTIONS

The "Safety Precautions" section describes the safety precautions relating to the use of FANUC servo motors, spindle motors, and servo amplifiers (power supply modules, servo amplifier modules, and spindle amplifier modules). Users of any servo motor or amplifier model are requested to read the "Safety Precautions" carefully before using the servo motor or amplifier.

The users are also requested to read an applicable Descriptions manual carefully and understand each function of the motor or amplifier for correct use.

The users are basically forbidden to do any behavior or action not mentioned in the "Safety Precautions." They are invited to ask FANUC previously about what behavior or action is prohibited.

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1.1 DEFINITION OF WARNING, CAUTION, AND NOTE

This manual includes safety precautions for protecting the user and preventing damage to the machine. Precautions are classified into Warning and Caution according to their bearing on safety. Also, supplementary information is described as a Note. Read the Warning, Caution, and Note thoroughly before attempting to use the machine.

WARNING

Applied when there is a danger of the user being injured or when there is a damage of both the user being injured and the equipment being damaged if the approved procedure is not observed.

CAUTION

Applied when there is a danger of the equipment being damaged, if the approved procedure is not observed.

NOTE

The Note is used to indicate supplementary information other than Warning and Caution.

* Read this manual carefully, and store it in a safe place.

1.2 FANUC AC SERVO MOTOR series FANUC AC SPINDLE MOTOR series

1.2.1 Warning

⚠ WARNING

- **Be safely dressed when handling a motor.**
Wear safety shoes or gloves when handling a motor as you may get hurt on any edge or protrusion on it or electric shocks.
- **Use a crane or lift to move a motor from one place to another.**
A motor is heavy. If you lift the motor by hand, you may get a backache, or you may be seriously injured when you drop the motor. A suitable crane or lift must be used to move the motor. (For the weight of motors, refer to their respective Descriptions manual.)
When moving a motor using a crane or lift, use a hanging bolt if the motor has a corresponding tapped hole, or textile rope if it has no tapped hole.
If a motor is attached with a machine or any other heavy stuff, do not use a hanging bolt to move the motor as the hanging bolt and/or motor may get broken.
- **Before starting to connect a motor to electric wires, make sure they are isolated from an electric power source.**
A failure to observe this caution is very dangerous because you may get electric shocks.
- **Be sure to secure power wires.**
If operation is performed with a terminal loose or connector loose, the terminal block or connector may become abnormally hot, possibly causing a fire. Also, the terminal may become disconnected, causing a ground fault or short-circuit, and possibly giving you electric shocks. See the section in Descriptions manual that gives the tightening torque for attaching power wires and short-bars to the terminal block.
- **Be sure to ground a motor frame.**
To avoid electric shocks, be sure to connect the grounding terminal in the terminal box to the grounding terminal of the machine.
- **Do not ground a motor power wire terminal or short-circuit it to another power wire terminal.**
A failure to observe this caution may cause electric shocks or a burned wiring.
(*) Some motors require a special connection such as a winding changeover. Refer to their respective motor Descriptions manuals for details.

 **WARNING**

- **Ground the machine side firmly.**
To avoid electric shock or fire, be sure to ground thickly and securely to power electric cabinet.
- **Do not supply the power to the motor while any terminal is exposed.**
A failure to observe this caution is very dangerous because you may get electric shocks if your body or any conductive stuff touches an exposed terminal.
- **Do not bring any dangerous stuff near a motor.**
Motors are connected to a power line, and may get hot. If a flammable is placed near a motor, it may be ignited, catch fire, or explode.
- **Do not get close to a rotary section of a motor when it is rotating.**
You may get your clothes or fingers caught in a rotary section, and may be injured. Before starting a motor, ensure that there is no stuff that can fly away (such as a key) on the motor.
- **Do not touch a motor with a wet hand.**
A failure to observe this caution is vary dangerous because you may get electric shocks.
- **Before touching a motor, shut off the power to it.**
Even if a motor is not rotating, there may be a voltage across the terminals of the motor.
Especially before touching a power supply connection, take sufficient precautions.
Otherwise you may get electric shocks.
- **Do not touch any terminal of a motor for a while (at least 5 minutes) after the power to the motor is shut off.**
High voltage remains across power line terminals of a motor for a while after the power to the motor is shut off. So, do not touch any terminal or connect it to any other equipment. Otherwise, you may get electric shocks or the motor and/or equipment may get damaged.
- **To drive a motor, use a specified amplifier and parameters.**
Driving a motor with other than the specified combinations of an amplifier and parameters may cause the motor to perform an unexpected operation; for example, the motor may get out of control, or produce excessively high torque. This may result in the motor or machine being damaged. Also, an object such as a workpiece or tool may fly off due to excessive rotation, possibly causing injury.

⚠ WARNING

- **Do not touch a regenerative discharge unit for a while (at least 30 minutes) after the power to the motor is shut off.**
A regenerative discharge unit may get hot when the motor is running.
Do not touch the regenerative discharge unit before it gets cool enough. Otherwise, you may get burned.
- **Do not touch a motor when it is running or immediately after it stops.**
A motor may get hot when it is running. Do not touch the motor before it gets cool enough. Otherwise, you may get burned.
- **Ensure that motors and related components are mounted securely.**
If a motor or its component slips out of place or comes off when the motor is running, it is very dangerous.
- **Be careful not get your hair or cloths caught in a fan.**
Be careful especially for a fan used to generate an inward air flow. Be careful also for a fan even when the motor is stopped, because it continues to rotate while the amplifier is turned on.
- **When designing and assembling a machine tool, make it compliant with EN60204-1.**
To ensure the safety of the machine tool and satisfy European standards, when designing and assembling a machine tool, make it compliant with EN60204-1. For details of the machine tool, refer to its Descriptions manual.

1.2.2 Caution

⚠ CAUTION

- **FANUC motors are designed for use with machines. Do not use them for any other purpose.**
If a FANUC motor is used for an unintended purpose, it may cause an unexpected symptom or trouble. If you want to use a motor for an unintended purpose, previously consult with FANUC.
- **Ensure that a base or frame on which a motor is mounted is strong enough.**
Motors are heavy. If a base or frame on which a motor is mounted is not strong enough, it is impossible to achieve the required precision.
- **Be sure to connect motor cables correctly.**
An incorrect connection of a cable cause abnormal heat generation, equipment malfunction, or failure. Always use a cable with an appropriate current carrying capacity (or thickness). For how to connect cables to motors, refer to their respective Descriptions manuals.
- **Ensure that motors are cooled if they are those that require forcible cooling.**
If a motor that requires forcible cooling is not cooled normally, it may cause a failure or trouble. For a fan-cooled motor, ensure that it is not clogged or blocked with dust and dirt. For a liquid-cooled motor, ensure that the amount of the liquid is appropriate and that the liquid piping is not clogged.
For both types, perform regular cleaning and inspection.
- **When attaching a component having inertia, such as a pulley, to a motor, ensure that any imbalance between the motor and component is minimized.**
If there is a large imbalance, the motor may vibrates abnormally, resulting in the motor being broken.
- **Be sure to attach a key to a motor with a keyed shaft.**
If a motor with a keyed shaft runs with no key attached, it may impair torque transmission or cause imbalance, resulting in the motor being broken.

1.2.3 Note

NOTE

- **Do not step or sit on a motor.**
If you step or sit on a motor, it may get deformed or broken. Do not put a motor on another unless they are in packages.
- **When storing a motor, put it in a dry (non-condensing) place at room temperature (0 to 40°C).**
If a motor is stored in a humid or hot place, its components may get damaged or deteriorated. In addition, keep a motor in such a position that its shaft is held horizontal and its terminal box is at the top.
- **Do not remove a nameplate from a motor.**
If a nameplate comes off, be careful not to lose it. If the nameplate is lost, the motor becomes unidentifiable, resulting in maintenance becoming impossible.
For a nameplate for a built-in spindle motor, keep the nameplate with the spindle.
- **Do not apply shocks to a motor or cause scratches to it.**
If a motor is subjected to shocks or is scratched, its components may be adversely affected, resulting in normal operation being impaired. Be very careful when handling plastic portions, sensors, and windings, because they are very liable to break. Especially, avoid lifting a motor by pulling its plastic portion, winding, or power cable.
- **Do not conduct dielectric strength or insulation test for a sensor.**
Such a test can damage elements in the sensor.
- **When testing the winding or insulation resistance of a motor, satisfy the conditions stipulated in IEC60034.**
Testing a motor under a condition severer than those specified in IEC34 may damage the motor.
- **Do not disassemble a motor.**
Disassembling a motor may cause a failure or trouble in it. If disassembly is in need because of maintenance or repair, please contact a service representative of FANUC.
- **Do not modify a motor.**
Do not modify a motor unless directed by FANUC. Modifying a motor may cause a failure or trouble in it.

NOTE

- **Use a motor under an appropriate environmental condition.**
Using a motor in an adverse environment may cause a failure or trouble in it.
Refer to their respective Descriptions manuals for details of the operating and environmental conditions for motors.
- **Do not apply a commercial power source voltage directly to a motor.**
Applying a commercial power source voltage directly to a motor may result in its windings being burned. Be sure to use a specified amplifier for supplying voltage to the motor.
- **For a motor with a terminal box, make a conduit hole for the terminal box in a specified position.**
When making a conduit hole, be careful not to break or damage unspecified portions.
Refer to an applicable Descriptions manual.
- **Before using a motor, measure its winding and insulation resistances, and make sure they are normal.**
Especially for a motor that has been stored for a prolonged period of time, conduct these checks. A motor may deteriorate depending on the condition under which it is stored or the time during which it is stored. For the winding resistances of motors, refer to their respective Descriptions manuals, or ask FANUC. For insulation resistances, see the following table.
- **To use a motor as long as possible, perform periodic maintenance and inspection for it, and check its winding and insulation resistances.**
Note that extremely severe inspections (such as dielectric strength tests) of a motor may damage its windings. For the winding resistances of motors, refer to their respective Descriptions manuals, or ask FANUC. For insulation resistances, see the following table.

MOTOR INSULATION RESISTANCE MEASUREMENT

Measure an insulation resistance between each winding and motor frame using an insulation resistance meter (500 VDC).
Judge the measurements according to the following table.

Insulation resistance	Judgment
100M Ω or higher	Acceptable
10 to 100 M Ω	The winding has begun deteriorating. There is no problem with the performance at present. Be sure to perform periodic inspection.
1 to 10 M Ω	The winding has considerably deteriorated. Special care is in need. Be sure to perform periodic inspection.
Lower than 1 M Ω	Unacceptable. Replace the motor.

1.3 FANUC SERVO AMPLIFIER series

1.3.1 Warnings and Cautions Relating to Mounting

1.3.1.1 Warning

▲ WARNING

- **Check the specification code of the amplifier.**
Check that the delivered amplifier is as originally ordered.
- **Mount a ground fault interrupter.**
To guard against fire and electric shock, fit the factory power supply or machine with a ground fault interrupter (designed for use with an inverter).
- **Securely ground the amplifier.**
Securely connect the ground terminal, ground connector and metal frame of the amplifier and motor to a common ground plate of the power magnetics cabinet.
- **Be aware of the weight of the amplifier and other components.**
Control motor amplifiers and AC reactors are heavy. When transporting them or mounting them in the cabinet, therefore, be careful not to injure yourself or damage the equipment. Be particularly careful not to jam your fingers between the cabinet and amplifier.
- **Never ground or short-circuit either the power supply lines or power lines.**
Protect the lines from any stress such as bending. Handle the ends appropriately.
- **Ensure that the power supply lines, power lines, and signal lines are securely connected.**
A loose screw, loose connection, or the like will cause a motor malfunction or overheating, or a ground fault.
Be extremely careful with power supply lines, motor power lines, and DC link connections through which a large amount of current passes, because a loose screw (or poor contact in a connector or poor connection between a connector terminal and a cable) may cause a fire.
- **Insulate all exposed parts that are charged.**

⚠ WARNING

- **Never touch the regenerative discharge resistor or radiator directly.**
The surface of the radiator and regenerative discharge unit become extremely hot. Never touch them directly. An appropriate structure should also be considered.
- **Close the amplifier cover after completing the wiring.**
Leaving the cover open presents a danger of electric shock.
- **Do not disassemble the amplifier.**
- **Ensure that the cables used for the power supply lines and power lines are of the appropriate diameter and temperature ratings.**
- **Do not apply an excessively large force to plastic parts.**
If a plastic section breaks, it may cause internal damage, thus interfering with normal operation. The edge of a broken section is likely to be sharp and, therefore, presents a risk of injury.

1.3.1.2 Caution

CAUTION

- **Do not step or sit on the amplifier.**
Also, do not stack unpacked amplifiers on top of each other.
- **Use the amplifier in an appropriate environment.**
See the allowable ambient temperatures and other requirements, given in the corresponding descriptions.
- **Protect the amplifier from corrosive or conductive mist or drops of water.**
Use a filter if necessary.
- **Protect the amplifier from impact.**
Do not place anything on the amplifier.
- **Connect the power supply lines and power lines to the appropriate terminals and connectors.**
- **Connect the signal lines to the appropriate connectors.**
- **Do not block the air inlet to the radiator.**
A deposit of coolant, oil mist, or chips on the air inlet will result in a reduction in the cooling efficiency. In some cases, the required efficiency cannot be achieved. The deposit may also lead to a reduction in the useful life of the semiconductors. Especially, when outside air is drawn in, mount filters on both the air inlet and outlet. These filters must be replaced regularly.
So, an easy-to-replace type of filter should be used.
- **Before connecting the power supply wiring, check the supply voltage.**
Check that the supply voltage is within the range specified in Descriptions manual, then connect the power supply lines. If the supply voltage is over than the range specified in descriptions manual, the equipment may be damaged or burned.
- **Ensure that the combination of motor and amplifier is appropriate.**
- **Ensure that valid parameters are specified.**
Specifying an invalid parameter for the combination of motor and amplifier may not only prevent normal operation of the motor but also result in damage to the amplifier.
- **Ensure that the amplifier and peripheral equipment are securely connected.**
Check that the magnetic contactor, circuit breaker, and other devices mounted outside the amplifier are securely connected to each other and that those devices are securely connected to the amplifier.

▲ CAUTION

- **Check that the amplifier is securely mounted in the power magnetics cabinet.**
If any clearance is left between the power magnetics cabinet and the surface on which the amplifier is mounted, dust entering the gap may build up and prevent the normal operation of the amplifier.

- **Apply appropriate countermeasures against noise.**
Adequate countermeasures against noise are required to maintain normal operation of the amplifier. For example, signal lines must be routed away from power supply lines and power lines.



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1.3.1.3 Note

NOTE

- **Keep the nameplate clearly visible.**
- **Keep the legend on the nameplate clearly visible.**
- **After unpacking the amplifier, carefully check for any damage.**
- **Mount the amplifier in a location where it can be easily accessed periodic inspection and daily maintenance.**
- **Leave sufficient space around the machine to enable maintenance to be performed easily.**
Do not place any heavy objects such that they would interfere with the opening of the doors.
- **Keep the parameter table and spare parts at hand.**
Also, keep the specifications at hand. These items must be stored in a location where they can be retrieved immediately.
- **Provide adequate shielding.**
A cable to be shielded must be securely connected to the ground plate, using a cable clamp or the like.

1.3.2 Warnings and Cautions Relating to a Pilot Run

1.3.2.1 Warning

⚠ WARNING

- **Before turning on the power, check that the cables connected to the power magnetics cabinet and amplifier, as well as the power lines and power supply lines, are securely connected. Also, check that no lines are slack.**
A loose screw, loose connection, or the like will cause a motor malfunction or overheating, or a ground fault.
Be extremely careful with power supply lines, motor power lines, and DC link connections through which a large amount of current passes, because a loose screw (or poor contact in a connector or poor connection between a connector or terminal to a cable) may cause a fire.
- **Before turning on the power, ensure that the power magnetics cabinet is securely grounded.**
- **Before turning on the power, check that the door of the power magnetics cabinet and all other doors are closed.**
Ensure that the door of the power magnetics cabinet containing the amplifier, and all other doors, are securely closed. During operation, all doors must be closed and locked.
- **Apply extreme caution if the door of the power magnetics cabinet or another door must be opened.**
Only a person trained in the maintenance of the corresponding machine or equipment should open the door, and only after shutting off the power supply to the power magnetics cabinet (by opening both the input circuit breaker of the power magnetics cabinet and the factory switch used to supply power to the cabinet). If the machine must be operated with the door open to enable adjustment or for some other purpose, the operator must keep his or her hands and tools well away from any dangerous voltages. Such work must be done only by a person trained in the maintenance of the machine or equipment.
- **When operating the machine for the first time, check that the machine operates as instructed.**
To check whether the machine operates as instructed, first specify a small value for the motor, then increase the value gradually. If the motor operates abnormally, perform an emergency stop immediately.
- **After turning on the power, check the operation of the emergency stop circuit.**
Press the emergency stop button to check that the motor stops immediately, and that the power being supplied to the amplifier is shut off by the magnetic contactor.

 **WARNING**

- **Before opening a door or protective cover of a machine to enable adjustment of the machine, first place the machine in the emergency stop state and check that the motor has stopped.**

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1.3.2.2 Caution

⚠ CAUTION

- **Note whether an alarm status relative to the amplifier is displayed at power-up or during operation.**
If an alarm is displayed, take appropriate action as explained in the maintenance manual. If the work to be done requires that the door of the power magnetics cabinet be left open, the work must be carried out by a person trained in the maintenance of the machine or equipment. Note that if some alarms are forcibly reset to enable operation to continue, the amplifier may be damaged. Take appropriate action according to the contents of the alarm.
- **Before operating the motor for the first time, mount and adjust the position and speed sensors.**
Following the instructions given in the maintenance manual, adjust the position and speed sensors for the spindle so that an appropriate waveform is obtained.
If the sensors are not properly adjusted, the motor may not rotate normally or the spindle may fail to stop as desired.
- **If the motor makes any abnormal noise or vibration while operating, stop it immediately.**
Note that if operation is continued in spite of there being some abnormal noise or vibration, the amplifier may be damaged. Take appropriate corrective action, then resume operation.
- **Observe the ambient temperature and output rating requirements.**
The continuous output rating or continuous operation period of some amplifiers may fall as the ambient temperature increases. If the amplifier is used continuously with an excessive load applied, the amplifier may be damaged.
- **Unless otherwise specified, do not insert or remove any connector while the power is turned on. Otherwise, the amplifier may fail.**

1.3.3 Warnings and Cautions Relating to Maintenance

1.3.3.1 Warning

WARNING

- **Read the maintenance manual carefully and ensure that you are totally familiar with its contents.**
The maintenance manual describes daily maintenance and the procedures to be followed in the event of an alarm being issued. The operator must be familiar with these descriptions.
- **Notes on replacing a fuse or PC board**
 - 1) Before starting the replacement work, ensure that the circuit breaker protecting the power magnetics cabinet is open.
 - 2) Check that the red LED that indicates that charging is in progress is not lit.
The position of the charging LED on each model of amplifier is given in Descriptions manual. While the LED is lit, hazardous voltages are present inside the unit, and thus there is a danger of electric shock.
 - 3) Some PC board components become extremely hot. Be careful not to touch these components.
 - 4) Ensure that a fuse having an appropriate rating is used.
 - 5) Check the specification code of a PC board to be replaced. If a modification drawing number is indicated, contact FANUC before replacing the PC board.
Also, before and after replacing a PC board, check its pin settings.
 - 6) After replacing the fuse, ensure that the screws are firmly tightened. For a socket-type fuse, ensure that the fuse is inserted correctly.
 - 7) After replacing the PC board, ensure that it is securely connected.
 - 8) Ensure that all power lines, power supply lines, and connectors are securely connected.
- **Take care not to lose any screws.**
When removing the case or PC board, take care not to lose any screws. If a screw is lost inside the unit and the power is turned on, the machine may be damaged.

⚠ WARNING

- **Notes on replacing the battery of the absolute pulse coder**
Replace the battery only while the power is on. If the battery is replaced while the power is turned off, the stored absolute positioning data will be lost. Some series servo amplifier modules have batteries in their servo amplifiers. To replace the battery of any of those models, observe the following procedure: Open the door of the power magnetics cabinet; Leave the control power of the power supply module on; Place the machine in the emergency stop state so that the power being input to the amplifier is shut off; Then, replace the battery. Replacement work should be done only by a person who is trained in the related maintenance and safety requirements. The power magnetics cabinet in which the servo amplifier is mounted has a high-voltage section. This section presents a severe risk of electric shock.
- **Check the number of any alarm.**
If the machine stops upon an alarm being issued, check the alarm number. Some alarms indicate that a component must be replaced. If the power is reconnected without first replacing the failed component, another component may be damaged, making it difficult to locate the original cause of the alarm.
- **Before resetting an alarm, ensure that the original cause of the alarm has been removed.**
- **Contact FANUC whenever a question relating to maintenance arises.**
- **Notes on removing the amplifier**
Before removing the amplifier, first ensure that the power is shut off. Be careful not to jam your fingers between the power magnetics cabinet and amplifier.

1.3.3.2 Caution

CAUTION

- **Ensure that all required components are mounted.**
When replacing a component or PC board, check that all components, including the snubber capacitor, are correctly mounted. If the snubber capacitor is not mounted, for example, the IPM will be damaged.
- **Tighten all screws firmly.**
- **Check the specification code of the fuse, PC board, and other components.**
When replacing a fuse or PC board, first check the specification code of the fuse or PC board, then mount it in the correct position. The machine will not operate normally if a fuse or PC board having other than the correct specification code is mounted, or if a fuse or PC board is mounted in the wrong position.
- **Mount the correct cover.**
The cover on the front of the amplifier carries a label indicating a specification code. When mounting a previously removed front cover, take care to mount it on the unit from which it was removed.
- **Notes on cleaning the heat sink and fan**
 - 1) A dirty heat sink or fan results in reduced semiconductor cooling efficiency, which degrades reliability. Periodic cleaning is necessary.
 - 2) Using compressed air for cleaning scatters the dust. A deposit of conductive dust on the amplifier or peripheral equipment will result in a failure.
 - 3) To clean the heat sink, do so only after turning the power off and ensuring that the heat sink has cooled to room temperature. The heat sink becomes extremely hot, such that touching it during operation or immediately after power-off is likely to cause a burn. Be extremely careful when touching the heat sink.

1.3.3.3 Note

NOTE

- **Ensure that the battery connector is correctly inserted.**
If the power is shut off while the battery connector is not connected correctly, the absolute position data for the machine will be lost.
- **Store the manuals in a safe place.**
The manuals should be stored in a location where they can be accessed immediately if so required during maintenance work.
- **Notes on contacting FANUC**
Inform FANUC of the details of an alarm and the specification code of the amplifier so that any components required for maintenance can be quickly secured, and any other necessary action can be taken without delay.

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