

THREE-PHASE SYNCHRONOUS MOTOR FOR VARISPEED-686SS5  
CONSTANT TORQUE SERIES (WITH PG)  
**INSTRUCTIONS**

TOTALLY-ENCLOSED, TOTALLY-ENCLOSED EXTERNALLY FAN-COOLED TYPE  
PERMANENT MAGNET TYPE

200/400V

MODEL: SST-

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Upon receipt of the product and prior to initial operation, read these instructions thoroughly,  
and retain for future reference.

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This instruction manual covers the synchronous motor for VARISPEED - 686SS5.

To properly use the motor, read this manual thoroughly and retain for easy reference for inspections and maintenance etc.

### General Precautions

- The drawings presented in this manual are sometimes shown without covers or protective guards. Always replace the cover or protective guard as specified first, and then operate the products in accordance with the manual.
- The drawings presented in this manual are typical examples and may not match the product you received.
- This manual is subject to change due to product improvement, specification modification, and manual improvement. When this manual is revised, the manual code is updated and the new manual is published as a next edition. The edition number appears on the front and back covers.
- If the manual must be ordered due to loss or damage, inform your YASKAWA representative or one of the offices listed on the back of this manual.
- YASKAWA will not take responsibility for the results of unauthorized modifications of this product. YASKAWA shall not be liable for any damages or troubles resulting from unauthorized modification.

## SYMBOLS FOR SAFE OPERATION


In this manual, NOTES FOR SAFE OPERATION are classified as WARNING, or CAUTION.





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



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

Even items described in  CAUTION may result in a vital accident in some situations. In either case, follow these important items.

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

ISO	JIS
	

The ISO symbol is used in this manual.

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

NOTE

These are steps to be taken to insure proper operation and to avoid malfunctions, etc.

# NOTES FOR SAFE OPERATION

## WARNING

(Page)

### (General)

- Do not use general -purpose motors in an explosive gaseous atmosphere.  
Failure to observe this warning may cause fire or injury.
- Disconnect all power before wiring.  
Failure to observe this warning may cause electric shock.
- Transportation, installation, wiring, operation, maintenance and inspection should be performed only by authorized personnel.  
Failure to observe this warning may cause electric shock, injury or fire.

### (Wiring)

- When connecting a motor to a power supply cable, perform the wiring following the wiring diagram in the terminal box or instruction manual.  
Failure to observe this warning may cause electric shock or fire.
- Do not forcibly bend, pull, or pinch the power source or lead cables.  
Failure to observe this warning may cause electric shock.

### (Installation)

- Make sure to ground the motor in accordance with local electrical codes. 24  
Failure to observe this warning may cause electric shock.
- When mounting a motor on the ceiling or wall, follow installation guidelines as specified by related catalogs or technical sheets to prevent dropping of the motor. 13  
Failure to observe this warning may cause injury.

### (Operation)

- Do not operate motor with the terminal box cover removed. Replace the terminal box cover after wiring, etc. 25  
Failure to observe this warning may cause electric shock.
- Never get near to or touch the rotor shaft, etc. during operation. 25  
Failure to observe this warning may cause injury by being caught in a moving part.
- At power failure, make sure to turn OFF the power source. 25  
Failure to observe this warning may cause injury.

## WARNING

	(Page)
<b>(Maintenance)</b>	
<ul style="list-style-type: none"><li>● When connecting a power supply lead to a power source cable, perform the wiring following the wiring diagram in the terminal box or the instruction manual. Failure to observe this warning may cause electric shock or fire.</li></ul>	26
<b>(Repair, reassembly)</b>	
<ul style="list-style-type: none"><li>● Personnel with electronic medical devices such as pacemakers should not stand near the rotor. Failure to observe this warning may cause malfunction of the electronic medical device.</li></ul>	31

## CAUTION

	(Page)
<b>(General)</b>	
<ul style="list-style-type: none"><li>● Do not use a motor exceeding rated specifications. Failure to observe this caution may cause electric shock, injury, or damage to the motor.</li><li>● Do not put fingers or enter foreign matter into motor openings. Failure to observe this caution may cause electric shock, injury or fire.</li><li>● Do not use a motor with any part damaged. Failure to observe this caution may cause injury or fire.</li><li>● Never modify the product. Otherwise, it will invalidate the guarantee.</li><li>● Do not put any obstacles near the motor obscuring the nameplate.</li><li>● Never remove the nameplate.</li></ul>	
<b>(Transportation)</b>	
<ul style="list-style-type: none"><li>● During transport, care must be taken to avoid dropping or overturning the motor. For motors with eyebolts, use them. However, after installing the motor to the machine, do not use the eyebolts to lift the whole machine with the motor. Confirm the allowable lifting weight of the lifting tool and the weight of motor by the nameplate, the package, external dimensions drawing or the catalog. Failure to observe this caution may cause the dropping or overturning of the motor, resulting in personal injury or equipment damage.</li></ul>	9
<b>(Receiving)</b>	
<ul style="list-style-type: none"><li>● Verify that the received motor is the one you ordered. Installing the wrong product can result in personal injury or equipment damage.</li></ul>	8
<b>(Installation)</b>	
<ul style="list-style-type: none"><li>● Never leave flammable materials around the motor. Failure to observe this caution may cause fire.</li></ul>	13

## CAUTION

	(Page)
<ul style="list-style-type: none"> <li>● Do not put any obstacles which may restrict motor ventilation. Failure to observe this caution may degrade cooling effect, and cause an explosion, ignition or injury by abnormal rise of temperature.</li> </ul>	13
<ul style="list-style-type: none"> <li>● When rotating the motor by the shaft end, insulate the terminal of the lead wire. Failure to observe this caution may cause electric shock.</li> </ul>	13
<ul style="list-style-type: none"> <li>● When coupling a motor to a machine, care should be taken for alignment of coupling, belt tension, or sheave parallelism. In the case of direct coupling, care should be taken for direct coupling accuracy: Adjust belt tension properly for belt coupling. Before starting drive, tighten the sheave and coupling bolts securely. Failure to observe this caution may cause injury by machine parts scattering and damage to equipment.</li> </ul>	16
<ul style="list-style-type: none"> <li>● Provide a fence or guard around rotating parts. Failure to observe this caution may cause injury.</li> </ul>	16
<ul style="list-style-type: none"> <li>● When driving a motor individually, remove the key inserted in the motor shaft end. Failure to observe this caution may cause injury.</li> </ul>	16
<ul style="list-style-type: none"> <li>● Before coupling a motor to a machine, make sure that the motor is rotating in the correct direction. Failure to observe this caution may cause injury, or damage to equipment.</li> </ul>	16
<ul style="list-style-type: none"> <li>● Never lean or hang on to a motor. Failure to observe this caution may cause injury.</li> </ul>	16
<ul style="list-style-type: none"> <li>● Do not touch the shaft end key slot with bare fingers. Failure to observe this caution may cause injury.</li> </ul>	16
<b>(Wiring)</b>	
<ul style="list-style-type: none"> <li>● When measuring insulation resistance, do not touch the terminal. Failure to observe this caution may cause electric shock.</li> </ul>	21
<ul style="list-style-type: none"> <li>● Perform wiring conforming to National Electrical Code or to Local Electrical Codes. Failure to observe this caution may cause burn-out or fire.</li> </ul>	21
<ul style="list-style-type: none"> <li>● An overload protector is required by various electrical codes. It is also recommended that other protectors such as an earth leakage circuit breaker be provided. Failure to observe this caution may cause burn-out or fire.</li> </ul>	21
<ul style="list-style-type: none"> <li>● Do not make direct connection to commercial power source. Failure to observe this caution may cause damage to the circuit or motor by over-current.</li> </ul>	21
<ul style="list-style-type: none"> <li>● Do not make connection to inverter other than specified. Correct operation can not be performed, and may cause damage to the equipment or injury.</li> </ul>	21
<b>(Operation)</b>	
<ul style="list-style-type: none"> <li>● Do not touch the motor with fingers or body since exposed surfaces may reach high temperatures. Failure to observe this caution may cause injury.</li> </ul>	25

## CAUTION

	(Page)
<ul style="list-style-type: none"><li>● When a malfunction occurs, stop operation immediately. Failure to observe this caution may cause electric shock, injury or fire.</li></ul>	25
<b>(Maintenance)</b>	
<ul style="list-style-type: none"><li>● When measuring insulation resistance, do not touch the terminal. Failure to observe this caution may cause electric shock.</li></ul>	26
<ul style="list-style-type: none"><li>● When performing maintenance work such as grease replenishment or discharge, care must be taken to avoid touching the rotating shaft, etc. Failure to observe this caution may cause injury.</li></ul>	26
<ul style="list-style-type: none"><li>● Do not touch the motor frame with bare hands since the motor frame is heated to high temperature. Failure to observe this caution may cause injury.</li></ul>	26
<b>(Repair, reassembly)</b>	
<ul style="list-style-type: none"><li>● Repair or reassembly should be performed by qualified personnel only. Failure to observe this caution may cause electric shock, injury or fire.</li></ul>	26
<ul style="list-style-type: none"><li>● When extracting the rotor, special attention should be paid to its magnetism. Failure to observe this caution may cause injury or damage to the stator coils.</li></ul>	31
<ul style="list-style-type: none"><li>● Avoid any magnetic obstacles such as iron particles around the rotor. Failure to observe this caution may cause injury.</li></ul>	31
<ul style="list-style-type: none"><li>● Avoid leaving watches, measurement instruments, etc. close to the rotor. Failure to observe this caution may cause malfunction of watch, measurement instrument, etc.</li></ul>	31
<ul style="list-style-type: none"><li>● Make sure there is no foreign matter such as iron particles before inserting the rotor properly. Failure to observe this caution may cause injury or damage to the stator coils.</li></ul>	31
<b>(Disposal)</b>	
<ul style="list-style-type: none"><li>● When disposing a motor, treat it as a general industrial waste, abiding by local statutory legislation.</li></ul>	35
<ul style="list-style-type: none"><li>● Before disposal, demagnetize the rotor by raising temperature to 500°C or higher using a gas burner or stove.</li></ul>	35



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# 1 RECEIVING

 <b>CAUTION</b>
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- |  |
|--|
| <ul style="list-style-type: none"><li>● Verify that the received motor is the one you ordered.<br/>Installing the wrong product can result in personal injury or equipment damage.</li></ul> |
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When the product is delivered, check the following points:

- Do product specifications correspond with that of the purchase order ?
- Are any parts missing ?  
Check with the attached shipping documents and the purchase order.
- Can the output shaft be rotated easily by hand ?  
For models with thrust stopper, remove before rotating. A permanent magnet installed in the rotor may cause some irregular rotation, but it is not considered as malfunction.
- Are any parts damaged ?  
Visually check the exterior and verify there has been no damage during transport.
- Is hardware properly seated and tightened ?  
Check all hardware with appropriate tools.

If any of the above check points is unsatisfactory, contact your YASKAWA representative.

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## 2 TRANSPORTATION

### CAUTION

- During transport, care must be taken to avoid dropping or overturning the motor.  
For motors with eyebolts, use them. However, after installing the motor to the machine, do not use the eyebolts to lift the whole machine with the motor.  
Confirm the allowable lifting weight of the lifting tool and the weight of motor by the nameplate, the package, external dimensions drawing or the catalog.  
Failure to observe this caution may cause the dropping or overturning of the motor, resulting in personal injury or equipment damage.

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#### NOTE

For models with thrust stopper, remount the stopper to avoid damage to the bearings by vibration or shocks during transportation.

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## 3 STORAGE

When the motor is kept in storage temporarily or not operated for long periods, observe the following points.

### 3.1 Storage Location

Keep the motor in the following location.

- Clean and dry.
- Indoor

If not, close the motor with the cover to avoid entry of water and dust.

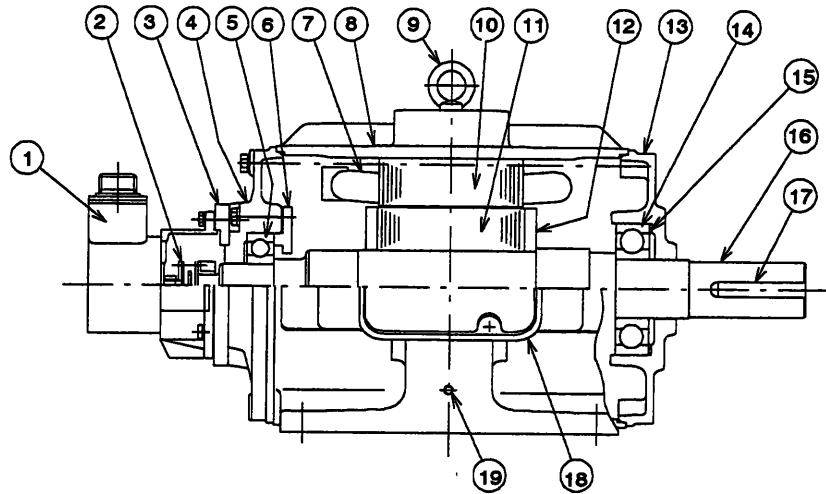
### 3.2 Monthly Inspection During Storage

Perform monthly inspection during storage.

- Provide rust prevention on the machine processing surfaces such as shaft.
- Rotate the motor by hand 30 times and more, or operate the motor without load for 5 minutes.
- Check if any rust exists on the motor. Though the motor is provided with anticorrosive painting, rust may be generated depending on storage conditions.
- Confirm the insulation resistance  $3M\Omega$  and more of the windings.

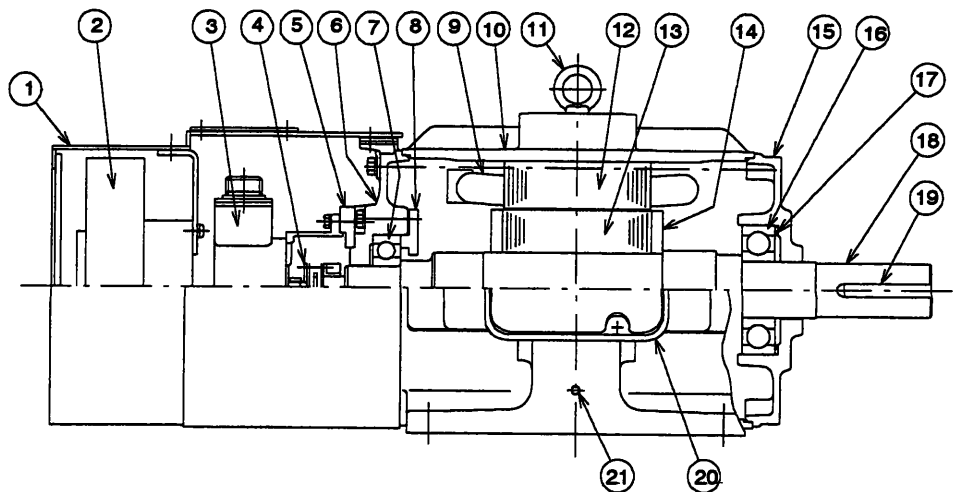
## 4 CONSTRUCTION

Motor construction is shown below.



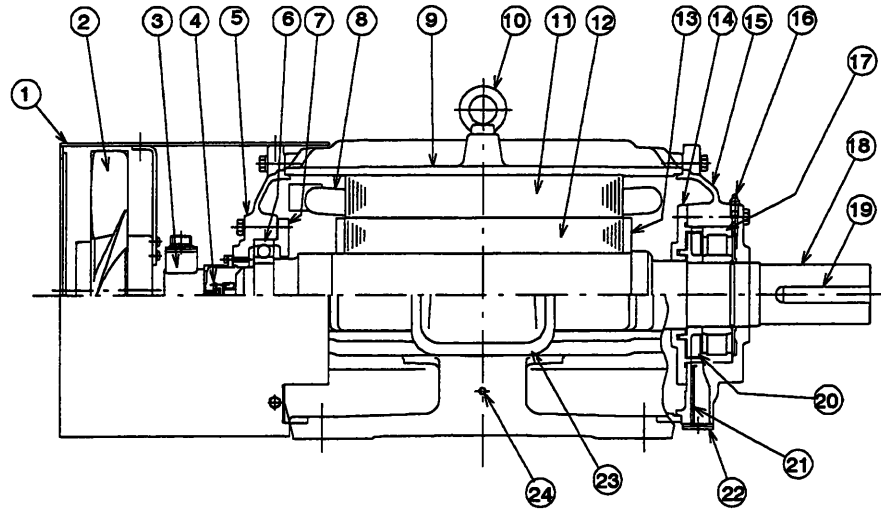
① PG	⑦ Stator coil	⑬ Bracket
② Coupling	⑧ Frame	⑭ Bearing (shielded type)
③ Intermediate plate	⑨ Eyebolt	⑮ Wave washer
④ Bracket	⑩ Stator core	⑯ Output shaft
⑤ Bearing (shielded type)	⑪ Rotor core	⑰ Key
⑥ Bearing cover	⑫ Rotor core retainer	⑱ Terminal box
		⑲ Ground terminal

Fig. 4.1 Construction (totally-enclosed, with PG, shielded bearing)



① Fan cover	⑧ Bearing cover	⑮ Bracket
② Fan	⑨ Stator coil	⑯ Bearing (shielded type)
③ PG	⑩ Frame	⑰ Wave washer
④ Coupling	⑪ Eyebolt	⑱ Output shaft
⑤ Intermediate plate	⑫ Stator core	⑲ Key
⑥ Bracket	⑬ Rotor core	⑳ Terminal box
⑦ Bearing (shielded type)	⑭ Rotor core retainer	㉑ Ground terminal

Fig. 4.2 Construction (externally fan-cooled, with PG, shielded bearing)



① Fan cover	⑨ Frame	⑰ Bearing (regreasable type)
② Fan	⑩ Eyebolt	⑱ Output shaft
③ PG	⑪ Stator core	⑲ Key
④ Coupling	⑫ Rotor core	⑳ Grease valve
⑤ Bracket	⑬ Rotor core retainer	㉑ Grease swab
⑥ Bearing (shielded type)	⑭ Bearing cover	㉒ Grease discharger cover
⑦ Bearing cover	⑮ Bracket	㉓ Terminal box
⑧ Stator coil	⑯ Grease nipple	㉔ Ground terminal

Fig. 4.3 Construction (externally fan -cooled, with PG, regreasable bearing)

## 5 INSTALLATION

### ⚠ WARNING

- When mounting a motor on the ceiling or wall, follow installation guidelines as specified by related catalogs or technical sheets to prevent dropping of the motor.  
Failure to observe this warning may cause injury.

### ⚠ CAUTION

- Never leave flammable materials around the motor.  
Failure to observe this caution may cause fire.
- Do not put any obstacles which may restrict motor ventilation.  
Failure to observe this caution may degrade cooling effect, and cause an explosion, ignition or injury by abnormal rise of temperature.
- When rotating the motor by the shaft end, insulate the terminal of the lead wire.  
Failure to observe this caution may cause electric shock.

Install the motor using the following procedures.

### 5.1 Anticorrosive Painting

Anticorrosive painting is provided on the ends of output shaft and flange surfaces. Remove the painting with thinner before installing the motor. Do not put thinner on other parts or places.

### 5.2 Working Space for Grease Discharge

A grease discharger is provided for the motor with regreasable bearings as shown in Fig. 5.1. When installing the motor, keep enough working space for grease discharge.

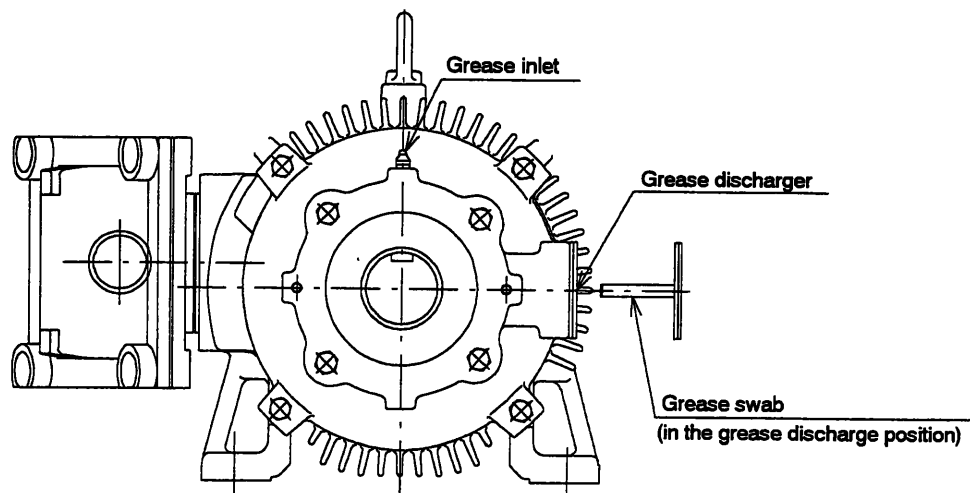


Fig. 5.1 Grease Discharger

### 5.3 Location

Install the motor in a place which meets the following requirements.

- Dry, well ventilated
- Free of dust and dirt
- Easily inspected
- Not subject to water, rain or oil (Motor is not for outdoor-use.)
- The speed detector (PG) and cooling fan installed on the opposite side of the coupling is not subjected to shocks. (Cooling fan may not be installed on some small capacity models.)

### 5.4 Installation Direction

As standard, the shaft of motor should be horizontally installed.

In the other cases, some partial modifications may be necessary depending on the model. Contact your YASKAWA representative.



## 5.5 Foundation and Mounting Plates

The beds, base or slide rails should be solid and strong enough to sustain the motor weight and dynamic weight during operation in order to avoid any vibration.

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**NOTE**

1. When motor is mounted on the common base or beds with machine, make a supporting structure with rigidity (120% and more) high enough to separate the natural frequency of the motor supporting system including base and beds, from the motor rotation frequency. Also, separate the area of integral multiple of motor rotation frequency from the natural frequency.
  2. When two or more motors are installed close to each other, insufficient foundation may cause vibration transmission from one motor to the other, damaging the motor shaft. Particularly, as motors stopped for long periods may undergo damage from friction corrosion, vibration (amplitude) of the motor at interruption should be kept to  $3\ \mu\text{m}$  or less.
-

## 6 COUPLING TO LOAD

### ⚠ CAUTION

- When coupling a motor to a machine, care should be taken for alignment of coupling, belt tension, or sheave parallelism. In the case of direct coupling, care should be taken for direct coupling accuracy: Adjust belt tension properly for belt coupling. Before starting drive, tighten the sheave and coupling belts securely.  
Failure to observe this caution may cause injury by machine parts scattering and damage to equipment.
- Provide a fence or guard around rotating parts.  
Failure to observe this caution may cause injury.
- When driving a motor individually, remove the key inserted in the motor shaft end.  
Failure to observe this caution may cause injury.
- Before coupling a motor to a machine, make sure that the motor is rotating in the correct direction.  
Failure to observe this caution may cause injury, or damage to equipment.
- Never lean or hang on to a motor.  
Failure to observe this caution may cause injury.
- Do not touch the shaft end key slot with bare fingers.  
Failure to observe this caution may cause injury.

When mounting couplings and sheaves, avoid excessive force by hitting. Carefully fit the key into the keyway or perform shrink fit in order not to damage the shaft.

For direct coupling, pay attention to the points shown in Fig. 6.1. For belt coupling, the shafts of motor and the machine should be parallel and the line between two sheaves and the shaft should make a square line.

For gear coupling, the shafts of motor and machine should be parallel and the centers of the gear teeth should fit securely.

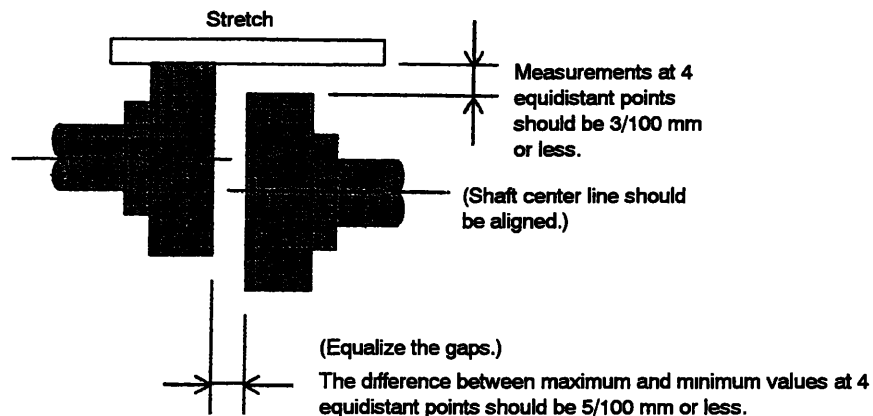


Fig. 6.1 Direct Coupling

## 6.1 V - belt Tension

For V-belt couplings, the sheaves, type of belt, quantity, loaded position and belt tension load should be decided carefully in order not to damage the shaft and bearings.

Tables 6.1 and 6.2 show the application for standard motors.

Table 6.1 Load to Obtain Proper V-belt Tension (Standard V-belt)

(Act of Contact: 140 degree, Speed: 2.04)

Output (kW)	Speed (r/min)	Sheave Dimensions (mm)		Belt		Loaded Position of Belt (mm)	Tension Load per Belt TD (N/Qty)	
		Min. pitch dia.	Max width	Type	Quantity		When replacing	When readjusting
0.4	1150	80	20	A	1	10	7.8 to 8.8	5.9 to 7.8
	1450	75	20	A	1	10	6.9 to 7.8	5.4 to 6.9
	1750	75	20	A	1	10	5.9 to 6.9	4.4 to 5.9
0.75	1150	80	35	A	2	17.5	7.8 to 8.8	5.9 to 7.8
	1450	80	20	A	1	10	10.8 to 12.7	8.8 to 10.8
	1750	80	20	A	1	10	9.8 to 10.8	7.8 to 9.8
1.5	1150	100	35	A	2	17.5	11.8 to 12.7	8.8 to 11.8
	1450	90	35	A	2	17.5	10.8 to 11.8	7.8 to 10.8
	1750	90	35	A	2	17.5	8.8 to 10.8	6.9 to 8.8
2.2	1150	100	50	A	3	25	11.8 to 12.7	8.8 to 11.8
	1450	100	35	A	2	17.5	13.7 to 15.7	10.8 to 13.7
	1750	90	35	A	2	17.5	11.8 to 13.7	8.8 to 11.8
3.7	1150	125	63	B	3	31.5	15.7 to 17.6	12.7 to 15.7
	1450	112	50	A	3	25	13.7 to 15.7	10.8 to 13.7
	1750	112	50	A	3	25	11.8 to 13.7	9.8 to 11.8
5.5	1150	150	63	B	3	31.5	19.6 to 21.6	14.7 to 19.6
	1450	125	63	B	3	31.5	18.6 to 21.6	14.7 to 18.6
	1750	125	63	B	3	31.5	16.7 to 18.7	12.7 to 16.7
7.5	1150	150	82	B	4	41	19.6 to 22.5	15.7 to 19.6
	1450	150	63	B	3	31.5	21.6 to 24.5	16.7 to 21.6
	1750	150	63	B	3	31.5	19.6 to 22.5	14.7 to 19.6
11	1150	170	101	B	5	50.5	20.2 to 23.5	15.7 to 20.2
	1450	160	82	B	4	41	22.5 to 25.5	17.6 to 22.5
	1750	160	82	B	4	41	20.6 to 23.5	15.7 to 20.6
15	1150	224	101	B	5	50.5	22.5 to 25.5	17.6 to 22.5
	1450	170	101	B	5	50.5	23.5 to 26.5	17.6 to 23.5
	1750	170	101	B	5	50.5	21.6 to 24.5	16.7 to 21.6
18.5	1150	224	110.5	C	4	55.2	35.3 to 40.2	27.4 to 35.3
	1450	200	101	B	5	50.5	25.5 to 28.4	19.6 to 25.5
	1750	200	101	B	5	50.5	23.5 to 26.5	18.6 to 23.5
22	1150	224	136	C	5	68	34.3 to 39.2	26.5 to 34.3
	1450	224	101	B	5	50.5	27.4 to 31.4	21.6 to 27.4
	1750	224	101	B	5	50.5	25.5 to 29.4	19.6 to 25.5
30	1150	265	136	C	5	68	40.2 to 46.1	31.4 to 40.2
	1450	224	136	C	5	68	39.2 to 45.1	30.4 to 39.2
	1750	224	136	C	5	68	38.2 to 44.1	30.4 to 38.2
37	1150	265	161.5	C	6	80.7	41.2 to 47.0	32.3 to 41.2
	1450	224	161.5	C	6	80.7	40.2 to 46.1	31.4 to 40.2
	1750	224	161.5	C	6	80.7	39.2 to 45.1	30.4 to 39.2

Output (kW)	Speed (r/min)	Sheave Dimensions (mm)		Belt		Loaded Position of Belt (mm)	Tension Load per Belt TD (N/Qty)	
		Min. pitch dia.	Max. width	Type	Quantity		When replacing	When readjusting
45	1150	280	187	C	7	93.5	41.2 to 48.0	32.3 to 41.2
	1450	265	161.5	C	6	80.7	44.1 to 51.0	34.3 to 44.1
	1750	265	161.5	C	6	80.7	44.1 to 51.0	34.3 to 44.1
55	1150	300	212.5	C	8	106.2	43.1 to 49	33.3 to 43.1
	1450	265	187	C	7	93.5	46.1 to 52.9	36.3 to 46.1
	1750	265	187	C	7	93.5	46.1 to 52.9	35.3 to 46.1
75	1150	355	233	D	6	116.5	76.4 to 87.2	59.8 to 76.4
	1450	315	212.5	C	8	106.2	51.0 to 58.8	39.2 to 51.0
	1750	315	212.5	C	8	106.2	52.9 to 60.8	41.2 to 52.9

Table 6.2 Load to Obtain Proper V-belt Tension (Narrow V-belt)

(Act of Contact: 140 degree, Speed: 2.04)

Output (kW)	Speed (r/min)	Sheave Dimensions (mm)		Belt		Loaded Position of Belt (mm)	Tension Load per Belt TD (N/Qty)	
		Min. pitch dia.	Max. width	Type	Quantity		When replacing	When readjusting
0.4	1150	71	17.4	3V	1	8.7	8.8 to 9.8	6.9 to 8.8
	1450	71	17.4	3V	1	8.7	6.9 to 7.8	5.4 to 6.9
	1750	71	17.4	3V	1	8.7	5.9 to 6.9	4.9 to 5.9
0.75	1150	75	17.4	3V	1	8.7	14.7 to 16.7	11.8 to 14.7
	1450	71	17.4	3V	1	8.7	12.7 to 14.7	9.8 to 12.7
	1750	71	17.4	3V	1	8.7	10.8 to 11.8	8.8 to 10.8
1.5	1150	75	27.7	3V	2	13.9	15.7 to 17.6	11.8 to 15.7
	1450	75	27.7	3V	2	13.9	12.7 to 14.7	9.8 to 12.7
	1750	75	27.7	3V	2	13.9	10.8 to 11.8	8.8 to 10.8
2.2	1150	90	27.7	3V	2	13.9	18.6 to 20.6	14.7 to 18.6
	1450	75	27.7	3V	2	13.9	17.6 to 20.6	13.7 to 17.6
	1750	75	27.7	3V	2	13.9	14.7 to 17.6	11.8 to 14.7
3.7	1150	100	38	3V	3	19	18.6 to 21.6	14.7 to 18.6
	1450	100	27.7	3V	2	13.9	22.5 to 25.5	17.6 to 22.5
	1750	100	27.7	3V	2	13.9	18.6 to 21.6	14.7 to 18.6
5.5	1150	140	38	3V	3	19	19.6 to 22.5	15.7 to 19.6
	1450	100	38	3V	3	19	21.6 to 25.5	16.7 to 21.6
	1750	100	38	3V	3	19	18.6 to 21.6	14.7 to 18.6
7.5	1150	140	48.3	3V	4	24.1	20.6 to 23.5	15.7 to 20.6
	1450	125	38	3V	3	19	23.5 to 27.4	18.6 to 23.5
	1750	125	38	3V	3	19	20.6 to 23.5	15.7 to 20.6
11	1150	140	58.6	3V	5	29.3	23.5 to 26.5	18.6 to 23.5
	1450	125	48.3	3V	4	24.1	26.5 to 30.4	20.6 to 26.5
	1750	125	48.3	3V	4	24.1	22.5 to 25.5	17.6 to 22.5
15	1150	160	68.9	3V	6	34.4	23.5 to 26.5	18.6 to 23.5
	1450	125	68.9	3V	6	34.4	23.5 to 27.4	18.6 to 23.5
	1750	125	68.9	3V	6	34.4	20.6 to 23.5	15.7 to 20.6
18.5	1150	180	60.4	5V	3	30.2	52.9 to 59.8	41.2 to 52.9
	1450	140	68.9	3V	6	34.4	26.5 to 30.4	20.6 to 26.5
	1750	140	68.5	3V	6	34.2	22.5 to 25.5	17.6 to 22.5
22	1150	180	77.9	5V	4	38.9	47.0 to 53.9	37.2 to 47.0
	1450	160	68.9	3V	6	34.4	27.4 to 31.4	21.6 to 27.4
	1750	160	68.9	3V	6	34.4	23.5 to 27.4	18.6 to 23.5

Output (kW)	Speed (r/min)	Sheave Dimensions (mm)		Belt		Loaded Position of Belt (mm)	Tension Load per Belt TD (N/Qty)	
		Min. pitch dia.	Max. width	Type	Quantity		When replacing	When readjusting
30	1150	224	77.9	5V	4	38.9	51.9 to 59.8	41.2 to 51.9
	1450	180	77.9	5V	4	38.9	51.9 to 59.8	41.2 to 51.9
	1750	180	77.9	5V	4	38.9	46.1 to 51.9	36.3 to 46.1
37	1150	224	77.9	5V	4	38.9	62.7 to 72.5	49.0 to 62.7
	1450	200	77.9	5V	4	38.9	57.8 to 66.6	45.1 to 57.8
	1750	200	77.9	5V	4	38.9	51.0 to 57.8	40.2 to 51.0
45	1150	224	95.4	5V	5	47.7	61.7 to 70.6	48.0 to 61.7
	1450	224	77.9	5V	4	38.9	62.7 to 72.5	49.0 to 62.7
	1750	224	77.9	5V	4	38.9	55.9 to 63.7	43.1 to 55.9
55	1150	250	112.9	5V	6	56.4	56.8 to 65.7	45.1 to 56.8
	1450	224	95.4	5V	5	47.7	61.7 to 70.6	48.0 to 61.7
	1750	224	95.4	5V	5	47.7	54.9 to 62.7	43.1 to 54.9
75	1150	315	112.9	5V	6	56.4	63.7 to 72.5	50.0 to 63.7
	1450	250	112.9	5V	6	56.4	63.7 to 73.5	50.0 to 63.7
	1750	250	112.9	5V	6	56.4	56.8 to 65.7	45.1 to 56.8

- \* 1. Adjust belt tension so that belt slack ( $\delta$ ) is the value obtained by the following equation when the tension load (Td) shown in Table 6.2 is given to one belt.

$$\delta = 0.016 \times t \text{ (mm)} \quad t : \text{span length of belt}$$

$$t = \sqrt{C^2 - \left(\frac{D-d}{2}\right)^2}$$

- \* 2. Tension load differs depending on the period the belt is used. Wrong application may cause damage to the shaft.  
 \* 3. The value "L" in Fig 6.3 shows the loaded position of belt. The bigger "L" is, the greater the stress to the shaft.

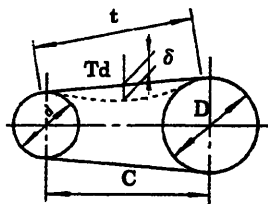


Fig. 6.2 Belt Tension

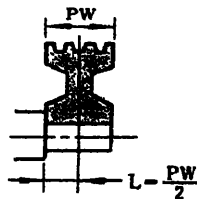


Fig. 6.3 Belt Loaded Position

## 6.2 Mounting V-belt Sheave

- Use of too many belts or excessive belt tension load may cause damage to the shaft and bearings.
- The act of contact between belt and sheave should be 140 degree and more.
- In order to minimize load on the bearings, make the loaded position of the sheave as close to the bearing side as possible, and the distance  $L$  between the sheave loaded position and bearing as short as possible.
- The belt loaded position is  $1/2$  of the rim width of V-belt sheave.
- In order not to restrict the natural cooling effect in the motor, use an arm type V-belt sheave as standard. When a plate type sheave is used, provide the largest ventilation hole as possible as shown in Fig 6.4.

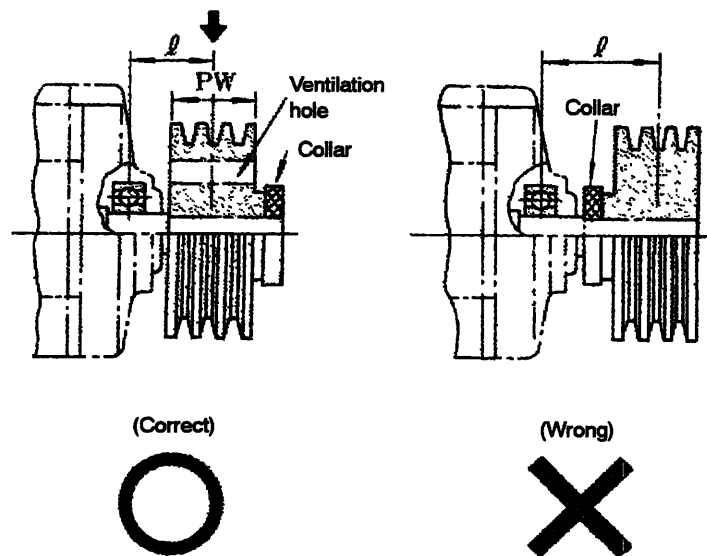


Fig. 6.4 Mounting V-belt Sheave

## 7 WIRING

### WARNING

- When connecting a motor to a power supply cable, perform the wiring following the wiring diagram in the terminal box or instruction manual.  
Failure to observe this warning may cause electric shock or fire.
- Do not forcibly bend, pull or pinch the power source or lead cables.  
Failure to observe this warning may cause electric shock.

### CAUTION

- When measuring insulation resistance, do not touch the terminal.  
Failure to observe this caution may cause electric shock.
- Perform wiring conforming to National Electrical Code or to Local Electrical Codes.  
Failure to observe this caution may cause burn-out or fire.
- An overload protector is required by various electrical codes. It is also recommended that other protectors such as an earth leakage circuit breaker be provided.  
Failure to observe this caution may cause burn-out or fire.
- Do not make direct connection to commercial power source.  
Failure to observe this caution may cause damage to the circuit or motor by over-current.
- Do not make connection to inverter other than specified.  
Correct operation can not be performed, and may cause damage to the equipment or injury.

### Precautions at Wiring

- Wiring should be performed in conformity with Electric Installation and Technique Standards and local electric power company regulation. Long distance wiring may increase voltage drop.
- Care should be taken not to damage cables at cable entrance during operation.

### 7.1 Terminal Box and Wiring (refer to Table 7.1, Fig. 7.1)

The diameters of cable entrance of terminal box are shown in Fig. 7.1.

Table 7.1 Cable Entrance Diameters

Output (Standard) (kW)			Frame No.	Cable Entrance Diameters Indoor -type class 3 corrosion -re- sistant type
1750 r/min 87.5 Hz 6-pole	1450 r/min 72.5 Hz 6-pole	1150 r/min 57.5 Hz 6-pole		
0.4	0.4	-	71B	27 mm dia.
0.75	0.75	0.4	71B	27 mm dia.
1.5	-	0.75	80B	27 mm dia.
2.2	1.5	1.5	90B	27 mm dia.
3.7	2.2	2.2	100B	27 mm dia.
5.5	3.7	-	100B	33 mm dia.
7.5	5.5	3.7	100B	33 mm dia.
11	7.5	5.5	112B	33 mm dia.
15	11	7.5	132A	56 mm dia.
18.5	15	11	132B	56 mm dia.
22	18.5	15	132B	56 mm dia.
30	22	18.5	160A	56 mm dia.
37	30	22	160B	56 mm dia.
45	37	30	180A	56 mm dia.
55	45	37	180B	56 mm dia.
75	55	45	180C	56(92) mm dia.

Note: 92 mm dia. is applied for 200 V.

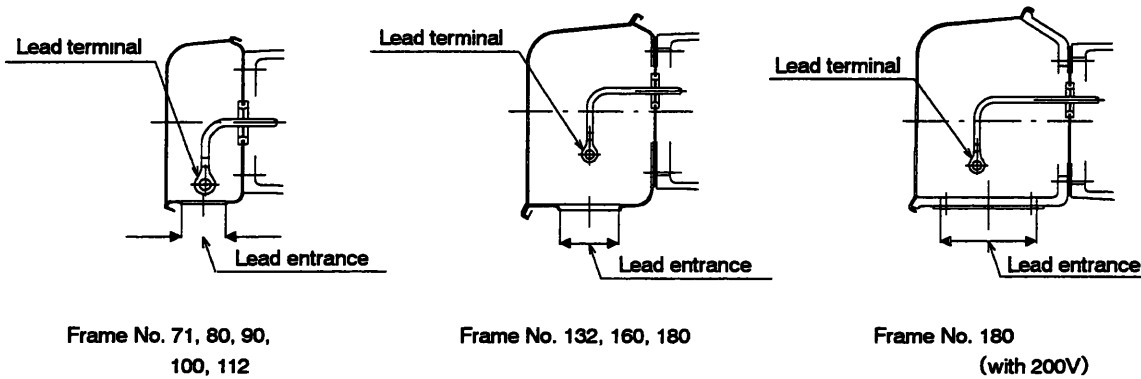


Fig. 7.1 Terminal Box Construction



## 7.2 Connection to Lead Terminals

Wiring cables should be connected to lead terminals as shown in Fig. 7.2.

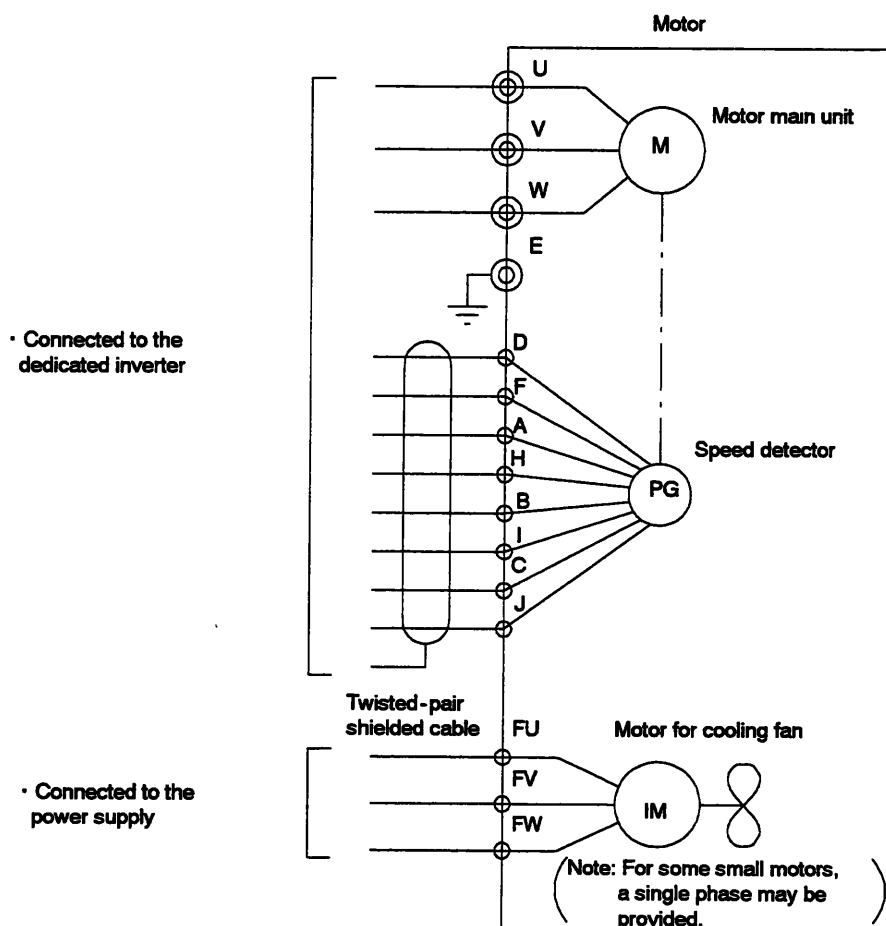


Fig. 7.2 Connection to Lead Terminals

- For inverter connection, refer to the instruction manual of the inverter specified for the motor.
- Connection to the motor for cooling fan should be made with the voltage and frequency mentioned in the external drawing.
- Shielded cables should be used for speed detector (PG) to avoid influence of noise.
- The wiring distance between the inverter and the motor should be 100m or less.

## 7.3 Grounding

### **WARNING**

- Make sure to ground the motor in accordance with local electrical codes.  
Failure to observe this warning may cause electric shock.

The ground terminals are provided in terminal box or the foot of motor (for flange type, on the rear side of flange surface). Be sure to make grounding.

## 7.4 Wiring

Wiring of motor should be made correctly in the following procedures.

1. Remove the terminal box cover.
2. After making temporary connection between lead terminal and power supply cable, perform a test run to confirm the correct direction of rotation. Counter clockwise rotation as viewed from the coupling side is standard, however, if reverse rotation is required, interchange any two of the three leads.
3. Attach pressure terminals to the end of power cable conductors, and connect them to the motor lead terminals, then fasten both with bolts.
4. The joint section should be taped with adhesive tape such as vinyl tape for insulation.

## 8 OPERATION

### WARNING

- Do not operate motor with the terminal box cover removed. Replace the terminal box cover after wiring, etc.  
Failure to observe this warning may cause electric shock.
- Never get near to or touch the rotor shaft, etc. during operation.  
Failure to observe this warning may cause injury by being caught in a moving part.
- At power failure, make sure to turn OFF the power source.  
Failure to observe this warning may cause injury.

### CAUTION

- Do not touch the motor with fingers or the body since exposed surfaces may reach high temperatures.  
Failure to observe this caution may cause injury.
- When a malfunction occurs, stop operation immediately.  
Failure to observe this caution may cause electric shock, injury or fire.

Before operating the motor, check the following.

- Before starting operation, confirm that installation, the coupling to load, wiring, fuse and grounding are properly made.
- Start the operation with as light a load as possible, and increase gradually to full load at motor full speed.
- Measure the primary current of the motor by ammeter and check the value on the nameplate. Reduce load if overloaded.

## 9 MAINTENANCE

### WARNING

- When connecting a power supply lead to a power source cable, perform the wiring following the wiring diagram in the terminal box or the instruction manual.  
Failure to observe this warning may cause electric shock or fire.

### CAUTION

- When measuring insulation resistance, do not touch the terminal.  
Failure to observe this caution may cause electric shock.
- When performing maintenance work such as grease replenishment or discharge, care must be taken to avoid touching the rotating shaft, etc.  
Failure to observe this caution may cause injury.
- Do not touch the motor frame with bare hands since the motor frame is heated to high temperature.  
Failure to observe this caution may cause injury.
- Repair or reassembly should be performed by qualified personnel only.  
Failure to observe this caution may cause electric shock, injury or fire.

## 9.1 Inspection Schedule

Make periodic inspection as shown in Table 9.1.

Table 9.1 Inspection Schedule

Schedule	Running	At Rest	Inspection Item	Inspection Method	Allowable Range
Daily	○		Motor vibration	Check bearing part by hand or measure with vibrometer	Max. amplitude : 50 m and less
	○		Motor noise	By hearing	Without noise accompanied with mechanical vibration and mechanical abnormal noise
	○		Bearing noise	By hearing	Without intermittent or abnormal noise
	○		Temperature of motor and bearing	By hand or with thermometer	No large difference from the value on test report. No radical change from the previously measured value.
	○		Opening of ventilation window of motor	Visual check for accumulated dust	No restriction of ventilation and cooling
	○		Motor smell	By smelling	Without abnormal smell
	○		Coupling to load	Visual check	Without abnormal vibration and noise
	○		Load current	By ammeter	The rated load current and less
Monthly		○	Loose bolts of motor	Tighten with wrench	Not loosening
		○	Clean motor exterior	With compressed air	Without dirt or dust accumulated
	○		Bearing grease	Replenish grease with grease gun	-
		○	Loose terminal box cover fastening bolts	Tighten with wrench	No loosening
		○	Deterioration of leads in terminal box	Visual check	No deterioration
		○	Slack or damage of grounding wire	Tighten with wrench	Without slack or damage
Yearly		○	Insulation resistance of stator coil	Check with megger	3M $\Omega$ and more
		○	Replacement of bearing	-	-
		○	Clean motor exterior	With compressed air	No dirt and dust

## 9.2 Bearings

The life of bearings and grease replenishment frequency differs depending on the capacity and speed of the motor, and the ambient conditions. However, the following should be taken into consideration.

For bearing replacement, use the bearing number indicated on the nameplate.

### ■ Shielded Ball Bearings

Grease replacement is not possible, therefore, replace the bearing when grease has deteriorated or decreased. Under normal operation, replace once every 2 years.

### ■ Regreasable Bearings

Regreasable bearings are of YASKAWA over-grease protection construction.

Replenishment schedule and type and amount of grease are shown in Tables 9.2 and 9.3. Replenish the grease according to "REGREASING" on the nameplate attached to the motor. Using other grease than indicated may shorten grease replenishment intervals.

Table 9.2 Replacement of Bearing or Grease

Type of bearing	Replacement of bearing	Replenishment of grease	Remarks
Shielded ball bearings	Every 2 years	-	Be sure to use the bearing number indicated on the nameplate attached to the motor.
Regreasable bearings	Every 4 years	Every 3000 hours operation	

Table 9.3 Replenishment Amount of Grease

Bearing No.	Grease Replenishment Amount (g)	Grease Replenishment Amount at Replacement of Bearings (g)	
		When motor is to be used immediately after replacement of bearing	When motor is not be used for a long time after replacement of bearing
NU314	45	75 (30)	140 (95)
NU316	55	95 (35)	180 (120)
NU318	80	120 (50)	260 (190)
NU320	100	170 (70)	320 (220)
NU322	135	210 (100)	440 (330)
NU324	155	230 (120)	510 (400)

Note: The amount in parentheses indicates the amount for grease replenishment inside bearings.

## 9.3 Type of Grease

Regreasable bearings are provided with Multemp SRL (made by Kyodo Oil Co. Ltd.) at factory. Use the same type of grease for replenishment. Mixing with other types of grease may shorten grease life.

## 9.4 Grease Replenishment

Replenishment of grease should be performed with motor running. Grease replenishment with the motor at rest will not give sufficient replacement of grease. Replenish grease slowly, otherwise, grease leakage alongside the shaft may be caused. Replenish grease in the following procedures, referring to Fig. 9.1.

1. Remove the cover of the grease discharger, and take out the used grease in discharger with grease swab. The discharger filled with grease may cause grease leakage at replenishment.
2. Install a grease gun at grease inlet, and inject the specified amount of grease with motor running. Replenishment of grease with motor at rest may cause grease leakage alongside the shaft due to over-greasing.
3. One minute after grease replenishment, reinstall the cover. Reinstalling the cover immediately after replenishment may cause over-greasing.

After grease is replenished, the bearing temperature will rise for a while (time may differ from a few hours to one day), before returning to normal temperature.

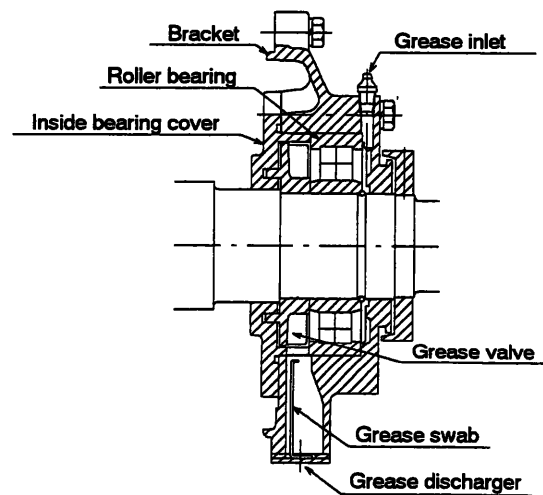


Fig. 9.1 Regreasable Bearing

## 9.5 Replacement of Bearings

When replacing bearings, observe the following points.

- Do not handle bearing with bare hands, use clean gloves, etc. to prevent rust.
- Keep bearing clean and free from dust.
  - Cover bearing with clean paper, etc. to prevent dust until installation on the motor.
- Bearing should be cooled naturally. Do not use compressed air or fan which raises dust.

Replace bearing in the following procedures.

### ■ Type of Bearing

Be sure to use the bearing number indicated on the motor nameplate. The clearance code should be strictly respected.

### ■ Removal of Bearing

Remove the bearing by using gear puller as shown in Fig 9.2 but not pulling out the rotor from the stator.

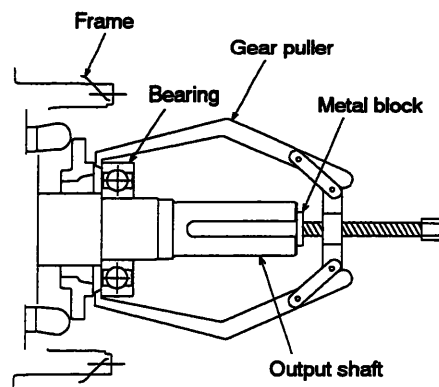


Fig. 9.2 Removal of Bearing

### ■ Installation of Bearing

- Apply grease lightly on the shaft.
- Apply grease on the labyrinth section to increase sealing effect.
- Heat bearing to 90°C to 110°C.
- Mount the bearing quickly and tightly against the shaft shoulder.
- For regreasable bearings, replenish the grease as specified on the motor nameplate.
- Make sure that bearing outer race rotates smoothly by hand.



## 10 OVERHAUL

### WARNING

- Personnel with electronic medical devices such as pacemakers should not stand near the rotor. Failure to observe this warning may cause malfunction of the electronic medical device.

### CAUTION

- When extracting the rotor, special attention should be paid to its magnetism. Failure to observe this caution may cause injury or damage to the stator coils.
- Avoid any magnetic obstacles such as iron particles around the rotor. Failure to observe this caution may cause injury.
- Avoid leaving watches, measurement instruments, etc. close to the rotor. Failure to observe this caution may cause malfunction of watch, measurement instrument, etc.
- Make sure there is no foreign matter such as iron particles before inserting the rotor properly. Failure to observe this caution may cause injury or damage to the stator coils.

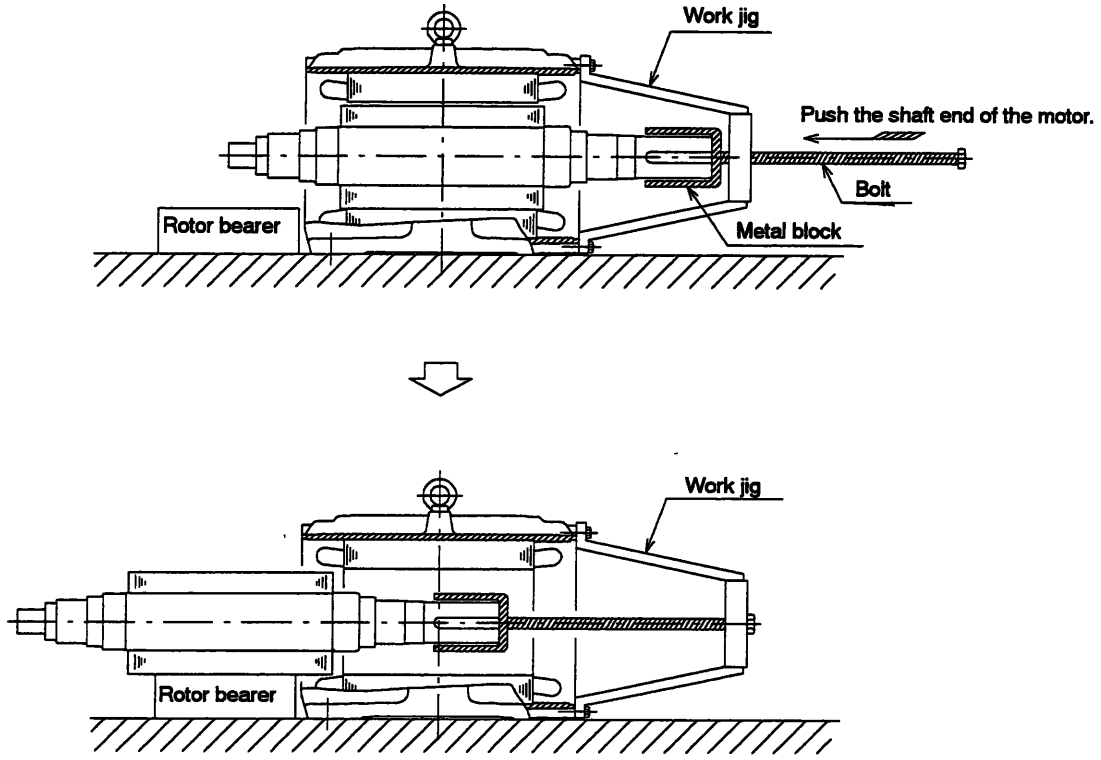
The magnet provided for the rotor attracts the stator so strongly that it may be difficult or dangerous to extract the rotor from the stator using only ordinary tools. When extracting the rotor from the stator is required such as for rewinding of stator coils, contact your YASKAWA representative for overhaul.

Table 10.1 shows the contents of YASKAWA overhaul.

Table 10.1 Contents of YASKAWA Overhaul

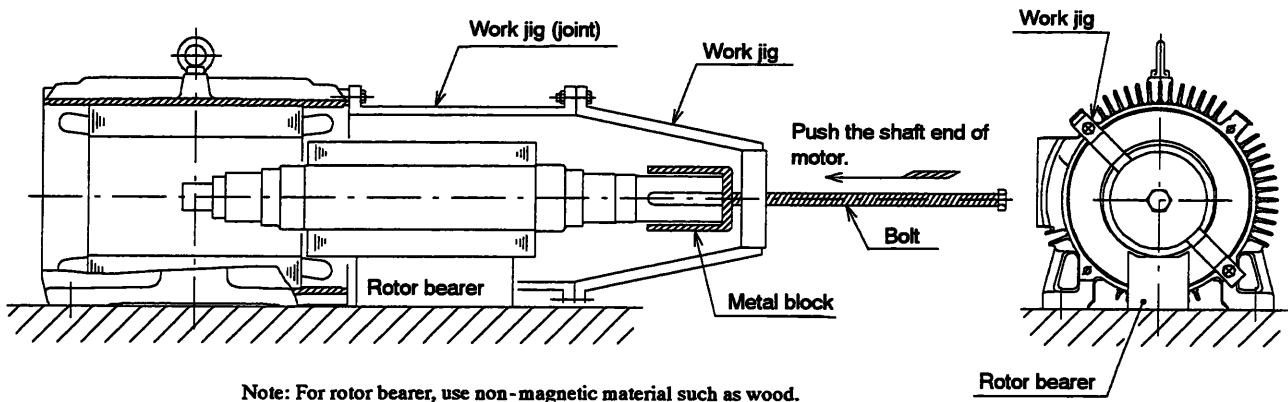
Item	Contents
Inspection of motor exterior	Check for abnormality on motor exterior
Test	-
Inspection after disassembly	Check for abnormality on each parts
Cleaning parts	Clean the parts
Replacement of parts	Replace bearing, gum packing and abnormal parts
Assembly	Reassembly
Painting	Repainting

When the work of extracting rotor from stator is performed at user side, it is recommended that the work jig as shown in Figs. 10.1 and 10.2 be used.



Note: For rotor bearer, use non-magnetic material such as wood.

Fig. 10.1 Extracting Rotor



Note: For rotor bearer, use non-magnetic material such as wood.

Fig. 10.2 Inserting Rotor

# 11 TROUBLESHOOTING

Table 11.1 shows abnormal phenomena, causes, inspection method and measures for troubleshooting.

Table 11.1 Troubleshooting

Symptom	No.	Possible cause	Method	Measures to be taken
Motor does not start. (no beating sound)	1	Power failure	Measure the voltage across inverter input terminals R, S and T.	Contact the electric power company.
	2	Breakage of leads or any two phases of windings open	Measure the voltage across motor terminals U, V, and W.	Check for disconnected section and repair or rewind.
	3	Interlock is not properly released. <ul style="list-style-type: none"> <li>• Loose connection</li> <li>• Inverter failure</li> <li>• Circuit not complete</li> </ul>	Check visually. If defect is not found, check each device and its connection with power OFF.	<ul style="list-style-type: none"> <li>• Release interlock and adjust.</li> <li>• Repair or replace with power OFF.</li> </ul>
	4	Inverter detected a failure and tripped	Check error indicator on inverter.	Follow the instruction manual of the inverter.
Motor does not start.(beating sound)	5	An inverter other than specified is being used.	Check the nameplate of inverter to verify the type is SSA.	Replace with inverter type SSA.
	6	Overloaded	<ul style="list-style-type: none"> <li>• Check if motor is overloaded.</li> <li>• Check if motor and load are not locked.</li> </ul>	<ul style="list-style-type: none"> <li>• Reduce load or increase motor capacity</li> <li>• Find cause and return to normal state.</li> </ul>
Motor starts, then inverter overload protection turns ON.	7	Improper inverter setting	<ul style="list-style-type: none"> <li>• Check starting current.</li> <li>• Check inverter overload capacity.</li> <li>• Check load starting torque.</li> </ul>	<ul style="list-style-type: none"> <li>• Set the acceleration time of inverter longer.</li> <li>• Increase inverter capacity.</li> </ul>
	8	Short-circuit between motor coil layers	Measure coil resistance of each layer to check balance.	Replace motor if unbalanced .
	9	Short-circuit in external wiring	Check external wiring.	Repair the short-circuit or replace the wiring.

Symptom	No.	Possible cause	Method	Measures to be taken
Motor starts, and after a while, inverter over current protection turns ON.	10	Inverter capacity is too small.	Check inverter capacity.	Increase inverter capacity.
	11	Starting time too long	<ul style="list-style-type: none"> <li>• Measure starting time.</li> <li>• Check acceleration time set value of inverter.</li> <li>• Check load <math>GD^2</math>.</li> </ul>	<ul style="list-style-type: none"> <li>• Set optimum value.</li> <li>• Increase inverter capacity.</li> </ul>
	12	Lowered power supply voltage	Measure voltage across motor terminals U, V, and W.	If the voltage is -10% of rating or less, evaluate the power supply capacity, cable capacity, etc. to obtain proper voltage.
	13	Overloaded	Check load current with the rated current.	Reduce load, or replace with larger capacity motor.
	14	Insufficient connection between layers	Measure resistance between motor terminals U, V, and W.	When each resistance value is extremely unbalanced, the cause for Nos. 7 and 8 can be suspected.
Motor does not accelerate. Or decelerate during running.	15	Power supply voltage is lowered and the torque is insufficient	Measure voltage across motor terminals U, V, and W.	Evaluate the power supply capacity and cable capacity to obtain proper voltage.
	16	Overloaded	Check load current with the rated current	Reduce load, or replace with larger capacity motor.

**Note:** In case of unbalanced power supply voltage, the motor output decreases largely so that motor stops, or the motor temperature increases to burn out the coil. Correct power supply voltage unbalance so that each phase current meets the rated value or less.

## 12 DISPOSAL

### CAUTION

- When disposing a motor, treat it as a general industrial waste, abiding by local statutory legislation.
- Before disposal, demagnetize the rotor by raising temperature to 500°C or higher using gas burner or stove.





# THREE-PHASE SYNCHRONOUS MOTOR FOR VARISPEED-686SS5 INSTRUCTIONS

## **TOKYO OFFICE**

New Pier Takeshiba South Tower, 1-16-1, Kaigan, Minatoku, Tokyo 105 Japan  
Phone 81-3-5402-4511 Fax 81-3-5402-4580

## **YASKAWA ELECTRIC AMERICA, INC.**

### **Chicago-Corporate Headquarters**

2942 MacArthur Blvd. Northbrook, IL 60062-2028, U.S.A.  
Phone 1-847-291-2340 Fax 1-847-498-2430

### **Chicago-Technical Center**

3160 MacArthur Blvd. Northbrook, IL 60062-1917, U.S.A.  
Phone 1-847-291-0411 Fax 1-847-291-1018

## **MOTOMAN INC. HEADQUARTERS**

805 Liberty Lane West Carrollton, OH 45449, U.S.A.  
Phone 1-937-847-6200 Fax 1-937-847-6277

## **YASKAWA ELÉTRICO DO BRASIL COMÉRCIO LTDA.**

Avenida Brigadeiro Faria Lima 1664-5° CJ 504/511, São Paulo, Brazil  
Phone 55-11-815-7723 Fax 55-11-870-3849

## **YASKAWA ELECTRIC EUROPE GmbH**

Am Kronberger Hang 2, 65824 Schwalbach, Germany  
Phone 49-6196-569-300 Fax 49-6196-888-301

## **Motoman Robotics AB**

Box 504 S38525 Torsås, Sweden  
Phone 46-486-48800 Fax 46-486-41410

## **Motoman Robotec GmbH**

Kammerfeldstraße 1, 85391 Allershausen, Germany  
Phone 49-8166-900 Fax 49-8166-9039

## **YASKAWA ELECTRIC UK LTD.**

3 Drum Mains Park, Orchardton Woods, Cumbernauld, Scotland, G68 9LD, United Kingdom  
Phone 44-1236-735000 Fax 44-1236-458182

## **YASKAWA ELECTRIC KOREA CORPORATION**

Paik Nam Bldg. 901 188-3, 1-Ga Euljiro, Joong-Gu Seoul, Korea  
Phone 82-2-776-7844 Fax 82-2-753-2639

## **YASKAWA ELECTRIC (SINGAPORE) PTE. LTD.**

151 Lorong Chuan, #04-01, New Tech Park Singapore 556741, Singapore  
Phone 65-282-3003 Fax 65-289-3003

## **YATEC ENGINEERING CORPORATION**

Shen Hsiang Tang Sung Chiang Building 10F 146 Sung Chiang Road, Taipei, Taiwan  
Phone 886-2-563-0010 Fax 886-2-567-4677

## **BEIJING OFFICE**

Room No. 301 Office Building of Beijing International Club, 21  
Jianguomenwai Avenue, Beijing 100020, China  
Phone 86-10-6532-1850 Fax 86-10-6532-1851

## **SHANGHAI OFFICE**

27 Hui He Road Shanghai 200437 China  
Phone 86-21-6553-6600 Fax 86-21-6531-4242

## **YASKAWA JASON (HK) COMPANY LIMITED**

Rm. 2909-10, Hong Kong Plaza, 186-191 Connaught Road West, Hong Kong  
Phone 852-2803-2385 Fax 852-2547-5773

## **TAIPEI OFFICE**

Shen Hsiang Tang Sung Chiang Building 10F 146 Sung Chiang Road, Taipei, Taiwan  
Phone 886-2-563-0010 Fax 886-2-567-4677

## **SHANGHAI YASKAWA-TONGJI M & E CO., LTD.**

27 Hui He Road Shanghai China 200437  
Phone 86-21-6531-4242 Fax 86-21-6553-6060

## **BEIJING YASKAWA BEIKE AUTOMATION ENGINEERING CO., LTD.**

30 Xue Yuan Road, Haidian, Beijing P.R. China Post Code: 100083  
Phone 86-10-6233-2782 Fax 86-10-6232-1536



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MANUAL NO. TOE-C451-2  
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