

# mitsubishi

## Mitsubishi Vector Inverter Motor (SF-V5RU Series)

### Instruction Manual

**Request**

The dealer is requested to hand this Instruction Manual to those who actually use the motor.


## To Use Mitsubishi Vector Inverter Motor Safely


We thank you for adopting Mitsubishi vector inverter motor.

It is advised to fully read this Instruction Manual and all other attached documents before using (installation, operation, maintenance/inspection, etc.) the vector inverter motor so as to use it correctly. It is also advised to learn the knowledge, safety information and precautions on motor before use.

After reading through the Instruction Manual, be sure to keep it at a place where those who use the motor can read it at any time.

This instruction manual indicates the safety precaution rank discriminatingly as "DANGER" and "CAUTION" as shown below.

 **DANGER** : This indicates such case as when handling the motor in wrong manner may cause a dangerous situation to occur, probably resulting in a cause of fatality or serious injury.

 **CAUTION** : This indicates such case as when handling the motor in wrong manner may cause a dangerous situation to occur, probably resulting in a cause of medium-degree trouble or light injury or in property damage.

Note that even the items shown for " **CAUTION**" may lead to a serious result, depending on situation.

Be sure to observe all these items strictly, as either item indicates the essential contents.

### **DANGER**

#### [General]

- Do not use the motor in the explosive atmosphere, as it may result in a cause of injury, fire, etc.
- Be careful not to perform the work under live wire condition. Be sure to perform the work with the power supply turned OFF.
- The works such as transportation, installation, piping, wiring, operation, maintenance and inspection must be performed by those who have technical knowledge. Otherwise, it may result in electric shock, injury, fire, etc.

#### [Piping/wiring]

- Execute the connection to the power cable in accordance with the connection diagram arranged in the terminal box or Instruction Manual. Otherwise, it may result in electric shock or fire.
- Be careful not to bend, pull or hold the power cable or motor lead wire forcibly. Otherwise, it may result in electric shock.

#### [Installation/adjustment]

- Set the grounding terminal securely. Otherwise, it may result in electric shock.
- Since the inverter motor may fall, depending on the condition when it is installed on the ceiling or wall, install it in accordance with the installation conditions shown in the motor delivery specifications, which indicate the detailed application range. Otherwise, it may result in a cause of injury.

#### [Operation]

- Do not operate the inverter motor with the terminal box cover removed. After completion of work, restore the terminal box cover to the original position. Otherwise, it may result in electric shock.
- Be careful never to come near or touch the rotating body (shaft, etc.) during operation. Otherwise, the operator may be rolled in, probably resulting in injury.
- When the power interruption occurs, be sure to turn OFF the power switch. Otherwise, it may result in injury.

#### [Maintenance/inspection]

- Execute the connection to the power cable in accordance with the connection diagram arranged in the terminal box or Instruction Manual. Otherwise, it may result in electric shock or fire.

## CAUTION

### [General]

- Do not use the motor for other specifications than those designated to the motor. Otherwise, it may result in electric shock, injury, breakage, etc.
- Do not put the finger or material through the motor opening. Otherwise, it may result in electric shock, injury, fire, etc.
- Do not use the damaged motor. Otherwise, it may result in injury, fire, etc.
- Do not put any obstacle near the nameplate, or remove the nameplate, so that the nameplate is visible all the time.
- Since the modification of product by customer is out of scope of guarantee by Mitsubishi, Mitsubishi will not be responsible for any damage resulting from such modification.

### [Transportation]

- ◎ Since the motor is a precision device provided with a detector, be careful not to drop it, or apply any strong shock to it.
- Make it a rule to transport the motor carefully, as causing it to drop or fall down may result in dangerous situation.  
For the motor provided with a hanging bolt, be sure to use it for lifting. After installing the inverter motor to the equipment, however, do not attempt to lift the entire equipment, using the hanging bolt. Check the motor weight, referring to the nameplate, packing box, outline drawing, etc. prior to lifting. Be careful not to lift the motor exceeding the rated load of lifting device.

### [Unpacking]

- Check the package for top/bottom before unpacking. For wooden flask packing, in particular, unpack the package with care taken to nails. Otherwise, it may result in injury.
- Check that the product is consistent with the product ordered. If wrong product is installed, it may result in injury, breakage, etc.

### [Installation/adjustment]

- ◎ When connecting the motor to the shaft end, be careful not to apply any shock such as by hitting it with a hammer, etc.  
Otherwise, it may result in a cause of detector fault.
- Be careful not to put any obstacle at the circumference of motor, which may disturb the air ventilation. Otherwise, the cooling may be obstructed, resulting in unusual heating, fire, burn, etc. When necessary to remove the fan cover, secure a proper space to pull it out toward the counter-load side.
- When connecting the inverter motor to a load, pay caution to the centering, belt tension, pulley parallelism, etc. When direct-coupling the motor, be careful of direct-coupling accuracy. When connecting the motor through belt, adjust the belt tension to a proper value. Tighten the tightening bolt of the pulley and coupling securely prior to operation. Otherwise, it may result in injury or equipment breakage due to scattering of broken piece.
- Arrange a proper cover to the rotating part, to prevent the operator from touching such part. Otherwise, it may result in injury.
- To rotate the motor independently, remove the key attached to the main shaft. Otherwise, it may result in injury.
- Check the motor for rotating direction before connecting it to the equipment. Otherwise, it may result in equipment breakage.
- Never get on the motor, or hang from the motor. Otherwise, it may result in motor breakage or injury.
- Be careful not to touch the key groove located at the end of motor shaft, with bare hands. Otherwise, it may result in injury.

### [Piping/wiring]

- Connect the wiring correctly to the inverter output side (U, V, W).
- Do not connect the commercial power supply directly to the motor. Otherwise, it may result in a cause of fault.
- Connect the cooling fan correctly. Otherwise, it may result in heating of motor, fire or burn.
- Select a suitable flexible metal piping or cable glands for this motor's terminal box section protective structure (IP44).

## 【Wiring procedures】

- Use good wiring equipment, and follow the electrical facility technical standards and power company standards.

If the wiring distance between the inverter and motor is long, the motor torque could drop due to a drop in the main circuit cable's voltage, especially during a high frequency output. In this case, wire so that the voltage drop is 2% or less during the motor operation.

An example of selecting the equipment for a 20m wiring distance is shown below.

**Table 1 Motor wiring (For 200V class)**

Output (kW)	Terminal screw size	Tightening torque N·m	Crimp terminal	HIV wire, etc.		PCV wire	No-fuse breaker (NFB *1) or earth leakage breaker (ELB) (*2)	
				mm <sup>2</sup>	AWG	mm <sup>2</sup>	Standard	When power factor improving reactor is installed
1.5	M6	3	2-6	2	14	2.5	30AF 15A	30AF 15A
2.2	M6	3	2-6	2	14	2.5	30AF 20A	30AF 15A
3.7	M6	3	3.5-6	3.5	12	4	30AF 30A	30AF 30A
5.5	M6	3	5.5-6	5.5	10	6	50AF 50A	50AF 40A
7.5	M6	3	8-6	8	8	10	100AF 60A	50AF 50A
11	M8	10	14-8	14	6	16	100AF 75A	100AF 75A
15	M8	10	22-8	22	4	25	225AF 125A	100AF 100A
18.5	M8	10	38-8	38	2	35	225AF 150A	225AF 125A
22	M8	10	38-8	38	2	35	225AF 175A	225AF 150A
30	M10	20	60-10	60	1/0	70	225AF 225A	225AF 175A
37	M10	20	100-10	100	4/0	95	400AF 250A	225AF 225A
45	M10	20	100-10	100	4/0	120	400AF 300A	400AF 300A
55	M10	20	150-10	150	MCM300	185	400AF 400A	400AF 350A

\*1. Select the NFB type according to the power capacity.

\*2. Select a UL or cUL approved breaker when using this product in the United States or Canada.

**Table 2. Motor wiring (For 400V class)**

Output (kW)	Terminal screw size	Tightening torque N·m	Crimp terminal	HIV wire, etc.		PCV wire	No-fuse breaker (NFB *1) or earth leakage breaker (ELB) (*2)	
				mm <sup>2</sup>	AWG	mm <sup>2</sup>	Standard	When power factor improving reactor is installed
1.5	M6	3	2-6	2	14	2.5	30AF 10A	30AF 10A
2.2	M6	3	2-6	2	14	2.5	30AF 15A	30AF 10A
3.7	M6	3	2-6	2	14	2.5	30AF 20A	30AF 15A
5.5	M6	3	2-6	2	14	2.5	30AF 30A	30AF 20A
7.5	M6	3	3.5-6	3.5	12	4	30AF 30A	30AF 30A
11	M8	10	5.5-8	5.5	10	6	50AF 50A	50AF 40A
15	M8	10	8-8	8	8	10	100AF 60A	50AF 50A
18.5	M8	10	8-8	8	8	16	100AF 75A	100AF 60A
22	M8	10	14-8	14	6	16	100AF 100A	100AF 75A
30	M10	20	22-10	22	4	25	225AF 125A	100AF 100A
37	M10	20	22-10	22	4	35	225AF 150A	225AF 125A
45	M10	20	38-10	38	2	35	225AF 175A	225AF 150A
55	M10	20	60-10	60	1/0	70	225AF 200A	225AF 175A

\*1. Select the NFB type according to the power capacity.

\*2. Select a UL or cUL approved breaker when using this product in the United States or Canada.

**Table 3. Motor protector and forced cooling fan wiring (Common for 200/400V)**

Part name	Terminal screw size	Tightening torque N·m	Crimp terminal	HIV wire, etc.		PCV wire
				mm <sup>2</sup>	AWG	mm <sup>2</sup>
Thermal protector	M4	2	1.25-4	0.9	18	1.1
Cooling fan	M4	2	1.25-4	0.9	18	1.1

Note 1. Connect the motor protection thermal protector to OH and SD on the INV side.

Note 2. Connect the cooling fan to a commercial power supply. (7.5kW or smaller: Single-phase, 11kW or larger: 3-phase)

**[Operation]**

- ◎ Check/adjust each parameter of inverter prior to operation.  
Otherwise, the equipment may move unexpectedly, depending on the equipment used. For parameter setting, refer to the "Inverter Instruction Manual".
- Since the motor may reach considerably high temperature during operation, be careful not to allow the body or hand to touch the motor. Otherwise, it may result in burn. Also, select a supply cable that takes into consideration the surface temperature of the motor.
- When any fault occurs, stop the operation immediately.  
Otherwise, it may result in electric shock, injury, fire, etc.
- Make it a rule to use the motor and inverter by the designated combination.

**[Maintenance/inspection]**

- When measuring the insulation resistance, be careful not to touch the terminal directly with bare hands.  
Otherwise, it may result in electric shock.
- Since the motor frame may reach high temperature, be careful not to touch it with hands. Otherwise, it may result in burn.

**[Repair/disassembling/modification]**

- The repair/disassembling/modification work should be absolutely performed by the specialist.  
Otherwise, it may result in electric shock, injury, fire, etc.

**[Disposal]**

- When disposing the motor, dispose it as a general industrial waste.

**Note:** Keep in mind that the items marked with ● show the general items, and those marked with ◎ show the contents particular to the vector inverter motor.

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**1. Inspection at time of purchase**

Check for the following items after the motor has arrived and before starting the installation. Check the package for top/bottom before unpacking. For wooden flask packing, in particular, unpack the package with care taken to nails.

- a. Check that the output (kW), number of poles (POLE), type (TYPE), voltage (V), frequency (Hz), etc. indicated on the nameplate are consistent with those ordered.
- b. Check that the motor shaft is turned lightly with hands without any scratch. (Be careful not to cut hands with key groove.)
- c. Check that the motor is not damaged due to accident, etc. during transportation.

If any doubtful point, damage, etc. are found when the above checks are performed, inform them to Mitsubishi or sales agent, etc. together with manufacturing No. (SERIAL) and status. Do not use the damaged motor or the motor of non-designated specifications. Otherwise, it may result in electric shock, injury or breakage.

## 2. Transportation/storage/installation

### (1) Transportation

For motor of which single unit weight exceeds 30kg, use the eyebolt attached for transportation. Since this eyebolt is arranged to lift the motor, never lift the motor using the eyebolt with the motor attached to the opponent equipment, as it may result in extremely dangerous situation.

### (2) Storage

- a. When the motor is not used immediately, keep it stored with care taken to the following points:
  - (a) Store the equipment at a clean and dry place.
  - (b) When storing the equipment at an outdoor place or at a humid place, be sure to keep the entire product covered with a waterproof cover, to prevent the rainwater or dust from entry.
- b. Make it a rule to keep the equipment stored with care taken to the above points, and to check it for following items from time to time (approx. once every month).
  - (a) Measure the winding for insulation resistance, to check that the measurement value is  $1M\Omega$  or more. If it is found to be decreased to lower than  $1M\Omega$ , dry the winding in accordance with the section 13(1) "Maintenance of coil and insulator", for complete moisture prevention.
  - (b) The equipment has been applied with rust preventive paint, to avoid rust during use, however, check from time to time for absence of rust, depending on the storage condition.
  - (c) When storing the equipment for a long time, apply the rust preventive again to the machined surface such as shaft, etc.
  - (d) When storing the equipment at a warehouse, or storing it for a long time under installation condition, make it a rule to perform the hand-turning operation approx. once every month, or non-load operation for approx. 5 minutes.
  - (e) When storing the equipment for a long time, refer to the "Long-time storage procedure (BAN-13984)" prepared separately.

## 3. Installation

Install the equipment properly with care taken to the following points, as the undesirable installation may cause the motor life to be shortened, or result in direct accident.

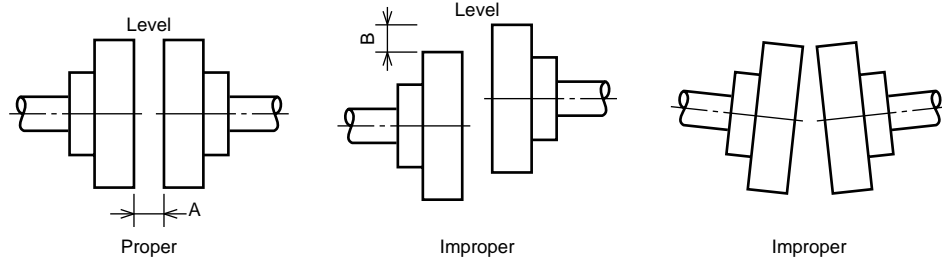
- (a) Do not attempt to install the equipment in the explosive atmosphere or at an outdoor place.
- (b) The standard motor is not proper for use at a place where the acid or alkali may exist a lot. When necessary to install the equipment at such a place, consult Mitsubishi, and use a corrosion-proof type motor. (The motor is compatible up to "Corrosion grade-3" or equivalent.)
- (c) When installing the equipment on a floor, under the shaft or on the ceiling, etc., perform such work in accordance with the "Installation conditions" indicated in the motor delivery specifications.
- (d) Arrange a proper protective cover, etc. to the coupling, belt and pulley, connections between motor and opponent equipment, to prevent the foreign matter from contacting, and the operator from touching them mistakably.
- (e) Select such installation place as to facilitate the maintenance/inspection.
- (f) Set the nameplate at a visible place all the time. Do not put any obstacle near the nameplate, or remove the nameplate, so that the nameplate is visible all the time.
- (g) Do not install the motor near the wall or close to the other equipment, as it may obstruct the motor cooling air passage, resulting in a cause of the motor overheated. Install the motor with sufficient clearance (normally 20cm or more) secured at the entrance of motor ventilation port. Since it is necessary to remove the fan cover when replacing the encoder or fan, secure a proper space to pull it out toward the counter-load side.  
(90 to 132Fr: 200mm or over, 160/180Fr: 250mm or over, 200/225Fr: 300mm or over)
- (h) Never put any combustibles at the circumference of motor.
- (i) Never get on the motor, or hang from the motor.
- (j) Install the motor securely on the rigid frame such as dedicated installation floor, steel frame, etc., using the foundation bolt, in such a manner that the motor shaft installed is horizontal by all means. (For vertical type motor, install it with the shaft set vertically and its shaft end directed downward.)  
For special motor, install it in accordance with the specifications. The reason why the motor is vibrated unusually is mainly because the motor is installed on a weak foundation or connected incorrectly to the opponent equipment. Consequently, be sure to install and connect the motor correctly.

## 4. Connection to equipment

### (1) Direct-connection (Fig.1)

Install the motor in such a manner that the center of motor shaft forms a straight line with the center of opponent equipment shaft correctly.

Lay the liner to the leg of motor or equipment as required, to make a complete adjustment.

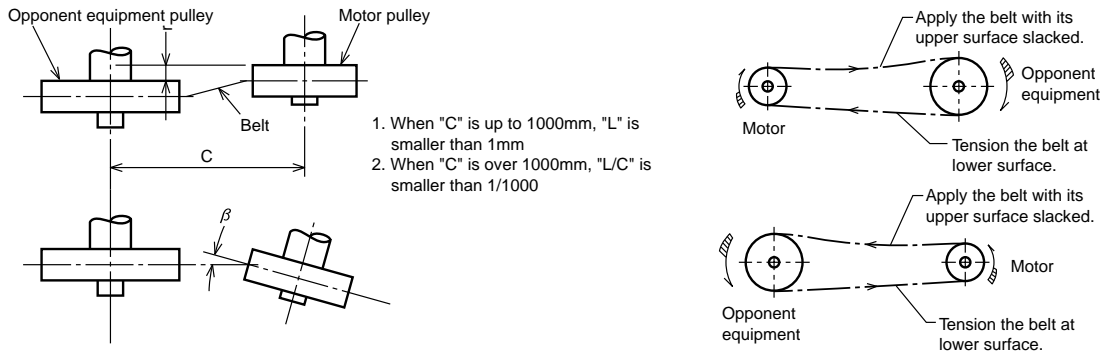


**Fig.1 Direct-connection to opponent equipment**

1. Perform the adjustment, so that the dimension-A is equal at whichever the measurement may be performed, using a clearance gauge.  
(Irregularity of width-A: 3/100mm or less)
2. Perform the adjustment so that there is no roughness as shown in B. (Concentricity: 3/100mm or less)

### (2) Connection of motor to equipment through belt

- a. Install the motor with the shaft of motor set in parallel to that of opponent equipment, so that the centerline of both pulleys forms a straight line. (Fig.2)



**Fig.2 Belt application method**

- b. Set the belt with its lower side located at the tension side.

For this purpose, determine the rotation direction of opponent equipment before determining the motor position. (Fig.2)

- c. For distance between motor and opponent equipment, refer to Table-1.
- d. Belt tensioning procedure

When the belt is tensioned excessively, the bearing may be damaged, or an accident (broken shaft) may occur. When the belt is tensioned insufficiently, on the other hand, the belt may slip, resulting in damage or disengagement. To tension the flat belt properly, tension it to such level that it is turned lightly when it is pulled with one hand.

Tension the V-belt as shown below.

- (a) Find the contact distance  $t$  between belt and V-pulley by using the following equation, or by measuring it actually.

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

**Table-1 Distance between motor shaft and opponent equipment shaft**

	V-belt	Flat belt
Proper distance	$\times 2$ of $D + d$	$\times 5$ to $\times 6$ of $D$
Minimum distance	$D + d$	$\times 3$ of $D$

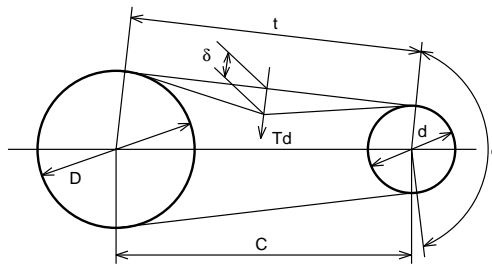


- (b) Find the center of  $t$ , and apply the load vertically to the V-belt at this center point, to find the deflection load  $T_d$  (kg) which allows the deflection amount ( $\delta$ ) at the time to reach the value shown below.

$$\delta = 0.016 \times t \text{ (mm) (Fig.3)}$$

For instance, the deflection amount for belt contact distance of 1m is 16mm ( $=0.016 \times 1000$ ).

- (c) Find the deflection load  $T_d$  (kg) for each belt, and adjust the belt tension, so that the average value is within the range of value shown in Table-3.
1. When using more than two V-belts, use the matched set of which belt length is consistent.
  2. Since the belt may become elongated and loosened in 2 to 8 hours when the operation is performed with a new belt applied, re-tension the belt in accordance with the deflection load ( $T_d$ ) shown in Table-3.
  3. When replacing the belt with a new one, do not fail to perform the adjustment. When using the old belt, adjust the tension in accordance with the re-tensioning deflection load ( $T_d$ ).



$D$  : Large V-pulley diameter (mm)  
 $d$  : Small V-pulley diameter (mm)  
 $C$  : Center distance (mm)  
 $T_d$  : Deflection load (kg) (See Table 3.)  
 $\phi$  : Contact angle

**Fig.3**

- e. When the belt is loosened during use, adjust it, using the adjusting bolt arranged to the slide base of motor. When the flat belt used may slip, apply a few quantity of belt wax. Do not use any wax to the V-belt.
- f. Since the selection of pulley may become a problem for case when the motor is installed to the equipment through belt, refer to the section 5 "Application of belt and pulley".
- g. The deflection load  $T_d$  shown in Table 3 shows a value for case when the contact angle between the belt and V-pulley is  $140^\circ$ . When the contact angle is changed, therefore, multiply the deflection load (shown in Table 3) by compensation coefficient  $K$  (shown in Table-2), to find each deflection load.

**Example:** 55kW, 4-pole, standard V-belt, contact angle of  $180^\circ$   
 In this case, the deflection load  $T_d$  ( $180^\circ$ ) to tension a new belt is given as follows:  
 $K \times T_d$  ( $140^\circ$ ) =  $0.9 \times (46 \text{ to } 53) = 41.4 \text{ to } 47.7$

**Table 2 Contact angle compensation coefficient**

Contact angle $\phi$	$140^\circ$	$150^\circ$	$160^\circ$	$170^\circ$	$180^\circ$
K	1.0	0.98	0.94	0.91	0.9

- h. When using the other V-belt/V-pulley than those shown in Table 3, it is necessary to calculate the deflection load  $T_d$  (N) separately. For calculation method, refer to the belt maker's catalog or No.108 "Tension/application of V-belt" shown in the technical document issued by the Japan Electrical Manufactures' Association.

**(3) Connection of motor to equipment with gear (gear coupling)**

Engage the gear with the motor shaft kept in parallel to that of opponent equipment correctly. Check for the following points, to examine whether the motor shaft is engaged properly with that of opponent equipment.

- a. Check that the centers of both gears are consistent.
- b. Where possible, turn the motor with a thin coat of red oxide applied, to check that the gear teeth are in contact evenly.
- c. Check that any rolling sound or streaking sound is not generated when the motor is rotated.
- d. Measure the backlash, using a thickness gauge, to check that the measurement value is proper.

#### (4) Chain drive

With the gears arranged, adjust the chain length to such level that the chain is slightly slacked. In this case, perform the adjustment so that the distance between the centers of both shafts is greater than "Diameter of large gear + Diameter of small gear". Consult the chain maker for maximum speed ratio, chain lubrication, etc.

#### (5) Other precautions

Secure the balance of parts fixed to the motor shaft (such as pulley, coupling, gear, etc.), to the grade G2.5 or over specified in JIS B0905 "Balance quality of rotating equipment".

Note that the improper balance may cause the motor to vibrate unusually.

#### Notes:

1. The red brown rust generated at the outer ring of bearing or worn housing is caused due to repeated fine movement/wear of bearing fitting point, which may probably generated by such unbalance.
2. For commercially available flexible coupling, exercise caution to the allowable center run-out.
3. When attaching the pulley, coupling, etc., be careful not to hit them forcibly, as the bearing and encoder may be damaged.

When there is a big tightening allowance with shaft, fit it, using the shrinkage-fitting method.

**Table 3 List for application of V-belt/V-pulley to standard motor and for deflection load (contact angle: 140°)**

Rated output [kW]	Number of poles	Standard V-belt						Narrow V-belt					
		Type	Quantity	Pulley		Deflection load Td (N/piece)		Type	Quantity	Pulley		Deflection load Td (N/piece)	
				Nominal diameter (minimum value)	Width (maximum value)	To tension a new belt	To re-tension a belt			Nominal diameter (minimum value)	Width (maximum value)	To tension a new belt	To re-tension a belt
1.5	4	A	2	90	35	11 to 12	7.8 to 11	3V	2	75	27.7	13 to 15	9.8 to 13
2.2	4	A	2	100	35	14 to 16	11 to 14	3V	3	75	27.7	18 to 21	14 to 18
3.7	4	A	3	112	50	14 to 16	11 to 14	3V	2	100	27.7	23 to 25	18 to 23
5.5	4	B	3	125	63	19 to 22	15 to 19	3V	3	100	38.0	22 to 25	17 to 22
7.5	4	B	3	150	63	22 to 25	17 to 22	3V	3	125	38.0	24 to 27	19 to 24
11	4	B	4	160	82	23 to 25	18 to 23	3V	4	125	48.3	26 to 30	21 to 26
15	4	B	5	170	101	24 to 26	18 to 24	3V	6	125	68.9	24 to 27	19 to 24
18.5	4	B	5	200	101	25 to 28	20 to 25	3V	6	140	68.9	26 to 30	21 to 26
22	4	B	5	224	101	27 to 31	22 to 27	3V	6	160	68.9	27 to 31	22 to 27
30	4	C	5	224	136	39 to 45	30 to 39	5V	4	180	77.9	52 to 60	41 to 52
37	4	C	6	224	161.5	40 to 46	31 to 40	5V	4	200	77.9	58 to 67	45 to 58
45	4	C	6	265	161.5	44 to 51	34 to 44	5V	4	224	77.9	63 to 73	49 to 63
55	4	C	7	265	187	46 to 53	36 to 46	5V	5	224	95.4	62 to 71	48 to 62

## 5. Application of belt and pulley

If the belt is selected/tensioned improperly when connecting the motor to the opponent equipment through belt, the excessive force may be applied to the shaft end and bearing, which may result in shortened service life, generation of breakage, etc. Consequently, select and attach the belt with care taken to the following points:

- (1) The application of motor side V-pulley and V-belt is as shown in Table 3. In the following cases, check that the load applied to the belt is smaller than the allowable radial load of motor prior to use.

- When the diameter of pulley is smaller than the value shown in Table 3
- When the number of belts used is increased
- When the stepped section of motor shaft is not in level with the end surface of pulley rim, etc.

When the load due to belt is greater than the allowable radial load of motor, re-select the motor or belt/pulley.

The relationship between pulley and force applied to the motor shaft is as follows.

Relationship between pulley diameter and force applied to shaft ...

The greater the diameter becomes, the smaller the force applied to the shaft becomes.

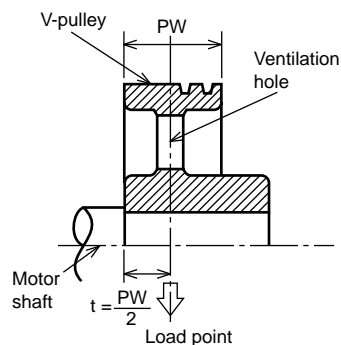
Relationship between pulley width and force applied to stepped section of shaft ...

The greater the width becomes, the greater the force applied to the stepped section of shaft becomes.

Relationship between force applied to center in axial direction of pulley and force applied to stepped section of shaft ...

The greater the clearance between center and stepped section of shaft becomes, the greater the force applied to the stepped section of shaft becomes. (Attach the motor in such a manner that the stepped section of motor shaft is in level with the end surface of pulley rim.)

(Fig.4)



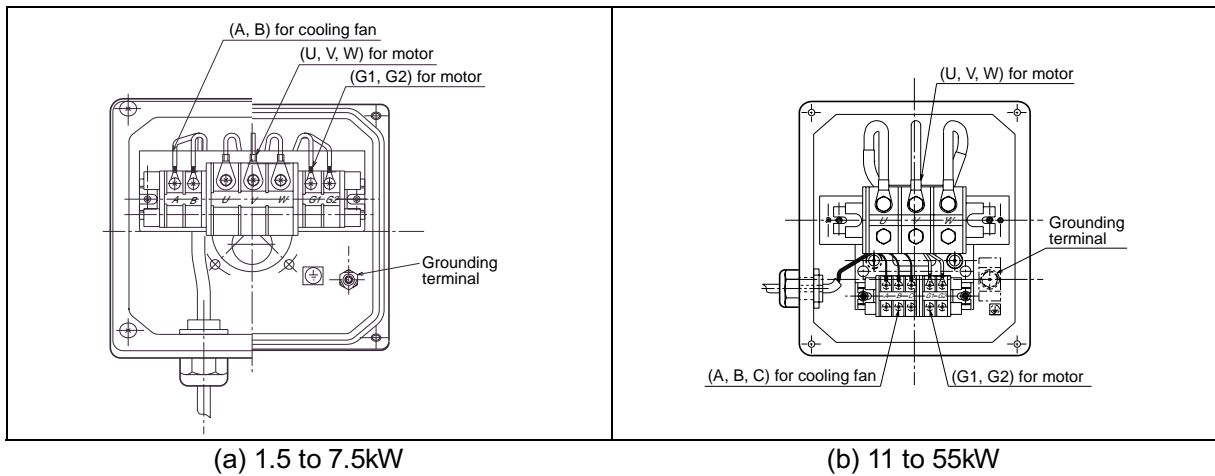
**Fig.4 Pulley installation procedure**

- (2) Use the arm type pulley having a ventilation port, so that the motor ventilation/cooling should not be interfered. When using a flat plate type, drill as large hole as possible. (Fig.4)
- (3) The V-belt speed is as follows:
  - Standard V-belt 30m/sec., maximum (maximum 4-pole motor pulley diameter: up to 320)
  - Narrow V-belt 40m/sec., maximum (maximum 4-pole motor pulley diameter: up to 425)
- (4) Select the speed change ratio, to such level as to allow the contact angle  $\theta$ (Fig.3) between belt and pulley to be over  $140^\circ$ .

## 6. Wiring

### (1) Detailed drawing of terminal box

The lead wires for motor, cooling fan and thermal protector are bundled at the same position as motor terminal box as shown in Fig.5.

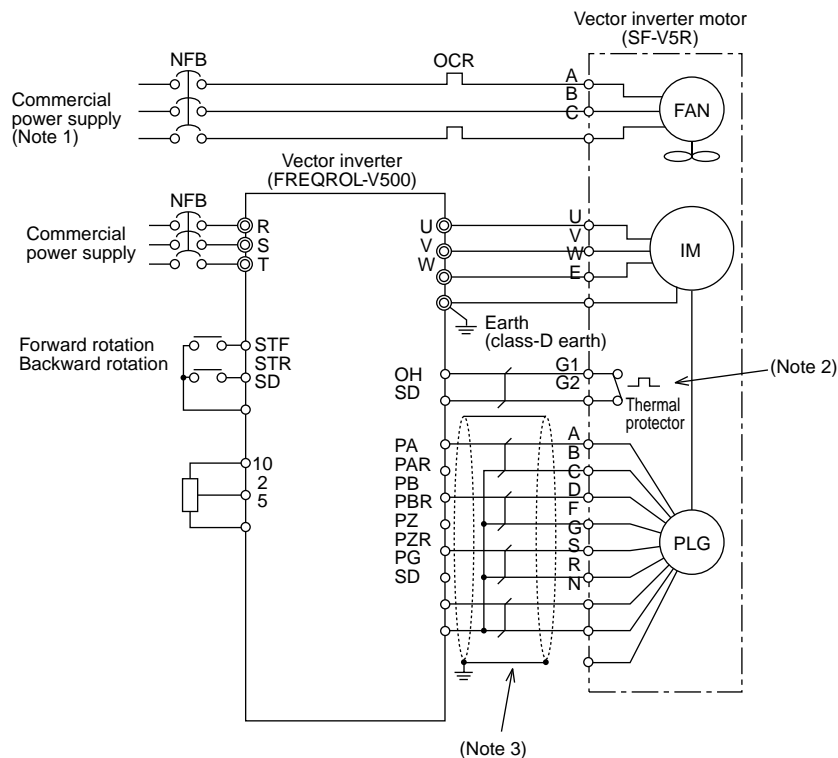


**Fig.5 Detailed drawing of terminal box**

In addition, there are also encoder connectors arranged at the other points.

### (2) Lead wire connection method

It is recommended to use the method shown in Fig.6, for connection of each lead wire.

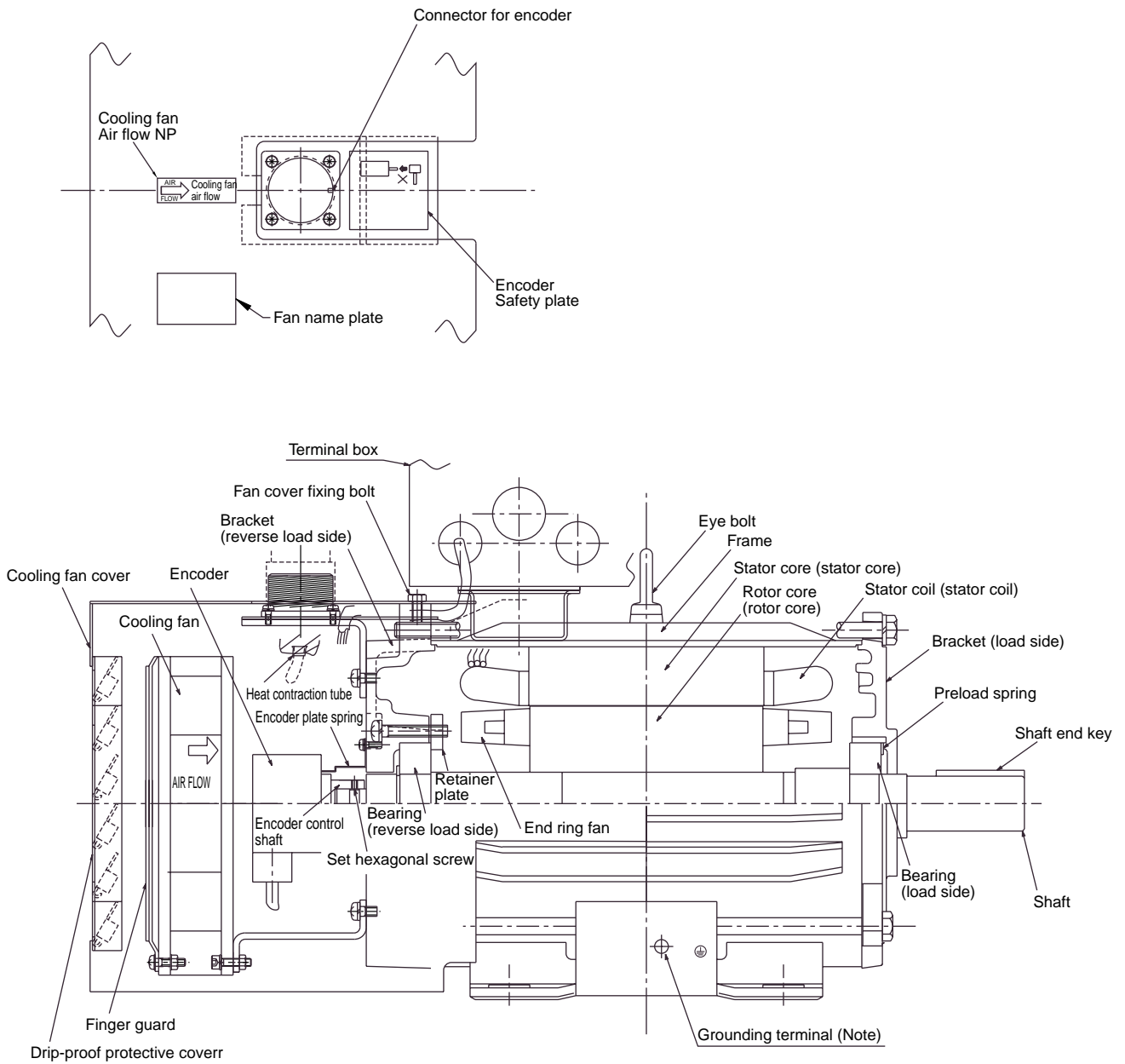


**Fig.6 Lead wire connection method**

- (Note 1)** Connect the cooling fan power supply to the commercial power supply side. The cooling fan (FAN) power supply of 7.5kW or less is of single phase.
- (Note 2)** Use the equipment with thermal protectors (G1, G2) (used for protection of motor overload) connected.
- (Note 3)** It is recommended to use the dedicated cable (FR-V5CBL) for encoder (PLG).

## 7. Structure

This structure is equipped with an encoder on the reverse load side and a cooling fan. The vector inverter motor structure is shown in diagram 7.



**Fig 7 Vector inverter motor structural diagram (example)**

(Note) Always install the grounding terminal on the frame installation leg section in addition to the grounding terminal in the terminal box (refer to Fig. 5).

## 8. Initial start-up

To start the inverter motor for the first time, check for the following items before turning ON the power switch.

- (a) When the motor gets damp during transportation or storage, check that the insulation resistance is over the specified value (1M $\Omega$  or over). Be careful not to touch the terminal directly with bare hands, as the operator may be electrically shocked during measurement of insulation resistance.
- (b) Check that the screws at each part are not loosened.
- (c) When the motor is stored for a long time, check that the dust, etc. are not accumulated at the cooling fan, etc. In that case, remove the fan cover to check for absence of dust. When any foreign matter is accumulated, remove such foreign matter.
- (d) Rotate the shaft with hands, to check that it is turned freely without any scratch. In this case, be careful not to allow the hand to be cut by the key groove.
- (e) Check that the fuse used provides the proper capacity.
- (f) Check that the motor is connected properly, and that the grounding (earth) is connected securely.
- (g) When allowing the motor to rotate in reverse direction may result in inconvenience, check the motor independently for rotation direction prior to operation. In this case, remove the key attached to the shaft.  
(Set the rotation direction, using the vector inverter combined.)
- (h) Check that the motor is connected correctly to the equipment.

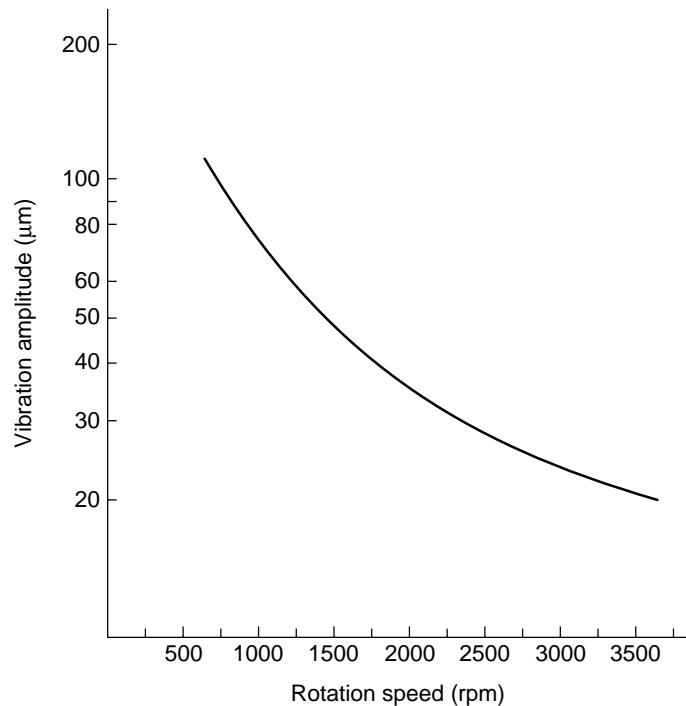
## 9. Operation

- (a) Make it a rule to minimize the load before turning ON the switch, but to apply the designated load when the motor has reached the full speed.
- (b) Check the current, using the vector inverter, etc. to confirm whether the load applied is proper, and adjust the current as required, to the value less than that indicated at the column-A of nameplate. Note that allowing the current exceeding the value indicated on the nameplate to flow may cause the motor to operate under over-load condition, probably resulting in the generation of burning accident.
- (c) Note that starting the motor excessively continuously may result in a cause of motor fault.
- (d) Check that there is not any failure in the bearing sound.
- (e) Be sure to turn OFF the switch when a power failure occurs during operation. Note that leaving the power supply turned ON may cause the motor to fail to start or to be burnt due to heavy load, or the motor to start insidiously, depending on the status of load when the power supply is applied, resulting in unexpected accident.
- (f) Be careful not to put the finger or other foreign matters such as screwdriver, etc. in the motor through the opening of fan cover during operation. Be careful not to touch the rotating part of cooling fan. Otherwise, it may cause an injury or breakage, resulting in dangerous situation.
- (g) Since the motor surface may reach high temperature during operation, be careful not to allow the hand or body to make touch with the motor surface. Otherwise, it may result in burn.
- (h) The temperature rise limits of coil/bearing are as shown below:  
Class-F coil: 100K (resistance method), bearing: 65K [surface] (thermometer method)  
**(Note 1)** When the ambient temperature is higher than 40°C, the temperature rise limit is decreased by the difference from such ambient temperature.
- (i) When a failure occurs, stop the operation immediately.

## 10. Vibration

### (1) Allowable vibration during operation

- a. While the load equipment is operating by the motor, the motor is affected by the direct-coupling accuracy with the load equipment or by the vibration generated from the load equipment, causing the motor to be vibrated. The magnitude is also changed due to status of foundation or base. The vibration is desirable to be small as a matter of fact. Fig.8 shows such range as not to practically infringe the operation, though it may be slightly changed due to motor rotating speed, installation condition, etc. When the vibration generated, exceeds such allowable value, it is necessary to examine the cause, and to take the proper corrective measure as required.
- b. The motor of standard construction is generally resistible against the shock of approx.  $4.9\text{m/s}^2$  (0.5G).  
When the motor is used for press, etc. where the vibration acceleration of over the value may be applied to the motor, consult the dealer.  
The values in parenthesis show the reference values.
- c. When the fan, blower, etc. are attached directly to the motor shaft, or when coupling them directly to the opponent equipment, the increased unbalance at the equipment side may increase the motor vibration, probably causing the bearing, etc. to be damaged. Secure the equipment side balance quality to over the grade G2.5 specified in JIS B0905 "Balance quality of rotary equipment".



**Fig.8 Allowable vibration (maximum value at frame) of motor**

### (2) Vibration during shut-down

Note that fretting (fine wear on raceway of bearing rolling element due to relative small vibration) may occur on the bearing when the vibration is transmitted to the motor under shut-down, which may lead to the generation of unusual bearing sound or to broken bearing.

When such fretting occurs, it is necessary to take the following measures, so that the ball or roller and inner ring/outer ring should not have the relative motion at the same position all the time.

- a. Rotate the motor all the time by taking some way or other.
- b. Fix the raceway of bearing rolling element so as not to vibrate relatively.
- c. When the vibration is not excessively big, operate more than two motors alternately at an interval of several days.
- d. Reduce the vibration of adjacent equipment during operation.
- e. Modify the foundation or floor construction, so as to reduce the motor vibration during shutdown.

## 11. Maintenance/inspection

Since whether the maintenance is performed properly may greatly affect the service life of motor, performing the daily inspection/periodical inspection shown below will ensure the stabilized operation for a long time.

### (1) Daily inspection

Items	Methods	Contents
Sound	Audible check	Listening the sound at each part of motor, using a listening rod will make it possible to detect the magnetic sound, mechanical sound, or other unusual sound generated from bearing, cooling fan and encoder.
Overheat	Smell	It is possible to detect the special smell (scorching smell of varnish) generated when the motor is overheated due to motor overload, ventilation disturbance, etc.
Temperature rise (judgement of appearance)	Instrument (visual check)	Check that there is not any oil leakage, and that the ventilation passage is not interfered. Do not attempt to touch the bearing, frame, etc., to check the temperature of bearing, frame, etc., as it is dangerous. In such a case, use a temperature measurement instrument such as alcohol thermometer, etc.

### (2) Periodical inspection

It is advised to perform the periodical inspection, referring to the following table, though the inspection period may be depending on the working condition.

Items	Inspection period guideline	Contents
Disassembling, inspection	Monthly	1) Check that the insulation resistance measured is over the specified value (1MΩ or over). Be careful not to touch the terminal directly with bare hands during measurement. Otherwise, it may cause the operator to be shocked electrically, resulting in dangerous situation. 2) Surface painting: When the painting is peeled off, repair it, otherwise the rust may be generated abruptly.
	Every 3 months	Perform the maintenance/inspection of cooling fan, to check for adhesion of oil mist, etc.
	Yearly	1) Coil/insulator: Check the coil for loosened fastening string, adhesion of dust, etc. 2) Painting: Where applicable, execute the repair painting even if the painting is not peeled off. 3) Others: Check the other points. If any broken part is found, repair or replace such part, and clean the part.
Encoder	Approx. 20,000 hours*	The bearing provides the shortest service life. When replacing the bearing, replace it as an encoder set.
Cooling fan	Approx. 20,000 hours*	The bearing provides the shortest service life. When replacing the bearing, replace it as a cooling fan set.
Bearing	Approx. 20,000 hours*	When the shielded ball bearing has reached its recommended replacement period, replace it with a new one.

**Note:** The recommended replacement period (marked with \*) indicates the target design life, or a guideline part replacement period at designated use condition (load ratio: approx. 70%, base rotation speed: 1,500 rpm). It is essential to perform the daily inspection/periodical inspection for prevention of environment deterioration. It is recommended to perform the inspection systematically.

### (3) Period and scope of quality assurance

The repair, disassembling and modification must be absolutely performed by the specialist. It is to be acknowledged that the modification of product by the customer is out of scope of guarantee by Mitsubishi.

- When any non-conformity occurs in the product within one year after delivery due to Mitsubishi's responsibility, Mitsubishi will basically repair it free of charge.
- The scope of guarantee for product is only for product delivered.



## 12. Changing the encoder

The encoder is a precision type component therefore replace it in a dust free area. Also, clean off any dust and foreign objects etc. adhering around the motor encoder from the dirty areas.

\* The encoder is commonly specified between 1.5kW and 55kW. Use the following model name when ordering from us.  
Encoder model name: NOC-HP2048-2MHT 15-035-15 Nihon Densan Nemicon brand

**⚠ CAUTION :** When removing the encoder during bearing replacement etc., carry out this replacement procedure with caution.

### 12-1 Removing the encoder

- (1) Make sure the power is turned off.
- (2) Loosen and remove the reverse load side bracket fixing bolt from the Cooling fan cover. (Fig. 9)
- (3) Remove the cooling fan cover. Also, clean the cooling air mouth and inner surface of the cooling fan cover. (Fig. 10)

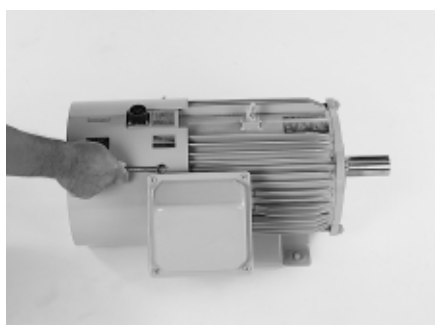


Fig. 9



Fig. 10

- (4) Loosen the cooling fan fixing screw and remove the cooling fan. (Fig. 11)

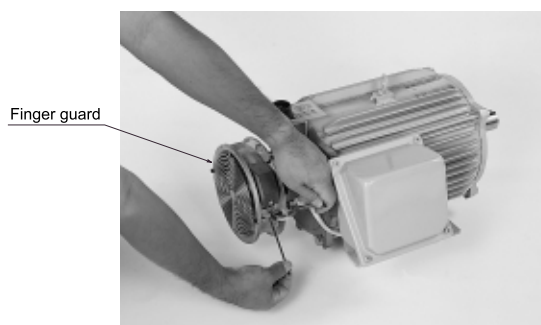


Fig. 11

- (5) Remove the binding band that fixes the cable in place and peel off the adhesive tape. (Fig. 12)  
Next remove the binding band from the area shown in Diagram 13. When doing this be sure not to damage the cable with a cutter etc. (Fig. 13)

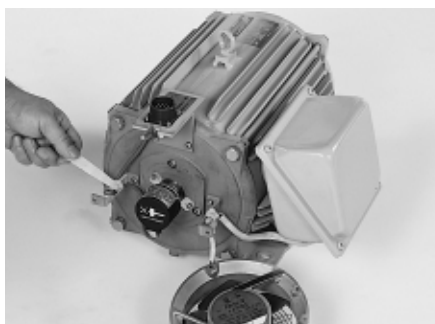


Fig. 12

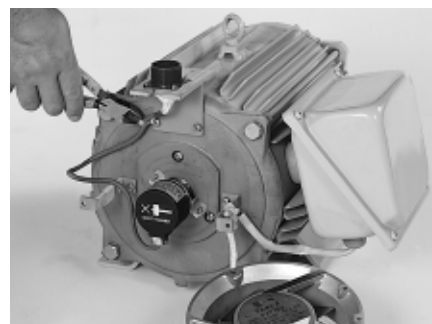


Fig. 13

- (6) Loosen the screw that are fastened to the encoder plate spring and remove them. (Fig. 14)
- (7) Loosen the set hexagonal screws (2 places) that fix the encoder control shaft, pull out the encoder completely from the shaft and carefully remove it. (Fig. 15)

**⚠ CAUTION :** Clean away any dirt on the installation surface of the encoder and on the outside of the encoder.



**Fig. 14**



**Fig. 15**

- (8) Loosen the fastening screws of the connector and plug area and remove. (Fig. 16)



**Fig. 16**

**⚠ CAUTION :** The encoder is a precision type component therefore be careful not to apply any force.

## 12-2 Installing the encoder

(Before installing the encoder check the model name. Refer to page 12 for the model name.)

- (1) Install the encoder in reverse order of its the removal.  
When installing the main body of the encoder onto the motor shaft, make sure to install it so as not to cause any damage to the encoder bearing. If there are any bulges at the area where the shaft is fit, with a smooth cut file or 400-grit sandpaper remove the bulging area.  
**Note)** Make sure that there is no moisture, oil, dust or rust etc. attached to the area where the shaft is fit. If there are any foreign objects adhering wipe with acetone and completely remove.
- (2) <Work standards when inserting the encoder> (Fig. 17)



Fig. 17

- i) As in Fig. 18-a, position the plate spring on the installation surface and lightly place it so that there is no gap. Make sure that it is not installed so that the plate spring is close but not touching (Fig. 18-b) or leaning (Fig. 18-c).
- ii) Without any force tighten the screws that fasten to the plate spring of the encoder main body. When tightening, support the plate spring lightly and tighten while taking care that it twists as little as possible.
- iii) With the stop set hexagonal screws that fix the encoder control shaft, tighten and fix the control shaft and the motor shaft. (Fig. 19)

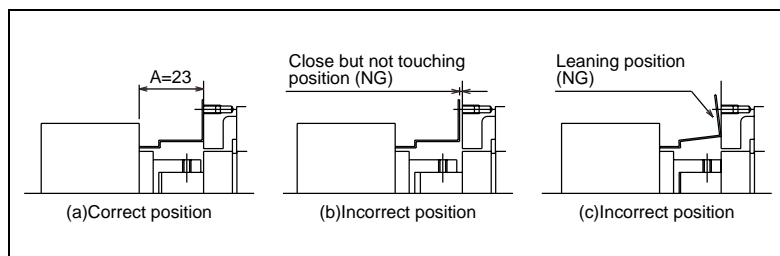


Fig. 18



Fig. 19

- (3) Check criteria after fastening the encoder: after carrying out the installation work for the encoder, check the nominal dimension  $A=23\text{mm}$  between the encoder installation surface and housing. It can be determined that if it is 23mm the installation has been done correctly. (If possible aim for between 22.8mm and 23.2mm)
- (4) Install in the direction of the connector, positioning key groove on the load shaft side. (Fig. 20)

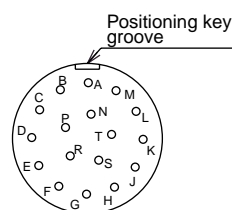


Fig. 20

- (5) Fix the encoder cable by inserting the binding band into the tube of the crimp terminal and the crimp area. (Fig. 21-a).

Next, fix the encoder cable by winding adhesive tape around it about two times without touching the rotation section of the cooling fan. (Fig. 21-b). <Adhesive tape: Nitto Denko brand No.188UL width 19mm equivalent>

When doing this, be careful with the cable returning point (☆ mark R6 as a guide: diagram 21-c) and the encoder outlet straight section and the cable curve. (Fig. 21-d)

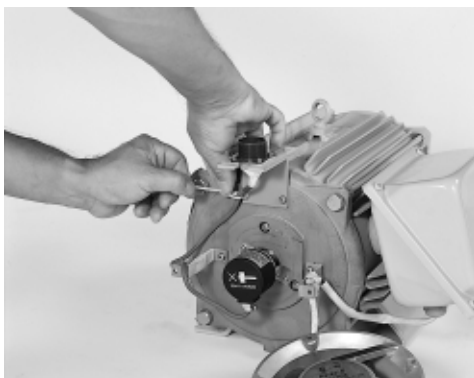


Fig. 21-a

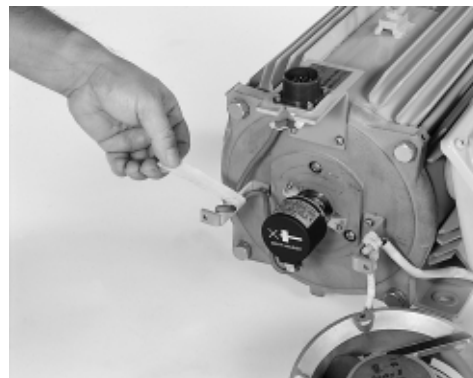


Fig. 21-b

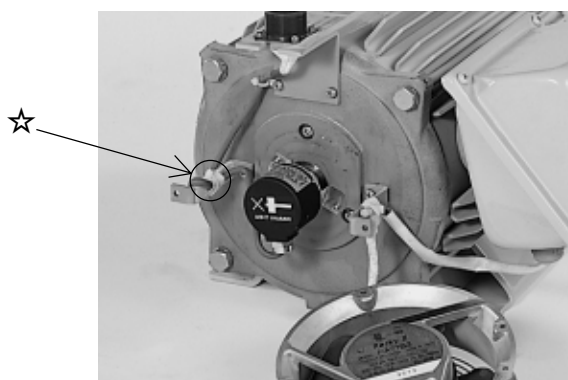


Fig. 21-c



Fig. 21-d

- (6) Install the encoder in the air flow direction of the cooling fan on the motor side.  
**Note)** After assembling, turn on the cooling fan and check the cooling air direction.

- (7) Install the cooling fan cover. (Fig. 22)  
**Note)** Make sure that the lead cable of the cooling fan is not pushing against the edge of the fan cover.



Fig. 22



<Completed product visual>

### 13. Maintenance of coil and insulator

#### (1) When the coil gets damp

When the coil gets damp during transportation, storage or shutdown, measure the insulation resistance, using an insulation resistance meter at the time planned for maintenance.

When the insulation resistance measured is decreased to lower than the following value, be sure to dry the coil.

Low-voltage motor     $1\text{M}\Omega$  when measured for one minute, using a 500V insulation resistance meter at  $40^{\circ}\text{C}$

Space heater         $1\text{M}\Omega$  when measured for one minute, using a 500V insulation resistance meter at normal temperature (before charging)

To dry the coil, disassemble the motor, to dry the coil in accordance with the following procedure until the desired insulation resistance is recovered.

- a. Dry the coil within drying furnace having temperature of not more than  $90^{\circ}\text{C}$ .
- b. Cover the motor with canvas or equivalent cover, drill a hole at the top of cover through which the moisture is relieved, and blow the hot blast air or insert a heating unit or lamp, to dry the coil. In this case, it is necessary to control temperature so as not to exceed  $90^{\circ}\text{C}$ .

#### (2) When the coil is stained

When the coil is stained, or the insulation resistance fails to be improved even if the coil is dried, clean the coil in accordance with the following procedure.

- a. Wipe the coil to remove the dust, clean the coil with cleanser, using hot water or low-pressure steam, and then rinse it in clean water.
- b. When the stain fails to be fully removed with cleanser, clean it with volatile oil, gasoline or carbon tetrachloride, using a cloth or brush. In this case, be careful not to be poisoned.
- c. Dry the coil in accordance with the procedure described in item (1).
- d. Where applicable, brush, spray or dip the high-grade varnish while the coil is hot after it has been dried.
- e. Be sure to check the insulation resistance before starting the operation.