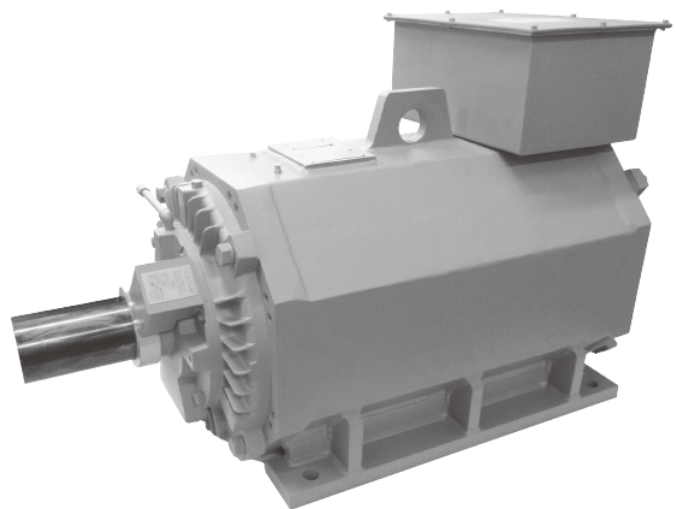


TOYO **ED** MOTOR

INSTRUCTION MANUAL

Permanent-magnet synchronous motor

Water-cooled **EDM** Series



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Please read surely the following precautions

Introduction

We thank you for your adoption of Toyo Denki ED Motor (permanent magnet type synchronous motor). This Manual shows handling method of ED motor and precautions on use for customers having general knowledge on permanent magnet type synchronous motor. Before use, please read this Manual carefully until getting of enough knowledge on our ED motor and use it when it is in optimum condition. After reading, please keep this Manual close to the place where ED motor is used. In case of lease or transfer of ED motor, deliver this Manual together. When ED motor is used combining with machine or equipment, please arrange this Manual to be handed to the end user surely. If this Manual is lost or damaged, please order new one from us or our distributor. Meanwhile there is a possibility that we change parts of ED motor for the purpose of improvement of quality/performance or for safety. At such time, there may be a case that a part of content and illustration, etc. of this Manual does not conform to the original parts, for which please understand. If there are any points which are unclear, please consult us or our distributor.

Safety precautions


Before works of installation, operation, maintenance, inspection, etc., please read carefully this Manual and the manual of Inverter equipment (VF66B, etc.) and all of other attached documents surely for correct use. Please use ED motor after getting enough knowledge on it as well as information on safety and all precautions. After reading, keep this Manual close to the place where operator can read it easily at anytime. In this Manual, ranking of safety precautions is classified to [Danger] and [Caution].

Danger

: In case of error in operation, dangerous situation may occur and it could result in death or serious injury.

Caution

: In case of error in operation, dangerous situation may occur and it could result in medium or light injury, or damage to physical property only.

Even in case of above  **Caution**, there is a possibility to lead to serious result depending on the situation.

Since important contents are written in both safety precautions, make sure to observe them.

Danger

(General)

- Works of transportation, installation, piping, wiring, operation, maintenance, inspection must be carried out by qualified expert. Otherwise, that could result in electric shock, injury, fire, etc.
- Avoid the work in state of hot-line. Be sure to work after breaking of power supply. Otherwise, that could result in electric shock.
- Even in state that power supply is interrupted, voltage is generated at motor terminal while motor is running. Do not touch the motor until perfect stop of rotor and also avoid the work. Otherwise, that could result in electric shock and injury.
- In state that the power supply is interrupted, do not apply the motor to the usage which has a possibility of being rotated faster than motor rating speed by the load. Otherwise, that could result in burning and fire.
- Never use the motor in explosive atmosphere. Otherwise, that could result in injury, fire, etc.

(Installation)

- Surely ground the terminal for earthing. That could result in electric shock.
- In case of use of motor fitting on the ceiling or on the wall, it may drop depending on the conditions. Therefore, please obey to catalog and technical materials in regard to the details of range of use. Otherwise, that could result in injury.
- Operate the motor after confirmation that protection devices are firmly connected and they activate normally. Otherwise, that could result in injury and fire.

 Danger

- Do not operate the motor in state that the cover of terminal box is removed. After work, fit the cover of terminal box at the original position. Otherwise, that could result in electric shock.

(Piping, wiring)


- Connection with power supply cable should be done in accordance with connection diagram or Instruction Manual. Erroneous wiring could result in electric shock and fire.
- Do not bend or pull or put between something the power supply cable and lead wire of motor forcibly. Otherwise, that could result in electric shock.

(Operation)

- Never approach to or contact the rotating objects (shaft, etc.) during operation. Otherwise, that could result in injury by being caught.
- When power is interrupted, turn off the power supply surely. Otherwise, that could result in injury when power is supplied again.

(Maintenance and inspection)

- Connection with power supply cable should be done in accordance with connection diagram or Instruction Manual. Erroneous connection could result in electric shock and fire.

 Caution

(General)

- For installation place of motor, secure safe and adequate space for maintenance and inspection. Otherwise, trouble of electric shock and injury could occur.
- Do not use the motor under out of specifications of that motor. Otherwise, that could result in electric shock, injury, breakage, etc.
- Do not insert finger or object into the aperture of motor. Otherwise, that could result in electric shock, injury, fire, etc.
- Do not use damaged motor. Otherwise, that could result in injury, fire, etc.
- In case of work at high place, prepare enough measures for prevention of drop. Otherwise, trouble of injury by drop could occur.
- Since remodeling by user is out of range of our guarantee, we are not responsible for it.
- Do not put obstacles in front of motor name plate in order for operator to see it at any time.
- Do not remove the name plate.

(Transportation)

- Since drop and falling down of the product during transportation is dangerous, please pay enough attention for such work. As to motor, surely use designated position for hanging. After installation of motor combined with machine, do not hang whole set of motor-machine at the position for hanging of motor only. Before hanging, confirm mass of motor by name plate, packing case, outline drawing, catalog, etc. and do not hang the heavier motor than the rated load of hanger. Breakage of hanger and consequent drop as well as falling down could result in breakage of motor and injury.

(Unpacking)

- Unpack the case after confirmation of top and bottom. Otherwise, that could result in injury.
- Confirm whether reached product is just the ordered one. Installation of erroneously delivered product could result in injury, breakage, etc.

(Installation, adjustment)

- Never place any inflammable objects around the motor. Otherwise, that could result in fire.
- Do not place any objects which prevent ventilation, around the motor. Otherwise, that could result in burn and fire by extraordinary overheat caused by prevention of cooling
- When motor is connected with machine, pay attention on centering, belt-setting, parallel degree of pulley, etc. In case of series connection, pay attention on direct-connection accuracy. In case of belt connection, adjust tensile strength of belt correctly. Before operation, tighten clamp bolts of pulley and coupling firmly. Otherwise, trouble of injury and breakage of equipment caused by scattering of fragments could occur.
- Avoiding touch with rotating part, mount the cover, etc. Otherwise, that could result in injury.

 Caution

- In case of rotating of motor alone, remove temporarily fixed key to the main shaft. Otherwise, that could result in injury.
- Before connection of motor with machine, confirm its direction of rotation. Otherwise, that could result in injury and breakage of equipment.
- Never get on and dangle from motor. Otherwise, that could result in injury.
- Do not touch with bare hand the keyway at shaft end of motor. Otherwise, that could result in injury.

(Piping, wiring)

- At the time of measurement of insulation resistance, do not touch the terminals. Otherwise, that could result in electric shock.
- Carry out wiring work in accordance with [Electrical Facilities Technical Standards] and [Inner Wiring Regulations]. Otherwise, that could result in fire.

(Operation)

- Since motor gets very hot during operation, do not touch it with hand or body. Otherwise, that could result in burn.
- When error occurred, stop operation immediately. Otherwise, that could result in electric shock, injury, fire, etc.

(Maintenance, inspection)

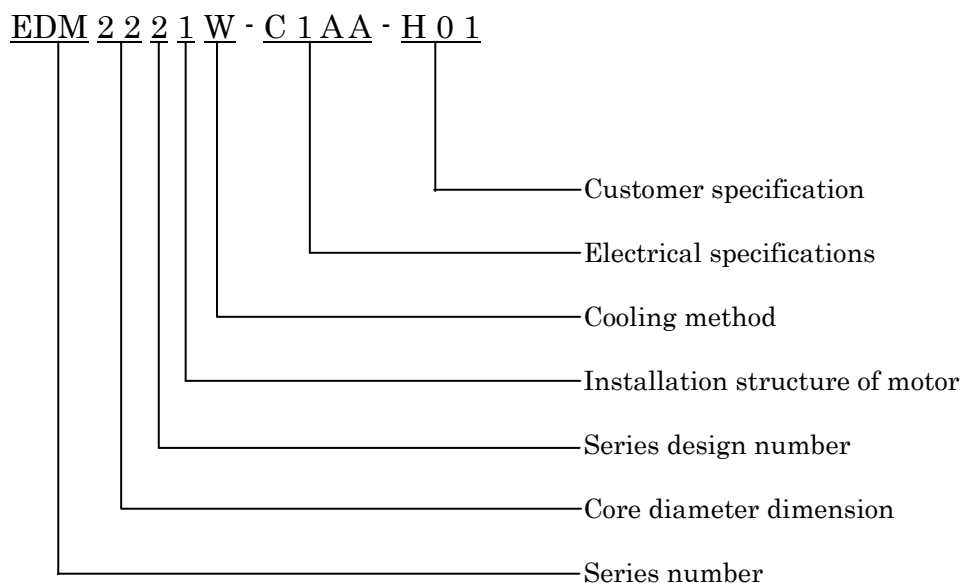
- At the time of measurement of insulation resistance, do not touch the terminal. Otherwise, that could result in electric shock.
- At the time of injection/discharge of grease to/from bearing, do not touch rotating object. Otherwise, that could result in injury.
- Since frame of motor gets very hot, pay attention at the time of maintenance and inspection in order to avoid burn.

(Repair, disassembly)

- Repair and disassembly should be done by qualified expert. Otherwise, electric shock, injury, fire, etc. could occur.

EDM Series ED motor is the most suitably designed motor for Inverter drive by Toyo Denki having high level technology in rotary machine and control equipment.

Explanation of type name



I. Structure of motor

The motor is cooled by cooling water flowing directly into the stator. The structure of the motor is shown in Fig. 1. Cooling water is injected into the stator through a water inlet in the outer frame. The water chambers in the outer frame are suitably partitioned to form water channels, through which the cooling water flows and finally reaches the water outlet in the outer frame.

The water channels and the outer frame are one piece and there is no risk of water leaking in the process.

In addition, the connection of each component of the water passage is made outside the motor, so that even in the unlikely event of water leakage due to age-related deterioration, water will not enter the electrical conductive parts.

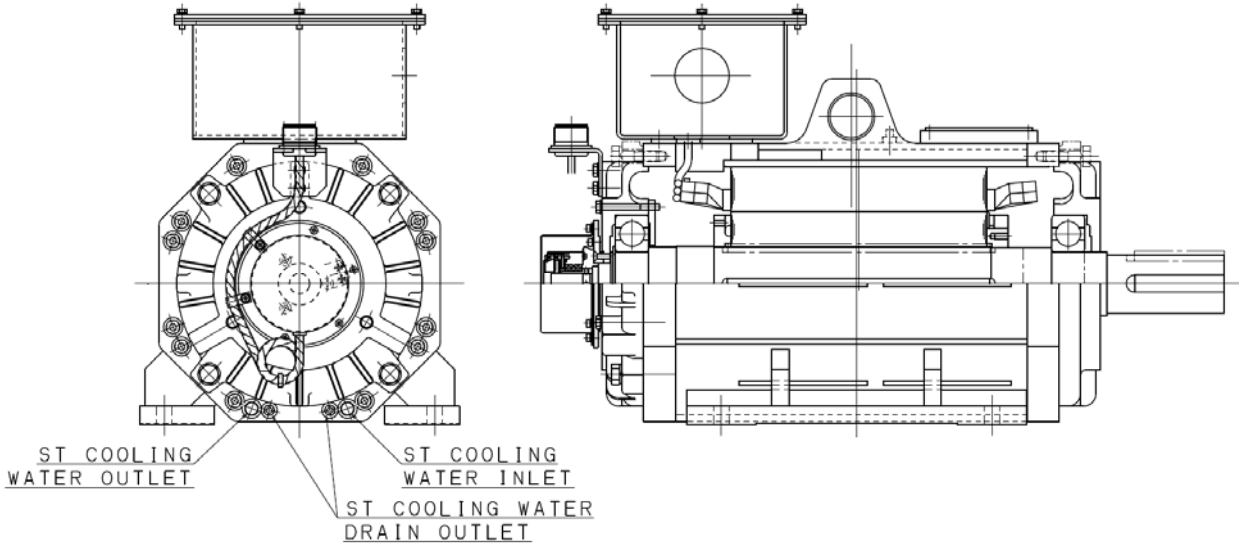


Fig.1 Structural cross section.

II. Preparation for operation

1. Checking at arrival of motor

When the ordered motor arrived, please check paying attention to the following points.

- (1) Check the motor with our invoice separately sent.
- (2) Check the motor for damage, rusting, dropping of accessories, etc.
- (3) There is a case that the rotor of motor is fixed in order to prevent the bearing from being damaged during transportation. Check the rotor and remove it.
- (4) Rotate the shaft end manually to confirm smooth rotation.
- (5) Check the motor output, voltage, current, frequency, rotation speed, etc. shown on the name plate.

2. Installation

2.1 Installation place

Ideally, motors should be installed in the following locations.

- (1) Areas with low humidity and dust.
- (2) Locations not affected by harmful gases, chemicals, etc.
- (3) Where the ambient temperature is between 5 and 40°C.

For low temperatures, special care should be taken as the motor may be damaged due to freezing of the cooling water.

※Cooling water temperature

As for the water temperature, please ensure that the water temperature is below 35°C, as stated in the delivery outline drawing. For the minimum water temperature, please ensure that there is no condensation.

- (4) Places where work such as inspection, cleaning and maintenance can be easily carried out.
- (5) Where there is little vibration

2.2 Connection with counterpart machine

(1) Foundation work

In order to minimize the vibration and misalignment during operation, strong foundation is required. If foundation is incomplete, machine will vibrate and bearing life will be shortened, to which please pay attention. The most ideal foundation in order to prevent generation of vibration is a strong concrete foundation but if such concrete foundation cannot be made because of counterpart machine and relation with the place, install the motor on the steel frame with bolts firmly arranging that the motor shaft exactly level (or perpendicular for a vertical motor) surely. For the base, achieve the level degree of 0.2/1000mm or less accurately. Also, clean the surfaces of concrete foundation / steel frame and of the leg of motor for ideal installation.

(2) In case of flexible coupling

- 1) Mark the matchmarks on the outer surface of coupling.
- 2) In order to rotate the couplings together, connect couplings of the counterpart machine and of the motor by one bolt.
- 3) Fix a dial gauge firmly to outer surface of one coupling. (Fig. 2)
- 4) Move the matchmark of the coupling to the top and measure the dimension-g by clearance gauge and dimension-h by dial gauge.

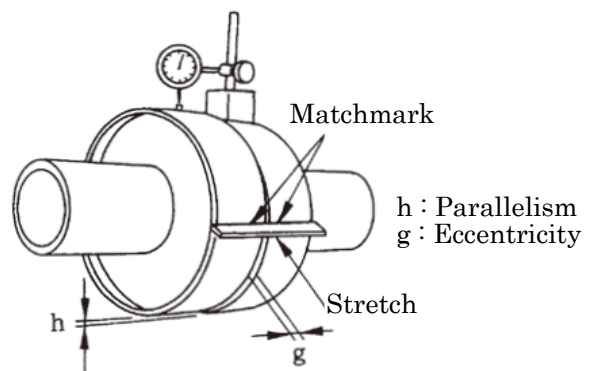


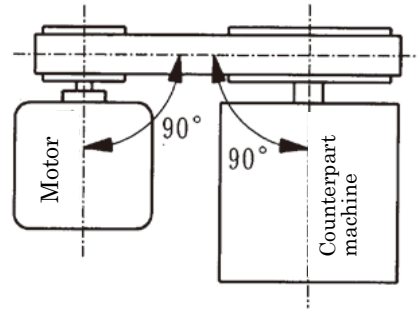
Fig. 2

- 5) Rotate the coupling and carry out same measurement as above item 4) at every 90 of quadrant positions.
- 6) Adjust using shim plates so that the difference between maximum and minimum of the measured values will be 0.03mm for both g and h. Every time the measurement for adjustment is carried out, tighten the installation part with bolt sufficiently. When dial gauge cannot be fitted for a small motor, apply the stretch to the outer surface of one coupling and measure the clearance between stretch and the other coupling.

(3) In case of belt drive

Set the counterpart machine shaft and motor shaft accurately parallel and apply the belt in such a way that both pulley centers coincide each other.

The belt is apt to be stretched too much however, excessive stretching will damage the bearing and cause unexpected accidents such as breakage of motor shaft, etc., to which please pay attention.



1) Belt stretching method

Step 1 : Firstly, find the belt span (L_s). Belt span is the length of the portion of belt between contact points with both pulleys.

Step 2 : Apply the force (P_k), which is required for deflection (δ), at the center of the belt span. This required force for deflection (δ) should be calculated by the formula 5 shown below and it should be within the range of P_{k1} - P_{k2} .

Step 3 : Stretch the belt in such a way that the deflection (δ), when the force is applied, will be the value found by the following formula.

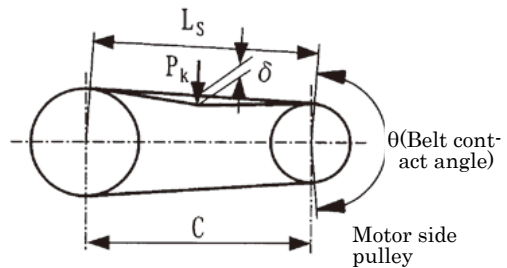


Fig. 3 Belt stretching method

$$\delta = 0.016 \cdot L_s$$

2) Calculation formula

Step 1 : How to find belt contact angle (small pulley side) ... Formula 1

Formula 1

$$\theta = 180^\circ - 2 \sin^{-1} \frac{d_2 - d_1}{2C}$$

Step 2 : How to find initial tension (F_0) Formula 2

Formula 2

$$F_0 = 0.9 \left\{ 500 \left(\frac{2.5 - K_\theta}{K_\theta} \right) \frac{P_d}{Z \cdot v} + m \cdot v^2 \right\}$$

F_0 : Initial tension (N)

Table 1

K_θ : Contact angle correction factor

P_d : Design power (kW)

Contact angle (θ)	140°	150°	160°	170°	180°
Correction factor (K_θ)	0.89	0.92	0.95	0.98	1

$P_d = P_N \times (K_o + K_i)$ P_N : Load power (motor output, in general) (1kW)

K_o : Load correction factor (1.0 ~ 1.5)

K_i : Idler correction factor (0 ~ 0.2)

Z : Number of belt v : Belt speed (m/sec) m : Mass/unit of belt (kg/m)

Note) Determine K_o , K_i depending on the machine to be used and operation time, referring JIS Standard or catalog, etc. of belt maker.

Step 3 : How to find span (L_s) Formula 3

Formula 3

$$L_s = \sqrt{C^2 - \frac{(d_2 - d_1)^2}{4}}$$

L_s : Span (mm)
 C : Distance between shafts (mm)
 d_2 : Large pulley nominal diameter (mm)
 d_1 : Small pulley nominal diameter (mm)

Step 4 : How to find deflection (δ) Formula 4

Formula 4 $\delta = 0.016 \cdot L_s$ δ : Deflection (mm)

Step 5 : How to find necessary force (P_{k1} , P_{k2}) for deflection (δ) ... Formula 5

Formula 5

$$P_{k1}(\text{min. value}) = \frac{F_o + Y}{16}$$

P_{k1} : Necessary force (min. value) (N) for deflection (δ)

$$P_{k2}(\text{max. value}) = \frac{1.25 \times F_o + Y}{16}$$

P_{k2} : Necessary force (max. value) (N) for deflection (δ)

Table 2

	Kind of belt	Y(N)	m(kg/m)
Standard V belt	A type	15	0.12
	B type	20	0.20
	C type	30	0.36
	D type	60	0.66
Narrow V belt	3Vtype	20	0.08
	5Vtype	39	0.20
	8Vtype	98	0.50

Table 3

Type of motor	EDM 22	EDM 27	EDM 31	EDM 35	EDM 43
Permissible shaft load F(N)	5360	9080	12100	18800	24200
Q (mm)	110	140	140	170	175
Q' (mm)	68	93.5	106	91.3	108.8

[Note] Type of motor, for which the belt can be applied, is till EDM4321W. EDM4331W and EDM54, EDM68 are for direct connection only.

Belt speed should be :-

- Standard V belt (A, B, C, D types) 30m/sec or less
- Narrow V belt (3V, 5V, 8V types) 40m/sec or less

This matter should be taken into consideration when pulley diameter is determined. The belt tension differs depending on the kind of belt however, the radial load imposed on the motor shaft should be less than the values in the above table.

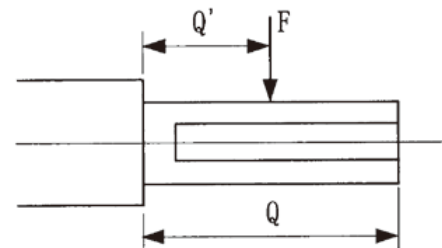


Fig. 4

(4) Mounting of coupling and belt pulley

Coupling and belt pulley should be mounted carefully not to damage the motor bearing. Lightly press-fit them by wooden or plastic hammer. In case of heating, heat them until about 100°C uniformly. In case of press-fitting, remove the rust preventive agent on the shaft end by petroleum solvent or alkali solvent, and apply molybdenum disulfide.

[Caution]

In case that the pulse oscillator for speed detection is provided on the shaft end of non-transmission side, be careful not to give impact to it when coupling and belt pulley are inserted since it may be damaged by such impact. (See Structural Drawings Fig.22~Fig.25)

- (5) In case of flange type motor flange engagement surface is accurately machined. If contaminant, paint, rust, etc. are found there, remove them surely.

3. Electric Wiring

3.1 Terminal box

There are main terminal box for motor main body terminals and thermistor. Connect external wirings correctly and firmly. Connection with pulse oscillator of motor side is connector-connection. For IP55 or waterproof specifications, be sure to use waterproof conduits, conduit fittings, and liquid gaskets to prevent water from entering the terminal box. After wiring, apply a liquid gasket to the fixing bolt of the terminal box cover to seal it.

3.2 Connection diagram

Fig. 5 shows the standard connection diagram. In case that the temperature sensing element (pt100Ω) and temperature element (bimetal type) are provided, all these terminals are housed in the main terminal box and their terminal symbols are as shown in Fig. 6.

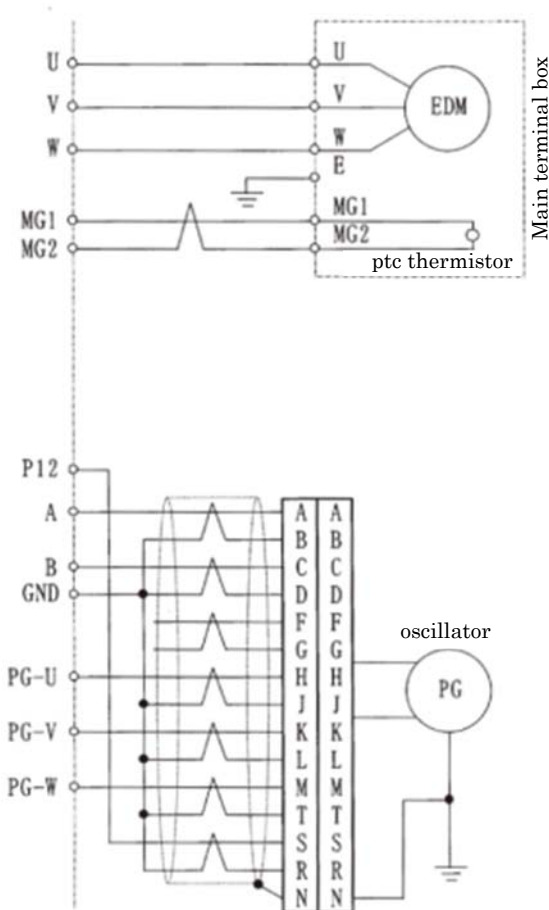


Fig. 5

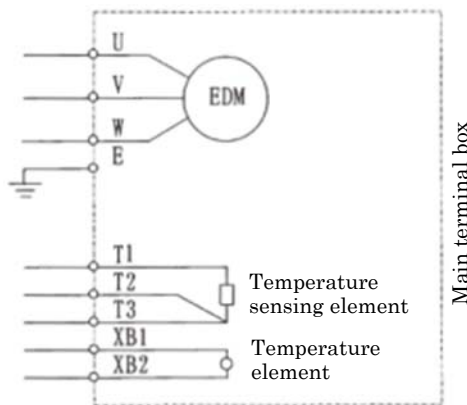


Fig. 6

[Caution]

If main power supply circuit are connected erroneously with terminals of ptc thermistor (terminals MG1, MG2), temperature sensing element (terminals T1, T2, T3) and temperature element (XB1, XB2), motor coil will be damaged caused by breakage of elements and so, enough attention should be paid. Also, do not measure insulation resistance by insulation resistance meter (Megger). If the motor is powered on with incorrect connections, the motor needs repair. It may cause electric corrosion of the bearing.

3.3 Direction of rotation

- (1) Direction of rotation must be correct.
- (2) Direction of rotation of the motor is expressed as seen from the shaft end of drive side. Standard direction of rotation of the motor is counterclockwise (CCW) in case that the phase sequence of power supply side is R, S, T and when these phases are connected with the motor terminal symbols U, V, W.

3.4 Checking of wiring

- (1) Terminals must be connected correctly in accordance with connection diagrams (Fig. 5, Fig. 6). Due attention should be paid to the following points.
 - 1) For the signal cable between pulse oscillator (PG) and controller, the twisted pair, shielded cable should be used for protection against noise. The length should be 100m or less. If the length exceeds 100m, please contact us. Also, connection with pulse oscillator of motor side is connector connection and therefore, undermentioned straight plug and cable clamp are needed in addition to the cable.

Recommendable cable ...Twisted pair, shielded cable ... CO-SPEV-SB(A)7P-0.5SQ
(product of Hitachi Metals, Ltd.)

Straight plug ... MS3106B-20-29S
(product of Japan Aviation Electronics Industry, Limited or equivalent)

Cable clamp ... MS3057-12A
(product of Japan Aviation Electronics Industry, Limited or equivalent)
 - 2) As to the shielded cable (N), ground that of the motor side only.
 - 3) Never carry out the measurement of insulation resistance (Megger test) of pulse oscillator. Use tester for this measurement.
 - 4) For the wiring cable of ptc thermistor, use twisted pair cable.
 - 5) The earthing terminal (E mark terminal) provided in the main terminal box must be grounded.

3.5 Detailed drawings of terminal boxes

Main terminal box (Fig. 7) are terminal block type. However, for the motors EDM43 or over, main terminal box is lug type.

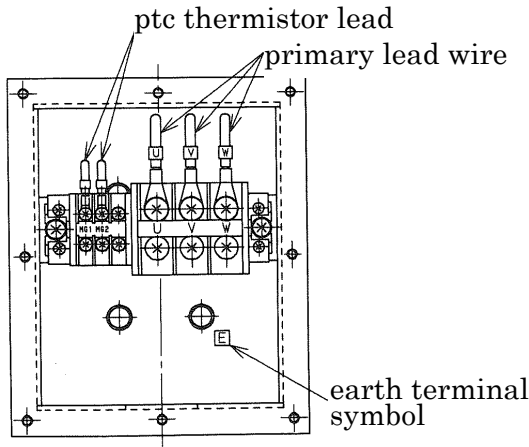


Fig. 7 Detailed drawing of main terminal box

4. Electrical Corrosion Measures

When the inverter drives the motor, high-frequency common mode voltage is generated. If impedance between the motor or machine and the ground is high, voltage is applied to both sides of a bearing, which may cause electrical corrosion.

To avoid this, take the following measures:

- (1) Be sure to connect an inverter plate and a machine surface plate to the ground.

Be sure to connect the ground wire between the inverter plate and the motor.

- (2) Put the motor and the machine on the same surface plate.

When the surface plate of the motor is isolated from that of the machine as shown in the figure below, axis current is applied from the machine bearing to a machine frame through a motor stator, a rotator, and a shaft. It may cause electrical corrosion in the machine bearing.

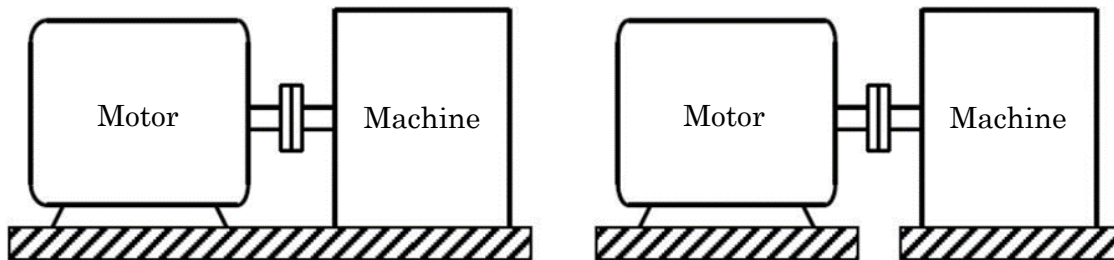


Fig. 8 Installation of motors and machinery

- (3) When the motor and the machine cannot be put on the same surface plate, using insulation coupling for a connection between the motor and the machine will be effective.
- (4) For belt driving, there is no problem on the machine side. Connect the inverter plate and the machine surface plate to the ground.
- (5) For a long distance between the inverter plate and the motor, install an output filter for inverter output to reduce high-frequency components.

5. Cooling water piping and cooling water

- (1) Always check the water inlet and outlet of the motor when piping.

- (2) Install the recommended sight glass, flow switch and strainer at the water inlet of the motor. The sight glass has a specific direction of fluid flow, so take care not to install it in the wrong direction. (See Fig. 9).

- A flow switch can be an auxiliary device with contacts that signal when the correct flow rate is not flowing.
- The strainer becomes a filter with a mesh coarseness of 40, which prevents foreign objects from entering the frame.
- For recommended auxiliary equipment, see VIII List of recommended auxiliary equipment.

- (3) Use industrial water for cooling water. Do not use anything other than water.

Recommended industrial water quality is shown in Table 4.

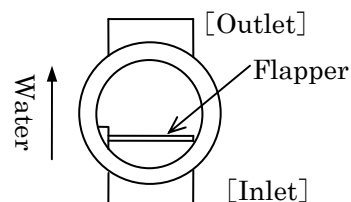


Fig. 9 Direction of flow in the sight glass

Table 4 Recommended industrial water quality

Item	Recommended value
PH(25°C)	7.0~8.0
Electrical conductivity (mS/m)	30 or less
Chloride ions (mg/L)	50 or less
Sulphate ions (mg/L)	50 or less
M Alkalinity (mg/L)	50 or less
Total hardness (mg/L)	70 or less
Calcium hardness (mg/L)	50 or less
Ionic silica (mg/L)	30 or less
Iron (mg/L)	1.0 or less
Copper (mg/L)	1.0 or less
Sulfide ions (mg/L)	Not to be detected.
Ammonium ions (mg/L)	0.3 or less
Residual chlorine (mg/L)	0.25 or less
Free carbonic acid (mg/L)	0.4 or less

Water quality standards in JRA-GL02:1994

- (4) As for the water temperature, please ensure that the water temperature is below 35°C, as stated in the delivery outline drawing. For the minimum water temperature, please ensure that there is no condensation.
- (5) The maximum allowable water pressure of the frame is 0.5 MPa or less.
- (6) If well water is used as cooling water, poor water quality will reduce cooling performance due to scale buildup. If water quality is poor, cleaning is required at shorter than normal intervals. Do not use well water near the coast as it contains seawater.
- (7) Do not use aluminum piping because corrosion of the aluminum material may clog the waterway.
- (8) If you have any questions or concerns regarding cooling water quality, please contact us. We can also provide dedicated water-cooled chillers or dedicated air-cooled chillers on request. Water quality issues can be improved by using circulating water for motor cooling water.

6. Water cooling circuit

(1) The water-cooling circuit for the motor (reference diagram) is shown in Fig. 10.

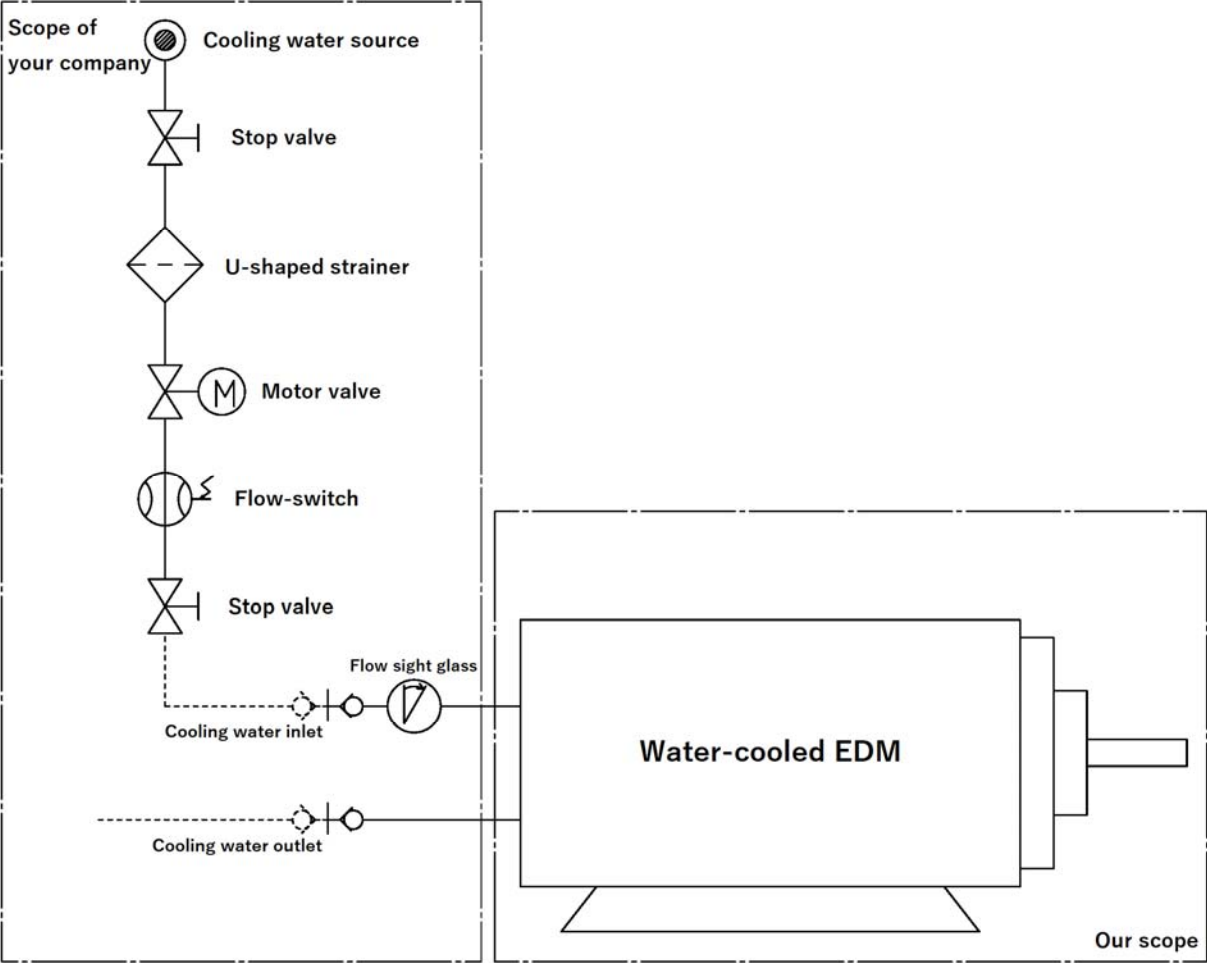


Fig. 10 Reference diagram Water cooling circuit

7. Cooling water quantity

- (1) When the motor is in operation, ensure that the amount of cooling water is at least as shown in Table 5.

		Table 5 Cooling water quantity		
		Type EDM****W		
		Flow rate **L/min		
Output	Speed	1800min ⁻¹	1500min ⁻¹	1200min ⁻¹
18.5kW		-	-	EDM2221W
		-	-	5L/min
22kW		-	EDM2221W	EDM2231W
		-	6L/min	6L/min
30kW		EDM2221W	EDM2231W	EDM2761W
		8L/min	9L/min(190V) 8L/min(380V)	6L/min
37kW		EDM2231W	EDM2761W	EDM2761W
		10L/min	7L/min	9L/min(190V) 8L/min(380V)
45kW		EDM2761W	EDM2761W	EDM2771W
		8L/min	9L/min	9L/min(190V) 8L/min(380V)
55kW		EDM2761W	EDM2771W	EDM2781W
		10L/min	10L/min(190V) 9L/min(380V)	11L/min(190V) 10L/min(380V)
75kW		EDM2772W	EDM2781W	EDM3141W
		13L/min	13L/min	12L/min
90kW		EDM2781W	EDM3141W	EDM3151W
		15L/min	13L/min	15L/min
110kW		EDM3141W	EDM3151W	EDM3161W
		16L/min	16L/min	16L/min
132kW		EDM3151W	EDM3161W	EDM3541W
		19L/min	18L/min	17L/min
160kW		EDM3161W	EDM3551W	EDM3551W
		22L/min	18L/min	20L/min
200kW		EDM3551W	EDM3561W	EDM3561W
		24L/min	22L/min	25L/min
250kW		EDM3561W	EDM4331W	EDM4331W
		28L/min	21L/min	24L/min
315kW		EDM4331W	EDM5422W	EDM5411W
		22L/min	27L/min	24L/min
375kW		EDM5412W	EDM5422W	EDM5451W
		31L/min	29L/min	27L/min
400kW		-	-	EDM5451W
		-	-	29L/min
450kW		EDM5452W	EDM5462W	EDM5462W
		39L/min	42L/min	37L/min
750kW		-	-	EDM6851W
		-	-	46L/min

※For those without a voltage indication, the flow rate is the same for 190 V and 380 V.

※For use with constant power characteristics and for specifications not listed above, refer to the cooling water quantity in the delivery drawings.

III. Trial operation and ordinary operation

1. Before powering

All of your purchased motors from us passed severe tests at our factory however, they may have a possibility of being damaged during transportation or affected by long storage, and so carry out following checking, confirmation before starting of operation.

(1) Precautions for working before trial operation

- 1) Check that the shaft fixer and cover for the time of storage were removed.
- 2) Check electric wiring was correctly carried out.
- 3) Check loose tightening bolts are found at individual part.
- 4) Check terminal box cover was fitted.
- 5) Check the motor is well ventilated.
- 6) Measurement of insulation resistance of stator coil to earth.

Insulation resistance is important for knowing the insulation state of the motor. Insulation resistance varies greatly depending on the type of equipment, insulation method, dimensions, rating, temperature, humidity, cleanliness, etc. In general, insulation resistance drops sharply as temperature rises, and the relationship between the logarithm of insulation resistance and temperature changes almost linearly within the operating temperature range (Fig. 11).

Therefore, understanding the relationship between insulation resistance and temperature is useful for maintenance. Relative values are important as well as absolute values. During maintenance, measure regularly and compare changes.

[How to measure the insulation resistance at first operation]

- Measure before starting the motor
 - Use a megger to measure.
 - Disconnect the motor main circuit on the inverter terminal block and measure between the motor terminals and ground.
 - Measure the insulation resistance one minute after voltage is applied.
 - Check if the measured value is 100MΩ or more at room temperature. If it is less than 100MΩ, please contact us.
 - Measure the temperature of the frame at the same time as measuring the insulation resistance, and write it together with the measured value of the insulation resistance.
- 7) Manually check that the shaft rotates smoothly.

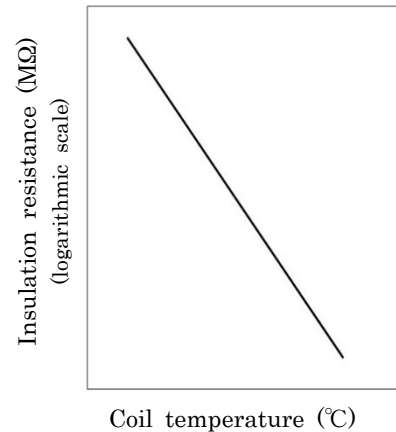


Fig.11 Example of relationship between temperature and insulation resistance

(2) Lubrication

For the grease lubrication type motors, the bearing portion is filled with grease before shipment. However, if they are not used for more than 6 months after arrival at the site, the grease must be replenished soon after starting of operation.

This work is not necessary in case of use of sealed-grease type bearing.

(3) Others

Check the status of direct connection and belt tension as well as tightening of bolts and nuts of the individual part.

2. Inspection of the cooling water area

Operate the cooling system only and inspect the following.

- (1) Check with a flow meter that the cooling water is flowing correctly.
- (2) Ensure that there are no water leaks.

3. Inspection during motor operation

- (1) If the direction of rotation is indicated, check that the direction of rotation is correct.

The direction of rotation of the motor is expressed as viewed from the shaft end on the drive side.

The standard direction of rotation of the motor is counterclockwise (CCW) when phases T1/U, T2/V and T3/W are connected to the motor terminal symbols U, V and W respectively when the power supply side phase order is T1/U, T2/V and T3/W.

- (2) Check the bearing and other parts for unusual noises.
- (3) Check for abnormal vibrations.
- (4) Check for unusual odors.
- (5) Check for imbalance in supply voltage and phase currents.

IV. Maintenance, checking

In order to prevent accidents in operation of the machine, daily monitoring or checking is required.

1. Daily checking

By touching and hearing, check the vibration and sound at the time of starting and during operation of the machine and confirm that there is no abnormality. It is recommended that a driving record be prepared for the following items.

- (1) Date, time of measurement. Weather of the day of measurement
- (2) Voltage, load current, frequency, rotation speed
- (3) Bearing temperature and ambient temperature
- (4) Abnormal noise and vibration
- (5) Whether or not there are any water leaks
- (6) Position of the flapper on the sight glass

2. Periodical checking

- (1) Measurement of insulation resistance
Measure the insulation resistance every month and confirm that it is 100 to 10 MΩ or more.
Measure at room temperature at least 24 hours after the motor has stopped. If the insulation resistance drops more rapidly than last time, or if it drops below 10MΩ at room temperature, please contact us.
- (2) Checking of bearing related items
- (3) Measurement of vibration
- (4) Looseness of tightening nuts
- (5) Condition of direct connection of coupling and belt tension
- (6) Cleaning of individual part
Clean each part of the motor once a month. If dust accumulates on the frame, the cooling effect will be reduced and the motor will overheat. Also, accumulation of dust on the ground brush may cause electrolytic corrosion of the bearing.
- (7) Checking of power supply condition
- (8) Checking of pulse oscillator
- (9) Inspection of strainers for cooling water pipework
- (10) Checking the amount of oil in the reducer with an oil gauge

Checking items are as shown above. Check the amount of oil in the speed reducer with an oil gauge every week, and for others, check every year.

To measure and monitor the machine vibration periodically is very important for the maintenance/checking of the machine. If vibration is large, it affects the bearing, winding and condition of direct-connection badly and therefore, investigate the cause and repair the faulty part. If the amount of oil in the reducer's oil gauge is low, the oil seal inside the reducer or motor may have deteriorated, causing an oil leak outside the reducer or inside the motor. Check for oil leaks and replace the oil seal if necessary. If oil is leaking inside the motor, the oil will come out by removing the rubber plug (Fig. 12) at the bottom of the motor frame. If oil comes out, drain the oil completely and replace the oil seal (Fig. 13).

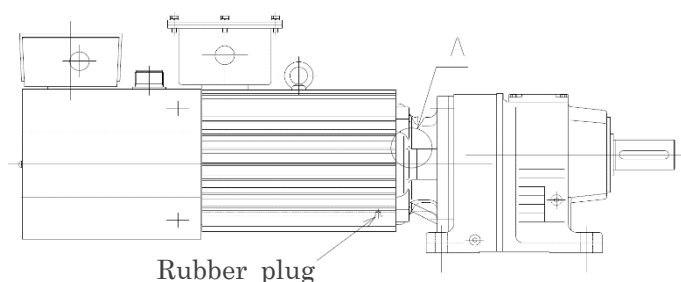


Fig. 12 Location of rubber plug

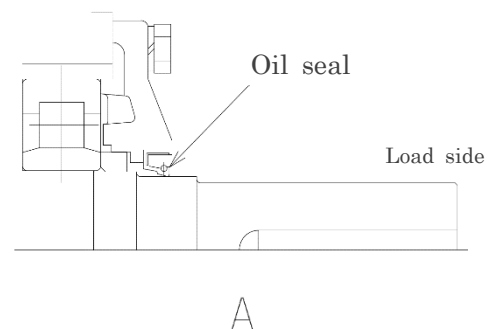


Fig. 13 Location of Oil seal

3. Cleaning of cooling water channels

3.1 Cleaning precautions

The cooling water channels are coated with a galvanized coating as an anti-corrosion treatment. Therefore, cleaning the cooling channels with chemicals is strictly prohibited as the paint will peel off. Also, when cleaning the cooling channels with a brush, avoid using wire brushes or other cleaning methods that may strip the paint.

3.2 Frequency and methods of cleaning

(1) Frequency

Regular cleaning of the cooling water channels prevents a reduction in cooling capacity and blockage of the channels due to deposits. Cleaning and inspection should always be carried out in the first year after the water has been supplied; the results of the second and subsequent inspections should be used as a basis for determining the results of the first inspection. If there is dirt in the water or the cooling channels become blocked in a short period of time, use a separately installed heat exchanger.

(2) Method

Clean according to the following procedure.

- 1) Empty the water in the cooling channels by draining the water from the drain outlet.
- 2) The cooling channels have a hole in each water chamber for cleaning. They are normally blocked by screw plugs, which must be removed.
- 3) After cleaning the cooling channels through the cleaning holes with a nylon brush, blow off any deposits with air. Air pressure should be limited to 0.49 MPa (5 kg/cm²). The maximum air pressure should be 0.49 MPa (5 kg/cm²). The degree of cleaning should be determined by illuminating the inside of the cooling channel inlet through the cleaning hole with a light and checking for adhesion. If the dirt is severe, use a neutral detergent. If detergent is used, always rinse with tap water.
- 4) After cleaning, remove the sealing tape from the screw plug and rewind the new sealing tape to seal each hole as it was originally.

4. Bearing and lubrication

4.1 Shielded bearing

For the motors of EDM22 and EDM27~EDM35 (non-load side), shielded type ZZ (non-contact type sealed grease) bearing is used. Generally, the bearing should be replaced at the time of periodical checking. Until that time, grease maintenance is not required. When replacing, specify a bearing-filled grease equivalent to Multemp SRL (of Kyodo Yushi Co.).

4.2 Grease replenish type bearing

The grease variety, replenishment quantity and replenishment interval are indicated on the nameplate.

- (1) Replenish the grease during operation at every replenishment interval (operation time) indicated on the name plate. In case that the net operation time is short due to short-time or repetitive operation, grease should be replenished in such a way that the elapsed time including stoppage will not become twice or more of the interval indicated on the name plate, or at least every 6 months - one year.
- (2) When grease is replenished, be sure to rotate (300 min^{-1} or more) the motor, clean the grease nipple, and replenish necessary quantity by grease gun through the nipple. At every time of grease replenishment, scrape out old grease from grease drain port.
- (3) When the grease is replenished, bearing sound will become temporarily louder a little or the bearing temperature will rise $5^{\circ}\text{C}\sim 10^{\circ}\text{C}$ higher than the normal one, because of excess grease, but it will return to normal one in several hours to 1 day.
- (4) Table 6 shows approximate values of grease replenishment quantity and replenishing timing.

Table 6 Grease replenishment quantity

Type of motor	Load side bearing No.	Replenishment quantity (g)	Replenishing timing (cumulative operating time) (Hr) at specified speed		
	Non-load side bearing No		1800 r/min	1500 r/min	1200 r/min
EDM2761W	NU313	33	3400	4200	5400
EDM2771W	6312ZZ	--	--	--	--
EDM2772W	NU316	47	3000	3700	4800
EDM2781W	6312ZZ	--	--	--	--
EDM3141V	NU316	47	3000	3700	4800
	6315ZZ	--	--	--	--
EDM3151W	NU320	72	2600	3200	4200
EDM3161W	6315ZZ	--	--	--	--
EDM3541W					
EDM3551W	NU324	102	2300	2900	3700
EDM3561W	6318	24	2300	2900	3700
EDM43**W					
EDM54**W	6324	102	4700	5800	7600
	6318	48	4700	5800	7600
EDM68**W	6326	116	4400	5500	7200
	6324	96	4400	5500	7200

At the forwarding from our factory, bearings are filled with Multemp SRL (of Kyodo Yushi Co.) unless otherwise specified, (or grease of the brand specified by user). For replenishment of grease, we recommend this Multemp SRL. If grease of this brand is not obtainable, the equivalent greases shown in the table below can be used.

Table 7

Maker name	Brand of grease
Kyodo Yushi	Multemp SRL
ENEOS	Multi Knock Wide 2
Shell Lubricants Japan	Shell Valiant grease M2
EMG Lubricants GodoKaisha	Unirex N2

4.3 Use of grease of different type for the grease replenish type bearing

- (1) Avoid mixed use of different brands of grease. Depending on the combination, properties of grease may greatly change.
- (2) In case that the user is compelled to use a grease of different brand from the grease of the time of delivery, the following method should be taken.
 - 1) Open the grease drain port and inject new grease while scraping out the old grease, during operation or by manual rotation of the shaft.
 - 2) Repeat this work until the new grease comes out of the grease drain port.
- (3) When the grease is injected, bearing temperature may rise. In such a case, stop the injection until lowering of bearing temperature. After that, repeat the injection of the grease.

4.4 Sound of bearing (Grease replenish type)

Sound of bearing during operation is classified as follows.

(1) Normal sound

The normal sound is continuous one. The race sound, jarring sound and retainer sound are considered as normal. The jarring sound may be misunderstood as an abnormal noise but it does not mean the abnormality of bearing. The jarring sound dies away temporarily when the grease is injected in general.

The jarring sound may be generated in the following cases.

- 1) In case of bearing clearance C3 or C4 for high speed machine
- 2) In case of cylindrical roller bearing
- 3) In case of operation in winter of low ambient temperature and of the beginning of operation after long stoppage.

(2) Abnormal sound

- 1) Flaw noise or dust noise, etc. are abnormal sound.
- 2) Abnormal sound is discontinuous and in some cases it accompanies vibration.
- 3) When abnormal noise sounds, inject new grease and observe change in sound and temperature for a while. If abnormal noise does not stop, the bearing should be replaced.

5. Checking of accessories

For checking of accessories of electromagnetic brake (except built-in type), speed reducer, etc., see the Instruction of Manual for accessories of the separate volume.

6. Service life of main accessory parts

Some parts of motor have their service life limit. It differs depending on the service environment/conditions and therefore, carry out checking or replacement of parts making the undermentioned service life limit as a criterion.

6.1 As to motor related parts

(1) Motor bearing (at ambient temperature of 40°C or lower and speed of 1800 r/min)

- 1) Grease replenish type bearing About 50,000 hours
- 2) Shielded bearing About 32,000~ 47,000 hours
 - Sealed grease is of Multemp SRL of Kyodo Yushi, or equivalent.
 - Life of shielded bearing is determined depending on the life of sealed grease. Life of sealed grease is affected by the ambient temperature and is shortened about 1/1.5 every time the ambient temperature rises 10°C from 40°C.

(2) Pulse oscillator ... About 4~5 years (at ambient temperature of 40°C or lower and speed of 1800 r/min)

(The shielded bearings of fan motor and pulse generator will reach the limit of their service life. This limit differs depending on the ambient temperature.)

(3) V ring on the load side(Only the waterproof version) About 25,000 hours

V ring on the non-load side..... About 25,000 hours

(Should be replaced at the same time as the encoder.)

(4) Oil sealAbout 10,000~15,000 hours as a criterion (Life differs greatly depending on the environmental conditions for use.)

6.2 Helical speed reducer (at ambient temperature of 40°C)

(1) Each bearing About 25,000 hours

(2) Oil sealAbout 10,000~15,000 hours as a criterion (Life differs greatly depending on the environmental conditions for use.)

(3) Replacement cycle of lubrication oil

First time : 500~1,000 hours after starting of operation.

Subsequently : Every 2,500 hours.

V. Storage

1. Storage

(1) In case that the motor is stored for 3 months or longer till the initial operation after receiving it or its operation is stopped for 3 months or longer, take the following steps.

- 1) Storage : The motor should be placed in the same posture with correct installation state, covered with waterproof sheet, and be kept at a dry place.
- 2) Exposed machined surface : Apply rust-preventive agent every 6 months. If motor is export-packed, unpack it after elapse of one year and apply the rust-preventive agent.
- 3) Rotation of shaft : Operate the motor for a few minutes every 3 months (and before long storage) or rotate the shaft manually about 10 times.
- 4) Bearing and lubrication
 - Shielded bearing : After storage of motor for 2 years or longer, pay attention whether abnormal sound is heard from bearing during trial operation. If it is heard, replace the bearing.
 - Grease replenishment type : Every one year, replenish the quantity indicated on the nameplate, see section IV.4.2.
- 5) Insulation resistance of winding : In case that the motor is not used for a long time, measure the insulation resistance of winding of the winding every 6 months and before starting of operation. Measure at room temperature at least 24 hours after the motor has stopped. Make sure that the insulation resistance is 100 to 10 MΩ or more. If the insulation resistance drops sharply from the previous time, or falls below 10MΩ, please contact us.
- 6) Space heater (when provided) : When the motor is stopped for 1 day or longer, energize the heater.
- 7) Surface painting : Re-paint every 2 years, as the need arises.
- 8) Rubber plug (when provided) : Periodically (at least every 6 months) and before starting operation, open the rubber plug at the bottom of the motor and check for oil leakage.

VI. Disassembly, Assembly

This motor incorporates permanent magnet in its rotor. Owing to this composition, pulling out of the rotor from the stator is quite difficult. Therefore, do not pull out the rotor from the stator at the time of disassembly/assembly of motor, such a case of replacement, etc. of bearing. Replacement of bearing can be carried out keeping the rotor inserted in the stator. Also, at the time of disassembly/assembly, do not proceed the work at load side and non-load side simultaneously. Surely after completion of work of one side, start the work of the other side (As to the order of work, starting from any of both side is available). Since magnetism of the magnet of rotor acts to outside a little during the works of disassembly/assembly of motor, do not make Watch, Magnetic Card, etc. approach to the motor. For IP55 or waterproof specifications, the joints of the components are sealed with a liquid gasket (ThreeBond 1212). When reassembling, apply a liquid gasket (ThreeBond 1212) to the joints of the parts in the same way as before disassembly to seal them.

1. Disassembly/assembly procedures

(See Fig. 14 below and structural sectioned drawings (Fig. 22~Fig. 25))

- (1) Break the power supply.
- (2) Remove the connection with the load.
- (3) Remove all the external wirings connected with the terminals in the terminal box.
- (4) Remove the connector connection for the encoder on the L bracket.

1.1 Non-load side

- (1) Remove the encoder connector from the L bracket.
- (2) Remove fitting screws of encoder cover and remove encoder cover. At this time, encoder output cable is led from lower part of encoder and therefore, pay attention not to be pulled this cable.
- (3) Remove screws, which fix the plate spring of encoder stator to the mount of encoder.

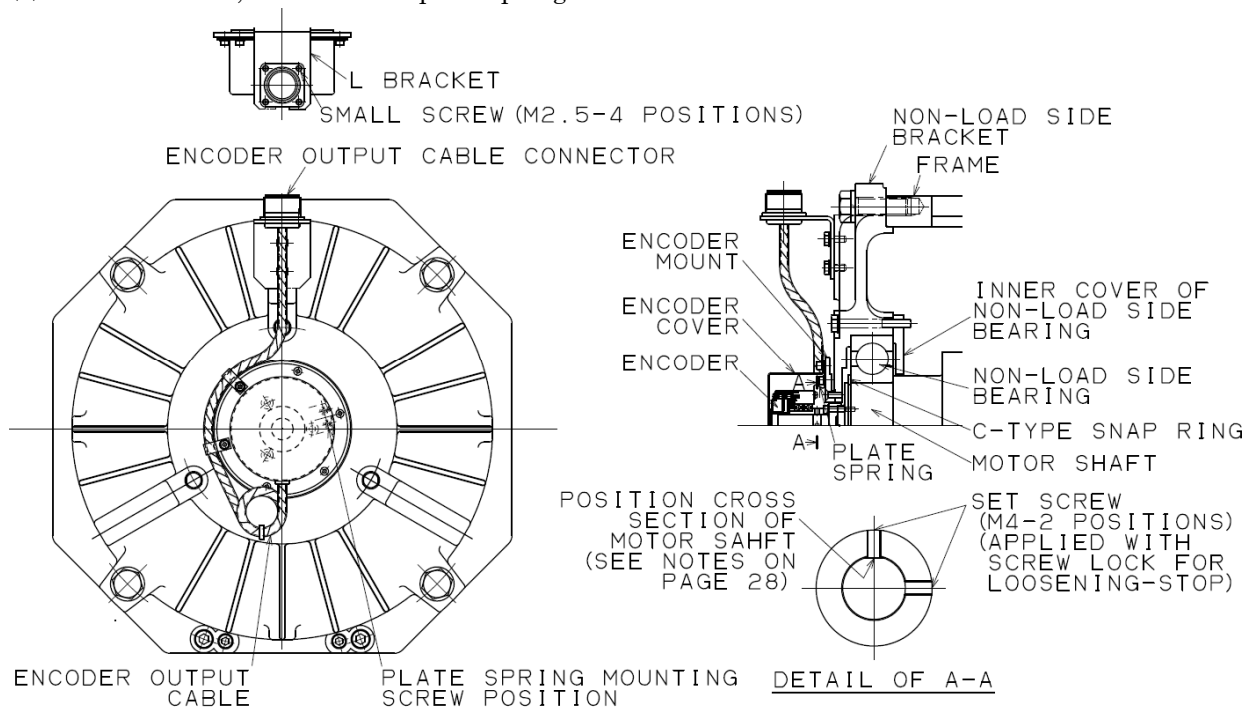


Fig. 14 Detailed view of the anti-load side encoder and bearing surround

- (4) Loosen about 3 turns the 2 setscrews fixing the encoder rotor to the motor shaft and remove encoder. (Do not take off the setscrews.) However, an adhesive (TB1342H) is used to prevent the set screws from loosening. Before removing the set screws forcibly, warm them up to about 100°C using a thin soldering iron and then remove them.

- (5) Remove the mounting screws from the encoder mounting stand and remove the encoder mounting stand. Attach a matching mark when removing the encoder mounting stand. (It is not necessary to remove the encoder mounting stand for EDM31** and smaller.)
- (6) Remove the V-ring. (EDM3551W models with encoder, EDM3561W models, EDM43**W to EDM6851W models)
The type of V-ring on the anti-load side is shown in Table 8.
- (7) Remove the bearing outer cover of non-load side (since the cover of EDM31 or less is unified type with bracket, remove the fixing bolts of the bearing inner cover). When that outer cover is removed, mark the matchmarks.
- (8) Remove the bracket of non-load side. When it is removed, mark the matchmarks.
- (9) Remove the insulated short shaft (this shaft is attached to EDM27 or over and not attached to EDM22 or less, of which shaft is unified type with motor shaft.) of non-load side shaft end. When that short shaft is removed, mark the matchmarks.
- (10) Remove the C-type snap ring by the pliers. (EDM3541W or less) Remove the bearing nut, bearing washer and outer slinger. (EDM3551W or over)
- (11) Pull out the bearing from shaft by the puller. (As to the details of replacement work of bearing, refer to item VI-2.)
- (12) After completion of replacement work of bearing, carry out assembly work under reversed procedure of disassembly. Align the matchmarks marked at the time of disassembly and tighten the bolts of diagonal positions alternately in order to avoid uneven tightening. Also, apply grease (Three Bond 1805 spray type) to the lip of the V ring. The shaft runout for mounting the encoder should be 0.05 mm or less at TIR. The measurement method of shaft runout is according to Fig.16. At that time, use a non-magnetic dial gauge. If the dial gauge is not nonmagnetic, it may not be possible to measure shaft runout correctly. The shaft runout correction method is as follows.
 - (a) If the encoder mounting shaft is integral with the motor shaft (Refer to Fig.17 (a)), adjust by tapping the shaft end with a plastic hammer (Less than 2LB) and a rod of soft material that does not damage the shaft. (For example, DURACON) Be careful as the impact may cause an abnormality if the shaft is subjected to an extremely strong impact.
 - (b) If the encoder mounting shaft is fixed to the motor shaft with bolts (Refer to Fig.17 (b)), loosen its bolts and adjust the mounting position. Be careful not to forget to tighten the bolt tightly at the end.
- (13) After assembling, rotate the shaft manually to confirm smooth rotation.

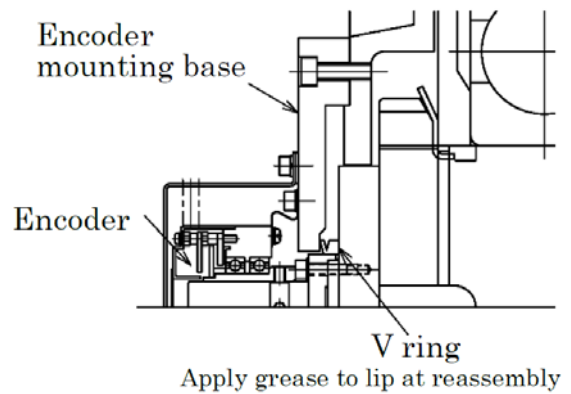


Fig.15 Position of V ring at non-load side

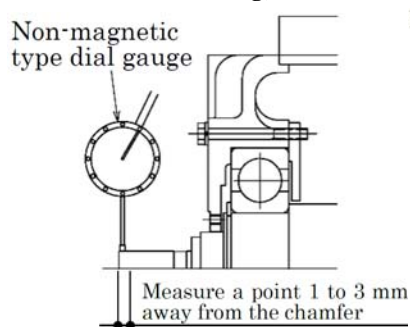


Fig.16 Runout measurement of encoder mounting shaft

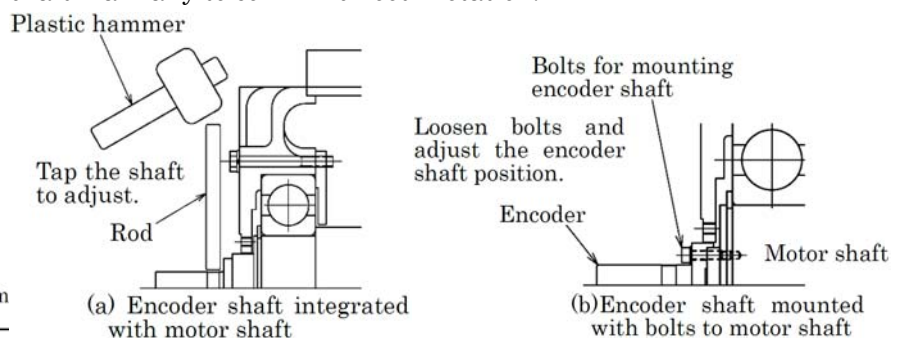


Fig.17 Shaft runout correction method

Table8 V-ring type on the non-load side (Only motors with an encoder)

Type of motor	Type of V-ring
EDM2221W~EDM3541W	None
EDM3551W~EDM6851W	V-40A

1.2 Load side

- (1) Remove the bearing outer cover of load side. (For EDM22, this cover is unified unit with bracket.) In addition, since the V ring is attached in the case of waterproof specification, remove the V-ring. Refer to the outline drawing to identify the type of V-ring.
- (2) Pull out the slinger of bearing outer side of load side from the shaft. Slinger is fixed to the shaft by screw at one position. (Motors, to which the outer slinger is attached, are EDM31 or over)
- (3) Remove the bracket of load side. When it is removed, mark the matchmarks. As to the motors EDM27~EDM43 using roller bearing, pay attention since bearing outer ring also is pulled out together.
- (4) Pull out the bearing from the shaft by puller. (As to the detail of replacement work of bearing, refer to item VI-2.)
- (5) After completion of disassembly, wash off the grease on the bearing and bearing cover, etc. by clean washing oil. (This work is unnecessary for the shielded bearing.)
- (6) Fill the cleaned bearing or replaced bearing with grease, turning the outer ring.
Fill the bearing cover with grease of about 1/2 to 1/3 of the capacity. (This work is unnecessary for the shielded bearing.)
- (7) Carry out assembly work under reversed procedure of disassembly procedure. Align matchmarks marked at the time of disassembly and tighten the bolts of diagonal positions alternately in order to avoid uneven tightening. Apply grease (Three bond TB1805 spray type) to the lip of V ring.
- (8) After assembling, rotate the shaft manually to confirm smooth rotation.

[Note]

- 1) Giving the impact to the encoder will cause trouble. Never hit it with hammer, etc. Since clearance fit is adopted for engaging of encoder rotor and shaft, they can be pulled out manually.
- 2) Even for the cases of removing and re-mounting of encoder at the times of replacement, etc. of bearing or encoder, setscrew position for fixing the encoder rotor is determined to make that the magnetic pole position detection of the rotor of motor is same. As shown in Detail of A-A Cross Section of Fig. 14, when one of 2 positions of setscrew M4 is coincided with flat cut position of motor shaft (one position of motor shaft, where setscrew contacts, is flat surface), mount the other setscrew arranging that it surely comes to the position turned 90° to counterclockwise seen from the non-load side shaft end (position where motor shaft is not cut flatly).
As to motors EDM31 or over, the part where encoder rotor is inserted, is an insulated short shaft. When this insulated short shaft is removed from motor shaft, be sure to mark the matchmarks. (After mounting, confirm that the direction of keyway position of output shaft of motor shaft and flat cut position of insulated short shaft is same.)

2. Replacement of bearing

2.1 Removal of roller bearing inner ring and ball bearing

- (1) The pliers are used for removing the C-type snap ring and the puller for removing the slinger and bearing.
- (2) For the roller bearing, apply a brass or copper plate to the outer ring and alternately hit it at diagonal positions on the circumference with a hammer to remove it from the shield. (Fig.18)
- (3) Pull out the ball bearing (Fig. 19) and roller bearing inner ring (Fig. 20) with a puller. In case of grease-replenish type structure, pull out above parts together with bearing inner cover and inside slinger.

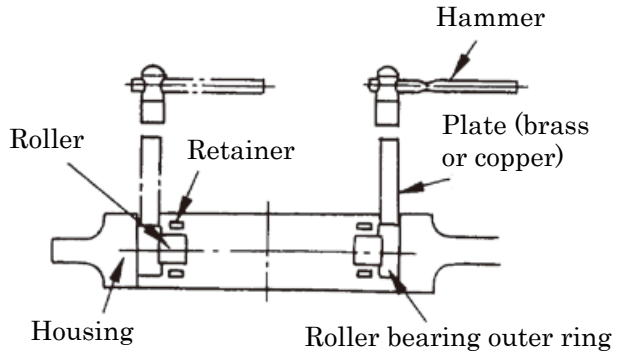


Fig.18 Removal of roller bearing outer ring

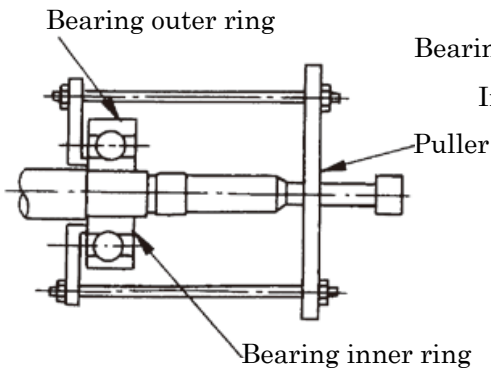


Fig.19 Removal of ball bearing

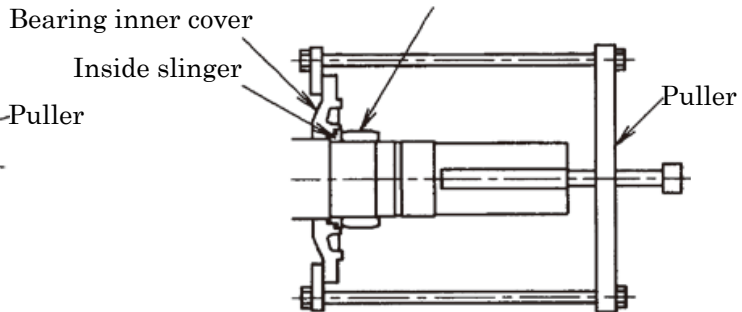


Fig.20 Removal of roller bearing inner ring

2.2 Mounting of bearing

- (1) New bearings packed and stored should not be unpacked until they are used.
- (2) Thinly apply the grease to the inner surface of the housing, in which the bearing is mounted.
- (3) Before insertion of bearing, mount bearing inner cover (if provided) and inside slinger (if provided) to the shaft. Similar to the bearing, make shrink fit of inside slinger to the shaft, referring item (4).
- (4) Heat the ball bearing or roller bearing inner ring in oil, thermostatic oven or by induction heater to about 80°C and insert it onto the shaft. Be careful not to over-heat it. For the shielded bearing, method of heating in oil should not be applied.
- (5) Filling quantity of grease for grease-replenish type In order to fill the grease in the clearance of the bearing itself and further in the grease injection passage, inject the replenishment quantity indicated on the name plate after assembling of rotary machine.

[Note]

After replacement of bearings of non-load side and load side (EDM27 or over), fit the stud (2 pcs.) to the holes for the bracket fitting bolt of bearing inner cover, before mounting of the bracket. By this work, bearing cover fitting bolt can be fitted easily. (See Fig.21)

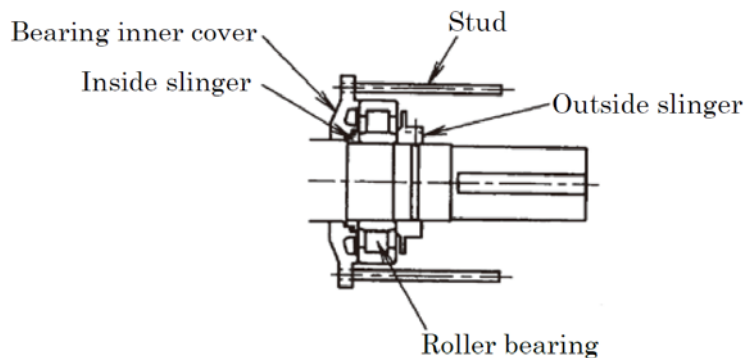


Fig.21

3. Structural drawing of motor

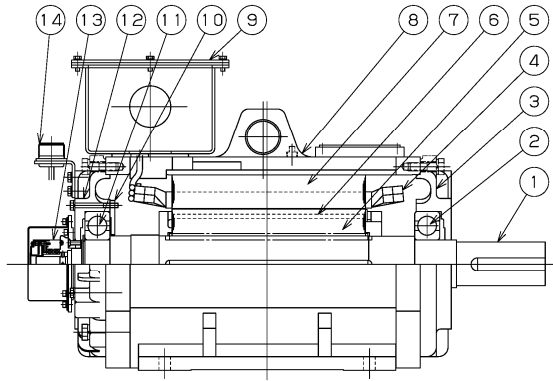


Fig. 22 Structural sectioned drawing of EDM 22***W

Table 9

No.	Name
1	Shaft
2	Load side double shielded ball bearing
3	Load side bracket
4	Stator coil
5	Rotor
6	Permanent magnet
7	Stator
8	Frame (Jacket structure)
9	Main terminal box
10	Non-load side bearing inner cover
11	Non-load side double shielded ball bearing
12	Non-load side bracket
13	Encoder
14	Encoder output cable connector

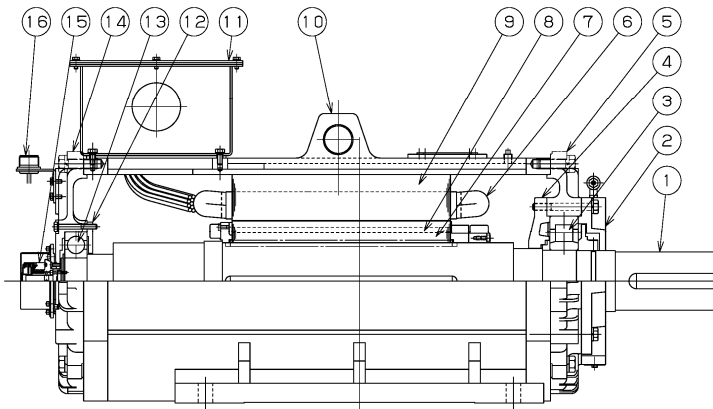


Fig. 23 Structural sectioned drawing of EDM27***W to EDM3541W

Table 10

No.	Name
1	Shaft
2	Load side bearing outer cover
3	Load side roller bearing
4	Load side bearing inner cover
5	Load side bracket
6	Stator coil
7	Rotor
8	Permanent magnet
9	Stator
10	Frame (Jacket structure)
11	Main terminal box
12	Non-load side bearing inner cover
13	Non-load side double shielded ball bearing
14	Non-load side bracket
15	Encoder
16	Encoder output cable connector

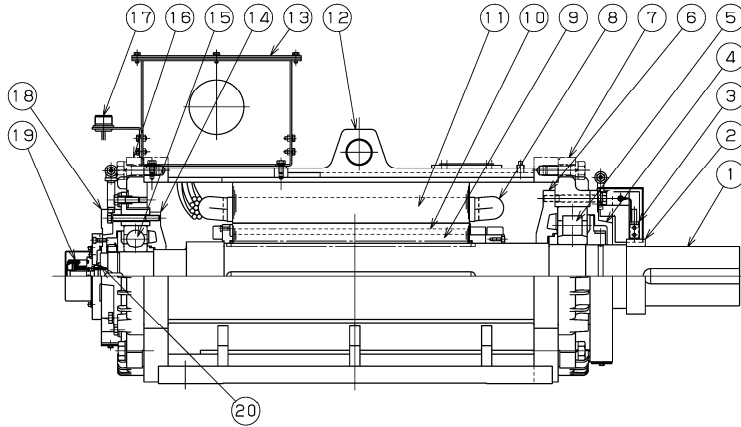


Fig. 24 Structural sectioned drawing of EDM3551W to EDM43**W

Table 11

No.	Name
1	Shaft
2	Slip ring
3	Earth brush
4	Load side bearing outer cover
5	Load side roller bearing
6	Load side bearing inner cover
7	Load side bracket
8	Stator coil
9	Rotor
10	Permanent magnet
11	Stator
12	Frame (Jacket structure)
13	Main terminal box
14	Non-load side bearing inner cover
15	Non-load side ball bearing
16	Non-load side bracket
17	Encoder output cable connector
18	Non-load side bearing outer cover
19	Encoder
20	V ring

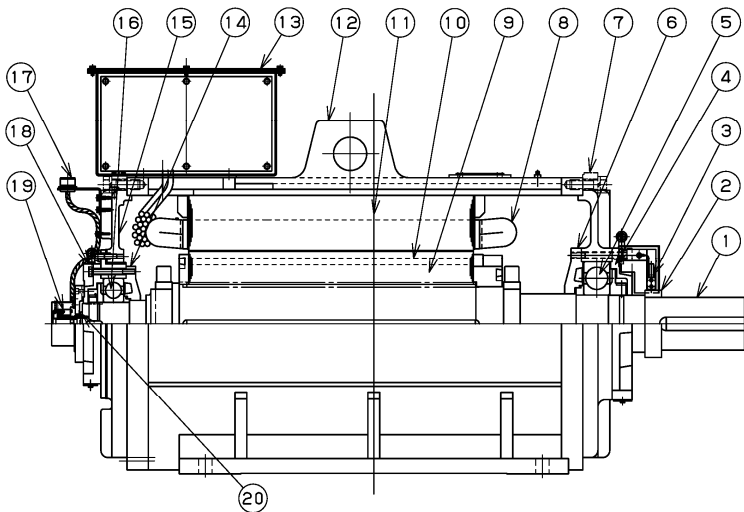


Fig. 25 Structural sectioned drawing of EDM54**W to EDM6851W

Table 12

No.	Name
1	Shaft
2	Slip ring
3	Earth brush
4	Load side bearing outer cover
5	Load side ball bearing
6	Load side bearing inner cover
7	Load side bracket
8	Stator coil
9	Rotor
10	Permanent magnet
11	Stator
12	Frame (Jacket structure)
13	Main terminal box
14	Non-load side bearing inner cover
15	Non-load side bracket
16	Non-load side ball bearing
17	Encoder output cable connector
18	Non-load side bearing outer cover
19	Encoder
20	V ring

VII. Troubleshooting of Motor

If the daily checking and periodical checking in " IV. Maintenance, checking " are correctly done, the motor satisfactorily works. Table 13 shows "Motor Troubleshooting" and Table 14 "Bearing Troubles and Causes". They should be referred to for daily maintenance/checking.

Table 13 Motor Troubleshooting

Cause		Phenomena	Shaft breakage	Loud noise/large vibration	Over heat		Uneven rotation	Protective relay operation	Leakage	Insulation resistance low	Remedy
					Motor	Bearing					
Installation	Place	Ambient temperature is high			⊙	○		⊙			Ventilate well
		Humidity is high							○	⊙	Consult maker
		Splashing of much water/oil					○		○	⊙	Prevent splashing
		Obstruction close to motor			⊙	○		○			Secure necessary space
		Large external vibration/impact		⊙		○					Vibration proofing
	Weak foundation		⊙								Strengthen it
Coupling with load	Direct coupling	Misalignment	○	⊙		○					Align correctly
		Large unbalance of coupling		⊙							Correct balance of coupling
	Belt	Misalignment of center between pulleys		⊙			○				Align the center
		Contact angle is small	⊙			○					Make proper pulley diameter
		Excessive tension of belt	⊙			⊙					Make proper belt tension
		Load point too away from motor	⊙			○					Put load point nearer the motor
		Large pulley impedes cooling air of motor			⊙			○			Provide vent hole for pulley
	Others	Dust on rotating portion		⊙		○					Remove dust
		Large axial load					⊙				Review axial
Wiring	Large voltage drop				⊙		○	⊙			Investigate wiring diameter/length
	Loosened terminals				⊙		○	○			Retighten terminals
	Incomplete earthing							○	⊙		Complete earthing
	Single-phase operation			⊙	⊙			⊙			Investigate connecting circuit
	Voltage unbalance			⊙	○			○			Investigate control side
	Wrong wiring of encoder							⊙			Change connecting circuit (If trouble occurs with encoder, replace it)
Load	Overload			○	⊙			⊙			Reduce load
	Large number of starts		○		⊙			○			Reduce number of starts
	Large inertia of load				⊙			○			Extend acceleration time
	Large vibration of counterpart machine			⊙							Investigate counterpart machine
	Large unbalance of load			⊙	○						Correct balance
Others	Bearing abnormality (motor)			⊙		⊙		○			Repair at specialized factory
	Disconnection of stator coil (motor)			○	○			⊙	⊙	⊙	Repair at specialized factory
	Abnormal bearing of encoder							⊙			Replace encoder
	Circuit failure of encoder							⊙			Replace encoder

Table 14 Bearing Troubles and Causes

Phenomena	Condition	Cause	Remedy
Flaking	① Flaking of rolling element	① Excessive interference ② Wrong selection of clearance ③ Operation clearance minus ④ Expansion due to temperature	① Caution in assembling or making shaft/bearing housing ② Review of clearance ③ Handling care in assembling ④ Investigation of service condition
	② Local flaking of raceway track	} Inclusion of dust, foreign matter or rusting/dent	Investigation of machining accuracy of shaft/bearing housing, investigation of tightening amount
	③ Flaking over entire circumference of raceway track		
	④ Flaking of place opposite to raceway track	① Elliptic distortion of shaft or bearing housing ② Faulty tightening ③ Faulty machining accuracy ④ Secular change, abnormal thrust load	Investigation of design of bearing surrounding
	⑤ Flaking over entire circumference off center of raceway track	① Warp of shaft ② Oblique installation of inner/outer rings	Investigation of design of bearing surrounding
	⑥ Flaking diagonally crossing raceway track		Investigation of service conditions
	⑦ Rolling element pitch-like flaking on raceway track		① Vibration during stoppage ② Rusting
Electrolytic corrosion	Crater-like concave, washboard-like flaw	Current passing	Investigation of design of bearing surrounding
Wear	① Extreme wear of raceway track/rolling element ② Wear of cage	① Foreign matter in lubricant ② Rusting	Investigation of lubricant and lubrication amount
Impression	① Concave (raceway track, etc.) ② Ground-like ③ Impact during handling ④ Flaw caused when assembling	Dust/foreign matter rolled between rolling element and raceway track Careless handling (dropping, etc.) Careless assembling	Investigation of working conditions when handling or assembling Careful handling Correct assembling
Damaged cage	① Damage ② Biased wear ③ Wear of pocket portion ④ Galling	① Moment load ② High-speed rotation ① Lubrication failure ② Foreign matter	Careful handling and review of service conditions Investigation of lubrication amount or lubricant
Seizure	① Discoloring/softening of raceway track ring/rolling element ② Damage	① Clearance is too small ② Insufficient lubrication ③ Improper lubricant Overload	① Investigation of proper clearance ② Investigation of lubrication amount and lubricant ③ Review of service conditions ④ Investigation of handling
Smearing	Galling of raceway track or rolling element surface	① Lubrication failure ② Inclination of rolling element (skewing) ③ Selection of lubricant	Investigation of lubricant/lubricating conditions
Creep	Wear, slipping, or discoloring of inside / outside diameter surface	① Insufficient interference of engagement ② Insufficient tightening of sleeve	① Investigation of tightening amount ② Investigation of machining accuracy of shaft/bearing housing ③ Design investigation
Cracking / chipping	① Cracking ② Mis-cutting	① Progress of impact/strike flaking ② Large interference Large R of installation	① Careful handling ② Investigation of tightening amount ③ Investigation of machining accuracy of shaft/bearing housing
Rusting	① Rusting over entire surface ② Partial rusting ③ Contact corrosion of engaged surface	① Wrong storage condition ② Leaving to stand ③ Improper cleaning ④ Rust preventive agent ① Improper packing ② Sweat ① Insufficient interference ② Fluctuating load	① Investigation of storage place ② Caution in handling ③ Investigation of rust preventive agent ① Review of machining of shaft-bearing housing ② Review of service conditions

Table 15 Trouble-shooting

No.	Details of defects	Cause	Treatment
1	Motor guard operates (Abnormal winding overheating)	Cooling water is not flowing. (Check with a flow meter.)	Refer to the cooling system's operating instructions for remedial action.
		The motor winding is faulty.	Repairs must be carried out in a specialized factory.
2	Noise at the bearing	Bearing is faulty.	The bearings need to be replaced.

VIII. List of recommended auxiliary equipment

Table 16

Type of motor	Sight glass	Flow switch	U-shaped strainer
EDM22**W	GKF13S-8A (WASINO KIKI CO., LTD.)	IFW5**-04-10 ^(**1) (SMC Corporation)	UOS-15A (WASINO KIKI CO., LTD.)
EDM27**W			
EDM31**W			
EDM35**W			
EDM43**W			
EDM54**W			
EDM68**W	GKF13S-20A (WASINO KIKI CO., LTD.)		UOS-20A (WASINO KIKI CO., LTD.)

(*1) Select the flow rate for the flow switch by referring to "Section II_7_Table 5 Cooling water quantity".

IX. Industrial Product Warranty

1. Free of Charge Warranty Period

The free of charge warranty period shall be “less than 1 year after installation in your company or your customers” or “less than 18 months after shipment from the factory or storage warehouse”, whichever comes first. In case of repair, overhaul or other maintenance by Toyo Denki or a company designated by Toyo Denki, the warranty period for the parts concerned shall be for 1 year from the date of acceptance inspection.

2. Warranty scope

(1) Problem diagnosis

As a general rule, initial diagnosis in the event of product failure should be performed by your company. However, if you request initial problem diagnosis, it can be performed on your behalf by Toyo Denki or a member of our service network. Please note that if Toyo Denki is not responsible for the cause of the failure, a fee will be charged for the initial diagnosis.

(2) Repair

Repair, part replacement, and onsite repair shall be provided free of charge. However, this shall not apply in the following cases:

- ① When the problem is a result of improper product handling, conditions, environment, usage method, etc., by you or your customer
- ② When the problem was caused by a system designed by you or your customer
- ③ When the problem was caused by deficiencies in a program created by you or your customer
- ④ When the problem originated in something other than the delivered product
- ⑤ When the problem was caused by modification performed without the prior approval of Toyo Denki
- ⑥ When the problem was caused by repair or modification performed by someone other than Toyo Denki or a company designated by Toyo Denki
- ⑦ When the problem was caused by a force majeure such as a natural disaster, fire, or accident.
- ⑧ Other cases where Toyo Denki is not responsible for the cause of the problem
- ⑨ The free of charge warranty period has expired

3. Disclaimer

Irrespective of whether the free of charge warranty period is in effect, this warranty shall not compensate you or your customer for any damages that are not the responsibility of Toyo Denki, or for any lost opportunity, lost profit, secondary damages, or accident due to the failure of the Toyo Denki product concerned. Moreover, compensation shall not be provided relating to articles other than the Toyo Denki product concerned.

4. Repair period after product discontinuation

Once the product has gone out of production, Toyo Denki will continue to provide repair service for the product for a period of seven years. However, please note that the procurement of electronic components for the product may become difficult during that time, and repair may not be possible.

5. Delivery conditions

In the case of standard products ordered without test operation and adjustment, delivery shall take place upon product arrival at your company, and Toyo Denki shall not be responsible for onsite test operation and adjustments.

TOYODENKI SEIZO K.K.

<https://www.toyodenki.co.jp/en/>

HEAD OFFICE: Tokyo Tatemono Yaesu Bldg, 1-4-16 Yaesu, Chuo-ku,
Tokyo, Japan ZIP CODE 103-0028

TEL : +81-3-5202-8132

FAX : +81-3-5202-8150

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