LVM-OM-E-002
(Rev.1)

Installation, Operation & Maintenance Manual of Low Voltage Motor

HYOSUNG HEAVY INDUSTRIES

Contents

1. Introduction

This manual does not cover all the details of the electric motor and related equipment, nor does it provide information on every possible situation that may arise during installation, operation, or maintenance. if you need additional information on a specific matter, please contact Hyosung Heavy Industries or your motor distributor

The information in this manual is intended for technicians qualified to install, operate, and maintain the motor. Assembly, operation, or maintenance must only be performed by qualified personnel. Engineers working with electrical power must be trained in safety, use the proper tools, and wear personal protective equipment.

Images, photos in the manual are for illustrative purposes only and may not represent the actual situation. Improper installation and operation of power equipment, without a proper understanding of the information in the manual, can result in serious harm to personal health and property. The manufacturer is not responsible for any of the above.

Any repairs, overhauls, or modifications made without the manufacturer's instructions will void the manufacturer's warranty, even if they are within the warranty period.

2. Safety Information

Employees working with motors should always prioritize safety and follow the guidelines below to prevent accidents.

- When using the motor, make sure to follow the local safety regulations in your area. You must also follow the precautions provided by the motor manufacturer, as well as the safety instructions for the machine you are using with the motor. Ensure that you follow the safety symbols and instructions on the motor, its packaging, and in the manual.
- Motors have rotating parts that can cause serious injury. Before performing any installation, repair, inspection, or maintenance, the motor must be disconnected from the power supply and brought to a complete stop to prevent accidental operation.
- Motors are installed in areas with high voltage, so be cautious of electric shock. The motor's surface may become very hot; exercise caution to avoid burns.
- Chemicals used to install, operate, and maintain motors can pose health risks, so follow safety precautions and wear personal protective equipment when handling them.
- Magnetic fields are generated during the operation of the motor. Do not use motors near medical devices, as they may cause malfunctions, data loss, or other issues
- Exercise caution when using motors in environments where explosive gases, dust, or fumes may be present. Make sure to carefully review the data sheet or nameplate of the motor, as it clearly specifies the hazardous areas where it can be used.

The following markings are used throughout the manual to emphasize certain conditions. Matters related to property damage are not included with a safety warning symbol. ‘Danger,’ ‘Warning,’ and ‘Attention’ are defined as follows. When multiple levels of risk exist, the strictest guidelines should always take precedence.

2.1 Danger

Describes imminent danger which could lead to death or serious injuries if care not taken.

2.2 Warning

Describes potential danger which could lead to death or serious injuries if care not taken.

2.3 Attention

Describes potential danger which could lead to injuries or property loss if care not taken.

3. Description

3.1 Purpose

This motor is designed to drive various industrial equipment and complies with NEMA MG1 standards. When using motors for non-industrial purposes, appropriate precautions must be taken to ensure the safety of nearby personnel. At this time, contact your local government agency for details on minimum requirements.

3.2 Degrees of protection

The motor is designed for the protection class indicated on the nameplate and can be installed in environments that are dusty or humid, as long as they meet the specified class. (Please refer to Table 3.1 for the degrees of protection)

Table 3.1 - Degrees of protection **(IP XX)**

1ST characteristic letters regarding Dust		2nd characteristic letters regarding Water	
0	Non-protected machine	0	Non-protected machine
1	Machine protected against solid objects greater than 50mm	1	Machine protected against dripping water
2	Machine protected against solid objects greater than 12mm	2	Machine protected against dripping water when tilted up to 15 degree
3	Machine protected against solid objects greater than 2.5mm	3	Machine protected against spraying water
4	Machine protected against solid objects greater than 1mm	4	Machine protected against splashing water
5	Dust-protected machine	5	Machine protected against water jets
6	Dust-tight machine	6	Machine protected against heavy seas

3.3 Installation Environment

The installation environment requirements for the motor are as follows. If your conditions exceed these standards, please contact Hyosung Heavy Industries or your motor distributor.

- Ambient temperature (max.): 104℉ (40℃)
- Altitude: ≤ 3,280 ft (1000 m)
- Humidity: ≤ 80 %
- Duty rating: Continuous (S1)

ATTENTION

If your installation environment exceeds these standard values, refer to section '7.4 Operating Conditions'. We are not responsible for any issues with the motor if it is used in an environment that exceeds our standards without prior approval.

4. Handling and Transport

For any direct, special, incidental or consequential damages to the motor or any characteristics arising from operations not mentioned in this document. Thus, damages due to improper storage, incorrect installation of the motor, or malfunction of the load equipment, any damage caused by the negligence of third parties are not guaranteed. Refer to section '12. Warranty' for items excluded from the warranty agreed upon with the customer.

4.1 Incoming inspection

We conduct basic tests on the product before shipment and only ship those that pass these tests. Upon receipt, please inspect the product for any damage that may have occurred during transportation. Check the ratings on the nameplate, especially kilowatt output, voltage, speed, frequency and protection and make sure that they are identical with the ordered item.

Hand-turn the shaft to see that it turns smoothly and also check the basic parts such as making sure there is no excessive play in the shaft. If there are any issues at all, immediately contact the distributor or Hyosung Heavy Industries.

4.2. Transportation

Motors with lifting lugs or eyebolts should always be lifted using lifting devices. Always use a suitable lifting device when lifting the motor. The eyebolt is designed to lift only the motor's weight, as specified on the nameplate.

The motor placed on the pallet must be lifted onto the pallet base, ensuring that the lifting device fully supports its weight. Do not drop the packaging, and handle the motor with care to prevent bearing damage.

⚠ WARNING

- The supplied eyebolts are designed to lift motors only. Do not use this eyebolt to lift the motor along with its base, pulley, pump, reducer, or any other attached components.
- Do not use a damaged, bent, or cracked eyebolt. Always check the condition of the eyebolts before lifting the motor.

If the contract does not specify the packaging method, the motor will be packaged based on its size, weight, and transportation method. Possible packaging options include cartons, pallets, skids, semi-enclosed, or fully enclosed packaging. Ensure compliance with the requirements for images displayed on the surface of the packaging for transportation.

4.3 Lifting

Before lifting, ensure that the eyebolts are fully tightened and securely fastened, and that the eyebolt face of the motor is in full contact with the frame. (Please refer to Figure 4.1 - 2)

Figure 4.1 - Correctly tightened

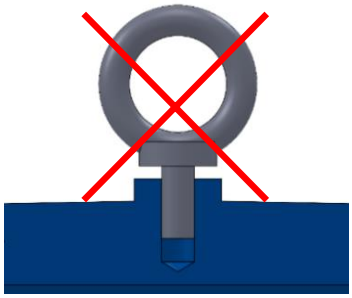


Figure 4.2 - Incorrectly tightened

⚠ WARNING

- Always use the designated eyebolt to lift the motor. Do not attempt to lift the motor using the shaft or carton box. It is crucial to use the proper eyebolt, as it is specifically designed for lifting the motor safely.
- Do not move the motor above the operator's head. When transporting it, ensure that it is kept close to the floor.

4.3.1 Horizontal type motor with one eyebolt

For lifting horizontal motors with only one eyebolt, the inclination angle must not exceed 30º from the vertical axis. (Please refer to Figure 4.3)

Figure 4.3 - Maximum allowable inclination angle for a motor with only one eyebolt

4.3.2 Horizontal motor with two eyebolts

If the motor has more than two eyebolts, all eyebolts must be used simultaneously when lifting the motor. The lifting chain or rope must remain vertical, and a spreader beam is recommended to protect the motor's surface. The maximum inclination angle of an electric motor equipped with two or more vertical lifting eyebolts according to Figure 4.4 shall not exceed 45° from the vertical axis.

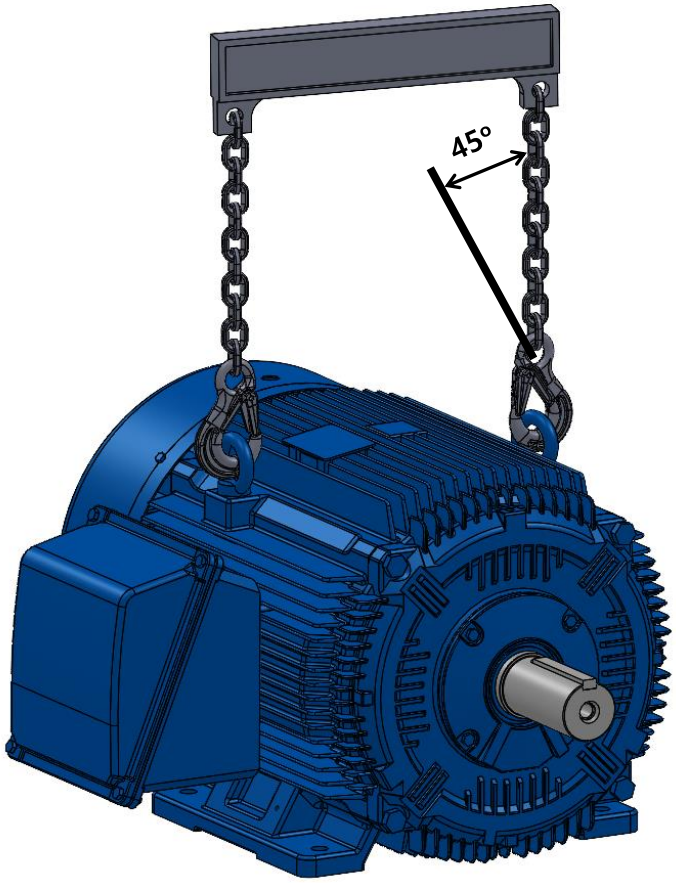


Figure 4.4 - Maximum allowable inclination angle for a motor equipped with two or more eyebolts

4.3.3 Vertical type motor

Vertical motors must be lifted using two lifting hooks simultaneously, and the lifting chain or rope must remain vertical. A spreader beam is recommended to protect the motor surface. If the motor is equipped with more than two eyebolts, all eyebolts must be used at the same time during lifting.

Figure 4.5 - Lifting a vertical type motor

⚠ WARNING

- The safe lifting of motors requires the use of a lifting device with adequate capacity to handle the weight and length of the motor.
- If the motor is lifted in any way other than as described in this manual, we cannot guarantee its safe lifting. We also cannot be held responsible for any issues that may occur.

5. Storage

The motor should be stored in a clean, dry, and well-ventilated area with minimal indoor vibration and little temperature variation (the ambient temperature should be between 50°F and 104°F, with humidity levels below 60%). Unless the motor is installed vertically, store it horizontally and do not place other objects on top of the motor.

If the motor is stored for an extended period, there is a possibility of rust forming on the machined surfaces, grease loss due to oil separation, or insulation degradation of the stator windings from moisture absorption. To prevent this from happening, make sure you do the following

- If you won't be using the motor for more than a month, or if it will be stored in a high-humidity area or a place where moisture and debris might get in, store the motor on a pedestal that's at least 4 inches high. Cover the motor with a waterproof cover, place a desiccant inside, and seal it. Make sure to change the desiccant regularly.
- The rust preventive coating is applied to help prevent rust. However, depending on the storage conditions, rust may still occur. To maintain protection, please reapply the rust inhibitor periodically (at least once a month).
- To prevent rust from forming on the bearings, rotate the shaft by hand for at least 10 full turns every two weeks after receiving the motor.
- When storing the motor for more than 6 months, rotate the shaft every 6 months to re-lubricate the grease. (Regrease the bearing after removing the grease outlet plug)
- If stored for more than two years, disassemble, clean, inspect, and then regrease the bearings. (Sealed bearings are recommended for change)
- Measure the insulation resistance every three months using a DC 500V class insulation resistance tester and properly maintain the insulation condition. (Please refer to Section '5.1.Insulation Resistance,' for instructions on measuring insulation resistance)
- When the motor is stopped, condensation may form inside and outside due to temperature differences between the interior and exterior. To prevent this, operate a space heater to keep the motor at least 9°F(5°C) warmer than the surrounding air. If a space heater is not available, regularly check the insulation resistance. If it falls below the specified value, use a secondary heater or another method to maintain the temperature.
- Do not stack more than two tiers high of motors packaged in cartons or wood, as this may damage the packaging. If your storage space is limited and you need to stack more than two tiers, use a storage rack to keep the weight off the motors.
- We are not responsible for any defects caused by improper storage due to failure to follow the instructions in this manual.

5.1 Insulation resistance

When storing or not in use, you must regularly measure the insulation resistance of the windings and record the measurement data. If the insulation resistance value falls below the reference value, take measures such as drying the motor windings or adjusting the storage conditions to restore the insulation resistance to the reference value or higher.

5.1.1 Measuring Insulation Resistance

Follow the procedure below to measure the insulation resistance.

(1) Prepare an insulation resistance tester
(2) Open the motor's terminal box. Using the insulation resistance tester, connect the red clip to the motor's lead wire and the black clip to the ground terminal or an unpainted area of the motor. Then, begin the measurement. (It is recommended to measure each phase separately, with each phase isolated. While measuring one phase, ensure that the other phases are grounded)
(3) Apply a direct current test voltage of DC 500V to the winding, wait for 1 minute, and then measure the insulation resistance. (If the OL indication appears on the insulation resistance tester before 1 minute, this is normal, as it indicates an infinite resistance greater than 1000 MΩ.)

Power supply cables and other external devices connected to the motor can influence the insulation resistance measurement. Therefore, they must be disconnected and grounded during the measurement.

When measuring insulation resistance, ensure that the power cable is disconnected and conduct the measurement in a safe environment.

5.1.2 Determining Insulation Resistance

The insulation resistance of the low-voltage motor stator windings must meet or exceed the reference value when measured with a DC 500V insulation resistance tester. Typically, a resistance of 5 MΩ or more at a winding temperature of 104°F is sufficient for safe use. Since the insulation resistance value decreases exponentially as the winding temperature increases, you can use the following equation to adjust the insulation resistance value according to the winding temperature. (Applied standards: IEEE Std 43)

$$R_C = K_T \times R_T$$

R_C: Insulation resistance (MΩ) at 104°F

K_T: Correlation coefficient of insulation resistance at

temperature T°F $[(0.5)^{(104-T)/18}]$

R_T: Insulation resistance at the measured temperature (MΩ)

T: Winding temperature at the time of measurement (°F)

To assist with the calculation, temperature-specific correlation coefficient values are provided in Table 5.1.

Table 5.1 - Insulation Resistance Correlation Factor (KT) for Different Winding Temperatures

Winding Temperature (°F)	Correlation coefficient K_T	Winding Temperature (°F)	Correlation coefficient K_T	Winding Temperature (°F)	Correlation coefficient K_T
33.8	0.067	69.8	0.268	105.8	1.072
35.6	0.072	71.6	0.287	107.6	1.149
37.4	0.077	73.4	0.308	109.4	1.231
39.2	0.082	75.2	0.330	111.2	1.320
41.0	0.088	77.0	0.354	113.0	1.414
42.8	0.095	78.8	0.379	114.8	1.516
44.6	0.102	80.6	0.406	116.6	1.625
46.4	0.109	82.4	0.435	118.4	1.741
48.2	0.117	84.2	0.467	120.2	1.866
50.0	0.125	86.0	0.500	122.0	2.000
51.8	0.134	87.8	0.536	123.8	2.144
53.6	0.144	89.6	0.574	125.6	2.297
55.4	0.154	91.4	0.616	127.4	2.462
57.2	0.165	93.2	0.660	129.2	2.639
59.0	0.177	95.0	0.707	131.0	2.828
60.8	0.189	96.8	0.758	132.8	3.031
62.6	0.203	98.6	0.812	134.6	3.249
64.4	0.218	100.4	0.871	136.4	3.482
66.2	0.233	102.2	0.933	138.2	3.732
68.0	0.250	104.0	1.000	140.0	4.000

The insulation resistance of the low-voltage motor should be assessed by comparing the corrected value at 104°F with the values in Table 5.2.

Table 5.2 - Evaluating Insulation Resistance

Insulation resistance(MΩ)	Acceptance
< 5	Dissatisfied
5 ~ 100	Insulation is degrading. Currently, the performance is satisfactory, but periodic checks should still be conducted.
> 100	Satisfied

If the insulation resistance is low, it could indicate the presence of moisture in the stator windings. In such cases, the product should be sent to a Hyosung Heavy Industries service center for proper inspection and repair. To improve insulation resistance by drying the motor, refer to section ‘8.4.3 Cleaning and Drying.’

6. Installation

Install the motor in a location suitable for the installation environment (refer to section ‘3.3 Installation Environment’). If the motor will be used at a high altitude or in an area with very low or high ambient temperatures, consult technical department of Hyosung Heavy Industries. The motor must be installed in a location with good ventilation, low dust and moisture, and easy access for inspection. Avoid locations with moisture, oil, or excessive external vibration.

Do not install an indoor type motor outdoors. if dust or moisture gets inside the electric motor, it can cause machine malfunctions and damage. Make sure to use a motor with the appropriate protection grade. Using a motor outside its rated protection grade may lead to damage, such as the inflow of foreign objects.

Check the items below before proceeding with the motor installation.

(1) Insulation resistance : The measured value must be within acceptable limit (refer to '5.1 Insulation resistance').

(2) Bearings: Check the grease condition, as well as for rust and noise caused by long-term storage. If the motor will not be operated immediately, manually rotate the shaft at least 10 times every two weeks to prevent oil separation of grease and rust.

(3) Terminal box: Ensure that the terminal box is properly sealed and that its interior is clean, dry, and free of corrosion. Ensure that the cable inlet is completely sealed and inspect the gasket for proper condition.
When assembling the terminal box cover, ensure that the gasket is securely fitted between the box and the cover to maintain the protection grade specified on the motor's nameplate.

(4) Cooling: Ensure that the frame cooling fins and cooling intake vents are clean and free from any external obstructions. Install the motor at least 8 inches away from walls or other obstacles. If sufficient clearance is not provided, cooling can be compromised, resulting in overheating and motor damage.

(5) Drain: If the motor has a drain plug on the load-side bracket or other locations, it is shipped from the factory with the drain plug closed. Users should periodically open the drain to release any accumulated condensation, then securely close it again.

If the motor is used in a hazardous area (such as environments with flammable or explosive gases, dust, etc.), ensure that the motor complies with explosion protection standards. Using a non-explosion proof motor may lead to explosions or fires, causing damage.

6.1 Foundation

The user is responsible for providing the necessary foundation for motor installation. To ensure optimal performance and longevity, the foundation should meet the following requirements:

(1) Smooth, level surface
   (a) It should be smooth, level, and as vibration-free as possible.
   (b) The foundation must be elevated above ground level and provide proper drainage.
   (c) It should be designed to prevent vibration from being transferred to the motor and avoid resonance.

(2) Surface uniformity of support
   (a) The foundation surface should provide uniform support for the motor foot or flange.
   (b) Precautions in design and installation must be taken to prevent motor frame deformation.
   (c) The level difference between the surfaces supporting the motor foot or flange should be within ±0.004 inches.
   (d) The motor should be rigidly supported on all four feet without any vibration. If there is a height difference between the feet, shim plates can be used if necessary.

(3) Resonance prevention
   To ensure the safe operation of the motor, a stable foundation is required, as well as a resonance margin for the natural frequency of the entire system. (E.g.: motor + bed + foundation + pipes, etc.) A resonance margin of at least 20% must be maintained at the frequencies corresponding to the motor's 1X RPM, twice the 1X RPM (2X), and twice the motor's power frequency (2FL).

6.2 Mounting

When mounting the motor to the load, secure it to a stable, level foundation using strong feet or flanges. Ensure the motor is properly aligned and level with the driven machine. Incorrect alignment or leveling can cause excessive vibration, potentially damaging the bearing.

When tightening the bolts for mounting the motor and assembling the base, do so carefully to avoid misalignment or damage to the machine. The threaded mating length of the bolts used for assembly should be at least 1.5 times the diameter of the bolt.

To correct any flatness deviations during mounting, the motor must be leveled. The leveling can be carried out by using compensation shims.

If a metallic base is used to adjust the height of the motor shaft end to match that of the driven machine, ensure that only the metallic base is leveled in relation to the concrete base. Record the maximum leveling deviation in the installation report.

6.3 Balancing

The motor is shipped standardized for balancing with no-load operation. The required special balancing quality level must be specified in the purchase order. Before assembling power transmission components such as pulleys and couplings onto the motor shaft, they must first be balanced with a half-key. Record the maximum balancing deviation in the installation report.

6.4 Connection and alignment of the motor

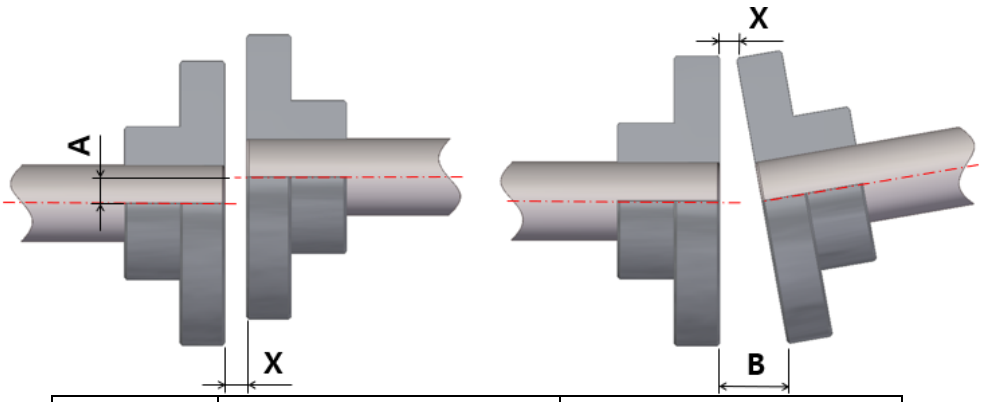
Proper alignment of the motor is critical to reduce vibration, damage to bearings and couplings. If you have

instructions from the coupling manufacturer, follow the coupling manufacturer's instructions for assembly and alignment.

(1) Direct coupling type

The motor center and the driven machine axis must be properly aligned. When mating shafts and couplings, apply the specified lubricant and gently insert them using a resin hammer to avoid impact and damage. Couplings that must be forcibly fitted onto the shaft should be heated with a heater before being pressed onto the shaft.

The motor shaft must be accurately aligned, both axially and radially, with the driven machine shaft using the appropriate tools and equipment, such as dial gauges and laser alignment instruments. If the coupling manufacturer's instructions are unavailable, it is recommended to base the connection tolerance of the coupling on Figure 6.1.



Tolerance	Rigid Coupling (in)	Flexible Coupling (in)
A	≤ 0.00118	≤ 0.00197
B	≤ 0.00118	≤ 0.00157
X	0	Coupling manufacturer's instructions

Figure 6.1 - Direct coupling alignment

(2) Belt Type

Align the shaft ends of the motor and the driven machine so that the centers of the pulleys are in line with each other and in perpendicular with the shafts. (Please refer to Figure 6.2)

In general, the closer a pulley, sheave, sprocket, or gear is mounted to the bearing side of the motor shaft, the less load it places on the bearing. The center point of the belt or system of V-belt must not be beyond the end of the motor shaft. The inner edge of the sheave or pulley rim should not be closer to the bearing than the shoulder on the shaft, but it should be positioned as close to this point as possible. The outer edge of the chain sprocket or gear must not go beyond the end of the motor shaft.

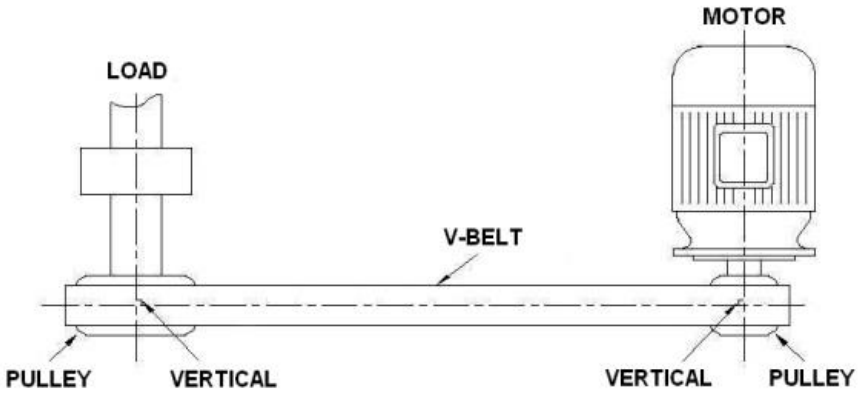


Figure 6.2 - Belt Pulley Alignment

When mounting shafts and pulleys, apply lubricant and gently tap them into place with a resin hammer or a similar tool to prevent impact and damage. Belt tension and pulley diameter significantly affect the bearing life and shaft strength of the motor, so it's important to install these components according to their specifications.

Set the belt tension to the initial tension by running the belt 3 to 4 times after installation. After 24 hours of operation, readjust the belt tension to account for initial elongation. Afterward, check the belt and adjust the tension every 3 months. Recommend that you record the maximum alignment deviation in the installation report.

ATTENTION

- If the motor is driven by a belt, select the pulley according to the standard specifications. Please refer to Table 6.1.
- Ensure proper belt tension and check the parallelism of the pulleys. Devices driven by any type of belt must be equipped with a protective guard to prevent injury from the belt.
- Do not belt-couple a high-speed, 2-pole motor with a capacity greater than 10 HP to a motor intended for direct coupling only. This coupling can cause the shaft rupture and result in an accident.

Table 6-1 - Recommendation on V-Belt and V-Pulley selection

Motor		Standard V-belt				Narrow width V-belt			
Rated Output (HP)	Pole	Belt Type	Number of Belt	Diameter of Pulley Pitch (in)	Width of Pulley rim (in)	Belt Type	Number of Belt	Diameter of Pulley Pitch (in)	Width of Pulley rim (in)
0.5	2	A	1	2.953	0.787	3V	1	2.795	0.685
1		A	1	3.150	0.787	3V	1	2.795	0.685
2		A	2	3.150	1.378	3V	1	2.953	0.685
3		A	2	3.543	1.378	3V	1	2.953	0.685
5		A	3	3.543	1.969	3V	2	2.953	1.091
7.5		A	3	4.409	1.969	3V	3	2.953	1.496
10		A	3	5.197	1.969	3V	4	3.150	1.902
0.5	4	A	1	2.953	0.787	3V	1	2.795	0.685
1		A	1	3.150	0.787	3V	1	2.795	0.685
2		A	2	3.543	1.378	3V	2	2.953	1.091
3		A	2	3.937	1.378	3V	2	2.953	1.091
5		A	3	4.409	1.969	3V	2	3.937	1.091
7.5		B	3	4.921	2.480	3V	3	3.937	1.496
10		B	3	5.906	2.480	3V	3	4.921	1.496
15		B	4	6.299	3.228	3V	4	4.921	1.902
20		B	5	6.693	3.976	3V	6	4.921	2.713
25		B	5	7.874	3.976	3V	6	5.512	2.713
30		B	5	8.819	3.976	3V	6	6.299	2.713
40		C	5	8.819	5.354	5V	4	7.087	3.067
50		C	6	8.819	6.358	5V	4	7.874	3.067
60		C	6	10.433	6.358	5V	4	8.819	3.067
75		C	7	10.433	7.362	5V	5	8.819	3.756
100		C	8	12.402	8.366	5V	6	9.843	4.445
125		-	-	-	-	5V	6	9.843	4.445

Motor		Standard V-Belt				Narrow width V-belt			
Rated Output (HP)	Pole	Belt Type	Number of Belt	Diameter of Pulley Pitch (in)	Width of Pulley rim (in)	Belt Type	Number of Belt	Diameter of Pulley Pitch (in)	Width of Pulley rim (in)
0.5	6	A	1	3.150	0.787	3V	1	2.795	0.685
1		A	2	3.150	1.378	3V	1	2.953	0.685
2		A	2	3.937	1.378	3V	2	2.953	1.091
3		A	3	3.937	1.969	3V	2	3.543	1.091
5		B	3	4.921	2.480	3V	3	3.937	1.496
7.5		B	3	5.906	2.480	3V	3	5.512	1.496
10		B	4	5.906	3.228	3V	4	5.512	1.902
15		B	5	6.693	3.976	3V	5	5.512	1.902
20		B	5	8.819	3.976	3V	6	6.299	2.713
25		C	4	8.819	4.350	5V	3	7.087	2.378
30		C	5	8.819	5.354	5V	4	7.087	3.067
40		C	5	10.433	5.354	5V	4	8.819	3.067
50		C	6	10.433	6.358	5V	4	8.819	3.067
60		C	7	11.024	7.362	5V	5	8.819	3.756
75		C	8	11.811	8.366	5V	6	9.843	4.445
100		D	6	13.976	9.173	5V	6	12.402	4.445
125		D	6	15.748	9.173	5V	6	13.976	4.445
150		D	7	15.748	10.630	8V	4	13.976	4.874
175		D	7	18.701	10.630	8V	4	15.748	4.874

6.5 Electrical Connection

The motor control circuit, overload protection device and grounding are to be in accordance to relevant electric standards. Wiring and connection must be done and verified by qualified personnel.

Verify that the voltage and frequency supplied match the specifications on the motor nameplate. When connecting the lead wires in the terminal box, ensure proper insulation for electrical safety.

⚠ WARNING

- The electrical connection must follow the diagram provided on the nameplate. (Please refer to Table 6.2)
- Always disconnect the power before starting work. Do not bend or pull the lead wires by force as it may cause fire or electric shocks from internal short circuit.
- The regulations regarding electrical connections always take precedence over the connection guidelines.

⚠ WARNING

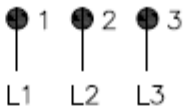
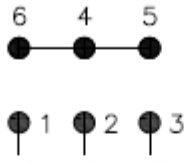
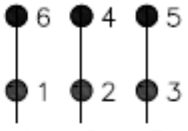
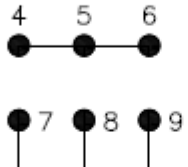
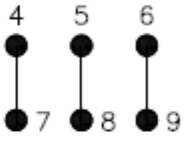
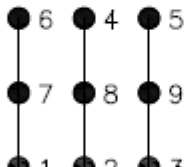
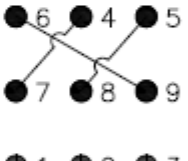
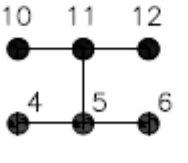
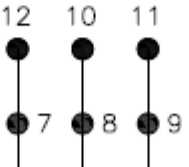
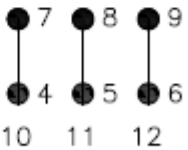
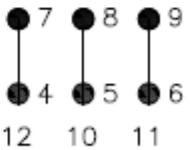
- For terminal voltage (e.g. 230/460V) or Y-△ starters, refer to the wiring diagram on the nameplate and connect according to the applicable LOW/HIGH voltage or START/RUN configuration. Otherwise, incorrect connections may damage the motor.
- For Y-△ starter motors, start with the Y connection and operate with the △ connection. If the operation in continued with Y, it may cause voltage drop, overload and overheating, potentially resulting in motor damage. When operating the motor with Y-△, it must be △ connected when it is direct on line.

- In particular, be cautious not to link the wires incorrectly due to linked wires(terminal voltage, double voltage, Y-D, where the lead wires are not 3 strands) in the terminal block.

⚠ ATTENTION

- Y-Δ Connection must be made at the control panel.
- When using a Y-Δ starter, a switch must be installed on the primary circuit and it must be left open when not in use.
- When continuous power is supplied to the motor's primary circuit, creeping discharge may deteriorate and damage the insulation. So be cautious at all times. (Apply 3 contactor method by primary circuit electro-magnetic switch.)

Table 6.2 - Standard wiring diagram for a three-phase induction motor

Qty. of Leads	Connection Diagram	
3		
6	 YY (START)	 △ (RUN)
9	 YY (LOW VOLTAGE)	 Y (HIGH VOLTAGE)
	 △△ (LOW VOLTAGE)	 △(HIGH VOLTAGE)
12	 YY (START)  △△ (RUN) LOW VOLTAGE	 Y (START)  △ (RUN) HIGH VOLTAGE

If the motor is equipped with a terminal block, refer to Table 6.3 for the correct procedure when connecting the power cable. Ensure that the nuts are tightened securely to prevent the terminal lugs on both the power source and the motor from loosening.

table 6.3 - Tightening torque of terminal block (brass bolt)

Stud/Nut Nominal Diameter	Tightening torque (lb-ft)
M4	0.89~ 0.96
M6	2.21~ 2.44
M8	4.43~ 4.87
M10	7.38~ 8.11
M12	10.33~ 11.37

If the motor does not come with a terminal block, first fasten the motor terminal lugs and the power source terminal lugs securely using bolts and nuts to prevent disconnection. After securing them, insulate the cable terminals with an appropriate insulating material that complies with the supply voltage and insulation class specified on the nameplate.

⚠ WARNING

- In particular, be cautious not to link the wires incorrectly due to linked wires (terminal voltage, double voltage, Y-D, where the lead wires are not 3 strands) in the terminal block.
- Applying excessive force beyond the specified tightening torque may cause the terminal block to break during tightening.

⚠ ATTENTION

- After completing the wiring, ensure that no tools or debris are left inside the terminal box. Then, securely close the terminal box cover. There is a risk of electric shock.
- Take the necessary precautions to ensure the protection level specified on the motor nameplate is maintained.
- Any unused cable inlets in the terminal box must be properly sealed with blanking plugs.
- Ensure that the terminal box cover is properly closed and sealed to prevent moisture and dust from entering.
- Cable entries used for power supply and control must be equipped with components (cable glands, conduits) that meet the applicable standards and regulations in each country.

6.6 Connecting Accessories

If the motor is equipped with accessories such as a thermal protection device (Pt100, Thermistor, Thermostat, etc.), space heater, brake, vibration sensor, encoder, or other components, follow the instructions on the accessory nameplates when connecting them to the control device. Failure to follow this procedure can result in damage to the motor and void the product warranty.

6.6.1 Resistance Temperature Detector (Pt100)

Pt100 sensors are made of platinum, and their resistance changes with temperature, providing accurate temperature measurements. The ‘100’ refers to the sensor's resistance of 100 ohms at 32°F (0°C), which is one of the values recognized as an international standard and is the standardized resistance value for Pt100 sensors. This value serves as a reference point for measuring the motor's temperature. As the temperature of the sensor changes, the temperature is determined by measuring the corresponding change in resistance. (Refer to Table 6-5 for resistance values at different temperatures.)

Pt100 sensors are installed individually, one for each phase (the quantity can be adjusted based on customer requirements). Wire the system as shown in Figure 6-3.

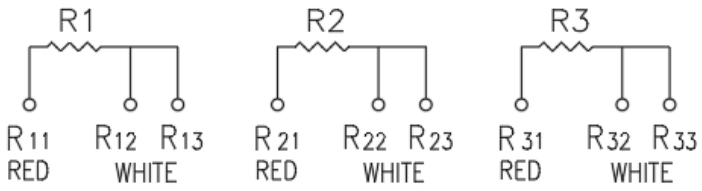


Figure 6.3 - Pt-100 Wiring Diagram

The alarm and trip temperatures for the motor's windings and bearings can be adjusted based on the customer's control scheme, but the trip temperatures must not exceed the values listed in Table 6.4.

Table 6.4 - Maximum Allowable Temperatures for Thermal Protection

-	Temperature rise	Maximum allowable temperature (°F)	
		Alarms	Trips
Winding	Class B	248	266
	Class F	293	311
Bearing	ALL	203	221

Table 6.5 - Equivalence between the Pt-100 resistance and the temperature (unit: Ω)

Temp. °F	0 0	1.8 1	3.6 2	5.4 3	7.2 4	9 5	10.8 6	12.6 7	14.4 8	16.2 9	Temp °C
-58	80.31	79.91	79.51	79.11	78.72	78.32	77.92	77.52	77.12	76.73	-50
-40	84.27	83.87	83.48	83.08	82.69	82.29	81.89	81.50	81.10	80.70	-40
-22	88.22	87.83	87.43	87.04	86.64	86.25	85.85	85.46	85.06	84.67	-30
4	92.16	91.77	91.37	90.98	90.59	90.19	89.80	89.40	89.01	88.62	-20
14	96.09	95.69	95.30	94.91	94.52	94.12	93.73	93.34	93.95	92.55	-10
32	100.00	99.61	99.22	98.83	98.44	98.04	97.65	97.26	96.87	96.48	0
Δ°F -	0 0	1.8 1	3.6 2	5.4 3	7.2 4	9 5	10.8 6	12.6 7	14.4 8	16.2 9	- Δ°C
32	100.00	100.39	100.78	101.17	101.56	101.95	102.34	102.73	103.12	103.51	0
50	103.90	104.29	104.68	105.07	105.46	105.85	106.24	106.63	107.02	107.40	10
68	107.79	108.18	108.57	108.96	109.35	109.73	110.12	110.51	110.90	111.29	20
86	111.67	112.06	112.45	112.83	113.22	113.61	114.00	114.38	114.77	115.15	30
104	115.54	115.93	116.31	116.70	117.08	117.47	117.86	118.24	118.63	119.01	40
122	119.40	119.78	120.17	120.55	120.94	121.32	121.71	122.09	122.47	122.86	50
140	123.24	123.63	124.01	124.39	124.78	125.16	125.54	125.93	126.31	126.69	60
158	127.08	127.46	127.84	128.22	128.61	128.99	129.37	129.75	130.13	130.52	70
176	130.90	131.28	131.66	132.04	132.42	132.80	133.18	133.57	133.95	134.33	80
194	134.71	138.88	135.47	135.85	136.23	136.61	136.99	137.37	137.75	138.13	90
212	138.51	142.67	139.26	139.64	140.02	140.40	140.78	141.16	141.54	141.91	100
230	142.29	146.44	143.05	143.43	143.80	144.18	144.56	144.94	145.31	145.69	110
248	146.07	150.22	146.82	147.20	147.57	147.95	148.33	148.70	149.08	149.46	120
266	149.83	153.96	150.58	150.96	151.33	151.71	152.08	152.46	152.83	153.21	130
284	153.58	157.70	154.33	154.71	155.08	155.46	155.83	156.20	156.58	156.95	140
302	157.33	161.43	158.07	158.45	158.82	159.19	159.56	159.94	160.31	160.68	150
320	161.05	165.14	161.80	162.17	162.54	162.91	163.29	163.33	164.03	164.40	160
338	164.77	168.65	165.51	165.89	166.26	166.33	167.00	167.37	167.74	168.11	170
356	168.48	172.54	169.22	169.59	169.96	170.33	170.00	171.07	171.43	171.80	180
Δ°F -	0 0	1.8 1	3.6 2	5.4 3	7.2 4	9 5	10.8 6	12.6 7	14.4 8	16.2 9	- Δ°C

6.6.2 Thermistor

As the winding temperature increases, the resistance change of the device is minimal. However, beyond a certain temperature, it exhibits a positive thermal coefficient (PTC) characteristic, where the resistance changes increase significantly. These thermistors are typically used with a Relay Unit (or 'controller'), which disconnects the mains power. Therefore, it is essential to use a Relay Unit with the correct specifications.

Use three thermistors in series, one for each phase (the quantity and installation method can be adjusted based on customer requirements). Wire the system as shown in Figure 6-4.

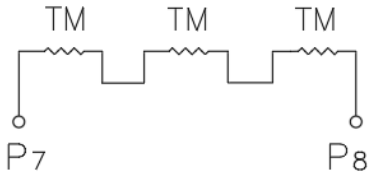


Figure 6.4 - Thermistor Wiring Diagram

Refer to the temperature-specific resistance values of the thermistors in Table 6.6 to set up the Relay Unit.

Table 6.6 - Resistance Values by Thermistor Temperature

Temperature rise	Reference Temperature (°F)	Reference Temperature - 9°F (Ω)	Reference Temperature +9°F (Ω)	Reference Temperature +27°F (Ω)
Class B	266	≤ 1650	≥ 3990	≥ 12000
Class F	302	≤ 1650	≥ 3990	>12000

6.6.3 Thermostat

Bimetals use 'B' contacts (normally closed contact), which are flat before current flows. When current passes through and the bimetal reaches a certain temperature, it bends and the contact opens.

Use three thermistors in series, one for each phase (the quantity and installation method can be adjusted based on customer requirements). Wire the system as shown in Figure 6-5.

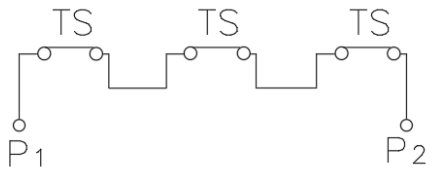


Figure 6.5-Thermostat Wiring Diagram

Refer to Table 6.7 Thermostat Operating Temperature

Table 6.7 - Thermostat Operating Temperatures

Temperature rise	Operating temperature (°F)	Return Temperature (Reference, °F)	Note
Class B	248±9	170.6±27	250 Vac
Class F	284±9	190.4±27	250 Vac

6.6.4 Space Heater

To protect motor windings from internal condensation and moisture during storage and after operation, a space heater is installed. Refer to Figure 6.6 below for the wiring diagram of the space heater.

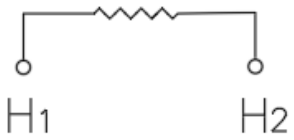


Figure 6.6 - Space Heater Wiring Diagram

Our space heaters use conductive carbon particles arranged in an infinite parallel circuit, rather than traditional resistance elements. It provides a self-regulating feature that adjusts heat output according to changes in ambient temperature. With this feature, an inrush current—ranging from 2 to 5 times the rated current—may occur for a few seconds when power is applied. This may cause a protective fuse to blow.

During cold winter conditions when the ambient temperature is low, a higher current may be drawn to generate a large amount of heat quickly. To address this, we recommend the following: Increase the fuse capacity, use a time-delay fuse, or replace the fuse with a circuit breaker designed for wiring.

⚠ WARNING

Do not supply power to the space heater while the motor is operating.

⚠ WARNING

Do not apply voltage or current exceeding the allowable limits for each accessory.

6.7 Start-up Method

As for start of the motor, DOL (direct on line) is recommended at rated voltage. However, if high staring current caused by DOL affects to the power source, you can use indirect starting method as it is compatible with voltage over load and motor to reduce starting current. Using a reduced voltage starter allows decrease in start torque of the motor, so please choose right starting way as refer to the below Table 6.8.

Besides, DOL is available through motor connection even you use different types of voltage starter.

Table 6.8 - comparison on voltage, starting torque, and current according to different starting methods.

Starting method		Voltage	Starting Torque	Start Current
Full voltage starting		100%	100%	100%
Y-△Starting		57.7%	33.3%	33.3%
Starting compensator (AUTO Tr.)	80% TAP	80%	64%	64%
	65% TAP	65%	42%	42%
	50% TAP	50%	25%	25%
Resistance-start motor (general) (adjust 80% of previous voltage)		80%	64%	80%
Reactors	50% TAP	50%	25%	50%
	45% TAP	45%	20%	45%
	37.5% TAP	37.5%	14%	37.5%

Note) The voltage, torque, and current is percentage value under DOL start at rated voltage

6.7.1 VFD (Variable Frequency Drive) Start

If the motor has to operate with variable frequency drive (VFD) for the purpose of efficiency, power factor control and other reasons, the operation has to comply with described standard according to NEMA MG1 Section 4 Part 31 and service condition as written on nameplate (voltage, current, frequency range, etc.).

When inverter is used, please conduct additional review on the following items to avoid burnout of motor

(1) When it comes to VFD (variable frequency drive), it has to be chosen appropriately according to motor's power and power supply condition (e.g. Voltage, and current capacity, etc.).
(2) We recommend an inverter switching frequency as a range from 2.5 kHz to 5 kHz. If you use excessively beyond the range, inverter noise can occur, so please reach to the inverter supplier (company) when you are faced the situation.
(3) To prevent electric shock, the motor, VFD, metal conduit, and all metal parts have to be connected to grounded circuit.
(4) If the motor and VFD has a distance between them, reflected wave results in increase of micro surge voltage, leading to the motor's breakdown; therefore, the VFD has to be placed close to the motor as much as possible. Cable distances are for reference only and can be further limited by hot and humid environments (refer Table 6.9). if the power lead distance is exceeded, appropriate protective measures must be taken to protect the motor, such as installing a surge filter.

Table 6.9 – Max. Cable distance from VFD output to motor (For reference only)

Switching Frequency	380V	460V	575V
2.5 kHz	220 ft	130 ft	50 ft
5 kHz	160 ft	100 ft	40 ft

(5) Proper gauge, and the shortest length of conductor as much as possible are used, and metal conduit is used for construction. In addition, shielding of the conductors can reduce electromagnetic interference with other electronic equipment.

(6) It is recommended that using different types of filter (e.g. dv/dt filter, common mode filter, etc.) on inverter to prevent the motor's breakdown and electrolytic corrosion on bearing derived from high level of surge voltage of inverter.

(7) When you operate the motor with VFD, winding insulation is going to be weaken as the motor temperature climbs up due to harmonics. Also, do not operate beyond the operating frequency range indicated on the nameplate; because, operation under low frequency will increase the temperature due to lack of the motor's cooling capacity.

(8) As to equipment operated with motor, it has its own resonant frequency; if the rotation speed is changed with VFD, the equipment can make loud vibration and noise at a junction(matching) point. Sometimes, it causes damage to the equipment. If the resonance cannot be avoided, there is an inverter's jump function possible to avoid the resonance as letting the inverter's output frequency (it is resonance frequency) moves up and down.

(9) The output waveform of VFD, it is a power source based on pulse type unlike with commercial power source; due to the switching frequency making this waveform of the power source, it makes electronic noise of the motor. Noise reduction measures when using VFDs include changing the carrier frequency, attaching noise filters, and separating the power and control lines.

⚠ WARNING

- Always follow the VFD manufacturer's safety instructions before operating the motor with VFD. Even power is not provided to VFD, high AC and DC voltage exist in VFD. To keep away from damage to humans, refer to VFD operation instructions.
- Proper programming of VFD parameter is the most critical point. Read and understand the VFD manufacturer's instruction manual. Use the data on the motor nameplate. VFD programming should only be performed by qualified personnel.

7. Operation

Repeated starts can overheat the motor and cause burnout. If you carry out starting work repeatedly, please make sure to secure sufficient time to allow the motor to be cooled down in-between the start to prevent the overheating. Under no load condition, check the rotation status while the motor operates; verify whether abnormal noise of bearing exist or not. If excessive noise, vibration, and abnormal sounds (repeated clicking sounds or hitting sounds, etc.) are heard, please stop the motor operation promptly and reach to Hyosung Heavy Industries or distributor where sold the motor to you.

If an abnormal heating phenomenon occurs during operation, it should be checked whether the temperature rise limit is exceeded. If test run is fine, please operate the motor from min. load and increase the load gradually.
After completion of installation, please operate it as checking the detail items according to the following procedures

7.1 Pre-inspection before operation

(1) Does the axis rotate smoothly when it is turned with a hand?
(2) Is the lubricating oil is adequate?
(3) Are there any spots missed their bolts?
(4) Is the cooling fan attached and free of breakage?
(5) Are instruments, safeguards, etc. fully functional?
(6) Does insulation resistance (incl. Lead wires) stand over its standard value (criteria)? .
(See '5.1 Insulation resistance')
(7) Does the wiring match with the wiring diagram on the nameplate? (See '6.5 Electrical Connection')
(8) Is an emergency suspension possible?
(9) Did you establish any contact system?
(10) Do you have enough operation personnel? (headcount, and capabilities)
(11) Is the power supply voltage adequate?
(12) Have you checked the recorded past commissioning performance?

7.2 Checklist under operation

(1) Is the rotation direction appropriate?
(2) Are there any abnormal sound, and irregular sounds?
(3) Is there a strange odor(smell)?
(4) Are the starting time and starting current enough?
(5) Is vibration shown within acceptable control range? (See '7.5 Vibration')
(6) Is there any abnormalities in power system?

7.2.1 Rotation Direction

In terms of standard motor's rotation direction, from the view of load, it rotates counterclockwise way Check the rotation direction as operating the motor under no load connection environment; if the desired direction is not observed, please change the two phases of power source to conduct connection work, then the rotation direction will be changed. At that time, if that is a case of directional fan which rotates in a certain regular direction, you have to re-assemble it again as changing the rotation direction. if necessary, please discuss the issue with Hyosung Heavy Industries or distributor where sold the motor to you.

⚠ WARNING

- If the power goes out amid of its operation, be sure to turn off the power switch. If the power is recovered, re-starting can be made automatically; so unexpected accident can occur accordingly.
- Be careful with your hand and your body to be contacted with surface of operating (ongoing) motor as it is hot. You may suffer burn damage.

⚠ ATTENTION

- Do not operate the motor above rated voltage value written on nameplate. It may be burnt out due to overload operation.
- If it does not start within 15 seconds (based on DOL) after power is applied, please cut the power first of all. If over-current is applied continuously, the motor can be burnt out. If you need more detailed information on starting issues, please reach out Hyosung Heavy Industries or distributor where sold the motor to you.

7.3 Note (Important Points) after operation

Repeated starting can lead to overheating of the motor, and result in burnout damage. If you do restart, make sure you leave enough time between restarts to prevent overheating.

If general motor is operated under repeated rating condition (S3 and higher) continuously (even the general motor is made for operation under continuous rating (S1)), it can shorten life of the motor and burnout damage because of thermal impact. It has to be operated with the following frequency: 1 HOT/ 2 COLD per day; the operation should not exceed the designated number of operation, and its time according to its specification. If starting frequency is frequent, please contact with Hyosung Heavy Industries and distributor who sold the motor to you. If grease is filled overly amid of the operation, bearing temperature and vibration can rise temporally; and after a period of time, sometimes it stabilizes itself; in this case, this is not a failure of the motor.

If you do not operate the motor for a long time, please control and manage the motor according to '5. Storage' to prevent corrosion and insulation degradation.

7.4 Operating Condition

Unless otherwise specified on the order form, the motor is designed and built to operate at altitudes up to 3280 ft. above sea level and in max. temperatures ranging from 104°F (See '3.3 Installation Environment'). If there are any specification beyond normal condition, the information will be written on motor and nameplate.
If ambient temperature and altitude surpass the specified values, some components need to be changed. To apply special function which goes beyond installation environment condition, please reach out to Hyosung Heavy Industries or distributor who sold the motor.

If temperature and altitude of motor installation location are worse than their standard; the motor has to be operated with reduced output (P_{max} = P_{nom} x correction factor) by multiplying correction factor (written in Table 7.1) and rated output together.

Table 7.1 - Correction Factors depending on Ambient Temperature and Altitude Variations

Ambient temperature (°F)	Correction Factor for Standardized Ratings	Altitude (ft)	Correction Factor for Standardized Ratings
104 or less	1.0	3,280 or less	1.0
over 104-113	0.96	over 3280-4921	0.97
over 113-122	0.92	Over 4921-6562	0.94
over 122-131	0.87	over 6562-8202	0.90
over 131-140	0.82	over 8202-9843	0.86
		over 9843-11483	0.82
		over 11483-13123	0.77

Note) 1. If ambient temperature and altitude are applied in an overlapped way, multiply by their respective correction factors.
2. The value is a reference value; Hyosung Heavy Industries is not accountable for any problems and issues occur amid of operation.

If the motor power supply voltage and frequency fluctuate within the following range (refer to NEMA MG 1 Part12), it will not affect operation, but it may cause performance change and temperature increase that differ from the nameplate characteristics.

- ±10% of rated voltage at rated frequency
- ±5% of rated frequency at rated voltage
- The combined change in voltage and frequency is 10% of the rated value (sum of absolute values), provided that the change in frequency does not exceed ±5% and the change in voltage does not exceed ±6% of the rated voltage.

⚠ WARNING

If the motor is cooled by ambient air, clean the air inlet, outlet and cooling fins regularly to ensure air flows over the frame surface. Hot air should never be returned to the motor. The cooling air must be room temperature, limited to the temperature range shown on the motor nameplate.

7.5 Vibration

Vibration from the motors can shorten winding insulation and bearing life. Before installing the motor, measure the vibration under no load to ensure that it meets Garde A in Table 7.2 below.

If the measured vibration value is greater than the limit value, please contact Hyosung Heavy Industries or distributor. After the installation on the utilization equipment, if the measured vibration exceeds its management criteria, make sure to check the installation environment including connection with utilization equipment, levelness of bed, looseness of fixed section of bolt.

Table 7.2 - Unfiltered Housing Vibration Limits

NEMA Frame Size		NEMA Frame ≤ 210		NEMA Frame > 210	
Vibration Grade	Mounting	Displacement (mils, pk-pk)	Velocity (in./s, pk)	Displacement (mils, pk-pk)	Velocity (in./s, pk)
A	Resilient	2.4	0.15	2.4	0.15
	Rigid	N/A	N/A	1.9	0.12 *0.15
B	Resilient	1.0	0.06	1.6	0.10
	Rigid	N/A	N/A	1.3	0.08 *0.10

※ This level is the limit when the twice line frequency vibration level is dominant as defined in NEMA MG 1 Section 1, Part7 Clause 7.8.5

7.6 Bearing Noise

Ball and roller bearings have their own noise (race noise, click noise). These are considered normal noises; as for problematic noise on performance includes cage noise, squeal noise, flaw noise, and contamination noise.

(1) Normal noise (Race noise)
It is a continuous sound caused by the ball rotating the inner race and outer race. This is the noise seems like wind sound regardless of rotation number.

(2) Normal noise (Ball Drop noise, Click Noise)
It is a noise occurring in horizontal type; it is made as the ball placed on the bearing drops and touches to retainer and inner race amid of rotation. It does not occur amid of operation but it happens when number of rotation is decreased. In particular, this noise is shown before stop; therefore, if it resonates with bracket, it can make loud noise though it does not play a negative role in operation.

(3) Retainer noise (Cage Noise)
This is the noise produced when the retainer, ball, and inner race and outer race touch together at the same time; it includes irregular noise which has a no relation with a number of rotation. If happens on bearing which has big gap as made for high speed machine; when grease is filled, it will dissipate or lower; but, even after filling the grease, if the noise gets louder, you'd better to check the issue.

(4) Squeal Noise
It is created due to irregular operation of non-load area, and it relates with lubrication condition of

grease and gaps, and others; there is a bearing prevent to squeal noise but it does not avoid it fully. If it does not involve vibration, it is understood that no issue to operate(use). Generally, there are many cases disappearing the noise only with grease filling. In this case, consider the bearing is in normal condition. In some cases, the noise gets louder as resonating with bracket likewise drop noise.

(5) Flaw Noise

It is a noise showed when flaw or crack occur on inner race and outer race as well as ball, and etc. Its cycle is proportional to a number of rotation. In general, it entails vibration, but possible to detect as it has longer cycles before it stops. In addition, when you rotate the rotor slowly with your hand amid of its stop, you can detect there's marks (flaws) on certain area.

(6) Contamination Noise

It is a noise which is created as foreign matters enter inside of bearing; it has big cycle and many cases it is irregular. If the noise is not removed and remained; it can get flaws, therefore, you need to pay attention on the noise. The noise is likely to happen if assembling is conducted at unclean environment.

7.6.1 Bearing Noise Troubleshooting

When it comes to trial run of the motor, depending on grease condition inside of bearing, sometimes you may face with increase of bearing noise or squeal noise and others irregularly. In this case, please check the issue according to below Table 7.3.

Table 7.3 - Checkpoint when bearing noise occur

	Grease-filling type bearing	Shield(shielded) type bearing
1	Under operation condition, fill up 1/2 amount of grease as instructed on grease nameplate, and after operating the motor for 20-30 minutes, then inspect it.	After operating the motor for 20-30 minutes, then inspect it (Depending on bearing temp. rise, as the hardened grease's lubrication gets smooth, then noise can be removed)
2	As for C3 class bearing, after carrying out load operation more than 30 minutes then inspect it. → If the noise is eliminated, it is normal phenomenon due to the characteristics of the C3 bearing.	
3	In case of inverter-fed operation, the power source will be supplied with direct way to operate, and inspect it. → If the noise is eliminated, it is not a defect of motor but is inverter noise.	
4	Disconnect the power source amid of operation, then inspect it while the rotation is maintained without power source. → If the noise is removed, it is an electrical sound; you should contact Hyosung Heavy Industries or distributor.	
5	Disassemble utilization equipment and connected coupling, operate it under no-load condition, and inspect it. → If the noise is eliminated, utilization equipment and alignment check are required.	

※ If noise disappears amid of grease filling, please stop the filling work; within 30min, if the noise occurs again, please fill the grease additionally.

※ Noise can happen during initial operation period or because of hardening of grease which is filled in bearings under low temperature; if the bearing temperature rise under operation, then noise can be removed as the grease lubrication becomes smooth.

※ In terms of C3 bearing, it has bigger clearance than standard specification under cooling condition; it is a designed product to equip with excellent stability as it takes optimized clearance under thermal expansion. When load operation carries out more than 30mins, the noise can be eliminated; this is bearing's features rather than flaw of the motor.

8. Maintenance

The maintenance is necessary for reliable operation and extended service life of the motor. All repairs, including disassembly and assembly, must be performed by qualified and trained personnel as using proper tools and techniques. Hyosung Heavy Industries assumes no responsibility or liability for any repair service or maintenance work performed by unauthorized service centers or unqualified personnel for the service work.

Before your work, please make sure that the machine is stopped, and all wires connected to power source (e.g. lead lines of accessories, and of the motor) are disconnected from the power supply device. Regarding repeatedly-used load operation, it can play a negative role significantly to winding insulation and life of the rotator as it creates lot of far more heat rather than consecutive load operation. Thus, in case of repeated use of load, if standard motor, which is not designed based on its features, can cause burnout of winding. For more detailed information, please reach out to Technical department of Hyosung Heavy Industries

If an abnormal heating phenomenon of the motor occurs, stop the operation of the motor; and inspect the issue in accordance with '11. Troubleshooting' In terms of excessive noise and vibration should be identified and eliminated. According to '11. Troubleshooting', please inspect the motor.

Establish a regular inspection plan to check the operating condition of the motor, focusing on cleanliness, insulation, bearing condition, vibration, etc. to carry out inspection action.

⚠ WARNING

- Always disconnect power before conducting maintenance works with the product and opening terminal covers. There is a risk of electric shock.
- Do not randomly machine parts and use them. If it is used by randomly machining/producing the product, it can cause abnormal operation; it may result in serious personal injury or property damage. If client/user modify the product, we do not take any responsibilities as it goes beyond a scope of our warranty.

8.1 General inspection

Conduct inspection over the motor and coupling visually. Check for unusual noises, vibrations, excessive heating, signs of wear, misalignment, or damaged parts. Replace damaged parts as needed. Refer to the checklist below to establish general checklist items and procedures to perform periodic checks.

(1) Clean the sheath of motor. Remove oil spills and dirt from the surface of the motor frame to ensure better heat transfer.
(2) Refer to '5.1 Insulation Resistance' to measure the insulation resistance.
(3) Check the cooling fan condition and clean the air inlet and outlet to allow air to flow freely to the

motor surface.

(4) Inspect the condition of the seal and replace it if necessary.

(5) Drain the condensate inside the motor. After draining, reassemble the plug to ensure the level of protection indicated on the motor's nameplate.

(6) Check the connection of the power supply cable and ensure the correct clearance between the area with current flowing and grounded area.

(7) When tightening the bolts, verify that the tightening torque of the bolts meets the tightening torque criteria specified in Table 8.1.

Table 8.1 - Motor tightening torque by bolt strength (lb-ft)

Bolt Size	Pitch	Strength (4.8)		Strength (8.8)		Strength (12.9)	
		Min. Torque	Max. Torque	Min. Torque	Max. Torque	Min. Torque	Max. Torque
M3	0.5	0.4	0.5	0.8	0.9	1.2	1.5
M4	0.7	0.9	1.1	1.8	2.1	2.9	3.4
M5	0.8	1.9	2.2	3.6	4.3	5.9	6.9
M6	1	3.2	3.8	6.2	7.3	10.0	11.8
M8	1.25	7.8	9.1	15.0	17.6	24.3	28.5
M10	1.5	15.4	18.1	29.7	35.0	48.0	56.5
M12	1.75	26.8	31.5	51.8	61.0	83.8	98.6
M14	2			82.5	97.0	133	157
M16	2			129	151	208	245
M18	2.5			177	208	286	337
M20	2.5			251	295	406	477
M22	2.5			342	402	552	650
M24	3			434	511	702	826
M27	3			635	747	1026	1208
M30	3.5			862	1.14	1394	1640
M33	3.5			1173	1380	1897	2232
M36	4			1507	1773	2436	2866

(8) Check the condition of gasket inside of terminal box and cable gland gasket; if necessary, replace them.

(9) Verify the bearing operating conditions. Verify whether it has abnormal noise, vibration or other abnormal operation condition (e.g. Motor temp. rise). Check the grease condition and compare the operating time with the known lifetime.

(10) Record and archive all the changes you have made to the motor.

8.2 Lubrication

If the bearing of motor is sealed type from the factory, sufficient grease is filled with the bearing for lubrication though if the bearing is open type, it may need to fill the grease up depending on the condition.

In case of open type rolling bearing enabling grease filling, you need to refill the grease and use it as certain time passes depending on surrounding environments and conditions. See 8.2.1 for standard grease specifications of Hyosung Heavy Industries. See Table 8.2 for standard refueling intervals and top-off amounts.

The purpose of smooth lubrication of bearing is prevention of bearing accidents caused by severe friction; you have to control and manage the bearing away from grease contamination and penetration of foreign matters. As much as possible, avoid grease mixing, also in case of having poor surrounding environment, control and manage it by shortening the grease refilling cycle. Especially, as for cases of having poor surrounding environments and vertical installation condition of the motor, please carry out maintenance activities as shortening the refilling cycle written on Table 8.2.

Under low and high temperature environment as significantly different from general ambient temperature condition, you need to have discussion with technical department of Hyosung Heavy Industries. When it comes to refilling grease, it is recommended that open the oil drain plug and carry out the work as the motor is being stopped. If you need to refuel amidst of operation, you have to refuel with proper amount; keep in mind that excessive refueling allow grease to be entered inside of the motor, showing impact on winding insulation and others.

Table 8.2 - Grease Refill Cycle

Bearing No.	Initial filling volume (oz)	Refueling amount amidst of operation (oz)	Refilling Cycle (hr.)			
			2 Pole	4 Pole	6 Pole	8 Pole
6212	2.3	1.1	1200	4000	6500	9000
6222	11.3	2.5	-	1500	3500	5500
6312	3.5	1.4	1200	3500	6000	8000
6313	4.2	1.6	1200	3000	5500	7500
6314	5.3	1.8	1200	3000	5000	7000
6316	7.4	2.1	1200	2500	4500	6500
6317	8.5	2.3	-	2500	4000	6000
6319	11.3	2.6	-	1500	3500	5500
6311	2.8	1.2	1200	3500	6000	8500
6320	13.1	2.8	-	1500	3500	5000
6322	18.0	3.2	-	1000	3000	4500
NU313	3.5	1.6	-	1500	2500	3500
NU314	4.2	1.8	-	1500	2500	3500
NU315	4.9	1.9	-	1000	2000	3000
NU316	5.6	2.1	-	1000	2000	3000
NU317	6.3	2.3	-	1000	2000	3000
NU318	7.4	2.5	-	1000	2000	2500
NU319	8.8	2.6	-	900	1500	2500
NU320	10.3	2.8	-	800	1500	2500
NU324	19.4	3.5	-	500	1000	2000
NU220	6.5	2.1	-	1000	2000	3000
NU222	8.8	2.5	-	1000	2000	3000
NU224	11.1	3.0	-	800	1500	2000

※ As to grease refueling cycle, it may vary according to service environment and load conditions.

※ On the motor, if grease refueling information nameplate is attached, the information on the nameplate is put before any others.

8.2.1 Specification of Standard Grease

In terms of grease for bearing having grease refueling type, it features with the followings: excellent bearing lifetime, corrosion-resistance, and low noise by using Polyrex EM made by Mobil as it contains mineral oil and thickener in polyurea family. To replace and refill the grease, when it mixes with grease made based on different thickeners (e.g. Lithium) it may degrade lubrication performance due to chemical reaction; therefore, we do not recommend you the mix as there is a chance to face with bearing damage or occurrence of accident. As for details in specifications, see below table 8.3

.

Table 8.3 - Properties Table of Standard Grease

Name of grease		Polyrex EM
Manufacturer		Mobil
Color		Blue
Layout	Base oil	Mineral oil
	Thickener	Polyurea
Key Properties	Viscosity [cSt]	113
	Consistency [NLGI grade]	2
	Dropping Point [°F]	410
	Oil Separation [%], Test Value	1

At the installation site, if Polyrex EM is not prepared, follow the options: use other grease using Polyurea-based thickener, or rill new grease as removing fully the remained grease inside of channel of lubrication and bearing as the existing grease used. The grease must contain corrosion and oxidation inhibitors. It you are required to use non-standard grease because of environmental conditions and others, please contact Hyosung Heavy Industries or distributor.

8.2.2 Grease Injection (filling)

In terms of grease injection, please fill the grease complying with the following procedures.

(1) Stop the motor operation.

(2) Remove the grease drain plug on the bottom of the motor.

(3) Remove the protective cap from the grease nipple on the top of the motor.

(4) Check the bearing number and use a manual grease gun to inject the grease, referring to Table 8.2. Slowly rotate the shaft by hand to allow the injected grease to spread into the bearing, and remove any excess grease that escapes. (If the motor has a separate grease nameplate and sticker, we put the greasing standards on the nameplate and sticker before any others)

(5) After the motor operation, as 10-15min past, tighten the drain plug.

(6) Wipe off any unused and excess grease, and securely close the grease nipple cap.

※ If you need to refuel amid of operation, make sure to use the proper amount to fill. In case of over-fueling, it can cause grease to get inside the motor and affect winding's insulation, and others.

8.2.3 Greasing in the event of bearing noise

If bearing noise occurs amidst of the motor operation, please inject grease as following the below instructions.

(1) Remove the protective cap from the grease nipple on the top of the motor.

(2) According to the grease refilling cycle as shown in table 8.2, fill the grease gradually up to 50% of refilling amount, then fill it until the noise disappears. Then, as checking the bearing noise condition with stethoscope for 10 to 20 minutes, if the noise occurs again, you have to fill it additionally (if the noise does not disappear even you inject grease additionally, default of bearing is assumed, so please replace the bearing as sticking with the procedures shown in 8.3.

(3) With regard to oil left as it could not be filled, you need to wipe off and put the cap back of grease filling plug.

8.2.4 Grease filling under re-start after shutdown (stop)

When the motor is restarted after its shout-down (stop), you have to fill the grease according to the following procedures.

(1) If the motor is not operated for 2-3months, check whether grease oil flows down on the bottom of the motor (oil separation); if there is oil on the bottom, fill the 25% of initial oil filling amount according to table 8.2.

(2) If bearing noise happens as the motor is restarted, fill the grease step by step up to 50% of refilling amount, then fill it up until the noise is gone. At that time, around 30 minutes, check the bearing noise condition with stethoscope stick.

※ Oil Separation: This is a phenomenon happens when the motor is shut-down and stored for a long time, as the grease's oil is separated from thickener, and seeps on surface of grease. If the motor is stored for more than 6 months after installation, it should be refilled with grease while rotating the axis every 3 months.

⚠ WARNING

Insufficient grease due to under-filling, and excessive grease filling can cause bearings to overheat, leading to bearing failure.

8.3 Bearing replacement

Bearing replacement should be performed by qualified and trained personnel using the appropriate tools and techniques, using the procedures below.

8.3.1 Preparation before work

The preparation for replacing a bearing is described as follows.

Fixtures, tools, Jigs, and materials	Worker
• Spanner(Wrench) Set • Socket Wrench Set • Snap ring plier • Gear Puller • Crowbar • Rubber mallet • Liquid Silicone	• Wear personal protective equipment • Review the work instruction • Prepare jigs and materials

8.3.2 Working Procedures

8.3.2.1 Frame Size 320T or smaller

Refer to the part names, shapes, and location in Figure 9.1 and follow the procedure below.

(1) Shut off the power, and disconnect the power line inside of terminal box and lead wire of the motor.
(2) If the motor is equipped with grease-lubricated type bearings, remove the grease inlet/outlet components from the motor.
(3) For bearing replacement from non-drive side, dismantle hood and cooling fan.
  (a) Loosen the hood retaining bolts and dismantle the hood from bracket of non-drive side.
  (b) Remove the snap ring from the shaft using snap ring pliers, then detach the cooling fan.
(4) Release bracket assembling bolts from drive/non-drive sides; dismantle bracket from frame and bearing.
  (a) In terms of dismantling bracket, the separation is much easier by using crowbar and others on the gap.
  (b) Disassemble the non-drive end bracket.
  (c) Remove the drive end bracket from the stator together with the rotor assembly.
  (d) On the bracket of load side, the snap ring for retaining end play is assembled inside of housing; so bracket has to be dismantled after removing the snap ring with snap ring plier.
(5) Use the gear puller to disconnect the drive/non-drive side bearing. (See Figure 8.1)

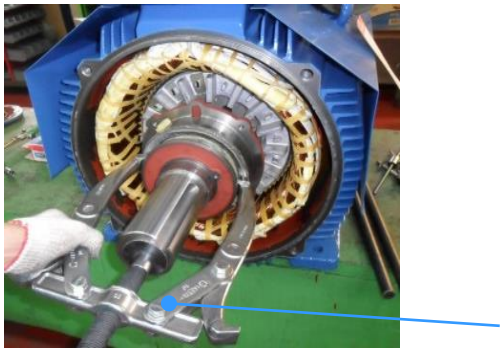


Figure 8.1 - Bearing Removal

(6) After removing the bearings, clean the shaft of any foreign matters.
(7) Insert new bearing into the shaft.
  (a) As for bearings with an inner diameter of 40 mm or less, use a jig and tap with a rubber mallet. For bearings with an inner diameter greater than 40 mm, assembly is performed using an induction heating machine or by shrink fitting.
  Here, keep in mind to avoid putting high temperature or excessive shock on bearing.
  (b) As for bearing from load side, insert snap ring for end play fixation first, then put bearing.
(8) After cleaning bracket bearing housing area, then apply small amount of grease on housing to have easy assembling. To satisfy IP degree, apply silicone to frame joint section.
(9) Temporarily assemble the bracket onto the bearing so that it is level, then lightly tap the bracket with a rubber mallet or an aluminum rod to complete the assembly.
  (a) Assemble the snap ring for securing end play on the drive end bracket.
  (b) At the bracket from non-drive side, insert wave washer and assemble it.
(10) After tightening the bracket assembly bolts, remove any silicone that has squeezed out.
(11) Assemble cooling fan and hood from non-drive side.
(12) In case of grease filling type, assemble the grease inlet/outlet components.
(13) After completion of bearing replacement, check whether any abnormalities are shown related to bearing noise by operating the motor with no-load condition. Also, measure vibration.

8.3.2.2 Frame Size 360T or larger

Refer to the parts name, shapes, and locations of Figure 9.2, and perform it in accordance with the below procedures.

(1) Shut off the power, and disconnect power line inside of terminal box and lead wire of the motor.
(2) Disassemble the grease inlet/outlet components from the motor.
(3) For bearing replacement from non-drive side, dismantle hood and cooling fan.
  (a) Loosen the hood retaining bolts and dismantle the hood from bracket of non-drive side.
  (b) Remove the snap ring from the shaft using snap ring pliers, then detach the cooling fan.
(4) Remove the fastening bolts of the inner/outer bearing cap.
(5) Release bracket assembling bolts from drive/non-drive sides; dismantle bracket from frame and bearing.
  (a) In terms of dismantling bracket, the separation is much easier by using crowbar and others on the gap.
(6) By using snap ring plier, remove the snap ring for securing the slinger, then detach the slinger form the shaft. (applicable to 400T and above)
(7) When it comes to bearing separation, it is the same as the procedures shown in (5) - (6) in 8.4.2.1.
(8) The new bearing will be inserted to the shaft with induction heating machine or shrink fit.
  At this time, pay attention to do not put high temperature as excessive impact on the bearing.
(9) Assemble slinger and snap ring for fixation to the shaft.
(10) After cleaning bracket bearing housing area, then apply small amount of grease on housing to have easy assembling. To satisfy IP degree, apply silicone to frame joint section.
(11) Temporarily assemble the bracket onto the bearing so that it is level, then lightly tap the bracket with a rubber mallet or an aluminum rod to complete the assembly.
  (a) At the bracket from non-drive side, insert wave washer and assemble it.
(12) Assemble the inner and outer bearing caps to the bracket (The outer bearing cap is applied to models with 400T or larger)
(13) The subsequent assembly is the same as steps (10) through (13) in 8.4.2.1.

8.4 Disassemble, inspect, and repair the motor

Disassembly/assembly and repair of the motor must be performed by qualified and trained personnel using the appropriate tools and techniques in accordance with the procedures below. See Figure 9.1-2 for the name, shape, and location of each part.

8.4.1 Initial inspection

(1) Visually inspect the exterior of the motor for broken parts, and turn the shaft by hand to see if it turns.
(2) After powering it off, open the terminal box cover and disconnect the power line and motor lead wires.
(3) Measure and record the insulation resistance and wire-to-wire resistance at the motor lead wire terminals.
(4) Record the installation conditions, including alignment and leveling, and others before disassembling the motor.

8.4.2 Disassembly

(1) Turn the power off.
(2) Open the terminal box cover.
(3) Disconnect all wiring connected to the motor
(4) Uncouple the motor from the load.
(5) Remove the motor base retaining bolts.
(6) Transport it to the disassembly site.
(7) Disassemble the terminal box.
(8) Disassemble the related components in accordance with procedure ‘8.3.2 Working Procedure'
(9) Detach the bracket from the frame.
(Be careful not to damage the iron core or windings when disassembling)
(10) Disconnect the slinger from the shaft. (Applies limited to frame size is 360T and higher)
(11) Separate the stator and rotor.
(12) After disassembly, check the following points and replace any defective parts with new ones.
(a) Visually inspect the motor for any broken parts inside the motor.
(b) Check for rust caused by internal condensation.
(c) Check the bearing rotation status.
(d) As for replacement of bearing, refer to ‘8.3 Bearing replacement’ to replace it.
(e) After removing the bearing, check the dimensions of bearing mounting area on the shaft.
(f) Check bearing housing’s inner diameter’s tolerance of bracket.

8.4.3 Cleaning and drying

As for the motor operated for a long time, dust or contamination matter having oil content can pile up in and outside of the motor depending on installation environment and operation status and others. Thus wash up and clean up the motor as following the below methods.

(1) As for general cleaning by using high pressure washer, it is recommended cleaning with water. When it comes to cleaning, pay attention to avoid penetration of water inside of the motor. To

remove piled dust and dirt inside of the motor, you can avoid damage of internal components or insulation of winding as using the vacuum cleaner using compressed air. As to a far severe dust or winding contaminated with oil content, it has to be wiped off with cloth by using solvent. The solvents have a low flash point and are hazardous to humans, you have to make sure to be careful to use it.

(2) In terms of rust inside of the motor due to condensation, it has to be removed with sandpaper or brush. At that time, pay attention to avoid any damages for internal components of the motor.

(3) After removing the bearing, in cases of corrosions detected from the rotator, you have to put proper countermeasures such as repairing, replacement and others.

(4) With regard to drying of stator and rotor, it has to be dried up with using hot air heater; this turn, the heating temp. should not exceed 194°F(±18°F); also the drying has to be made fully for around 8-10 hours.
After completing the drying process, the cooling is made at room temperature. In terms of stator, measure the insulation resistance according to '5.1 Insulation resistance.' If the measured resistance does not meet the criteria in Table 5.2, repeat the drying process. If the insulation resistance does not improve even you carry out multiple drying processes, you'd better to find out the cause of the lowered resistance level. If the damage is severe, you have to replace windings.
As for cases having difficulties to understand cause of the issue or doubts regarding winding damage, reach out to Hyosung Heavy Industries or distributor.

8.4.4 Assembling

Conduct the assemble in a reverse way of dismantling that you did. When it comes to replacement of grease filling type bearing, refill the grease according to Table 8.2 after cleaning the bearing housing.
After the assembling work, measure insulation resistance and line-to-line resistance, and compare the measured value with recorded values. If you recognize that is qualified product, check noise and vibration of the motor as operate the motor under no-load condition.
If necessary, paint the motor in accordance with motor specification. Hyosung Heavy Industries standard color is 0.5PB 3.2/4.4.

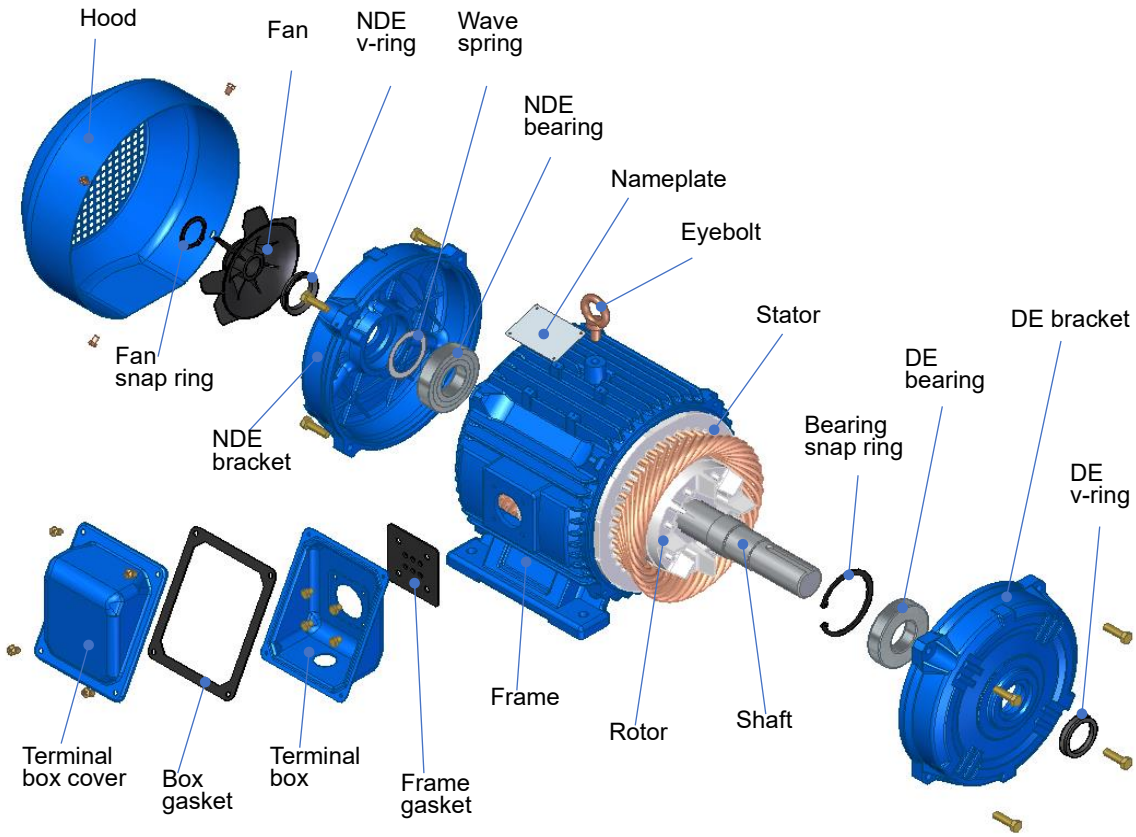
⚠ ATTENTION

- It is extremely dangerous for one person to dismantle and assemble alone. Please make sure to carry out the work with no less than 2 people.
- In terms of disassembling, please organize the parts in orders to avoid confusion amid of assembling work.
- With regard to important components (e.g. Bearing, winding, etc), make sure to do not put damage (penetration of foreign matters, impact, etc.) them.
- When it comes to dismantling and assembling, perform the works by expert. There are risks including electric shock, injury, fire, burnout and others.

9. Spare Parts

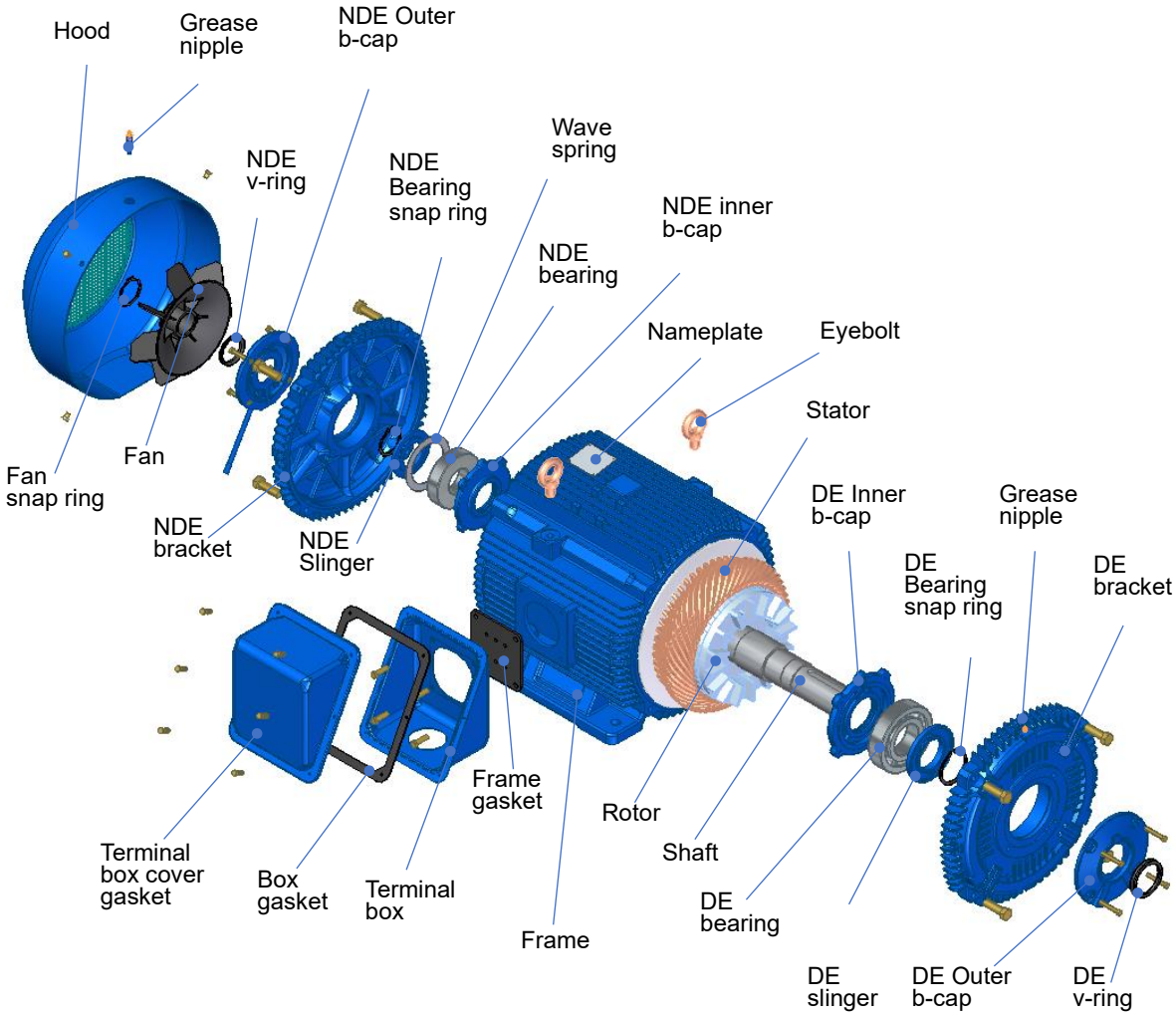
When you placing an order of spare or repair parts, you need a information of the motor's model serial number, manufacturing number written on the nameplate of the motor and parts name (see Figure 9.1,2).

In terms of spare parts, Hyosung Heavy Industries and official distributor have to purchase them. If you use non-authorized parts, it may result in failure of the motor, degradation of the performance, and can nullify the product warranty. In terms of spare parts that you do not use promptly, carry out anti-corrosion process with the products as referring to '5. Storage', and store them to avoid any damages.



Note) DE : Drive end
NDE : Non-drive end

Figure 9.1 – Disassembled motor diagram (Frame size 320T and smaller)



Note) DE : Drive end
NDE : Non-drive end
b-cap : Bearing cap

Figure 9.2 – Disassembled motor diagram (Frame size 360T and larger)

10. Disposal

The packaging of the motor is made up of cardboard, wood, nails, etc. These materials are recyclable, but must be recycled, disposed of, or incinerated in accordance with applicable laws and regulations in each country.

As for motors, it is made up of ferrous metals (cast iron, steel sheet), non-ferrous metals (copper, aluminum), and plastic materials. It you need to dispose of motor, we recommend that you disassemble it and sort it in some various materials for recycling. With respect to non-recyclable materials, they must be disposed of in an industrial landfill or incinerated in accordance with each country's laws and regulations. When it comes to details regarding disposal related laws and regulations, reach to local government institution.

11. Troubleshooting

If you face with any problems amidst of using the motor, please deal with the issue as seeing the malfunction and table showing countermeasures. If the problem you are experiencing is not listed in the table below or is not resolved by applying the countermeasures, please contact Hyosung Heavy Industries or distributor.

Problem	Cause	Countermeasure
Motor fails to start	Cables have been disconnected.	Re-connect.
	Switch contact failure	Check and repair contact parts of the switch.
	Stator coil failure	Contact Hyosung Customer Support Center.
	Fuse failure	Check the appropriate capacity for the fuse and replace.
	Open circuit in winding	Check for loose wiring or contact Hyosung.
	Overload	Reduce the load to rated level.
	Damaged bearing	Replace bearing or contact Hyosung.
Damaged shaft	Belt connection angle is too small.	Adjust the diameter of the pulley.
	Belt tension is too weak.	Adjust the tension of the pulley.
	Load point is far from the motor.	Adjust the load point closer to the motor.
	The shaft center of motor and driven machine is misaligned when directly connected.	Align the center of motor and the driven machine.
	Motor is too frequently started.	Reduce the frequency of starting.
Noise and vibration	External vibration and shock	Remove external vibration.
	Weak foundation	Fortify the foundation.
	The shaft center of motor and driven machine is misaligned when directly connected.	Align the center of motor and the driven machine.
	Coupling ends are unbalanced.	Balance the coupling ends.
	The centers of the pulleys are misaligned.	Align the centers.
	Foreign particles on the rotating parts	Check and clean the rotating parts for dust or foreign particles
	Single phase operation	Check the connection circuit for proper three phase operation.
	Unbalanced voltage	Check with the grid operator or power supplier.
	Vibration from load	Check the load (driven machine) for the cause of vibration.
	Unbalanced load	Check the load (driven machine) for proper balancing.
	Bearing failure	Check according to the instruction manual 7.6 and if the noise continues, contact Hyosung Customer Support Center.
	Belt tension is too weak.	Adjust the tension of the pulley.
	Switch contact failure	Check and repair contact parts of the switch.
	Overload	Reduce the load to rated level.
	Stator coil failure	Contact Hyosung Customer Support Center.
	Entry of foreign particles	Remove the foreign matters

Problem	Cause	Countermeasures
Motor overheat	High ambient temperature	Facilitate ventilation.
	Obstacle is close to the motor.	Remove any obstacles within 20cm from the motor.
	Voltage drop	Adjust the thickness and length of the cables and consult with the grid operator or power supplier.
	Single phase operation	Check the connection circuit for proper three phase operation.
	Overload	Reduce the load to rated level.
	Motor is too frequently started.	Reduce the frequency of starting.
	Moment of inertia of the load is too big.	Contact Hyosung Customer Support Center.
	Cooling fan is damaged.	Replace the cooling fan
	Ventilation inlet or outlet is blocked.	Clean any blocked vents.
	Unbalanced voltage	Check with the grid operator or power supplier.
	Inappropriate relay capacity	Replace with a compatible relay.
	Y-D start was applied to a motor that does not support such.	Use a three-contactor method.
Bearing overheat	Belt tension is too weak.	Adjust the tension of the pulley.
	Bearing failure	Replace the bearing.
	Grease has been deteriorated from heat or has been polluted.	Replace the grease.
	High ambient temperature	Facilitate ventilation.
	Environment is high in humidity and very oily.	Protect the motor from moisture and oil.
	Obstacle is close to the motor.	Remove any obstacles within 20cm from the motor.
	External vibration and shock	Remove external vibration.
	The shaft center of motor and driven machine is misaligned when directly connected.	Align the center of motor and the driven machine.
	Belt connection angle is too small.	Adjust the diameter of the pulley.
	Load point is far from the motor.	Adjust the load point closer to the motor.
	Foreign particles on the rotating parts	Check and clean the rotating parts for dust or foreign particles
	Thrust is too big.	Reduce the thrust.
	Unbalanced load	Check the load (driven machine) for proper balancing.
	Cooling fan is damaged.	Replace the cooling fan.
	Ventilation inlet or outlet is blocked.	Clean any blocked vents.

Problem	Cause	Countermeasures
Irregular rotation	The centers of the pulleys are misaligned.	Align the centers.
	Voltage drop	Adjust the thickness and length of the cables and and consult with the grid operator or power supplier.
Activation of protective relay	Voltage drop	Adjust the thickness and length of the cables and and consult with the grid operator or power supplier.
	Single phase operation	Check the connection circuit for proper three phase operation.
	Inappropriate relay capacity	Replace with a compatible relay.
	Stator coil failure	Contact Hyosung Customer Support Center.
	High ambient temperature	Facilitate ventilation.
	Obstacle is close to the motor.	Remove any obstacles within 20cm from the motor.
	Pulley interrupts cooling motor	Apply vent to pulley
	Cables have been disconnected.	Re-connect.
	Switch contact failure	Check and repair contact parts of the switch.
	Improper grounding	Check and fix grounding.
	Unbalanced voltage	Check with the grid operator or power supplier.
	Overload	Reduce the load to rated level.
	Motor is too frequently started.	Reduce the frequency of starting.
	Moment of inertia of the load is too big.	Reduce the load inertia.
	Bearing failure	Replace the bearing..
Short circuit	Improper grounding	Check and fix grounding.
	Stator coil failure	Contact Hyosung Customer Support Center.
	High humidity	Lower the humidity..
	Environment is high in humidity and very oily.	Protect the motor from moisture and oil.
Low insulation resistance	High humidity	Lower the humidity..
	Environment is high in humidity and very oily.	Protect the motor from moisture and oil.
	Stator coil failure	Contact Hyosung Customer Support Center.
	External vibration and shock	Remove external vibration.
	Y-D start was applied to a motor that does not support such.	Use a three-contactor method.

12. Warranty

As for a case using the product in accordance with this manual, the warranty is valid for 3 years after its delivery. If the shipping date is unclear, use the manufacturing date on the nameplate. However, the following are excluded from this warranty.

(1) When the problem is caused by negligence on user side.

(2) When your installation is not suitable

(3) When the ambient temperature at the time of use exceeds the temperature range listed on the nameplate

(4) When ambient conditions around the cooling fan or vents impede airflow

(5) When operation is carried out in a range surpassing the rated voltage and rated frequency

(6) When the operation is performed beyond the range written on other name plate or auxiliary nameplate

(7) When modification or repair are carried out by others rather than supplier.

(8) When the delivered products to end user has different appearance and packaging compared with them as it was delivered from the factory.

(9) Other cases that are not the responsibility of the provider, such as natural disasters, fires, etc.

The warranty herein refers to the warranty of the delivered unit, and any damage caused by the failure of the repaired unit must be negotiated separately.

All inspection and repairs occurred after the warranty periods, they will be charged. In terms of the warranty period, also, our company deals with repair of faults and investigation to finding out cause of the faults even the problems are derived from beyond the above-mentioned reasons. Therefore, if you have regarding issues, please reach out Hyosung Heavy Industries or the motor distributor.

If you have any questions or concerns of the product, please check the followings:

(1) Nameplate descriptions
Serial number of manufacturing, model, kilowatt output, speed, voltage, frequency, and others.

(2) Service environment
Type of load, installation location and other special notes

Please note that the contents of this documentation are subject to change without notice. While we prioritize the accuracy of this manual, please let us know if you find any errors, omissions, or other unclear information.

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■ **Sales**

Sales team for exclusive agency of motor	**TEL: 02)707-6330**	**FAX: 02)707-6444**
Sales team for domestic business of motor	**TEL: 02)707-6340~2**	**FAX: 02)707-6444**
Sales team for overseas business of motor	**TEL: 02)707-6881~3**	**FAX: 02)707-6039**
Sales team for plant & Marine	**TEL: 055)268-8574~6**	**FAX: 055)268-8579**

■ **Low Voltage Motor Tech Communication** **TEL: 055)279-7330~7** **FAX: 055)268-9835**

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