TOSHIBA

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Installation and Maintenance Manual
440 – 6800 Frame
TIC Houston

Horizontal Squirrel Cage Medium-Voltage Induction Motor

DN: IM-191051E Rev 2
Date: January, 2015

Horizontal Squirrel Cage Medium-Voltage Induction Motor Installation and Maintenance Manual

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Introduction

This manual provides information on how to safely install, couple to the driven equipment, and maintain the Toshiba **Squirrel Cage Medium-Voltage Induction Motor**.

The squirrel cage induction motor was designed for an extended service life under very demanding conditions. However, should the motor require service, this manual includes a section that assists the repair technician with maintenance, disassembly/assembly, part replacement, and testing.

Maintenance recommendations include cleaning methods, bearing lubrication, disassembly support, and testing methods.

All Toshiba motors are manufactured, inspected, and tested to rigid standards that are equal to or exceed the standards required by the National Electrical Manufacturer's Association (NEMA), National Electrical Code (NEC), American National Standards Institute (ANSI), and testing per Institute of Electrical and Electronic Engineers (IEEE) Standard 112.

Note: *For ALL references to the National Electrical Code (NEC), see the latest release of the National Electrical Code.*

Important Notice

The instructions contained in this manual are not intended to cover all details or variations in equipment types, nor may it provide for every possible contingency concerning the installation, operations, or maintenance of this equipment. Should additional information be required, contact the TIC Customer Support Center.

The contents of this manual shall not become a part of or modify any prior or existing agreement, commitment, or relationship. The sales contract contains the entire obligation of Toshiba International Corporation. The warranty contained in the contract between the parties is the sole warranty of Toshiba International Corporation and any statements contained herein do not create new warranties or modify the existing warranty.

Any electrical or mechanical modifications to this equipment without prior written consent of Toshiba International Corporation may void all warranties or other safety certifications. Unauthorized modifications may also result in a safety hazard or equipment damage.

Misuse of this equipment could result in injury and equipment damage. In no event will Toshiba International Corporation be responsible or liable for direct, indirect, special, or consequential damage or injury that may result from the misuse of this equipment.

About This Manual

This manual was written by the Toshiba International Corporation Technical Publications Group. This group is tasked with providing technical documentation for the Toshiba **Squirrel Cage Medium-Voltage Induction Motor**. Every effort has been made to provide accurate and concise information to you, our customer.

At Toshiba International Corporation we are continuously striving for better ways to meet the constantly changing needs of our customers. E-mail your comments, questions, or concerns about this publication to Technical-Publications-Dept@tic.toshiba.com.

Manual's Purpose and Scope

This manual provides information on the various features and handling procedures including

- Installation,
- Alignment and coupling,
- System operation,
- Maintenance, and
- Spare parts recommendations.

Included is a section on general safety instructions that describe the warning labels and symbols that may be used on the motor and throughout the manual. Read the manual completely before installing, operating, performing maintenance, or disposing of the motor.

This manual and the accompanying drawings should be considered a permanent part of the equipment and should be readily available for reference and review at the installation site. Dimensions shown in the manual are in English and/or the metric equivalent.

Because of our commitment to continuous improvement, Toshiba International Corporation reserves the right, without prior notice, to update information, make product changes, or to discontinue any product or service identified in this publication.

Toshiba International Corporation (TIC) shall not be liable for direct, indirect, special, or consequential damages resulting from the use of the information contained within this manual.

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Contacting TIC’s Customer Support Center

Toshiba International Corporation’s Customer Support Center can be contacted to obtain help in resolving any motor problem that you may experience or to provide application information.

The Support Center is open from 8 a.m. to 5 p.m. (CST), Monday through Friday. The Center’s toll free number is US (800) 231-1412 or (855)803-7091/Local (713) 466-0277/Fax (713) 896-5252 CAN (800) 872-2192 MEX 01 (800) 527-1204. For after-hours support, follow the directions in the outgoing message when calling.

You may also contact Toshiba International Corporation by writing to:

Toshiba International Corporation

13131 West Little York Road

Houston, Texas 77041-9990

Attn: Medium Voltage Marketing Department

For further information on Toshiba International Corporation’s products and services, please visit our website at www.toshiba.com/tic/.

Table of Contents

General Safety Information 1

Safety Alert Symbol 1

Signal Words 1

Special Symbols 1

Equipment Warning Labels 2

Qualified Personnel 3

Handling, Storage, and Installation 4

Receipt of Equipment 4

Lifting and Handling 4

Storage 5

Motor Installation 6

Location 6

Unpacking 6

Foundation 6

Bedplate Installation and Leveling 8

Grouting 8

Magnetic Center Adjustment 9

Motor Coupling and Alignment 10

Flexible Coupling 10

Rigid Coupling 10

Balancing Direct Coupled Motors 12

Vibration 12

Motor Operation 13

Motor Start-Up Precheck 13

Motor Testing 13

Maintenance 14

Cleanliness 14

Insulation Resistance 14

Recommended Practice for Drying 15

Lubrication and Bearings 16

Antifriction Bearings 16

Sleeve Bearings 18

Forced-Lubrication System 19

Heating of Bearings 20

Environmental Factors 21

Motor Disassembly and Reassembly 22

Remove/Replace Antifriction Bearings 22

Remove the Bearings 22

Install the Bearings 23

Remove/Replace Sleeve Bearings 24

Rotor Removal 26
Lifting Rotor 26
Removing Rotor 26
Inserting Rotor 26
Electrical Testing 27
Field Insulation Test 27
Effect of Altitude on Temperature Rise 27
Special Equipment (Accessories) 28
Space Heaters 28
Stator Temperature Detectors 28
Resistance Temperature Detectors 28
Thermocouple 28
Bearing Temperature Detectors 28
Air Filters 29
Ordering Information and Spare Parts 30
Ordering Information 30
Spare Parts Listing 30
Service Guide 31

General Safety Information

DO NOT attempt to install, operate, maintain, or dispose of this equipment until you have read and understood all of the product safety information and directions that are contained in this manual.

Safety Alert Symbol

The **Safety Alert Symbol** is comprised of an equilateral triangle enclosing an exclamation mark. This indicates that a potential personal injury hazard exists.

Signal Words

Listed below are the signal words that are used throughout this manual followed by their descriptions and associated symbols. When the words **DANGER**, **WARNING**, and **CAUTION** are used in this manual, they will be followed by important safety information that must be carefully followed.

⚠ DANGER

The word **DANGER** preceded by the safety alert symbol indicates that an imminently hazardous situation exists that, if not avoided or if instructions are not followed precisely, will result in serious injury to personnel or loss of life.

⚠ WARNING

The word **WARNING** preceded by the safety alert symbol indicates that a potentially hazardous situation exists that, if not avoided or if instructions are not followed precisely, could result in serious injury to personnel or loss of life.

⚠ CAUTION

The word **CAUTION** preceded by the safety alert symbol indicates that a potentially hazardous situation exists that, if not avoided or if instructions are not followed precisely, may result in minor or moderate injury.

CAUTION

The word **CAUTION** without the safety alert symbol indicates that a potentially hazardous situation exists that, if not avoided or if instructions are not followed precisely, may result in equipment and property damage.

Special Symbols

To identify special hazards, other symbols may appear in conjunction with the **DANGER**, **WARNING**, and **CAUTION** signal words. These symbols indicate areas that require special and/or strict adherence to the procedures to prevent serious injury to personnel or loss of life.

Electrical Hazard Symbol

A symbol that is comprised of an equilateral triangle enclosing a lightning bolt indicates a hazard of injury from electrical shock or burn.

Explosion Hazard Symbol

A symbol that is comprised of an equilateral triangle enclosing an explosion indicates a hazard of injury from exploding parts.

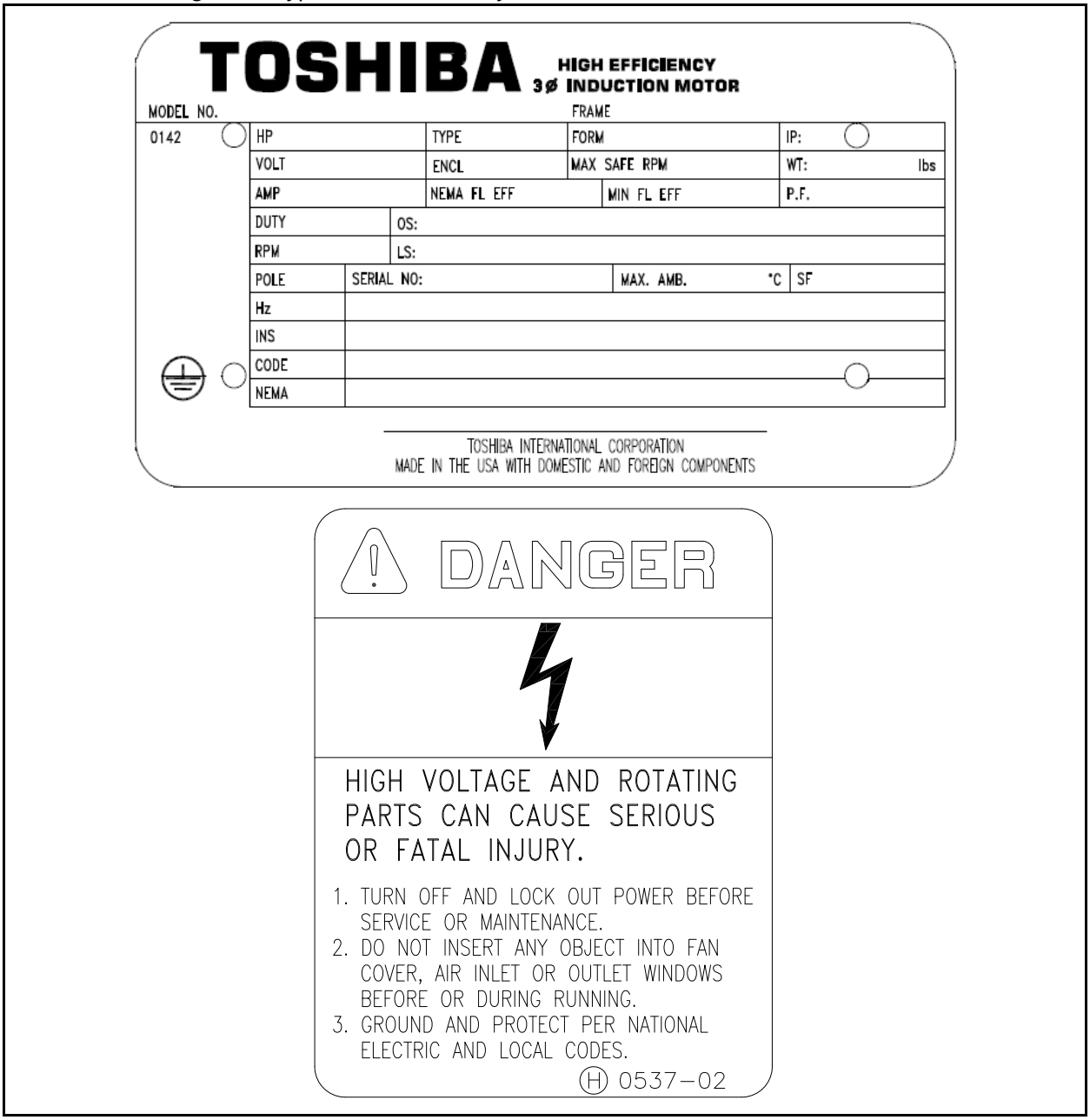
Equipment Warning Labels

DO NOT attempt to install, operate, perform maintenance, or dispose of this equipment until you have read and understood all of the product labels and user directions that are contained in this manual.

Warning labels that are attached to the equipment will include the exclamation mark within a triangle. **DO NOT** remove or cover any of these labels. If the labels are damaged or if additional labels are required, contact the Toshiba Customer Support Center.

Labels attached to the equipment exist to provide useful information or to indicate an imminently hazardous situation that may result in serious injury, severe property and equipment damage, or loss of life if safe procedures or methods are not followed as outlined in this manual.

Figure 1. Typical labels that may be found on the motor.



Qualified Personnel

Installation, operation, and maintenance shall be performed by **Qualified Personnel <u>Only</u>**. A Qualified Person is one that has the skills and knowledge relating to the construction, installation, operation, and maintenance of the motor. In conjunction with the aforementioned, will be familiar with the electrical equipment and will have received safety training on the hazards involved with motor operation and of the driven equipment (Refer to the latest edition of NFPA 70E for additional safety requirements).

Qualified Personnel shall:

- Have read and understood the entire manual.
- Be familiar with the construction and function of the motor, the equipment being driven, and the hazards involved.
- Be able to recognize and properly address hazards associated with the application of motor-driven equipment.
- Be trained and authorized to safely energize, de-energize, ground, lock out/tag out circuits and equipment, and clear faults in accordance with established safety practices.
- Be trained in the proper care and use of protective equipment such as safety shoes, rubber gloves, hard hats, safety glasses, face shields, flash clothing, etc., in accordance with established safety practices.

For further information on workplace safety, visit www.osha.gov.

Handling, Storage, and Installation

The installation requirements are discussed in the typical installation sequence, but some tasks may require repetition if a subsequent adjustment affects an earlier procedure.

When connecting to other machinery, confirm that the installed machinery is properly mounted before attempting to align or grout the motor or generator. Particular attention must be taken in the alignment of machines for direct drive.

Receipt of Equipment

Upon arrival of the equipment, confirm that all components have been received and that there is no evidence of damage during shipment.

In the event of damage, the nature and extent of the damage should be reported without delay. Notify the carrier and the Toshiba Customer Support Center.

When communicating with a Sales Office or the Toshiba Customer Support Center, reference Toshiba invoice numbers, the type and rating of the motor, Toshiba Sales Order Number, and any other information such as the purchase order number, etc., that would assist in identifying the equipment. If no other information is available, the equipment can be identified by the serial number located on the nameplate.

Describe as completely as possible the damage that has occurred, what shortages exist, what features have been omitted, or the problem encountered with the shipment.

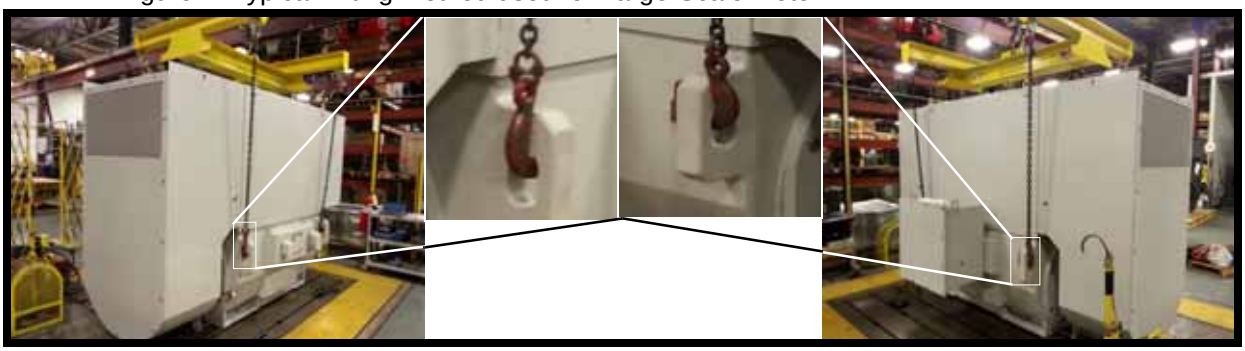
Lifting and Handling

Lifting slings should be in good condition and be padded where contact is made with finished machine surfaces. A spreader bar should be used where lifting cables might otherwise crush the top edge or cause damage to the lifted equipment.

Failure to observe these precautions may result in damage to the equipment, injury to personnel, or both.

Assembled units are to be handled as one piece by attaching a sling (or slings) to the lifting provisions of the motor enclosure casting only, as indicated on the outline drawing. Assembled units should not be handled by attaching slings to the shaft, bearing pedestals, or arbitrary places on the stator frame.

Figure 2. Typical Lifting Method used for Large-Scale Motor.



Storage

Care should be taken to keep the equipment covered when moving from a cold location to a warm location to prevent the formation of condensation. Should condensation occur, allow the motor to dry thoroughly before applying power (see pg. 15 for drying methods).

If the equipment is not put into immediate use, it should be stored in a clean and dry location. For long periods of storage, especially where moisture and/or dust is prevalent, the equipment should be covered to protect it from corrosion.

If the motor is to be stored unused for longer than two weeks, prepare and maintain the motor by performing the following precautionary steps.

- Place the motor in a location that will protect the motor from flooding and from access to corrosive gases or metal particles.
- Avoid storage locations that may allow for excessive vibration. If exposed to vibration while stored, the shaft must be locked to avoid any movement.
- Cover machined metal parts with a weather-proof cover — Leave ventilating areas exposed.
- Insert silica gel bags for moisture control.
- Ensure that all unpainted areas are covered. Retouch any scratches or flaked painted areas.
- Ensure that the condensate plugs and/or drain plugs are functional and secured (if applicable).
- On very large equipment, close all air openings and loosely cover motor completely (allow for ventilation). Place silica gel bags inside of the motor. Ensure that all coverings are properly secured. If using a bag to protect, ensure that it is secure at the bottom.
- If the motor is equipped with space heaters, ensure that all heaters are functional. The motor interior temperature should be maintained above the ambient dew point temperature. It is recommended that the interior temperature be 5° C (or 9° F) above the dew point temperature (e.g., dew point temp = 25° C, then internal = 30° C min./dew point temp = 77° F, then internal = 86° F min.).
- If the motor is designed for outdoor operation, it will not be affected by extreme or sudden temperature changes or inclement weather in general. However, a weather-proof cover with provisions for adequate ventilation should be used to guard against intrusion of salt, dust, or other abrasive or corrosive materials.
- An inspection and maintenance schedule is required. If the motor is to be stored for six months or longer, it is to be given a megohm meter (megger) test every three to six months in addition to the aforementioned storage precautions. A record of the insulation resistance values, temperature, time, humidity, and length of voltage application is to be recorded to show winding conditions. Test results also provide pre-startup conditions. See the section titled Insulation Resistance on pg. 14 for more information on testing the insulation.
- It is recommended that the motor shaft be turned several rotations (unpowered) once a month ending at 90° forward of the initial starting position. For bearings on motors stored for longer than six months, it is strongly recommended that the oil or grease level be checked and added (if required) every six months. The preferred storage setting is in a warehouse or an enclosed building, using the aforementioned storage precautions.
- If improperly stored, sleeve bearings must be inspected before motor operation.
- Bearings are to have the oil or grease level checked before removing the motor from storage and being placed into service. Add oil or grease if required.
- All oil must be drained from the motor and a shaft-locking mechanism must be installed before transporting the motor from storage.

Motor Installation

Location

Unless otherwise specified, the ambient operating temperature is -25° to 40° C (-13° to 104° F).

Install the motor in a well-ventilated location that is easily accessible for cleaning, inspection, and maintenance — this includes being away from walls and other obstructions to permit a free passage of air.

Avoid installation locations that would allow exposure to coal and mill dust, leaky pipes, steam/moisture, acids, alkalines or fumes thereof, or any other harmful substances.

Do not install the motor in an area where flammable gases or combustible material may be present, or around any hazardous processes, unless designed for such an application.

Unpacking

If the motor has been exposed to a low temperature, do not remove the coverings until the motor has had sufficient time to attain a temperature that is close to that of the room in which it is to be unpacked.

Otherwise, when opened, moisture will condense on the cold parts. This may reduce the electrical resistance of insulations or cause rust or corrosion of metallic parts.

Foundation

A rigid foundation is necessary for smooth, stable, and reliable operation.

A satisfactory bond between the foundation and the grouting is required. The foundation surface must be roughened (if not cured rough) and cleaned before the bedplate or soleplate (hence forth will be referred to as bedplate) is secured to it.

Anchor Foundation Bolt

The purpose of foundation bolts is to anchor the motor and bedplate to the foundation such that, structurally, the foundation, motor, and bedplate become a single mass (see Figure 4. on pg. 7).

The bolt is enclosed in a casing three or four diameters larger than the bolt. This allows the bolt to be sprung horizontally when placing the motor bedplate in position for mounting — this permits slight adjustments for errors in the bolt position. Concrete is not placed inside of the casing at the time that the foundation is poured. Instead, the casing is filled with grout at the time that the motor is finally grouted into position.

A foundation template, pattern, or frame, usually fabricated from wood, should be used to support the bolts and casings while the foundation is being built up around them. The dimensions required in constructing the supporting frame for the bolts and casings may be obtained from construction diagrams or by measuring the base of the motor.

The motor should be mounted securely onto a bedplate that is rigid enough to prevent any base-to-motor or motor-to-base vibration. The base must not impose bending or twisting strains on the motor housing (see Figure 4. on pg. 7).

Figure 3. Foundation Bolts.

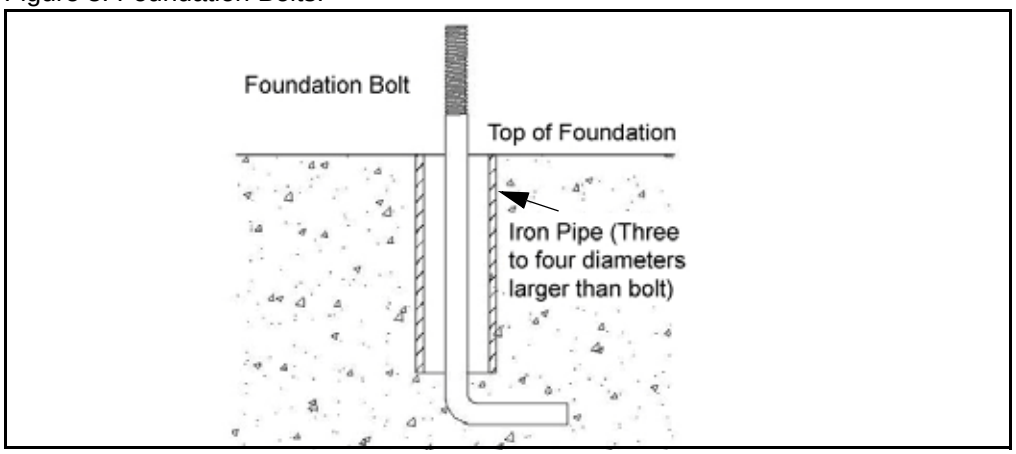
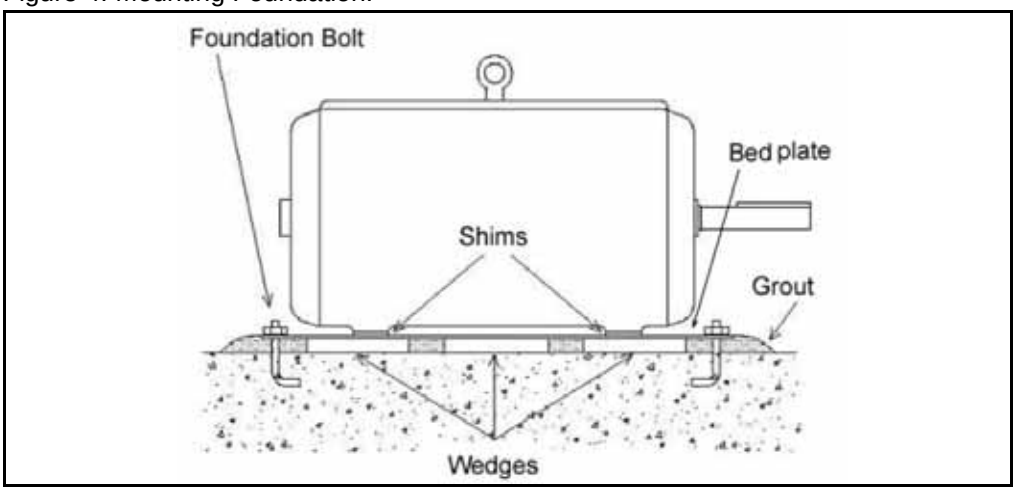
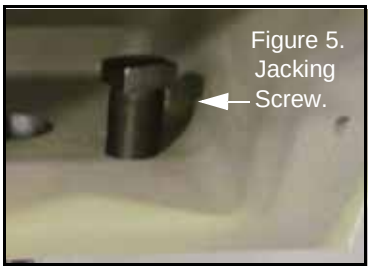


Figure 4. Mounting Foundation.



When mounting the motor, use of slotted shims is recommended as it may be necessary to remove or add shims when aligning the shafts. The use of proper shims inserted under each mounting foot will prevent distortion of the motor housing when the mounting bolts are secured.



The following procedure is recommended for mounting the motor.

Note: *Where available, use the **Jacking Screw** to raise or lower the motor when shimming. Shims used shall be the same size as the foot print of the motor.*

1. Identify the mounting foot of the motor that will require the most shims and install shim(s) to that mounting foot.
2. Tighten the mounting foot bolt.
3. Insert feeler gauges under the remaining mounting feet to determine the thickness of shims required.
4. Insert the required number of shims under each mounting foot and tighten the mounting bolts.

Note: *Use a small number of thick shims rather than a large number of thin shims (0.200" max.).*

5. Measure the alignment using the procedure provided in the section titled Motor Coupling and Alignment on pg. 10.

Bedplate Installation and Leveling

Install the bedplate onto the foundation by performing the following procedure.

1. Place ¾” – 1” thick iron wedges onto the foundation at the motor mounting location.

Note: *The iron wedges shall cover at least 75% of the motor mounting footprint.*

2. Position the iron wedges equally spaced and close to the foundation bolts.
3. Place the bedplate onto the foundation.
4. Use the iron wedges to position and level the bedplate onto the foundation.
5. Secure the bedplate onto the foundation using the foundation bolts.
6. Torque the foundation bolts securely.

The ¾” – 1” of space between the foundation and the bedplate is to be filled with grout.

DO NOT remove the wedges when grouting the bedplate — wedges are to properly sized for the application so as not to interfere with the grout form.

Grouting

The foundation mounting surface must be rough and clean to provide good anchorage for the grout. The grout shall be of the non-shrinking type.

Apply the grouting between the foundation and the bedplate by performing the following procedure.

1. Wash the top of the foundation.
2. Where possible, build a form (border) that extends 2” around the periphery of the bedplate area. The form is used to contain the grout during the grout application.
3. Pour and pack in the grout.
4. Grout in by building a low dam around the inside and outside of the bedplate. Where possible, allow grout to extend beyond the bedplate periphery 2” on all sides.
5. Pack the grout to a height of ½” above the underside of the bedplate.

Note: *Too deep of a grouting will cause difficulty if the motor must be removed at a later date.*

Magnetic Center Adjustment

The rotor of a motor equipped with sleeve bearings must be on magnetic center. Otherwise undue forces on the bearings and/or coupling may result. The magnetic center is indicated by a scribe mark on the extension end of the shaft. The scribe mark will be outside of the bearing housing and in line with the top edge of the housing (see Figure 6.).

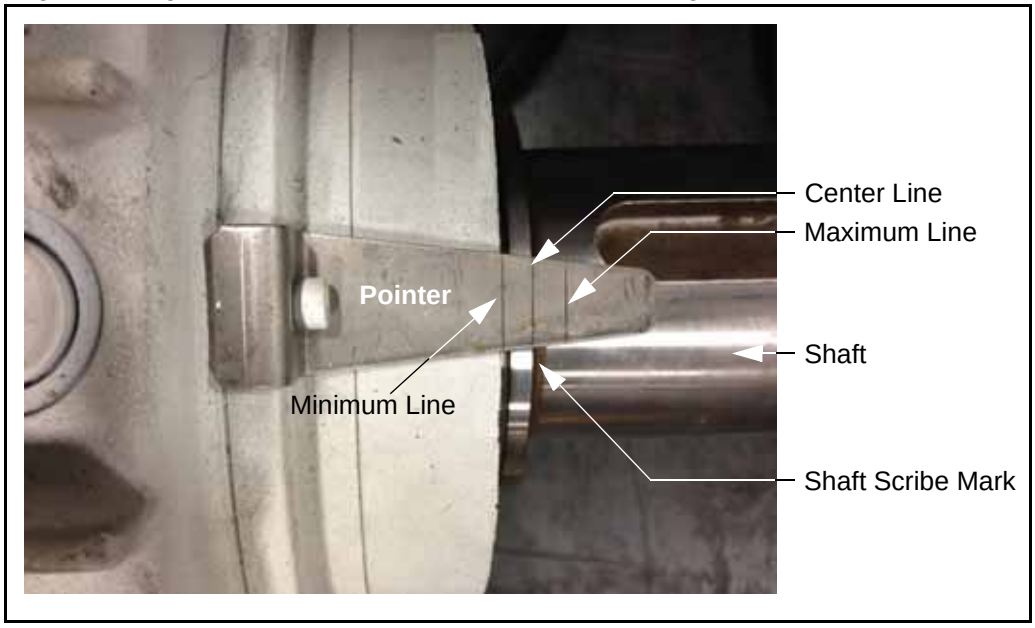
The scribe mark is a groove in the shaft cut with a lathe — a close examination of the shaft will reveal the scribe. In the case of a double shaft extension, the scribe mark can be found by examining the extensions.

Align the scribe mark with the center line of the Pointer range before coupling the motor to the driven equipment.

The magnetic center of motors equipped with sleeve bearings is established by the Toshiba Quality Control Department during testing.

Motors equipped with antifriction bearings do not have their magnetic centers indicated by a scribe mark. The rotor is placed in magnetic center at the Toshiba factory and no further adjustment is required at the time of installation.

Figure 6. Magnetic Center Scribe Mark, Pointer, and Range.



Motor Coupling and Alignment

The motor must be permanently coupled to the shaft of the load and properly aligned.

Load couplings may be of two types; **Flexible** or **Rigid**. The alignment of both types is critical for stable operation while running.

Flexible Coupling

Though most flexible couplings can withstand greater misalignment than rigid couplings, extreme misalignment can cause vibration and premature failure of the motor bearings and/or shaft.

The tolerance for the **Axial Alignment** and for **Axial Parallelism** of a flexible coupling is 0.002” (see pg. 11 for more on measuring the motor-load coupling).

Once the coupling halves have been properly aligned, bolt the feet of the motor into position and then bolt the two coupling halves together for normal service.

Flexible coupling must be used with sleeve bearings. The maximum end-play tolerance is 0.375”.

Rigid Coupling

Extreme care must be taken to obtain proper alignment when using rigid couplings. The tolerance for the **Axial Alignment** and **Axial Parallelism** of the two rigid coupling halves is 0.0005” to 0.001”.

The **Axial Alignment** may be set and/or checked by using a dial indicator as shown in Figure 7 on pg. 11 or by using a straight edge and feeler gauge as shown in Figure 8. on pg. 11.

The preferred method of checking alignment is with a dial indicator and is performed as follows. Bolt the dial indicator to one of the coupling halves and mark the position of the dial button on the opposite coupling half with a chalk mark. Set the indicator dial to zero at the first position and then rotate both halves of the coupling to a new position and note the reading. All readings must be made with the dial button located at the chalk mark, and no fewer than six readings should be made.

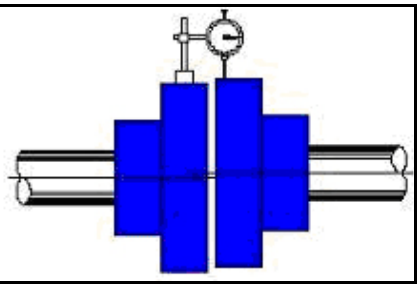
A variation in the dial reading at different positions of coupling rotation will indicate whether the machine should be raised, lowered, or moved to one side. The goal is to obtain a common center point between the shaft of the motor and the shaft of the driven equipment to within the specified tolerance.

Axial Parallelism is a measure of the separation of the coupling faces. The separation between the faces of the two coupling halves is an indication of whether the shafts of the motor and the load are parallel. This value may be set and/or checked using a dial indicator as shown in Figure 9. on pg. 11 or using a feeler gauge as shown in Figure 10. on pg. 11. The dial indicator is fastened to one coupling half and a reference surface fastened to the other coupling half.

Mark the location of the dial button on the reference surface and make all readings with the indicator in this position. Set the dial of the indicator to zero for the first reading and use this reading as the reference. Be sure to rotate both halves of the coupling the same amount, aligning the button of the indicator and the mark on the reference surface for each of at least six readings.

A variation of the readings at different positions will indicate how the motor needs to be adjusted to obtain the proper alignment. After each adjustment of the motor, repeat the above procedure to ensure that the proper alignment and leveling are acheived.

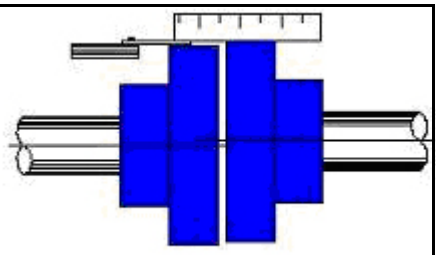
Figure 7. The preferred method of measuring **Axial**



Axial Alignment is the measure of the difference between the two center points of the two shafts. This setting is critical in the transfer of power from the motor to the load.

Figure 7 shows the preferred method for this making measurement. Place the dial indicator on the coupling as shown to measure the coupling halves for alignment. The specification for this metric for a rigid coupling is 0.0005 – 0.001". The specification for this metric for a flex coupling is ±0.002".

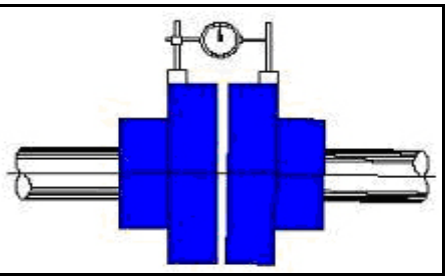
Figure 8. The straight edge and feeler gauge method of measuring **Axial Alignment**.



An alternate method used for measuring the **Axial Alignment** is with the use of the straight edge and feeler gauge.

The straight edge is used to indicate a difference between the couplings and the feeler gauge provides a value for the difference if detected.

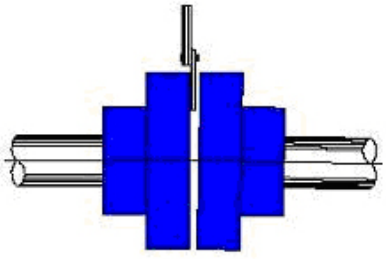
Figure 9. The preferred method of measuring **Axial Parallelism**.



Axial Parallelism (or axial spacing) refers to the parallel alignment of the motor shaft and the shaft of the driven equipment. The preferred method for measuring this metric is using a dial indicator as shown in Figure 9.

The dial indicator will measure the coupling gap between the flange of the motor and the flange of the driven equipment around the entire mating surface. This value is measured at a minimum of six places around the mating surface.

Figure 10. F eeler gauge method of measuring **Axial**



A feeler gauge may also be used to measure **Axial Parallelism**.

The specification for this metric for a rigid coupling is 0.0005 – 0.001".

The specification for this metric for a flex coupling is ±0.002".

Failure to align the motor system properly stresses the motor and the driven machine. This results in premature failure of the bearings, seals, couplings, and shaft.

Alignment failure may also result in looseness of foundation bolts and bedplate, high vibration and temperatures, increased power consumption, and a shortened motor life.

Balancing Direct Coupled Motors

Toshiba motors are balanced at the factory to industry standard tolerances. Field disassembly/ assembly may result in unbalanced operation. Should this occur, disconnect the coupling halves and rotate one shaft 90° with respect to the other shaft. Re-connect the coupling and run the motor.

If the unbalanced condition persists, disconnect and rotate the same shaft another 90° until balanced operation resumes.

If a chain, gear, V-belt, or flat belt drive is used on the output shaft, perform a minimum sprocket diameter check.

Direct coupling via a flexible means does not require a check for minimum sprocket diameter.

Vibration

On new installations, excessive vibration may be encountered while runing. Listed below are some of the more common causes.

- Improper shimming and/or a soft foot.
- Misalignment.
- Shafts of the motor and load are not properly aligned.
- Unbalanced load.
- Worn bearings on the motor and/or driven machine.
- A resonant mounting condition, the effect of which is increased when the motor is coupled to the load.
- Vibration of the driven equipment.
- Sprung shafting.
- Improper or cracked foundation.
- Electrical imbalance.
- Rotor imbalance.

Seek the simple solution first.

Table 1 lists acceptable vibration test limit levels. A vibration detector will be required to measure the system vibration levels.

Table 1. Vibration Limits (for resiliently mounted machines).

RPM at 60 Hz	Velocity (in/s peak)	Velocity (mm/s peak)	
3600	0.15	3.8	***Note:*** *NEMA values at no load.*
1800	0.15	3.8	
1200	0.15	3.8	***Note:*** *For machines with rigid mounting, multiply the limiting values by 0.8.*
900	0.12	3.0	
720	0.09	2.3	***Note:*** *All large Toshiba motors are constructed to make field balancing possible. Sleeve bearing motors are designed with split bearings so that the rotor can be run in its own bearings while balancing.*
600	0.08	2.0	

After satisfactory alignment and vibration testing, install dowel pins in the base of the motor and in the bases of the driven equipment. This will prevent creeping and subsequent misalignment during operation.

Motor Operation

Motor Start-Up Precheck

Perform the following checks before the initial start up.

- Inspect the motor for foreign materials and general cleanliness.
- Ensure that the motor is dry — particularly on the first start and after the machine has stood idle for some time.
- Ensure that all drain and fill plugs/caps are secured.
- Ensure that all gaskets are in place and all bolts/screws are secured.
- Ensure that the oil level and/or grease quantity is correct.
- Use a megohmmeter to determine the condition of the windings (e.g., moisture present, winding shorts, etc.).
- Check all connections to the motor and ensure that the proper phase connections are applied and are secured.
- Ensure that all auxillary connections are secured.
- Turn off space heaters during motor operation.
- Ensure that the applied input voltage and frequency is within ±10% and ±5%, respectively, of the nameplated voltage and frequency.
- Check the alignment of the motor and coupled load such that the shaft and bearings of the motor will not be subjected to unnecessary strain or wear.
- If possible, ensure that the rotor turns freely.
- Ensure that there are no obstructions or interferences to motor operation. **DO NOT** turn the rotor by inching (short thrusts at reduced power).

⚠ DANGER

Ensure that all personnel are clear of the motor and the driven equipment during the following test.

Motor Testing

- Run the motor without a load to confirm direction of rotation and basic functionality. Motors with unidirectional blowers can be operated only in the direction shown on the rotation plate attached to the motor.

  If the opposite direction is required for a 3-phase motor, switch any two of the 3-phase input lines or contact the Toshiba Customer Support Center for support.

Note: *The certified motor outline will define the motor direction.*

- Run the motor for approximately one hour to check for any unusual heating of bearings or windings. This also permits lubrication warm-up before torque is applied to rotating parts.
- Run the motor under a load. Check the bearing housing occasionally while running. Using the proper protective gear and/or measuring device, ensure that bearing overheating does not occur.

Maintenance

Routine cleaning, lubrication, and inspections are required components of preventive maintenance. Proper maintenance results in extended mean-time between failures and greatly reduced repairs.

It is also important to create and store maintenance records. These records serve as a guide to preventive maintenance and provides an indication of what spare parts should be stocked to prevent lengthy motor outages.

The frequency of routine checks will depend on several variables. A few of the primary operational considerations are:

- Cleanliness
- Insulation resistance
- Lubrication and bearings
- Environmental factors such as excessive moisture, dust, etc.

Cleanliness

Dirt, dust, and oil are the greatest enemies of electrical equipment. When dirt or dust settles on a machine it may prevent heat dissipation and restrict ventilating passages. This may lead to overheating and insulation breakdown. Some types of dust are electrically conductive and may also cause insulation breakdown.

Dust and dirt may be removed from electrical equipment with dry compressed air, dry cloths, or by brushing. The compressed air must be dry and at a low pressure (less than 25 psi) as not to damage the insulation. Grit, iron and copper dust, graphite, and lamp black should be removed by suction. Hose tips for either pressure or suction should not be metal.

Dust and dirt also have a harmful effect in that they tend to absorb oil or grease. This may result in the formation of gum that is not easily removed.

Oil or grease covered machines should be cleaned thoroughly and have a fresh coating of insulating varnish applied. Most of the oil or grease can be removed with a cloth moistened with an appropriate solvent/cleaner. A brush should be used for surfaces difficult to reach by hand. Use a spray gun to clean inaccessible slots and passages. After using the solvent, be sure to dry the windings with dry compressed air.

DO NOT use a solvent that has toxic effects or which has a deteriorating affect on varnish.

Insulation Resistance

Moisture may develop in a motor during long-term storage. To determine if there is moisture in the motor, an insulation test may be used. A megohmmeter (megger) can be used to measure the insulation resistance which is an indicator of the presence of moisture in the motor.

The insulation resistance is to be measured per IEEE Standard 43.

When comparisons are made between present and previous readings, it is possible to observe the winding insulation trend. When correlating periodic readings, it is desirable to test at a definite voltage and time, and to record other pertainent conditions (e.g., ambient temperature, humidity, etc.).

The recommended minimum insulation resistance in megohms at 40° C (104° F) is equal to the rated motor potential in kilovolts plus one megohm (refer to IEEE Standard 43).

Recommended Practice for Drying

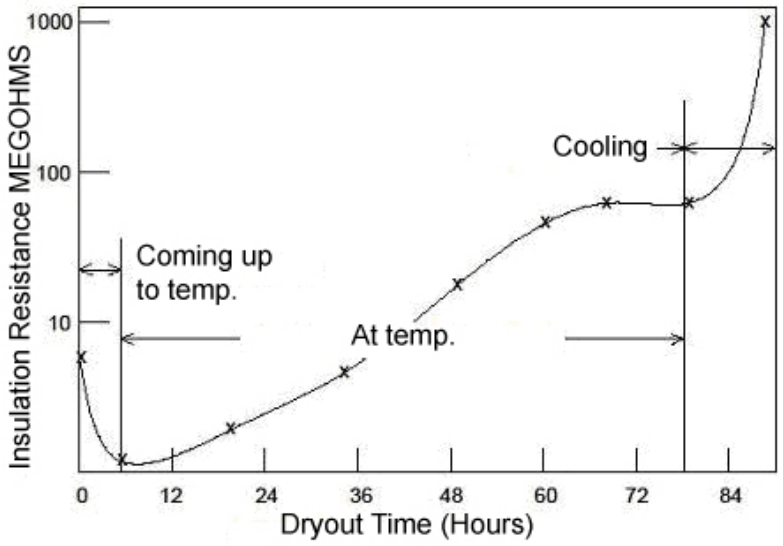
Drying the motor will be required if the insulation resistance value is too low. This may be accomplished by using an external heat source or by circulating direct current through the coils.

Apply External Heat

Place the motor into an enclosure and apply heat from steam pipes or electric strip heaters. The enclosure should have a vent at the top for the evaporated moisture to escape.

This process should be carried out slowly or winding damage could result (see Figure 11.). Sufficient time should be allowed for the process. At no time should the temperature be allowed to exceed 85° C (185° F).

Figure 11. Insulation Resistance vs. Drying Time.



Apply Direct Current

An alternative method of drying the windings requires direct current. Frequently, welding sets are available and can be operated in parallel to obtain the desired current. For suitable drying temperature, the direct current (DC) should be about one-half of the rated alternating current (AC) value specified on the nameplate of the motor.

DO NOT exceed an insulation temperature of 75° C (167° F).

Securely connect the leads from the current transformer and temperature detectors. Current flow and the temperature are to be monitored to protect the motor from damage.

The current **MUST BE LIMITED** so that the maximum temperature of the windings do not exceed 85° C (185° F).

The insulation resistance drops rapidly initially as the winding heats up, then rises slowly as the moisture is driven off, and finally levels off at a steady value. Drying may be concluded when a fairly steady value of insulation resistance is reached.

It is advisable to keep annual records of insulation resistance readings and the conditions (e.g., ambient temperature, humidity, etc.) under which the readings are taken.

Lubrication and Bearings

Lubricants are used in the bearings to reduce friction and wear between rubbing surfaces and to dispense heat. Lubrication is one of the most important check points for proper maintenance. This check must be carried out in accordance with the instructions supplied with the motor.

The need for cleanliness when working with bearings and lubricants is extremely important. Dirt and other foreign materials can severely shorten the service life of the bearings.

Periodically, the bearing lubricant should be checked to ensure proper operation. If an inspection reveals that the lubricant is dirty, it should be changed immediately. The grade of lubricant used for each motor is given on the lubricant information section of the nameplate.

It is especially important to check the lubrication level during the first few operating hours — a dropping level may indicate leakage. It should be noted that motors may have a different lubricant level while running than while stationary. This difference is typically shown by the lubricant gauge.

CAUTION

DO NOT overfill the oil reservoir or over grease the bearings. The lubricant pouring temperature must be lower than the ambient air temperature. Adherence to this thermal rating is critical to the life of the motor — especially in climates with severe winter temperatures.

Antifriction Bearings

Induction motors equipped with antifriction bearings are shipped with the bearing housings packed with grease.

For maximum service, motors should be lubricated at intervals determined by the type, size, and severity of service.

Under normal operating conditions, it is only necessary to regrease Toshiba antifriction bearing motors in accordance with the specifications listed in Table 2. The recommended frequency of regreasing will be dependent upon the operating speed and conditions.

Excessive greasing is a contributor to motor failure. Over greasing overheats the bearings and contaminates the windings, which may reduce service life.

Table 2. Recommended Regreasing Schedule for Antifriction Bearings.

Motor Speed (RPM)	Approximate Hours of Operation	
	Normal Conditions	Severe Conditions
3600	1500 – 2000	750 – 1000
1800	3000 – 4000	1400 – 2000
1200 & below	6000 – 8000	3000 – 4000
Note: For sleeve bearings 1800 RPM & below and in the absence of other instructions, it is recommended that the above hours be reduced to ½ of the listed values.		

Normal conditions are considered to include most ambient atmospheres and operational requirements.

Severe conditions include the following:

- Exposure to extreme dust, dirt, or other atmospheric contaminants.
- Direct exposure to moisture beyond normal atmospheric humidity.

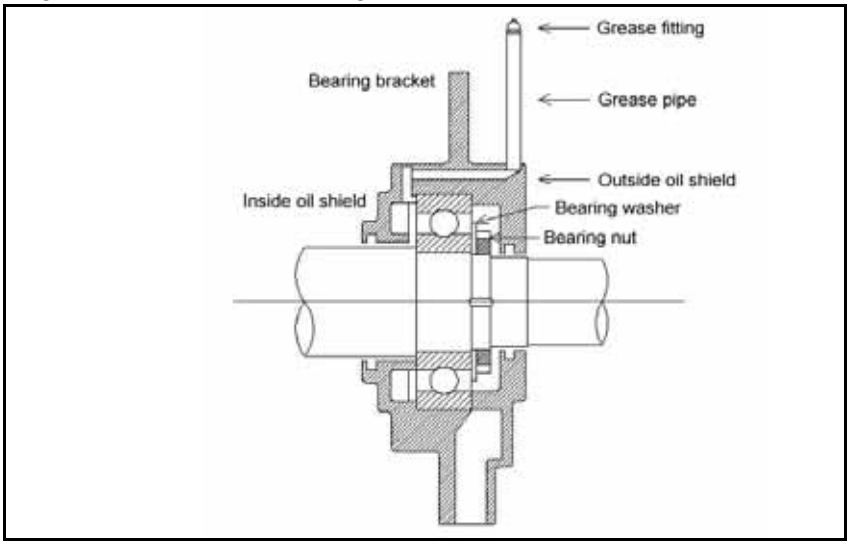
- Shock, vibration, or loading beyond rating.
- Extremes of operational cycling such as long shut-down, frequent starting, or reversing.

It is recommended that the following greases (or their equivalent) be used in Toshiba motors.

Table 3. Recommended Antifriction Bearing Grease for Normal Conditions.

Manufacturer	**Normal Ambient Temperature** -20° C to 40° C (-4° F to 104° F)
Exxon Mobil Corp.	Polyrex EM (Toshiba Standard Grease)
Phillips 66	Polytac Grease 2
Chevron Products Co.	SRI #2
Exxon Mobil Corp.	Exxon Unirex N
Shell Oil Co.	Shell Dolium R
Texaco	Polystar RB2

Figure 12. Antifriction Bearing Lubrication.



The following steps are to be followed when greasing the motor. Refer to Figure 12.

1. Clean the exterior of the motor.
2. Remove the lubrication fitting and the grease discharge cover.
3. If the grease has hardened, remove the hardened lubricant that has accumulated in the area around the relief plug with a wooden or plastic stick.

   Note: In severe conditions, run the motor until the bearing chamber is warmed to the temperature that will allow the grease to flow more easily.
4. Using the grease type printed on the nameplate, regrease the motor with a low pressure grease gun.
5. Run the motor for approximately 10 minutes to ensure that the excess grease has been expelled. For optimum operation, the bearing chamber should be filled with grease to three-quarters capacity.
6. Replace the lubrication fitting and drain.

   Note: If the bearings are rough, the motor should be disassembled and the bearings replaced. Repack the bearings and the bearing chamber with enough grease to fill the chamber to approximately three-quarters full at assembly.

Sleeve Bearings

⚠ CAUTION

Motors with sleeve bearings are not shipped with lubricant. Thus, before the motor can be started, the oil chamber or oil system must be filled with the proper oil type.

The oil chamber should be filled through a filter to the level indicated on the bearing housing site glass.

Toshiba recommends that the same oil type be used for the life of the motor in order to prevent troubles caused by incompatible lubricant mixtures.

Under most circumstances, it is not advisable to add preservatives or rust-preventing compounds to the oil system unless such recommendations are made by the manufacturer of the lubricant.

Table 4. Recommended Oil Specification.

Ambient Temperature ° C (° F)	Speed (RPM)	Viscosity (SSU at 100° F)	Oil Type	Recommended Relubrication Interval (approx. hrs. of operation)
-18 to 10 (0 to 50)	All	140 to 170	ISO VG32	8000
10 to 38 (50 to 100)	Above 1200	140 to 170	ISO VG32	6000
	450 to 1200	270 to 325	ISO VG46	8000
38 to 52 (100 to 126)	Above 1200	270 to 325	ISO VG46	3000
	450 to 1200	540 to 700	ISO VG68	5000

Note: For applications with ambient temperatures above 52° C (126° F) or below -18° C (0° F), consult special lubrication instructions supplied or contact the Toshiba Customer Support Center. Ambient temperature is air temperature or oil sump temperature in a customer-supplied pressure lube system.

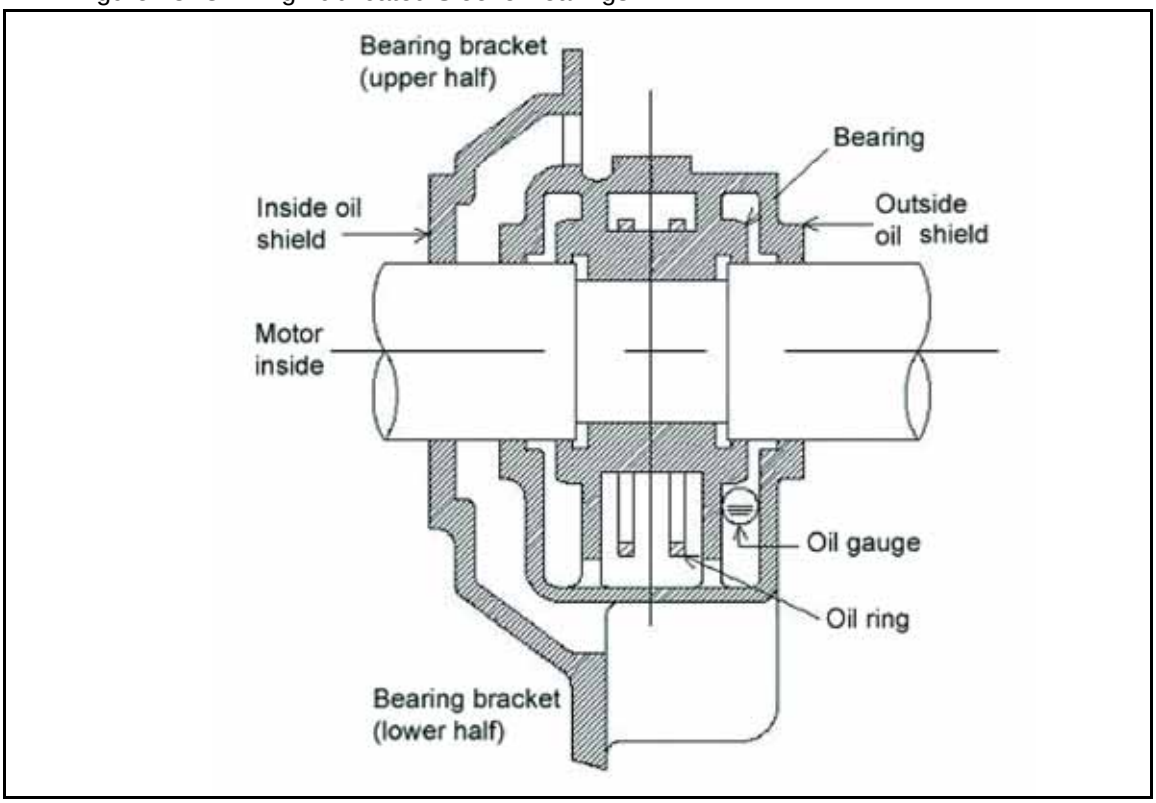
Note: A rust and oxidation inhibited turbine oil containing an antifoaming agent is recommended. Oil viscosity (Saybolt second universal @ 38° C [100° F]) conforms to the listed values to ensure proper bearing life.

Note: The recommended relubrication interval is a guide for estimating the proper allowable operation time between oil changes under normal operating conditions. In the absence of other special instructions, assume ½ of this time is proper for more severe operating conditions as listed in Table 2 on page 16. Regardless of the operating time, it is recommended that the oil be changed at least once per year.

Table 5. Typical Oils Satisfactory for use in Toshiba Motors.

Company	Trade Name		
	Grade 2 Turbine Oil ISO VG32	**Grade 2 Turbine Oil ISO VG46**	**Grade 2 Turbine Oil ISO VG68**
BP	Energol THB32	Energol THB33	Energol THB34
Castrol	Perfecto T32	Perfecto T33	Perfecto T34
Exxon Mobil	DTE Oil Light	DTE Oil Light	DTE Oil Light
Nippon Mitsubishi	FKB Turbine 32	FKB Turbine 33	FKB Turbine 34
Shell	Turbo T32	Turbo T33	Turbo T34
Texaco	Regal Oil R&O 32	Regal Oil R&O 33	Regal Oil R&O 34

Figure 13. Oil Ring Lubricated Sleeve Bearings.



Forced-Lubrication System

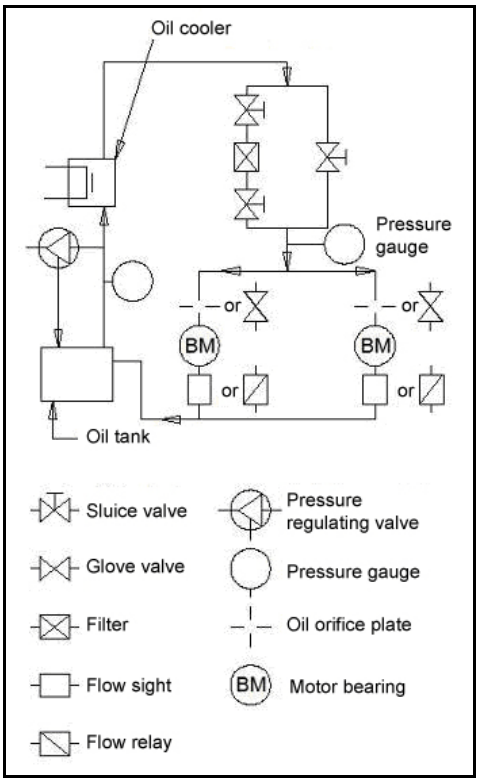
Forced-lubrication bearings are used for many large high-speed motors.

The required oil pressure for the motor is 10 psi. An orifice provided for the bearings can reduce the supplied oil pressure to the rated level, so long as the supply pressure is less than 15 psi.

The supply oil pressure of a specific system must be clarified in the ordering process. If the supply pressure exceeds 15 psi, a reducing valve must be used to adjust the oil pressure. A diagram showing the path of the oil flow in a typical flood-lubricated system is shown in Figure 14. on pg. 20.

There must be an orifice at each bearing oil inlet piping unless flow control devices are used elsewhere.

Figure 14. Typical Oil Flow Diagram



Because the drain side of the bearings is based on a gravity return, the oiling system must be installed such that the sump tank is below the motor bearing chamber level.

Ensure that the tank oil level is below the return line level so that the return oil can flow back to the reservoir freely.

Heating of Bearings

Bearings should be periodically checked for excessive heating. This is very important during the run-in period when overheating occurs most frequently. If overheating does occur, immediately determine the cause and take corrective action.

Overheating of Antifriction Bearings

It is always advisable to make frequent checks on the temperature of the bearings. Total bearing temperature should not exceed 140° C (284° F).

Toshiba standard settings for antifriction bearings alarm activation is 100° C (212° F) and trips at 110° C (230° F).

Listed below are the most probable causes of bearings overheating.

- Grease contamination.
- Insufficient amount of grease.
- Too much grease — Causing churning.
- Grease too stiff — Prevents free action in the bearings.
- Excessive thrust due to misalignment or excessive imposed loads.
- Pounding caused by bearings being loose on shaft or balls being worn.
- Actual bearing failure caused by a broken ball, broken cage, or flat balls.
- Heat from an external source causing a high bearing temperature.

Problems due to grease failures are many times due to inferior grease that is not neutral or free of moisture, acid, or non-lubricating fillers. These characteristics cause the grease to turn rancid in a short period of time and may actually etch and roughen the highly polished surface of the bearings. Some grease types also tend to become tacky or gummy and prevent freedom of the ball or roller action.

For performance issues caused by degredation of grease performance, the bearings should be disassembled and thoroughly cleaned with petroleum solvent or flushing oil. The bearing chamber should then be refilled with a new good grade of grease. Be sure that all solvent is removed before filling with grease. Fill the bearing chamber to three-quarters capacity to obtain the best efficiency. See the nameplate of the motor for the correct grease type to be used.

Bearing malfunctions may be caused by a coupling misalignment. **DO NOT** exert pressure on one side of the frame to make it fit into an uneven base or floor. If the frame distortion is excessive, bearing operation will be affected.

Mechanical failures caused by defective bearings should be remedied by replacing the bearings, determining the underlying cause, and taking the steps to avoid a recurrence of the problem. Excessive temperature rise of the bearings may also be reduced by removing the source of external heat if applicable.

Overheating of Sleeve Bearings

The temperature of sleeve bearings (taken with a thermometer close to the bearing lining) should not be more than 45° C (113° F) over the ambient temperature. Bearing failure is likely to result if the bearing temperature exceeds 95° C (203° F).

Toshiba standard settings for sleeve bearings alarm activation is 95° C (203° F) and trips at 100° C (212° F).

If excessive heating does occur, shut down the motor immediately and determine the cause of the overheating.

Listed below are the most probable causes.

- Improper alignment.
- Rough bearing surfaces.
- Improper fitting of linings, particularly around the oil grooves.
- Oil is of a poor grade, dirty, or wrong viscosity.

In the event of overheating, determine the cause immediately and take corrective action.

Environmental Factors

Motors that are installed in locations with excessive humidity, dust, etc., should be inspected more frequently than machines operating in clean and dry locations. Checks should be made to ensure that lubricants are clean and that the motor enclosure is free of moisture and dirt.

Take corrective action immediately if unsatisfactory conditions are observed.

Motors installed outside are more susceptible to adverse conditions and should be inspected more frequently.

Inspect for general cleanliness, proper lubrication, and loss of integrity of the protective painting (chips, fading, etc.).

Motor Disassembly and Reassembly

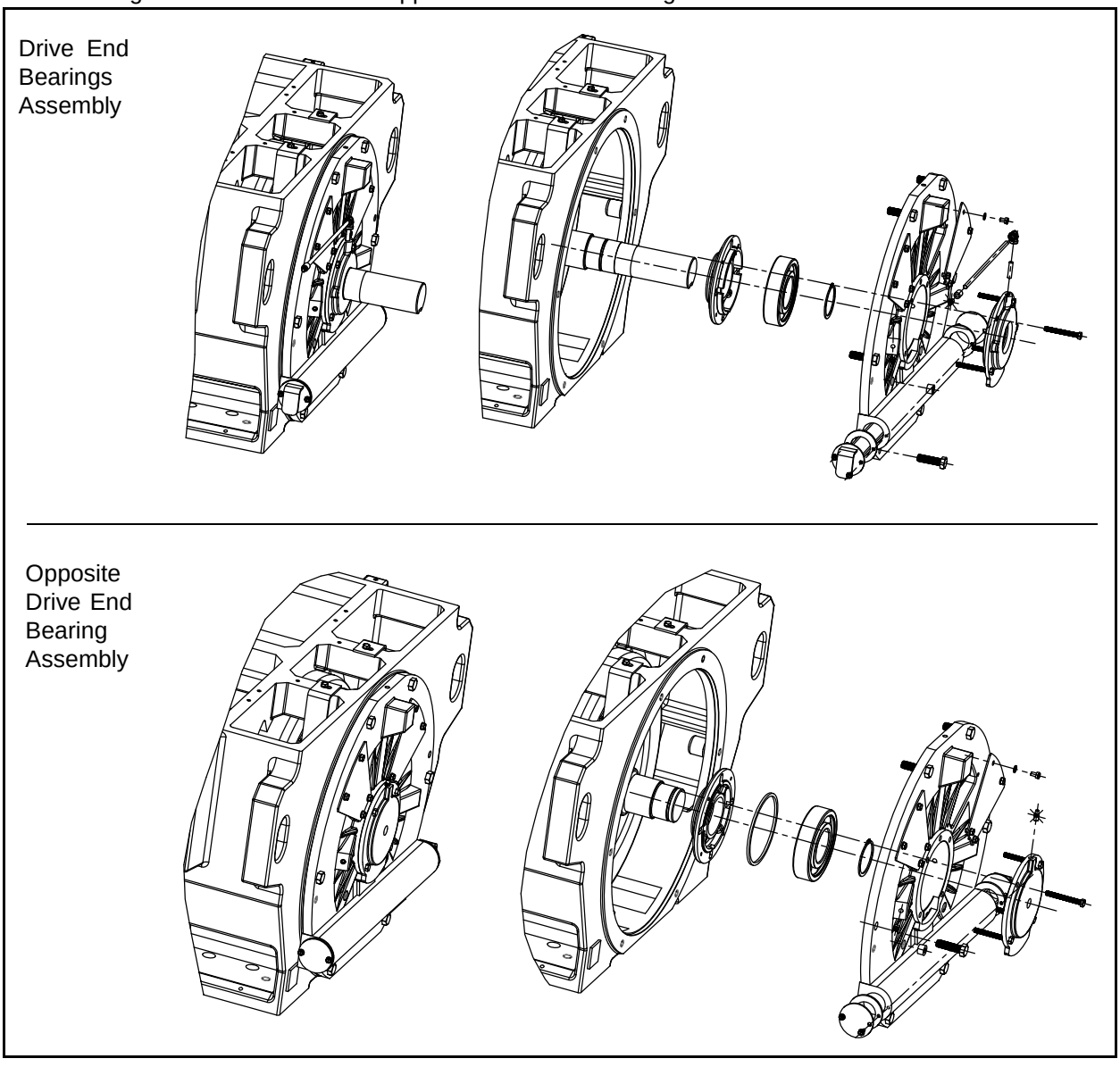
Remove/Replace Antifriction Bearings

When removing or replacing a bearing set, there are several guidelines that should be adhered to in every case. Following these rules closely will prevent damage to the bearings or motor and will result in a longer bearing life.

Remove the Bearings

When removing the bearings, always use an approved bearing puller. Follow all standard bearing puller instructions and safety procedures (i.e., safety glasses, protective gloves, etc.).

Figure 15. Drive End and Opposite Drive End Bearing Assemblies.

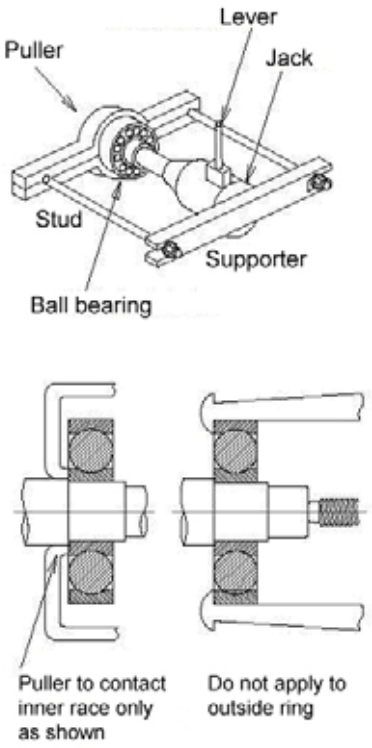


Install the Bearings

Bearing Installation Precautions

- **NEVER** open the protective cover on new bearings — Prevents dust or dirt exposure.
- **DO NOT** remove the bearings from the received package until the moment of installation. **Always** open the package in a clean place.
- **NEVER** clean new antifriction bearings — The slushing oil on new bearings should not be removed.
- **DO NOT** pack the bearings to capacity as this will cause overheating. Fill the bearing chamber to three-quarters capacity with clean grease.
- **DO NOT** force the bearings onto a shaft by means of the outer race.
- **DO NOT** attempt to force the bearings onto a badly worn shaft or a shaft that is too large for the bearings.

Figure 16. Bearing Puller.



Installation

Pressing in or induction heating are commonly accepted bearing installation methods.

When pressing in, coat the shaft with a thin film of oil.

Note that the metal tube fits against the inner race of the bearings. **DO NOT** strike the tube very hard — tapping will suffice.

Induction heating is the process wherein the bearings are heated in an oven or oil bath allowing for it to expand and slide onto the shaft. Before heating, ensure that the inner diameter of the bearings have been checked against the shaft journal dimension to prevent too tight of a fit after the bearings cool. The maximum difference of bore to journal should be 0.0004”.

Use a temperature of approximately 121° C (250° F). If the temperature is too high damage to the bearings may result and if the temperature is too low it may cause the bearings to seize onto the shaft.

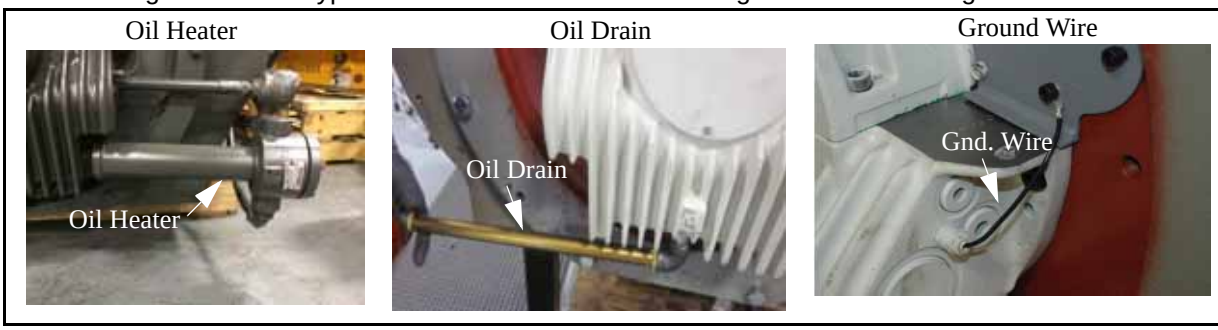
Remove/Replace Sleeve Bearings

Remove Ancillary Items

Note: *Remove the bearing RTDs before removing the bearings or any accessories.*

Removal of the sleeve bearings include the removal of all ancillary connections and systems from the upper/lower bearing covers first (i.e., oil heaters, oil drain, grounding wires, etc.).

Figure 17. Item types to be removed before removing the sleeve bearings.

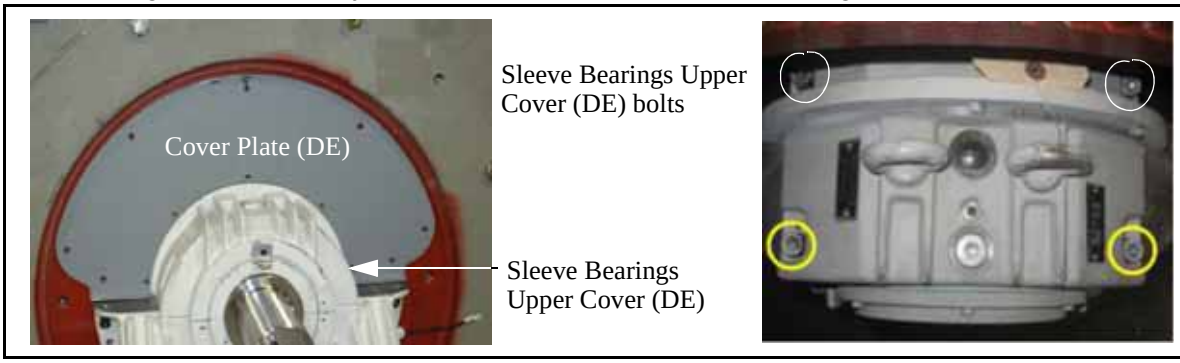


Remove Sleeve Bearings Cover Plate/End Cap

Remove the periphery mounting screws of the **Cover Plate (**DE**)**. Remove the **Cover Plate** (DE).

Remove the **Sleeve Bearings Upper Housing** (DE) bolts.

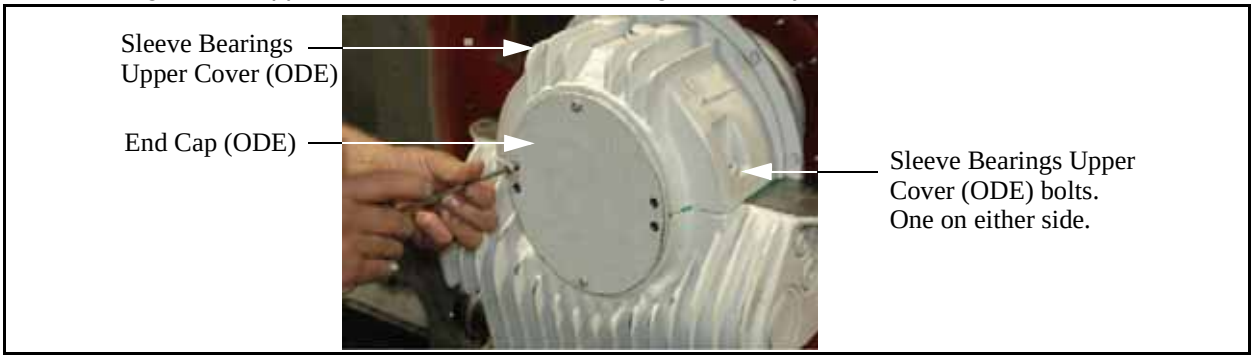
Figure 18. Assembly Covers for the Drive End Sleeve Bearings.



Remove the periphery mounting screws of the ODE **End Cap**. Remove the ODE **End Cap**.

Remove the mounting bolts of the **Sleeve Bearings Upper Housing** (ODE). Remove the **Sleeve Bearings Upper Housing** (ODE).

Figure 19. Opposite Drive End Sleeve Bearings Assembly.



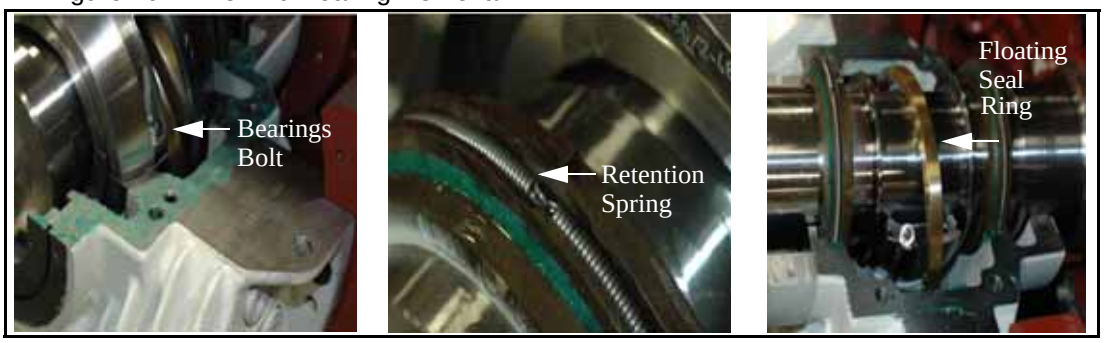
Remove the Drive End Bearings

Once the **Drive End** bearings are exposed, remove the two **Bearing Bolts** (one on either side of the bearing).

Remove the **Retention Spring** of the **Floating Seals**.

Remove the **Floating Seal Ring** by pressing out one of the joining pins to open the ring, then rotate the ring off of the shaft. Clean the **Floating Seal Ring** and place the ring in a lint-free cloth until required for reassembly.

Figure 20. Drive End Bearing Removal.



Remove the **Upper Sleeve Bearing** (DE).

Raise the shaft and support it with blocks to remove the pressure from the remaining lower bearing. Rotate the bottom sleeve bearing half to the top of the shaft and remove it.

Note: *It will not be necessary to remove the lower half of the bearing housing. However, the lower housing half can be removed by removing the screws of the holding caps and accessory piping, and then lifting it out of the bearing arm fit.*

Note: *The Antirotation notch must align to the top half of the bearing housing (**CAUTION:** Seals may break if misaligned.).*

Clean the lower bearing housing thoroughly before reassembling the bearing.

To reassemble, perform the above steps in the reverse order.

Reassemble Torque Specifications

Sleeve Bearing Torque Specifications		
	Bearing Size — ft. lbs.	
Flange Screws	7 — 24 ft. lbs.	
	9 — 24 ft. lbs.	
	11 — 51 ft. lbs.	
Shell Split Line Screws	7 — 3 ft. lbs.	
	9 — 5 ft. lbs.	
	11 — 6 ft. lbs.	
Housing Split Line Screws	7 — 24 ft. lbs.	
	9 — 24 ft. lbs.	
	11 — 51 ft. lbs.	
Note: — Do Not Loosen Bolts With Torque Wrench —		

Rotor Removal

CAUTION

The rotor may be pulled out as required for internal inspection, repair, and cleaning.

After disassembling the bearing brackets, bearings, and other accessories, the rotor is lifted with chain blocks connected to the shaft ends, shifted along the axial plane, and pulled out of the stator.

Axial space requirements for the rotor removal and reinsertion will be two times the rotor length.

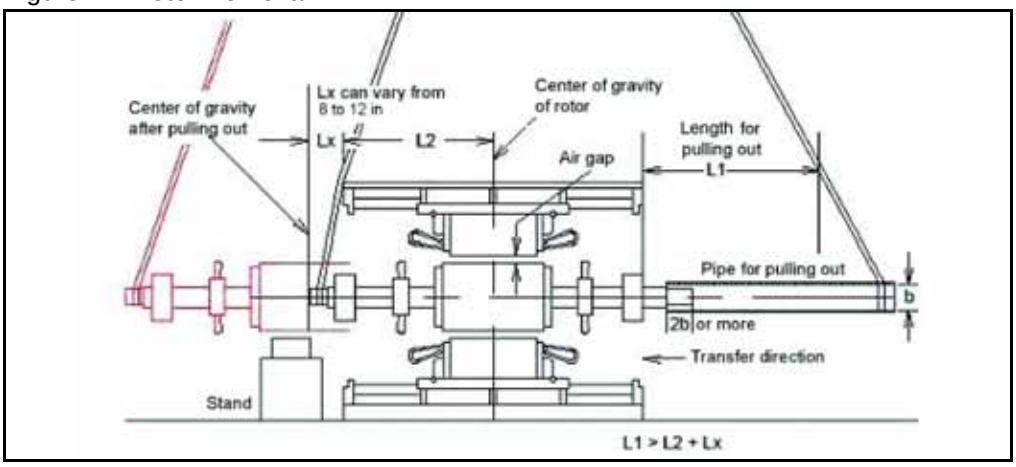
Two or more lifting hooks which can micro-adjust the horizontal shift and height of the rotor will be required. Typically, the rotor is lifted by chain blocks hung to the hooks of a traveling crane.

A pipe or extension shaft that is capable of holding the rotor shaft will be required to pass the rotor through the stator.

When a pipe is used, it shall be of the material matching the rotor weight and have an inner diameter of 0.2 to 0.78” (5.08 to 19.8 mm) larger than the mating shaft diameter.

Wind a protective sheet around the rotor shaft at the contact point to a length of at least twice the pipe diameter. The shaft may then be inserted into the pipe.

Figure 21. Rotor Removal.



Lifting Rotor

1. Insert the extracting pipe.
2. Wind the protective sheet around the contact portion of the shaft.
3. Insert the pipe to a depth of at least twice the diameter of the pipe.
4. Slowly lift the rotor through the chain block, paying close attention to the rotor-to-stator air gap.

Removing Rotor

Ensure that the rotor does not contact the stator throughout the operation.

Slowly shift the rotor along its axial plane. When the center of gravity of the rotor exits the stator, rest the rotor on the stand. Pull-out is completed.

Inserting Rotor

The insertion is made by the reverse order of pull-out.

Completion of the insertion phase occurs when the difference between the core ends of the stator and rotor are equal at both ends.

Electrical Testing

Field Insulation Test

Field insulation tests on large motors are performed to determine the following:

- The condition of the insulation.
- The need to recondition insulation system to prolong the life of the motor.
- A long-range program to detect progressive deterioration.

Because the motor may be commissioned within a wide range of environments and applications, this section will discuss installation variables and other systemic considerations that apply with each installation.

Each installation must be evaluated for the specific conditions of the application to determine the test method that is best-suited for the application.

The insulation resistance test is made with DC rather than AC to determine if a system can be tested with high voltage. For 0 – 7000 volt form-wound induction motors, the tests in Table 6 are recommended.

Table 6. Recommended Insulation Tests.

Type of Winding	Voltage Range	Type of Test					
		AC Hipot		DC Megger		DC Hipot	
		Pre Service	In Service	Pre Service	In Service	Pre Service	In Service
Form	0 – 600	Yes	Yes	Yes	Yes	No	No
	601 – 7000	Yes	No	No	No	Yes	Yes

Effect of Altitude on Temperature Rise

Because most motors are cooled by convection and because the density and corresponding cooling ability of the air decreases with altitude, allowances must be made for operation in altitudes above 3300 feet.

NEMA Standards specify that the temperature rise as tested at low altitudes shall be less than that tabulated in the **Temperature Rise Standard** by 1% of the specified temperature rise for each 330 feet increase in altitude above 3300 feet.

As an illustration, an open motor tested at sea level must have a full load temperature rise of only 64° C (147° F) to be suitable for operation at 9900 feet altitude with the standard temperature rise of 80° C (176° F).

The calculations are shown below:

Standard Temperature Rise Open Motor = 80° C

Allowance for 9900 Feet Altitude

Maximum Permissible Temperature Rise at Low Altitude is 64° C (80° C - 16° C).

$$\frac{9900 - 3300}{330 * 100} * 80°C = 16°C$$

Special Equipment (Accessories)

Some of the following special equipment or accessories that may be required will depend upon the size of the motor, moisture, dust, ambient temperature, etc.

Space Heaters

Space heaters are provided in electrical motors that operate under damp, cold, humid, or environmentally exposed conditions.

To counteract dampness, heaters are designed to maintain the internal temperature of the motor at approximately 5° C (41° F) above the ambient temperature.

Heaters may be specially designed to keep lubricants from becoming excessively cold. Operating temperatures may be controlled to meet various requirements.

The location of the space heaters in the machine is dependent on the use for which they are provided. Typically, the heaters are mounted on one or both of the bearing arms, the frame, or coil guards.

Where heaters are to be used, some consideration should be given to the installation position as it applies to the disassembly of the equipment (when required).

Do not operate the space heaters while the motor is running.

Stator Temperature Detectors

Many large motors are equipped with temperature detectors to detect the stator winding temperature. The type of detector used is based solely on the customer requirements. The leads are brought out to a separate auxiliary terminal box.

Several types of temperature detectors are available for sensing stator winding temperature. High-voltage motors are equipped with a separate auxiliary terminal box.

Resistance Temperature Detectors

A Resistance Temperature Detector (RTD) is a variable resistor in which the resistance value of the component varies as a function of an ambient thermal condition. The resistance variation is used to indicate changes in temperature. The RTDs are installed in the motor slots.

Thermocouple

Thermocouples are comprised of the connection between two dissimilar metals that produce a voltage when heated. This voltage is calibrated and used to indicate the ambient motor temperature.

Thermocouples are installed in the motor slots. The thermocouples are designed to operate in conjunction with other instruments.

Bearing Temperature Detectors

Many sleeve bearing motors are supplied with some type of bearing temperature detector. These devices will provide a warning or shut down the equipment if the bearings overheat. The overheat may be of one of several causes (e.g., misalignment, loss of lubrication, etc.).

Bearing temperature detectors may be one of several varieties. Typical detectors are resistance-temperature detectors, thermocouples, thermistors, bulbs filled with expandable liquids, bimetallic elements, etc. Each of these detector types require some form of switching equipment to process the signal from the device.

Air Filters

Air filters on motors are designed to trap air borne dirt before it gets into the working parts of a motor. The usefulness of filters is dependent upon the operating environment and how frequently they are cleaned and/or changed.

Listed below are the available types of air filters.

- Metallic Air Filters

  These are permanent, cleanable, viscous-type filters made of galvanized metal construction. Stainless steel and Monel construction are also available. It is constructed of horizontal layers of galvanized wire screen mesh (so arranged as to provide a large filtering area) and has no direct passages through the filter media.

- Non-Metallic Filters

  These are washable, replaceable filters of foam with a metallic frame for support.

- Dry Type Filters

  These are non-reusable filters composed of a fiberglass material on a round wire frame.

All motors are designed to operate properly with or without air filters. However, air filters do tend to restrict and reduce the volume of air that cools the motor. To ensure that the motor does not reach a critical temperature, stator winding protection devices are recommended.

Ordering Information and Spare Parts

Ordering Information

Toshiba motors may be ordered using the part naming convention listed in **Appendix A** of the ***2013 Low & Medium Voltage Motor Catalog***.

The catalog may be found at the Toshiba.com\tic\ website.

From the home page, click Products\Motors**2013 Catalog**.

Note: *The 2013 version is the latest released version at the time of the release of this manual.*

Spare Parts Listing

The recommended spare parts listed in Table 7 are wear items and are normally the most susceptible to damage. The table should be considered as a guide only, but it will offer reasonable security for normal operations.

Stock size will depend primarily on the application. Critical applications where continuous operation is of primary importance will naturally require a larger supply of parts.

Each user will have to evaluate the proper requirements in this respect.

Table 7. Recommended Spare Parts for AC Motors.

Item	Part Name	1 to 4 Motors	5 to 9 Motors	10 to 25 Motors
1	DE Bearings (AF)	1	2	2
2	NDE Bearings (AF)	1	2	2
3	Oil Rings (where required)	1 set	1 set	2 sets
4	Sleeve Bearing Liners	1 set	1 set	2 sets

Service Guide

The following table lists operational symptoms that may occur, probable causes, and the suggested approaches to a solution. This table is intended as both a diagnostic aid and a quick reference sheet. If the source of the malfunction is unknown, or the solution is not achieved after using this information, report the matter to the Toshiba Customer Support Center.

Table 8. Troubleshooting Chart.

Symptom	Probable Cause	Remedy
Failure to start	• Loose, unattached, or incorrectly fastened electrical connections. • Low line voltage. • Excessive load. • Open circuit in stator windings or in squirrel cage bars. • Short circuit in rotor or stator.	• Confirm as correct and tighten all mechanical and electrical connections. • Check panel meters. • Reduce load. • Remove load/retest. • Run a continuity check. Check condition of coils and bars. Repair if possible. If impractical, order renewal parts from the Toshiba Customer Support Center.
Motor overheating	• Overloaded. • Improper line voltage or incorrect frequency. • Ventilation obstructed. • Unbalanced electrical power. • Excessive heat, humidity, dirt, etc., has adversely affected insulation.	• Reduce load. • Clean motor. • Check voltage of each phase. • Failing bearings. • Motor/load misalignment. • Perform an insulation resistance check with a megger.
Noisy or overheated bearings	• Misalignment between motor and driven machine. • Excessive, low, or improperly packed grease (if grease lubed). • Low oil level (if oil lubed). • Improper fit of bearings (especially in oil grooves) or in Babbitt liners. • Excessive belt tension or excessive load side thrust. • Contaminated oil.	• Check alignment and correct as necessary. • Clean bearings and repack with proper viscosity grease. Check for damage. • Drain and fill to correct level with correct viscosity. Check for scoring of bearing surfaces. • Replace bearings if damaged. • Reduce belt tension or load side thrust. Check alignment and correct as necessary. • Drain oil, flush clean, and refill with recommended oil.

Symptom	Probable Cause	Remedy
Abnormal noise or abnormal vibration	• Foreign matter between fan and another object. • Single-phase operation. • Unbalanced electrical power. • Air gap is unequal. • Loose coupling between motor and the driven equipment. • Loose motor and/or driven equipment.	• Check fan path for obstruction. • Remove foreign object — Keep surroundings free of foreign objects. • Check for unbalanced voltage. • Align the rotor to the center of the stator. • Check and/or replace bearings. • Tighten mounting bolts securely.
Vibration	• Improper alignment between motor and driven machine. • Loose or incorrect base attachment. • Worn bearings. • Unbalanced load. • Warped base.	• Measure vibration amount with vibration sensor at sides of frame and bearings at shaft height. Determine if the source is in the motor or in the driven machine. If vibration is in excess of the values in Table 1 on page 12, corrective measures must be taken. • Measure around concentric periphery of coupling with both clamps and dial gage, or with feeler gage and straight edge. Realign if required. Check vertical with a bubble scale or plumb bob. • Check coupling and make adjustments as required. • Remove the load and run the motor to determine if the load is unbalanced. • Worn drive gears of the driven machine.
Improper direction	• Improper direction.	• Reverse any two of the 3-phase power leads to the motor and observe the direction of rotation. Refer to connection plate, connection drawing, or the certified motor outline.
Poor or intermittent overall performance	• Improper grounding.	• Add a ground strap.

Index

A

Accessories, 28
Air Filters, 29
Antifriction Bearings, 16
Axial Alignment, 11
Axial Parallelism, 11

B

Balancing Direct Coupled Motors, 12
Bearing Temperature Detectors, 28
Bedplate Installation and Leveling, 8

C

Cleanliness, 14
Customer Support, 2

D

Drying, 15

E

Electrical Testing, 27
Equipment Warning Labels, 2

F

Flexible Coupling, 10
Foundation Bolt, 6

G

General Safety Information, 1
Grouting, 8

H

Handling, Storage, and Installation, 4
Heating of Bearing, 20

I

Important Notice, 3
Installation, 4
Insulation Resistance, 14

J

Jacking Screw, 7

L

labels, 2
Lubrication and Bearings, 16

M

Magnetic Center Adjustment, 9
Maintenance, 14
Motor Coupling and Alignment, 10
Motor Disassembly, 22
Motor Installation, 6
Motor Operation, 13
Motor Reassembly, 22
Mounting, 7

O

Ordering Information, 30
Overheating of Antifriction Bearings, 20
Overheating of Sleeve Bearings, 21

Q

Qualified Personnel, 3

R

Remove/Replace Sleeve Bearing, 24
Rigid Coupling, 10
Rotor Removal, 26

S

Service Guide, 31
Signal Words, 1
Sleeve Bearings, 18
Space Heaters, 28
Spare Parts, 30
Spare Parts Listing, 30
Special Equipment, 28
Special Symbols, 1
Start-Up Precheck, 13
Storage, 4

T

Temperature Detectors, 28
Testing, 13
Troubleshooting Chart, 31

V

Vibration, 12
Vibration Limits, 12

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