

# **TOSHIBA**

TOSHIBA INTERNATIONAL CORPORATION

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# **INSTRUCTION MANUAL**

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**INSTALLATION – OPERATION – MAINTENANCE**

***JK Series 720 Ampere Medium Voltage Controllers***

***Issued: 9/19***



## 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, operation, or maintenance of this equipment. Should additional information be required, contact your Toshiba 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 the prior written consent of Toshiba International Corporation may void all warranties or other safety certifications. Unauthorized modifications may also result in 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

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 [TIC-Controls@toshiba.com](mailto:TIC-Controls@toshiba.com).

## Purpose and Scope of Manual

This manual provides information on how to safely install, operate, maintain, and dispose of your JK controller/starter. The information provided in this manual is applicable to the **JK 720** only.

This manual provides information on the various features and functions of this device, including:

- Installation
- Operation
- Mechanical and electrical specifications

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

This manual and the accompanying drawings should be considered a permanent part of the equipment and should be readily available for reference and review. Dimensions shown in the manual are in imperial units and/or the metric equivalent. Connection drawings within this document convey the typical topology of the JK 720 controller.

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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 system 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/Fax (713) 937-9349 CAN (800) 872-2192 MEX 01 (800) 527-1204. For after-hours support follow the directions of 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**

For further information on Toshiba International Corporation's products and services, please visit our website at [www.toshiba.com/tic](http://www.toshiba.com/tic).

## TOSHIBA INTERNATIONAL CORPORATION

### JK Series Controller

Complete the following information and retain for your records.

Model Number: \_\_\_\_\_

Serial Number: \_\_\_\_\_

Project Number (if applicable): \_\_\_\_\_

Date of Installation: \_\_\_\_\_

Inspected By: \_\_\_\_\_

Name of Application: \_\_\_\_\_

## 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.

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.



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.



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.



The word **NOTE** provides helpful information.

### NOTE

## 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 are there 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.

## Qualified Personnel

Installation, operation, and maintenance shall be performed by **Qualified Personnel ONLY**. A Qualified Person is one that has the skills and knowledge relating to the construction, installation, operation, and maintenance of the electrical equipment and has received safety training on the hazards involved (Refer to the latest edition of NFPA 70E for additional safety requirements).

**Qualified Personnel** shall:

- Have carefully read the entire manual.
- Become familiar with the construction and function of the starter, 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](http://www.osha.gov).

## Equipment Inspection

- Upon receipt of the equipment, inspect the packaging and equipment for shipping damage.
- Carefully unpack the equipment and check for parts that may have been damaged during shipping, missing parts, or concealed damage. If any discrepancies are discovered, it should be noted with the carrier prior to accepting the shipment, if possible. File a claim with the carrier if necessary and immediately notify your Toshiba Customer Support Center.
- **DO NOT** install the starter if it is damaged or if it is missing any component(s).
- Ensure that the rated capacity and the model number specified on the nameplate conform to the order specifications.
- Modification of this equipment is dangerous and is to be performed by factory trained personnel **ONLY**. When modifications are required, contact your Toshiba Customer Support Center.
- Inspections may be required after moving the equipment.
- Contact your Toshiba Customer Support Center to report discrepancies or for assistance, if required.

## Handling and Storage

- Use proper lifting techniques when moving the equipment, including properly sizing up the load, getting assistance, and using a forklift, if required.
- Store in a well-ventilated location, preferably in the original packaging, if the equipment will not be used upon receipt.
- Store in a cool, clean, and dry location. Avoid storage locations with extreme temperatures, rapid temperature changes, high humidity, moisture, dust, corrosive gases, or metal particles.
- The storage temperature range of the contactor is 23° to 104° F (-5° to 40° C). If stored at a lower temperature or where high humidity exists, a cubicle space heater is required, powered from an external 120Vac source.
- **DO NOT** store the unit in places that are exposed to outside weather conditions (e.g. wind, rain, snow).
- Store in an upright position.

## Disposal

Never dispose of electrical components via incineration. Contact your state environmental agency for details on disposal of electrical components and packaging in your area.





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## RECEIVING, HANDLING/MOVING, AND UNPACKING

### Receiving and Unpacking

Upon receipt of the equipment, do the following:

- All JK Series units are shipped in the vertical (upright) position and should be handled accordingly when received. If the controller is not upright upon receipt, notify the carrier of possible damage. Upright the units as soon as possible and immediately notify the nearest Toshiba representative.
- Carefully unpack the unit and make an immediate inspection for any concealed damage which might have occurred during shipment. If damage is found, it should be noted with the carrier prior to accepting the shipment, if possible. Report any damage immediately and file a claim with the freight carrier within 15 days of receipt.
- Verify that the starter description on your unit matches your purchase order. The starter information is located on stickers in the medium voltage incoming compartment.
- Keep the equipment upright.



**Do not install or energize equipment that has been damaged.**



**Do not lay the equipment on its side or upside down.**

### Handling and Moving

Medium voltage controllers should be handled with care to avoid damage to components, frame, and finish (Fig. 1).

The capability of the moving equipment to handle the weight of the controller shipping section should be confirmed. The equipment should remain secured to the shipping skid to prevent distortion of the frame during moving and to minimize tipping. Extreme care should be exercised during any movement and placement operations to prevent dropping or tipping.



**Do not place any part of your body beneath the equipment being lifted. Improperly secured equipment can fall or tip over quickly and without notice.**



### Using a Forklift

A forklift truck may offer a more convenient method of handling the controller. A safety strap should be used when handling with a forklift. The ends of the forks should not enter the bottom of an open-bottom enclosure.

**Fig. 1 Moving the Controller**

### Overhead Lifting

When it is necessary to move the equipment between elevations, overhead hoisting may be required. Lifting angles (for multiple controller sections) are provided on top of the enclosure for this purpose. Spreaders (Fig. 2) should be used to provide the vertical lift on single controllers to prevent eye-bolt failure. Always keep the controller upright while lifting. Some controller sections may contain heavy or special equipment that will cause the center of gravity to be off-center. Rigging lengths should be adjusted to maintain the controller in an upright position. The angle between the lifting cables and vertical should not be allowed to exceed 45 degrees (Fig. 3). Ropes or cables should not pass through the holes in lifting angles or eye-bolts. Slings with safety hooks or shackles of adequate load rating should be used.

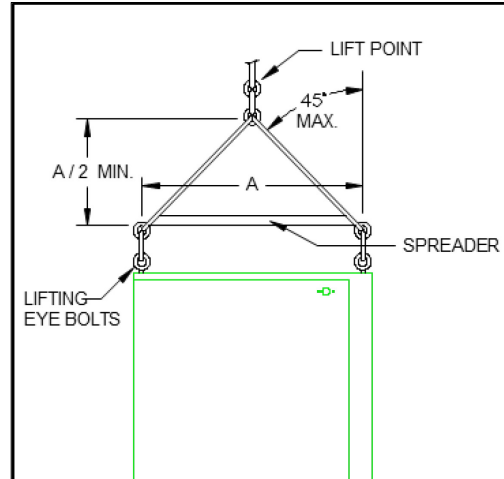


Fig. 2 Use of Spreader Bar - Single Section

### Initial Inspection

- Make a complete visual check of the unit for damage which may have occurred during shipping and handling. Do not attempt to continue installation or start up the unit if it is damaged.
- Check for loose mechanical assemblies or broken wires which may have occurred during transportation or handling. Loose electrical connections will increase resistance and cause the unit to function improperly.
- Prior to beginning the installation, verify that the load and JK unit are rated for the proper amperage and voltage.

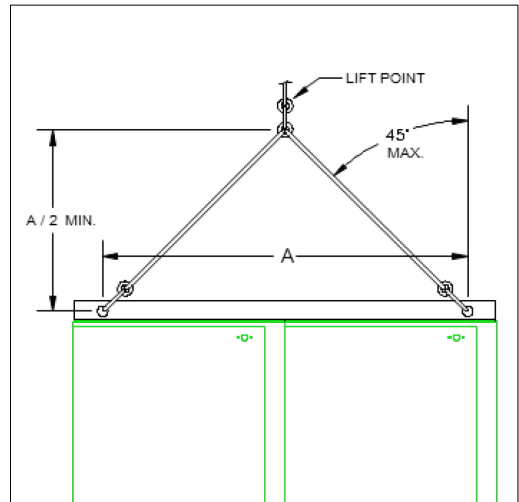


Fig. 3 Lifting Multiple Sections

## LOCATION

### Storage

If the controller is to be stored for any length of time prior to installation, the packing should be restored for protection during that period. Where conditions permit, the packing should be left intact until the controller is at the final installation position. If the packing (Fig. 4) is removed, the top and openings of the controller should be covered during the construction period to protect it against dust and debris.

### Indoor Equipment

Controllers designed for indoor installation (e.g. Type 1, 12) that are not to be installed and energized immediately should be stored in a clean, dry space where a uniform temperature prevents condensation. Preferably, the controller should be stored in a heated building, with adequate air circulation and protected from dirt and water. Equipment should be stored where it is not subject to mechanical damage, especially



Fig. 4 Storage

during building construction. An indoor controller that is to be stored outdoors should be securely covered for protection from weather conditions and dirt. Temporary electrical heating should be installed to prevent condensation. Approximately 150 watts per enclosure is usually adequate.

**NOTE:** All loose packing or flammable materials should be removed before energizing space heaters.

### Outdoor Equipment

An un-energized controller designed for outdoor installation (e.g. Type 3R) should be kept dry internally by installing electrical heating or by energizing provided space heaters. All openings, either used or unused, should be covered or sealed to prevent the entry of rain, vermin, insects, etc.

### Routine Inspection

Routine scheduled inspection should be established if storage for an extended period is anticipated. This is to check for condensation, corrosion, vermin, and adequacy of space heating. Prior to inspection, the equipment should be carefully examined for evidence of physical damage, corrosion, or other deterioration.



**WARNING**

**Do not install equipment found to have damage or deterioration that could affect the unit performance.**

## INSTALLATION

### Rating Verification - Prior To Installation

The maximum fault capability of the power system at the point of installation should be verified and must not exceed the short-circuit rating of the controller (see RATINGS section). All system accessories, such as surge suppressers, lightning arresters, etc., should be checked to verify their ratings capacity.



**DANGER**

**Do not exceed the ratings specified on the controller nameplate or system accessories.**

### Location

Overhead should be checked for plumbing condensation, sprinklers, or similar possible sources of trouble. A clearance of 1/2 inch should be provided between a wall and the rear of the controller for indoor equipment, when rear access is not required. If rear access is required in either environment, a minimum of 30 inches should be provided. Consult local codes in case more space is required.

A minimum of 48 inches working space should be allowed in front of the controller. This minimum should be increased if necessary to accommodate movement around open enclosure doors to comply with applicable codes.

If the location for installation is damp, space heaters may be required. If space heaters (Fig. 5) are furnished inside the controller, they should be connected in accordance with the wiring diagram furnished.

**⚠ WARNING**

**Do not install this equipment in areas where unusual service conditions exist, unless the equipment has been specially designed for the particular environment.**



**Fig. 5 Typical Space Heater**

### Service Conditions

Toshiba medium voltage controllers are intended for usual service conditions as defined by NEMA. The equipment should not be exposed to corrosive or explosive fumes, dusts, vapors, dripping or standing water, abnormal vibration, shock, tilting, or other abnormal operation conditions. The temperature of the ambient air surrounding the controller should be between the limits of 0°C (32°F) and +40°C (104°F). The altitude of the equipment installed should not exceed 3300 ft. (1000m).

**NOTE:** Temperature or altitude conditions outside of the usual limits may require derating or other special equipment, such as heating, cooling, or ventilation. Contact Toshiba for further information.

**⚠ WARNING**

**Do not install this equipment in areas where unusual service conditions exist, unless the equipment has been specially designed for the particular environment.**

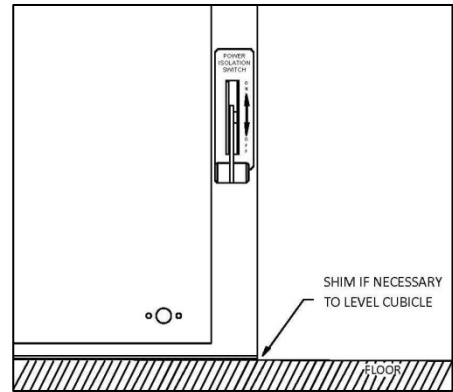
### Installation Site Preparation

It is recommended that site preparation be completed before the controller is unpacked, so that possible problems such as headroom, conduit location, cable tray locations, ventilation, etc. can be solved, assuring a proper installation in compliance with the building plans and codes. The floor on which the controller will be placed must be level so that the enclosure is not distorted when bolted in place. Ensure the equipment adequately clears any underground raceways or cables.

**Mounting**

Each shipping section must be leveled and firmly secured to its supporting foundation. Steel shims may be used for final leveling (Fig. 6), if necessary. When three or more shipping sections are to be arranged in one continuous line-up, the center shipping section should normally be located first.

Follow the equipment outline drawings to determine the location of the mounting bolt holes and any conduit locations.



**Fig. 6 Leveling Using Shims**

Various methods may be used to anchor the enclosure to the foundation, including expandable inserts or “J” bolts embedded in concrete. The recommended size for anchor bolts is 1/2” (Fig. 7).

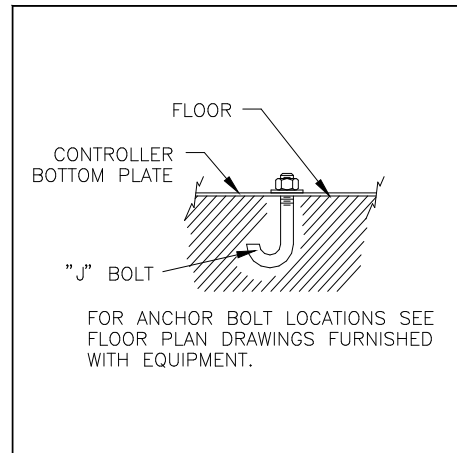


**WARNING**

**For heavy equipment, enclosure must be securely anchored to prevent tipping over.**

**Additional Cabinet Entries**

If conduit entry locations are required in areas other than the removable plates, cover the electrical assemblies to prevent metal filings from becoming lodged in areas which may cause a reduction in the high voltage clearances or a short circuit. After the work is completed, thoroughly clean the area and inspect the unit for foreign material.



**Fig. 7 Securely Anchor the Controller**

**Ground Connections**

The controller line-up must be grounded in accordance with the requirements of the National Electrical Code. Proper equipment grounding must be established before making any incoming power connection. If a main ground bus (Fig. 8) is furnished, make the ground connection to this bus. If there is no ground bus, the sections which are shipped separately should be connected to ensure a continuous grounding path.

Each section contains a vertical ground bus extending from the main ground bus or ground pad to each controller compartment.



**Fig. 8 Main Ground Bus**



Special attention should be paid to protection for operating personnel, to protection of equipment itself (e.g. ground fault relays), and protection of sensitive transducers or control devices that are electronic in nature.

The following may be used as a general guide with regard to equipment grounding.

Controller used as service equipment for a grounded system or as a main section for a separately derived system:

- a. The grounding electrode conductor (ground wire) sized in accordance with NEC 250 should be run from the grounding electrode to the controller ground bus or ground terminal.
- b. Unless already done at the factory, a main bonding jumper should be installed from the incoming grounded connector bus (neutral) to the ground bus or designated grounding point. If a jumper is not furnished, one having a size in accordance with NEC 250 should be selected.
- c. Steps (a) and (b) should effectively connect together the grounding electrode, the controller frame, all outgoing equipment grounding conductors, and the grounded neutral bus of the system.
- d. No connection should be made to ground on the load side of any neutral disconnecting line or any sensor used for ground fault protection. No connections should be made between outgoing grounding connectors and the neutral.
- e. Where the controller or system is dual-fed (double-ended) and has ground fault protection, special precautions are necessary to accomplish proper grounding and bonding.

Controller used as service equipment for an ungrounded system or as a main section for a separately derived system:

- a. A grounding electrode conductor (ground wire) sized in accordance with NEC 250 should be run from the grounding electrode to the controller ground bus or ground terminal.
- b. If the system is grounded at any point ahead of the controller, the grounded conductor should be run to the controller in accordance with NEC 250 and connected to the ground bus or ground terminal.
- c. Steps (a) and (b) should effectively connect together the grounding electrode, the controller frame, all outgoing equipment grounding connectors, and any grounded conductor which runs to the controller.

Controller not used as service equipment or as a main section for a separately derived system, and used on either a grounded or ungrounded system:

- a. The controller frame and any ground bus should be grounded by means of equipment grounding conductors having a size in accordance with NEC 250 and run with the main supply conductors or by bonding to the raceway enclosing the main supply conductors in accordance with NEC 250.

- b. Ground leads should be connected to cable potheads/shields as specified by the manufacturer of these devices.

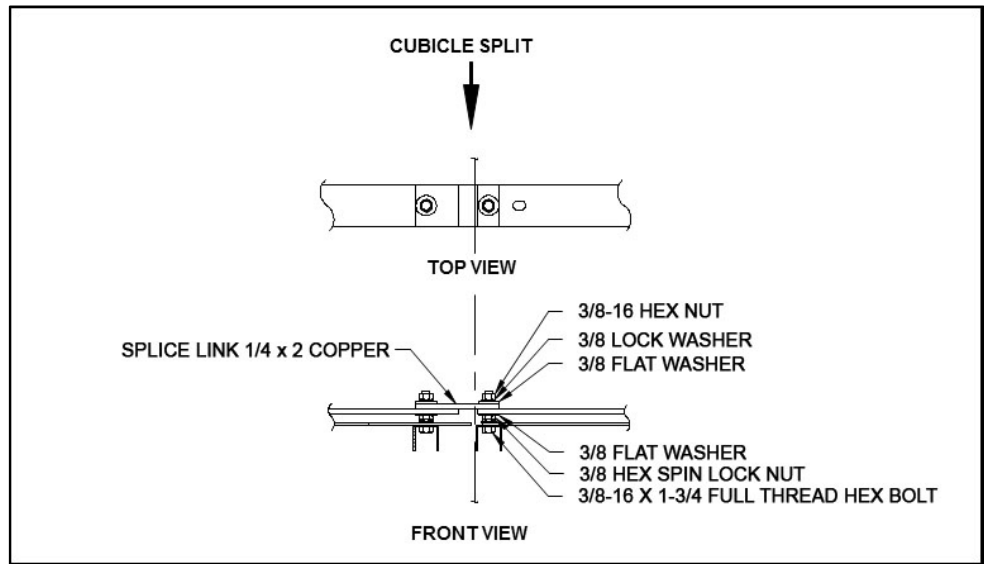


Fig. 9 Ground Bus Splice

**Medium Voltage Power Connections**

Use a properly calibrated torque wrench to tighten all MV connections according to Figures 10a and 10b.

Cable and wire bundles that enter the controller enclosure should be routed to avoid interference with moving parts. Minimum bending radius for the type of cable used should be observed.

Power cables should be braced and/or laced to withstand short circuit forces wherever such cables are unsupported. Power cables should be adequately sized to carry the motor full load current in accordance with NEC requirements, and have an adequate voltage rating. Cables should be dressed and terminated as appropriate to the voltage class and cable manufacturer’s recommendations.

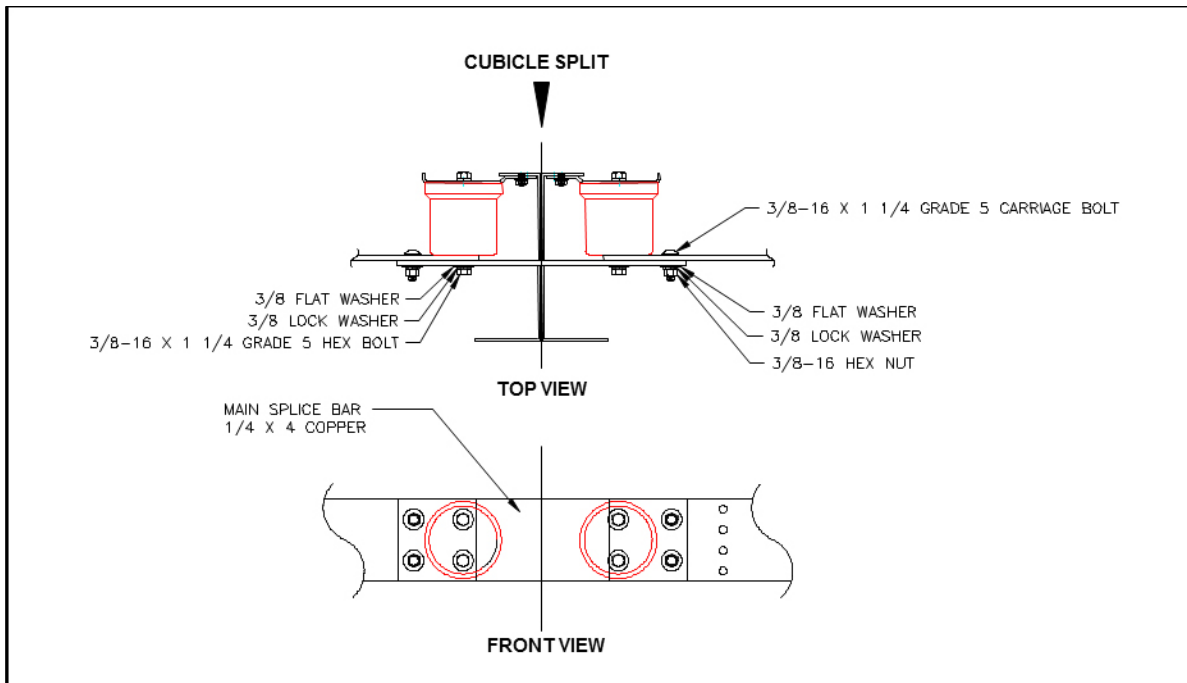
Bolt Size	Torque at Full Engagement (ft – lbs)
1/4 - 20	6
3/16 - 18	12
3/8 - 16	18
7/16 - 14	30
1/2 - 13	45
9/16 - 12	68
5/8 - 11	90
3/4 - 10	150
7/8 - 9	240
1.0 - 8	245

Fig. 10a Torque Specs for MV Power Connections

Main power bus (when provided) and horizontal ground bus are supplied with links to join shipping sections together. These should be installed in accordance with Fig. 9 through Fig. 12. All access covers, barriers, partitions, etc., that are temporarily removed during installation must be replaced.

Bolt Size	Torque at Full Engagement (ft – lbs)	Type of Connection
1/2 - 13	45	Bus - Bus
3/8 - 16	28	Bus - Bus
	25	Bus - Glastic Ins.
	18	Bus - Porcelain Ins.
5/16 - 18	15	
M 12	35	

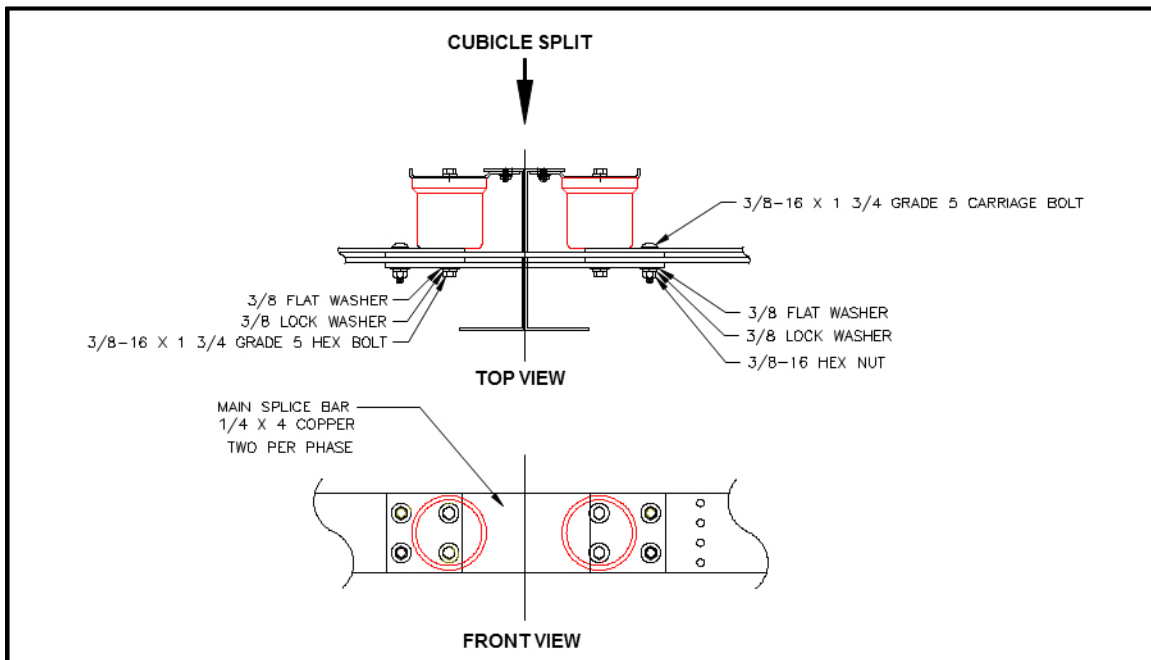
Fig. 10b Torque Specs for Bus Connections



**Fig. 11 Main Bus Splice Connections - 1200A Main Bus**

**NOTE:** Covers and braces supplied only for protection during shipment should not be replaced. All debris and tools should be removed from each compartment as cabling is completed.

**Remove part number identification or any label on the splice bus before installation. Tighten and torque the bolts for all bus splice connections and other bus if loosened during installation of the bus splice.**



**Fig. 12 Main Bus Splice Connections - 2000A  
(Consult Factory For 3000A Main Bus Splice)**

### Incoming Line

On the standard JK, incoming power cable connections should be made at the points shown on the wiring diagram furnished with the equipment. These connections will normally be made in a separate incoming compartment to bus lugs, an incoming load interrupter switch, or a vacuum circuit breaker.

### Load Connections

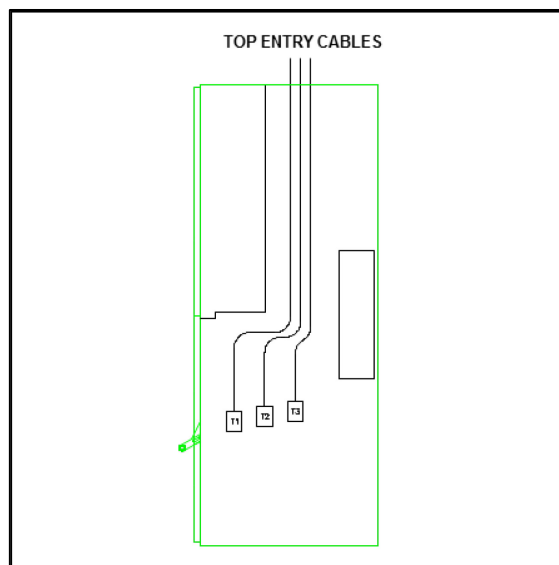
Outgoing load connections are made in the controller compartment to the three copper pads located on the left hand side wall.

Typical routing of load cables is depicted in Fig. 13 and Fig. 14 for top and bottom entry of cables, respectively.

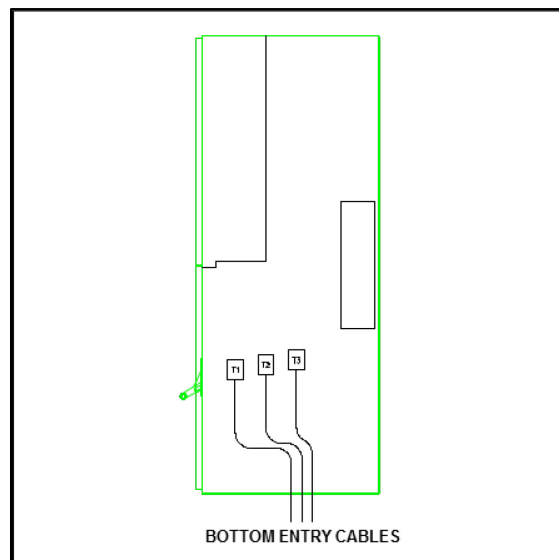
Load cable termination arrangements for certain controllers, such as reduced voltage autotransformer types, may differ from those shown in this manual. In these cases, refer to the drawings furnished with the equipment.

When routing and terminating load cables, observe the following:

- Use listed compression connectors suitable for the cable being used.
- Use the 1/2" hardware provided with the controller to attach cable connectors to bus pads. After installation, torque hardware to 45 lb-ft.
- After installation, check to see that at least three inches of clearance is maintained between live parts of opposite polarity and between live parts and ground.



**Fig. 13 Controller Load Wiring - Top Entry**



**Fig. 14 Controller Load Wiring - Bottom Entry**

**PRE-ENERGIZATION CHECK**

**General**

AFTER INSTALLATION, BUT BEFORE ENERGIZING THE CONTROLLER for the first time, follow the procedure below to verify that the equipment is properly installed and functional.

There is a rating data label (Fig. 15) on the inside of each medium voltage compartment door. Verify that the controller ratings properly match the system data by checking the following:

1. Verify agreement of load current (e.g. motor full load & locked rotor current with nameplate).
2. Verify that system voltage, number of phases, and frequency matches controller rating.
3. Verify that available short circuit current of power system is less than rated short circuit capacity of controller.

Check connections - Although the equipment and devices have been completely tested at the factory, a final field check should be made that all electrical wiring and bus bar connections are correct and have not become loose in transportation (Fig. 16). Refer to the MAINTENANCE Section for electrical joint specification.

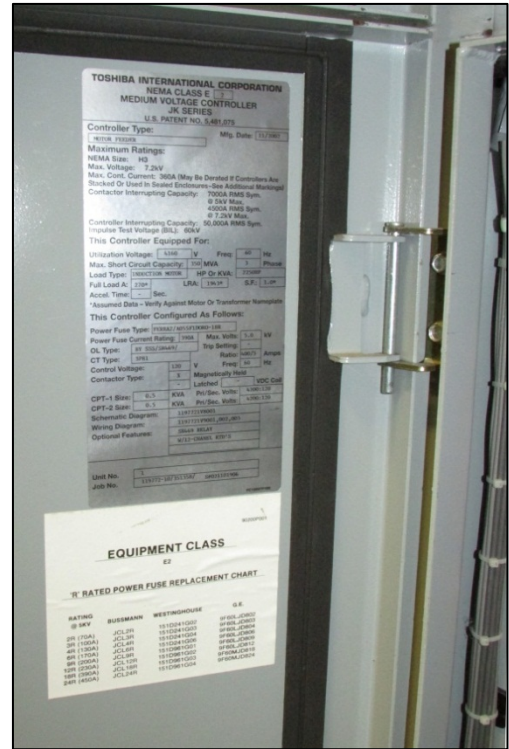
All blocks or other temporary braces used for shipment must be removed.

Before closing the enclosure, all metal chips, scrap wire, and other debris left over from installation must be cleaned out. If there is an appreciable accumulation of dust or dirt, the enclosure should be cleaned by using a brush, vacuum cleaner, or clean, lint free brush.

The integrity of all bus bar supports must be checked to confirm they are secured and without damage.

Care should be exercised that when covers are installed and doors closed, no wires are pinched, and that all enclosure parts are properly aligned and tightened.

A supply of spare parts, fuses, etc. should be established. Instruction manuals and diagrams should be collected and filed.



**Fig. 15 Data Label on Controller**



**Fig. 16 Check Connections**

**Wiring Check**

Field wiring (Fig. 17) should be checked for clearance to live busses where necessary, physically secured to withstand the effects of fault current.

All grounding connections should be checked.

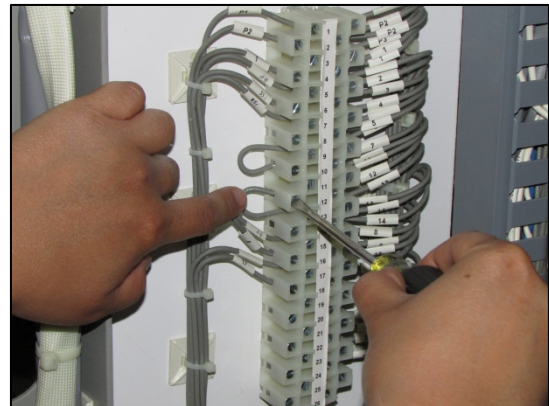
Each load should be connected to its intended controller, and phase rotation should be corrected prior to startup.



**Fig. 17 Wiring Check**

Shorting jumpers (Fig. 18) for current transformer secondary windings must be removed once the secondary circuit is completed. A circuit transformer must not be operated with its secondary windings open.

Changes made to circuit diagrams during installation should be recorded.



**Fig. 18 Removing Current Transformer Shorting Jumpers**

**Device/Mechanism Checks**

All devices should be checked for damage (Fig. 19). All necessary repairs or replacements should be made.

**WARNING** Do not energize damaged equipment that has not been repaired and verified.

Ensure that safety signs are not covered or obscured by paint.

**WARNING** Do not remove, cover, or destroy any safety signs.

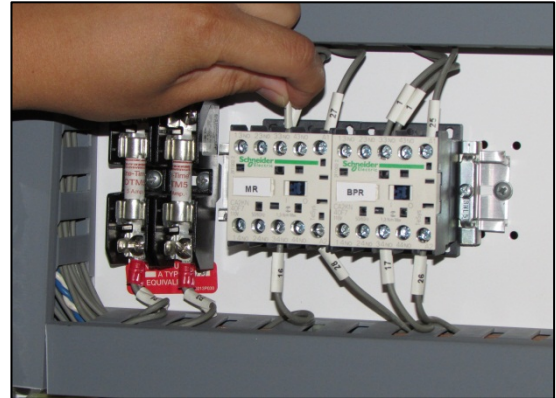


Fig. 19 Device/Mechanism Check

The setting of any adjustable current (e.g. motor overload protection relay) and voltage trip mechanisms should be verified to the proper values.

**NOTE:** Damage from faults can be reduced if devices used for short circuit and ground fault protection are chosen and set to operate at values as close to minimum as feasible, while allowing normal transients.

All switches, relays, and other operating mechanisms should be manually exercised to make certain that they are properly aligned and operate freely.

Operating mechanisms such as interlocks, key switches, etc. should be checked for function as intended for protection of personnel and equipment.

The motor/load protection relay should be checked to be sure that proper settings have been programmed per the motor/load specification sheet and nameplate data (Fig. 20). Check the instruction manual for the specific relay supplied with your equipment for factory default settings and additional protection and programming details

**NOTE:** Factory settings are per the information provided by the customer. If not provided, factory settings include CT & PT ratio, estimated motor/load FLA. Settings like motor service factor and overload class will be minimum (e.g. 1.0 S.F, Class 10 OL curve) which may cause a nuisance trip during the initial start unless adjusted for the application. Most settings are disabled and many should be turned on at the end of commissioning.

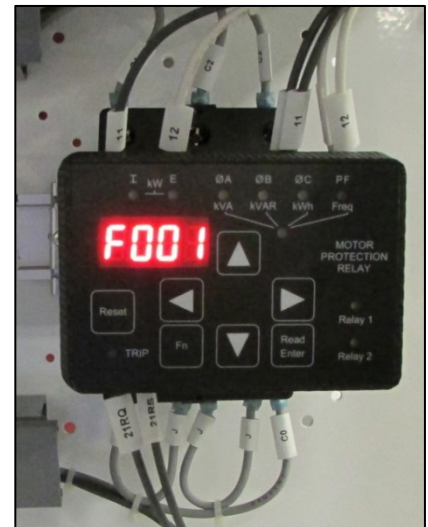


Fig. 20 Protection Relay Setting Check

Power circuit fuses were selected and installed in accordance with the application requirements. Confirm the proper fuses were provided. The fuses must be completely inserted in their holders. Instructions on removing and installing the fuses can be found in this manual on page 29.

**Electrical Checks**

With incoming power isolated and all loads disconnected electrically, the control circuit and other mechanisms should be exercised to determine that the devices operate properly. An auxiliary source of control power will be necessary to provide power to the electrical operators.



**Electrical shock hazard. Do not touch energized components during a test using auxiliary power.**

The ground fault protection system (if furnished) should be tested in accordance with the instructions furnished with the device.

An electrical insulation test should be performed to ensure that the controller and associated field wiring are free from short circuits and grounds. The preferred method is to perform a dielectric test at 2.25 times the nominal system voltage plus 2000 volts. This should be done phase-to-ground, phase-to-phase, and phase-to-neutral (if applicable), with all switches, contactors and circuit breakers opened. Disconnect any devices which may have limited dielectric strength and that are not intended for this test.

The light or buzzer, or both, used to indicate breakdown should be calibrated to indicate failure with an output current between 1.5 and 2.0 milliamperes per 1000 volts applied.



**Hazardous voltages are present during dielectric testing that can result in serious injury or death. High potential test should be performed only by qualified personnel. Refer to safety instructions provided with the test equipment.**

All devices must be set to their normal or OFF position before energizing incoming power.



## GENERAL DESCRIPTION

Toshiba JK 720 ampere medium voltage controllers are AC general-purpose NEMA Class E2 controllers designed for applications at utilization voltages ranging from 2.3 through 6.6 kV. They are normally used to control motor loads, although other types of loads such as variable frequency drives (VFDs), transformers and capacitors are possible.

### Construction

The standard enclosure size for the 720 ampere controller is 36" wide by 36" deep by 90" high. One controller is supplied per vertical section. Each section is divided into two isolated compartments, each with a separate door. The lower compartment contains medium voltage controller components (>600V) while the upper compartment contains low voltage components (<600V) (Fig. 21).

Main horizontal bus is provided when required to supply power to a line-up of controllers. The main bus is located at the rear of the enclosure midway between the top and bottom. A common ground bus is also provided for multiple sections.

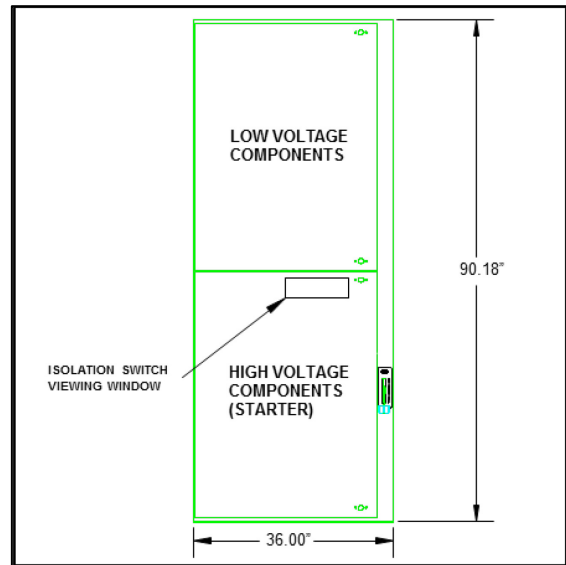


Fig. 21 Standard Controller Arrangement

The medium voltage compartment (Fig. 22) consists of:

- 1) Fix-mounted non-load break isolation switch
- 2) Fix-mounted vacuum contactor
- 3) Fix-mounted current-limiting power fuses
- 4) Current transformers for metering
- 5) Control power transformer and optional potential transformer
- 6) Load cable terminations



Fig. 22 Controller Compartment

**Controller Compartment**

**A. Isolation Switch**

Power is switched on and off to the controller by a fix-mounted, externally-operated, three-pole, non-load break, isolation switch (Fig. 23). When the switch is in the off position, incoming power is isolated from the controller compartment interior by an automatic shutter. For additional safety, the load terminals of the switch are automatically grounded when the switch is off.

Three bolted-in current-limiting power fuses provide primary short-circuit protection for the controller and load circuit. These fuses are connected between the isolation switch and the vacuum contactor. The vacuum contactor load terminals are cabled through three metering current transformers (plus a ground sensor, if supplied) to the outgoing load terminals. Current transformers furnished are of the window (donut) type.



**Fig. 23 Isolation Switch**

The isolation switch is mechanically interlocked with the vacuum contactor and the compartment door. Details of the interlocking are discussed in Section F.

The position of the isolation switch blades can be observed through a window in the medium voltage compartment door. Thus, it is possible to have visual evidence that the power source is isolated before entering the medium voltage compartment. The switch is also provided with lock-out provisions (Fig. 24).

The isolation switch has a maximum interrupting capacity of 0.4 amperes.



**Do not connect additional load to the isolation switch.**



**Fig. 24 Isolation Switch Lockout**

**B. Vacuum Contactor**

The Type HCV-6KAU vacuum contactor (Fig. 25) used in Toshiba JK 720 ampere controllers is a compact, fix-mounted device. It is mounted to the floor of the controller compartment, beneath the isolation switch.

Switching occurs entirely within vacuum bottles, which results in long life with virtually no maintenance. The contactor is mechanically interlocked with the isolation switch so that the switch may not be opened or closed unless the contacts of the vacuum contactor are open.

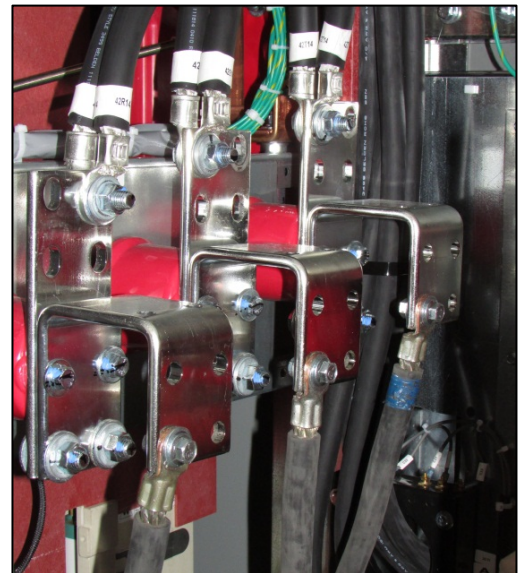


**Fig. 25 Type HCV-6KAU Vacuum Contactor (Note: Clear Cover Not Included In Assembled Gear)**

**C. Outgoing Load Connections**

Connections for outgoing load cables are located at the left side of each controller compartment (Fig. 26). Cables may enter the controller from either the top or bottom of the enclosure, at the points indicated on the outline drawings furnished with the equipment.

Up to two 500MCM shielded or non-shielded cables per phase can be accommodated entering either from the top or bottom of the enclosure. Space is provided for installation of termination kits (stress cones) and user-supplied one- or two-hole compression type connectors.



**Fig. 26 Load Cable Connections**

**D. Control Power/Potential Transformers**

A control power transformer (Fig. 27) is fix-mounted on the floor of the controller compartment. Power is supplied to the fused primary of the control power transformer from the load side of the main power fuses.

Optionally, a second transformer (Fig. 28), normally used as an instrument transformer, can be mounted in the compartment. When this option is supplied, the two transformers are normally connected in an open-delta arrangement.

Another option sometimes supplied is a second control power transformer connected in parallel with the first to increase the available KVA capacity.

Both the control and optional potential transformer are used to supply power to the low voltage circuits of the controller. This includes power for the vacuum contactor operating coil and instrumentation. Reference the equipment's schematic drawing(s) for details.



**Fig. 27 Control Power Transformer**

An electrical interlock is provided to ensure that all load is disconnected from the control power transformer secondary winding before the power isolation switch can be opened or closed.



**Fig. 28 Optional 2<sup>nd</sup> Transformer**

**E. Operating Handle**

The external operating handle shown in Fig. 29 is used to control the operation of the isolation switch. Moving the handle upward turns the switch on, thus applying incoming power to the main current-limiting fuses.

Moving the handle down opens the isolation switch, de-energizing all medium voltage incoming power to the controller compartment. At the same time, an automatic shutter within the switch closes, providing an effective barrier between the controller compartment and the incoming supply. The opening of the switch also causes the line side of the power fuses to be grounded.

Further details on the isolation switch and external operating handle can be found in the Maintenance section.



**Fig. 29 Operating Handle**

**F. Interlocks - Mechanical**

**a. Door Interlock**

A mechanical interlock is provided to prevent opening or closing the medium voltage compartment door unless the switch operating handle is off (Fig. 30).



**Fig. 30 Door Interlock**

**b. Handle Interlock**

Two mechanical interlocks are provided to prevent operating the switch handle improperly.

The first interlock prevents moving the handle from OFF to ON unless the compartment door is closed (Fig. 31).

The second interlock prevents the switch handle from being moved in either direction unless the contacts of the vacuum contactor are open (Fig. 32).

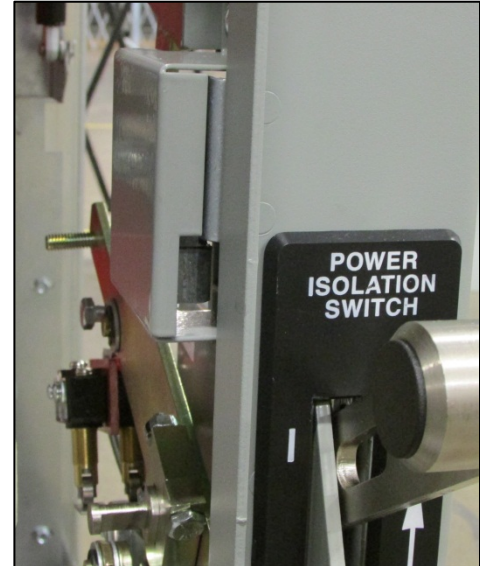


Fig. 31 Handle Interlock to Door

**c. Vacuum Contactor Interlock**

The vacuum contactor is mechanically interlocked to prevent it from closing unless the switch handle is in the fully ON or fully OFF position. The interlock shown in Fig. 32 provides this function.

If the switch handle is in an intermediate position, and a closing signal is given to the contactor, it is mechanically prevented from operating.

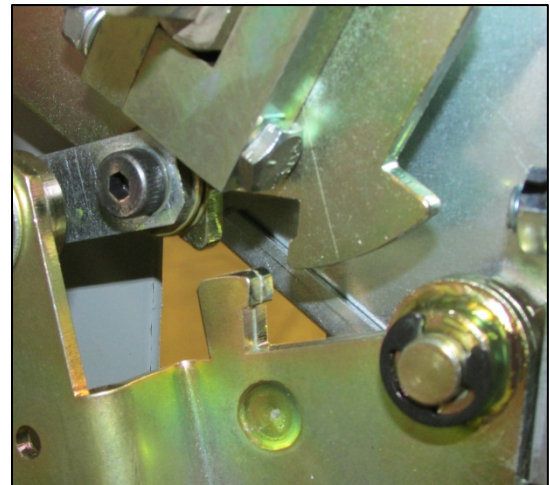


Fig. 32 Handle Interlock to Vacuum Contactor

## G. Interlocks - Electrical

### a. Control Power Interlock (CPI)

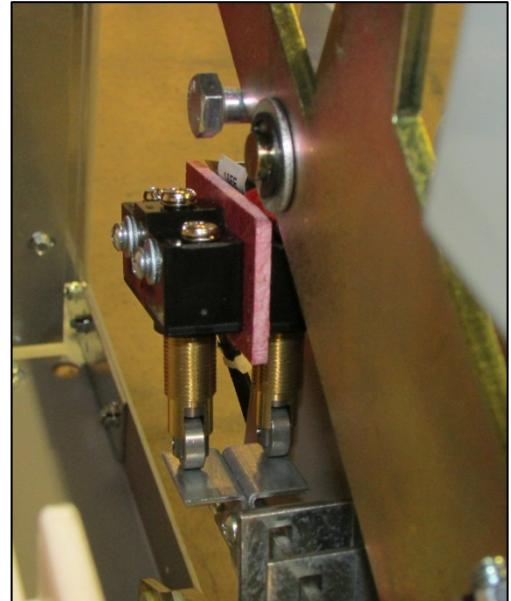
The control power interlock (CPI) is a microswitch which is directly driven by the operation of the switch handle (Fig. 33). This normally open switch is closed only when the handle is fully ON. It ensures that all load is disconnected from the control power transformer secondary winding before the isolation switch can be operated.

As the switch handle is moved from ON to OFF, the CPI opens before the main contacts of the power isolation switch. Conversely, during closing of the switch, the CPI contacts do not close until the switch contacts have fully closed. The isolation switch is therefore only subjected to making and breaking currents equal to the no-load magnetizing current of the transformer. More than one CPI may be present. Reference the equipment's schematic drawings to confirm number of CPIs in the equipment.



**WARNING**

**Do not connect any additional load to the isolation switch.**



**Fig. 33 Control Power Interlock**

### b. Test Power Interlock (TPI)

The test power interlock (TPI) is a scheme provided to allow simulated operation of the controller from a separate control power (test) source with power removed from the medium voltage circuit. During normal controller operation with the isolation switch closed, control power is fed from the control transformer secondary to a receptacle mounted on the low voltage wireway (Fig. 34). A plug inserted into this receptacle supplies power to the controller's low voltage compartment.

For testing purposes, the isolation switch must be turned off and the controller door must be opened. The plug is then removed and inserted into an ordinary extension cord. Plugging the extension cord into a conventional outlet provides 120VAC power for performing control circuit operational tests while the medium voltage circuit is de-energized. The CPI(s) prevent the high voltage back feeding on the CPT (PT) primary.



**Fig. 34 Test Power Receptacle**

**Low Voltage Compartment**

The low voltage compartment contains controller components rated 600 volts maximum, which may include such items as overload relays, pilot devices, control relays, etc.

**WARNING**

**Hazardous Voltage. Turn off and lock out control circuit power before servicing.**

In the standard controller arrangement, the low voltage compartment is located in the upper half of the enclosure. A subpanel is located behind the low voltage door, which is used to mount various relays and other devices. The subpanel is hinged in such a way that it can be swung open, if necessary, to gain access to the main horizontal bus which is located directly behind the low voltage compartment (Fig. 35).



**Hazardous Voltage. Turn off and lock out all control and primary power before opening this panel.**



**Fig. 35 Low Voltage Subpanel Opened to Expose Main Bus**

A low voltage vertical wireway feeds directly into the lower left hand corner of the low voltage compartment. This wireway provides isolation for control wires entering the bottom of the enclosure. Control wires entering the top of the enclosure feed directly into the low voltage compartment. A horizontal low voltage wireway is provided at the lower front of the low voltage compartment. At each end of the horizontal wireway there is an opening for inter-cubicle control wiring.



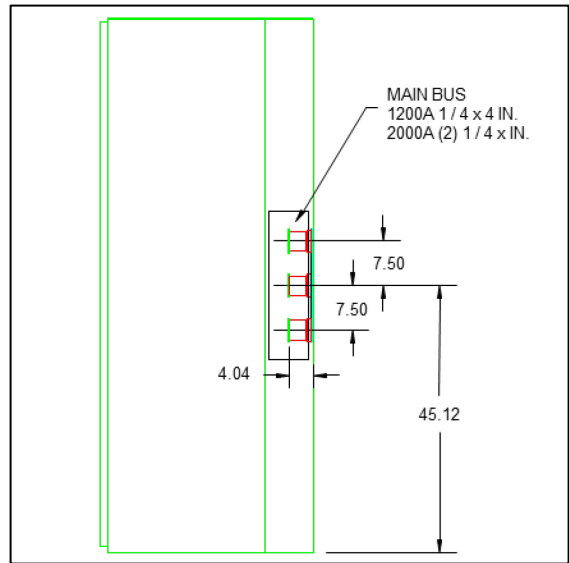
**Main Bus Compartment**

Main bus bars extending horizontally throughout a line-up are located in an isolated compartment located in the rear center of the enclosure (Fig. 36). From the main bus, riser bars supply power to the controller. Standard main bus bars are copper with tin plating.

Access to the main bus compartment can be obtained either by removing the enclosure back sheet or by swinging open the hinged low voltage subpanel and then removing a fixed barrier that covers the main bus.

**⚠ DANGER**

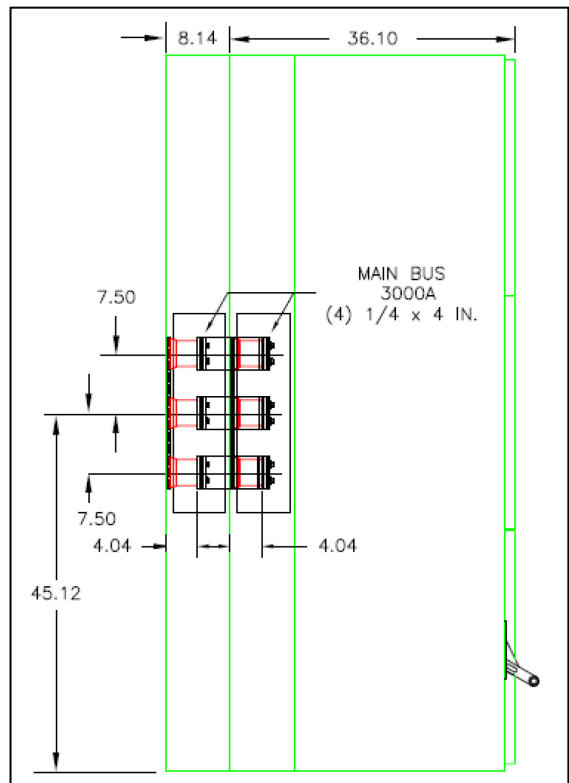
**Hazardous Voltage. Turn off and lock out all control and primary power before accessing this compartment.**



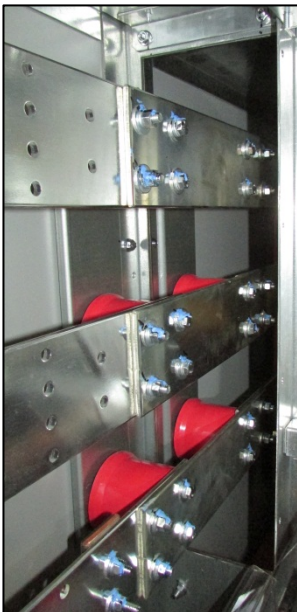
**Fig. 36a Main Bus (1200A & 2000A) Compartment**

Bus splice links (Fig. 37) are furnished for joining the main bus and ground bus between shipping sections. With the low voltage subpanel swung open and the main bus barrier removed, all splice links can be installed from the front of the unit. Refer to Installation Section for details.

A copper ground bus, located in front of the main bus compartment and above the isolation switch, is used to provide a common ground between cubicles. The ground bus also provides a termination point for grounding the enclosure and for connecting the ground wires from shielded cable terminators.



**Fig. 36b Main Bus (3000A) Compartment**



**Fig. 37 Bus Splice Links**

**CONTACTOR RATINGS****Table 1 Contactor Type HCV-6KAU (Magnetically Held)**

Maximum Voltage	7200 Volts
Rated Operational Current	720 Amps
Rated Thermal Current	800 Amps
Interrupting Capacity (NEMA Class E1)	7200 Amps RMS Sym. @ 7.2 kV Max
Permissible Switching Frequency	600/Hour
Mechanical Life	1,000,000 Operations
Electrical Life	200,000 Operations
Pick-Up Voltage AC or DC	85% (Hot) – 70% (Cold)
Drop-Out Voltage AC or DC	50% (Hot) – 40% (Cold)
Rated Control Voltage AC	115-240 V 50/60 Hz
Rated Control Voltage DC	125-250 V
Coil Circuit Inrush	6.0~7.0A @ 120Vac (840VA (AC) – 875W (DC)
Coil Circuit Holding	0.8~1.0A @ 120Vac (48VA)
Auxiliary Contact Arrangement	3 N.O. - 3 N.C.
Auxiliary Contact Rating	10 A, 48-600Vac Max. (NEMA Class A600)

**Contactactor Type HCV-6KALU (Latched Type)**

Permissible Switching Frequency	300/Hour
Mechanical Life	200,000 Operations
Tripping Voltage	60% or less of Coil Rating DC (Cold)
Tripping Current	4.8A Peak @ 125Vdc

A latched contactor is the same as magnetically-held type, except number of auxiliary contacts is reduced to 2 N.O. - 2 N.C. Standard operating voltage is 120Vac Close/125Vdc Trip.

**CONTROLLER RATINGS**

**Table 2 Short-Circuit & Withstand Capability**

Interrupting Capacity (Sym. Amperes)	Interrupting Capacity (Sym. MVA)	Short Time Capability 30 Seconds	Short Time Capability 1 Second	Dielectric Withstand 1 Minute	Impulse Voltage Withstand
50,000 RMS @2.3-6.6kV (7.2kV Max)	200@2.3kV 350@4.0kV 400A4.6kV 570@6.6kV	4320 A	10,800 A	22 kVac	60 kV BIL

**Table 3 Continuous Current Rating**

Enclosure Type	Max. Continuous Amperes One-High Controller
NEMA-1 Ventilated	720
NEMA-1 Non-Ventilated	650
NEMA-12, 3R	600

**Table 4 Approximate Maximum Horsepower Based On Continuous Current**

Enclosed Maximum Continuous Current (Amperes)*	Maximum Horsepower Rating						Maximum Kilowatt Rating	
	2300V, 3-Phase			4200V, 3-Phase			6600V, 3-Phase	
	Synchronous Motors		Induction Motors	Synchronous Motors		Induction Motors	Synchronous Motors	Induction Motors
	0.8 P.F.	1.0 P.F.		0.8 P.F.	1.0 P.F.		0.8 & 1.0 P.F.	
720	3000	3500	3000	5500	6000	5500	C.F.	7000
650	2750	3000	2750	5000	5500	5000	C.F.	6300
600	2500	2750	2500	4500	5000	4500	C.F.	6000

\* - Motor FLA depends on manufacturer, speed, and other factors which must be considered.  
 C.F. – Consult factory with your application requirements.

## OPERATION

### Initial Energization

Energizing a medium voltage controller or line-up of controllers for the first time is potentially dangerous. Therefore only qualified personnel, as defined in the SAFETY section of this manual, should energize the equipment (Fig. 38). If equipment damage or poor installation practices have escaped detection in the PRE-ENERGIZATION CHECK, major damage, including personal injury, can result when the power is applied. Extra precaution is recommended on initial energization of the equipment.



**Hazardous Voltage. Improperly installed or damaged equipment will result in severe injury, death, and property loss. Correct all problems prior to energizing this equipment.**



**Only qualified personnel should energize this equipment.**



Fig. 38 Preparing For Initial Energization

In order to minimize the risk of injury or damage, there should be no load on the controller or group of controllers when incoming power is first turned on. All downstream loads, including distribution equipment and other remote devices, should be turned off. The isolation switch ahead of each controller should be in the off position.

The equipment should be energized in sequence by starting at the source end of the system and working towards the load end. First, the main devices, then the feeder devices, and then the branch circuit devices should be closed.

With all removable barriers in place and all doors closed and latched, the devices should be turned on with a firm, positive motion. Protective devices and switches that are not quick-acting should not be "teased" into the closed (or open) positions. The isolation switch handle should be moved between the OFF and ON positions in a single continuous smooth movement (Fig. 39).

After all disconnect devices have been closed, contactors may be operated to turn on loads such as motors, transformers, variable frequency drives, etc.



Fig. 39 Closing Isolation Switch

## MAINTENANCE

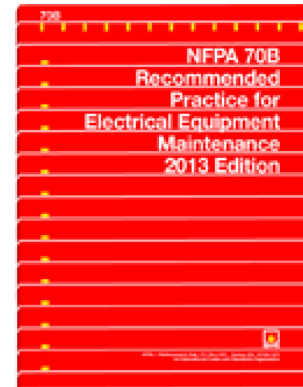
In order to ensure continued reliable and safe operation of the equipment, a program of periodic maintenance must be established. Operating and environmental conditions will dictate the frequency of inspections required. NFPA Publication 70B "Electrical Equipment Maintenance" (Fig. 40) may be used as a guide for setting up the maintenance program.

### Maintenance Record

A permanent record of all maintenance work should be kept. At a minimum, this record should include information on:

- 1) Items inspected
- 2) Test reports
- 3) Equipment condition
- 4) Corrective actions or adjustments
- 5) Date of work
- 6) Comments

The degree of detail will depend on the operating conditions.



**Fig. 40 NFPA 70B  
Electrical Equipment  
Maintenance**



**Contact with energized components can cause severe injury or death. Turn off and lock out Primary and Control Circuit Power before servicing.**



**Improper maintenance can cause severe injury, death, and extensive property damage. Only qualified and authorized persons are to install, operate, or service the equipment.**



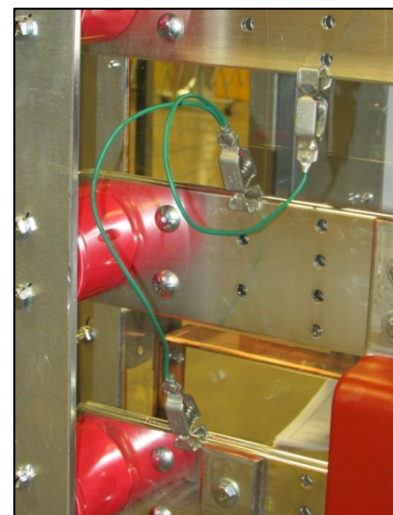
**This equipment utilizes both low and high voltage for operation. Verify that all test equipment is suitable for the voltage being checked.**

**NOTE: Refer to the SAFETY section of this manual for important information.**

After disconnecting and locking out incoming power and before performing any maintenance, it is recommended that a safety ground be connected to the main power bus (Fig. 41). After maintenance is complete, perform the checks in the PRE-ENERGIZATION CHECK section of this manual before restoring power.

The following pages detail maintenance procedures recommended for Toshiba JK 720 ampere medium voltage controllers. In general, the following items should be included on the maintenance checklist:

- Cleaning
- Checking and tightening of electrical connections
- Checking of fuses and fuse connections
- Proper installation of any removable barriers
- Vacuum contactor maintenance



**Fig. 41 Attaching Safety Ground**

The information presented here is intended to cover preventive maintenance only. It does not cover major rework or repair. The following **MAINTENANCE SHOULD BE PERFORMED AT LEAST ANNUALLY** or more frequently depending on operating conditions.

**General Inspection**

Thoroughly clean the equipment, removing all dust, dirt, and other accumulations. Wipe insulators clean using a clean, dry cloth. Do not use petroleum-based solvents or cleaners.

Check for any signs of moisture inside the enclosure. If there are signs of dripping water entering the enclosure, eliminate the source. Thoroughly dry any insulation which shows signs of wetness and repeat the dielectric test procedure given in the PRE-ENERGIZATION CHECK. Replace insulators, if necessary.

Check for any signs of rusted or corroded parts.

Check for free movement of all moving parts and mechanisms. Lubricate, if necessary, with Toshiba B9 grease.



**WARNING**

**Grease is conductive. Do not apply grease to electrical insulation.**

**Electrical Joints**

Examine all visible terminals and joints for signs of overheating (Fig. 41). An overheated connection will appear discolored. Be suspicious of any conducting joint which has a darker color than other similar joints.

Check all bolted connections for tightness. The proper torque is dependent on the size of the hardware and the materials used. As a general guide, use the following Fig. 43. The values apply to metal-to-metal joints (e.g. copper-to-copper). When applying torque to a bolt threaded into an insert, molded into a plastic part, use approximately 2/3 the torque shown.



**Fig. 42 Check Electrical Joints**

Bolt Size	Torque at Full Engagement (ft – lbs)
1/4 - 20	6
3/16 - 18	12
3/8 - 16	18
7/16 - 14	30
1/2 - 13	45
9/16 - 12	68
5/8 - 11	90
3/4 - 10	150
7/8 - 9	240
1.0 - 8	245

**Fig. 43 Torque Specs for MV Power Connections**

**Power Fuses**

The power fuses supplied in Toshiba JK 720 ampere controllers are of the bolt-in or clamp-in type, therefore overheating due to loss of fuse clip pressure is not a problem. The tightness of the fuse clamping bolts (Fig. 44) should, however, be periodically checked and maintained within a range of 20-30 ft-lbs.

Check the power fuses for any signs of discoloration. A fuse barrel which appears darker than others indicates overheating. Possible causes of fuse overheating, other than load problems, are misapplication (fuse current rating too small), loose fuse connections, or a damaged fuse.



**Fig. 44 Checking Power Fuse Clamping Bolt Torque**

Check the fuse barriers for cleanliness and proper positioning, as shown in Fig. 45. There are three vertical barriers, two located between adjacent fuses and a third between the right hand fuse and the operator mechanism. A fourth angle-shaped barrier is positioned in front of the isolation switch (Fig. 46).

**Vacuum Contactor**

Maintenance instructions for the HCV-6KAU vacuum contactor are provided in a separate publication, number VF010H08A. Contact the equipment supplier or the factory if this publication is needed and was not provided with the equipment.



**Fig. 45 Fuse Barrier Placement**

**⚠ CAUTION**

**Radiation Exposure Hazard. X-Radiation may cause illness or injury. Stay at least 1 meter (3.3 feet) away from the contactor during high-potential tests.**



**Fig. 46 Angled Barrier In Front Of The Isolation Switch**



**Isolation Switch**

The isolation switch provided in each controller is a bolted pressure type device. It is designed to maintain proper adjustment and contact pressure over its mechanical life of 10,000 close-open cycles. Under normal operating conditions, no maintenance is required other than periodic inspection and cleaning.

Wipe off any dust or dirt which may have accumulated on the switch housing, the insulating blade drive links, and the shutter.

Open and close the switch and verify that no excessive force is required. Observe that the line terminal shutter opens and closes properly. Lubricate the moving parts of the handle mechanism and, if necessary, apply a light coat of Toshiba B9 grease to the inside contact surfaces of the switch blades. Contact the equipment supplier or the factory to obtain B9, grease if required.

**WARNING**

**Grease is conductive. Do not allow grease to contact the switch housing or the insulated shutter.**

Examine the current-carrying switch blades for any sign of discoloration due to overheating.

Each bolted pressure switch blade assembly is pre-torqued and adjusted to the proper settings at the factory. **DO NOT** attempt to change the torque settings or replace any individual parts of this assembly in the field.

If it is necessary to replace the blade assemblies, contact the nearest Toshiba representative.

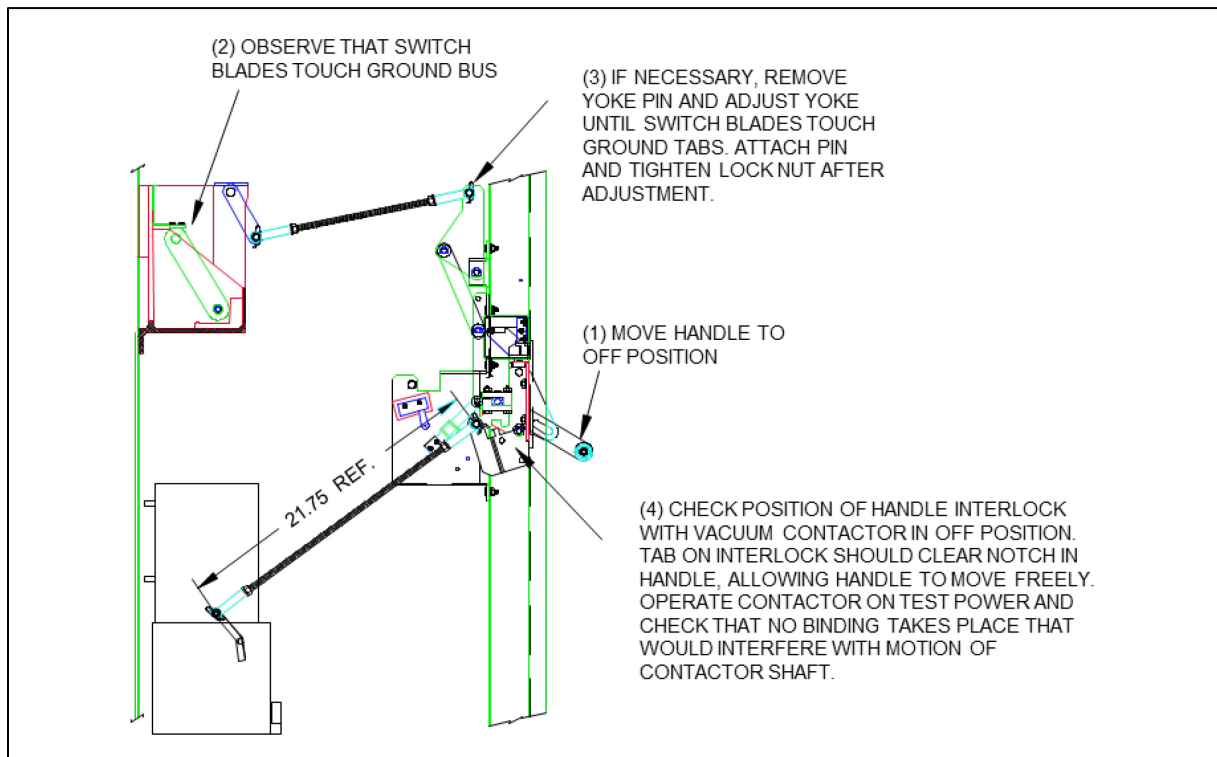
### Switch Handle Mechanism And Interlock

The handle mechanism which operates the isolation switch is adjusted at the factory and under normal operation requires no further adjustment. Alignment can be checked, however, as follows (Fig. 47):

#### **⚠ DANGER**

**Hazardous Voltage. Turn off and lock out primary power.  
Opening barriers will expose medium voltage.**

- 1) Move the handle to the full OFF position.
- 2) Observe that the isolation switch blades are in contact with the ground pads.
- 3) If adjustment is required, loosen lock nut securing yoke on handle end of connecting rod. Remove pin which attaches yoke to handle drive lever. Turn yoke in required direction to achieve adjustment defined in step 2. Attach yoke and pin to drive lever and tighten yoke lock nut.



**Fig. 47 Switch Mechanism and Interlock Adjustment**

- 4) Check the position of the handle interlock with the vacuum contactor in the OFF position. The tab extending from the interlock should clear the notch in the handle, allowing the handle to be moved freely between OFF and ON. Operate the contactor on test power and check that there is no binding and that the contactor is able to reach its full travel in both directions.

The moving joints of all linkages should be occasionally lubricated with a light coat of Toshiba B9 grease.

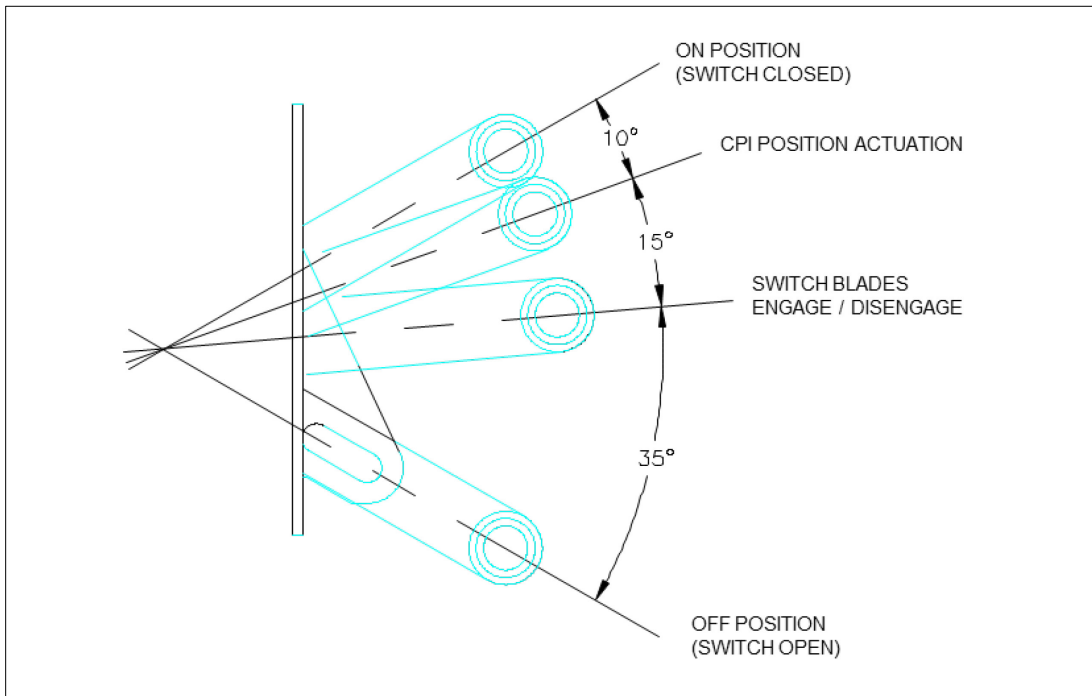
**Interlocks**

Circumvent the handle interlock by pushing a screwdriver through the slot and operate the handle several times.

**⚠ DANGER Turn off and lock out Primary and Control Circuit Power.**

Check that the CPI electrical interlock (microswitch) operates each time the handle is moved. The CPI (control power interlock) should close approximately 10° before the handle reaches the full ON position. As the handle is moved from ON to OFF, the CPI switch should open by the time the handle has moved approximately 10° or one inch (Fig. 48).

Refer to the GENERAL DESCRIPTION section for the location of the handle mechanical interlocks and the CPI electrical interlock.



**Fig. 48 Interlock Sequence Check**

**Control Power/Potential Transformers**

Wipe off the surface of the transformers (Fig. 49).

Check the condition of the primary fuses and fuse clips. Check all screws for tightness.



**Fig. 49 Inspect Transformer(s)**

## MAINTENANCE AFTER A FAULT CONDITION

The following covers procedures to return to service a medium voltage controller, which has been required to interrupt a load side short-circuit or ground fault. These procedures are not intended to cover devices such as wiring and motors, which may also require attention.

In an installation which has been properly coordinated and in service prior to a fault, the opening of the current-limiting power fuses in the controller indicates a fault condition in excess of operating overload. This fault condition must be corrected and necessary repairs made to the load circuit before re-energizing the controller.

The following inspection and repair procedures should be carried out by qualified personnel.



**Hazardous Voltage. Turn off and lock out Primary and Control Circuit Power before any inspection or testing.**

### Enclosure

Check the condition of the enclosure for any signs of bowing or deformation. Check the condition of the doors and latches for damage.

If substantial damage has occurred to the enclosure, such as deformation, displacement of parts, or burning, this indicates a problem within the controller that requires major reconditioning or complete replacement of the controller. In this event, contact the nearest Toshiba representative.

### Isolation Switch

The external operating handle must be capable of opening the switch. If the handle fails to open the switch or if visual inspection after opening indicates deterioration beyond normal wear and tear such as overheating or pitting of blades, insulation breakage, or charring, contact your Toshiba representative.

### Fuse Mounting

Check the condition of the power fuse mounting hardware, clamps, and insulating bases. Any deterioration of these components requires replacement of the damaged parts.

### Terminals and Internal Conductors

Indication of arcing damage, overheating, or both, such as discoloration and melting of insulation, requires replacement of the damaged parts.

### Overload Relay

The overload relay must be checked to verify that it will still trip properly. Follow the test instructions provided with the overload device for verifying trip characteristics.

### Vacuum Contactor

Operate the vacuum contactor electrically from test power and observe that it opens and closes freely. If the vacuum bottles show any sign of binding, they should be replaced. Contact your Toshiba representative. Check for any sign of arcing damage to the insulated housing.

### Return to Service

Before returning the controller to service, repeat the procedure outlined in the **PRE-ENERGIZATION CHECK** section of this manual.



# TOSHIBA

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