Document: VF010H04

TOSHIBA

INSTRUCTION MANUAL

INSTALLATION - OPERATION - MAINTENANCE

JKSSS Series

Medium Voltage Solid State Starters

Issued: 5/01
Manufactured in the USA

Table of Contents

SAFETY

IMPORTANT MESSAGES

Read this manual and follow its intructions. Signal words such as DANGER, WARNING and CAUTION will be followed by important safety information that must be carefully reviewed.

⚠ DANGER Indicates a situation which will result in death, serious injury, and severe property damage if you do not follow instructions.

⚠ WARNING Means that you might be seriously injured or killed if you do not follow instructions. Severe property damage might also occur.

⚠ CAUTION Means that you might be injured if you do not follow instructions. Equipment damage might also occur.

NOTE Give you helpful information.

READ SAFETY SIGNS

To avoid injury, you must read and follow all safety signs.

Keep the safety signs visible and in good shape. Never remove or cover any safety sign.

⚠ DANGER

QUALIFIED OPERATORS ONLY

Only qualified persons are to install, operate, or service this equipment according to all applicable codes and established safety practices.

A qualified person must:

1) **Carefully read the entire instruction manual.**
2) Be skilled in the installation, construction or operation of the equipment and aware of the hazards involved.
3) Be trained and authorized to safely energize, de-energize, clear, ground, lockout and tag circuits in accordance with established safety practices.
4) Be trained and authorized to perform the service, maintenance or repair of this equipment.
5) Be trained in the proper care and use of protective equipment such as rubber gloves, hard hat, safety glasses, face shield, flash clothing, etc. in accordance with established practices.
6) Be trained in rendering first aid.

SAFETY

SAFETY CODES

Toshiba motor control is designed and built in accordance with the latest applicable provisions of NEMA and the National Electrical Code. Installations must comply with all applicable state and local codes, adhere to all applicable National Electric Code (NFPA 70) standards and instructions provided in this manual.

HAZARDOUS VOLTAGE will cause severe injury, death, fire, explosion and property damage.

- Turn off and lock out Primary and Control Circuit Power before servicing.
- Keep all panels and covers securely in place.
- Never Defeat, Modify, or Bypass any Safety Interlocks.
- Qualified Operators only.

⚠ WARNING

Never attempt to install, operate, maintain or dispose of this equipment until you have first read and understood all of the relevant product warnings and user directions that are contained in this Instruction Manual.

Use only Toshiba-authorized replacement parts.

This equipment is designed and built in accordance with applicable safety standards in effect on the date of manufacture. Unauthorized modifications can result in voiding the warranty, severe injury, death and property damage. Do not make any modifications to this equipment without the written approval of Toshiba.

For assistance, address correspondence to:

Toshiba International Corporation
Field Service Department
13131 West Little York Road
Houston, Texas 77041 USA

or call: (713) 466-0277 Fax: (713) 466-8773
(800) 231-1412
(800) 527-1204 (Canada)

Please complete the following information for your records and retain with this manual:

Model: _____

Serial Number: _____

Date of Installation: _____

Inspected by: _____

Reference Number: _____

Chapter 1 - Introduction

It is the intent of this manual to provide a guide for ***safely*** installing, operating and maintaining Toshiba controls. This manual consists of a section on general safety instructions and is marked throughout with warning symbols. Read this manual thoroughly before installation, operation and maintenance of this equipment.

This manual and all accompanying drawings should be considered a permanent part of the equipment. They should be readily available for review and reference at all times. This manual is not intended to cover all details, combinations, or variations of the equipment. Always refer to drawings accompanying the equipment for additional details.

All safety warnings must be followed to ensure personal safety. General safety instructions are found on the previous pages. Read and save these instructions for future reference.

Follow all precautions to attain proper equipment performance and longevity.

Dimensions shown in the manual are in metric and/or their English equivalent.

This manual is divided into major sections of interest, as follows:

INSTALLATION - Provides information on the installation location and service conditions, mounting and anchoring of the equipment, connection of cables, and **Pre-energization Check**.

ADJUSTMENTS & START-UP - Provides preprogramming instructions and preliminary start-up procedures.

PROGRAMMING - Includes details on the programming the control module. Detail information on the various parameters (i.e. I/O programming, communications, statistical data) can be found here.

MAINTENANCE AND TROUBLE SHOOTING - Lists the basic maintenance procedures for this equipment necessary for safe and reliable operation. Covers procedures to return the controller to service after a load side fault has been interrupted.

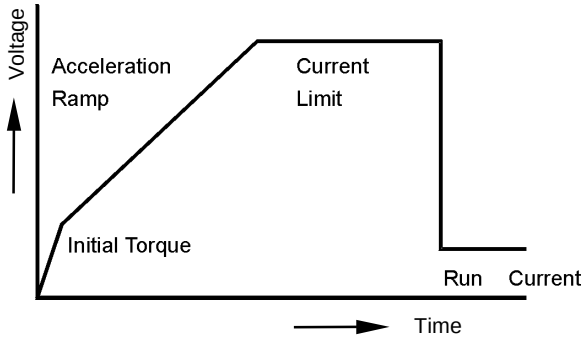
WARRANTY AND LIMITATION OF LIABILITY - Details Toshiba International Corporation's standard warranty terms.

This chapter is a brief introduction to the JKSSS Series soft start control and describes product operation and unit features. To begin set up procedures immediately, proceed to Chapter 2 - Installation.

1.1 - Theory of Operation

1.1.1 - General

The JKSSS Series is a three phase, microprocessor-based digitally controlled reduced voltage soft start for medium voltage AC motor applications. The unit controls the motor start up by delivering an adjustable amount of initial voltage and current to the motor, then slowly increasing the voltage and current to 100 percent. The JKSSS Series has a linear voltage vs. time ramp, unless in variable torque configuration (see Section 5.7.1). This adjustable acceleration ramp allows a smooth transition from the point where the motor shaft begins to turn, to full motor speed, regardless of the type of load. The JKSSS Series also features a selectable dual adjustment mode that can be programmable for a second load type. The JKSSS Series is offered in voltages from 2.3kV to 14kV, and current ratings up to 600A. Contact the factory for other voltage/current requirements.



The acceleration ramp time for a typical start-up is thirty (30) seconds or less, and is adjustable to allow the motor to smoothly accelerate the load. The current limit is adjustable from 100% to 500% (intended) of programmed motor full load amperage (FLA). This adjustment is separate from the acceleration time, to allow greater control of peak power usage.

At the end of the start cycle, the unit will switch in a bypass contactor placing the unit across the line, with overload protection still present. Additional run protections include: over voltage, under voltage, under current, phase loss, motor not connected, electronic shear pin, shorted SCRs and over temperature protection. In addition to these standard features, the JKSSS Series also offers the following unique features for reliable, trouble-free operation.

1.1.2 - Sustained Pulse Firing Circuit

Proper SCR control is critical to solid state motor starter performance. Incorrect gate signal timing can cause SCR misfiring as well as current and voltage imbalances. Toshiba's JKSSS Series is designed to eliminate this problem, providing smooth, reliable and repeatable soft start control. Toshiba uses the Sustained Pulse method, as opposed to the other firing methods. The Sustained Pulse method has a very high noise immunity and is much less likely to misfire the SCRs because of the sustained DC level kept on the SCRs. In order to obtain the best, and most reliable signal, the JKSSS has a digital controller which monitors all of the currents and voltage feedbacks. This ensures that the gate signal timing to the SCRs is precise and prevents misfires. Line reactors are not needed with the JKSSS Series.

1.1.3 - Transformer Isolation Design

The second important item in a Toshiba medium voltage soft starter design is the very high insulation level, providing maximum protection for operating personnel. The JKSSS Series securely isolates medium voltage from low voltage using four separate transformers. The JKSSS potential transformers provide insulation and supply three-phase 120VAC to the gate drive transformer and the firing boards. The gate drive (ring) transformer takes the 120VAC and steps it down to 28VAC to be used as the sustaining power for the gating signal and provides insulation to the 120VAC.

The current transformers also insulate the medium voltage from the current feedback signals. The fiber optics for each SCR provide isolation between the medium voltage and the gating signals. The potential transformer (PT) supplies 120VAC for the logic on each starter, which provides isolation between the medium voltage and low voltage.

1.2 - Specifications

SPECIFICATIONS		
Type of Load	Three Phase, Medium Voltage, AC Induction or Synchronous Motors	
Supply Voltage	2300, 3300, 4160, 6600, 11000/14000Vac, +10% to -15%	
SCR Current Ratings	Continuous: Overload: 1 Cycle:	125% of Controller Rating 500% for 60 Seconds 850% (internally protected by the Electronic Shear Pin setting)
Frequency	50 or 60 Hz, +/- 2 Hz hardware selectable	
Nominal HP Rating	2300V 3300V 4160V 6600V 11 - 14kV	200HP - 2500HP 200HP - 3000HP 250HP - 5000HP 300HP - 7500HP 800HP - 15000HP
Overall Efficiency	In Bypass Mode: Through SCRs:	99.94% 99.70%
Operating Temperature	0º to 40ºC (32º to 104ºF)	
Storage Temperature	-20º to 65ºC (-4º to 149ºF)	
Humidity	5% to 95%, non-condensing	
Altitude	3300 ft (1000m) above sea level without derating	
Auxiliary Contacts	3 sets of Form C, 8A, 250V	
Transient Voltage Protection	dv/dt circuits (one per SCR module)	
BIL Rating	2300 - 6600V 11 - 14kV	60kV 75 - 110kV

Short-Circuit & Withstand Capability - JKSSS4 (360A Unit)

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	200 @2.3kV 350 @4.0kV 400 @4.6kV 570 @6.6kV	2400A	6000A	AC 19kV DC 26kV	60kV BIL

1.3 - Design Features

The Standard JKSSS configuration is a complete starter package which includes the following features:

Isolation Switch: An isolation switch is provided in the incoming power section of the starter assembly. The maximum voltage is 7200V.

Power is switched on and off to the controller by a fixed-mounted, externally-operated, three-pole isolation switch. When the switch is in the opened 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 opened. This allows any stored energy in the controller load circuit to be discharged by closing the contactor using test power.

A viewing window in the Main Incoming Power Compartment allows visual inspection of the disconnect blade status with the medium voltage door closed.

The external operating handle for the isolation switch is designed to accept up to three external padlocks in the OFF position.

For additional information on the isolation switch, see instruction manual VF010H01, VF010H02 or VF010H03.

Power Fuses: As a NEMA class E2 controller, current limiting primary power fuses are provided for each incoming phase.

Power fuses are ANSI class “R.” The fuses are sized according to motor full load and locked rotor current and are coordinated with the overload relay. The fuse and overload coordination is designed to allow the contactor to interrupt normal running currents and operating overload currents up to the minimum interrupting current of the fuses. Higher overcurrents up to the maximum rated fault current are interrupted by the power fuses. The power fuses are arranged horizontally at the top of the input isolation contactor. In this position, the blown fuse indicators on the fuses are visible, through the viewing window, when the medium voltage door is closed.

SCR Power Modules: For each phase, the SCRs are matched devices arranged in inverse parallel pairs and in series strings as indicated below to facilitate sufficient PIV ratings for the applied voltage.

200 & 400A Units			
System Voltage	**Series Pairs**	**Total Number of SCRs**	**PIV Rating**
2300V	0	6	6500V
3300/4160V	2	12	13000V
6600V	3	18	19500V
11 - 14kV	6	36	39000V

600A Units			
System Voltage	**Series Pairs**	**Total Number of SCRs**	**PIV Rating**
2300V	2	12	7000V
3300/4160V	4	24	14000V
6600V	6	36	21000V
11 - 14kV	6	36	39000V

Transients: RC snubber networks provide Transient Voltage Protection for each phase SCR Power Module to reduce dv/dt damage.

Firing Circuit: The SCRs are gated (turned on) using a Sustained Pulse Firing Circuit. This circuitry is amplified and isolated from the control voltage by means of fiber optics for current and ring transformers *(see section 1.1.2 & 1.1.3)*.

Contactors: Vacuum contactors are provided for both In-Line Isolation and SCR Bypass. The contactor voltage ratings are: 7.2kV for 2300-6600V units, 15kV for 11-14kV units.

A sequencing feature controls the contactors. Under normal operating conditions it ensures that both contactors always make and break under no-load conditions to maximize contactor life.

Vacuum contactors are rated for the maximum starting current of the unit design. The Bypass Contactor is rated to be capable of emergency start *(see section 4.4)*.

For further information on the vacuum contactor, see the instruction manual on the vacuum contactor supplied with the equipment, and also either VF010H01 (400A Drawout Type) or VF010H03 (Fixed Type).

A sequencing feature controls the contactors. Under normal operating conditions it ensures that both contactors always make and break under no-load conditions to maximize contactor life.

Vacuum contactors are rated for the maximum starting of the unit design. The Bypass Contactor is rated to be capable of emergency start *(see section 4.4)*.

The 14kV, 600Amp units utilize vacuum breakers and drawout type controllers - rated for 15kV at 600 Amps. The motorized incoming breaker has two indicating lights, 3 current timers, overcurrent relay. The motorized bypass breaker has two indicating lights.

1.4 - Structure and Power Bus

The JKSSS Series is a heavy duty design. Special consideration has be given to enclosure and unit design to ensure that it is suitable for most applications and environments.

Structures: 11 gauge frame with 16 gauge side, back and top sheets. Doors are 12 gauge steel. The enclosure assembly is NEMA / EEMAC type 1 as standard. Type 12 and 3R are available as an option.

Sections: In a typical arrangement, each enclosure is divided vertically into three major compartments, each with a separate door. The uppermost and lowermost compartments contain medium voltage controller components (>600V) while the middle compartment contains low voltage components (<600V). Other variations of this basic arrangement are possible.

The Main Incoming Compartment houses the main disconnect switch, main power fuses and input isolation contactor. A viewing window provides clear indication of the switch position without opening the compartment.

Main Bus Compartment contains the horizontal bus bars (if provided). Top, bottom or side cable entry can be made with minimum bending.

One or more Starter Power Compartments contain the, bypass vacuum contactor, SCR power modules, instrument transformers and all other medium voltage devices. Adequate room is provided for motor lead connections to be made with minimum conductor bend.

A Low Voltage Control Compartment houses the digital microprocessor controller and LCD operator interface, along with any other low voltage devices. This allows the operator to make adjustments without exposure to the line voltages.

Removable conduit entry plates are provided in the top and bottom of the enclosures to facilitate drilling and punching of conduit holes without exposing the equipment to contamination from metal debris.

Enclosure Finish: The enclosure is suitable for use in noncorrosive environments. The paint is ANSI 61 gray polyurethane powder over a zinc phosphate pretreatment with a minimum thickness of 2 mil.

Lifting Provisions: Eyes or angles capable of supporting the maximum weight of each shipping split are provided on the top of the enclosure.

Power Bus: Optional main horizontal phase bus bars can be configured to extend the entire length of the starter lineup. Bus bar material is tin-plated as standard with insulated bus, or silver plating as an option.

Bracing: Main bus bars are braced with non-tracking fire resistant non-hygroscopic insulation supports and have a minimum fault current bracing of 50,000 Amps rms sym.

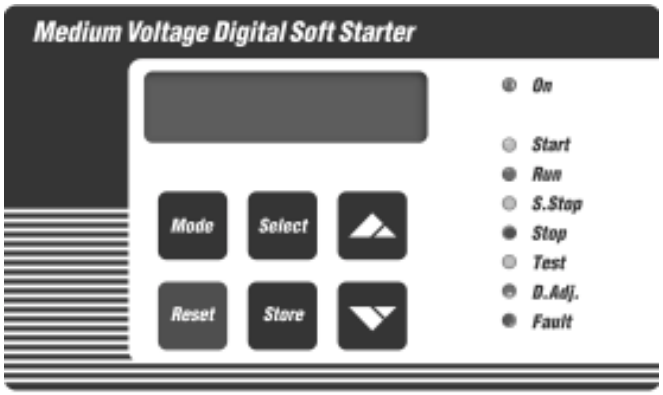
Connections: All bus connections use 2 bolts minimum, with Belleville spring washers to ensure tightness. Splice kits for each shipping split are included, along with specific installation instructions.

Ground Bus: A continuous ground bus bar with a minimum rating of 600 Amps extends the entire length of the starter at the middle compartment of each enclosure. A grounding splice connects each vertically adjacent compartment. The blades of the isolation switch is connected to ground in the open position.

Seismic Qualifications: The entire starter assembly, when properly installed *(see section 2.5)*, withstands vertical and horizontal accelerations typical of seismic Zones 1 through 4 as defined in the UBC. The assembly will not overturn or show significant lateral movement, but cannot be expected to continue operating during, or after, a seismic event.

1.5 - Digital Control Unit

A microprocessor based Digital Control Unit (DCU) is the heart and brains of the JKSSS starter. It provides four main groups of functionality to the controller: Operator Control, System / Motor Protection, Serial Communications and Statistical Data as described herein. Subsequent sections of this manual are grouped according to the logical presentation of the programming interface, so references to appropriate sections are provided.



1.5.1 - Operator Control Functions

Operator Interface: A 2 line x 16 character LCD display is provided, programmable in 4 languages (English, French, Spanish and German), with 6 function keypad and 8 diagnostic LEDs.
LCD Display includes 9 modes of operation: Display Mode, Main Parameters, Start Parameters, Stop Parameters, Dual Adjust Parameters, Communications Parameters, I/O Programming, Statistical Data and Reset Mode *(see section 5.2)*.

Memory: The Interface and controller incorporates 3 memory systems for storing parameters:

EPROM nonvolatile memory containing factory preset default parameters.

EEPROM nonvolatile programmable memory for storing the EPROM defaults, operator programmed parameters and fault history.

RAM flash memory for on-line response to changes in the system parameters.

Keypad: Six (6) function keys are mounted behind a sealed membrane with tactile feedback designed for entering and selecting data in high audible noise environments *(see section 5.2)*.

Indicators: Eight (8) LEDs provide additional visual indication of the following modes of operation: On, Start, Run, Dual Adjust, Soft Stop, Stop, Fault, and Test *(see section 5.3).*

Digital Controller: The Digital Control Unit (DCU) is a microprocessor-based design suitable and protected for use in the high-electrical noise environment of phase controlled SCR firing equipment. The controller is a plug-in module using multi-pin connectors for easy replacement or upgrade, and is universal for all starter sizes. User control adjustments include the following features: Motor FLA, Soft Start Curve, Pulse Time, Initial Voltage, Current Limit, Acceleration Time, Soft Stop Curve, Deceleration time, Final Torque, Dual Adjustment and Reset *(see sections 5.5 - 5.14)*.

A Test Switch and 120V power inlet connector are provided in the low voltage compartment, allowing the digital controller to energize and operate when the main power disconnect is off. This enables control circuit testing without running the motor *(see section 4.1).*

The starter includes 5 opto-isolated 120V control inputs for Start, Stop, Soft Stop, Test and Dual Adjust *(see section 2.10)*.

1.5.2 - Motor and System Protection Functions

The DCU provides the following protection features for the motor and the starter: Under Current, Electronic Overload, Overload Trip Delay, Electronic Shear Pin, Under Voltage, Over Voltage, Stall Protection, Number of Starts, Start Period and Start Inhibit *(see sections 5.6.10 - 5.6.11 and 5.7.6 - 5.7.10)*. The unit will monitor and shut down the starter when fault values are exceeded or indicated. It also displays the fault condition on the LCD, trips the Fault Contact and illuminates the associated LED.

The nonadjustable features listed below will be displayed and activate the fault trip, but are not programmable.

Phase Loss:	One or more phases are missing for more than one second.
Phase Sequencing:	Phase sequence on incoming power is not A-B-C separated by 120°.
Wrong Connection:	Detects internal wiring faults or loss of motor connection.
SCR Over-Temp.:	Thermal sensors in the Power Module detect a temperature exceeding 185° F (85° C).
Shorted SCR:	Detects one or more shorted SCR in any Power Module after being turned off and inhibits restarting.
Anti-Oscillation:	Automatic circuit will override the Acceleration Setting Time if the motor reaches full speed before the end of ramp. This is a protective feature only, no trip / adjustment is associated.

1.5.3 - Serial Communications

Serial communications capability allowing full functionality is built in as a standard feature of the JKSSS. RS485 communications capabilities are built in for multi-drop communications to plant wide systems.

The protocol is MODBUS RTU, and includes selectable parameters for: Soft Starter Number, Baud Rate, Parity Check and Serial Link Number *(see section 5.11)*.

The Microsoft Windows compatible software allows full programming, monitoring and control of the starter. Full instructions for that interface are included when specified.

Faults can be cleared by software but the first restart must be done at the DCU. Refer to the communications manual for more information.

1.5.4 - Statistical Data

The DCU maintains statistical operating data in nonvolatile memory without the need for batteries. Statistical Data includes the following: Last Start Period, Last Start Maximum Current, Total Run Time, Total Number of Starts, Last Trip, Trip Current, and Total Number of Trips *(see section 5.12)*.

Statistical Data can be reset to zero thought the Reset function *(section 5.14)*, but can be locked out using the Parameter Lock dip switch *(see sections 3.1 - 3.2)*.

1.6 - TCB Control Board

The TCB is a board that provides interconnections between the Digital Control Unit and the control logic connections. It is a 120 VAC control board with several auxiliary dry control contacts with built-in time delay circuits and emergency bypass functions. It also controls the sequence of the inline isolation contactor and bypass contactor and provides provisions for shutdown interlocks. *(See section 2.10.3)*

Chapter 2 - Installation

For additional information on the equipment, refer to the following additional instruction manuals:
For fixed type input isolation contactor - "JK Series Medium Voltage Controllers - Fixed Type", manual number **VF010H03** or "JK Series 720 Ampere Medium Voltage Controllers", manual number **VF010H02**.
For drawout type input isolation contactor - "JK Series Medium Voltage Controllers", manual number **VF010H01**.

2.1 - Receiving, Handling/Moving and Unpacking

Upon receipt of the equipment, do the following:

- All JKSSS 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 unit as soon as possible. Immediately notify the nearest Toshiba representative.
- Carefully unpack the unit and make an immediate inspection for any 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.
- Carefully unpack the equipment sufficiently to check for concealed damage and to 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. If is located on stickers in the medium voltage, incoming compartment.

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

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

Handling and Moving

Medium voltage motor controllers should be handled with care, to avoid damage to components and to the frame or its finish.

The capability of the moving equipment to handle the weight of the controller shipping section should be confirmed. The equipment shoud 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.

⚠WARNING **Do not place any part of your body beneath 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.

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. 1) 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. 2). 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.

2.2 - 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 motor and JKSSS unit are rated for the proper amperage and voltage.

2.3 - 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 is removed, the top and openings of the controller should be covered during the construction period to protect it against dust and debris.

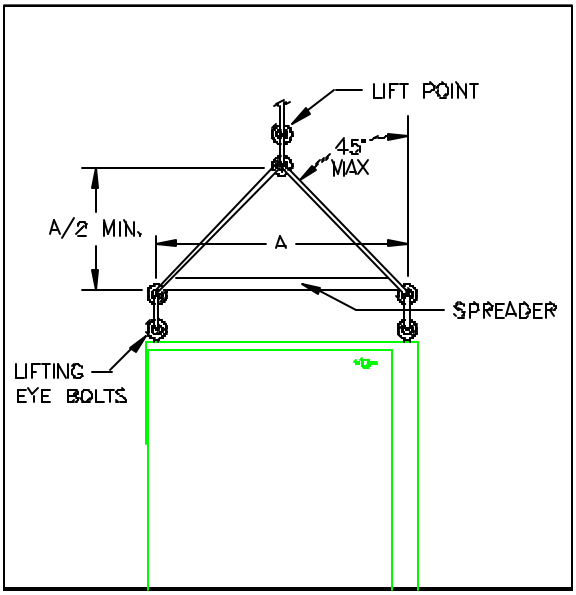


Fig. 1 Use of Spreader Bar - Single Section

Indoor Equipment

Controllers designed for indoor installation (NEMA Type 1, 12) which 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 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.

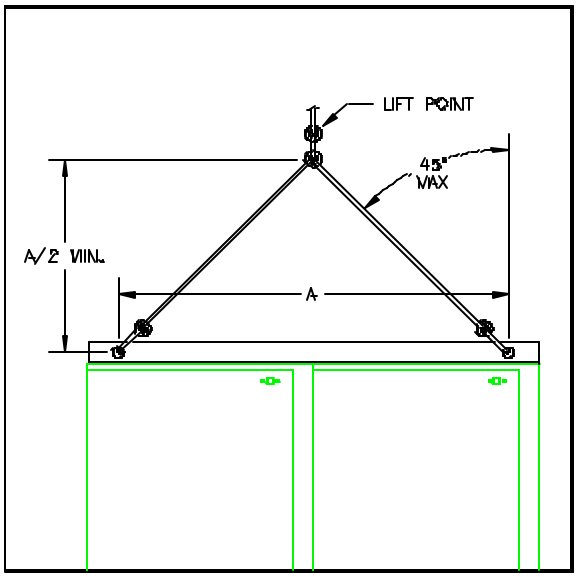


Fig. 2 Lifting Multiple Sections

Outdoor Equipment
An unenergized controller designed for outdoor installation (NEMA Type 3R, EPIC building, etc.) should be kept dry internally by installing electrical heating or by energizing self-heaters, if provided. 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.**

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.

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.

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.

If the location for installation is damp, space heaters may be required. If space heaters 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.**

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.

2.4 - Dimensions

Consult factory for dimensions.

2.5 - Mounting

Each shipping section must be leveled and firmly secured to its supporting foundation. Steel shims may be used for final leveling (Fig. 3), if necessary. When three or more shipping sections are to be arranged in one continuous line-up, the center shipping section should normally be the first located.

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

Sill channels may or may not be furnished, depending on order specifications. Refer to outline drawings furnished for location of sill channels, if furnished.

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. 4).

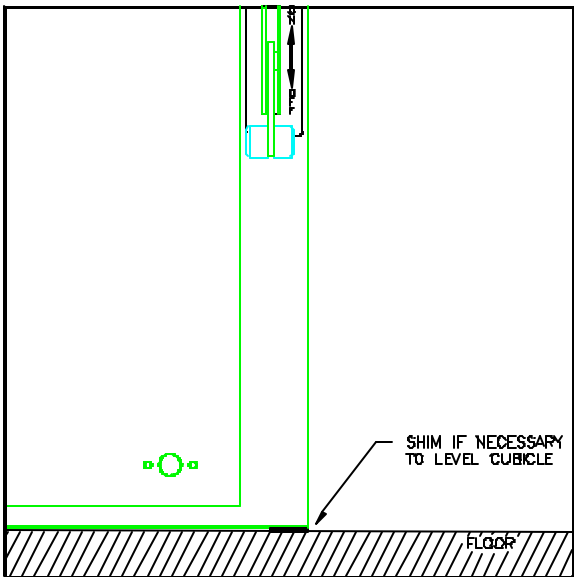


Fig. 3 Leveling Using Shims

WARNING **Heavy Equipment. Enclosure must be securely anchored to prevent tipping over.**

2.6 - 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 reinspect the unit for foreign material.

2.7 - Pre-energization Check

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 on the inside of each medium voltage compartment door. Verify that the controller ratings properly match the system data by checking the following:

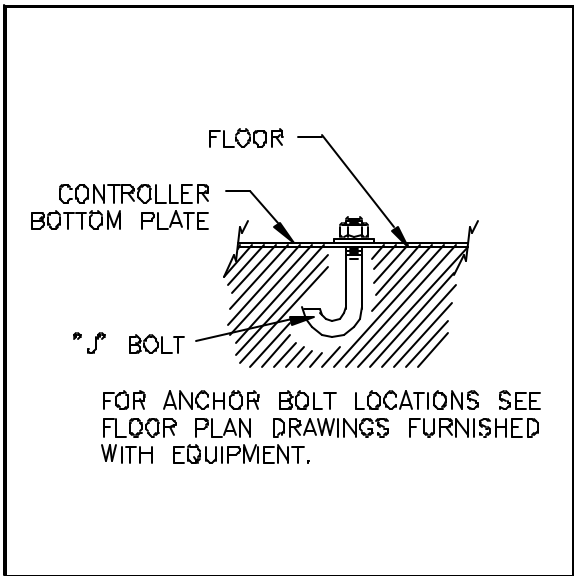


Fig. 4 Securely Anchor the Controller

1. Verify agreement of full load current, locked rotor current and acceleration time with motor 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. Refer to 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 for secureness and 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.

WIRING CHECK

Field wiring 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 motor should be connected to its intended controller, and phase rotation should be correct prior to startup.

Changes made to circuit diagrams during installation should be recorded.

DEVICE/MECHANISM CHECKS

All devices should be checked for damage. 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.**

The setting of any adjustable current 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.

Overload relay settings should be checked to be sure they are selected and adjusted to the proper settings per the load nameplate data.

Power circuit fuses were selected and installed in accordance with the application requirements. Fuses must be completely inserted in their holders. Instruction on removing and installing the fuses can be found in one of the following manuals: VF010H03 (Fixed Type) or VF010H01 (Drawout Type).

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.

⚠WARNING **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 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.

⚠WARNING **Hazardous voltages are present during dielectric testing which can result in serious injury or death.**

High potential tests 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.

2.8 - Warnings & Cautions

⚠WARNING **This section involves working with potentially lethal voltage levels! Use extreme caution to prevent injury. Pressing "Stop" push button does <u>not</u> remove AC mains potential.**

⚠WARNING **Do not service this equipment with voltage applied! The unit can be the source of fatal electric shocks! To avoid shock hazard, disconnect main power and control power before working on the unit. Warning labels must be attached to terminals, enclosure and control panel to meet local codes.**

⚠CAUTION **Do not connect the capacitors to the load side (motor side) of the unit.**
This will cause di/dt damage to the SCRs when they are turned on.

⚠CAUTION **Do not connect the capacitors to the input side of the unit.**
If you cannot avoid using capacitors across the power lines, they must be located as far upstream as possible of the input line contactor. In this situation, optional power factor correction (PFC) caps contactor should be specified. For additional information and specifications, please contact the factory.

⚠CAUTION **Never interchange the input and output power connections on the unit.**
This will cause excessive voltage to the control circuit logic.

⚠CAUTION **For bus protection, it is strongly recommended to use non-gap lightning arrestors in areas where lightning is a significant problem.**
The arrestors should be mounted on the nearest utility pole.

2.9 - Medium Voltage Power Connections

Use a properly calibrated torque wrench to tighten all MV connections according to the chart.

Connections

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.

Bolt Size	Torques at Full Engagement (ft - lbs)
1/4" - 20	4 - 6
5/16" - 18	10 - 15
3/8" - 18	20 - 30
1/2" - 13	40 - 50

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.

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. 5 through Fig. 7.

All access covers, barriers, partitions, etc. that are temporarily removed during installation must be replaced.

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.

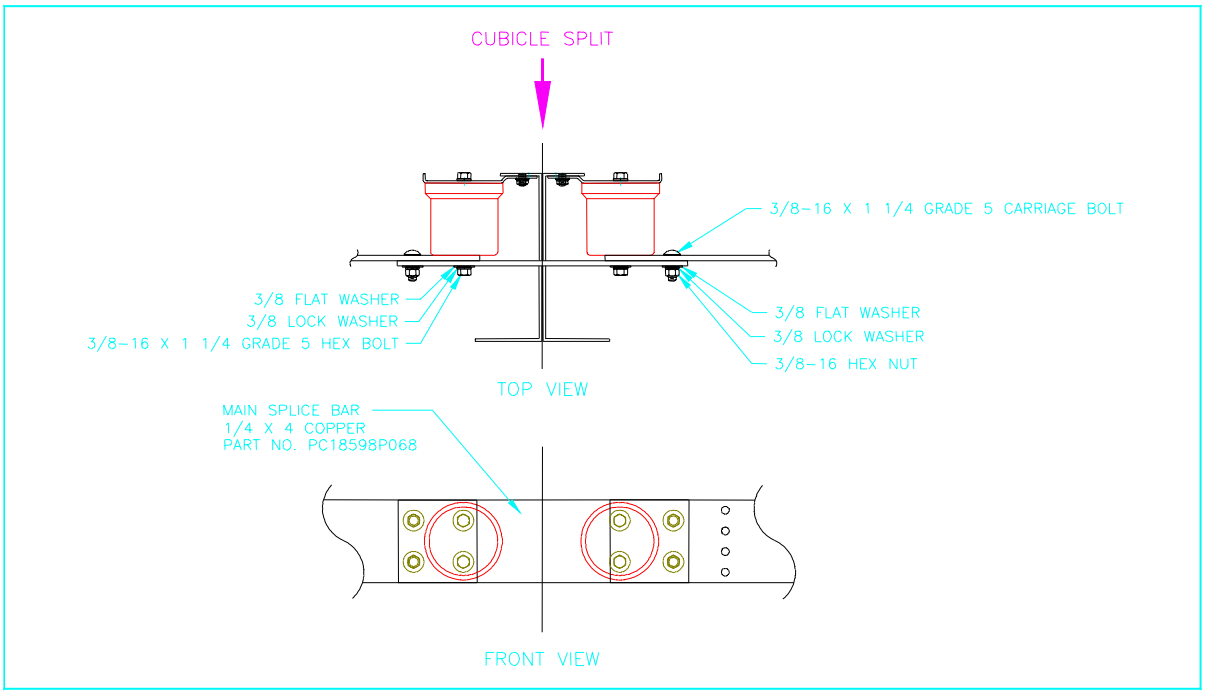


Fig. 5 Main Bus Splice Connections - 1200A Main Bus

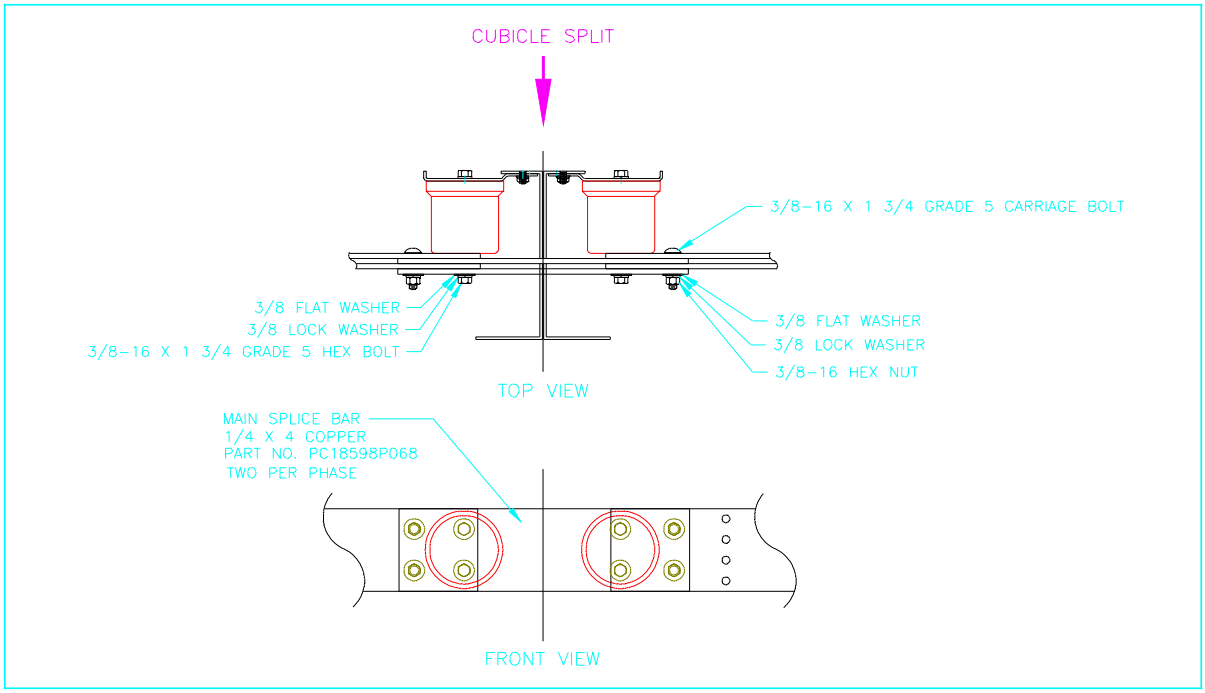


Fig. 6 Main Bus Splice Connections - 2000A Main Bus

2.9.1 - Incoming Line

On the Standard JKSSS, incoming power cable connections should be made at the points shown on the wiring diagram furnished with the equipment.

Note: Proper phase sequence must be observed when connecting the input power. For example, phase A must lead phase B, which in turn must lead phase C by 120° respectively. If the phase rotation is not correct, a fault light and the LCD display will indicate the problem. The SCR output will be clamped.

2.9.2- Load Connections

The load cables should be routed through the wireways furnished within the enclosure. Load cable termination arrangements, refer to the drawings furnished with the equipment.

2.9.3- 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 is furnished, make the ground connection to this bus. If there is no ground bus, the sections which are shipped separately should be connected in such a way as 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.

Special attention should be paid to protection for operating personnel, to protection of equipment itself, (i.e. such as ground fault relays, if used) 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.

<u>Controller used as service equipment for a grounded system or as a main section for a seperately derived system:</u>

a. The grounding electrode conductor (ground wire) sized in accordance with NEC 250-94 should be run from the grounding electrode to the controller ground bus or ground terminal. See also NEC 250-91 (a) and 250-92 (a).

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 250-79 (c) 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.

<u>Controller used as service equipment for an ungrounded system or as a main section for a separately derived system.</u>

a. A grounding electrode conductor (ground wire) sized in accordance with NEC 250-94 should be run from the grounding electrode to the controller ground bus or ground terminal. See also NEC 250-91(a) and 250-92(a).

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 250-23 (b) 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 250-95 and run with the main supply conductors or by bonding to the raceway enclosing the main supply conductors in accordance with NEC 250-91 (b).

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

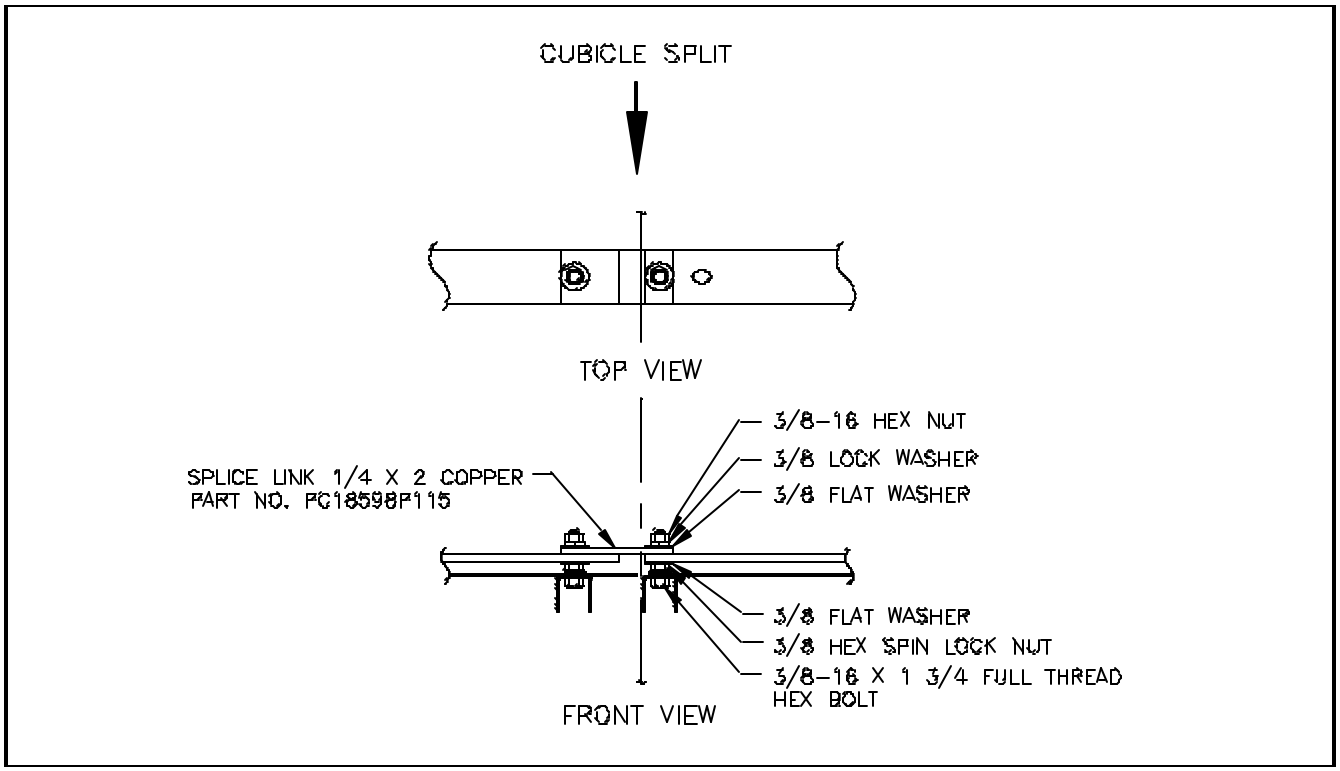


Fig. 7 Ground Bus Splice Connections

2.10 - Control Connections and TCB

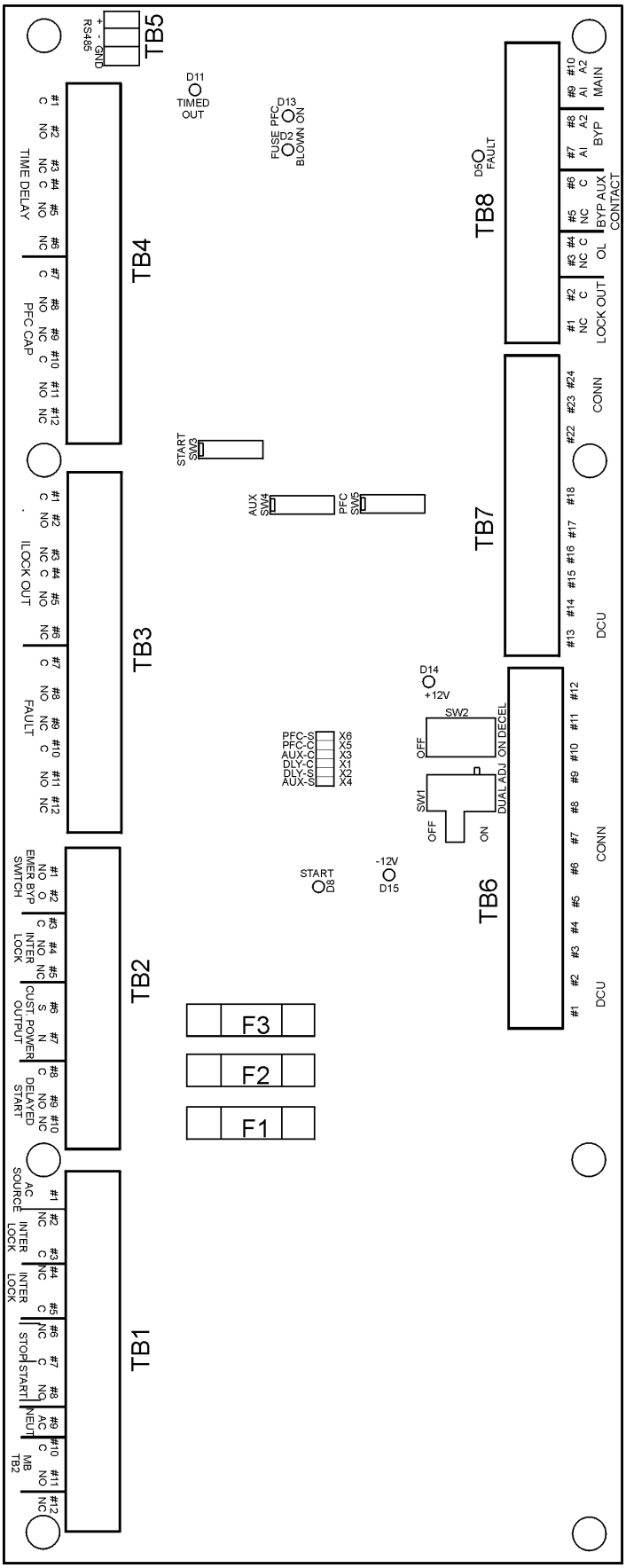
For control connections, refer to the drawings furnished with the equipment.

WARNING

This section involves working with potentially lethal voltage levels! Use extreme caution to prevent injury.

Do not bypass the electrical or the mechanical interlocks. This will cause severe equipment damage and possible fatal injury.

Control Connections and TCB



2.10.1 - TCB

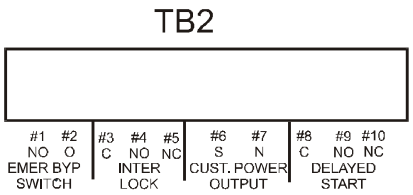
The TCB is a board that provides interconnections between the Digital Control Unit and the customer's control logic connections. It is a 120 VAC control board with several auxiliary dry control contacts with built-in time delay circuits and emergency bypass functions. It also controls the sequence of the inline isolation and bypass contactor and provides provisions for shutdown interlocks. *(See section 2.10.2)*

2.10.3 - Description of Terminal Connections

Start/Stop Control - Terminal Block 1 (TB1) Positions:

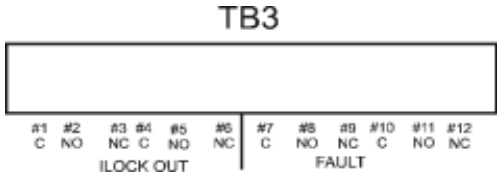
- 1 and 9 are the 120 VAC control power. The recommended VA is 750 or higher if the control power transformer (CPT) has not been supplied by Toshiba. The CPT is supplied on all complete starter units (i.e. "soft starter with Line Start Panel"). ***Note: This transformer should not be used for other 120VAC operations or power sources.***
- 2-3 and 4-5 are factory jumpered and can be removed for customer's normally closed, dry, shutdown contacts.
- 6-7-8 are for either two wire or three-wire start/stop logic. Two wire is connected to positions 6 and 8 with a N.O. dry, maintained start/stop contact. Three wire control connects to 6 with 7 as the stop push-button, and the start push-button is connected to 7 and 8.
- 10-11-12 is a dry FORM C contact. The contact is an immediate start/stop contact.

Emergency Bypass Control - Terminal Block 2 (TB2) Positions:



- 1 and 2 is an emergency bypass contact. If a dry contact closes position 1 and 2, this causes the Digital Control Unit to be shut off so there is no display. It also pulls in the bypass contactor. When the start is initiated it pulls in the inline isolation contactor which starts the motor across the line. ***Note: When using the contactor in the Emergency Bypass mode, the electronic overload protection is no longer functional. External overload protection must be provided for safe motor operation.***
- 3-4-5 are a FORM C contact. This is a dry contact that is initiated by the emergency contact being closed. It provides indication of the emergency bypass mode.
- 6 and 7 is a customer connection for control power. Position 6 is the 120 VAC supply at (400 VA) and position 7 is the return.
- 8-9-10 are a FORM C contact. The dry contact is a delayed start/stop contact. The amount of delay is determined by X1, X2 and SW3 (see "Switch Positions" and "Jumper Selection" on the following page).

Fault - Terminal Block 3 (TB3) Positions:



- 1-2-3 and 4-5-6 are sets of FORM C contacts. These are a dry contact that operates when a blown fuse indication is given or disconnect is open.
- 7-8-9 and 10-11-12 are sets of FORM C contacts. These are fault contacts that change state if a fault condition occurs.

Optional Relay - Terminal 4 (TB4) Positions:

- 1-2-3 and 4-5-6 are sets of FORM C contacts. These are auxiliary time delay contacts that will change state, after a delay, when the At Speed contact is initiated. X3, X4 and SW4 determine the amount of delay. (See switch position and Jumper selection on the following page)
- 7-8-9 and 10-11-12 are sets of FORM C contacts. These are power factor correction capacitor (P.F.C.) contacts to pull in an isolation contactor for the power factor correction capacitors (if required by customer). These will change state when the At Speed contact is initiated. X5, X6 and SW5 determine the amount of delay. (See "Switch Positions" and "Jumper Selection" on the following page).

Terminal 5 Block (TB5) Positions:

RS485 connections, software required (if wiring distance is >25 ft. then make use of termination resistors as needed).

Terminal Block 6 (TB6) Positions:

(Factory wired) DCU connections 1-12

Terminal Block 7 (TB7) Positions:

(Factory wired) DCU connections 13-24

Terminal Block 8 (TB8) Positions:
(Factory wired - if Line Start Section Package is supplied. If not, customer wired. See section 6.3)
- Positions 1 and 2 accept dry, normally closed contacts from blown fuse indicators and/or disconnect interlock contact.
- Positions 3 and 4 accept dry, normally closed contacts from an external overload protection device (required if emergency bypass is used).
- Positions 5 and 6 accept dry, normally closed contact from the bypass contactor for an At Speed indication. (Factory wired)
- Positions 7 and 8 are wired to the coil of the bypass contactor and energizes and de-energizes the contactor. (Factory wired)
- Positions 9 and 10 are wired to the coil of the inline isolation contactor and energizes and de-energizes the contactor.

Note: All customer contacts are 960VA, 120VAC (max.) rated dry contacts.

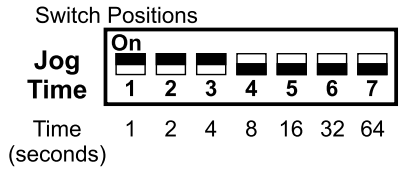
LEDs provided:
- -12 VDC power supply
- +12 VDC power supply
- Start = start is initiated to TCB board
- Fault = any fault has occurred
- Fuse Blown = disconnect open or blown fuse has activated
- PFC On = Power Factor Correction Capacitor contacts have energized
- Timed Out = Auxiliary time delay contacts have energized

Jumper Selection - Counting in increments
Start Delay
- X1 = (DLY-C) Start time delay in cycles
- X2 = (DLY-S) Start time delay in seconds (Factory setting)

Auxiliary (At Speed) Delay (from time bypass closes to when contacts change state)
- X3 = (AUX-C) Auxiliary time delay in cycles
- X4 = (AUX-S) Auxiliary time delay in seconds (Factory setting)

Power Factor Correction (PFC) Capacitors Delay (From time bypass closes to when contacts change state)
- X5 = (PFC-C) Power correction caps time delay in cycles
- X6 = (PFC-S) Power correction caps time delay in seconds (Factory setting)

Switch Positions



- SW1 = ON/OFF Dual Adjust mode (Factory setting:OFF for Ramp #1)
- SW2 = ON/OFF Switch for activating decel (Factory setting: OFF, no decel)
  ON = Soft stop decelerates the motor
  OFF = Allows motor to coast to a stop (Factory setting)
- SW3 = Start Delay; 7 position dip switch binary count up to 127 seconds/cycles. See jumper selection above. (Factory set: 2 seconds)
- SW4 = Auxiliary (At Speed) Delay; 7 position dip switch binary count up to 127 seconds/cycles. See jumper selection above. (Factory set: 3 seconds)
- SW5 = PFC time delay; 7 position dip switch binary count up to 127 seconds/cycles. See jumper selection above (Factory set: 3 seconds).

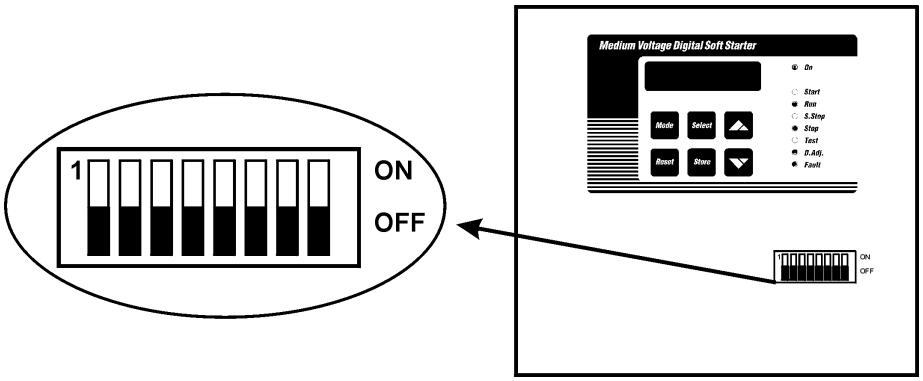
Chapter 3 - Adjustments

3.1 - Introduction

To achieve the proper time, torque and ramp settings the motor should be operated at its full load starting condition. Each unit has been programmed with application specific preset values and is fully tested before leaving the factory. The initial settings are set to accommodate most motor load conditions, and may be suitable for operating your motor. Check each setting for compatibility with your motor ratings and motor running characteristics. It is recommended that you first try the factory settings.

After programming, the s (increase) and t (decrease) keys may be disabled to prevent field changes. This is done using the dip switch position 8 in the “ON” position.

3.2 - DIP Switch Settings



Position 1	Minimizes or maximizes I/O Programming, Statistical Data and Resetting Default Parameters and Statistical Data parameter pages
Position 2	Factory Only (Off)
Position 3	Factory Only (Off)
Position 4	Factory Only (Off)
Position 5	Language *(refer to chart at right)*
Position 6	Language *(refer to chart at right)*
Position 7	Enables the extended parameters
Position 8	Enables the parameter setting lock (Prevents unauthorized program changes)

Language Settings:

English	5-Off, 6-Off
French	5-Off, 6-On
German	5-On, 6-Off
Spanish	5-On, 6-On

3.3 - Starting Adjustments

The JKSSS unit is set at the factory with typical starting characteristics that perform well in most applications. When the system is ready to start, try the initial setting first. If the motor does not come up to speed, increase the current limit setting.

In certain load situations, some programming may be required before start-up. See *Chapter 5 - Programming, Sections 5.7 and 5.8* for detailed instructions on programming particular starting and stopping setting.

Chapter 4 - Start-up

WARNING **The JKSSS unit deals with potentially lethal voltage levels. You must be certain that personnel are thoroughly trained in the applicable safety precautions before proceeding with this section!**

4.1 - Preliminary Start-Up Check List

Please make the following checks before applying power to the unit:

- Verify that all wiring is completed and all connections are tightened.
- Check the motor FLA and confirm the correct motor FLA is programmed into the unit.
  Note: *It is necessary to connect the motor to load terminals T1, T2 and T3, or the "Wrong Connection Protection" will be activated.*
- Verify control logic via 120V test power. A separate 120 VAC test source should be supplied to the control logic without powering up the medium voltage section for control logic testing. It also allows isolation of the 120 VAC from back-feeding the control power transformer.
- Connect Control supply. The "On" and "Stop" LEDs will light up.
- Review all parameters and readjust as required. *See Chapter 5 - Programming* for detailed instructions.
- Connect line voltage to line terminals.
- Verify that the interlocks for the system are installed and working properly.
- Verify that the supply transformer is correctly sized.
- Check for any loose mechanical parts or metal debris in the enclosure.
- Check the motor strapping and connections.
- Verify that the unit is properly grounded.

4.2 - 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. If faults caused by damage or poor installation practices have not been detected in the PRE-ENERGIZATION CHECK section, major damage including personal injury can result when the power is applied. Extra precaution is recommended on initial energization of the equipment.

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

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

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. 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 OFF and ON positions in a single continuous smooth movement.

After all disconnect devices have been closed, contactors may be operated to turn on the loads.

Additional information on Initial Energization is provided in a separate publication, number VF010H01 and VF010H03, in the Operation section.

4.3 - Quick Start-Up

The following parameters must be programmed before proceeding to "Sequence of Operation:"

- Initial Voltage *(see section 5.7.3)*
- Soft Start Curve *(see section 5.7.1)*
- Current Limit *(see section 5.7.4)*
- Acceleration Time *(see section 5.7.5)*

If decel is enabled, the following parameters must also be programmed:

- Deceleration Time *(see section 5.8.2)*
- Soft Stop Curve *(see section 5.8.1)*
- Final Torque *(see section 5.8.3)*

4.4 - Sequence of Operation

1. Press the "SELECT" button at the default screen to display the Motor FLA in percentage. This display monitors the current ramp.
2. Close the "Start" contact. The "Start" LED will light up. Press the "SELECT" button at the default screen until the motor FLA is displayed in a percentage. This display will allow you to monitor the current ramp. If the motor starts to turn, proceed to (9). If not, stop the motor and increase the "Initial Voltage" setting and start again until the motor starts to turn shortly after start signal. If the initial inrush current and mechanical shock are too high, decrease the "Initial Voltage" setting and proceed to (4).
3. The motor begins to turn. If the motor accelerates to nominal speed, proceed to (10). If the motor does not accelerate to speed, the unit will give a "Long Start Trip." In this case, reset the "Long Start Trip" and restart the unit with a higher current limit setting. If the current during acceleration is too high, decrease the "Current Limit" setting and proceed to (5).
4. After the motor has accelerated the load to full speed, listen for the bypass contactor to close. The run LED will energize on the DCU.
5. Open the "Stop" contact and wait until the motor stops. Verify that the following occurs:
   a) Listen for the bypass contactor to open to verify that it de-energizes and the main contactor remains energized only if the decel operation has been enabled. The motor current goes to zero (0) as the SCRs shut off.
   b) If "Soft Stop" is selected, check the "Final Torque" setting to be sure that sufficient motor torque is present when the power is shut off.
6. Increase the "Initial Voltage" and the "Current Limit" settings by 10% to allow for load changes.
7. Close the "Start" contact and confirm acceleration to full speed as required.
8. If acceleration time is too short, increase "Acceleration Time" settings as required.
9. Check the total starting time and set the "Maximum Start Time" to approximately 5 seconds longer than the maximum time required to complete starting.
10. Verify that all settings are programmed as desired.
11. Repeat same procedure for "Stop" and all other parameters.

4.5 - Emergency Bypass Operation (Optional)

⚠WARNING **UNDER NO CIRCUMSTANCES SHOULD THE TOGGLE SWITCH "BYPASS" BE OPERATED WITH POWER APPLIED TO THE UNIT.**

- Remove input power (open input disconnect switch).
- Open incoming medium voltage compartment door.
- Toggle "SSS/BYPASS" switch to bypass position (bypass overload is now enabled).
- Close and secure the medium voltage compartment door, and then close the isolation switch.
- Overload protection is required (customer supplied if factory emergency overload protection option not supplied.

⚠CAUTION **IN THE EMERGENCY BYPASS MODE, THERE IS NO OVERLOAD PROTECTION UNLESS OPTIONAL OR CUSTOMER SUPPLIED OVERLOAD IS SUPPLIED.**

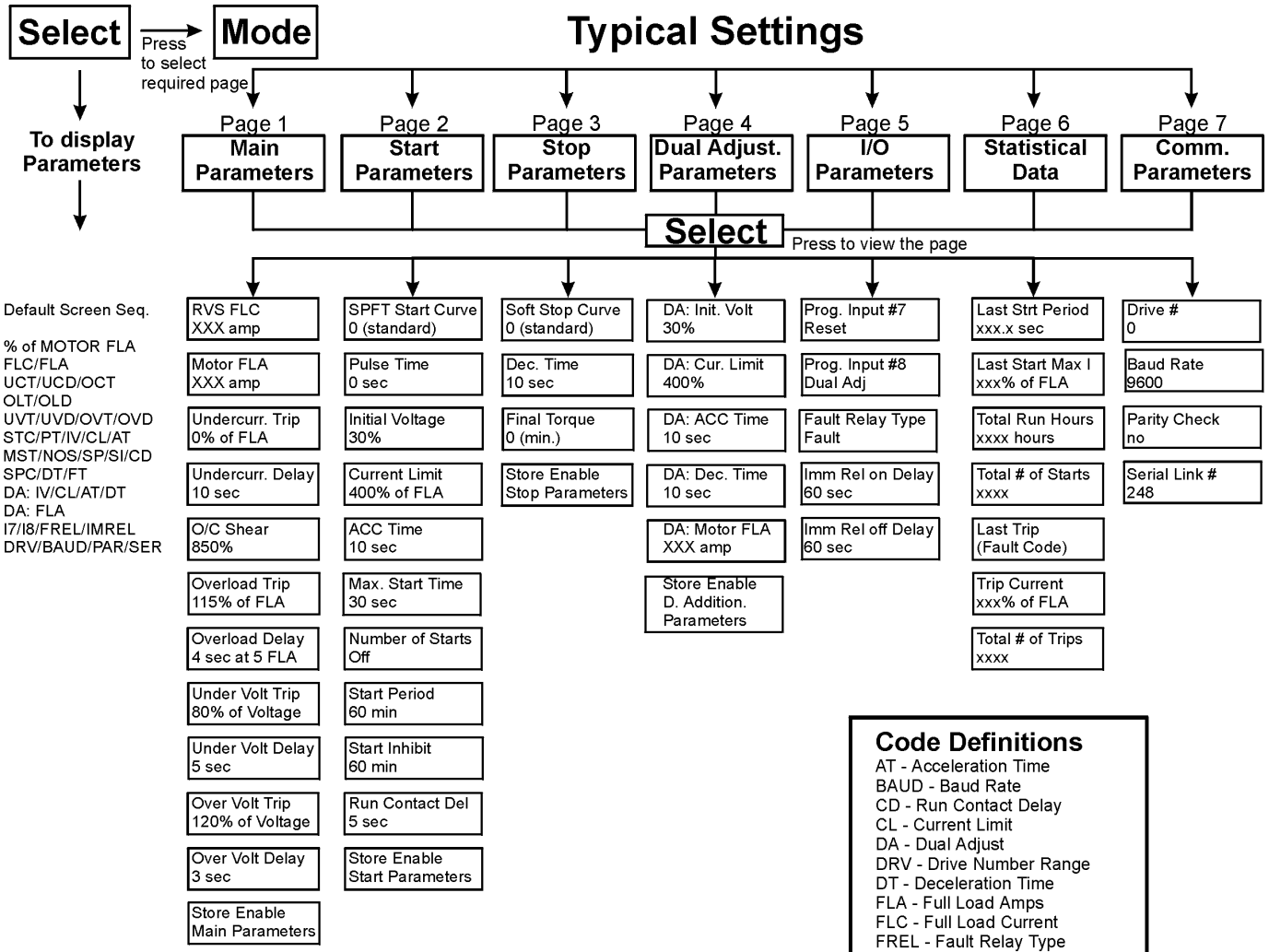
The starter is now operable as a normal across-the-line starter. When power is applied, the bypass contactor (or breaker) is immediately energized, tying the units input terminals directly to its output terminals. When the "ON/OFF" contact is closed, the main contactor is energized and the motor starts at full voltage. When the "ON/OFF" contact is opened, the motor is disconnected from the line via the main in-line vacuum contactor (or breaker).

⚠CAUTION **WHEN OPERATING IN THIS MODE THE DCU IS OFF. MOTOR PROTECTION IS REDUCED TO MOTOR FUSES AND THE SEPARATE OVERLOAD PROTECTION (CUSTOMER SUPPLIED OR OPTIONAL EQUIPMENT).**

Chapter 5 - Programming

5.1 - Introduction

This chapter explains the Digital Control Unit (DCU) command keys, LCD display and program features.



Code Definitions

AT - Acceleration Time
BAUD - Baud Rate
CD - Run Contact Delay
CL - Current Limit
DA - Dual Adjust
DRV - Drive Number Range
DT - Deceleration Time
FLA - Full Load Amps
FLC - Full Load Current
FREL - Fault Relay Type
FT - Final Torque
I7 - Prog. Input #7
I8 - Prog. Input #8
IMREL - Imm. Relay on Delay
IMREL - Imm. Relay off Delay
IV - Initial Voltage
MST - Maximum Start Time
NOS - Number of Starts
OCT - Shear Pin
OLD - Over Load Trip Delay
OLT - Over Load Trip
OVD - Over Volt Trip Delay
OVT - Over Volt Trip
PAR - Parity Check
PT - Pulse Time
SER - Serial Link No.
SI - Start Inhibit
SP - Start Period
SPC - Soft Stop Curve
STC - Soft Start Curve
UCD 0 Under Current Trip Delay
UCT - Under Current Trip
UVD - Under Volt Trip Delay
UVT - Under Volt Trip

5.2- Command Keys

MODE - Pressing the “MODE” button allows you to scroll through the following programming page selections:

- Display (Default)
- Main Parameters
- Start Parameters
- Stop Parameters
- Dual Adjustment Parameters
- Communications Parameters
- I/O Programming Parameters
- Statistical Data

SELECT - Pressing the “SELECT” button allows you to advance through each function within a parameter mode.

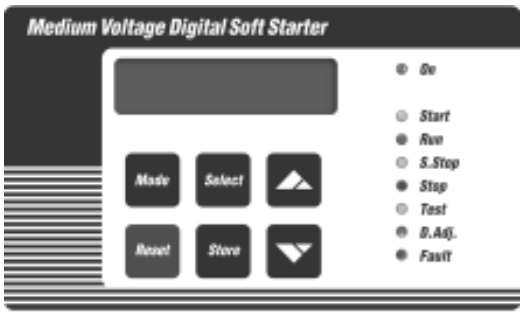
s / t - These buttons will increase or decrease the selected parameter setting.

STORE - Pressing the “STORE” button will store all the programmed selections. To accurately store the programmed settings “STORE” must not be pressed until the page sequence is completed.

RESET - Pressing the “RESET” button will clear the fault signal when a fault condition has been corrected and the start signal has been removed. **It is recommended that the cause of the fault be corrected before attempting a reset or restart.**

5.3 - LED Indicators

ON - Digital Control Unit (DCU) is powered up.
TEST - Test mode.
D. ADJUST - System is running under the Dual Adjustment feature.
FAULT - System has faulted. The LCD screen will provide a fault indication code.
START - Hardware or software start signal.
RUN - Motor is up to speed.
S. STOP - Motor is decelerating.
STOP - Hardware or software stop signal.



5.4 - Parameter Settings

The following are step-by-step instructions to program the parameter settings using the DCU keypad.

Note: **The parameter settings cannot be stored until the entire page sequence is completed. The "STORE ENABLE" command screen will only appear at the end of each page. See Section 5.6.12 for detailed storing instructions.**

5.5 - Display Mode

The Display Mode allows quick scanning through all of the program settings. The upper line displays functions and the lower line displays settings. Pressing the "SELECT" button allows you to scroll through the program settings.

Note: This mode is read-only, parameters cannot be changed in this mode.

5.6 - Main Parameters

Press the "MODE" button to advance to the Main Parameters mode. The LCD will display the main parameters page. Press the "SELECT" button to advance to each function. Use the s / t buttons to increase or decrease the parameter settings.

5.6.1 - Unit Ratings (RVS FLC)

DO NOT CHANGE! Factory use only.

The soft starter full load current has been programmed by the factory to correctly reflect the maximum amperage rating of the unit.

5.6.2 - Full Load Amperes (Motor FLA)

Factory Setting = Customer's Motor FLA

The motor FLA is programmed at the factory.

5.6.3 - Undercurrent Trip (UCT)

Factory Setting = 0%
Range = 20% - 90%

The undercurrent trip is the percentage of the motor FLA where the starter will fault. This can be customized to a specified percentage of full load current where the unit stops the motor. During initial motor testing, the undercurrent trip should be turned off (0%).

5.6.4 - Undercurrent Delay (UCD)

Factory Setting = 5 sec
Range = 0 - 40 sec

The amount of time allowed before tripping the unit on undercurrent condition.

5.6.5 - Overload Trip (OLT)

Factory Setting = 115% of the FLA
Normal Range = 75% - 150%

Standard motor overload with thermal memory, triggering a fault when the motor output current exceeds the programmed percentage of the motor FLA.

5.6.6 - Overload Delay (OLD)

Factory Setting = 4 sec
Range = 0 - 10 sec

The amount of time allowed before tripping the unit on overload condition.

5.6.7 - Shear Pin Trip

Factory Setting = 850%
Range = 200% - 850%

The maximum allowable current while motor is starting. (Acts as an electronic "shear pin") This does not affect the overload current sensing. This feature should be used in cases with sensitive load-to-gear ratios.
Note: Be sure that the electronic "Sheer Pin Trip" is set in accordance with load limitations and below the motor's locked rotor current.

5.6.8 - Under Voltage Trip (UVT)

Factory Setting = 75%

Range = 70% - 90%

The under voltage trip is the percentage of the nominal voltage where the starter will fault. This can be customized to a specified percentage of full voltage where the unit control will stop the motor.

5.6.9 - Under Voltage Trip Delay (UVD)

Factory Setting = 5 sec

Range = 0 - 10 sec

The amount of time allowed before tripping the unit on an under voltage condition.

5.6.10 - Over Voltage Trip (OVT)

Factory Setting = 125%

Range = 110% - 125%

The over voltage trip is the percentage of nominal voltage where the starter will fault. This can be customized to a specified percentage of full voltage where the unit control will stop the motor.

5.6.11 - Over Voltage Delay (OVD)

Factory Setting = 10 sec

Range = 0 - 10 sec

The amount of time allowed before tripping the unit on an over voltage condition.

5.6.12 - Store Enable Main Parameters

To accurately store the programmed settings, the page sequence must be completed before attempting to "Store Enable." Press the "SELECT" button until the LCD reads **"Store Enable."** Press the "STORE" button. When the parameters have been stored correctly, the LCD screen will read: **Data Saved OK**.

If parameters have been stored incorrectly, the LCD will read: **Data Saved Wrong**. *[See troubleshooting section for assistance]*

5.7 - Start Parameters

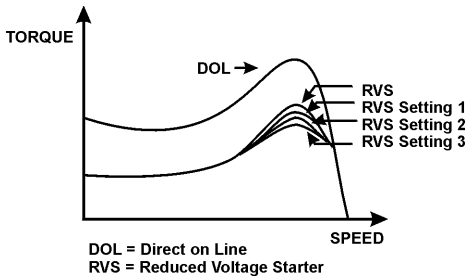
Press the "MODE" button to advance to the "Start Parameters" mode. The LCD will display the start parameters page. Use the "SELECT" button to advance to each function. Use the s / t buttons to increase or decrease the parameter settings.

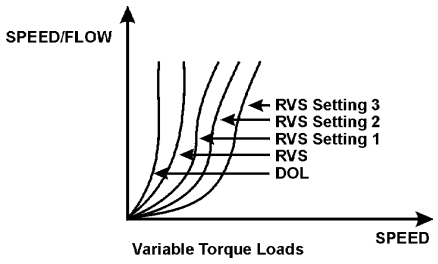
5.7.1 - Soft Start Curve

Factory Setting = 0

0 = Standard Start

1- 3 = Variable Torque





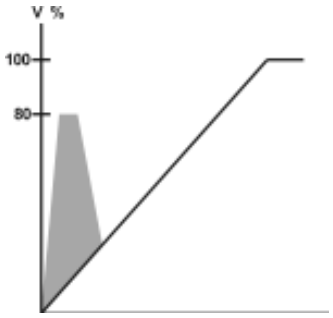
There are four (4) settings in this parameter. Zero (0) allows for the standard current/start feedback. For variable torque loads, such as fans and pumps, use Selections 1, 2 and 3. This allows the unit to alter the start parameters based on current feedback depending on the required motor acceleration curve. The higher the number, the greater the variation in the start curve.

5.7.2 - Pulse Time (PT)

Factory Setting = 0

Range = 0 - 2 sec

The amount of time the motor will remain in pulse start mode. Pulse start, or "kick start," is an initial voltage of 80% for a programmed amount of time, which then returns to the initial voltage level of the soft start curve. Pulse time should remain at zero (0) except where required for high inertia or high friction loads. The pulse time should be programmed as short as possible, yet allow the motor to rotate as soon as the start command is given.



Pulse Time (PT)

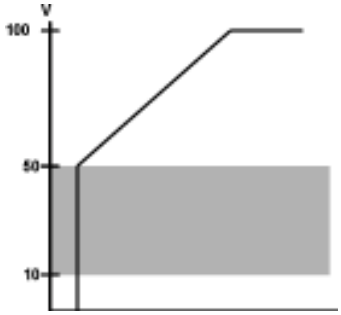
5.7.3 - Initial Voltage (IV)

Factory Setting = 30%

Range = 10% - 50% of nominal voltage

The percentage of voltage where the start curve will begin. If the motor does not start as soon as the start command is given, increase the initial voltage until rotation begins.

Note: The torque is directly proportional to the square of the voltage. This determines the inrush current and the mechanical shock on the system. The initial voltage should be set as low as possible, yet allowing the motor to rotate as soon as the start command is given.



Initial Voltage (IV)

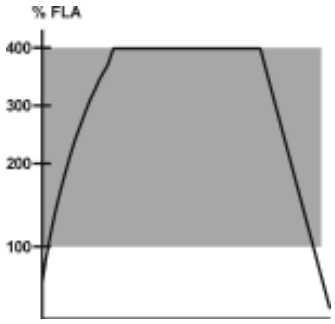
5.7.4 - Current Limit (CL)

Factory Setting = 350%

Range = 100% - 400% of the programmed motor FLA

The percentage of motor FLA which will be the maximum peak current draw allowed. The current can be limited for purposes such as limited current, peak demand charges and unique starting characteristics. A setting that is too low will cause the motor to stall or prevent the motor from reaching full speed. Generally, this adjustment should be set 20% above the minimum kW required to bring the motor up to full speed. If the motor does not reach full speed by the programmed acceleration time, increase the current limit.

A low current setting may extend the ramp time. If the motor reaches full speed before the voltage reaches nominal, the unit will override the acceleration time adjustment, causing the voltage to quickly ramp to full voltage and preventing any oscillation in the motor.



Current Limit (CL)

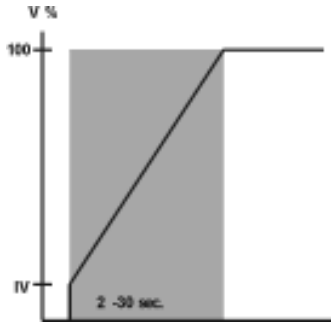
Do not set the current limit too low on variable starting loads. This will cause the unit to trip after exceeding the "Maximum Start Time" setting. (*See section 5.7.6)*

5.7.5 - Acceleration Time (AT)

Factory Setting = 25 sec

Range = 2 - 30 sec

The amount of time for the motor to achieve full voltage from initial starting voltage. Actual time may be affected if motor is lightly loaded. In a lightly loaded condition, the unit will sense that the motor is up to speed and increase to full voltage. (Anti-oscillation inhibitor). If heavily loaded, the current limit will extend the ramping time.



Accel Time (AT)

5.7.6 - Maximum Start Time (MST)

Factory Setting = 30 sec

Normal range = 0 - 30 sec

This parameter is designed as stall protection for the motor. It is the maximum amount of time allowed for the motor to reach full speed. If the load is not up to speed by the programmed time, the soft start will trigger the motor to stop. This parameter should be programmed to be greater than acceleration time. With high inertia loads, the maximum start time may be set up to 240 seconds.

5.7.7 - Number of Starts
Factory Setting = 10
Range = 1 - 10, OFF

The maximum number of starts allowed in a given time period. If exceeded, the unit will not allow additional starts until the start inhibit time has been met. This feature can be turned off by setting it at OFF.

5.7.8 - Starts Period
Factory Setting = 60 min
Range = 1 - 60 min

The time period for maximum number of starts. Example: Number of Starts = 10, Starts Period = 60
In this case, the unit would allow a maximum of 10 starts in a 60 minute period. *Note: Factory presets are typical only. Consult motor manufacturer for maximum start ratings of the actual motor.*

5.7.9 - Start Inhibit
Factory Setting = 30 min
Range = 1 - 60 min

The amount of time before additional starts will be allowed after the maximum number of starts in the start period has been exceeded.
Example: Number of Starts = 10, Starts Period = 60, Start Inhibit = 10
In this case, the unit would allow a maximum of 10 starts in a 60 minute period. If this is exceeded, the unit would wait 10 minutes before allowing another start.

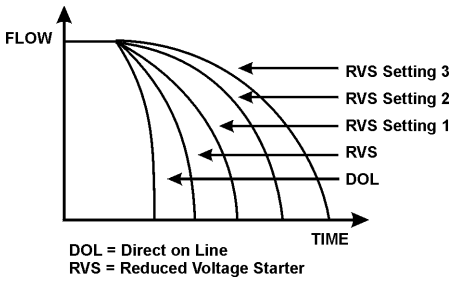
5.7.10 - Run Contact Delay (CT)
Factory Setting = 1 sec
Range = 1 - 120 sec

The amount of delay time between the motor being up to speed and when the unit will pull in the bypass contactor.

5.8 - Stop Parameters
Press the “MODE” button to advance to the Stop Parameters mode. The LED will display the stop parameters page. Use the “SELECT” button to advance to each function. Use the s / t buttons to increase or decrease the parameter settings.

5.8.1 - Soft Stop Curve (SC)
Factory Setting = 0
0 = Standard Stop
1 - 3 = Variable Torque

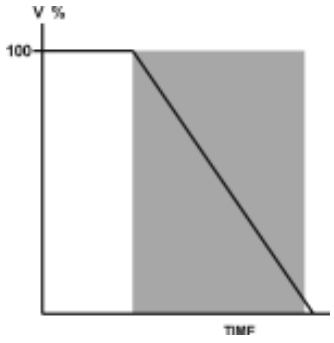
There are (4) settings in this parameter. Zero (0) allows for the standard decel closed loop. In most applications, the load torque decreases in squared relation to the speed. In these applications, reducing the voltage will reduce torque and the motor smoothly decelerates. In cases requiring different stopping characteristics, settings of 1, 2 and 3 allow the unit to alter the stop parameters based on the current feedback loop. The higher the number, the greater the variation in the stop curve. This setting should be set at zero (0) except for variable torque loads.



Soft Stop Curve (SC)

5.8.2 - Deceleration Time (DT)
Factory Setting = 25 sec
Range = 0 - 30 sec

This is the amount of time for the motor to ramp down from full voltage to the final torque setting when the soft stop input closes. The output voltage is gradually ramped down from full voltage to a programmable final torque setting for a controlled deceleration of high friction loads. This may be affected if the motor is lightly loaded.
Note: Closing the “Soft Stop” input opens the End of Acceleration contact and opens the bypass contactor. The load will then be transferred to the SCRs in a closed transition mode and the voltage will begin to ramp down.



Decel Time (DT)

5.8.3 - Final Torque (FT)

Factory Setting = 0 min

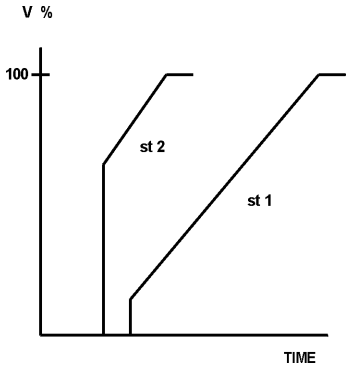
Range = 0 - 10 min

The point during deceleration where the motor is no longer moving the load. The final torque sensitivity is based on the current feedback, which is proportional to the motor torque. The programmed sensitivity will pick up the change in current based on the change in torque. The final torque setting has an adjustable range with the minimum sensitivity setting of (0) to a maximum sensitivity of (10). The minimum sensitivity (0) allows for maximum decel time, activating only when there is a significant change in current. The maximum sensitivity (10) allows for minimum decel time, activating immediately at any change in current.

5.9 - Dual Adjustment Parameters

Press the “MODE” button to advance to the Dual Adjustment Parameters mode. The LCD will display the dual adjustment parameters page. Use the “SELECT” button to advance to each function. Use the s / t buttons to increase or decrease the parameter settings.

The Dual Adjustment is designed as a second set of parameters to handle a specific load condition other than the primary load. These parameters will engage only when the dual adjust input is closed.



Dual Adjustment

5.9.1 - Dual Adjustment Initial Voltage (DA: IV)

Factory Setting = 30%

Range = 10% - 50% of nominal voltage

This parameter is the second setting of the soft start beginning voltage. For better motor cooling, this should be set as high as possible without causing a problem for the load. If the motor does not start as soon as the start command is given, increase the voltage until motor rotates.

5.9.2 - Dual Adjustment Current Limit (DA: CL)

Factory Setting = 400%

Range = 100% - 400% of motor FLA

This parameter is the second setting of the maximum peak current draw allowed. The current can be limited for purposes such as limited current, peak power charges and unique starting characteristics. If motor has not started by the programmed acceleration time, increase the dual adjustment current until motor has full start-up.

5.9.3 - Dual Adjustment Acceleration Time (DA: AT)

Factory Setting = 25 sec

Range = 1 - 30 sec

This parameter is the second setting for the amount of ramp time between the starting voltage and full voltage. This may be affected if the motor is lightly loaded. In lightly loaded starts, the starter will sense that the motor is up to speed and quickly ramp voltage to full on. This parameter should be programmed for the quickest time period the load will allow.

5.9.4 - Dual Adjustment Deceleration Time (DA: DT)

Factory Setting = 30 sec

Normal range = 0 - 30 sec

This is the amount of time for the motor to ramp down from full voltage to the final torque setting when the soft stop input closes. The output voltage is gradually ramped down from full voltage to a programmable final torque setting for a controlled deceleration of high friction loads. This may be affected if the motor is lightly loaded. *Note: Closing SW2 on the TCB board “Decel” opens the End of Acceleration contact and opens the bypass contactor. The load will them be transferred to the SCRs in a closed transition mode and the voltage will begin to ramp down.*

5.9.5 - Dual Adjustment Motor Full Load Amperage (DA: Motor FLA)

Factory Setting = Motor FLA

This parameter is the second setting for the motor FLA (i.e. on 2 speed motors). The motor FLA must not exceed the unit FLA. Use the s / t buttons to set the motor FLA.

5.10 - I/O Programming Parameters

Press the "MODE" button to advance to the I/O Programming Parameters mode. The LCD will display the I/O programming parameters page. Press the "SELECT" button to advance to each function. Use the s / t buttons to increase or decrease the parameter settings.

5.10.1 - Program Input #7

Factory Setting = N/A

This parameter is a future enhancement.

5.10.2 - Program Input #8

Factory Setting = N/A

This parameter is a future enhancement.

5.10.3 - Fault Contact Type

Factory Setting = Fault

This parameter sets the fault relay to either fault or fail-safe. (Normally energized or normally de-energized single pole, double throw SPDT.)

5.10.4 - Immediate Contact "On" Delay

Factory Setting = 0 sec

Range = 0 - 60 sec

The amount of time before the immediate relay contact closes after the start command is given.

5.10.5 - Immediate Contact "Off" Delay

Factory Setting = 0 sec

Range = 0 - 60 sec

The amount of time before the immediate relay contact opens after the stop command is given.

5.11 - Communications Parameters

Press the "MODE" button to advance to the Communications Parameters mode. The LCD will display the communications parameters page. Press the "SELECT" button to advance to each function. Use the s / t buttons to increase or decrease the parameter settings. *Note: Refer to communications manual for Windows 95 communications.*

Note: These parameters must be matched with the existing network, contact the network administrator for settings.

5.11.1 - Drive Number

Factory Setting = 0

Range is 0 - 999

This parameter establishes the drive number for the MODBUS communications. Use the s / t buttons to set the drive number.

5.11.2 - Baud Rate

Factory Setting = 9600

Range = 1200, 2400, 4800, 9600 baud

The baud rate of the communications hardware.

5.11.3 - Parity Check

Factory Setting = Even

This parameter allows the parity to be even, odd or none.

5.11.4 - Serial Link Number

Factory Setting = 248 (off)
Range = 1 - 247

The number assigned to the unit to allow multiplexing.

5.12 - Statistical Data

Press the “MODE” button to advance to the Statistical Data Parameters mode. The LCD will display the statistical data page. Press the “SELECT” button to advance to each function.

Note: This mode is read-only, parameter adjustments cannot be made in this mode. See section 5.5.9 for instructions to reset the statistical data.

5.12.1 - Last Start Period

The amount of time it took the motor to start during the last starting period.

5.12.2 - Last Start Maximum Current

The maximum current during the last start period.

5.12.3 - Total Run Time

The total run time since the controller was reset.

5.12.4 - Total Number of Starts

The total number of starts since the controller was reset.

5.12.5 - Last Trip

The cause of the last fault.

5.12.6 - Trip Current

The percentage of current at the last trip.

5.12.7 - Total Number of Trips

The number of trips since the controller was reset.

5.13 - Resetting Default Parameters

Press the “MODE” and the t buttons simultaneously to advance to the Resetting Default Parameters mode. The LCD will display the Resetting Default Parameters page. *(See section 3.2)*

Pressing the “MODE” and “STORE” buttons simultaneously will reset all the parameters to the default values.

⚠CAUTION **This will also reset the parameters set at the factory which should not be changed. Consult the factory before resetting the default parameters.**

Note: *If the parameter setting lock dip switch is “on,” this parameter will be disabled.*

5.14 - Resetting the Statistical Data

Press the “MODE” and the t buttons simultaneously, this will advance to the Resetting Default Parameters page. From this page, press the “SELECT” button to advance to Resetting the Statistical Data.

5.14.1 - Statistical Data

Press the “RESET” and “STORE” buttons simultaneously to reset all of the statistical data. After resetting the statistical data to zero (0), the until will return to the statistical data screen.

5.14.2 - Program Version

To display the program version, press the “SELECT” button from the Statistical Data screen.

Chapter 6 - Maintenance and Troubleshooting

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 inspection required. NFPA Publication 70B "Electrical Equipment Maintenance" may be used as a guide for setting up the maintenance program.

6.1 - 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.

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

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

WARNING **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. 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 fixed type JK 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

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.

6.2 - 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 B8 grease.

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

ELECTRICAL JOINTS

Examine all visible terminals and joints for signs of overheating. 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 table:

Hardware Size	Torque(ft-lbs)
1/4-20	4-6
5/16-18	10-15
3/8-16	20-30
1/2-13	40-50

The above values apply to metal-to-metal joints, e.g., copper-to-copper, etc. When torquing a bolt threaded into an insert molded into a plastic part, use approximately 2/3 the torque shown.

POWER FUSES

Check the condition of the back stab terminals on the cartridge for any signs of damage or discoloration. If there is any excessive build-up of dirt or other foreign material, wipe clean and relubricate with a light coat of Toshiba B8 grease, making sure that no grease gets on the insulated fuse housing.

Wipe off any dust or dirt which may have accumulated on the inside or outside of the power fuse cartridge or on the vacuum contactor housing.

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 clips, or damaged fuse.

Check the torque on the bolts which clamp the fuse clips to the fuse ferrules. The proper torque is 4-6 lb-ft.

Check the fuse barriers for cleanliness and proper positioning. There are four vertical barriers located between and outside fuses. A fifth angle shaped barrier, is positioned horizontally across the four barriers toward the back.

Addtional maintenance for the fuses are provided in a separate publication, number VF00W103.

VACUUM CONTACTOR

Maintenance instructions for the HCV-5HA vacuum contactor are provided in a separate publication, number VF00W103.

⚠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.**

WITHDRAWABLE CONTACTOR CARRIAGE (Optional on 200A and 400A Units)

Maintenance instructions for the withdrawable contactor carriage are provided in a separate publication, number VF010H01, in the Maintenance section.

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.

Maintenance instructions for the isolation switch are provided in a separate publication, number VF010H01 and VF010H03, in the Maintenance section.

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. Adjustment can be checked, however, as shown in a separate publication, number VF010H01 and VF010H03, in the Maintenance section.

INTERLOCKS

Maintenance instructions for the interlocks are provided in a separate publication, number VF010H01, VF010H02 and VF010H03, in the Maintenance section.

CONTROL POWER TRANSFORMER

Maintenance instructions for the control power transformers are provided in a separate publication, number VF010H01, VF010H02 and VF010H03, in the Maintenance section.

SCRs

The unit should be checked periodically for dirt, moisture or industrial contaminants. These can cause high voltage arc-over, carbon tracking or prevent proper cooling of the SCR heat sinks. All bolts should be checked annually for proper tightness using an accurate torque wrench and the table in section 2.9.

Note: *If the unit is installed in a contaminated environment and forced air cooling is used, blower filters must be checked and cleaned regularly to insure proper air flow and cooling of the enclosure.*

6.3 - Failure Analysis

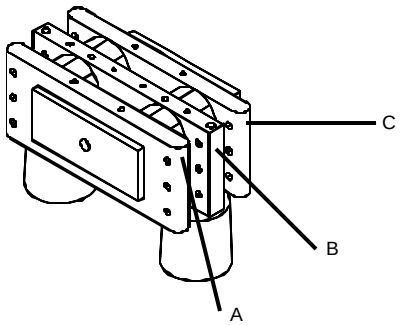
When a fault occurs, the Fault LED will light and the LCD will display the fault code. *Note:* Storing and saving selected parameters is **not** possible when the "Start," "Soft Stop" or "Fault" LED is lit.

Fault	Possible Cause
Shear Pin	The current exceeds programmed set point. Check FLA and FLC settings. Check motor and cable connections.
Overload	The current exceeds the programmed overload trip point, or overload thermal register was filled Check FLA, FLC and everload settings, check the motor current, wait to let the motor and starter cool down before restarting.
Under Voltage	The line voltage has dropped below the programmed level for the preset time. Check the Under Voltage and Time Delay settings. Check line voltage on L1, L2 and L3.
Over Voltage	The line voltage exceeds the programmed level for the preset time. Check the Over Voltage and Time Delay settings. Check line voltage on L1, L2 and L3.
Phase Loss	One (1) or two (2) of the phases are missing. Check the line phases.
Phase Sequence	The line phase sequence is wrong. check the line phase sequence, if wrong, interchange the two line phases. If the motor rotates in the wrong direction, swap the two wires on the load side.
Shorted SCR	One or more the SCRs are short circuited. SCRs may fail due to: * High voltage spikes not protected by proper external factors. * Frequent starting and maximum or fault conditions.
Heat Sink Overtemp	Heat sink temp is above 85º C. Check the power section and remove all dust and contaminants to improve cooling. Check that the motor is not being started too frequently and consult the factory. Bypass contactor not operating or failed.
Long Start Time	The Starter output voltage does not reach nominal at the preset time. Check FLA, FLC and the Maximum Start Time (MST) settings. Increase the Max Start Time (MST), Initial Voltage (IV), Current Limit (CL) or decrease Acceleration Time (AT) as necessary.
Wrong Connections	The motor is not properly connected to the load terminals.
Wrong Parameters	The parameters were not transferred from RAM to EPROM. This may happen after replacing the EPROM with a new version. Preset the "RESET" buttons then the "TEST" button and save the new default parameters by Pressing the "STORE" button.
Under Current	The current has dropped below the programmed level.
Data Saved Wrong	Parameters were stored incorrectly. Verify that the motor is not accelerating, decelerating or in fault mode. If problem persists, contact factory.

Note: *If the problem persists after the required programming changes have been made, and all corrective actions have been taken, please contact the factory for assistance.*

6.3.1 - SCR Testing Procedure

Perform the SCR Heat Sink Ohm test on each Stack Assembly.



Test	Ohm Meter Reading	Result
From Position A to Position B	Greater than 10K Ohm	Pass
	Less than 10K Ohm	Fail
From Position B to Position C	Greater than 10K Ohm	Pass
	Less than 10K Ohm	Fail
Gate to Cathode For Each SCR	10 to 100 Ohms	Pass (Typical 8 to 20 Ohms)
	Less than 10 or greater than 100 Ohms	Fail

6.4 - 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.

⚠ WARNING **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 which 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.

POWER FUSE CARTRIDGE

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

TERMINALS AND INTERNAL CONDUCTORS

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

OVERLOAD RELAYS

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.

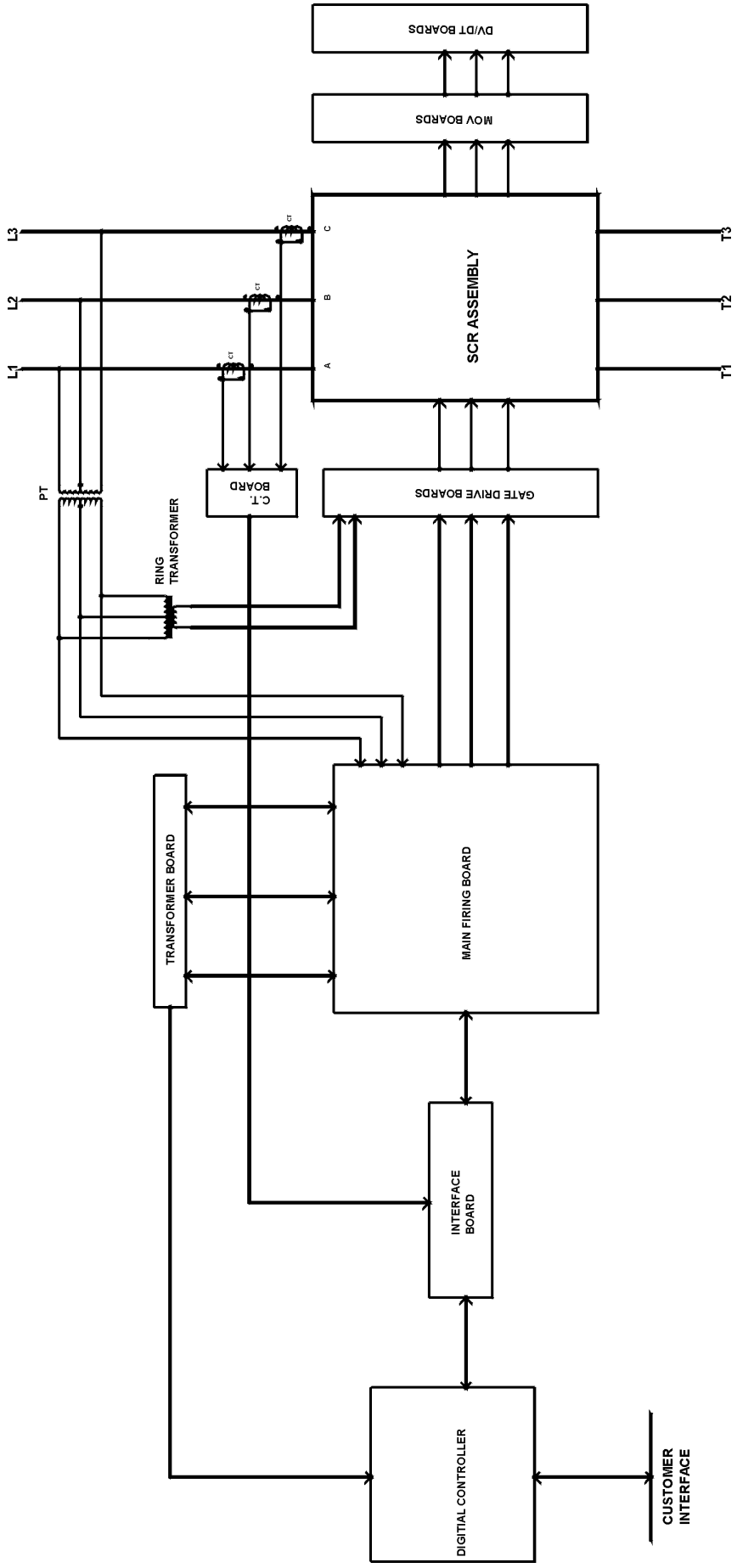
VACUUM CONTACTOR

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

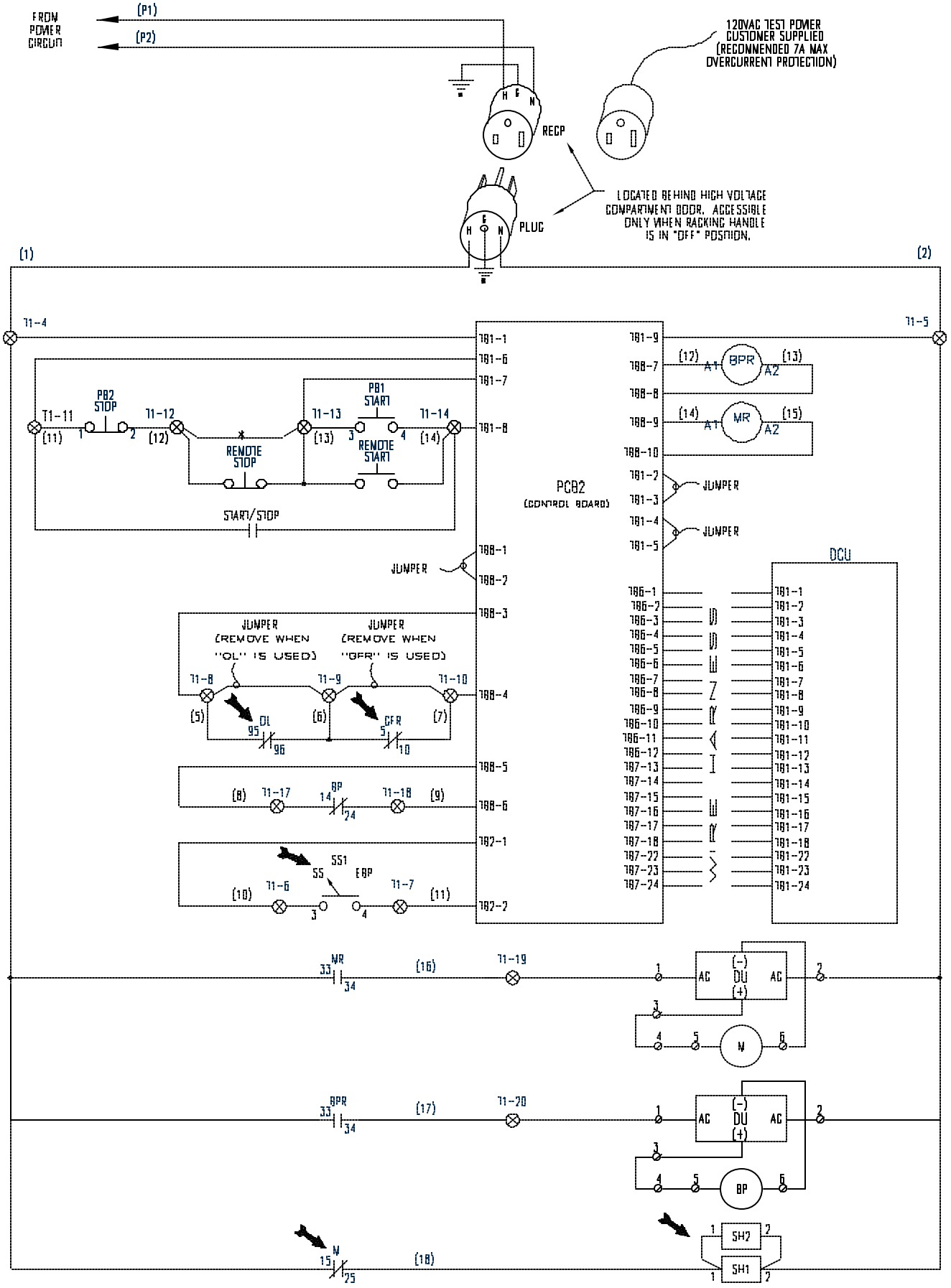
RETURN TO SERVICE

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

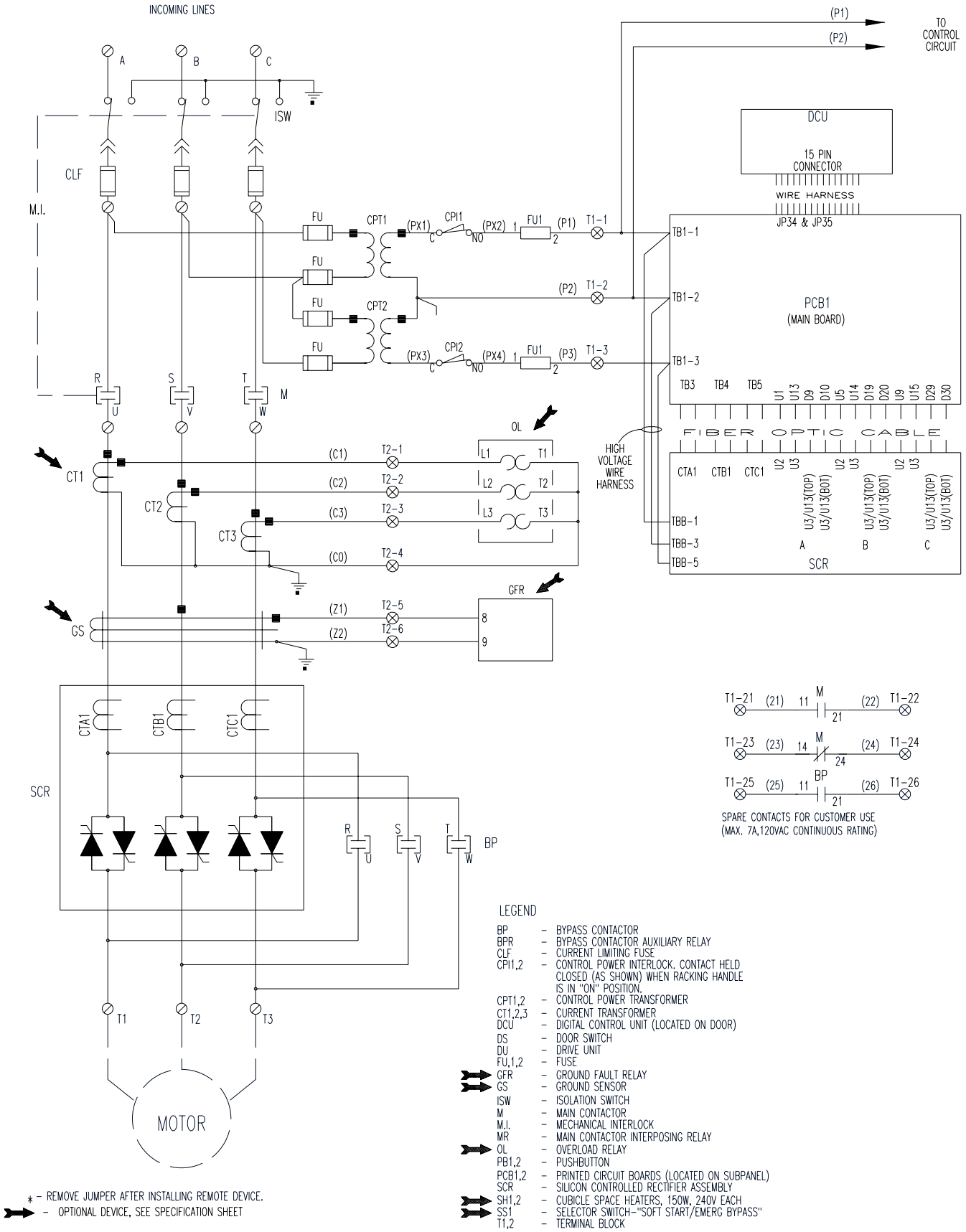
6.5 - Typical Block Diagram



6.6 - Typical Control Ladder Logic



6.7 - Typical 3-Line Diagram



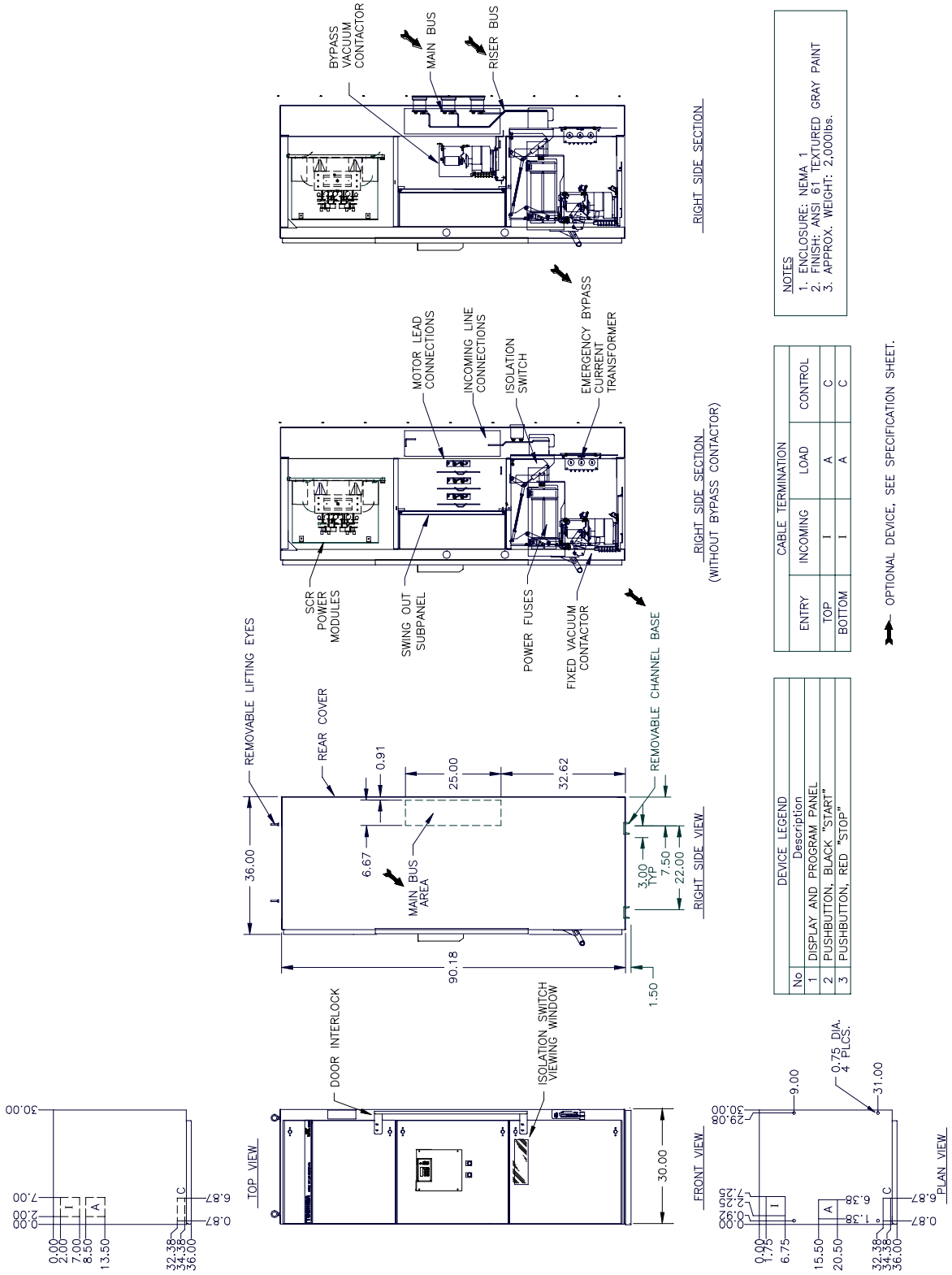
LEGEND

BP	–	BYPASS CONTACTOR
BPR	–	BYPASS CONTACTOR AUXILIARY RELAY
CLF	–	CURRENT LIMITING FUSE
CPI1,2	–	CONTROL POWER INTERLOCK. CONTACT HELD CLOSED (AS SHOWN) WHEN RACKING HANDLE IS IN "ON" POSITION.
CPT1,2	–	CONTROL POWER TRANSFORMER
CT1,2,3	–	CURRENT TRANSFORMER
DCU	–	DIGITAL CONTROL UNIT (LOCATED ON DOOR)
DS	–	DOOR SWITCH
DU	–	DRIVE UNIT
FU,1,2	–	FUSE
GFR	–	GROUND FAULT RELAY
GS	–	GROUND SENSOR
ISW	–	ISOLATION SWITCH
M	–	MAIN CONTACTOR
M.I.	–	MECHANICAL INTERLOCK
MR	–	MAIN CONTACTOR INTERPOSING RELAY
OL	–	OVERLOAD RELAY
PB1,2	–	PUSHBUTTON
PCB1,2	–	PRINTED CIRCUIT BOARDS (LOCATED ON SUBPANEL)
SCR	–	SILICON CONTROLLED RECTIFIER ASSEMBLY
SH1,2	–	CUBICLE SPACE HEATERS, 150W, 240V EACH
SS1	–	SELECTOR SWITCH–"SOFT START/EMERG BYPASS"
T1,2	–	TERMINAL BLOCK

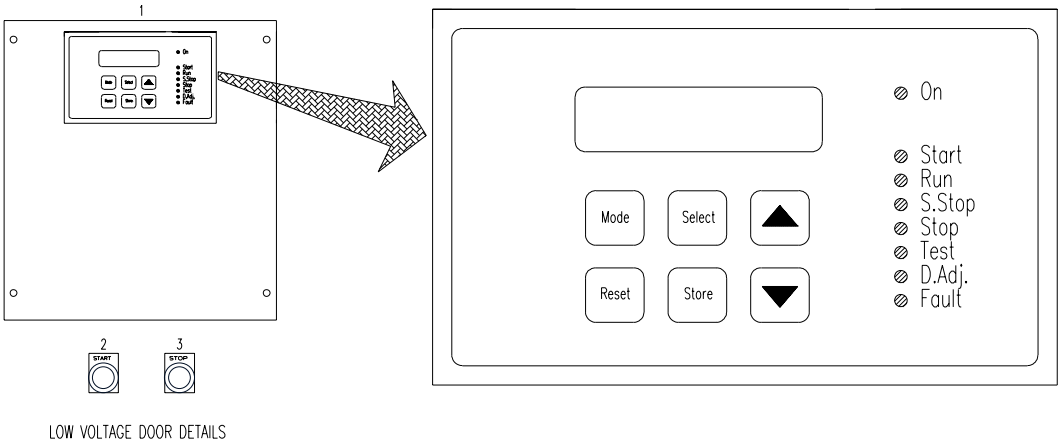
* – REMOVE JUMPER AFTER INSTALLING REMOTE DEVICE.

– OPTIONAL DEVICE, SEE SPECIFICATION SHEET

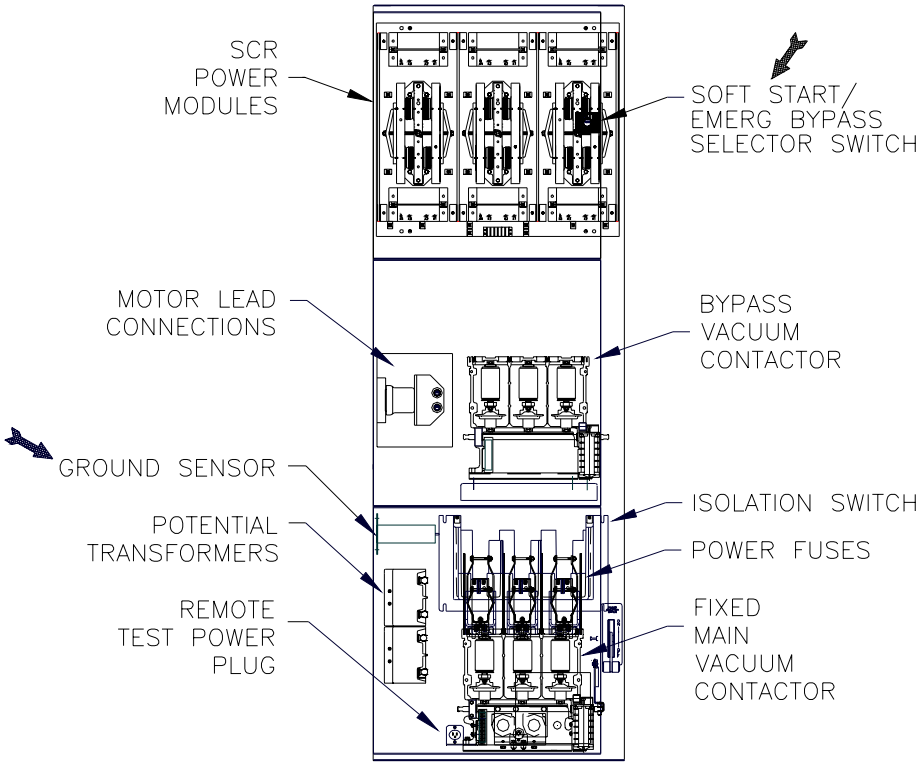
6.8 - Typical Dimensions and Mechanical Layout for 2300-4200V, 360A Max. Starter



Dimensions are for reference only.



LOW VOLTAGE DOOR DETAILS



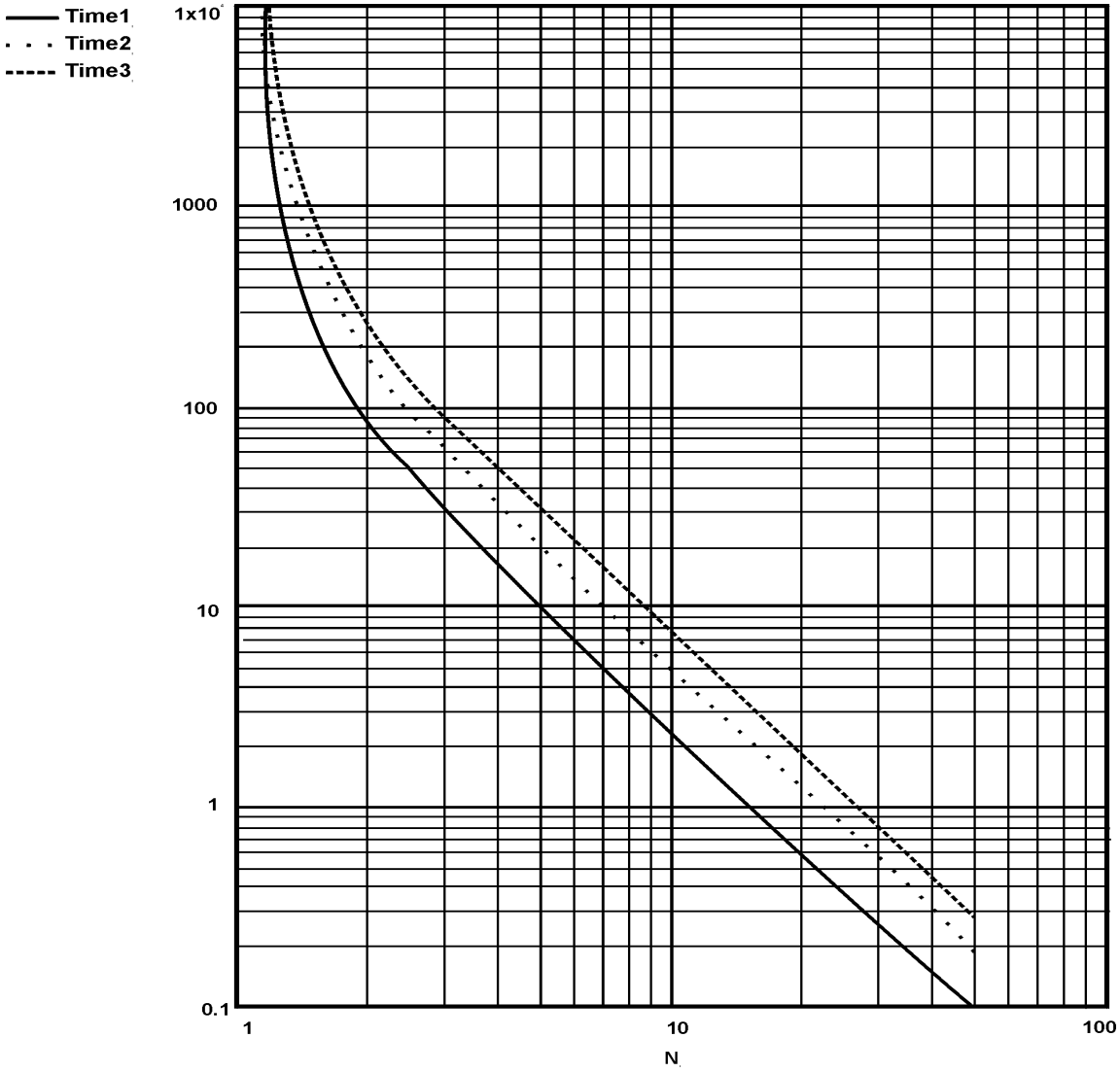
FRONT VIEW

(WITHOUT DOORS & SWING OUT SUBPANEL)

— OPTIONAL DEVICE

6.9 - Overload Curve Definition

The following is the overload curve calculation as programmed by the DCU. Adjustments of the Overload Trip (OLT) XXX% of the FLA and Overload Delay (OLD) XX sec at 5 FLA.



OLT = FLA * SF of Motor
FLA = Motor Full Load Current
AC = Motor Current
A = Motor Current as percent of FLA
OLD = Class of Overload (K1 is correction factor)

Motor and Overload Information
I: = 116, 117..5000B: = 2
K1: = 6 K2: = 137500
OLT: = 115
OLD: = 10
OLE: = 20
OLF: = 30
FLA: = 1000

Formula for calculation of Overload Curve:

$$AC_I = \frac{I}{100} \cdot FLA$$

$$A_I = \frac{AC_I}{FLA} \cdot 100$$

$$N_I = \frac{A_I}{100}$$

$$Time\ 1_I = \frac{K2}{(A_I)^B - OLT^B} \cdot \frac{OLD}{K1}$$

$$Time\ 2_I = \frac{K2}{(A_I)^B - OLT^B} \cdot \frac{OLE}{K1}$$

$$Time\ 3_I = \frac{K2}{(A_I)^B - OLT^B} \cdot \frac{OLF}{K1}$$

6.10 - Spare Parts List

JKSSS4 Spare Parts

Description	Additional Information	Quantity Req / Unit
Current Transformer Board	Motor Ampere Rating	3
Current Transformer	2300V	3
	4160V	3
Heatsink	200A - 2300V	3
Assembly	400A - 2300V	3
With Boards	200A - 4160V	3
(1 Phase)	400A - 4160V	3
Gate Drive Board (Included in Heatsink Assembly)		6
Gate Drive Transformer	2300V	3
	4160V	6
DV/DT Board	2 per phase	6
MOV	2 per phase	6
SCRs	200A, 2300V set of 2	3
	200A, 4160V set of 4	3
	400A, 2300V set of 2	3
	400A, 4160V set of 4	3
Bypass Contactor	400A	1
Isolation Contactor (Fixed Type)	400A	1
Isolation Contactor (Drawout Type)	400A	1
Main Power Fuses	Motor Ampere Rating or HP & Voltage	3
Main Control Board		1
Timer Control Board		1
Digital Control Module		1

WARRANTY AND LIMITATION OF LIABILITY

Toshiba International Corporation ("Company") warrants that all equipment and parts described herein will be free from defects in materials and workmanship. THIS WARRANTY WILL EXPIRE EIGHTEEN (18) MONTHS AFTER THE DATE ON WHICH SUCH EQUIPMENT AND PARTS (EXCLUDING REPAIRED OR REPLACEMENT EQUIPMENT AND PARTS FURNISHED PURSUANT TO THIS WARRANTY) ARE SHIPPED BY THE COMPANY TO THE INITIAL PURCHASER OR TWELVE (12) MONTHS AFTER SUCH EQUIPMENT AND PARTS (EXCLUDING REPAIRED OR REPLACEMENT EQUIPMENT AND PARTS FURNISHED PURSUANT TO THIS WARRANTY) ARE FIRST PLACED IN OPERATION, WHICHEVER PERIOD FIRST EXPIRES.

The Company will, at its option, repair or replace such equipment or part which is defective under the terms of the foregoing warranty, free of charge; provided the purchaser (1) promptly notifies the Company in writing of such defect, and (2) furnishes the Company satisfactory proof thereof, and (3) establishes that the equipment or part has been properly installed, maintained and operated within the limits of rated capacity and normal usage and in accordance with this manual, and (4) if requested by the Company, returns the defective equipment or part to the Company and pays all expenses incurred in connection with such return. The repaired or replacement equipment or part will be delivered, free of charge, to the purchaser F.O.B. the Company's warehouse or, at the Company's option, F.O.B. a Company authorized service shop, not loaded on truck or other carrier. The purchaser will pay the costs applicable to the equipment or part following such delivery, including, without limitation, all handling, transportation, assembly, insurance, testing and inspection charges.

THE FOREGOING OBLIGATION TO REPAIR OR REPLACE EQUIPMENT PARTS SHALL BE THE SOLE AND EXCLUSIVE REMEDY OF THE PURCHASER, ITS CUSTOMERS AND USERS OF THE EQUIPMENT AND PARTS FOR BREACH OF THE FOREGOING WARRANTY. THE COMPANY WILL HAVE NO OBLIGATIONS TO DISASSEMBLE ANY EQUIPMENT OR PART WHICH IS DEFECTIVE WITHIN THE TERMS OF THE ABOVE WARRANTY OR TO INSTALL ANY REPAIRED OR REPLACEMENT PART OR EQUIPMENT OR TO PAY ANY COSTS INCURRED IN CONNECTION WITH ANY SUCH DISASSEMBLY OR INSTALLATION. THE COMPANY, TOSHIBA CORPORATION AND THEIR SUPPLIERS AND SUBCONTRACTORS HEREBY DISCLAIM ALL OTHER EXPRESS, STATUTORY AND IMPLIED WARRANTIES, INCLUDING, WITHOUT LIMITATION, ALL EQUIPMENT AND PARTS FURNISHED PURSUANT TO THE FOREGOING WARRANTY AND ALL IMPLIED WARRANTIES OF MERCHANTABILITY.

The total liability of the Company, Toshiba Corporation and their suppliers and subcontractors for any loss, damage or claim, whether in contact, tort (including negligence and liability without fault), or otherwise, arising out of, connected with or resulting from the equipment and parts described in this manual or the performance or breach of any contract for the sale or supply of such equipment and parts, or from the design, manufacture, sale, delivery, resale, installation, technical direction or supervision of installation, inspection, testing, repair, replacement, operation, maintenance or use of any such equipment or part or any service relating thereto furnished by the Company shall not in any event exceed the price allocable to the equipment, part or service which gives claim, loss or damage. In no event, whether as a breach of contract or warranty, alleged negligence, liability without fault, or otherwise, shall the Company, Toshiba Corporation or their suppliers or subcontractors be liable for special or consequential damages, including, without limitation, loss or profits or revenue, loss of equipment described herein or any associated equipment, cost of capital, cost of substitute equipment or parts, facilities or services, down-time costs, labor costs or claims of customers of the purchaser for such damages.