TOSHIBA

Document: VF010H05

INSTRUCTION MANUAL

INSTALLATION - OPERATION - MAINTENANCE

JKSSS Plus Series

Medium Voltage Solid State Starters

Firmware Rev 6.96
Issued: 9/09
Manufactured in the USA

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.

Note: The contents of this manual will not become apart of or modify the warranty policy. The terms of which are set forth at the end of this manual.

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
(800) 231-1412
(800) 527-1204 (Canada)

Fax: (713) 466-8773

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

Model: _____

Serial Number: _____

Date of Installation: _____

Inspected by: _____

Reference Number: _____

JKSSS+ Series
Medium Voltage Solid State Soft Starters
2.3 - 4.2KV

Installation & Operation Manual

Reference Chart

Chapter 1 - Introduction

This chapter is an introduction to the Toshiba ***JKSSS+ Series*** reduced voltage solid state starter for medium voltage AC motors. It describes the basic configuration, operation and unit features. It is highly recommended that new users read this section thoroughly to gain a basic understanding of the starter system before attempting to start up a unit. If you are already familiar with the ***JKSSS+ Series*** starter, you may begin setup procedures immediately by proceeding to Chapter 2 – Installation.

1.1 Overview

The standard ***JKSSS+ Series*** solid state starter is a complete NEMA Class E-2 motor controller designed for the starting, protection and control of AC medium voltage motors. It contains the motor disconnect switch, motor circuit fuses, control power transformer, a line isolation contactor, SCR stack assemblies, a bypass contactor, low voltage controls and motor terminal blocks in that order. An optional “soft start only” version is also available which is supplied without the control power transformer, the disconnect switch and line isolation contactor. (The soft start only model must be used with a customer supplied, mechanically interlocked line start panel).

1.2 Specifications

Unit Overload Capacity (Percent of motor FLA)	500% - 60 seconds 1 Cycle: up to 14 x FLA (internally protected by programmable short circuit)
Frequency	50 or 60Hz, ±2Hz hardware selectable
Power Circuit	6 SCRs, 12 SCRs or 18 SCRs (model dependent)
SCR Peak Inverse Voltage Ratings	6500V - 13000V (model dependent see page 4)
Phase Insensitivity	User selectable phase sequence detection
Transient Voltage Protection	RC snubber dv/dt networks (one per SCR module)
Ambient Condition Design	Enclosed units: 0° to 40°C (32° to 104°F) 5 - 95% relative humidity 0 - 3300 ft. (1000m) above sea level without derating (Ratings for ambient conditions external to unit)
Control	2 or 3 wire 120VAC, CPT supplied on standard units
Auxiliary Contacts	Multiple: Form C (contacts), rated 5 Amps, 240VAC max.
	8 Relays (4 programmable) - Form C contact
	Fault Indicator: Form C contact
BIL Rating	2300V - 4200V 60kV
Approvals	UL, cUL (2.3 - 4.2kV, max. 400A)

1.2 Specifications (continued)

Advanced Motor Protection	
Two Stage Electronic Overload Curves	Starting: Programmable for Class 5 through 30 Run: Programmable for Class 5 through 30 when "At-Speed" is detected.
Overload Reset	Manual (default) or automatic
Retentive Thermal Memory	Overload circuit retains thermal condition of the motor regardless of control power status. Unit uses real time clock to adjust for off time.
Dynamic Reset Capacity	Overload will not reset until thermal capacity available in the motor is enough for a successful restart. Starter learns and retains this information by monitoring previous successful starts.
Phase Current Imbalance Protection	Imbalance Trip Level: 5 - 30% current between any two phases Imbalance Trip Delay: 1 -20 seconds
Over Current Protection (Electronic Shear Pin)	Trip Level: 100 - 300% of motor FLA Trip Delay: 1 - 20 seconds
Load Loss Trip Protection	Under Current Trip Level: 10 -90 % of motor FLA Under Current Trip Delay: 1 - 60 seconds
Coast Down (Back Spin) Lockout Timer	Coast Down Time Range: 1 - 60 minutes
Starts-per-hour Lockout Timer	Range: 1 - 6 successful starts per hour Time between starts: 1 - 60 minutes between start attempts
Programmable Outputs	
Type / Rating	Form C (DPDT), Rated 5 amps 240 VAC max, (1200 VA)
Run Indication	Programmable
At Speed Indication	Programmable
Acceleration Adjustments	Programmable Ramp Types: Voltage or Current Ramp (VR or CR) Starting Torque: 0 - 100% of line voltage (VR) or 0 - 600% of motor FLA (CR) Ramp Time: 1 to 120 seconds Current Limit: 200 - 500% (VR or CR)
Dual Ramp Settings	4 Options: VR1+VR2; VR1+CR2; CR1+CR2; CR1+VR2 Dual Ramp Control: Ramp 1 = Default Ramp 2 = selectable via dry contact input
Deceleration Adjustments	Begin Decel Level: 0 - 100% of line voltage Stop Level: 0 to 1% less than Begin Decel Level Decel Time: 1 - 60 seconds
Jog Settings	Voltage Jog: 5 - 75%
Kick Start Settings	Kick Voltage: 10 - 100% Kick Time: 0.1 - 2 seconds
Fault Display	Shorted SCR, Phase Loss, Shunt Trip, Phase Imbalance Trip, Overload, Overtemp, Overcurrent, Short Circuit, Load Loss, Undervoltage or Any Trip
Lockout Display	Coast Down Time, Starts Per Hour, Time Between Starts, and Any Lockout
Event History	
Up to 60 Events	Data includes cause of event, time, date, voltage, power factor and current for each phase and ground fault current at time of event

1.2 Specifications (continued)

Metering Functions	
Motor Load	Percent of FLA
Current Data	A, B, C Phase Current, Avg Current, Ground Fault (Option)
Thermal Data	Remaining thermal register; thermal capacity to start
Start Data	Avg Start Time, Avg Start Current, Measured Capacity to start, time since last start
RTD Data (Option)	Temperature readings from up to 12 RTDs (6 stator RTDs)
Voltage Metering	kW, kVAR, PF, kWH
Serial Communications	
Protocol	Modbus RTU
Signal	RS-485, RS-422 or RS232
Network	Up to 247 devices per mode
Functionality	Full operation, status view, and programming via communications port
Operator Interface	
LCD Readout	Alpha numeric LCD display
Keypad	8 function keys with tactile feedback
Status Indicators	12 LEDs include Power, Run, Alarm, Trip, Aux Relays
Remote Mount Capability	Up to 1000 circuit-feet from chassis (use twisted, shielded wire & power source)
Clock and Memory	
Operating Memory	SRAM loaded from EEPROM at initialization
Factory Default Storage	Flash EPROM, field replaceable
Customer Settings and Status	Non-volatile EEPROM, no battery backup necessary
Real Time Clock	Lithium ion battery for clock memory only

1.3 Design Features

The standard ***JKSSS+*** configuration is a complete NEMA Class E-2 motor controller 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.

  Typically the fuses are ANSI class “R” for units rated up to 4800V. The fuses are sized according to motor locked rotor current and are coordinated with the solid state overload relay. The fuse and overload coordination is designed to allow the controller and contactor to clear low and medium level faults. This prevents exceeding the contactor interrupt ratings. Fuses interrupt high level faults that exceed the contactor interrupt ratings. Fuse holders include blown fuse indicators (wired to the isolation contactor circuit) to disconnect all three phases if any one of the fuses clears *(see section 2.7)*.

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

- **RC Snubber Networks:** Provide Transient Voltage Protection for SCR Power Modules in each phase 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.

200 & 400 Amps Units			
Voltage	**Series Pairs**	**Total Number of SCRs**	**PIV Rating**
2300 V	0	6	6500 V
3300 / 4160 V	2	12	13000 V

600 Amps Units			
Voltage	**Series Pairs**	**Total Number of SCRs**	**PIV Rating**
2300 V	2	12	7000 V
3300 / 4160 V	4	24	14000 V

Unit PIV Ratings

- **Contactors:** Vacuum contactors are provided for both In-Line Isolation and SCR Bypass. The contactor voltage ratings are: 7.2kV for 2300 - 6900V units.

  A sequencing feature controls the contactors. Under normal operating conditions this ensures that both contactors make and break under no-load conditions to maximize contactor life. Vacuum contactors are rated for the maximum starting requirement of the unit design. The Bypass Contactor is rated to be capable of emergency start. 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).

- **Soft Start Only Option:** The ***JKSSS+ Series*** is also offered in an optional "Soft Start Only" package for use in retrofitting behind an existing customer supplied line start controller. In this configuration, **the Disconnect Switch, Fuses and Line Isolation Vacuum Contactor are NOT included in the *JKSSS+*** unit, so proper interlocking of sections containing medium voltage becomes the installer's responsibility.

  All retrofit "Soft Start Only" packages must be used with complete line isolation using a contactor or other "air-gap" device. The Optional "Soft Start Only" includes overload protection in normal operation mode and will sequence the isolation contactor, so all logic control should be done at the ***JKSSS+*** control unit. Avoid turning the ***JKSSS+*** on and off using the isolation device.

1.4 Structure and Power Bus

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

- **Structure**: 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. In the JK400, 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 Power Compartment** houses the main disconnect switch, amain 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 contactors, 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 keypad 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 bottom of the enclosure 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. 11 gauge steel is used in all enclosures. All NEMA 1 & 12 units have bottom entrance plates.

- **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 or silver-plated copper. All bus ratings are per UL Standard 347.

- **Bracing:** Bus bars are braced with non-tracking fire resistant non-hygroscopic insulation supports and have a minimum fault current rating of 50,000 Amps.

- **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 400 Amps extends the entire length of the starter near the bottom of each enclosure. A grounding strap connects each vertically adjacent compartment and also ties the grounding arm of the disconnect switch to the main ground bus bar *(see section 2.11)*.

- **Seismic Qualifications:** The entire starter assembly, when properly installed, 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 Theory of Operation

The power of the ***JKSSS+ Series*** is in the CPU, a microprocessor based protection and control system for the motor and starter assembly. The CPU uses Phase Angle Firing of the SCRs to apply a reduced voltage to the motor, and then slowly and gently increases torque through control of the voltage and current until the motor accelerates to full speed. This starting method lowers the starting current of the motor, reducing electrical stresses on the power system and motor. It also reduces peak starting torque stresses on both the motor and load mechanical components, promoting longer service life and less downtime.

Acceleration: The ***JKSSS+ Series*** comes standard with several methods of accelerating the motor so that it can be programmed to match almost any industrial AC motor application.

The factory default setting applies a **Voltage Ramp** with **Current Limit** as this has been proven the most reliable starting method for the vast majority of applications. Using this starting method, the Initial Torque setting applies just enough voltage to the motor to cause the motor shaft to begin to turn. This voltage is then gradually increased over time (as per the Ramp Time setting)

until one of three things happen: the motor accelerates to full speed, the Ramp Time expires or a Current Limit setting is reached.

If the motor accelerates to full speed before the ramp time setting has expired, an automatic Anti-Oscillation feature will override the remaining ramp time and full voltage will be applied. This will prevent any surging or pulsation in the motor torque, which might otherwise occur due to the load not being fully coupled to the motor when operating at reduced voltage and torque levels.

If the motor has not reached full speed at the end of the ramp time setting, the current limit setting will proportionally control the maximum output torque. Feedback sensors in the ***JKSSS+ Series*** provide protection from a stall condition, an overload condition or excessive acceleration time.

The Current Limit feature is provided to accommodate installations where there is limited power available (for example, on-site generator power or utility lines with limited capacity). The torque is increased until the motor current reaches the preset Current Limit point and it is then held at that level. Current Limit overrides the ramp time setting so if the motor has not accelerated to full speed under the Current Limit setting, the current remains limited for as long as it takes the motor to accelerate to full speed.

When the motor reaches full speed and the current drops to running levels, the soft starter detects an At-Speed condition and closes the Bypass Contactor. The Bypass Contactor serves to shunt power around the SCR stack assemblies to prevent heat buildup in the starter enclosure due to the slight voltage drop across the SCRs. At this point, the soft starter has the motor operating at full voltage, just as any other starter would.

Other starting methods available in the soft starter are:

- **Current Ramp:** Uses a closed current feedback PID loop to provide a linear torque increase up to a Maximum Current level.

- **Constant Current:** Current is immediately increased to the Current Limit point and held there until the motor reaches full speed.

- **Custom Curve:** Gives the user the ability to plot torque and time points on a graph. The soft starter will then accelerate the motor following these points.

- **Tachometer Feedback Ramp:** Uses a closed loop speed follower method monitoring a tachometer input signal from the motor or load shaft.

Deceleration: The soft starter provides the user with the option of having the load coast to a stop or controlling the deceleration by slowly reducing the voltage to the motor upon initiating a stop command. The Decel feature is the ***opposite of DC injection braking*** in that the motor will actually take longer to come to a stop than if allowed to coast to a stop. The most common application for the Decel feature is pumping applications where a controlled stop prevents water hammer and mechanical damage to the system.

1.6 General Protection

The soft starter is provided with a built-in motor protection relay that can be programmed for primary protection of the motor/load system. Operation of the soft starter can be divided into 4 modes; Ready, Start, Run and Stop.

Ready Mode: In this mode, control and line power are applied and the starter is ready for a start command. Protection during this mode includes the monitoring of current for leakage through multiple shorted SCRs or welded contacts on the Bypass Contactor. Other protection features in effect are:

- Starter Temperature
- Shorted SCR
- Phase Reversal (if enabled)
- Line Frequency Trip Window
- External Input Faults

Note: The “Programming Mode” can only be entered from the Ready Mode. During programming, all protection features and start command are disabled.

Start Mode: These additional protection functions are enabled when the soft starter receives a valid Start command:

- Phase Reversal (if enabled)
- Start Curve
- Acceleration Timer
- Phase Imbalance
- Short Circuit / Load Pre-check (Toe-in-the-Water)
- Ground Fault (Optional)
- External Input Faults
- Accumulated Starting FLA Units (I^2t Protection)
- Overload Protection
- Thermal Capacity

Note: Shorted SCR and Shunt Trip protection are no longer in effect once the soft starter goes into the Start Mode.

Run Mode: The soft starter enters the Run Mode when it reaches full output voltage *and* the motor current drops below the FLA setting (motor nameplate FLA plus service factor) for a predetermined period of time. During the Run Mode these additional protection features are enabled:

- Running Overload Curve
- Phase Loss
- Under Current / Load Loss
- Over Current / Electronic Shear Pin (Jam protection)
- External Input Faults

Stop Mode: Once a Stop command has been given, the protection features change depending on which Stop Mode is selected.

- **Decel Mode:** Retains all protection features of the Run Mode. At the end of Decel, the motor will be stopped and the protection features change as indicated below.

- **Coast-To-Stop Mode:** Power is immediately removed from the motor and the soft starter returns to the Ready Mode.

Additional protection features activated when the stop command is given include:
- Coast-Down / Back Spin Timer
- Starts-per-Hour
- Time Between Starts
- External Input Faults

1.7 Thermal Overload Protection

The ***JKSSS+ Series*** plays an important role in the protection of your motor in that it monitors the motor for excessive thermal conditions due to starting, running or even ambient conditions. The soft starter has a Dynamic Thermal Register system in the CPU that provides a mathematical representation of the thermal state of the motor. This thermal state information is kept in memory and is monitored for excesses in both value and rate of change. Input is derived from current imbalances and RTD measurements making it dynamic to all processes involving the motor. The starter monitors these conditions separately during Start and Run modes to provide proper thermal overload protection at all times.

Start Mode overload protection is selectable using one of three methods:

- **Basic Protection:** I^2t data is accumulated and plotted based on an Overload Curve selected in programming. This is programmed per NEMA Class 5-30 standard curves and is based on the Locked Rotor Current (from the motor nameplate) as programmed into the soft starter.

- **Measured Start Capacity:** The user enters a measured amount of thermal capacity from a pre-selected successful start as a setpoint to the Thermal Register for the soft starter to follow.

- **Learned Curve Protection:** The user sets the soft starter to the “LEARN” mode and starts the motor under normal starting conditions. The CPU then samples and records 100 data points during the start curve, analyzes them and creates a graphical representation in memory. The soft starter is then switched to Curve Follow protection mode and monitors motor performance against this curve. This feature is especially useful in initial commissioning tests to record a base line performance sample (in this case, it is not necessarily used for motor protection).

Run Mode overload protection is initiated when the starter determines that the motor is At-Speed. Overload Protection is initiated when the motor RMS current rises above a “pick-up point” (as determined by the motor nameplate FLA and service factor). Run mode protection is provided by the CPU monitoring the Dynamic Thermal Register. Data for the Dynamic Thermal Register is accumulated from I^2t calculations and cooling rates. A trip occurs when the register reaches 100% as determined by the selected Overload Protection Curve (NEMA Class 5-30 standard curves) and is based on the programmed Locked Rotor Current indicated on the motor nameplate. The Dynamic Thermal Register is altered, or “biased”, by the following conditions:

- **Current Imbalance:** Will bias the register higher to add protection from additional motor heating during a current imbalance condition.

- **Normal Cooling:** Provided when the motor current drops below the pick-up point or the motor is off line. The cooling rate is lower for motors that are off-line (such as after a trip) since cooling fans are also inoperative**.**

- **RTD Input:** Will bias the register in either direction based on real-time input of the motor, bearing and even ambient temperature conditions.

- **Dynamic Reset** is another feature that adds reliability and consistency to the performance of the soft starter. If a motor overload condition occurs and the soft starter trips, it cannot be reset until sufficient cool down time has elapsed. This cool down time is determined by the thermal state of the motor when it tripped (i.e. hot motors cool more quickly due to additional convection). The cool down time is also biased by RTD measurements when used.

- **Retentive Memory** provides continuous overload protection and real time reset even if power is lost. Upon restoration of power, the soft starter will read the Real Time Clock and restore the thermal register to what it should be given the elapsed time.

- **Learned Reset Capacity** is a feature that is unique to the ***JKSSS+ Series***. By sampling the amount of thermal capacity used in the previous three successful starts, the soft starter will not allow a reset until a sufficient amount of thermal capacity has been regained in the motor. This prevents nuisance tripping and insures that unsuccessful start attempts (which would otherwise use up the starts-per-hour capacity of the motor) are not counted.

1.8 Firing Circuit

The SCR gate firing circuit is critical to performance and stability of the system. The firing circuit includes several unique features which enhance the ruggedness, noise immunity and flexibility for maximized performance. In most applications, this performance is attained without the need for reactors or field installed devices. These features include:

Auto Synchronizing of the gate timing pulses match each phase firing angle to their respective phases. The starter actively tracks minor shifts in the line frequency, avoiding nuisance tripping that may happen with conventional gate firing systems. This is especially useful on portable or backup generator supplies, allowing the starter to be used confidently in applications that have unstable power**.**

Sustained Pulse firing keeps the firing signal active for 270 electrical degrees, ensuring that the DC gate pulse causes the SCR to fire even if line noise is present at a critical moment. This provides the soft starter with superior noise immunity and protects against misfiring, enhancing the system reliability.

Closed Loop Firing Control is a method of balancing the SCR firing pattern based on the desired output. The CPU uses feedback signals from both the output current and voltage providing smooth output and preventing imbalances during ramping which prevents unnecessary motor heating**.**

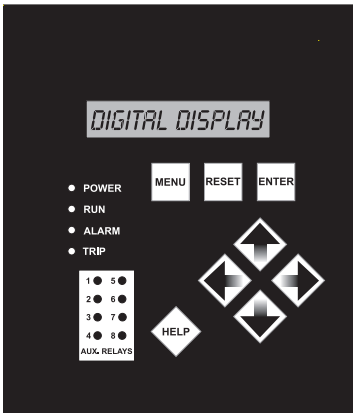
Transformer Isolation of the firing signals prevents interference from line noise and EMI/RFI signals that may be present. Specially designed 120V 3 phase isolation transformers provide potential measurement, firing board power and gate power systems while being isolated from the line voltage. High isolation Ring Transformers are used to step this down to 28Vac for the Sustained Pulse firing circuit, providing further isolation for the SCR gates.

Fiber Optic Isolation is provided for all signal interfaces between the Medium Voltage and Low Voltage systems. Even the current signals from CTs are converted to fiber optic signals for maximum isolation and safety.

1.9 Electronics

The ***JKSSS+ Series*** electronics systems are divided into two categories, Low Voltage and Medium Voltage, based solely on where they are located in the starter structure.

Low Voltage electronics include the Keypad Operator Interface, CPU and Main Power PC boards are located in an isolated Low Voltage Compartment of the enclosure.



Keypad Operator Interface

- **Keypad Operator Interface:** a 2 line x 20 character LCD display with backlighting for low ambient conditions. The display reads out in truncated English and can show multiple data points in each screen. Also included are 12 LED indicators, which include Power, Run, Alarm, Trip and the status of the 8 Aux. Relays. It communicates to the CPU via a serial link and, if necessary, can be remotely mounted up to 1000' from the soft starter.

- **CPU Board:** where the microprocessor and communications coprocessor reside. It is attached to the main power board, and communicates to it and the Keypad Operator Interface via serial links. The CPU determines operating functions, stores user programming and acts upon feedback signals for faults, metering and historical data. This board also contains the flash EPROM and SRAM memory, as well as the Analog I/O and terminations.

- **Main Power Board:** is also referred to as the Firing Board. It contains the Digital I/O relays and interfaces to the TCB board (see below) for user interface. It also controls the sequencing of the Isolation and Bypass contactors with the SCR firing. This board generates all firing signals for the SCR stacks and receives feedback signals from fiber optic transmitters. It converts analog levels to digital signals for the CPU. These firing pulses are via fiber optic signals to isolate them from the Medium Voltage environment.

Control Electronics are located in the medium voltage and low voltage sections of the soft starter. The main line power must be disconnected before these electronics can be accessed. They include the TCB, Gate Drive and Temp/CT boards.

- **TCB (Terminal and Control Board):** is the user connection interface board. It is located in the Low Voltage section in order to satisfy UL termination requirements, and does not connect directly to the medium voltage components other than the contactor coils. This board contains the user terminal blocks, output relays (duplicated), inputs and control power connections. It also contains additional timed relays for interfacing with Power Factor Correction contactors (if used) and other external devices. Please note Power Factor Capacitor warnings in Section 2.8.

- **Gate Drive Boards:** located directly on the SCR stacks. These boards communicate to the Main Power board via fiber optic cables. They amplify the gate pulse signals with power from the Ring Transformers to create the Sustained Pulse Firing of the SCRs. There is one Gate Drive board for each pair of SCRs in each stack.

- **Temp / CT Boards:** are attached to the Gate Drive boards on the SCR stacks and provide the heat sink temperature and current signals back to the Main Power Board via fiber optic cables.

- **MOV Boards:** are attached to standoffs mounted on the SCR heat sinks and are mounted directly below the Gate Drive boards. The MOV boards are used to protect the gate/cathode section of the SCRs.

- **DV/DT Boards:** are also attached to standoffs mounted on the SCR heat sinks and are mounted below the MOV boards. The DV/DT boards are used to reduce voltage transients across the stack assemblies.

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 should remain secured to the shipping skid to prevent distortion of the frame during moving and to minimize tipping. Extreme care should be exercised during any movement and placement operations to prevent dropping or tipping.

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.

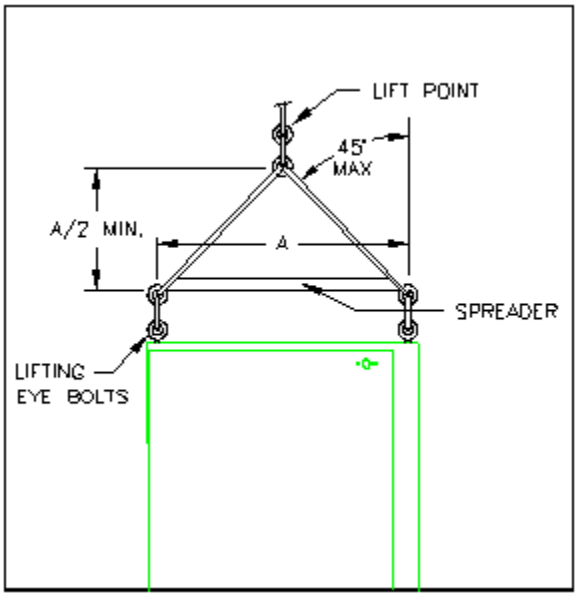


Fig. 1 Use of Spreader Bar - Single Section

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.

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.

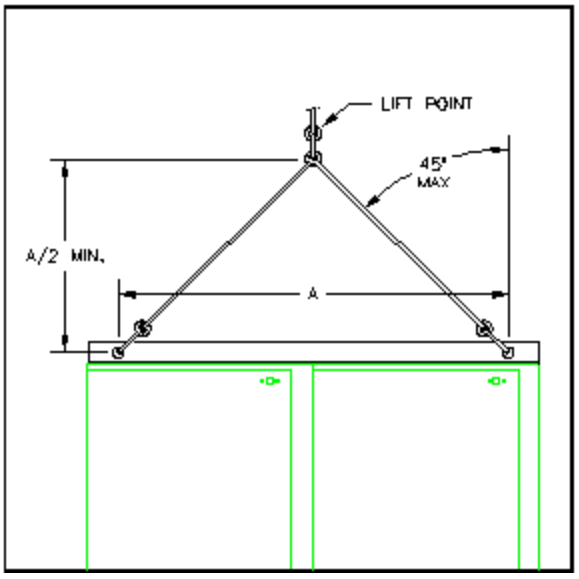


Fig. 2 Lifting Multiple Sections

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

Ratings				Standard JKSSS Class E2 Soft Starter											
Volts	NEMA Type 1			Type 1 Dimen. (in.)			NEMA Type 12/3R			Type 12 Dimen. (in.)			Type 3R Dimen. (in.)		
	Max. Amps	Nominal Max. HP	KW	H	W	D	Max. Amps	Nominal Max. HP	KW	H	W	D	H	W	D
2300	200	800	500	90	30	36	200	800	500	90	30	36	104	36	44
	360	1500	1000		30		310	1250	1000		30			36	
	600	2500	1900		72		600	2500	1900		72			78	
	720	3000	2250		72		Consult Factory			Consult Factory			Consult Factory		
3300	200	1000	600	90	30	36	200	1000	600	90	30	36	104	36	44
	360	1800	1200		30		310	1800	1200		30			36	
	600	3000	2200		72		600	3000	2200		72			78	
	720	4000	3000		72		Consult Factory			Consult Factory			Consult Factory		
4160	200	1500	1000	90	30	36	200	1250	1000	90	30	36	104	36	44
	360	3000	2000		30		310	2500	2000		30			36	
	600	5000	3750		72		600	5000	3750		72			78	
	720	5500	4000		72		Consult Factory			Consult Factory			Consult Factory		

Note: Dimensions are for reference only and subject to change. Contact factory for exact 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).

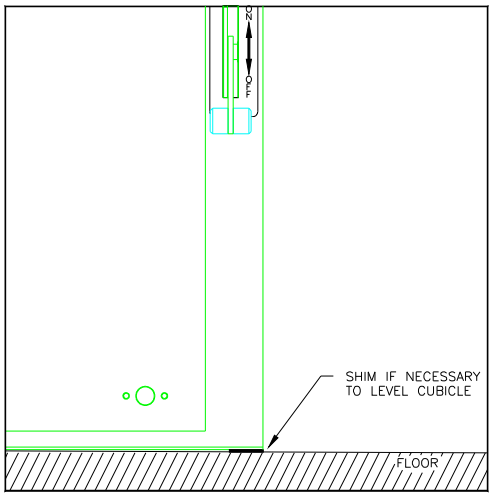


Fig. 3 Leveling Using Shims

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

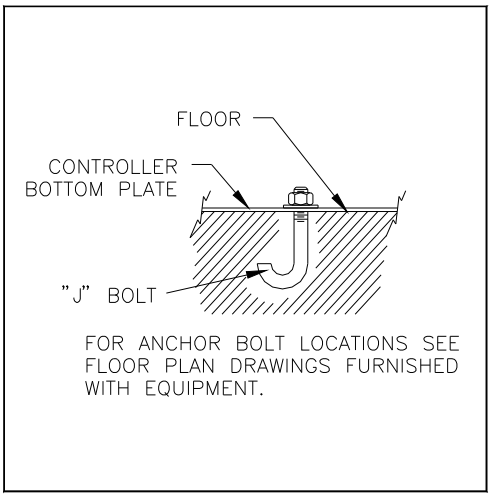


Fig. 4 Securely Anchor the Controller

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:

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 solid state starter.** 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.

⚠ CAUTION

SCR DAMAGE

Do not connect (PFC) capacitors to the load side of the unit.

Doing so will cause DI/DT damage to the SCRs when energized.

2.9 - Medium Voltage Power Connections

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

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

Torque Specs for MV Power Connections

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.

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.

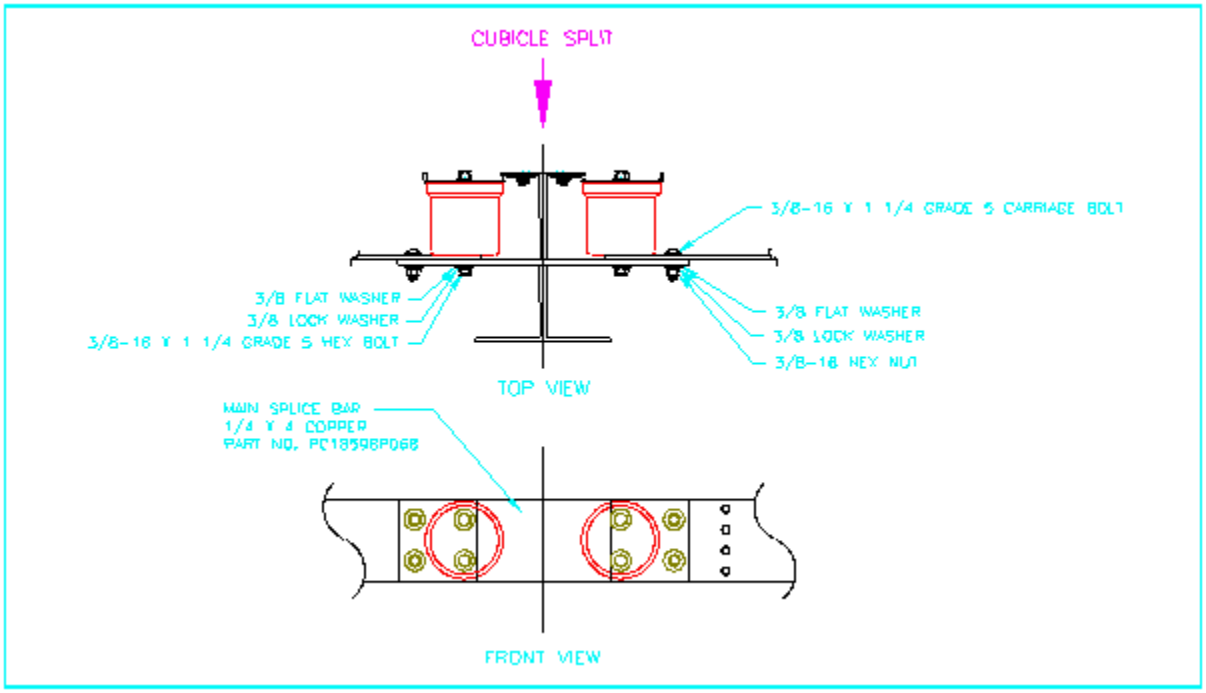


Fig. 5 Main Bus Splice Connections - 1200A Main Bus

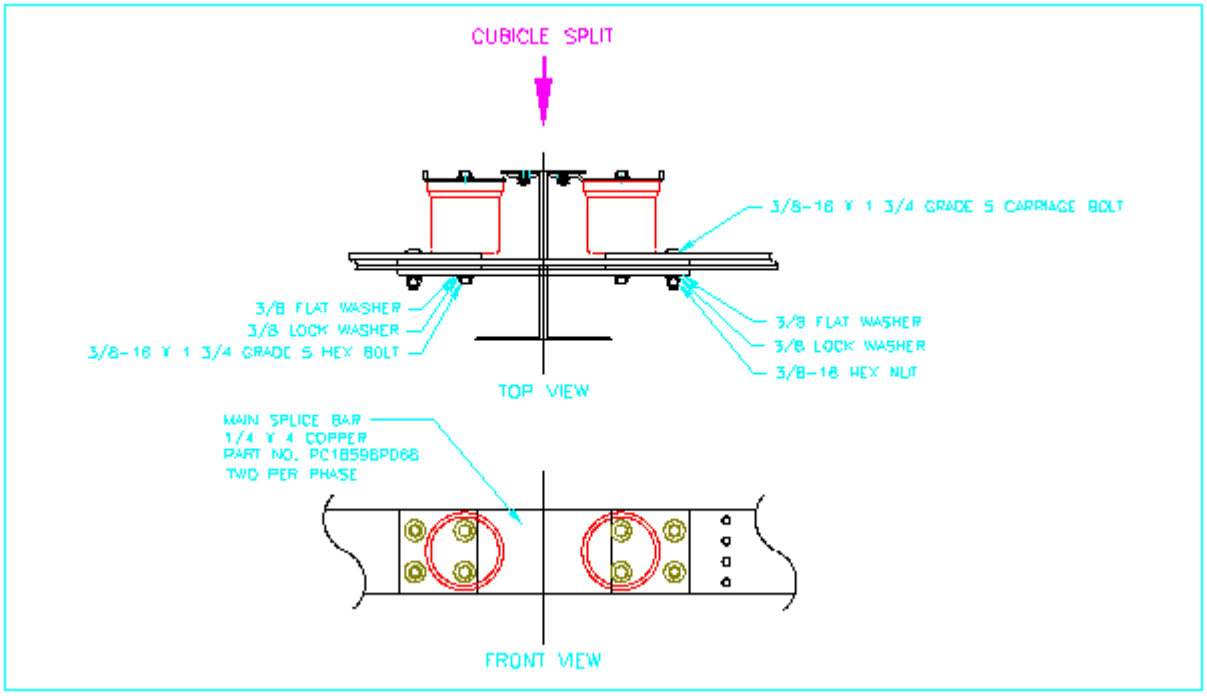


Fig. 6 Main Bus Splice Connections - 2000A Main Bus

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.

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

a. The grounding electrode conductor (ground wire) sized in accordance with NEC 250 should be run from the grounding electrode to the controller ground bus or ground terminal.

b. Unless already done at the factory, a main bonding jumper should be installed from the incoming grounded connector bus (neutral) to the ground bus or designated grounding point. If a jumper is not furnished, one having a size in accordance with NEC 250 should be selected.

c. Steps (a) and (b) should effectively connect together the grounding electrode, the controller frame, all outgoing equipment grounding conductors and the grounded neutral bus of the system.

d. No connection should be made to ground on the load side of any neutral disconnecting line or any sensor used for ground fault protection. No connections should be made between outgoing grounding connectors and the neutral.

e. Where the controller or system is dual-fed (double-ended) and has ground fault protection, special precautions are necessary to accomplish proper grounding and bonding.

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

a. A grounding electrode conductor (ground wire) sized in accordance with NEC 250 should be run from the grounding electrode to the controller ground bus or ground terminal.

b. If the system is grounded at any point ahead of the controller, the grounded conductor should be run to the controller in accordance with NEC 250 and connected to the ground bus or ground terminal.

c. Steps (a) and (b) should effectively connect together the grounding electrode, the controller frame, all outgoing equipment grounding connectors and any grounded conductor which runs to the controller.

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

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

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

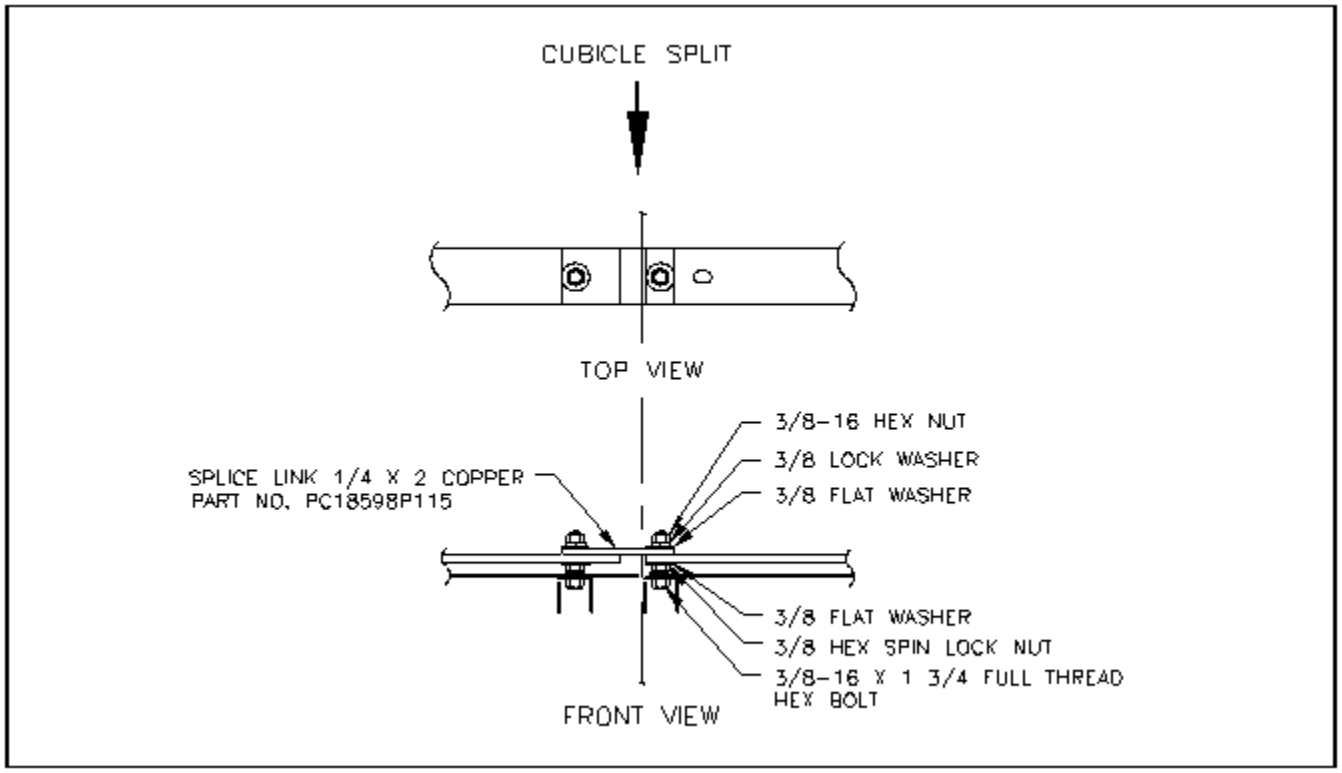


Fig. 7 Ground Bus Splice

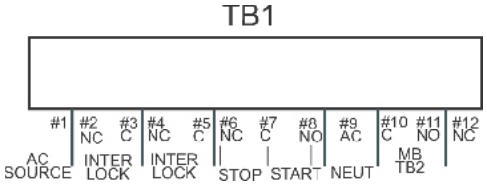
2.10 Control Connections - TCB (Terminal and Control Board)

WARNING **THIS SECTION INVOLVES POTENTIALLY LETHAL VOLTAGE LEVELS! USE EXTREME CAUTION TO PREVENT INJURY.**

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

2.10.1 JKSSS Plus-TCB Board

The ***JKSSS Plus-TCB*** board provides interconnections between the main power and CPU boards and the customer's control logic connections. It is a 120Vac control board with several auxiliary dry control contacts, 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)***

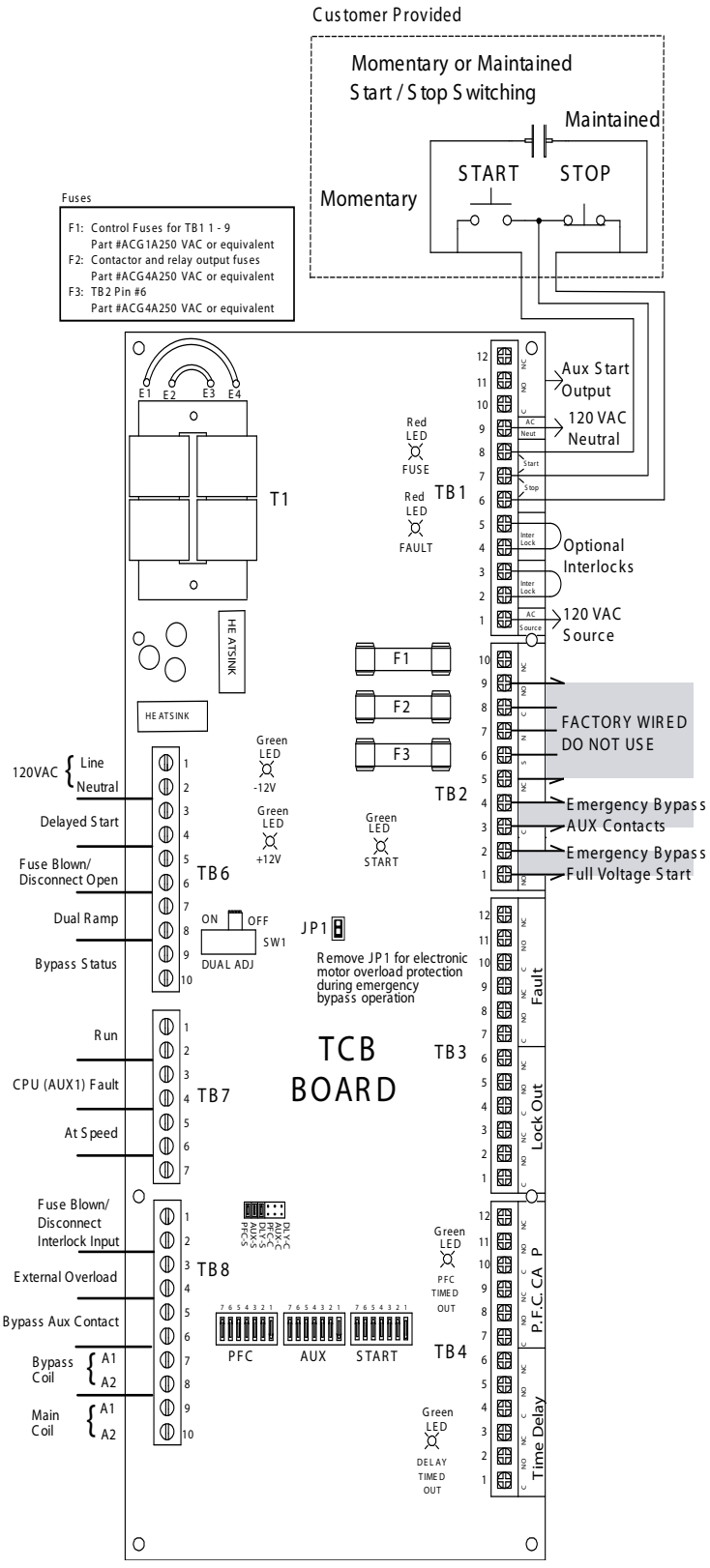


Start/Stop Control
Figure 2-1

2.10.2 Description of Terminal Connections

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

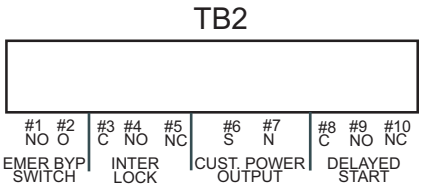
- Positions 1 and 9 are the 120 Vac control power.
- Positions 2-3 and 4-5 are factory jumpers installed and can be removed for customer's normally closed, dry, shutdown contacts (See Fig. 2-1 above).
- Positions 6-7-8 are for either two wire or three-wire start/stop logic. Two wire is connected to positions 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.
- Positions 10-11-12 is a dry FORM C contact. The contact is an immediate start/stop contact.



TCB (Terminal and Control Board)
Figure 2-2
(See page 85 for larger version)

Emergency Bypass Control - Terminal Block 2 (TB2):

- Positions 1 and 2 are for an emergency bypass contact. If a dry contact closes position 1 and 2, this causes the CPU to be shut off so there is no display. Then when a start is initiated, it pulls in the inline isolation contactor which starts the motor across the line. See section 3.6 for more details.
- Positions 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.
- Positions 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.
- Positions 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 next page. Note: Additional Time Delay to SP2 of the CPU programming.
- JP1 - Motor Protection Jumper. Removing jumper JP1 on the TCB Board will allow the soft starter CPU to continue providing electronic motor protection while operating in the Emergency Bypass Mode. If necessary to disable the CPU system during operation in Emergency Bypass, be sure JP1 is placed over both pins and an external means of overload protection is used.



Emergency Bypass Control
Figure 2-3

⚠ CAUTION

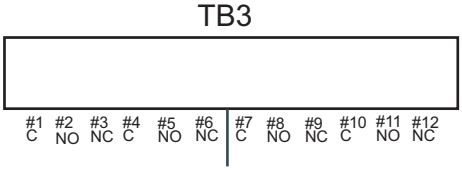
OVERLOAD PROTECTION LOSS

When operating the unit in Emergency Bypass Mode, there is no electronic overload protection.

External overload protection must be provided for continued safe operation.

Fault - Terminal Block 3 (TB3):

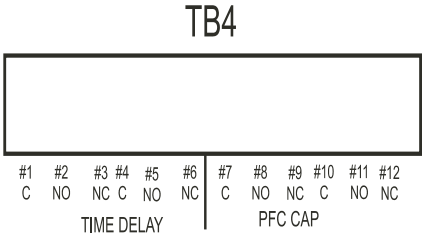
- Positions 1-2-3 and 4-5-6 are sets of FORM C contacts. These are dry contacts that operate when a blown fuse indication is given or disconnect is open.
- Positions 7-8-9 and 10-11-12 are sets of FORM C contacts. These are fault contacts that change state if any fault condition occurs.



Lockout/Fault Contacts
Figure 2-4

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 Start contact is initiated. X3, X4 and SW4 determine the amount of delay. (Switch Position and Jumper Selection on following page)
- Positions 7-8-9 and 10-11-12 are sets of FORM C contacts. These are power factor correction capacitor (PFC) contacts to pull in an isolation contactor for the capacitors (if required by the application). 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. Note: This delay is in addition to SP2 of the CPU programming.



Time Delay/PFC Cap Contacts
Figure 2-5

Terminal Block 6 (TB6):

- Positions 1 and 2 are 120 VAC power supply to the Main and CPU circuit boards.
- Positions 3 and 4 are the start input connections to the Main and CPU circuit boards.
- Positions 5 and 6 are the fuse blown input connections to the Main and CPU circuit boards.
- Positions 7 and 8 are the Dual Ramp input connections to the Main and CPU circuit boards.
- Positions 9 and 10 are the Bypass Status input connections to the Main and CPU circuit boards.

Terminal Block 7 (TB7):

- Positions 1 and 2 are the Run contacts (AUX 3) from the Main and CPU circuit boards to the TCB board. This signal is used to hold the Main Contactor closed during deceleration.
- Positions 3 and 4 are the Main and CPU circuit board output connections to the TCB that signal the AUX1 Fault Status.
- Positions 5 and 6 are the At Speed contacts (AUX 4) from the Main and CPU circuit boards that signal the Bypass Contactor to close.
- Position 7 has no connection..

Terminal Block 8 (TB8):

- 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.

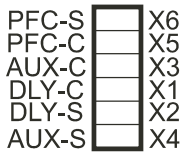
Note: All customer contacts are 960VA, 120VAC (Max) rated dry contacts.

LEDs provided on the TCB board (for low voltage testing only):

- -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

For the following, please refer to Figure 2-6.



Jumper Selection on TCB Board
Figure 2-6

Start Delay

This is a selectable delay period between the intiation of the start command and when the CPU actually receives the start signal. Selecting Jumper X1 or X2 determines the method by which this delay (in cycles or seconds) is calculated. See SW3 below for instructions on setting the actual delay time.

- X1 = (DLY-C) Start time delay in cycles
- X2 = (DLY-S) Start time delay in seconds (Factory setting)

Auxiliary (Start) Delay (from the time the start input is given). Selecting jumper X3 or X4 determines the method by which this delay is calculated (cycles or seconds). See SW4 below for instructions on setting delay time.

- X3 = (AUX-C) Auxiliary time delay in cycles
- X4 = (AUX-S) Auxiliary time delay in seconds (Factory setting)

Power Factor Correction (PFC) Capacitor Contactor Delay (From the time the bypass closes to when contacts change state). Jumper selection determines the method by which this delay is calculated. See SW5 for instructions.

- X5 = (PFC-C) Time delay in cycles
- X6 = (PFC-S) Time delay in seconds (Factory setting)

Switch Positions

Please refer to Figure 2-7.

- SW1 = ON = Dual Adjustment
  OFF = Disabled
- SW2* = Not used - Switches SW3, SW4 and SW5 are 7 position dip switches that use binary code to count up to 127 seconds/cycles (see “Jumper Selection” above).
- SW3 = Start Delay; 7 position dip switch uses binary count up to 127 seconds/cycles (see jumper selection above). Factory setting: 1 second.
- SW4** = Auxiliary (Start) Delay 7 position dip switch uses binary count up to 127 seconds/cycles (see jumper selection above). Factory setting: 1 second.
- SW5** = PFC time delay; 7 position dip switch uses binary count up to 127 seconds/cycles (see jumper selection above). Factory setting: 1 second.

* **Note:** This switch interacts with the CPU programming when the Decel function is enabled.

** **Note:** These times are in addition to SP2 in the CPU setpoints.

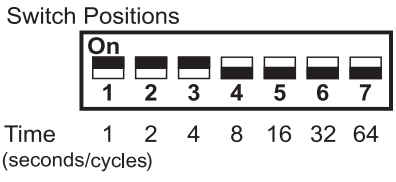


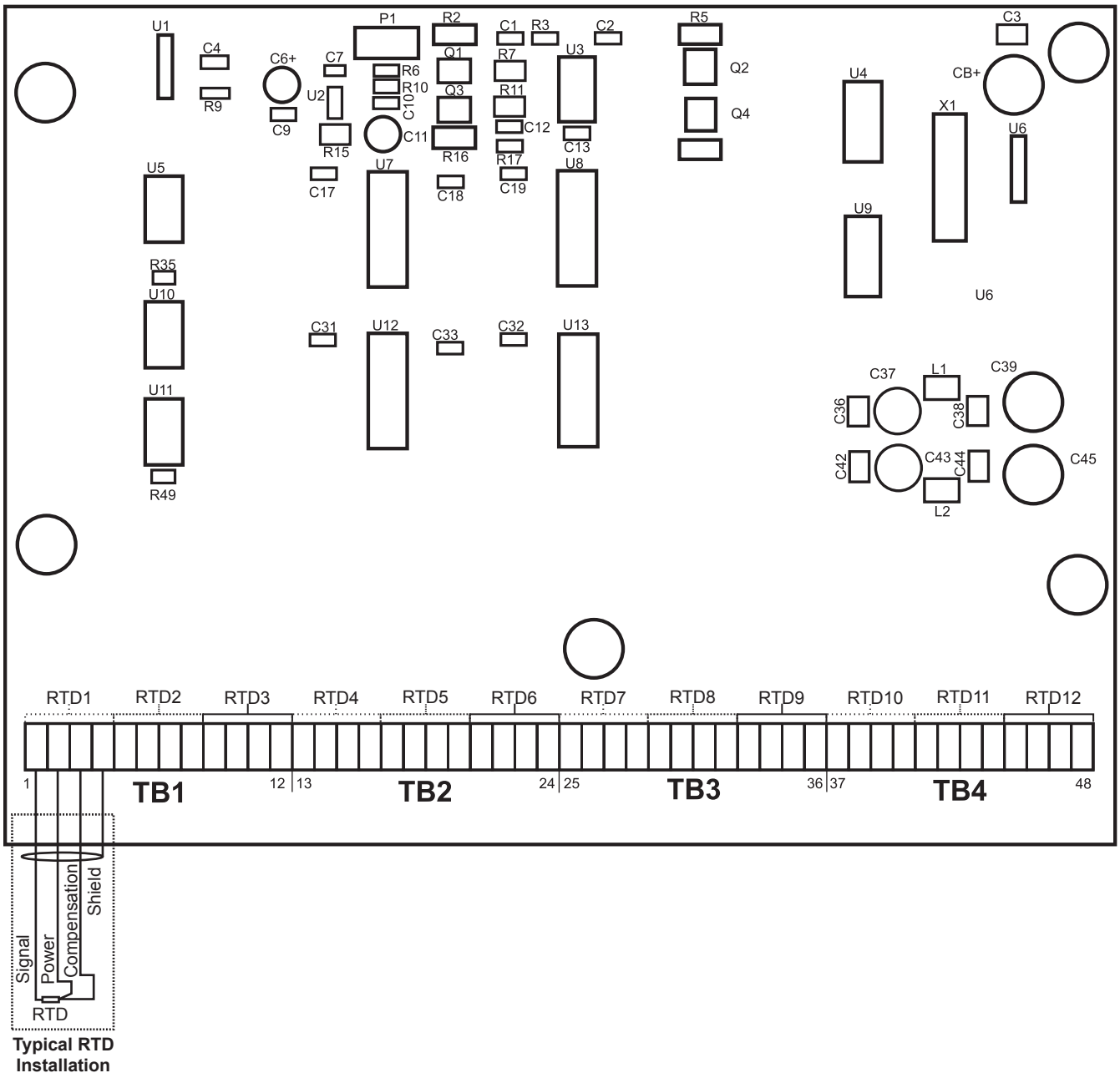
Figure 2-7

Example:

Switch settings are cumulative. Setting dip switch positions 1, 2, and 3 to “on” = 1+2+4 = 7 seconds total time. Note: This example applies to SW3, SW4 & SW5.

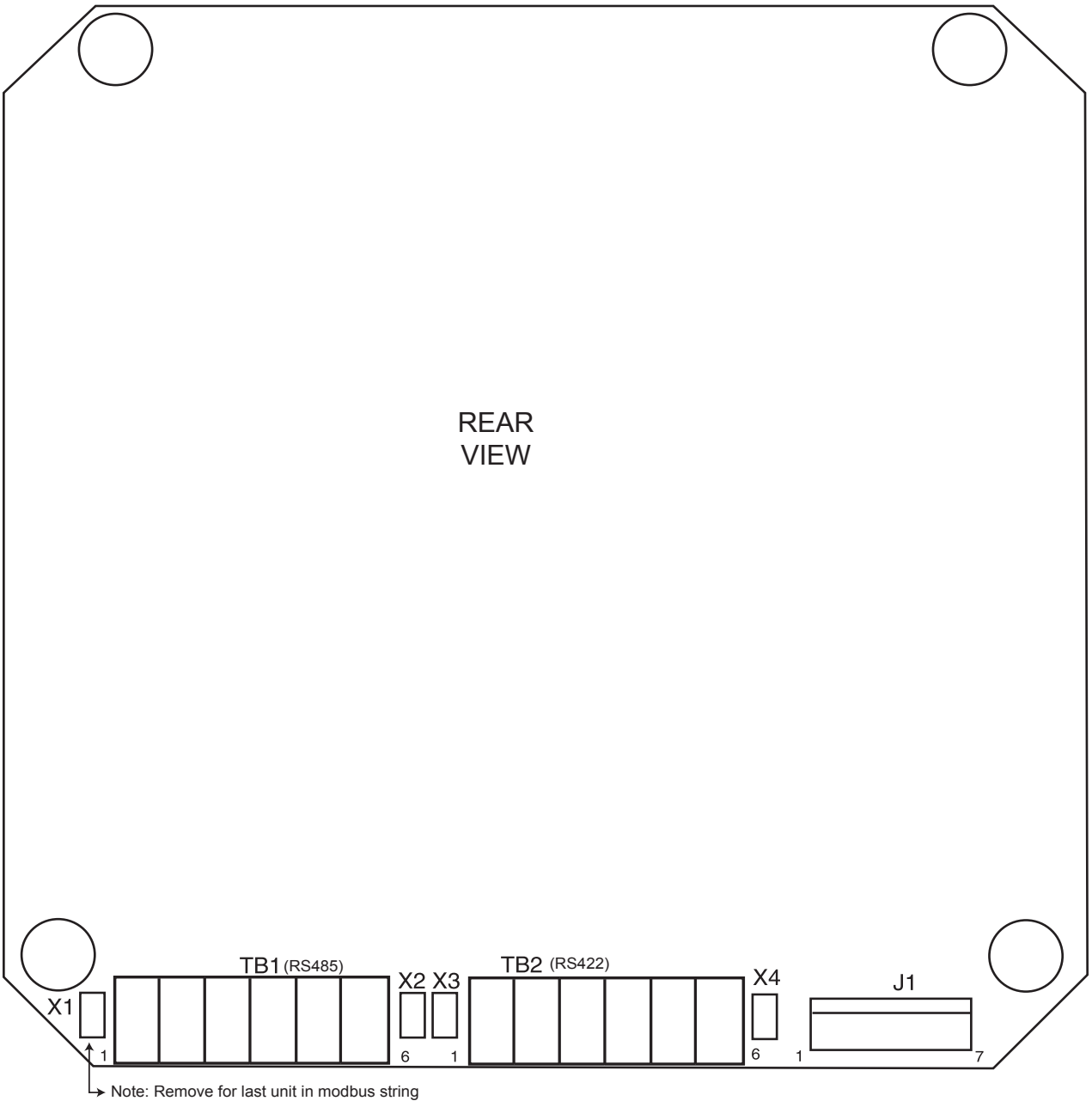
2.11 Reference Section

2.11a RTD Board

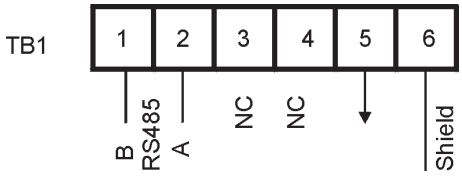


Typical RTD Installation

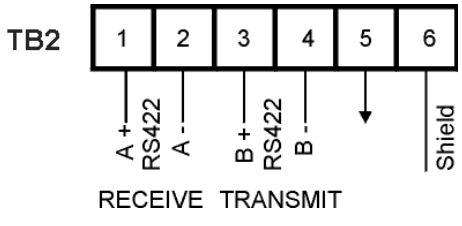
2.11b Communications Board



2.11c Communications Board Connections

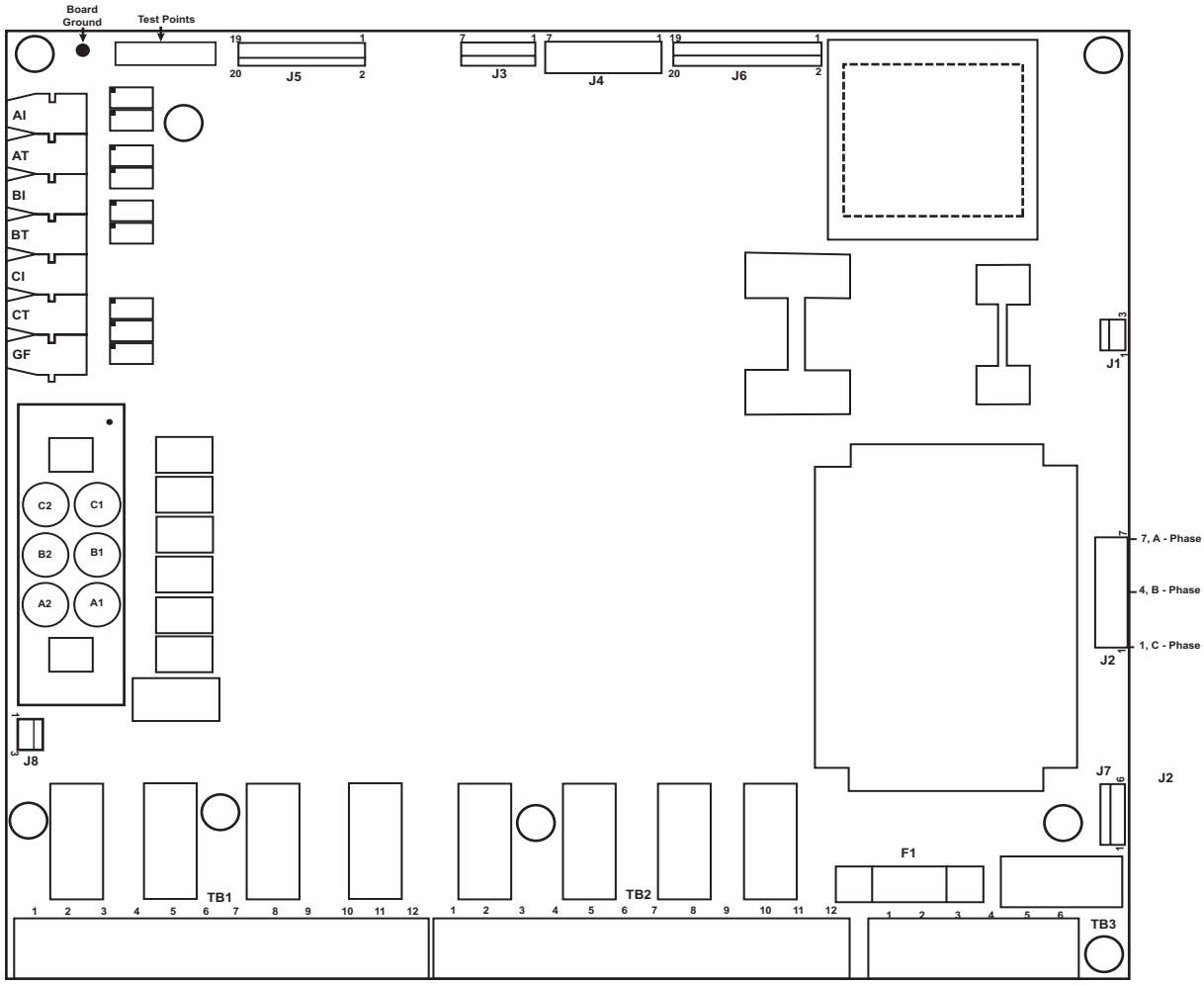


RS485 Connections
(Customer Connections)



RS422 Connections
(Factory Only)

2.11d Power Board



2.11e Power Board Connections

TB1

Factory use only. Do not reprogram.

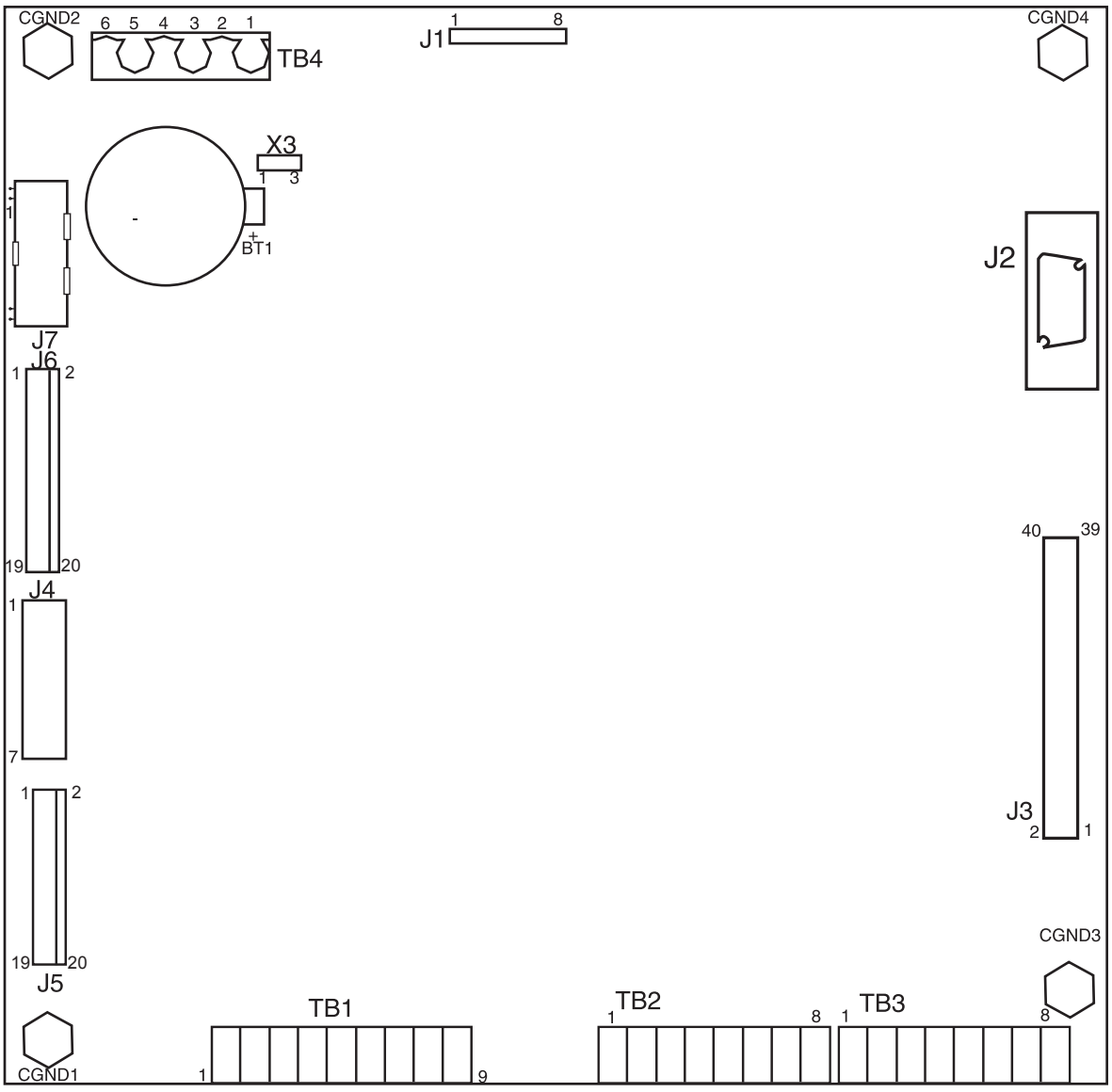
TB2

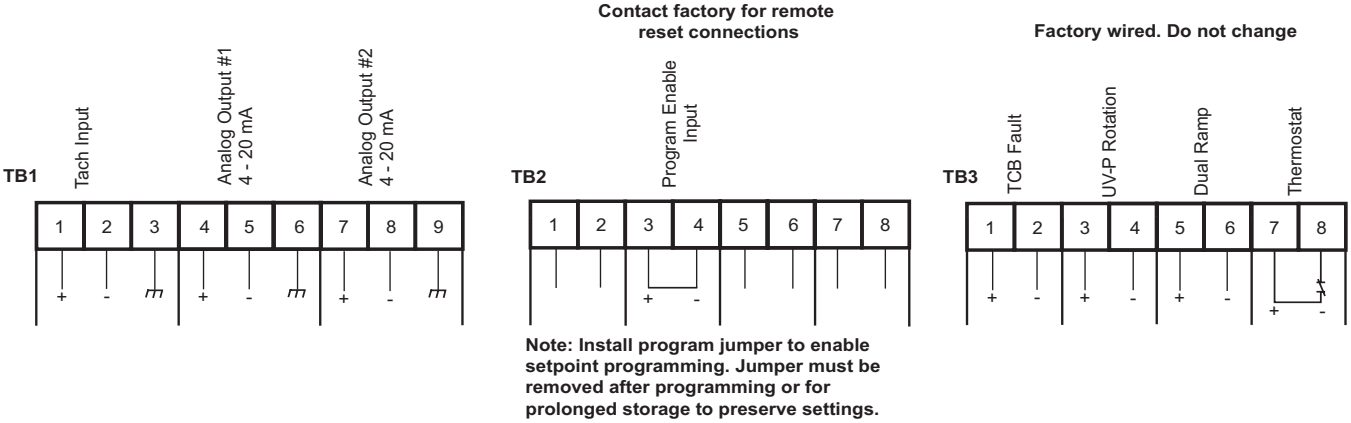
Refer to Setpoint Page 5 for programming information

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
C	N.O.	N.C.	C	N.O.	N.C.	C	N.O.	N.C.	C	N.O.	N.C.	C	N.O.	N.C.	C	N.O.	N.C.	C	N.O.	N.C.	C	N.O.	N.C.
AUX1 (TRIP) Relay			AUX2 (ALARM) Relay			AUX3 (RUN) Relay			AUX4 (AT SPEED) Relay			AUX5 Relay			AUX6 Relay			AUX7 Relay			AUX8 Relay		

(Max Relay Contact Rating is 240 VAC, 4A, 960VA)

2.11f CPU Board Connections





Note: Install program jumper to enable setpoint programming. Jumper must be removed after programming or for prolonged storage to preserve settings.

Chapter 3 - 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!**

3.1 Preliminary Start-Up Check List

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

- Qualified personnel have hi-potted the line and load wiring before connecting to the soft start. (Typically 1.5 x Rated Voltage)
- Verify that all wiring is completed and all connections are tightened.
- Check the motor nameplate and confirm the unit is programmed with the correct motor FLA.
  Note: It is necessary to connect the line power to L1, L2 and L3, or the "Phase Rotation Protection" will be activated.
- Verify control logic via 120V test switcher (available on standard JKSSS+ NEMA Class E2 Starters only). A separate 120Vac test receptacle can be supplied to the control logic without powering up the medium voltage section for control logic testing. It also allows isolation of the 120Vac from back-feeding the control power transformer.
- Connect control supply (Optional "Soft Start Only" Package only). The "On" and "Stop" LEDs will light up.
- Review all parameters and readjust as required. ***See Chapter 5 - Programming*** for detailed instructions. Try factory settings first.
- Verify that the interlocks for the system are installed and working properly.
- Verify that the feed transformer is correctly sized for the motor(s).
- 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.
- Remove tie straps from Blown Fuse Indicator.
- Connect line voltage to line terminals.

3.2 Introduction

It is best to operate the motor at its full load starting condition to achieve the proper time, torque and ramp settings. Initial settings are set to accommodate most motor conditions. **TRY INITIAL SETTINGS FIRST.** See Setpoint 5.1.2 Starter Confiuration (Setpoint Page 2) to make any adjustments.

3.3 Acceleration Adjustments

The 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 unit settings. If the motor does not come up to speed, increase the current limit setting. If the motor does not start to turn as soon as desired, raise the starting voltage adjustment. Adjustment description and procedures are described as follows. See Setpoint 5.1.2 Starter Configuration (Setpoint Page 2) for additional Accel settings.

3.3.1 Starting Voltage

Factory Setting = 20% of line voltage
Range = 0% - 100% of line voltage
Starting voltage adjustment changes the initial starting voltage level to the motor.

3.3.2 Ramp Time

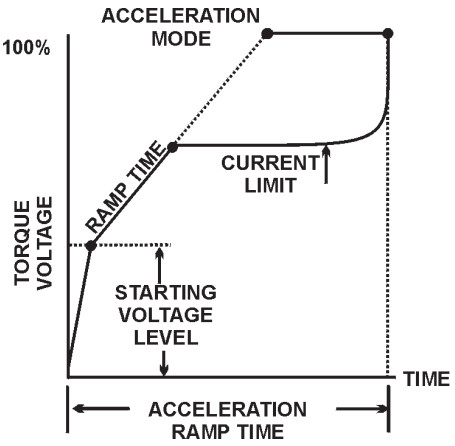
Factory Setting = 10 sec.
Range = 0 - 120 sec.
Ramp time adjustment changes the amount of time it takes to reach the current limit point or full voltage if the current limit point was not reached.

Note: Refer to your motor manual for the maximum number of starts per hour allowed by the manufacturer and do not exceed the recommended number.

3.3.3 Current Limit

Factory Setting = 350% of unit FLA
Range = 200% - 500% of unit FLA

The current limit adjustment is factory set for 350% of the unit's rating. The range of adjustment is 200% to 500%. The main function of current limit is to cap the peak current. It may also be used to extend the ramping time if required. The interaction between the voltage ramp and the current limit will allow the soft start to ramp the motor until the maximum current is reached and the current limit will hold the current at that level. The current limit must be set high enough to allow the motor to reach full speed. The factory setting of 350% is a good starting point. **Do not set the current limit too low on variable starting loads. This could cause the motor to stall and eventually cause the overload protection to trip.**



Note: If the motor does stall, refer to the motor manufacturer's motor data for the proper cooling time.

3.4 Deceleration Adjustments (Pump Control)

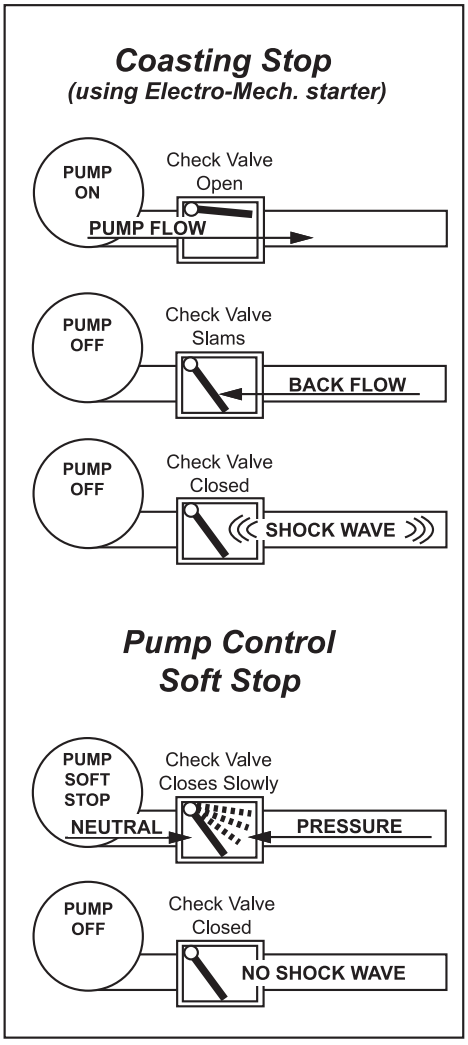
Decel extends the stopping time on loads that would otherwise stop too quickly if allowed to coast to stop. Decel control provides smooth deceleration until the load comes to a stop. Three adjustments optimize the deceleration curve to meet the most demanding requirements. The unit is shipped from the factory with the decel feature disabled.

Deceleration Applications

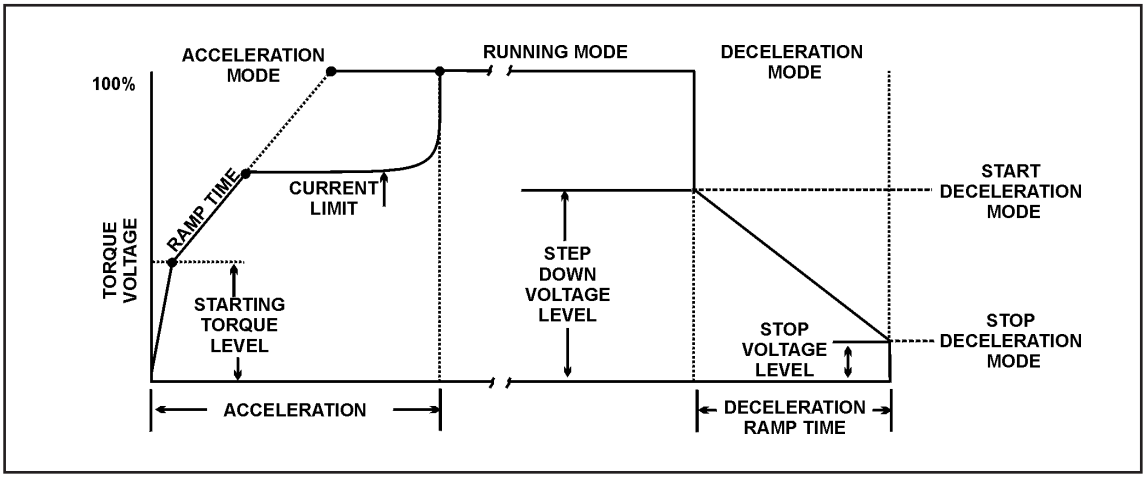
The unit is shipped from the factory with the decel feature disabled. Apply power and adjust the soft start before enabling or modifying the deceleration adjustments. Both acceleration and deceleration adjustments should be made under normal load conditions.

The deceleration feature provides a slow decrease in the output voltage, accomplishing a gentle decrease in motor torque during the stopping mode. This is the ***OPPOSITE OF BRAKING*** in that it will take **longer** to come to a stop than if the starter were just turned off. The primary use of this function is to reduce the sudden changes in pressure that are associated with "Water Hammer" and slamming of check valves with centrifugal pumps. Decel control in pump applications is often referred to as **Pump Control**.

In a pump system, liquid is being pushed uphill. The force exerted by gravity on the column of liquid as it goes up hill is called the "Head Pressure" in the system. The pump is sized to provide enough Output Pressure to overcome the Head Pressure and move the fluid up the pipe. When the pump is turned off, the Output Pressure rapidly drops to zero and the Head Pressure takes over to send the fluid back down the hill. A "Check Valve" is used somewhere in the system to prevent this (if necessary) by only allowing the liquid to flow in one direction. The kinetic energy in that moving fluid is suddenly trapped when the valve slams closed. Since fluids can't compress, that energy is transformed into a "Shock Wave" that travels through the piping system looking for an outlet in which it dissipates. The sound of that shock wave is referred to as "Water Hammer". The energy in that shock wave can be extremely damaging to pipes, fittings, flanges, seals and mounting systems.
By using the Soft Stop/Deceleration feature of the soft starter, the pump output torque is gradually and gently reduced, which slowly reduces the pressure in the pipe. When the Output Pressure is just slightly lower than the Head Pressure, the flow slowly reverses and closes the Check Valve. By this time there is very little energy left in the moving fluid and the



Shock Wave is avoided. When the output voltage to the motor is low enough to no longer be needed, the soft starter will end the Decel cycle and turn itself off.
Another common application for decel control is on material handling conveyors as a means to prevent sudden stops that may cause products to fall over or to bump into one another. In overhead crane applications, soft stopping of the Bridge or Trolley can prevent loads from beginning to over swing on sudden stops.



3.4.1 Start Deceleration Voltage

Factory Setting = 60% of line voltage
Range = 0% - 100% of line voltage
The step down voltage adjustment eliminates the dead band in the deceleration mode that is experienced while the voltage drops to a level where the motor deceleration is responsive to decreased voltage. This feature allows for an instantaneous drop in voltage when deceleration is initiated.

3.4.2 Stop Deceleration Voltage

Factory Setting = 20% of line voltage
Range = 0% - 100% of line voltage
The stop voltage level setpoint is where the deceleration voltage drops to zero.

3.4.3 Deceleration Time

Factory Setting = 5 sec.
Range = 0 - 60 sec.
The deceleration ramp time adjusts the time it takes to reach the stop voltage level set point. The unit should be restarted and stopped to verify that the desired deceleration time has been achieved.

⚠WARNING **DO NOT EXCEED THE MOTOR MANUFACTURER'S RECOMMENDED NUMBER OF STARTS PER HOUR. WHEN CALCULATING THE NUMBER OF STARTS PER HOUR, A DECEL CURVE SHOULD BE COUNTED AS A START CURVE. FOR EXAMPLE: RECOMMENDED NUMBER OF STARTS PER HOUR = 6, ALLOWABLE STARTS WITH DECEL CYCLE PER HOUR = 3.**

3.5 Sequence of Normal Operation

- Apply control power and check that the "Power" LED comes on. (Display 1)
- Apply three phase power to the unit. The motor should run only when the start command is applied.
- Apply the start command. (Display 2). The RUN LED will be lit. (Display 3) The AUX3 LED will be lit. If the motor does not enter run mode in the set time (Acceleration time limit, see SP8.2), a trip will occur.

- When the motor reaches full speed, the “AUX4” LED (At Speed) will be lit.
- The POWER, RUN, AUX3 LEDs will be lit, indicating that the contact has energized. IA, IB, IC will display the current setting for Phase A, Phase B, and Phase C and the G/F indicates ground fault. (Display 4)
- If the motor decelerates, or stops, during the acceleration period, hit the stop button immediately and open the disconnect line. If the unit does not follow this operational sequence, please refer to the Troubleshooting Chapter.

Display 1	**MOTOR STOPPED READY TO START**
Display 2	**MOTOR STARTING 00 X FLA**
Display 3	**OVERLOAD ALARM TIME TO TRIP: XXX SECS.**
Display 4	**IA: _ _ _ IB: _ _ _ IC: _ _ _ G/F: _ _ _**

It is best to operate the motor at its full load starting condition to achieve the proper time, torque and ramp settings. Initial settings are set to accommodate most motor conditions. **TRY INITIAL SETTINGS FIRST.** See Section 5.1.1 (Setpoint Page 2) to make any adjustments.

- Initial Voltage
- Soft Start Curve
- Current Limit
- Acceleration Time

If decel is enabled, the following parameters for Deceleration Time, Start Decel Voltage (see SP2) and Stop Decel Voltage (see SP2) must also be programmed.

3.6 Emergency Bypass Operation

⚠ DANGER

HAZARDOUS OPERATION

Do not operate the Bypass Contactor with medium voltage power applied to the unit.

Failure to follow this instruction will cause the motor to start unexpectedly.

Remove input power (using line start section and lock out disconnect).

- Close the emergency bypass contact**.**
- Re-close the disconnect on line start panel.
- If integral overload protection is not to be used (see JP-1 Motor Protection Jumper), then bimetallic or solid state overload protection is required (customer supplied if factory emergency overload protection option has not been included.)

⚠WARNING **IN THE EMERGENCY BYPASS MODE, THERE IS NO OVERLOAD PROTECTION UNLESS A SEPARATE (OPTIONAL OR CUSTOMER SUPPLIED) THERMAL OR SOLID STATE OVERLOAD RELAY IS INSTALLED, OR JP-1 (MOTOR PROTECTION JUMPER) IS REMOVED FROM THE TCB BOARD.**

The line start panel is operable as a normal across-the-line starter. When power is applied, the bypass contactor is energized, tying the input terminals directly to its output terminals. When the “ON/OFF” contact is closed, the main contactor is energized and the motor line starts. When the “ON/OFF” contact is opened, the motor is disconnected from the line via the main in-line vacuum contactor.

Chapter 4 - User Interface & Menu Navigation

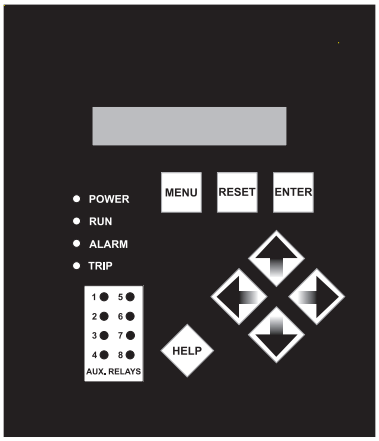
This chapter explains the keypad operator interface, the LCD descriptions and the programming features

4.1 Keypad/Operator Interface

The user keypad/ keypad operator interface consists of:

- 2 row by 20 characters Liquid Crystal Display (LCD)
- 12 LEDs
- 8 pushbuttons

Note: The soft start is menu driven and there are three levels of programming. The programming for two of these levels is password protected. Level two requires a three digit password and level three requires a four digit password.

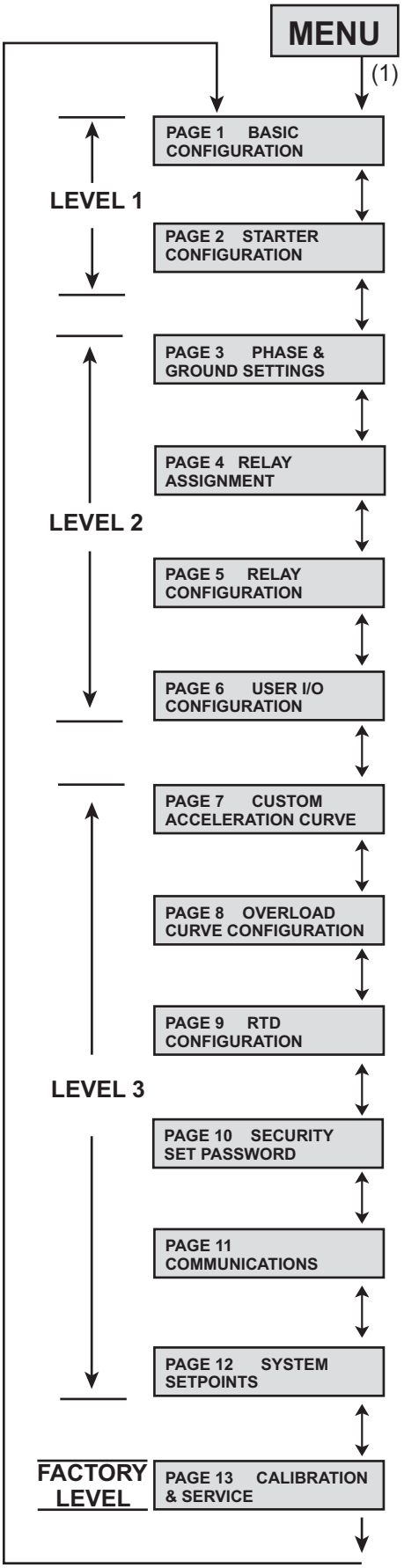


Keypad Operator Interface

Button	**MENU**	Toggle between the menu selection for metering and setpoint pages.
	RESET	Will clear the trip indicator and release the trip relay.
	ENTER	In the edit mode, press the ENTER pushbutton so the unit will accept the new programming information. When not in the edit mode, the ENTER pushbutton will toggle through the event indicator list (such as alarms or trips)
	HELP	Provides general help information about a specific setpoint or action.
	UP ARROW	Will scroll up through the setpoint and metering menu page. It will scroll to the top of the setpoint page or a section. In edit mode it will increase a setpoint in an incremental step or toggle through the available options in the setpoint.
	RIGHT ARROW	In the main menu the RIGHT ARROW button provides access to the setpoint page. For setpoint pages with multiple columns, the RIGHT ARROW will scroll the setpoint page to the right. When in edit mode it will shift one character to the right.
	DOWN ARROW	Will scroll down through the setpoint pages and down through the setpoints. In edit mode, it will decrement through values and toggle available options in the setpoint.
	LEFT ARROW	Will move to the left through setpoint pages with multiple columns. When in edit mode it will become the backspace key and will shift one character to the left.
LED	**Power**	Indicates control power is present
	Run	Indicates unit/motor is running
	Alarm	Lights in conjunction with AUX 2 to indicate event or warn of possible critical condition.
	Trip	Lights in conjunction with AUX 1 to indicate a critical condition has occurred.
	AUX 1-8	Auxilary relays

Note: The directional arrow buttons are sensitive. In edit mode, if the buttons are held for a long period, the scrolling speed will increase.

4.2 Menu Navigation



Notes:
1. The MENU keys allow you to toggle the screens between the Setpoint Menu and the Metering Menu. Simply use the arrow keys to get to the different screens within each menu.
   Example: To access Setpoint Page 3: PHASE & GROUND SETTINGS, press the MENU key once and the DOWN ARROW two times.
2. Levels 1, 2 and 3 indicate password protection levels for these setpoint pages.

4.2.1 Password Access

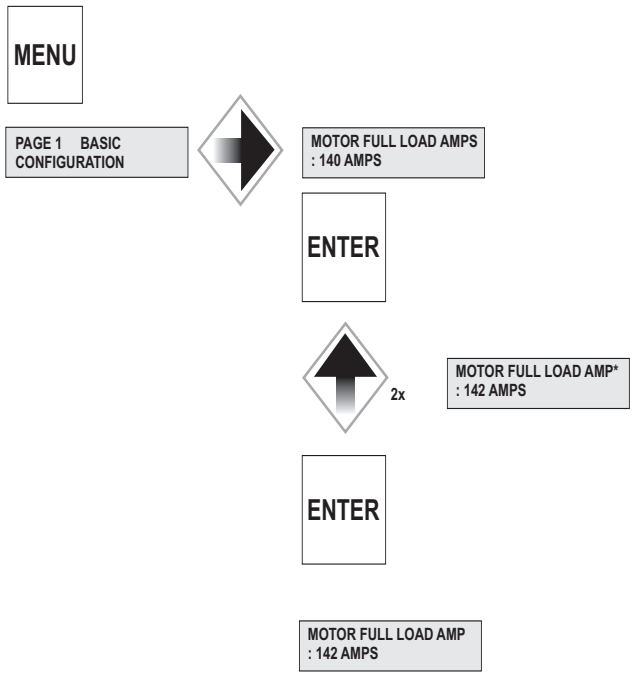
Screens in Level 1 of the setpoint menu can be changed without password access because they list basic motor information. Screens in Levels 2 and 3 require passwords because they provide more in-depth protection and control of the unit. The password in Levels 2 and 3 can be changed by the user.

NOTE: Setpoints can only be changed when the motor is in Stop/ Ready Mode! The soft starter will not allow a start if it is still in the Edit Mode. When the unit is in the Edit Mode, an asterisk is in the top right corner of the display.

4.2.2 Changing Setpoints

Example 1: Changing Motor FLA

A. Press MENU button to display Setpoint Page 1, Basic Configuration
B. Press the RIGHT ARROW you will view the screen Motor Full Load Amps.
C. Press the ENTER button for edit mode. Note the asterisk (*) in the top right corner of the LCD screen that indicates Edit Mode.
D. To change the value, select the UP ARROW or DOWN ARROW.
E. To accept the new value, press the ENTER button. The unit will accept the changes and will leave the edit mode. Note the * is no longer in the top right corner of the LCD Display.



Chapter 5 - Setpoint Programming

The ***JKSSS+ Series*** has thirteen programmable setpoint pages which define the motor data, ramp curves, protection, I/O configuration and communications. In Section 5.1, the setpoint pages are outlined in chart form. In Section 5.2 the setpoint pages are illustrated and defined for easy navigation and programming. Note: Setpoints can only be changed when the starter is in the Ready Mode. Also the soft start will not start when it is in programming mode.

5.1 Setpoints Page List

These charts list the Setpoint Page, the programmable functions and the section.

5.1.1 Basic Configuration (Setpoint Page1)

Setpoint Page	Security Level	Description	Factory Setting Default	Range	Section
Page 1 Basic Configuration	Level 1 No Passowrd Required	Motor Full Load Amps (FLA)	Model dependent	50 - 100% of Unit Max Current Rating (Model and Service Factor dependent)	SP1.1
		Service Factor	1.15	1.00 – 1.3	SP1.2
		Overload Class	10	O/L Class 5-30	SP1.3
		NEMA Design	B	A-F	SP1.4
		Insulation Class	B	A, B, C, E, F, H, K, N, S	SP1.5
		Line Voltage	Model dependent	1000 to 7200V	SP1.6
		Line Frequency	60	50 or 60 HZ	SP1.7

5.1.2 Starter Configuration (Setpoint Page 2)

Setpoint Page	Security Level	Description	Factory Setting Default	Range	Section
Page 2 Starter Configuration	Level 1 No Passowrd Required	Start Control Mode	Start Ramp 1	Jog, Start Ramp 1, Start Ramp 2, Custom Accel Curve, Start Disabled, Dual Ramp, Tach Ramp	SP2.1
		Jog Voltage	50%	5-75%, Off	SP2.2
		Start Ramp #1 Type	Voltage	Current, Voltage	SP2.3
		Initial Voltage #1	20%	0-100%	
		Ramp Time #1	10 sec	0-120 sec	
		Current Limit #1	350% FLA	200-500 %	
		Initial Current #1	200% FLA	0-300%	
		Ramp Time #1	10 sec	0-120 sec	
		Maximum Current #1	350% FLA	200-500 %	
		Start Ramp #2 Type	Disabled	Current, Voltage, Disabled	SP2.4
		Initial Voltage #2	60%	0-100 %	
		Ramp Time #2	10 sec	0-120 sec	
		Current Limit #2	350 % FLA	200-500 %	
		Initial Current #2	200% FLA	0-600 %	
		Ramp Time #2	10 sec	0-120 sec	
		Maximum Current #2	350% FLA	200-500 %	
		Kick Start Type	Disabled	Voltage or Disabled	SP2.5
		Kick Start Voltage	65%	10-100 %	
		Kick Start Time	0.50 sec	0.10-2.00	
		Deceleration	Disabled	Enabled or Disabled	SP2.6
		Start Deceleration Voltage	60%	0-100 %	
		Stop Deceleration Voltage	30%	0-59 %	
		Deceleration Time	5 sec	1-60 sec	
		Timed Output Time	Off	1-1000 sec, Off	SP2.7
		Run Delay Time	1 Sec	1-30 sec, Off	SP2.8
		At Speed Delay Time	1 Sec	1-30 sec, Off	SP2.9

5.1.3 Phase and Ground Settings (Setpoint Page 3)

Setpoint Page	Security Level	Description	Factory Setting Default	Range	Section
Page 3 Phase and Ground Settings	Level 2 Password Protection	Imbalance Alarm Level	15% FLA	5-30 %, Off	SP3.1
		Imbalance Alarm Delay	1.5 sec	1.0-20.0 sec	
		Imbalance Trip Level	20%	5-30 %, Off	SP3.2
		Imbalance Trip Delay	2.0 sec	1.0-20.0 sec	
		Undercurrent Alarm Level	Off	10-90 %, Off	SP3.3
		Undercurrent Alarm Delay	2.0 sec	1.0-60.0 sec	
		Overcurrent Alarm Level	Off	100-300 %, Off	SP3.4
		Overcurrent Alarm Delay	2.0 sec	1.0-20.0 sec	
		Overcurrent Trip Level	Off	100-300 %, Off	SP3.5
		Overcurrent Trip Delay	2.0 sec	1.0-20.0 sec	
		Phase Loss Trip	Enabled	Enabled or Disabled	SP3.6
		Phase Loss Trip Delay	0.1 sec	0-20.0 sec	
		Phase Rotation Detection	ABC	ABC, ACB or Disabled	SP3.7
		Phase Rotation Trip Delay	1.0 sec	1.0 - 20.0 sec	
		*Ground Fault Alarm Level	Off	5-90 %, Off	SP3.8
		*Ground Fault Alarm Delay	0.1 sec	0.1-20.0 sec	
		*Ground Fault Loset Trip Level	Off	5-90 %, Off	SP3.9
		*Ground Fault Loset Trip Delay	0.5 sec	0.1-20 sec	
		*Ground Fault Hiset Trip Level	Off	5-90 %, Off	SP3.10
		*Ground Fault Hiset Trip Delay	0.008 sec	0.008-0.250 sec	
		Overvoltage Alarm Level	Off	5 -30%, Off	SP3.11
		Overvoltage Alarm Delay	1.0 sec	1.0-30.0 sec	
		Overvoltage Trip Level	10%	5-30%, Off	SP3.12
		Overvoltage Trip Delay	2.0 sec	1.0-30.0 sec	
		Undervoltage Alarm Level	Off	5-30%, Off	SP3.13
		Undervoltage Alarm Delay	1.0 sec	1.0-30.0 sec	
		Undervoltage Trip Level	15%	5-30%, Off	SP3.14
		Undervoltage Trip Delay	2.0 sec	1.0-30.0 sec	
		Line Frequency Trip Window	Disabled	0-6 Hz, Disabled	SP3.15
		Line Frequency Trip Delay	1.0 sec	1.0-20.0 sec	
		P/F Lead P/F Alarm	Off	0.1-1.00, Off	SP3.16
		P/F Lead Alarm Delay	1.0 sec	1-120 sec	
		P/F Lead P/F Trip	Off	.01-1.00, Off	SP3.17
		P/F Lead Trip Delay	1.0 sec	1-120 sec	
		P/F Lag P/F Alarm	Off	.01-1.00, Off	SP3.18
		P/F Lag Alarm Delay	1.0 sec	1-120 sec	
		P/F Lag P/F Trip	Off	.01-1.00, Off	SP3.19
		P/F Lag Trip Delay	1.0 sec	1-120 sec	
		Power Demand Period	10 min	1 - 60 min	SP3.20
		KW Demand Alarm Pickup	Off KW	Off, 1-100000	
		KVA Demand Alarm Pickup	Off KVA	Off, 1-100000	
		KVAR Demand Alarm Pickup	Off KVAR	Off, 1-100000	
		Amps Demand Alarm Pickup	Off Amps	Off, 1-100000	

* Ground fault option must be installed.

5.1.4 Relay Assignments (Setpoint Page 4)

Setpoint Page	Security Level	Description	Factory Setting			Range	Section
			1st	2nd	3rd		
Page 4 Relay Assignments	Level 2 Password Protection	O/L Trip	Trip Only	None	None	None Trip(AUX1) Alarm(AUX2) AUX3 AUX4 AUX5-8 Only Available in 8 Relay System **Notes:** **AUX1 to AUX4 are for Factory Use only. Do not change!** **Only AUX 5 - 8 are used in the 2nd & 3rd relay assignments.**	SP4.1
		I/B Trip	Trip	None	None		
		S/C Trip	Trip Only	None	None		
		Overcurrent Trip	Trip	None	None		
		Stator RTD Trip	None	None	None		
		Non Stator RTD Trip	None	None	None		
		*G/F Hi Set Trip	Trip	None	None		
		*G/F Lo Set Trip	Trip	None	None		
		Phase Loss Trip	Trip	None	None		
		Accel. Time Trip	Trip Only	None	None		
		Start Curve Trip	Trip Only	None	None		
		Over Frequency Trip	None	None	None		
		Under Frequency Trip	Trip	None	None		
		I*I*T Start Curve	Trip	None	None		
		Learned Start Curve	Trip	None	None		
		Phase Reversal	Trip	None	None		
		Overvoltage Trip	Trip	None	None		
		Undervoltage Trip	Trip	None	None		
		Power Factor Trip	None	None	None		
		Tach Accel Trip	None	None	None		
		Inhibits Trip	Trip	None	None		
		Shunt Trip	None	None	None		
		Bypass Discrepancy	None	None	None		
		TCB Fault	Trip	None	None		
		External Input #2	None	None	None		
		Dual Ramp	None	None	None		
		Thermostat	Trip	None	None		
		O/L Warning	Alarm	None	None		
		Overcurrent Alarm	Alarm	None	None		
		SCR Fail Shunt Alarm	None	None	None		
		*Ground Fault Alarm	Alarm	None	None		
		Under Current Alarm	None	None	None		
		Motor Running	AUX3	None	None		
		I/B Alarm	Alarm	None	None		
		Stator RTD Alarm	None	None	None		
		Non-Stator RTD Alarm	None	None	None		
		RTD Failure Alarm	None	None	None		
		Self Test Fail	Trip	None	None		
		Thermal Register	Alarm	None	None		
		U/V Alarm	Alarm	None	None		
		O/V Alarm	Alarm	None	None		
		Power Factor Alarm	None	None	None		
		KW Demand Alarm	None	None	None		
		KVA Demand Alarm	None	None	None		
		KVAR Demand Alarm	None	None	None		
		Amps Demand Alarm	None	None	None		
		Timed Output	None	None	None		
		Run Delay Time	None	None	None		
		At Speed	AUX4	None	None		

5.1.5 Relay Configuration (Setpoint Page 5)

Setpoint Page	Security Level	Description	Factory Setting Default	Range	Section
Page 5 Relay Configuration	Level 2 Password Protection	Trip (AUX1) Fail-Safe	No	Yes or No	SP5.1
		Trip (AUX1) Relay Latched	Yes	Yes or No	SP5.2
		Alarm (AUX2) Fail-Safe	No	Yes or No	SP5.1
		Alarm (AUX2) Relay Latched	No	Yes or No	SP5.2
		AUX3 Relay Fail-Safe	No	Yes or No	SP5.1
		AUX3 Relay Latched	No	Yes or No	SP5.2
		AUX4 Relay Fail-Safe	No	Yes or No	SP5.1
		AUX4 Relay Latched	No	Yes or No	SP5.2
		AUX5 Relay Fail-Safe	No	Yes or No	SP5.1
		AUX5 Relay Latched	No	Yes or No	SP5.2
		AUX6 Relay Fail-Safe	No	Yes or No	SP5.1
		AUX6 Relay Latched	No	Yes or No	SP5.2
		AUX7 Relay Fail-Safe	No	Yes or No	SP5.1
		AUX7 Relay Latched	No	Yes or No	SP5.2
		AUX8 Relay Fail-Safe	No	Yes or No	SP5.1
		AUX8 Relay Latched	No	Yes or No	SP5.2

5.1.6 User I/O Configuration (Setpoint Page 6)

Setpoint Page	Security Level	Description	Factory Setting Default	Range	Section
Page 6 User I/O Configuration	Lavel 2 Passowrd Protection	Tachometer Scale Selection	Disabled	Enabled or Disabled	SP6.1
		Manual Tach Scale 4.0 mA:	0 RPM	0 - 3600	
		Manual Tach Scale 20.0 mA:	2000 RPM	0 - 3600	
		Tach Accel Trip Mode Select	Disabled	Underspeed, Overspeed or Disabled	SP6.2
		Tach Ramp Time	20 sec	1 - 120	
		Tach Underspeed Trip PT	1650 RPM	0-3600	
		Tach Overspeed Trip PT	1850 RPM	0 - 3600	
		Tach Accel Trip Delay	1 sec	1 - 60	
		Analog Output #1	RMS Current	Off, RPM 0-3600, Hottest Non-Stator RTD 0-200°C, Hottest Stator RTD 0 - 200°C, RMS Current 0 - 7500 A, % Motor Load 0 - 600% Kw	SP6.3
		Analog Output #1 4mA:	0	0-65535	
		Analog Output #1 20mA:	250	0-65535	
		Analog Output #2	% Motor Load	Same As Analog Input #1	SP6.4
		Analog Output #2 4mA:	0	0-65535	
		Analog Output #2 20mA:	1000	0-65535	
		User Programmable External Inputs			SP6.5
		TCB Fault	Enabled	Enabled or Disabled	
		Name Ext. Input #1	TCB Fault	User Defined, up to 15 Characters	
		TCB Fault Type	NO	Normally Open or Closed	
		TCB Fault Time Delay	1 sec	0-60 sec	
		External Input #2	Disabled	Enabled or Disabled	
		Name Ext. Input #2		User Defined, up to 15 Characters	
		External Input #2 Type	NO	Normally Open or Closed	
		External Input #2 Time Delay	0 sec	0-60 sec	
		Dual Ramp	Dual Ramp	Enabled or Disabled or Dual Ramp	
		Name Ext. Input #3	Dual Ramp	User Defined, up to 15 Characters	
		Dual Ramp Type	NO	Normally Open or Closed	
		Dual Ramp Time Delay	0 sec	0-60 sec	
		Thermostat	Enabled	Enabled or Disabled	
		Name Ext. Input #4	Thermostat	User Defined, up to 15 Characters	
		Thermostat Type	NC	Normally Open or Closed	
		Thermostat Time Delay	1 sec	0-60 sec	

5.1.7 Custom Acceleration Curve (Setpoint Page 7)

Setpoint Page	Security Level	Description	Factory Setting Default	Range	Section
Page 7 Custom Acceleration Curve	Level 3 Password Protection	Custom Accel Curve	Disabled	Disabled, Curve A, B, or C	SP7.1
		Custom Curve A			
		Curve A Voltage Level 1	25%	0-100%	
		Curve A Ramp Time 1	2 sec	1-60 sec	
		Curve A Voltage Level 2	30%	0-100%	
		Curve A Ramp Time 2	2 sec	1-60 sec	
		Curve A Voltage Level 3	37%	0-100%	
		Curve A Ramp Time 3	2 sec	1-60 sec	
		Curve A Voltage Level 4	45%	0-100%	
		Curve A Ramp Time 4	2 sec	1-60 sec	
		Curve A Voltage Level 5	55%	0-100%	
		Curve A Ramp Time 5	2 sec	1-60 sec	
		Curve A Voltage Level 6	67%	0-100%	
		Curve A Ramp Time 6	2 sec	1-60 sec	
		Curve A Voltage Level 7	82%	0-100%	
		Curve A Ramp Time 7	2 sec	1-60 sec	
		Curve A Voltage Level 8	100%	0-100%	
		Curve A Ramp Time 8	2 sec	1-60 sec	
		Curve A Current Limit	350% FLA	200-500%	
		Custom Curve B		Same Programmable Data Points and Ranges as Custom Curve A	
		Custom Curve C		Same Programmable Data Points and Ranges as Custom Curve A	

5.1.8 Overload Curve Configuration (Setpoint Page 8)

Setpoint Page	Security Level	Description	Factory Setting Default	Range	Section
Page 8 Overload Curve Configuration	Level 3 Password Protection	Basic Run Overload Curve			SP8.1
		Run Curve Locked Rotor Time	O/L Class	1-30 sec, O/L Class	
		Run Locked Rotor Current	600% FLA	400-800%	
		Coast Down Timer	Disabled	1-60 Min, Disabled	
		Basic Start Overload Curve			SP8.2
		Start Curve Locked Rotor Time	O/L Class	1-30 sec, O/L Class	
		Start Locked Rotor Current	600% FLA	400-800%	
		Acceleration Time Limit	30 sec	1-300 sec, Disabled	
		Number of Starts Per Hour	Disabled	1-6, Disabled	
		Time Between Starts Time	5 min	1-60 Min, Disabled	
		Area Under Curve Protection	Disabled	Enabled or Disabled	SP8.3
		Max I*I*T Start	368 FLA	1-2500 FLA*FLA*sec	
		Current Over Curve	Disabled	Disabled, Learn, Enabled	SP8.4
		Learned Start Curve Bias	10%	5-40%	
		Time for Sampling	30 sec	1-300 sec	

5.1.9 RTD Configuration (Setpoint Page 9)

Setpoint Page	Security Level	Description	Factory Setting Default	Range	Section
Page 9 RTD Configuration	Level 3 Password Protection	Use NEMA Temp for RTD Values	Disabled	Enabled or Disabled	SP9.1
		# of RTD Used for Stator	4	0-6	SP9.2
		RTD Voting	Disabled	Enabled or Disabled	SP9.3
		Stator Phase A1 Type	Off	120 OHM NI, 100 OHM NI, 100 OHM PT, 10 OHM CU	SP9.4
		RTD #1 Description	Stator A1	User defined, Up to 15 Characters	
		Stator Phase A1 Alarm Level	Off	0-240C (32-464F), Off	
		Stator Phase A1 Trip Level	Off	0-240C (32-464F), Off	
		Stator Phase A2 Type	Off	Same as Stator Phase A1	
		RTD #2 Description	Stator A2	User defined, Up to 15 Characters	
		Stator Phase A2 Alarm	Off	0-240C (32-464F), Off	
		Stator Phase A2 Trip Level	Off	0-240C (32-464F), Off	
		Stator Phase B1 Type	Off	Same as Stator Phase A1	
		RTD #3 Description	Stator B1	User defined, Up to 15 Characters	
		Stator Phase B1 Alarm Level	Off	0-240C (32-464F), Off	
		Stator Phase B1 Trip Level	Off	0-240C (32-464F), Off	
		Stator Phase B2 Type	Off	Same as Stator Phase A1	
		RTD #4 Description	Stator B2	User defined, Up to 15 Characters	
		Stator Phase B2 Alarm Level	Off	0-240C (32-464F), Off	
		Stator Phase B2 Trip Level	Off	0-240C (32-464F), Off	
		Stator Phase C1 Type	Off	Same as Stator Phase A1	
		RTD #5 Description	Stator C1	User defined, Up to 15 Characters	
		Stator Phase C1 Alarm Level	Off	0-240C (32-464F), Off	
		Stator Phase C1 Trip Level	Off	0-240C (32-464F), Off	
		Stator Phase C2 Type	Off	Same as Stator Phase A1	
		RTD #6 Description	Stator C2	User defined, Up to 15 Characters	
		Stator Phase C2 Alarm Level	Off	0-240C (32-464F), Off	
		Stator Phase C2 Trip Level	Off	0-240C (32-464F), Off	
		End Bearing Type	Off	Same as Stator A1	
		RTD #7 Description	End Bearing	User defined, Up to 15 Characters	
		End Bearing Alarm Level	Off	0-240C (32-464F), Off	
		End Bearing Trip Level	Off	0-240C (32-464F), Off	
		Shaft Bearing Type	Off	Same as Stator Phase A1	
		RTD #8 Description	Shaft Bearing	User defined, Up to 15 Characters	
		Shaft Bearing Alarm Level	Off	0-240C (32-464F), Off	
		Shaft Bearing Trip Level	Off	0-240C (32-464F), Off	
		RTD #9 Type	Off	Same as Stator Phase A1	
		RTD #9 Description	User defined	User defined, Up to 15 Characters	
		RTD #9 Alarm Level	Off	0-240C (32-464F), Off	
		RTD #9 Trip Level	Off	0-240C (32-464F), Off	

5.1.9 RTD Configuration Page 9 Cont'd

Setpoint Page	Security Level	Description	Factory Setting Default	Range	Section
Page 9 RTD Configuration	Level 3 Password Protection	RTD #10 Type	Off	Same as Stator Phase A1	SP9.4
		RTD #10 Description	User defined	User defined, Up to 15 Characters	
		RTD #10 Alarm Level	Off	0-240C (32-464F), Off	
		RTD #10 Trip Level	Off	0-240C (32-464F), Off	
		RTD #11 Type	Off	Same as Stator Phase A1	
		RTD #11 Description	User defined	User defined, Up to 15 Characters	
		RTD #11 Alarm Level	Off	0-240C (32-464F), Off	
		RTD #11 Trip Level	Off	0-240C (32-464F), Off	
		RTD #12 Type	Off	Same as Stator Phase A1	
		RTD #12 Description	User defined	User defined, Up to 15 Characters	
		RTD #12 Alarm Level	Off	0-240C (32-464F), Off	
		RTD #12 Trip Level	Off	0-240C (32-464F), Off	

5.1.10 Security Set Password Page 10

Setpoint Page	Security Level	Description	Factory Setting Default	Range	Section
Page 10	Level 3	Set Level 2 Password	100	000 – 999 Three Digits	SP10.1
		Set Level 3 Password	1000	0000 – 9999 Four Digits	SP10.2

5.1.11 Communications Page 11

Setpoint Page	Security Level	Description	Factory Setting Default	Range	Section
Page 11 Communiications	Level 3 Password Protection	Set Front Baud Rate	9.6 KB/sec	2.4, 4.8, 9.6, 19.2, 38.4 KB/sec	SP11.1
		Set Modbus Baud Rate	9.6 KB/sec	2.4, 4.8, 9.6, 19.2, 38.4 KB/sec	SP11.2
		Modbus Address Number	247	1 – 247	SP11.3
		Set Access Code	1	1 – 999	SP11.4
		Set Link Baud Rate	38.4 KB/sec	2.4, 4.8, 9.6, 19.2, 38.4 KB/sec	SP11.5
		Remote Start/Stop	Disabled	Enabled or Disabled	SP11.6

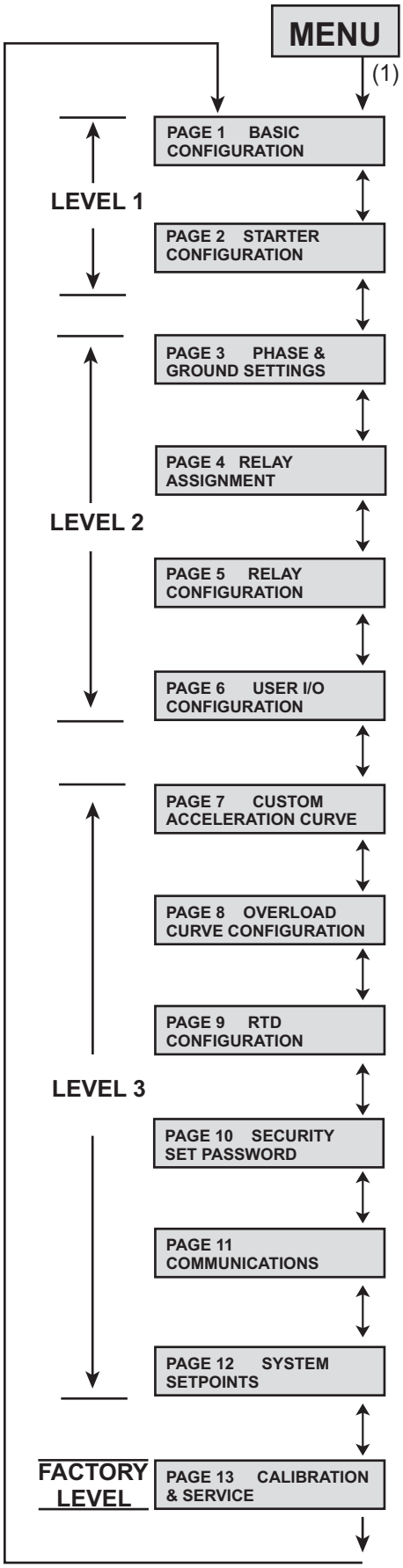
5.1.12 System (Setpoint Page 12)

Setpoint Page	Security Level	Description	Factory Setting Default	Range	Section
Page 12 System Setpoints	Level 3 Password Protection	Default Display Screen			SP12.1
		Metering Data Page #	1	Enter Metering Page (1-4)	
		Metering Data Screen #	1	Enter Metering Screen Page 1(1-10) Page 2 (1-11) Page 3 (1 - 29) Page 4 (1 - 6)	
		Alarms			SP12.2
		RTD Failure Alarm	Disabled	Enabled or Disabled	
		Thermal Register Alarm	90%	Off, 40-95%	
		Thermal Alarm Delay	10 sec	1-20 sec	
		Thermal Register Setup Info			SP12.3
		Cold Stall Time	O/L Class	O/L Class (5-30) or 4-40 second time delay	
		Hot Stall Time	½ O/L Class	½ O/L Class, 4-40 sec	
		Stopped Cool Down Time	30 Min	10-300 Min	
		Runing Cool Down Time	15 Min	10-300 Min	
		Relay Measured Cool Rates	Disabled	Enabled or Disabled	
		Thermal Register Minimum	15%	10-50%	
		Motor Design Ambient Temp	40C	10-90C	
		Motor Design Run Temperature	80% Max	50-100% of Motor Stator Max Temp	
		Motor Stator Max Temp	INS CLS	INS CLS, 10-240 C	
		I/B Input to Thermal Register	Enabled	Enabled or Disabled	
		Use Calculated K or Assign	7	1-50, On	
		Press Enter to Clr Thermal Register			SP12.4

5.1.13 Calibration and Service (Setpoint Page 13)

Setpoint Page	Security Level	Description	Factory Setting Default	Range	Section
Page 13 Calibration & Service	FACTORY USE ONLY	Set Date and Time (DDMMYY:HHMM)	FACTORY SET; ##/##/## ##:##		SP13.1
		Enter Date (DDMMYYYY)	FACTORY SET; ##/##/####	D=1-31, M=1-12, Y=1970-2069	
		Enter Time (HH:MM)	FACTORY SET; ##:##	H=00-23, M=0-59	
		Model # Firmware REV. #	FACTORY SET; ###### ######	Display Only, Cannot be changed	SP13.2
		Press Enter to Access Factory Settings		Available to Qualified Factory Personnel	SP13.3

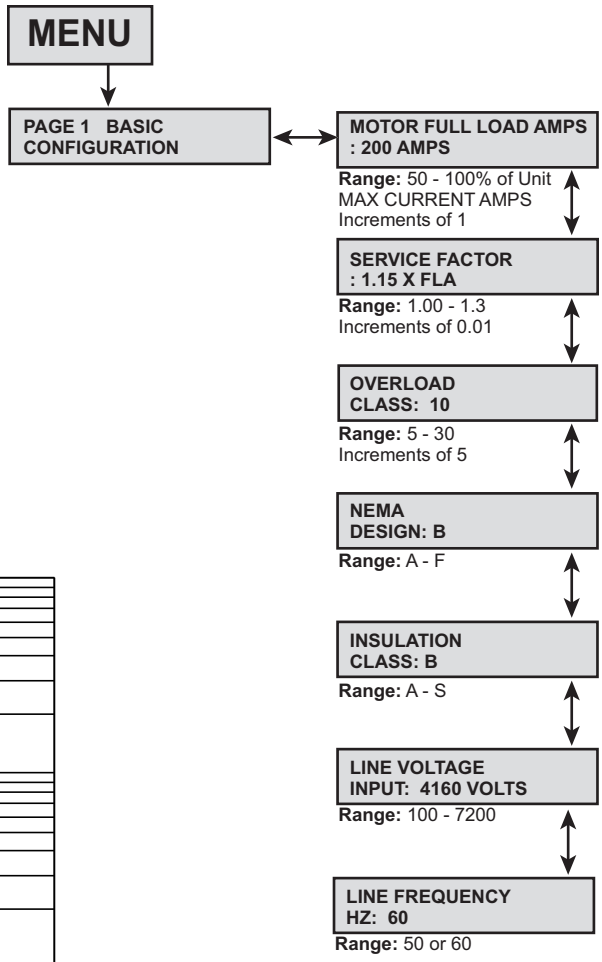
5.2 Setpoint Menu



Note:
1. Push MENU key to toggle the screens between Setpoint Menu and Metering Menu.
2. Follow the arrow keys to get to different screens.
   Example: For Page 3 PHASE & GROUND SETTINGS, press the MENU key and the DOWN ARROW two times.

SP.1 Basic Configuration (Setpoint Page 1)

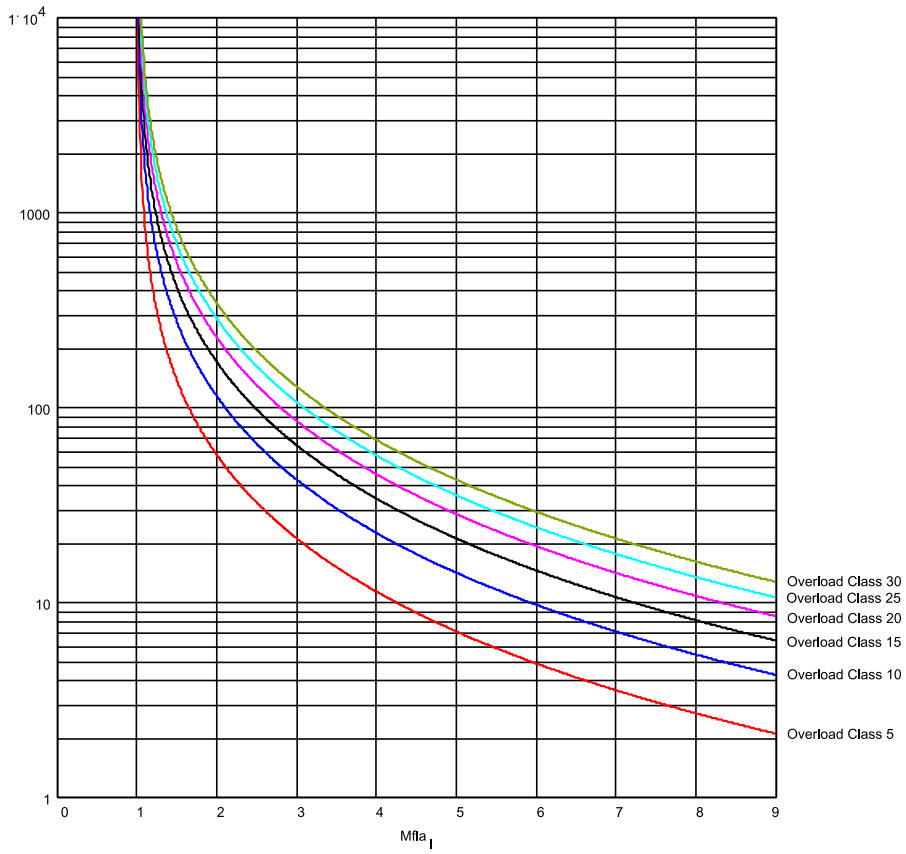
In Setpoint Page 1, the starter is looking for the following basic nameplate data of the motor.



SP1.1 Motor Full Load Amps: Allows the user to enter the motor's FLA rating. Range of adjustment is 50 - 100% (less programmed service factor).

SP1.2 Service Factor: Sets the pickup point on the overload curve as defined by the programmed motor full load current. Ex: If the motor FLA is 100 and the service factor is 1.15, the overload pickup point will be 115 Amps.

SP1.3 Overload Class: Choose the motor protection overload class, range from 5-30.
Ex: Overload Class 10 will trip in 10 seconds at six times FLA.



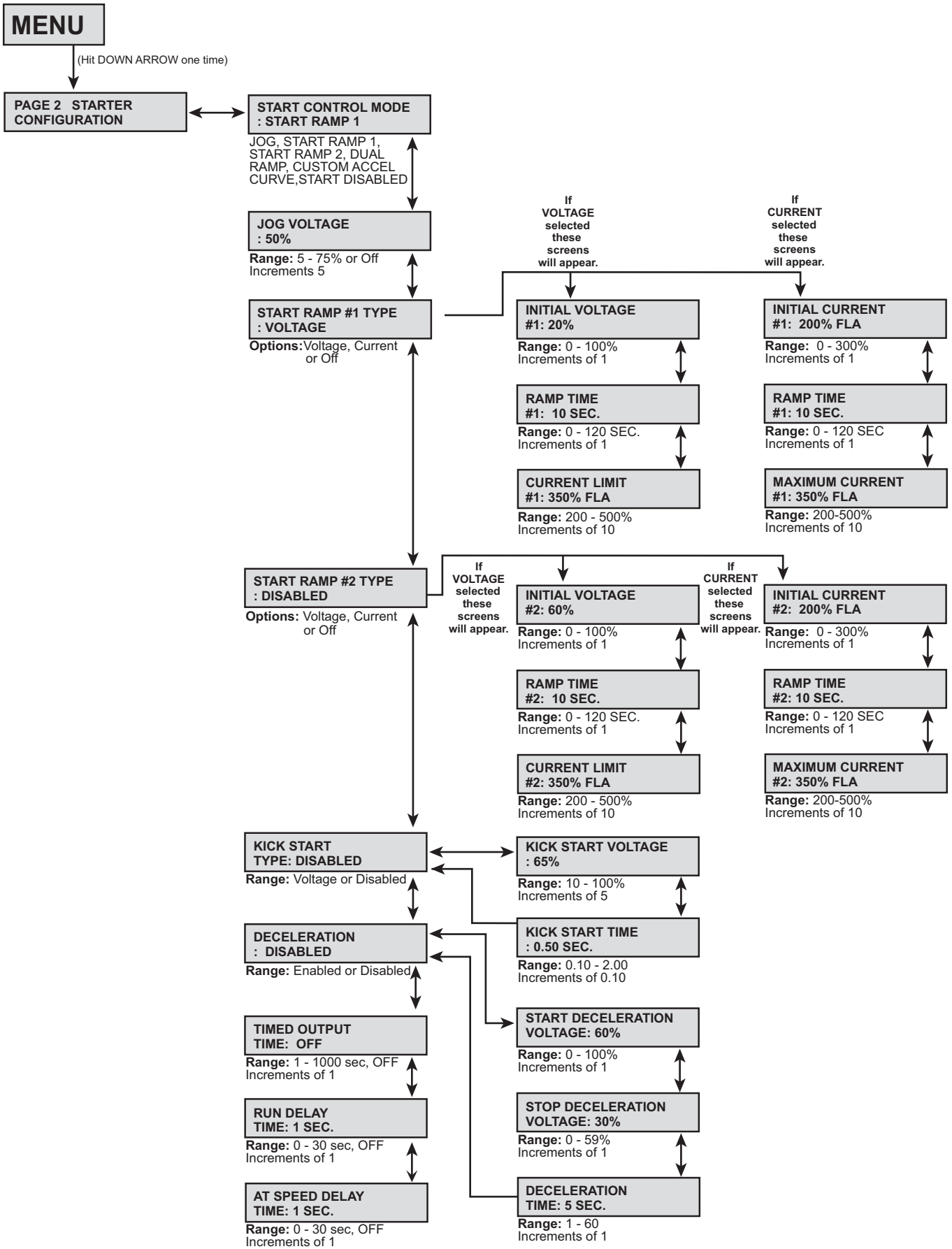
SP1.4 NEMA design: The motor design maximum allowed slip (Select from Class A through F).

SP1.5 Insulation Class: The motor insulation temperature class (Select A, B, C, E, F, H, K, N or S).

SP1.6 Line Voltage Input: Applied Voltage

SP1.7 Line Frequency: The user may choose either 50 Hz or 60 Hz.

SP.2 Starter Configuration (Setpoint Page 2)



SP.2 Starter Configuration (Setpoint Page 2)

Provides multiple choices for starting ramps that can be selected for particular loads and applications.

SP2.1 Start Control Mode: Start Ramp 1, Jog, Start Disabled, Tach Ramp, Custom Accel Curve, Dual Ramp, Start Ramp 2.

- **Dual Ramp:** The dual ramp mode works in conjunction with External Input #3. This allows the user to switch between the two start ramps without having to reconfigure the start mode. (For details on configuring External Input #3 for DUAL RAMP see Setpoint Page 6.)

- **Custom Accel Curve:** Allows the user to custom design the acceleration start curve to the application. (See setpoint page 7 for configuration setup.) ***Note:*** If Custom Accel Curve has not been enabled in setpoint page 7, the soft starter will ignore the start control mode and read this setpoint as disabled.

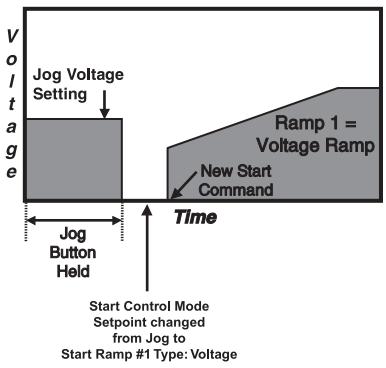
- **Tach Ramp:** See setpoint page 6 for configuration setup of tachometer input.

SP2.2 Jog Voltage: The voltage level necessary to cause the motor to slowly rotate.

SP2.3 Start Ramp 1 Type: The ramp type can be setup for either Voltage or Current. If Voltage is selected, initial voltage, ramp time and current limit are adjustable. If Current is selected, initial current, ramp time and maximum current are adjustable.

Start Ramp 1 Type: Voltage

- **Voltage Ramping** is the most reliable starting method, because the starter will eventually reach an output voltage high enough to draw full current and develop full torque. This method is useful for applications where the load conditions change frequently and where different levels of torque are required. Typical applications include material handling conveyors, positive displacement pumps and drum mixers. Voltage is increased from a starting point (Initial Torque) to full voltage over an adjustable period of time (Ramp Time). To achieve Voltage Ramping, select VOLTAGE for the START RAMP #1 TYPE setpoint and set CURRENT LIMIT #1 setpoint to 500% (the maximum setting). Since this is essentially Locked Rotor Current on most motors, there is little or no Current Limit effect on the Ramp profile.



- **Voltage Ramping with Current Limit** is the most used curve and is similar to voltage ramping. However, it adds an adjustable maximum current output. Voltage is increased gradually until the setting of the Maximum Current Limit setpoint is reached. The voltage is held at this level until the motor accelerates to full speed. This may be necessary in applications where the electrical power is limited. Typical applications include portable or emergency generator supplies, utility power near the end of a transmission line and utility starting power demand restrictions. Note: Using Current Limit will override the Ramp Time setting if necessary, so use this feature when acceleration time is not critical. To achieve Voltage Ramping with Current Limit, select VOLTAGE for the START RAMP #1 setpoint and set CURRENT LIMIT #1 setpoint to a desired lower setting, as determined by your application requirements.

Start Ramp 1 Type: Current

Current Ramping (Closed Loop Torque Ramping) is used for smooth linear acceleration of output torque. This ramp is only used on some conveyor systems (long haul or down hill). Output voltage is constantly updated to provide the linear current ramp, and therefore the available torque is maximized at any given speed. This is for applications where rapid changes in torque may result in load damage or equipment changes. Typical applications include overland conveyors if belt stretching occurs; fans and mixers if blade warping is a problem; and material handling systems if stacked products fall over or break. This feature can be used with or without the Maximum Current Limit setting. To achieve Current Ramping select CURRENT for START RAMP #1 TYPE setpoint and the MAXIMUM CURRENT #1 setpoint to the desired level.

Current Limit Only: (Current Step) start uses the Current Limit feature exclusively. This method of starting eliminates the soft start voltage/current ramp and instead, maximizes the effective application of motor torque within the limits of the motor. In this mode, setpoint RAMP TIME #1 is set to zero (0), so the output current jumps to the current limit setting immediately. Typically used in with a limited power supply, when starting a difficult load such as a centrifuge or deep well pump, when the motor capacity is barely adequate (stall condition or overloading occurs) or if other starting modes fail. Since ramp times are set to zero (0). START RAMP #1 TYPE is set to either VOLTAGE or CURRENT.

- **Initial Torque** (**Initial Voltage #1 or Initial Current #1**): Sets the initial start point of either

the Voltage Ramp or the Current Ramp. Every load requires some amount of torque to start from a standstill. It is inefficient to begin ramping the motor from zero every time, since between zero and the WK2 break-away torque level, no work is being performed. The initial torque level should be set to provide enough torque to start rotating the motor shaft, enabling a soft start and preventing torque shock damage. Setting this start point too high will not damage the starter, but may reduce or eliminate the soft start effect.

- **Ramp Time #1**: Sets the maximum allowable time for ramping the initial voltage or current (torque) setting to either of the following:
  1) the Current Limit setting when the motor is still accelerating, or
  2) full output voltage if the Current Limit is set to maximum.
  Increasing the ramp time softens the start process by gradually increasing the voltage or current. Ideally, the ramp time should be set for the longest amount of time the application will allow (without stalling the motor). Some applications require a short ramp time due to the mechanics of the system (i.e. centrifugal pumps, because pump problems can occur due to insufficient torque).

- **Current Limit:** Sets the maximum motor current the starter will allow during Ramping. As the motor begins to ramp, the Current Limit feature sets a ceiling at which the current draw is held. Current Limit remains in effect until the following occurs:
  1) the motor reaches full speed (detected by the At-Speed detection circuit) or
  2) the Overload Protection trips on Motor Thermal Overload.
  Once the motor reaches full speed, the Current Limit feature becomes inactive.

  In the Voltage Ramp Profile, the voltage output is increased until it reaches the Current Limit. Ramp time is the maximum amount of time it takes for the voltage to increase until the Current Limit setting takes over. With some load conditions, the Current Limit is reached before the Ramp Time expires.

  The Current Ramp profile varies the output voltage to provide a linear increase in current up to the Maximum Current setpoint value. A closed loop feedback of motor current maintains the Current Ramp profile.

SP2.4 Start Ramp 2: The same options and screen setups as Start Ramp 1. Note: CUSTOM ACCEL CURVE overrides the voltage or current start in Ramps 1 and 2 when selected to be the start control mode.

SP2.5 Kick Start: Used as an initial energy burst in applications with high friction loads.

- **Kick Start Voltage**: The initial voltage (as a percent of full voltage value) that is needed to start the motor (i.e. Breakaway or Initial Torque).

- **Kick Start Time**: The time the initial torque boost is applied.

SP2.6 Deceleration: Allows the motor to gradually come to a soft stop.

- **Start Deceleration Voltage**: The first part of the deceleration ramp. The soft starter initially drops to this voltage level upon receiving a STOP command. (Represented as a percent of voltage value.)

- **Stop Deceleration Voltage**: The drop-off point of the deceleration ramp. (Percent of voltage value.)

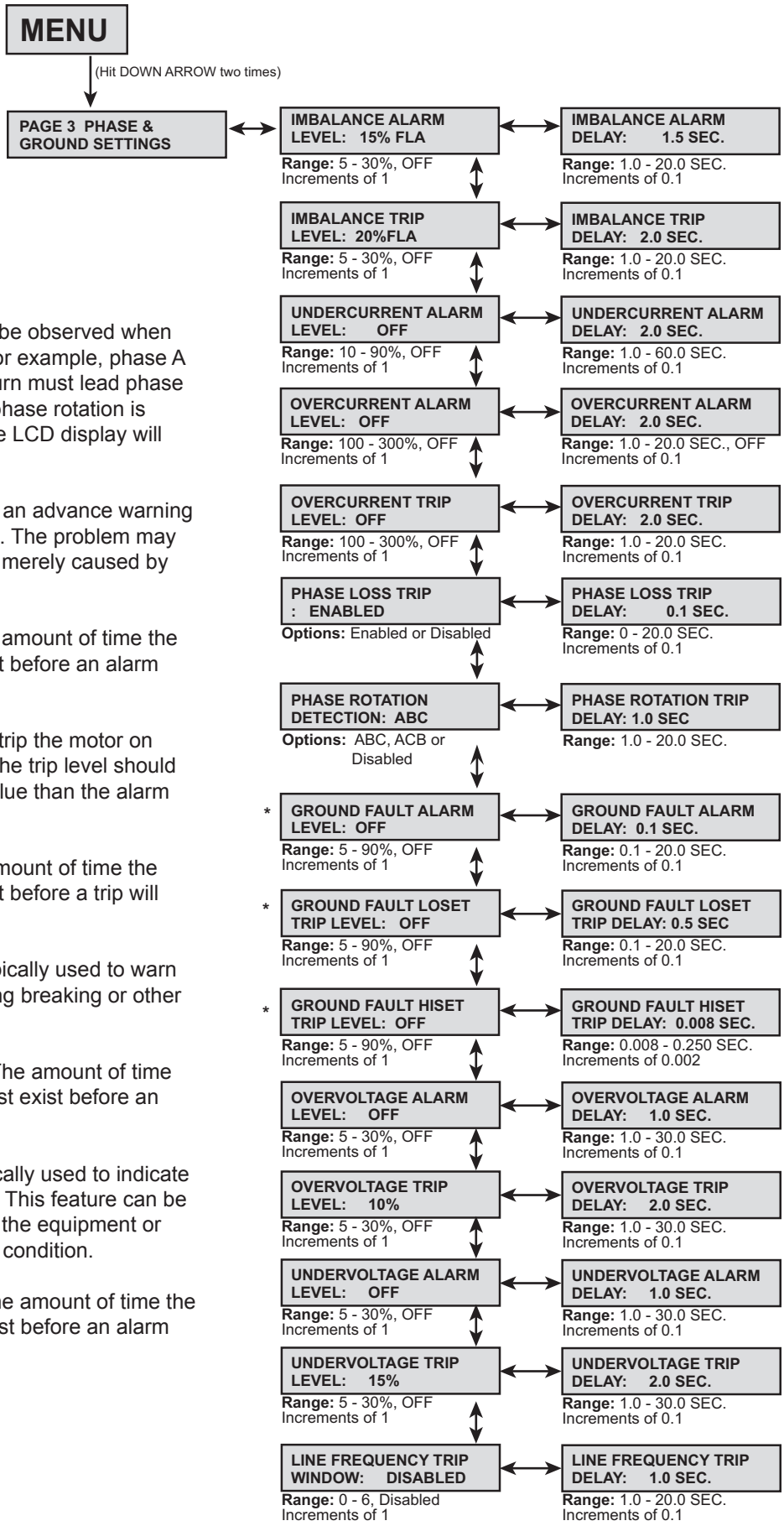
- **Deceleration Time**: Decel ramp time.

SP2.7 Timed Output: Used with an AUX 5-8 relay. When enabled, and upon a start command, it waits until the programmed time plus the run delayed time has expired. The relay energizes and remains so until a stop command is received. It de-energizes upon receiving a stop command.

SP2.8 Run Delay Time: Can be used with an AUX 5-8 relay. The delay timer begins upon receipt of the start command. The relay will then drop out when the time has expired.

SP2.9 At Speed Delay Time: Used with an AUX 4 relay, it waits until after the motor reaches the end of ramp and the programmed delay time has expired. The relay energizes until a stop command has been received.

SP.3 Phase & Ground Settings (Setpoint Page 3) (Security Level: 2)



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.

SP3.1 Imbalance Alarm Level: This is an advance warning of a phase imbalance problem. The problem may not be a fault in the motor, but merely caused by imbalanced voltages.

- **Imbalance Alarm Delay:** The amount of time the imbalance condition must exist before an alarm occurs.

SP3.2 Imbalance Trip Level: This will trip the motor on excessive phase imbalance. The trip level should be programmed to a higher value than the alarm level.

- **Imbalance Trip Delay:** The amount of time the imbalance condition must exist before a trip will occur.

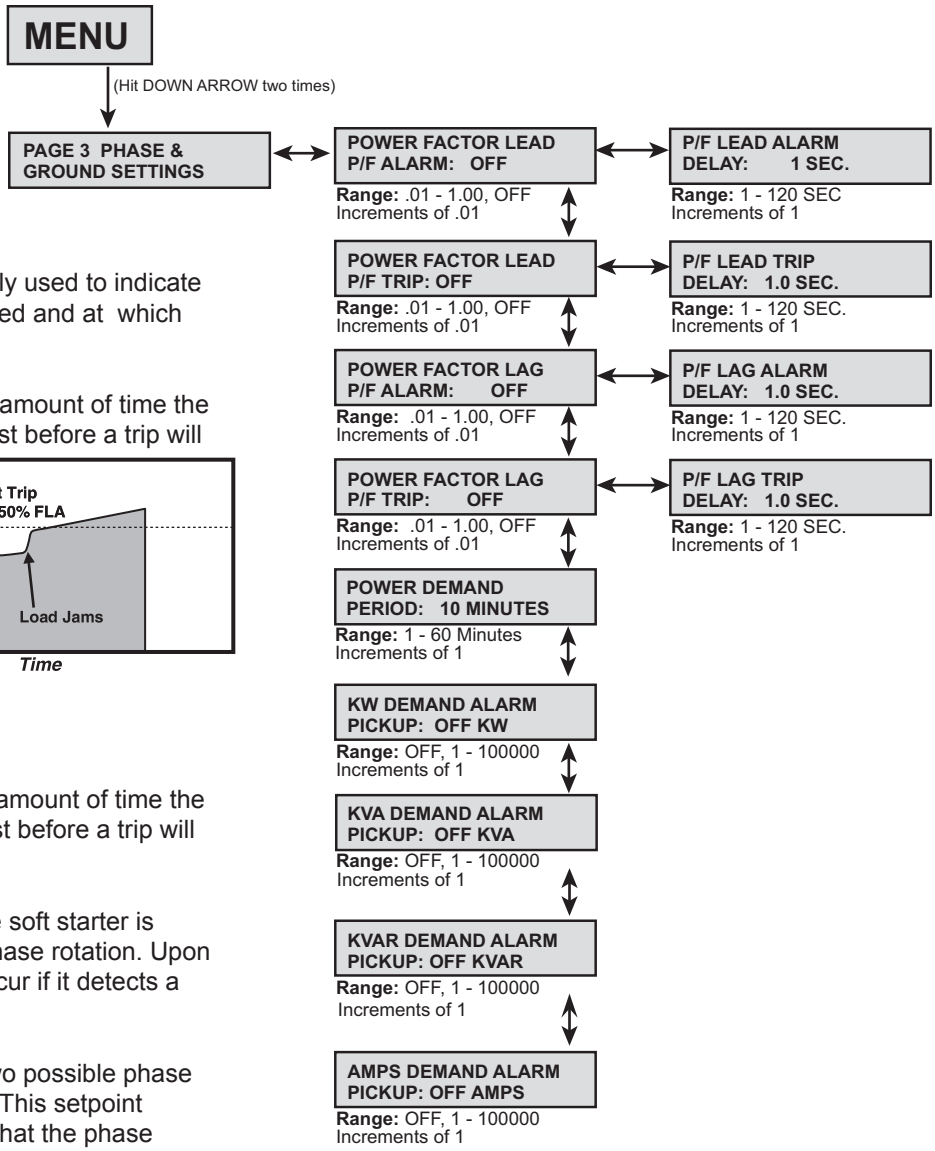
SP3.3 Undercurrent Alarm Level: Typically used to warn of possible load loss, a coupling breaking or other mechanical problems.

- **Undercurrent Alarm Delay**: The amount of time the undercurrent condition must exist before an alarm will occur.

SP3.4 Overcurrent Alarm Level: Typically used to indicate when the motor is overloaded. This feature can be used to either stop the feed to the equipment or warn operators of an overload condition.

- **Overcurrent Alarm Delay:** The amount of time the overcurrent condition must exist before an alarm will occur.

SP.3 Phase & Ground Settings (Setpoint Page 3)



SP3.5 Overcurrent Trip Level: Typically used to indicate the motor is severely overloaded and at which point a trip occurs.

- **Overcurrent Trip Delay:** The amount of time the overcurrent condition must exist before a trip will occur.

SP3.6 Phase Loss Trip: When enabled, the soft starter will trip the motor off-line upon a loss of phase power.

- **Phase Loss Trip Delay:** The amount of time the phase loss condition must exist before a trip will occur.

SP3.7 Phase Rotation Detection: The soft starter is continuously monitoring the phase rotation. Upon a start command, a trip will occur if it detects a change in the phase rotation.

- **Phase Rotation:** There are two possible phase rotation options: ABC or ACB. This setpoint monitors the wiring to ensure that the phase rotation is correct. To view the present phase rotation, go to Metering Page1, screen number 4.

SP3.8 * Ground Fault Alarm: Typically used to warn of low level ground current leakage.

- *** Ground Fault Alarm Delay:** The amount of time that the ground fault condition must exist before an alarm will occur.

SP3.9 * Ground Fault Loset Trip Level: Typically used to trip the motor on a low level of ground current leakage. This setpoint is intended to detect high impedance faults.

- *** Ground Fault Loset Trip Delay:** The amount of time that the ground fault condition must exist before a trip will occur.

SP3.10 * Ground Fault Hiset Trip Level: Used to trip the motor (within milliseconds) upon detecting a high level of ground current leakage. This setpoint is intended to detect low impedance faults.

- ***Ground Fault Hiset Trip Delay:** The amount of time that the ground fault condition must exist before a trip will occur.

SP3.11 Overvoltage Alarm Level: Typically used to indicate when the line voltage is too high. This is an alarm level.

- **Overvoltage Alarm Delay:** The amount of time that the overvoltage condition must exist before a trip will occur.

*Ground Fault Option must be installed

SP3.12 Overvoltage Trip Level: Typically used to indicate that the line voltage is too high and at which point a trip occurs

- **Overvoltage Trip Delay:** The amount of time that the overvoltage condition must exist before a trip will occur.

SP3.13 Undervoltage Alarm Level: Typically used to indicate when the line voltage is too low. This is an alarm level.

- **Undervoltage Alarm Delay:** The amount of time that the overvoltage condition must exist before a trip will occur.

SP3.14 Undervoltage Trip Level: Typically used to indicate that the line voltage is too low and at which point a trip occurs

- **Undervoltage Trip Delay:** The amount of time that the undervoltage condition must exist before a trip will occur.

SP3.15 Line Frequency Trip Window: The acceptable amount of drift above or below the line frequency (Hz) before a trip is generated.

- **Line Frequency Trip Delay:** The amount of time that the frequency drift condition must exist beyond the window before a trip will occur.

SP3.16 Power Factor Lead Alarm: Typically used to indicate a leading power factor.

- **Power Factor Lead Alarm Delay:** The amount of time that the power factor lead condition must exist beyond the window before a trip will occur.

SP3.17 Power Factor Lead Trip: The acceptable amount of power factor lead before a trip is generated.

- **Power Factor Lead Delay:** The amount of time that the power factor lead condition must exist beyond the window before a trip will occur.

SP3.18 Power Factor Lag Alarm: Typically used to indicate a lagging power factor.

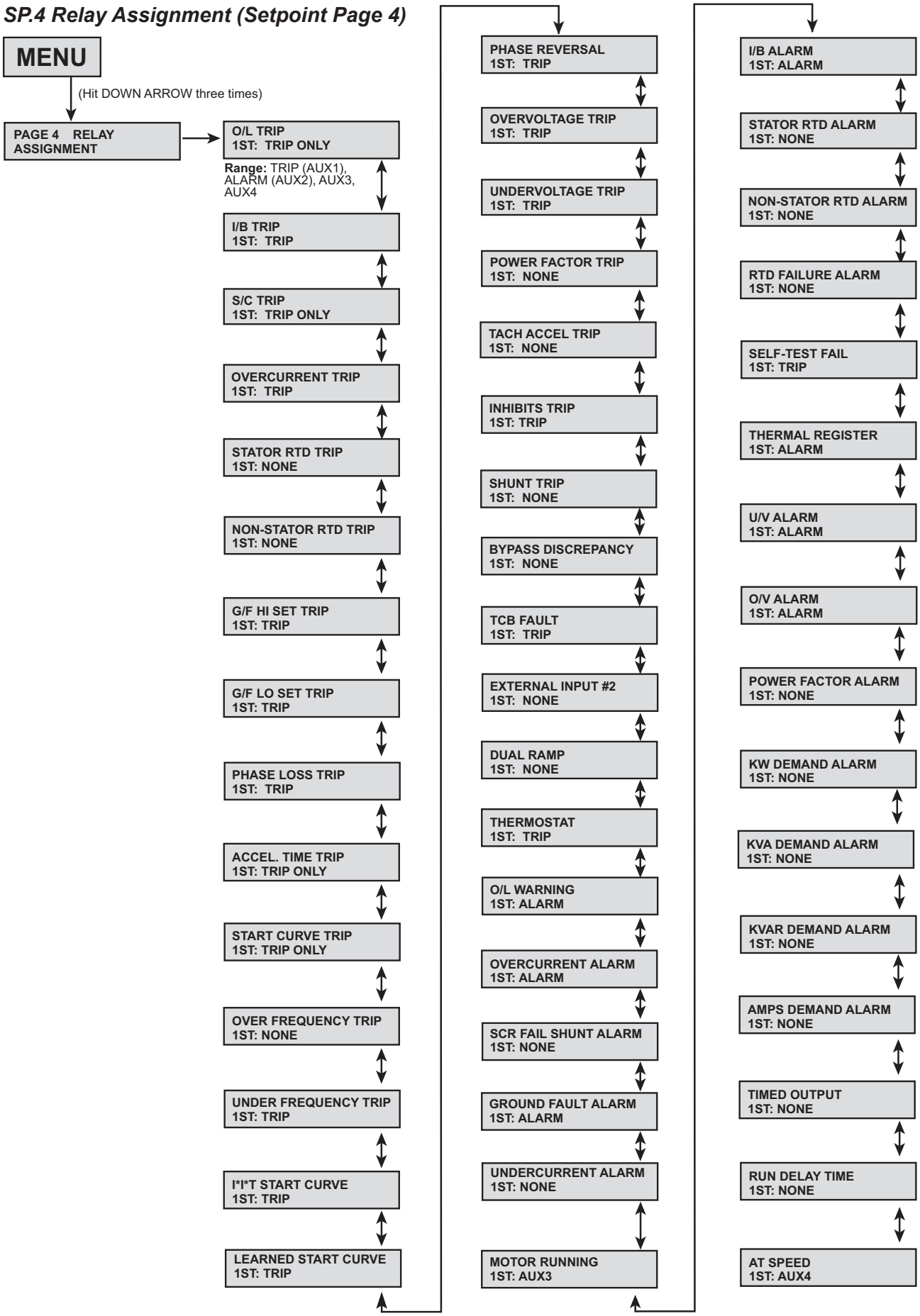
- **Power Factor Lag Alarm Delay:** The amount of time that the power factor lagging condition must exist beyond the window before a trip will occur.

SP3.19 Power Factor Lag Trip: The acceptable amount of power factor lag before a trip is generated.

- **Power Factor Lag Delay:** The amount of time that the power factor lag condition must exist beyond the window before a trip will occur.

SP3.20 Power Demand Period: The soft starter measures the demand of the motor for several parameters (current, kW, kvar, kVA). The demand values of motors assists in energy management programs where processes may be altered or scheduled to reduce overall demand. Demand is calculated by a programmed amount of time where current, kW, kvar and kva samples are taken and then averaged and stored to assess demand.

SP.4 Relay Assignment (Setpoint Page 4)



SP.4 Relay Assignment (Setpoint Page 4)
(Security Level: 2)

The protection functions are user programmable to an output relay. Factory setting for the trip functions assigned to TRIP (AUX1) relay and alarm functions to ALARM (AUX2) relay. AUX1 - 4 are Factory Set and should not be changed.

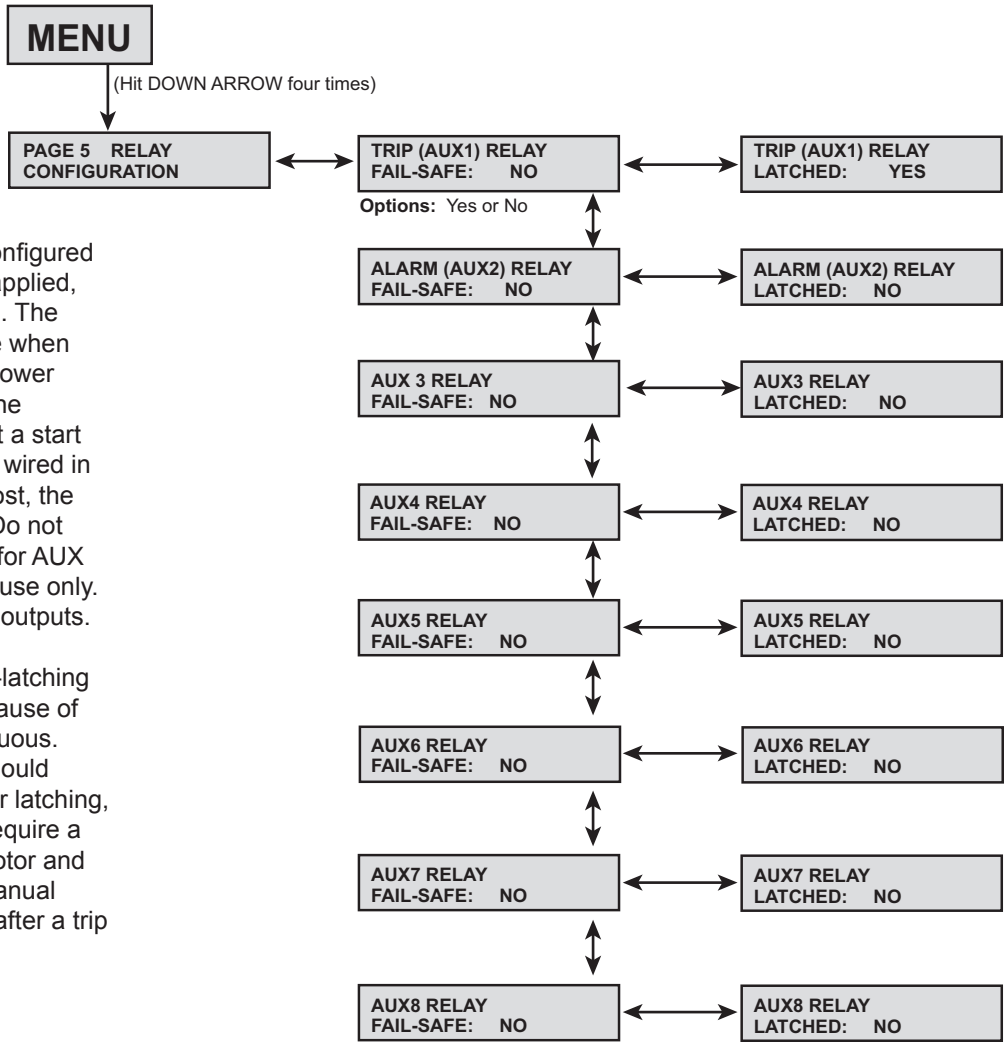
SP4.1 The following is a list of the user programmable functions.

FUNCTIONS	RELAY ASSIGNMENTS		
	1st	2nd	3rd
OVERLOAD TRIP	TRIP ONLY	NONE	NONE
IMBALANCE TRIP	TRIP (AUX1)	NONE	NONE
SHORT CIRCUIT TRIP	TRIP ONLY	NONE	NONE
OVERCURRENT TRIP	TRIP (AUX1)	NONE	NONE
STATOR RTD TRIP	NONE	NONE	NONE
NON-STATOR RTD TRIP	NONE	NONE	NONE
GROUND FAULT HI SET TRIP*	TRIP (AUX1)	NONE	NONE
GROUND FAULT LO SET TRIP*	TRIP (AUX1)	NONE	NONE
PHASE LOSS TRIP	TRIP (AUX1)	NONE	NONE
ACCEL TIME TRIP	TRIP ONLY	NONE	NONE
START CURVE TRIP	TRIP ONLY	NONE	NONE
OVER FREQUENCY TRIP	NONE	NONE	NONE
UNDER FREQUENCY TRIP	TRIP (AUX1)	NONE	NONE
I*I*T START CURVE	TRIP (AUX1)	NONE	NONE
LEARNED START CURVE	TRIP (AUX1)	NONE	NONE
PHASE REVERSAL	TRIP (AUX1)	NONE	NONE
OVERVOLTAGE TRIP	TRIP (AUX1)	NONE	NONE
UNDERVOLTAGE TRIP	TRIP (AUX1)	NONE	NONE
POWER FACTOR TRIP	NONE	NONE	NONE
TACH ACCEL TRIP	NONE	NONE	NONE
INHIBITS TRIP	TRIP (AUX1)	NONE	NONE
SHNT TRIP	NONE	NONE	NONE
BYPASS DISCREPANCY	NONE	NONE	NONE
TCB FAULT	TRIP (AUX1)	NONE	NONE
EXTERNAL INPUT 2	NONE	NONE	NONE
DUAL RAMP	NONE	NONE	NONE
THERMOSTAT	TRIP (AUX1)	NONE	NONE
OVERLOAD WARNING	ALARM (AUX2)	NONE	NONE
OVERCURRENT ALARM	ALARM (AUX2)	NONE	NONE
SCR FAIL SHUNT ALARM	ALARM (AUX2)	NONE	NONE
GROUND FAULT ALARM*	ALARM (AUX2)	NONE	NONE
UNDERCURRENT ALARM	NONE	NONE	NONE
MOTOR RUNNING	AUX3	NONE	NONE
IMBALANCE ALARM	ALARM (AUX2)	NONE	NONE
STATOR RTD ALARM	NONE	NONE	NONE
NON-STATOR RTD ALARM	NONE	NONE	NONE
RTD FAILURE ALARM	NONE	NONE	NONE
SELF TEST FAIL	TRIP (AUX1)	NONE	NONE
THERMAL REGISTER	ALARM (AUX2)	NONE	NONE
U/V ALARM	ALARM (AUX2)	NONE	NONE
O/V ALARM	ALARM (AUX2)	NONE	NONE
POWER FACTOR ALARM	NONE	NONE	NONE
KW DEMAND ALARM	NONE	NONE	NONE
KVA DEMAND ALARM	NONE	NONE	NONE
KVAR DEMAND ALARM	NONE	NONE	NONE
AMPS DEMAND ALARM	NONE	NONE	NONE
TIMED OUTPUT	NONE	NONE	NONE
RUN DELAY TIME	NONE	NONE	NONE
AT SPEED	AUX4	NONE	NONE

*Ground fault option must be installed.

SP.5 Relay Configuration (Setpoint Page 5) (Security Level: 2)

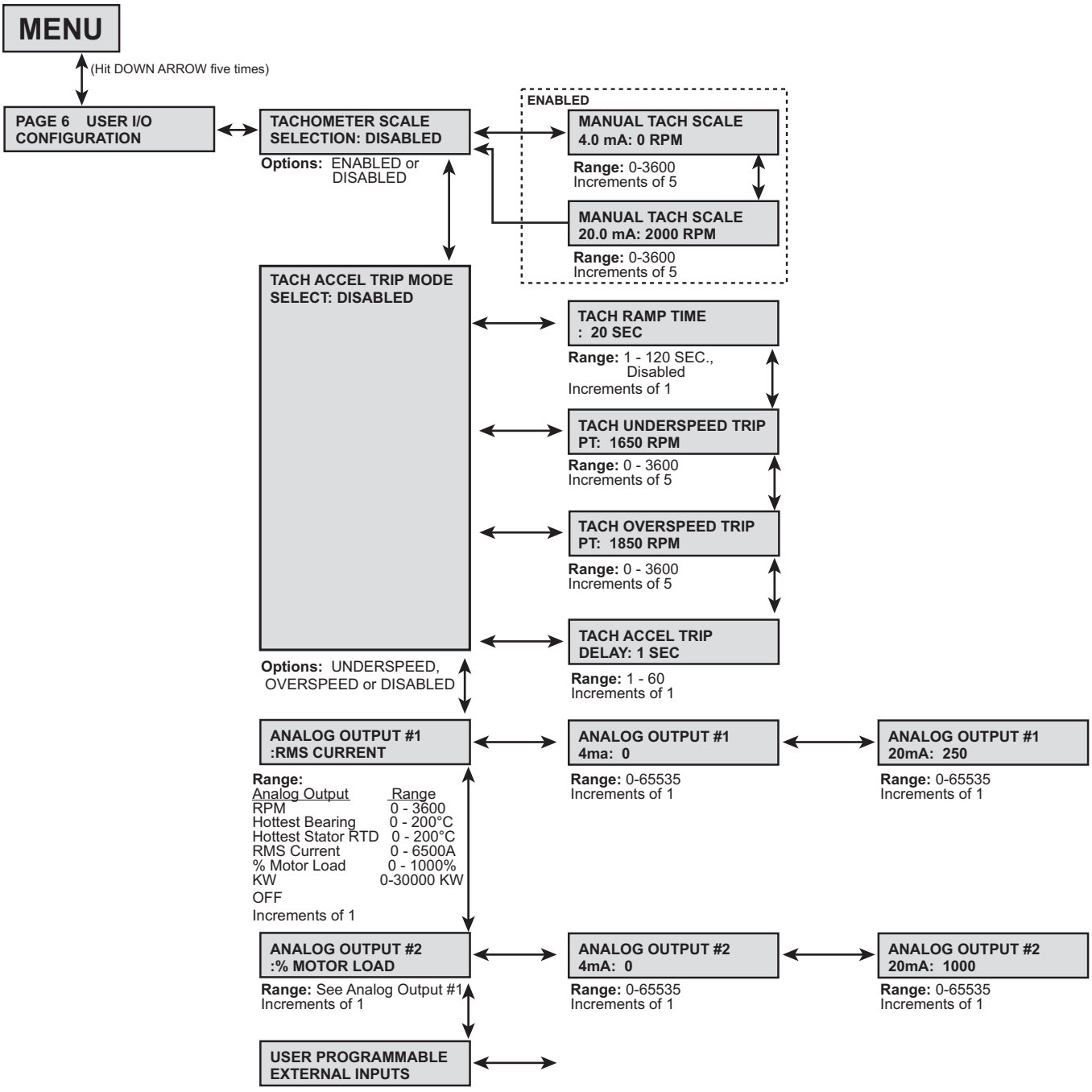
In Setpoint Page 5 the user can configure the four output relays as either fail-safe or non fail-safe and latching or non-latching.



SP5.1 When a relay has been configured as fail-safe and power is applied, the relay will be energized. The relay will then de-energize when an event occurs or if the power fails. Note: The relays in the soft starter will not prevent a start sequence unless they are wired in as interlocks. If power is lost, the motor power is also lost. Do not change the programming for AUX 1-4. These are for factory use only. AUX 5-8 are user defined outputs.

SP5.2 A relay configured as non-latching will reset itself when the cause of the trip event is not continuous. The TRIP (AUX1) relay should always be programmed for latching, because this trip should require a visual inspection of the motor and starter before issuing a manual reset to release the relay after a trip has been stored.

SP.6 User I/O Configuration (Setpoint Page 6)
(Security Level: 2)



Continued...

SP.6 User I/O Configuration (Setpoint Page 6) (Security Level: 2)

The controller can be configured to accept a tachometer feedback signal through the 4-20mA input.

SP6.1 The first screen of setpoint page 6 is TACHOMETER SCALE SELECTION. When this is set to ENABLED, the user will need to input the tachometer scale of the 4-20mA input range.

- **Manual Tach Scale 4.0 mA**: The unit is looking for an RPM value to assign to the lowest point on the scale. This value should represent the motor at zero speed.
- **Manual Tach Scale 20.0 mA**: The unit is looking for an RPM value to assign to the highest point on the scale. This value should represent the motor at full speed.

SP6.2 **Tach Accel Trip Mode Select:** When enabled, the underspeed or overspeed must be selected for the Tach Accel Trip. If underspeed is selected, only the Tach Underspeed Trip Point will be used. If overspeed is selected only the Tach Overspeed Trip Point will be used.

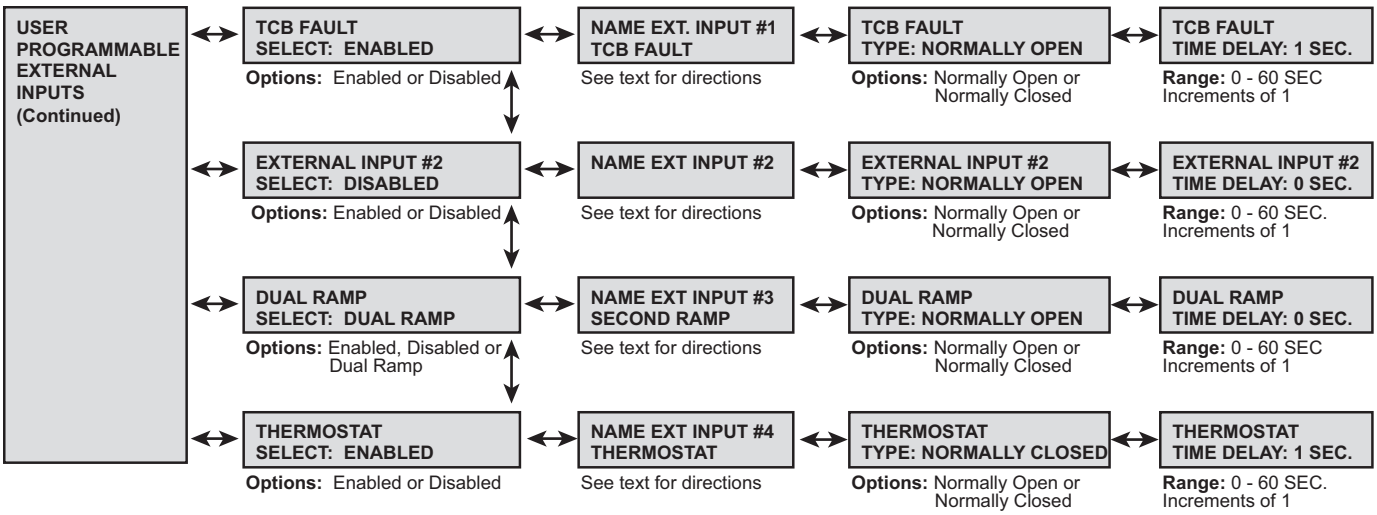
- **Tach Ramp Time:** This is the duration of time before the tachometer begins to sample.
- **Tach Underspeed Trip:** The minimum value of motor RPM which must be achieved before the Tach Ramp Time sample is taken.
- **Tach Overspeed Trip:** The maximum motor RPM allowed when the Tach Ramp Time sample is taken.
- **Tach Accel Trip Delay**: The duration of time that the Tach Accel trip condition must persist before a trip is generated.

SP6.3 The controller provides two 4-20mA analog outputs. Each analog output is independent of the other and can be assigned to monitor different functions. The available output ranges are RPM, Hottest Non-Stator (Bearing) RTD, Hottest Stator RTD, RMS current, % Motor Load, or kW.

- **Analog Output #1** – Select a function from the available options to be transmitted from the 4-20mA output. ***Note:*** If selecting RPM, the Tachometer feedback input signal must be present in order for the controller to give proper output. If selecting RTD, the RTD option must be installed and an RTD input signal must be present for a proper output to be given from the analog output.
- **Analog Output #1 (4 mA)**: Enter a value that the 4mA level will represent for the selected function; typically this value should be 0.
- **Analog Output #1 (20 mA):** Enter a value that the 20mA level will represent for the selected function.

SP6.4 **Analog Output #2** – All of the setpoints and setup screens for Analog Output #2 are the same as those for Analog Output #1.

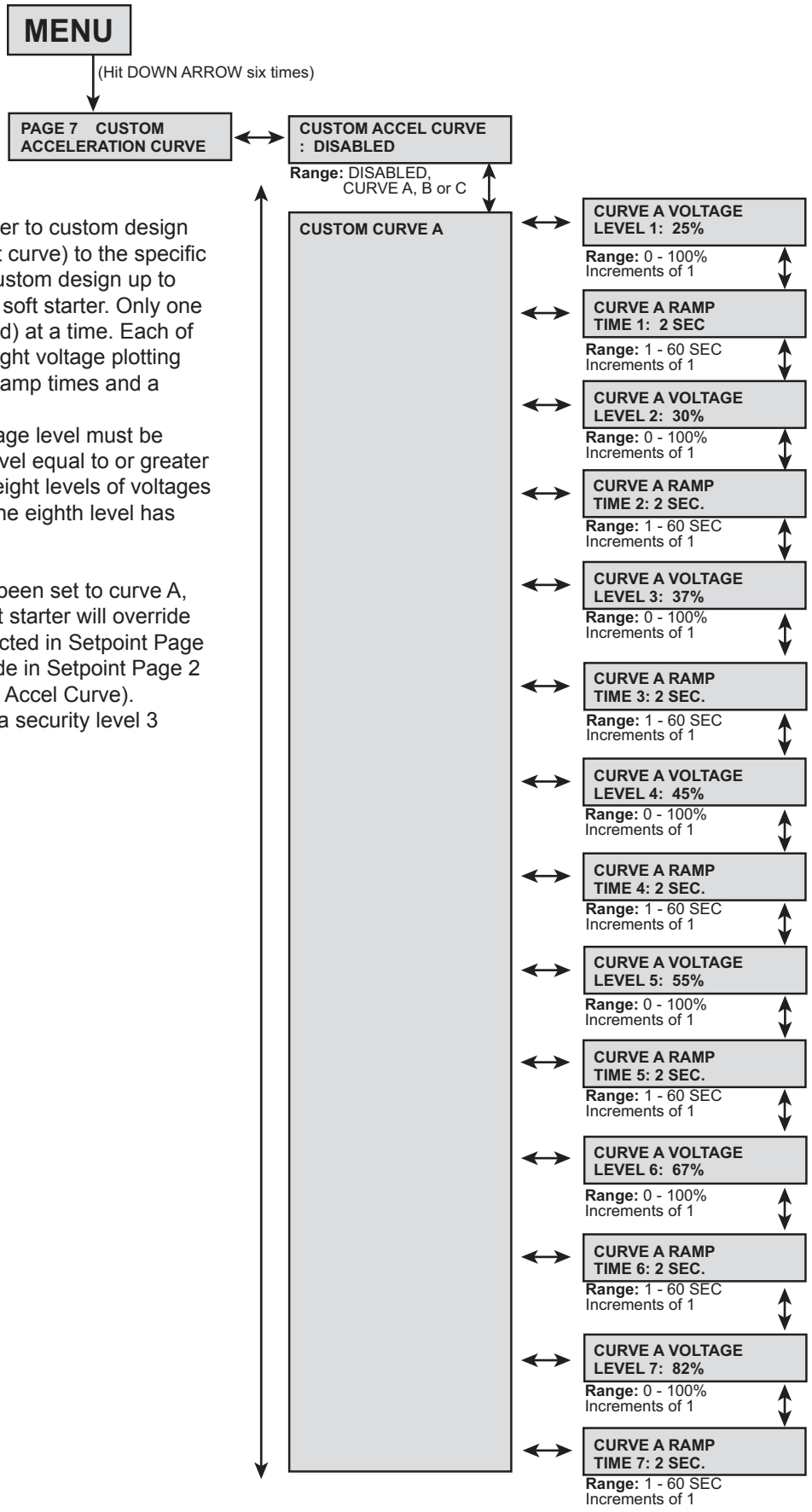
SP.6 User I/O Configuration (Setpoint Page 6)
(Security Level: 2)



SP6.5 User Programmable External Inputs: The controller provides up to 4 digital external inputs which are individually programmable. A description name can be assigned to each individual input for easy identification.

- **External Input #1:** Factory programmed for TCB Trip.
- **External Input #2:** If used, this setpoint must be enabled.
- **Name Ext. Input #2:** The user can assign a description name to the input to easily identify the cause of external trip or alarm. Up to 15 characters including spaces can be used to assign the name.
- **External Input #2 Type:** The external input can be set as either a normally open or normally closed contact.
- **External Input #2 Time Delay:** Upon a change in contact setting, the unit will wait the programmed amount of time before generating an output. If no delay is needed, then input 0 seconds. The controller will post an event upon seeing a change in state.
- **External Input #3**: The setup screens and setpoints for External Input #3 includes the option of being configured for Dual Ramp. In Dual Ramp mode, the initial contact setting is the same as the START RAMP #1. Upon a change in input contact state, the controller will switch over to START RAMP #2 and use that setting for start control mode. Note: The start RAMP types should only be switched while the motor is stopped. In Setpoint Page 4 Relay Assignments, do not assign any output relay to this function. The controller will ship with External input #3 programmed for dual ramp. If it is not needed, disable the dual ramp.
- **External Input #4**: This input screens are for the thermostat input and can be enabled or disabled. Note: It is recommended that this function remain enabled. If the thermostat indicates an over temperature condition, the controller will trip the motor.

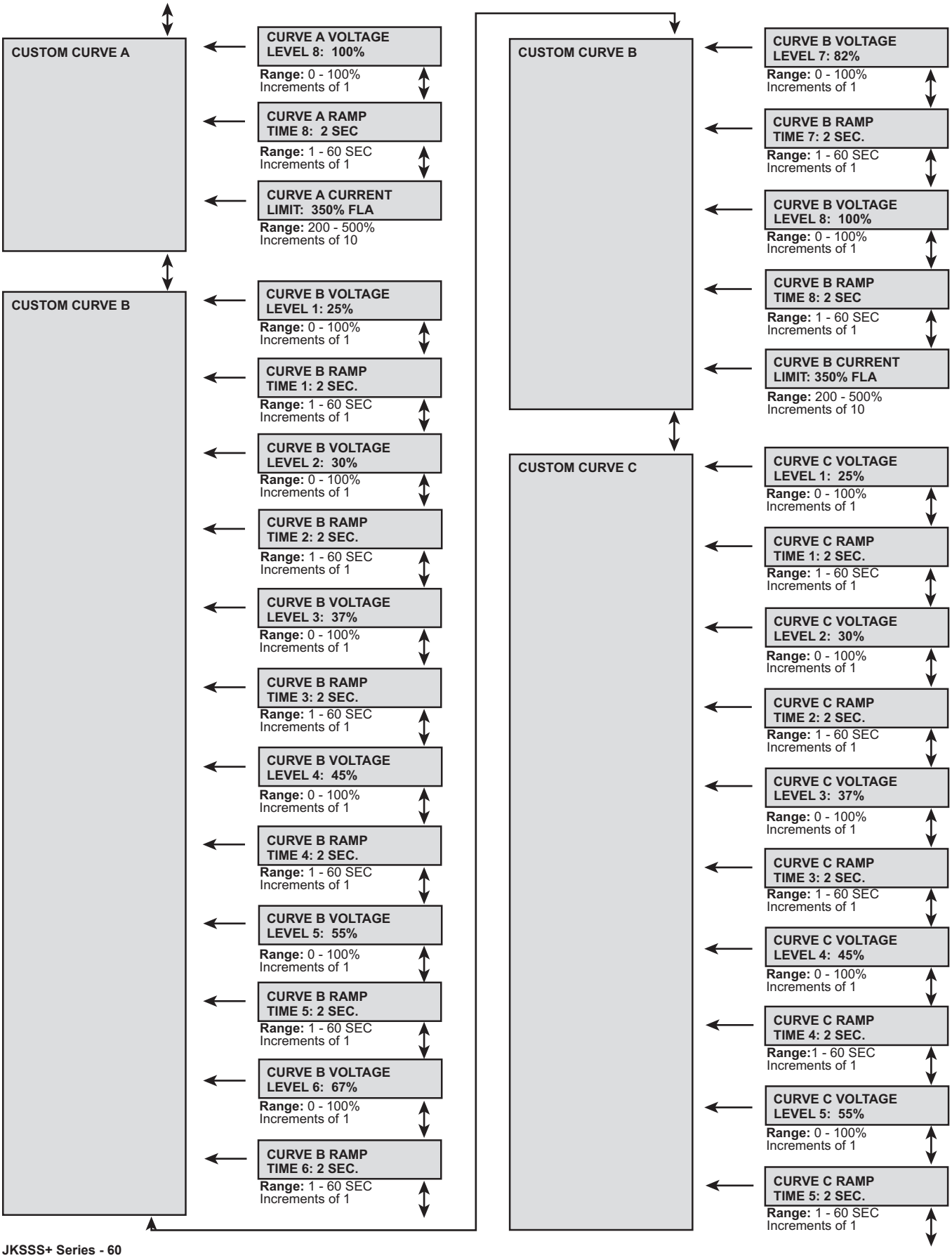
SP.7 Custom Acceleration Curve (Setpoint Page 7)
(Security Level: 3)



SP7.1 Setpoint Page 7 allows the user to custom design the acceleration curve (start curve) to the specific application. The user can custom design up to three different curves in the soft starter. Only one curve can be active (enabled) at a time. Each of the three curves allow for eight voltage plotting points, with corresponding ramp times and a current limit setting.
Note: Each successive voltage level must be programmed to a voltage level equal to or greater than the previous level. All eight levels of voltages must be programmed and the eighth level has been preset at 100%.

- If Custom Accel Curve has been set to curve A, B or C on this page, the soft starter will override the Start Control Mode selected in Setpoint Page 2, (even if Start Control Mode in Setpoint Page 2 has not been set to Custom Accel Curve).
  Note: Setpoint Page 7 has a security level 3 requirement.

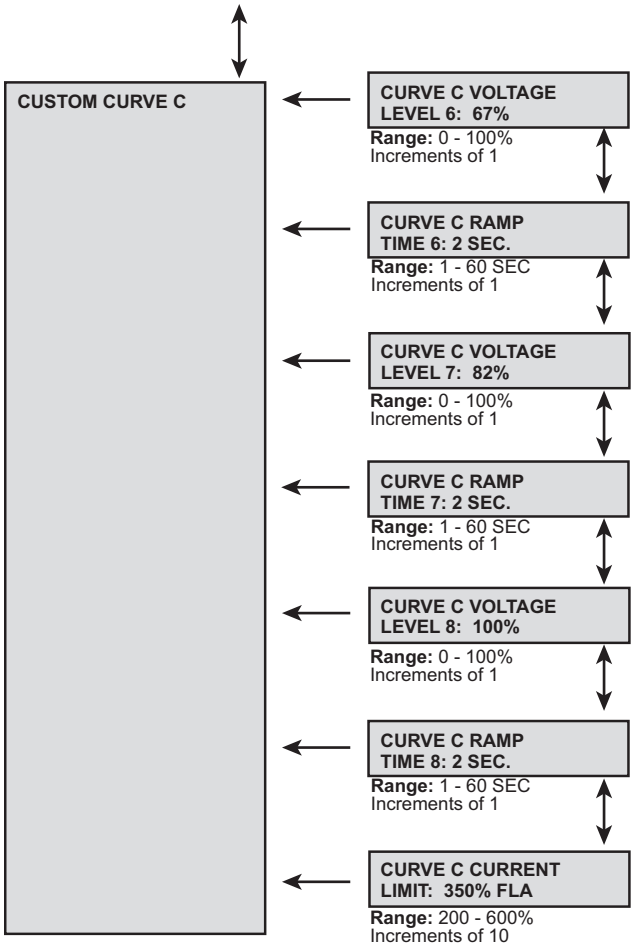
SP.7 Custom Acceleration Curve (Setpoint Page 7)
(Security Level: 3)



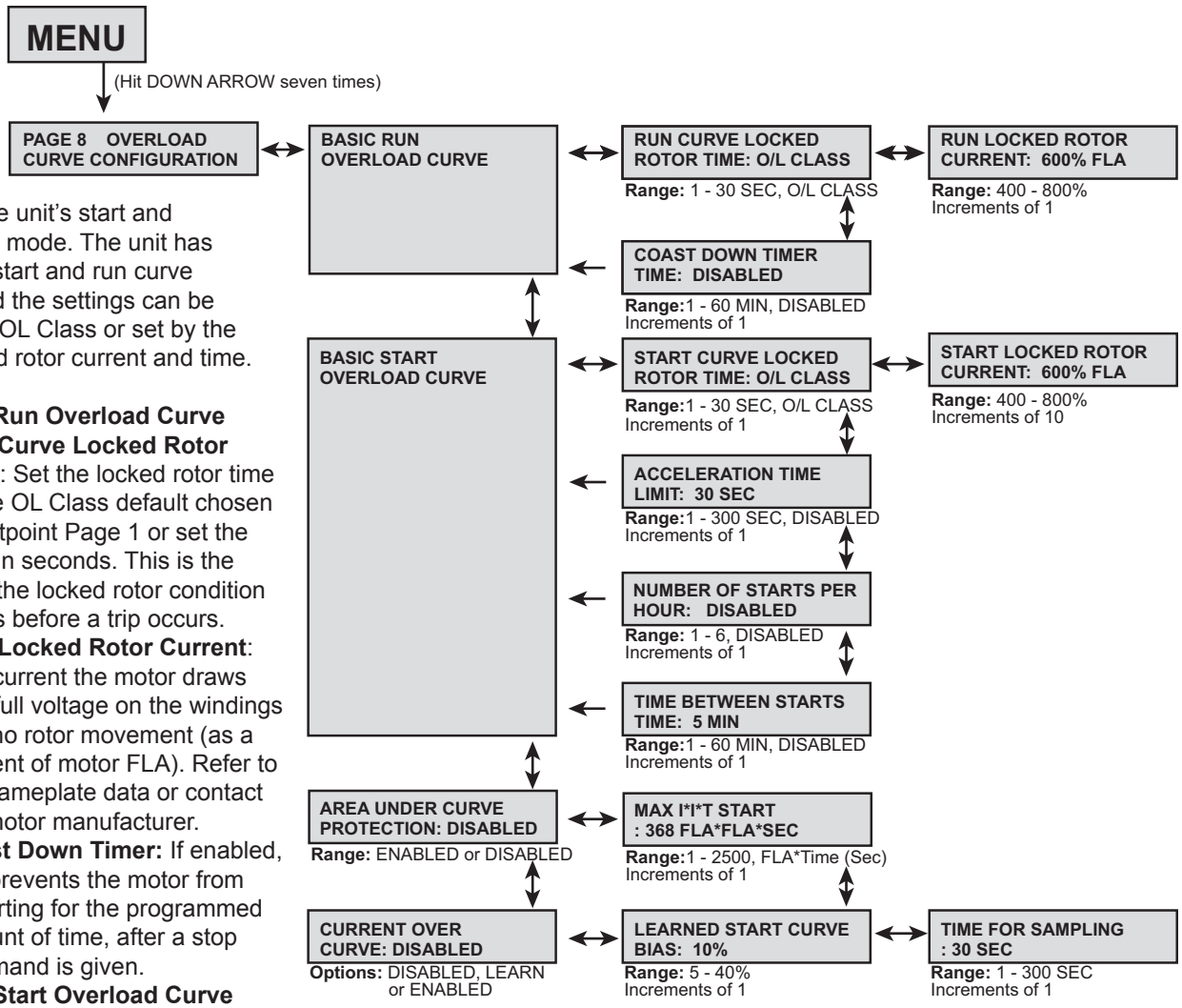
SP.7 Custom Acceleration Curve (Setpoint Page 7) (Security Level: 3)

SP7.1 Setpoint Page 7 allows the user to custom design the acceleration curve (start curve) to the specific application. The user can custom design up to three different curves in the soft starter. Only one curve can be active (enabled) at a time. Each of the three curves has eight voltage levels, with corresponding ramp times and a current limit setting.
Note: Each successive voltage level must be programmed to a voltage level equal to or greater than the previous level. All eight levels of voltages must be programmed and the eighth level has been preset at 100%.

- If Custom Accel Curve has been set to curve A, B or C on this page, the soft starter will override the Start Control Mode selected in Setpoint Page 2, (even if Start Control Mode in Setpoint Page 2 has not been set to Custom Accel Curve).
Note: Setpoint Page 7 has a security level 3 requirement.



SP.8 Overload Curve Configuration (Setpoint Page 8) (Security Level: 3)



Configures the unit's start and run protection mode. The unit has independent start and run curve protection and the settings can be based on the OL Class or set by the motor's locked rotor current and time.

SP8.1 Basic Run Overload Curve

- **Run Curve Locked Rotor Time**: Set the locked rotor time to the OL Class default chosen in Setpoint Page 1 or set the time in seconds. This is the time the locked rotor condition exists before a trip occurs.
- **Run Locked Rotor Current**: The current the motor draws with full voltage on the windings and no rotor movement (as a percent of motor FLA). Refer to the nameplate data or contact the motor manufacturer.
- **Coast Down Timer:** If enabled, this prevents the motor from restarting for the programmed amount of time, after a stop command is given.

SP8.2 Basic Start Overload Curve

- **Start Curve Locked Rotor Time:** The locked rotor time can be set to the OL Class default chosen in Setpoint Page 1 or to a specific time. The overload condition must exist for the programmed amount of time before a trip occurs.
- **Start Locked Rotor Current:** The current the motor draws with full voltage on the windings and no motor movement (as a percent of motor FLA). Refer to the motor nameplate data or contact the motor manufacturer.
- **Acceleration Time Limit**: If the motor does not enter run mode (reach at speed) within the preset time, the unit trips on acceleration time limit.
- **Number of Starts per hour:** If enabled, this limits the maximum number of starts permitted per hour. This setpoint allows a maximum of 6 starts per hour. Contact motor manufacturer.
- **Time Between Starts:** If enabled, the soft starter prevents another start attempt until the programmed time has expired.

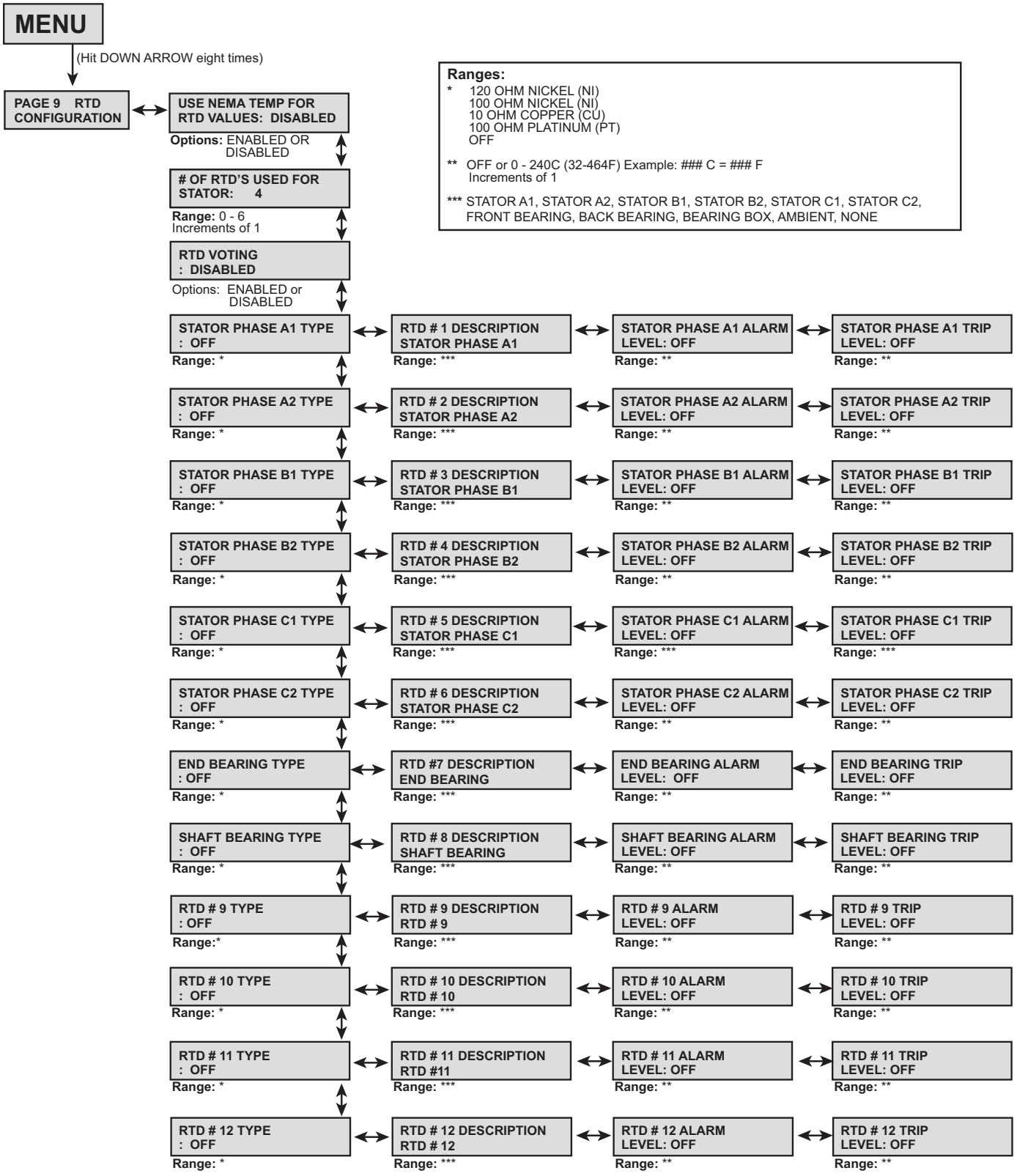
SP8.3 Area Under Curve Protection: If enabled, this secondary start protection uses both the basic start protection and the area under the curve protection.

- **Max I*I*T Start:** The maximum I^2T allowed during start. If the I^2T to start exceeds this number then the soft starter will generate a trip.

SP8.4 Current Over Curve: Learns the motor's starting characteristics and protects the motor based upon the learned curve. It is useful when commissioning a new motor.

- **Learn:** The unit reads the motor's starting characteristics. Start the motor and allow it to come to full speed. The start feedback enables the motor protection based on the learned start curve.
- **Learned Start Curve Basis:** The maximum allowed deviation above or below the start curve before a trip is generated.
- **Time for Sampling:** The time the soft starter continues to sample the start curve characteristic during learn the mode.

SP.9 RTD Optional Configuration (Setpoint Page 9)
(Security Level: 3)



SP.9 RTD Configuration (Setpoint Page 9) (Security Level: 3)

The soft starter comes with an RTD card that provides 12 programmable RTDs which are individually programmable for type. The available types are 100 ohm platinum, 100 ohm nickel, 120 ohm nickel and 10 ohm copper. Each RTD can be identified with a description name of up to 15 characters (including spacing). Also, each individual RTD has it own alarm and trip level.

SP9.1 Use NEMA Temp for RTD Value: When this setpoint is enabled, the soft starter will use the NEMA design insulation class to limit the maximum allowed range of the alarm and trip level. The maximum allowed temperature range is 240° C or (464°F).

SP9.2 # Of RTD'S Used for Stator: Up to six RTDs can be assigned to monitor the stator of the motor.

SP9.3 RTD Voting: When this is enabled, the soft starter will not post a trip until 2 RTD's have exceeded the trip level. This prevents nuisance RTD tripping.

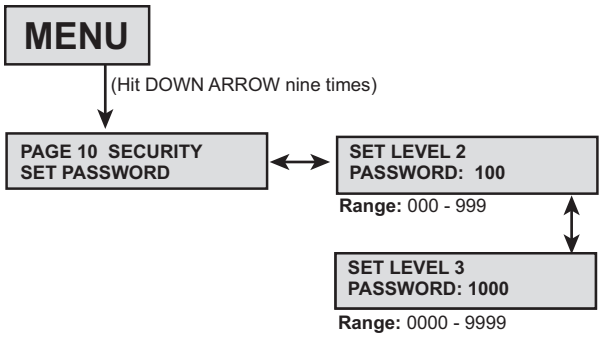
SP9.4 All 12 RTDs are configured in the following manner. The first column is the RTD type, the second column is the RTD description, the third column is the alarm level, and the fourth column is the trip level.
The first six RTDs have been pre-programmed with a description name for the STATOR, with two RTDs per phase. RTDs #1 & #2 have been named STATOR PHASE A1 and A2 respectively. RTDs #3 & 4 are named STATOR PHASE B1 and B2, RTDs #5 & 6 are named STATOR PHASE C1 and C2. If other description names are required, press the right arrow button from the RTD Type screen to go the RTD description screen. If no alarm or trip level is required these setpoints can be turned off.

SP.10 Set Password (Setpoint Page 10) (Security Level: 3)

The soft starter has three levels of user programmable setpoint screens. Level one setpoints do not require a password because the data contained in level one is basic nameplate data and starter control. Level two setpoint screens require a three-digit password to configure the protection schemes. Level three setpoint screens require a four-digit password to access the full range of protection and starter schemes.

SP10.1 Set Level 2 Password: This level uses a 3-digit password. The default level 2 password is 100.

SP10.2 Set Level 3 Password: Level three uses a 4-digit password. The default level 3 password is 1000.



SP.11 Communications (Setpoint Page 11) (Security Level: 3)

SP11.1 Set Front Baud Rate: Configures the RS232 communications baud rate.

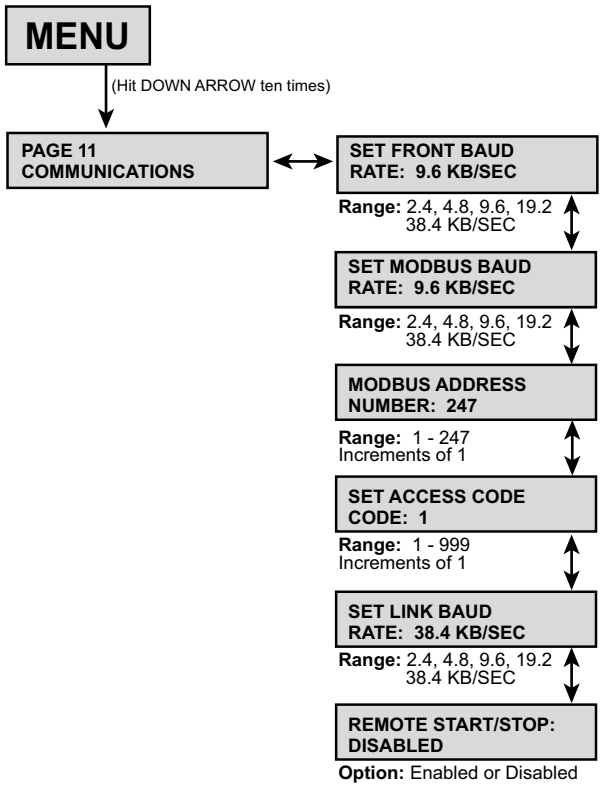
SP11.2 Set Modbus Baud Rate: Configures the Modbus communications baud rate.

SP11.3 Modbus Address Number: Assigns a Modbus address to the soft starter relay.

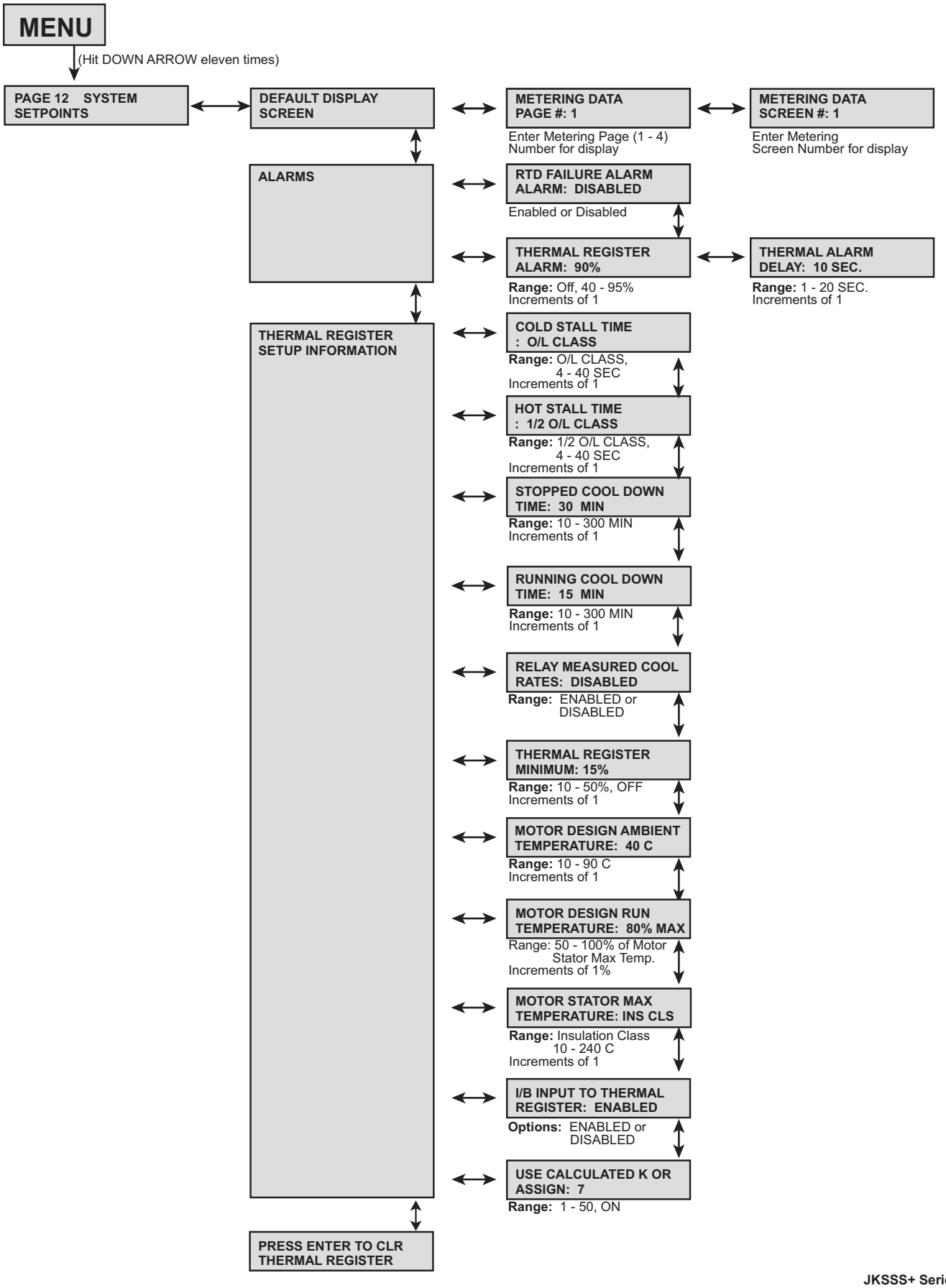
SP11.4 Set Access Code: Assigns an access code to the Modbus addressing. This is typically not used.

SP11.5 Set Link Baud Rate: Configures the RS422 communications baud rate between the keypad operator and the CPU board. (For applications with remote keypad only.)

SP11.6 Remote Start/Stop: Allows the RS485 Modbus communications to start and stop the motor. Contact factory for details.



SP.12 System Setpoints (Setpoint Page 12) (Security Level: 3)



SP.12 System Setpoints (Setpoint Page 12) (Security Level: 3)

SP12.1 Default Display Screen: This setpoint group allows the user to choose the default screen the soft starter displays while the motor is running. Select the metering page number (1-3), then select the metering screen number. The range varies depending on the selected page. To display a default screen, program the following two setpoints:

- **Metering Data Page#**: Range is Page 1 - 3.
- **Metering Data Screen#**: If Page 1 is selected as the default page, then Screens 1- 10 are available. If Page 2, Screens 1-29 are available. If Page 3 is selected, then Screens 1-6 are available. (See Metering Menu, MP.1, for screen number assignment.)

SP12.2 Alarms: Configures the RTD failure alarm and the thermal register alarm.

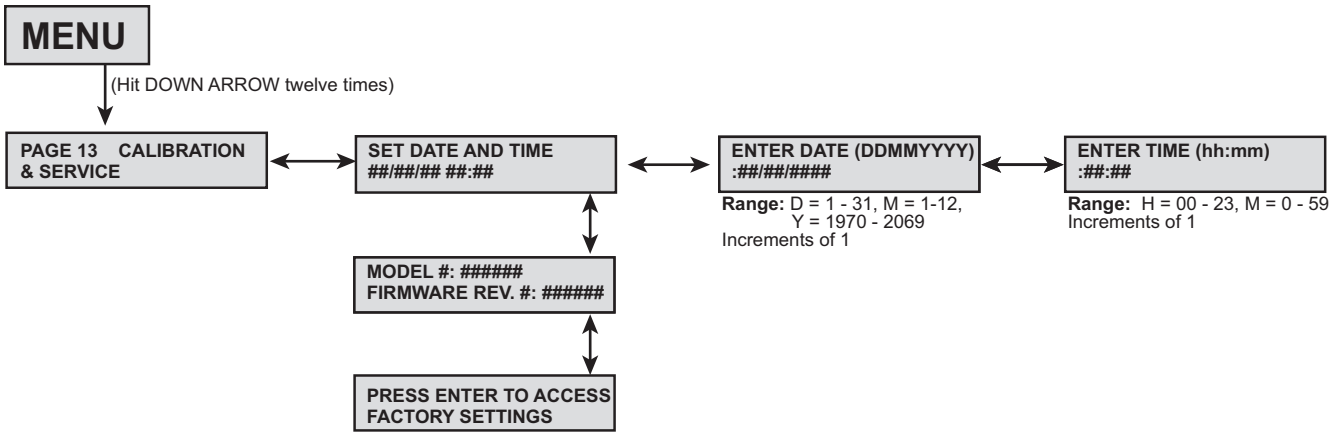
- **RTD Failure Alarm:** If enabled, and an RTD shorts or open, an alarm occurs.
- **Thermal Register Alarm:** Sets a level in the thermal register to generate an alarm when the Thermal Register Capacity Used has exceeded this level.
- **Thermal Alarm Delay:** The amount of time that the Thermal Register Used must exceed the setpoint before an alarm condition will occur.

SP12.3 Thermal Register Setup Information: This setpoint group will configure the thermal register and indicate to the soft starter which inputs to use when thermal modeling.

- **Cold Stall Time:** Enter the time from the motor manufacturer's specification sheet or use the time defined by the OL Class. This setpoint is used to define the thermal capacity of the motor.
- **Hot Stall Time:** Enter the amount of time specified by the motor manufacturer or use half of the time defined by the OL Class.
- **Stopped Cool Down Time**: The time the motor requires to cool down after it has stopped. Use only the data provided by the motor manufacturer. This setpoint is used to configure the cooling rate of the thermal register.
- **Running Cool Down Time:** The amount of time the motor requires for cooling down while running. Use only the data provided by the motor manufacturer.
- **Relay Measured Cool Rates:** When RTDs are used, the soft starter can be configured to use the measured cool rates from the RTDs instead of the programmed settings. This setpoint should only be enabled when RTDs are present.
- **Thermal Register Minimum:** Sets the value in the thermal register which represents a motor running at the nameplate current (with no overheating or negative sequence currents present).
- **Motor Design Ambient Temperature:** Use the data from the motor manufacturer's specifications. When RTDs are used, this setpoint will be the base point for the RTD biasing of the Thermal Register.
- **Motor Design Run Temperature:** Use the data from the motor manufacturer's specifications. This setpoint defines the operating temperature rise of the motor at full load amps or 100% load.
- **Motor Stator Max Temperature:** This represents the maximum temperature the stator insulation will withstand. The user may choose to use the temperature setting of the insulation class (selected in Setpoint Page 1) or enter a specific maximum temperature. This value should not exceed the stator's insulation temperature. This maximum temperature represents 100% thermal capacity.
- **U/B Input to Thermal Register:** Always enabled. It allows the soft starter to use the line current imbalance information to bias the Thermal Register.
- **User Calculated K or Assign:** When the setpoint is set to ON the controller will calculate the k constant factor for biasing the thermal register, or the user may choose to assign the k value.

SP12.4 Press Enter to CLR Thermal Register: Allows the level three password user to clear the thermal register for emergency restarts.

SP.13 Calibration & Service (Setpoint Page 13)
(Security Level: Factory Use Only)



SP.13 Calibration & Service (Setpoint Page 13)

Certain screens are displayed for user information only, such as: Current date and time, Model number and Firmware revision number. Setpoint changes in this page will only be accessible to factory personnel.

SP13.1 Set Date and Time: Displays the date and time.

- **Enter Date (DDMMYYYY)**: Allows the factory personnel to program the date for the soft starter in the format shown.
- **Enter Time (hh:mm)**: Allows the factory personnel to program the time for the soft starter.

SP13.2 Model & Firmware #: Displays the model number and firmware revision in the soft starter.

SP13.3 Press Enter to Access Factory Settings: Available to qualified personnel.

Chapter 6 - Metering Pages

The soft starter offers performance metering which gives the user the ability to view information about the motor and the ***JKSSS+*** unit.

6.1 Metering Page List

The following charts list each Metering Page and the functions within that page. The applicable section of the manual is also referenced.

6.1.1 Metering Menu & Data (Metering Page 1)

Metering Page	Description of Display	Screen
Page 1 Metering Menu & Data	Phase A, B, C and Ground Fault (Option)	1
	Average current of the % of imbalance and the motor's RPM	2
	Motor load as a percentage of motor FLA	3
	Line frequency and present phase sequence	4
	Percentage of remaining Thermal Register	5
	Thermal capacity required to start the motor	6
	Average time required to start	7
	Average current during start	8
	Measured I^2T required to start the motor	9
	Amount of time required to start the motor during the last successful start	10

6.1.2 Metering (Metering Page 2)

Metering Page	Description of Display	Screen
Page 2 Metering	Phase A, B, C currents and Power Factor	1
	Phase A, B, C currents and Ground Fault (Option)	2
	Displays kW and kVA	3
	Displays kVAR and Power Factor	4
	Displays Peak ON and kW Demand	5
	Displays Peak ON and kVA Demand	6
	Displays Peak ON and kVAR Demand	7
	Displays Peak ON and Amps Demand	8
	Clears Demand values	9
	Displays Megawatt hours used	10
	Press enter to clear statistics on MWH values	11

6*.1.3 RTD Values (Metering Page 3)*

Metering Page	Description of Display	Screen
Page 3 RTD Values	Hottest stator RTD (#1 - 6)	1
	Hottest non-stator RTD (#7 - 12)	2
	Temperature of start phase A1 in °C and °F	3
	Maximum temperature for RTD #1	4
	Same as Screens 3 - 4 for RTDs #2 - 12	5 - 26
	Clear the maximum temperature register (Level 3 password required)	27
	Measured running thermal stabilization time of motor (in minutes)	28
	Measured stopped cooling time (to ambient) of motor (in minutes)	29

6.1.4 Status (Metering Page 4)

Metering Page	Description of Display	Screen
Page 4 Status	Current status	1
	Amount of time remaining before an overload trip occurs	2
	Amount of time remaining from a thermal inhibit signal	3
	Coast down time remaining	4
	Amount of time remaining before a start command can be given	5
	Excessive number of starts per hour	6

6.1.5 Event Recorder (Metering Page 5)

Metering Page	Description of Display	Screen
Page 5 Event Recorder	Displays the event with date and time (Up to 60 events)	1
	Displays Phase A, B, C current values, Ground Fault (Option) at time of trip	1A
	Displays Vab, Vbc, Vca and Power Factor at time of trip	1B

6.1.6 Last Trip (Metering Page 6)

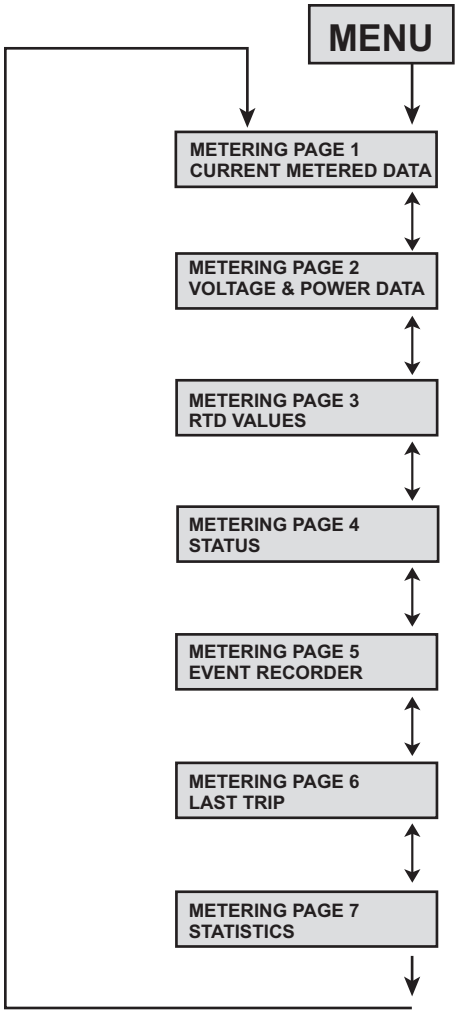
Metering Page	Description of Display	Screen
Page 6 Last Trip	Cause of last trip	1
	Measured phase current	2
	Measured voltage and power factor	3
	Imbalance percentage, the frequency and the kW	4
	Hottest stator RTD temperature	5
	Hottest non-stator RTD temperature	6

6.1.7 Statistics (Metering Page 7)

Metering Page	Description of Display	Screen
Page 7 Statistics	Total megawatt hours	1
	Accumulated total running hours	2
	Clear the total running hour count	3
	Total number of trips	4
	Number of start and run overload trips since the last statistical data clearing	5
	Number of frequency trips and imbalance trips	6
	Overcurrent trips	7
	Stator and non-stator RTD trips	8
	Ground fault hiset and loset trips	9
	Acceleration time trips	10
	Start under curve trips	11
	Start over curve trips	12
	I^2T start curve trips	13
	Learned start curve trips	14
	Fail shunt trip trips	15
	Phase loss trip trips	16
	Tach accel trip trips	17
	Undervoltage and Overvoltage trips	18
	Power Factor trips	19
	Phase reversal trips	20
	Ext Inp #1	21
	Ext Inp #2	22
	Ext Inp #3	23
	Ext Inp #4	24
	Press enter to clear statistics	25

6.2 Metering Menu

Push MENU key to toggle the screens between Setpoint Menu and Metering Menu and follow the arrow keys to get to different screens.



MP.1 Metering Data (Metering Page 1)

Displays the basic current metering data:

Screen 1: Phase A, B, C and ground fault (option) current.

Screen 2: Displays the average current, percent of imbalance and the motor's RPM (available with tachometer input)

Screen 3: Displays the motor load in percent of motor FLA.

Screen 4: Displays the line frequency and the present Phase Order.

Screen 5: Displays the percent of the remaining thermal register. In order for the motor to successfully start, the percentage must be greater than the thermal capacity required for a successful start.

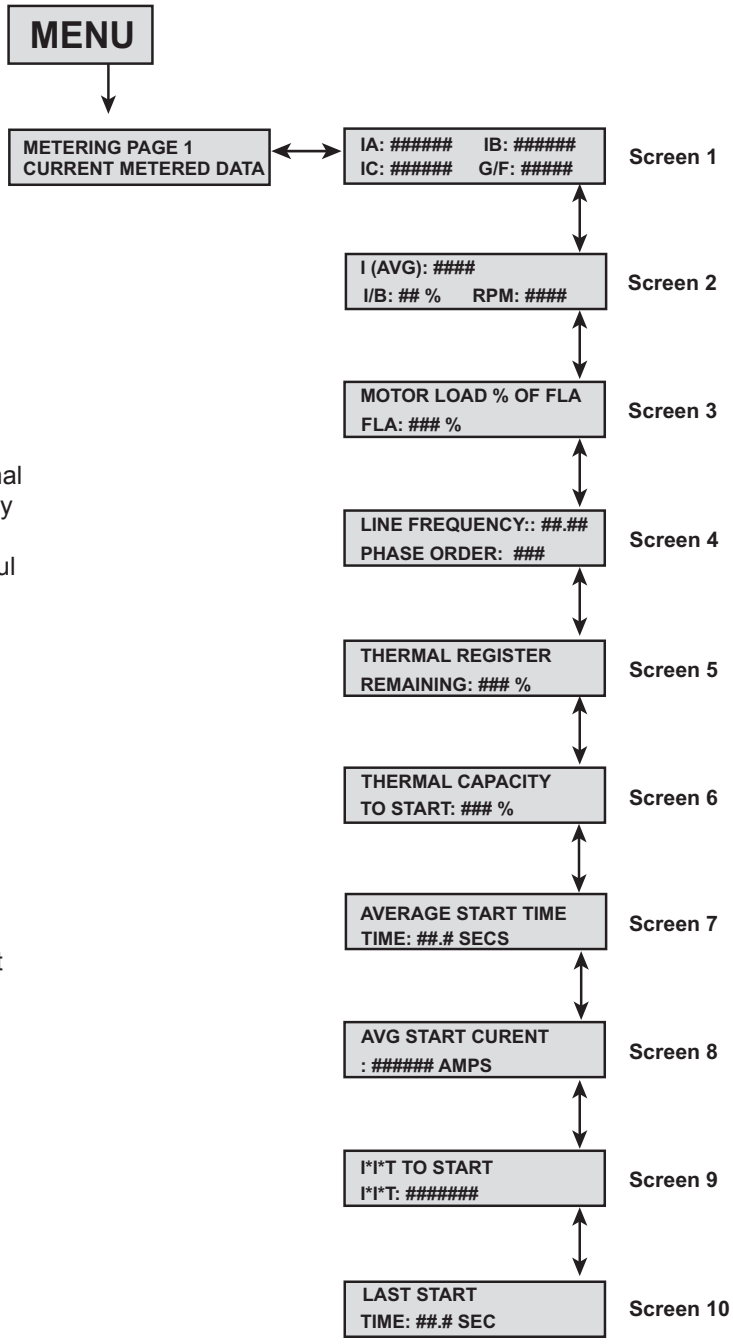
Screen 6: Displays the thermal capacity required to successfully start the motor.

Screen 7: Displays the average time required to start.

Screen 8: Displays the average current during start.

Screen 9: Displays the measured I^2T required to start the motor.

Screen 10: Displays the amount of time required to start the motor during the last successful start.



MP.2 Metering (Metering Page 2)

Displays the statistical voltage metering information.

Screen 1: Displays Phase A, B, C and Power Factor.
Note: P/F: N/A Motor stopped
P/F: LG #.## (Lagging)
P/F: LD #.## (Leading)

Screen 2: Displays Phase A, B, C and Ground Fault Current.

Screen 3: Displays KW and KVA.

Screen 4: Displays KVAR and Power Factor.

Screen 5: Displays Peak On and KW demand.

Screen 6: Displays Peak On and KVA demand.

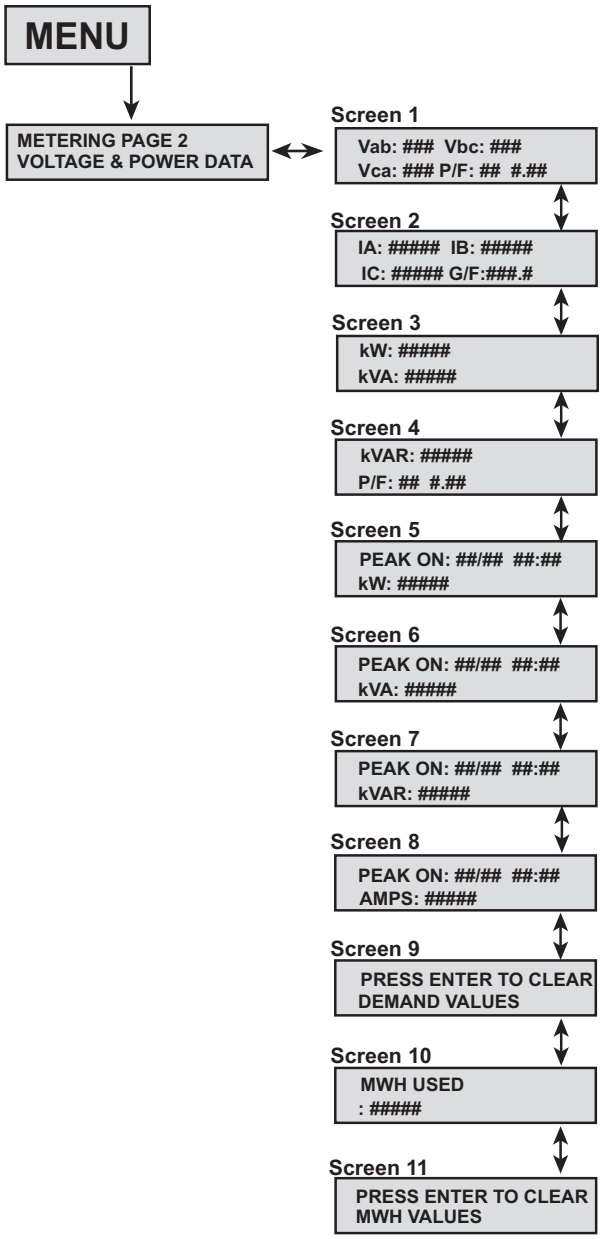
Screen 7: Displays Peak On and KVAR demand.
Note: P/F: N/A Motor stopped
P/F: LG #.## (Lagging)
P/F: LD #.## (Leading)

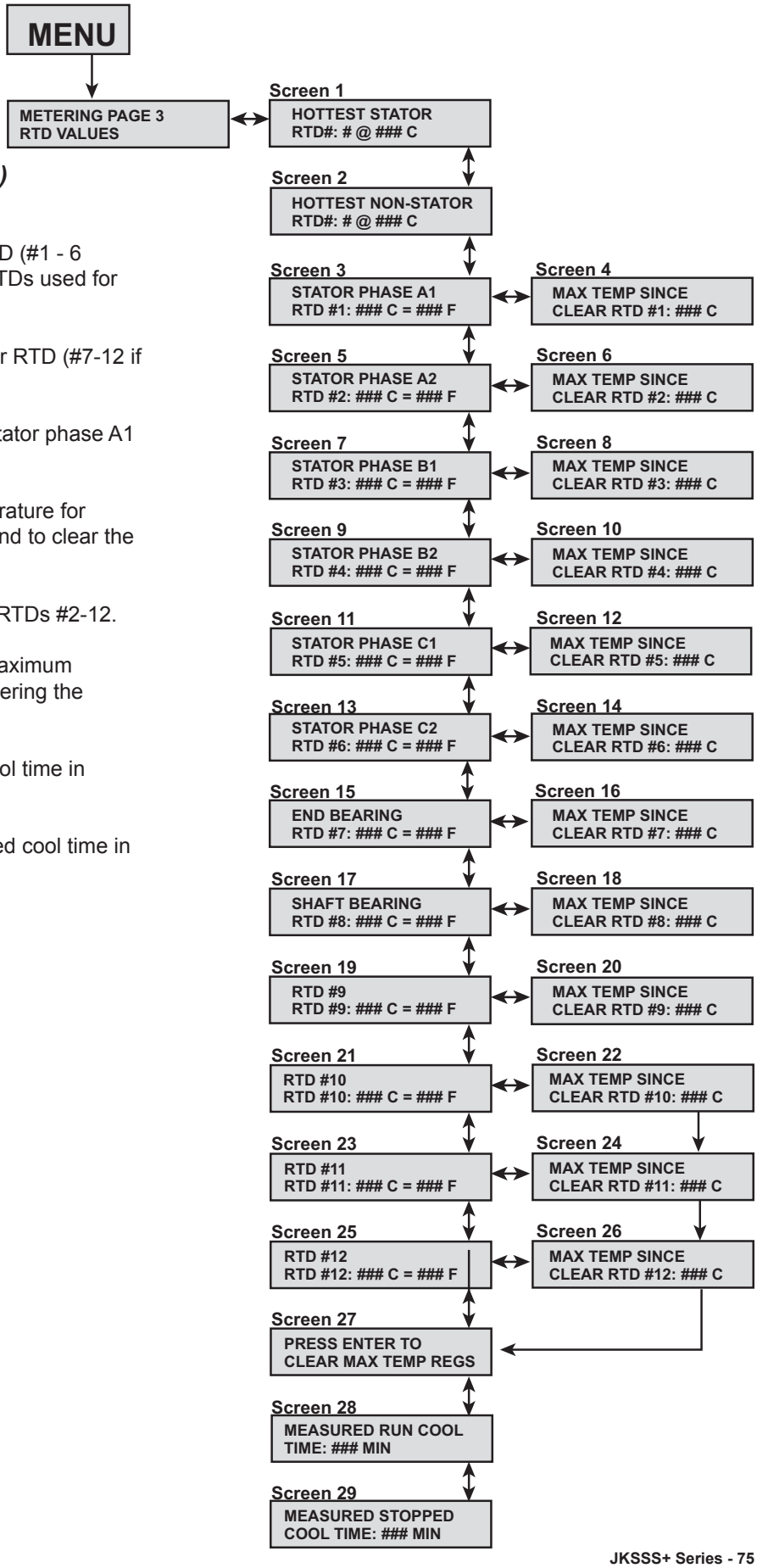
Screen 8: Displays Peak On and Amps demand.

Screen 9: Clears Demand Values.

Screen 10: Displays the Megawatts used per hour.

Screen 11: Press Enter to clear statistics on MWH values.





MP.3 RTD Values (Metering Page 3)

Displays the RTD information.

Screen 1: Displays the hottest stator RTD (#1 - 6 depending upon number of RTDs used for stator).

Screen 2: Displays the hottest non-stator RTD (#7-12 if #1-6 is used for stator).

Screen 3: Displays the temperature of stator phase A1 in °C and °F.

Screen 4: Displays the maximum temperature for RTD #1 since the last command to clear the thermal register.

Screen 5 - 26: Same as Screens 3 - 4 for RTDs #2-12.

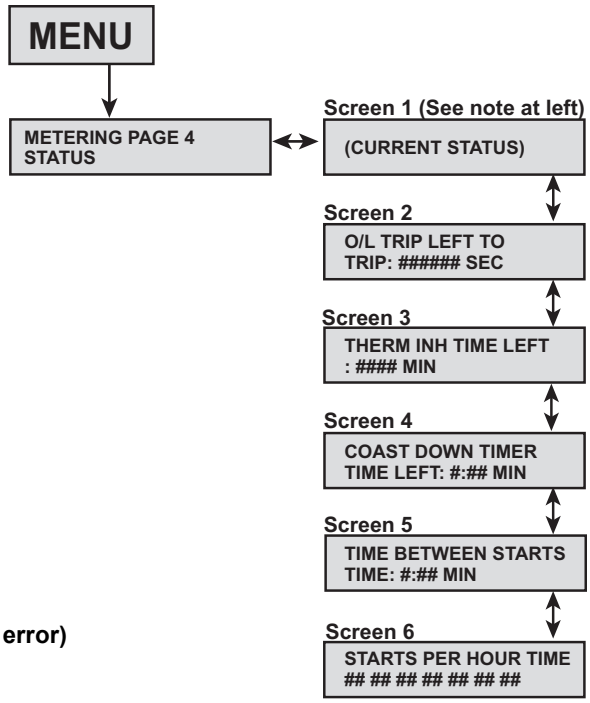
Screen 27: Allows the user to clear the maximum temperature register upon entering the setpoint level 3 password.

Screen 28: Displays the measured run cool time in minutes.

Screen 29: Displays the measured stopped cool time in minutes.

MP.4 Status (Metering Page 4)

Displays the present status of the soft start.



Screen 1: Displays the present state of the unit as follows:

Screen 1 Note:
CURRENT STATUS Screens include:

1. **MOTOR STOPPED READY TO START**
2. **MOTOR STARTING MULT. OF FLA**
3. **MOTOR RUNNING AT ###.## X FLA**
4. **LAST TRIP CAUSE NONE (or trip cause)**
5. **PROGRAMMING SETPOINTS**
6. **MOTOR STATUS UNKNOWN STATE ###** **(displays relay state upon error)**

Screen 2: Displays the amount of time remaining before an overload trip will occur.

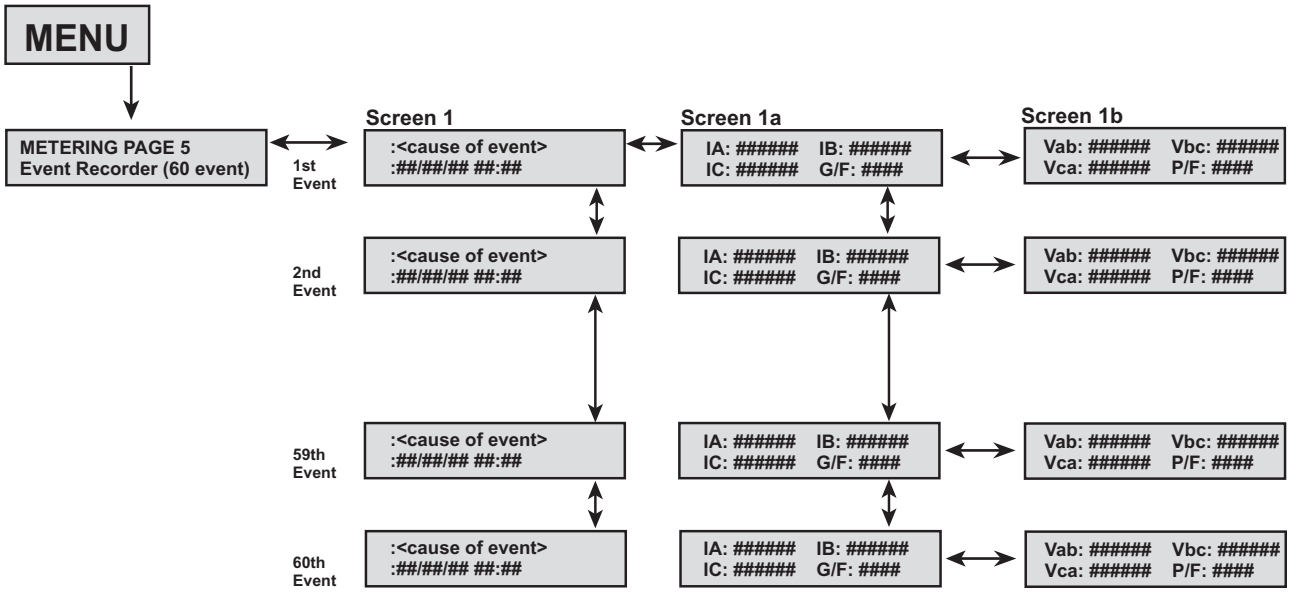
Screen 3: Displays the amount of time remaining from a thermal inhibit. The inhibit time comes from the amount of thermal register remaining versus the amount of thermal capacity required to start.

Screen 4: Displays the coast down time remaining (Backspin time). The time remaining depends upon the user setting in Setpoint Page 8, Coast Down Time.

Screen 5: Displays the amount of time remaining before a start command can be given.

Screen 6: If the number of starts per hour has exceeded the setting.

MP.5 Event Recorder - 60 Events (Metering Page 5)



All events will be viewed from oldest event in buffer to most recent event.

The events are listed from oldest to most recent.

Screen 1: Displays the event (i.e. Imbalance Trip) with the date and time it occurred.

Screen 1a: Displays the current of Phase A, B, C and the ground fault at the time of the trip.

Screen 1b: Displays the Vab, Vbc, Vca and power factor at the time of trip.

MP.6 Last Trip (Metering Page 6)

Displays the information regarding the last trip.

Screen 1: Displays the cause of the last trip.

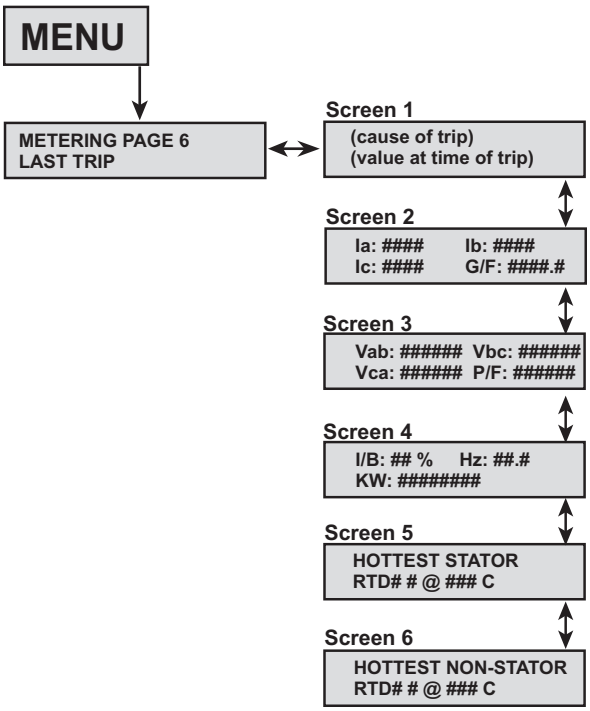
Screen 2: Displays the measured phase current at the time of the trip.

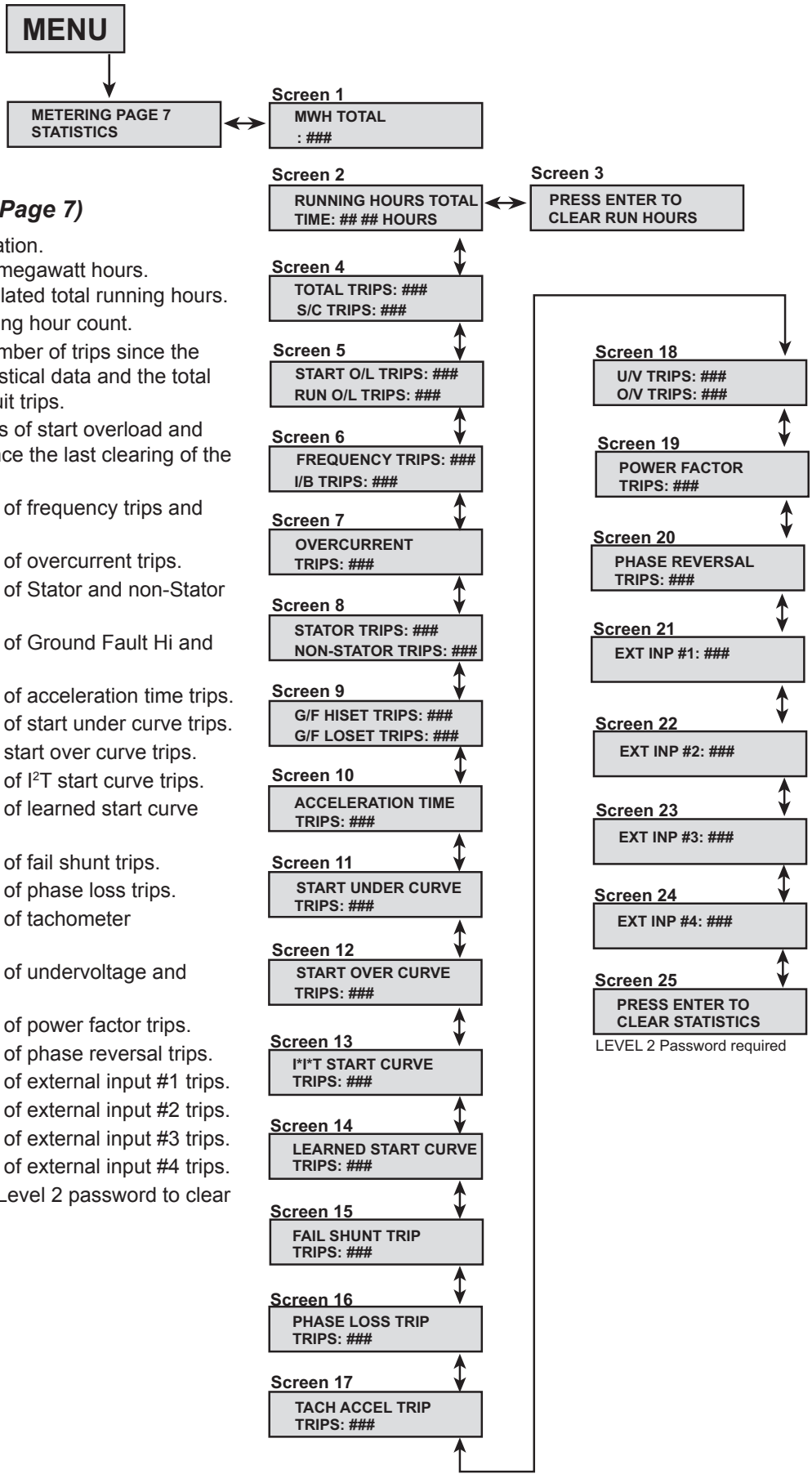
Screen 3: Displays the Vab, Vbc, Vca and power factor at the time of trip.

Screen 4: Displays the imbalance percentage, the frequency and the kW at the time of the trip.

Screen 5: Displays the hottest stator RTD temperature at time of the trip.

Screen 6: Displays the hottest non-stator RTD temperature at the time of the trip.





MP.7 Statistics (Metering Page 7)

Displays the statistical trip information.

Screen 1: Displays the total of megawatt hours.

Screen 2: Displays the accumulated total running hours.

Screen 3: Clears the total running hour count.

Screen 4: Displays the total number of trips since the last clearing the statistical data and the total number of short circuit trips.

Screen 5: Displays the numbers of start overload and run overload trips since the last clearing of the statistical data.

Screen 6: Displays the number of frequency trips and Imbalance trips.

Screen 7: Displays the number of overcurrent trips.

Screen 8: Displays the number of Stator and non-Stator RTD Trips.

Screen 9: Displays the number of Ground Fault Hi and Lo Set trips.

Screen 10: Displays the number of acceleration time trips.

Screen 11: Displays the number of start under curve trips.

Screen 12: Displays the number start over curve trips.

Screen 13: Displays the number of I^2T start curve trips.

Screen 14: Displays the number of learned start curve trips.

Screen 15: Displays the number of fail shunt trips.

Screen 16: Displays the number of phase loss trips.

Screen 17: Displays the number of tachometer acceleration trips.

Screen 18: Displays the number of undervoltage and overvoltage trips.

Screen 19: Displays the number of power factor trips.

Screen 20: Displays the number of phase reversal trips.

Screen 21: Displays the number of external input #1 trips.

Screen 22: Displays the number of external input #2 trips.

Screen 23: Displays the number of external input #3 trips.

Screen 24: Displays the number of external input #4 trips.

Screen 25: Requires a Security Level 2 password to clear the statistics.

Chapter 7 - Maintenance and Troubleshooting

The soft starter is designed to be a maintenance-free product. However, as with all electronic equipment, 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. According to the manufacturer's manual, check the contactor for air gap spacing of the vacuum bottles.

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.

7.1 - Failure Analysis

When a fault occurs, the LCD will display the fault error and the listed LED and AUX Relay will be lit. Please clear all faults before attempting to restart the unit. ***Note: If the problem persists after the required programming changes have been made, and all corrective action has been taken, please contact the factory for assistance.***

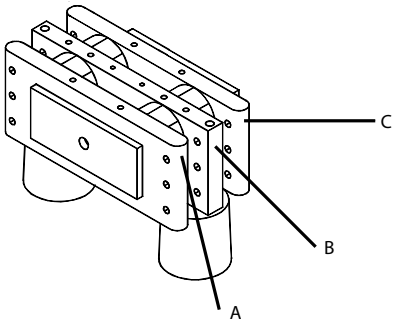
Problem	CPU LCD Display	LED	Aux Relay	Possible Cause	Solutions
One of the main fuses blows or circuit breaker opens when the power is applied or disconnect is open	**TCB FAULT TRIP**	Trip	AUX1	Short circuit between the inputs	Locate and remove short
				Faulty SCRs	Remove power and test SCR(s). Refer to Section 7.1.1 for the SCR testing procedure
Short Circuit Trip	**SHORT CIRCUIT TRIP**	Trip	AUX1	Short circuit or ground fault in motor/cabling	Locate and remove short or ground
				Phase Loss	Repair cause of phase loss
				Branch circuit protection not correctly sized	Verify correct sizing of branch circuit protection
				Faulty main circuit board	Remove power and replace main circuit board.
				Faulty SCRs	Remove power and test SCR(s). Refer to Section 7.1.1 for the SCR testing procedure
Single Phase Trip	**SINGLE PHASE TRIP (Check LCD display for possible fault indicators)**	Trip	AUX1	Single phase incoming power	Correct problem with incoming power
				Faulty SCRs	Remove power and test SCR(s). Refer to Section 7.1.1 for the SCR testing procedure
Thermostat trips during run	**EXTERNAL TRIP ON THERMOSTAT**	Trip	AUX1	Fan(s) not functioning (If supplied)	If fans have power, remove power and replace fan(s). If fans do not have power, find cause of power loss and repair.
				Heatsink coated with dirt	Remove power and clean heatsink with high pressure air (80 - 100 psi max clean and dry air)
				Overcurrent on unit	Verify that running current does not exceed unit rating
				Environment temperature over 122° F (ambient temperature for chassis units) or over 104°F (ambient temperature for enclosed version	Place unit in environment temperature less than 122°F for panel version or less than 104°F for enclosed version.
				Bypass failed to close	Check bypass contactor and wiring

Problem	CPU LCD Display	LED	Aux Relay	Possible Cause	Solutions
Phase Loss	**PHASE LOSS**	Trip	AUX1	Loss of 1 or more phases of power from utility or generated power	Check power source
				Blown power fuses	Check for short circuits
Overload	**OVERLOAD TRIP**	Trip	AUX1	Improper programming	Check motor nameplate versus programmed parameters
				Possible load damage or jammed load	Check motor currents
Stall prevention	**ACCEL TIME TRIP**	Trip	AUX1	Improper setting for motor load condition	Verify current limit setting
				Damaged load	Check for load failure
Under Voltage Trip	**UNDER VOLTAGE TRIP**	Trip	AUX1	Improper programming	Check setpoint settings
				Wrong position of disconnected breaker	Check disconnect or open breaker
				Main contactor failed to close	Check internal connections
				Transformer too small	Reduce current limit setting, saturation or sagging power supply transformer
Under Current Trip	**UNDER CURRENT TRIP**	Trip	AUX1	Improper programming	Check setpoint settings
				Unloaded motor	Check load
Self-test Failure	**SELF-TEST FAILURE**	Trip	AUX1	Failed CPU or Main Firing Board	Contact factory
				Vibration	Check internal wiring connections
Line Frequency Trip	**OVER OR UNDER FREQUENCY TRIP**	Trip	AUX1	Generator Power Problem or grid change	Troubleshoot and repair generator
					Contact utilities company
					Main board failure
					Three phase power removed from Main Board
Any Ground Fault Trip	**GROUND FAULT HI-SET OR LO-SET**	Trip	AUX1	Improper programming	Check program setpoints
				Any wire going to ground (I.e. stator ground, motor ground, soft start ground)	Check with megger or Hi-pot motor leads and motor
				High vibration or loose connections	Check internal connections
Motor stopped during run	Check for fault indication	Trip	AUX1	**Warning:** This is a serious fault condition. Ensure that the fault condition is cleared on the load before attempting to restart the motor.	
				Load shorted/ grounded/ faulted	Remove power and repair.
				Faulty main circuit board	Replace the main circuit board
Control circuit fuses blow after control power is applied.	None	None	None	Short in control circuit	Remove power, locate and remove this short
				Wrong control voltage	Apply the correct voltage to the control circuit

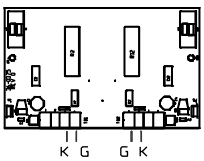
Problem	CPU LCD Display	LED	Aux Relay	Possible Cause	Solutions
Motor will not start	Any fault indication message	Trip	AUX1	No control voltage applied to control board	Apply control voltage to TB1 pins 1 and 6 on the power board
				Control power transformer failure or CPT fuse failure	Remove power and replace the power transformer or the CPT fuse
				Start circuit wired incorrectly	Remove power and correct the start circuit wiring
				No start command	Apply the start command
				No 3 phase line voltage	Apply 3 phase line voltage to the unit
				Shorted SCR in starter	Remove power and test SCR(s). Refer to Section 7.1.1 for the SCR testing procedure
				Faulty control logic	Remove power and repair the control logic.
				Failure of main circuit board	Replace the main circuit board
Motor vibrates/ Motor growls while starting or extremely unbalanced motor currents run mode	**IMBALANCE TRIP IMBALANCE ALARM**	Trip	AUX1	Faulty motor	Check the motor and the motor connections
				Faulty SCRs	Remove power and perform the SCR device checks
				Faulty gate/cathode on SCRs	Remove power and test SCR(s). Refer to Section 7.1.1 for the SCR testing procedure
				Faulty main circuit board	Replace the main circuit board
		Alarm	AUX2	Faulty motor/wiring	Troubleshoot and repair/replace wiring
				Faulty main circuit board	Replace the main circuit board

7.1.1 - SCR Testing Procedure

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



Gate Drive Board

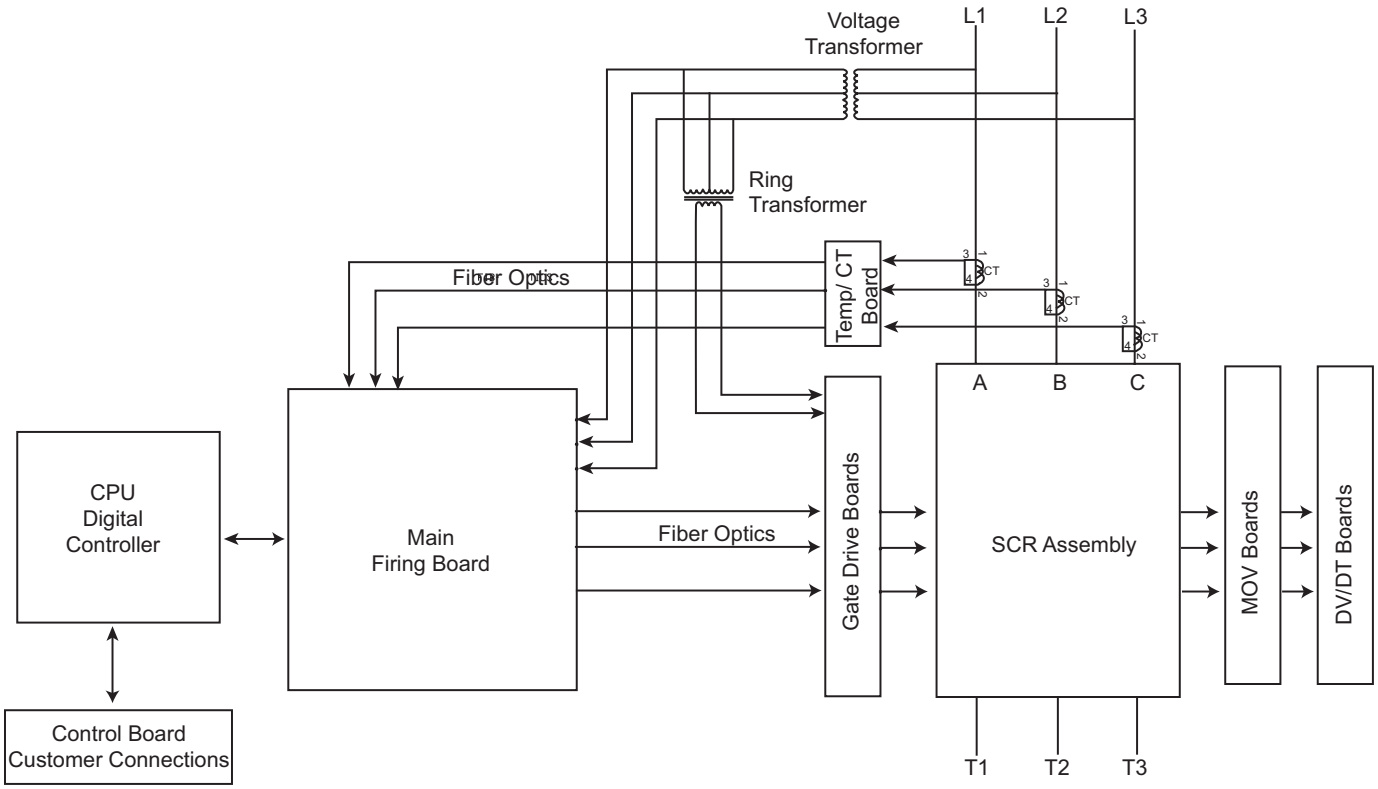


K = Cathode = Red Wire
G = Gate = White Wire

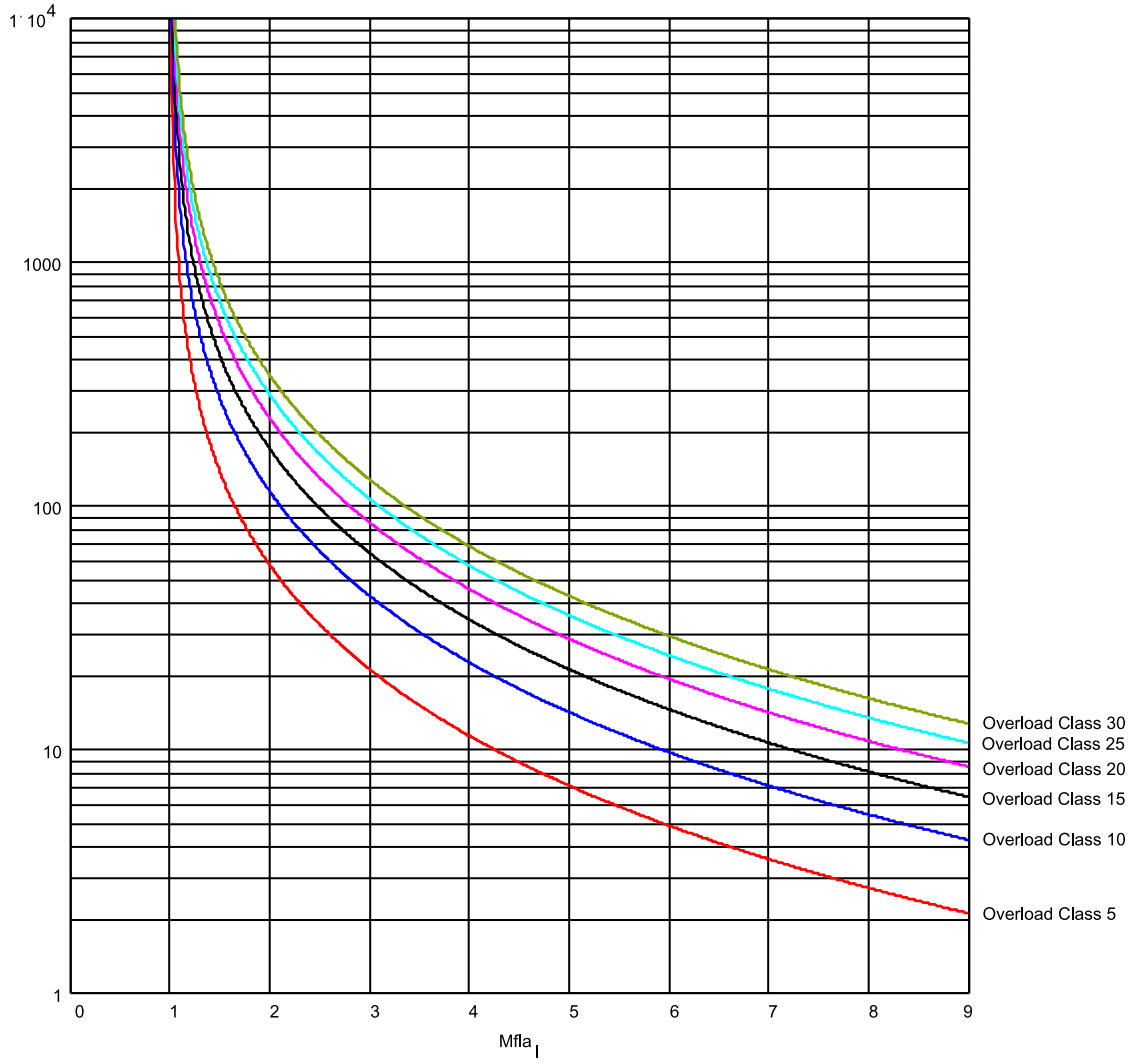
Test To Perform	Ohm Meter Reading	Test Result
From Position A to Position B	Greater than 10K Ohm	Pass
	Less than 10K Ohm	Fail
From Position B to Position C	Greater than 10K Ohm	Pass
	Less than 10K Ohm	Fail
Gate (G) to Cathode (K) for each SCR	8 to 100 Ohms	Pass (Typical 8 to 20 Ohms)
	Less than 10 or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

Note: Allow 15 minutes after shutdown for DV/DT network to discharge DC voltage.

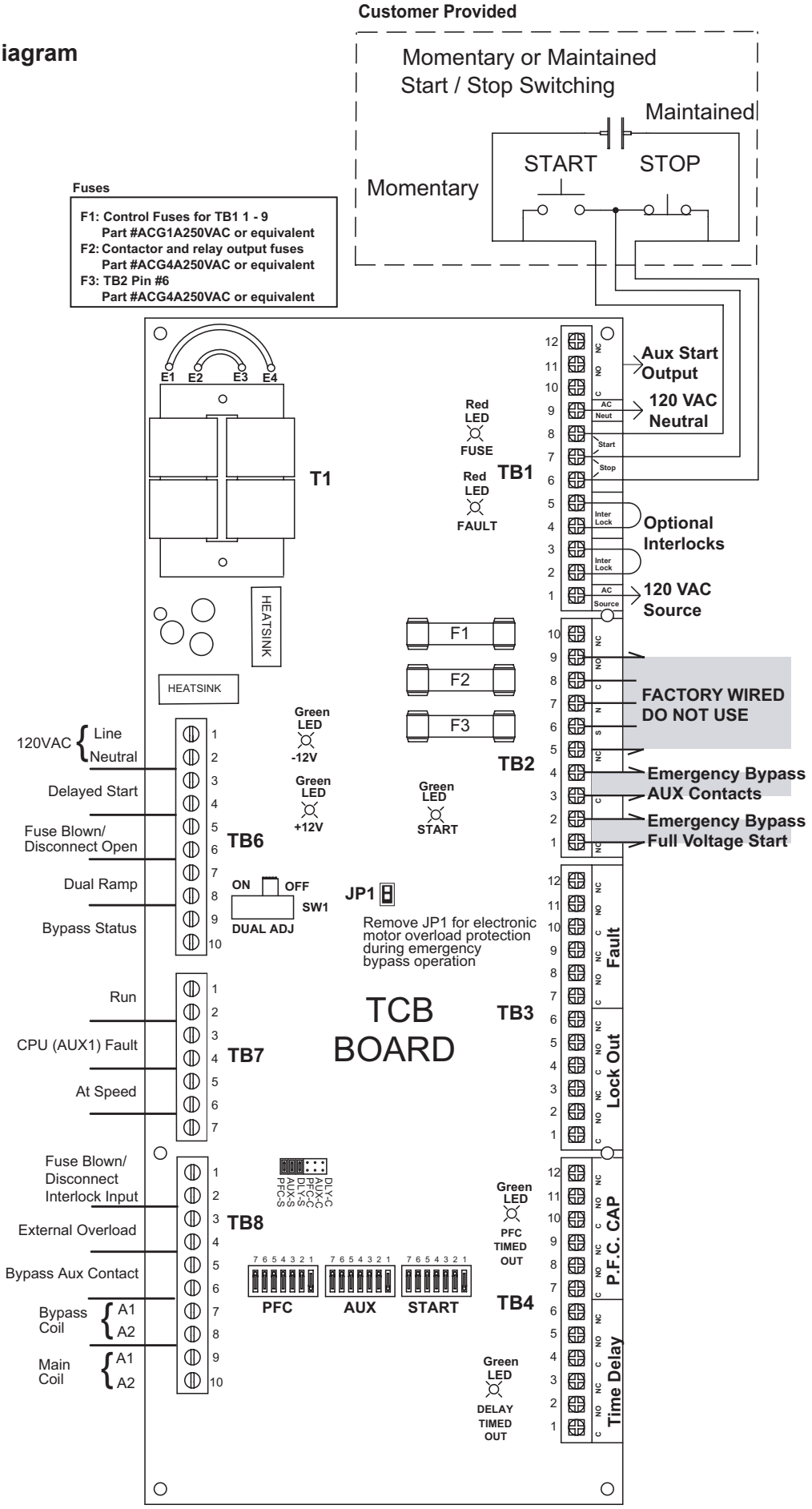
7.2 - Typical Block Diagram



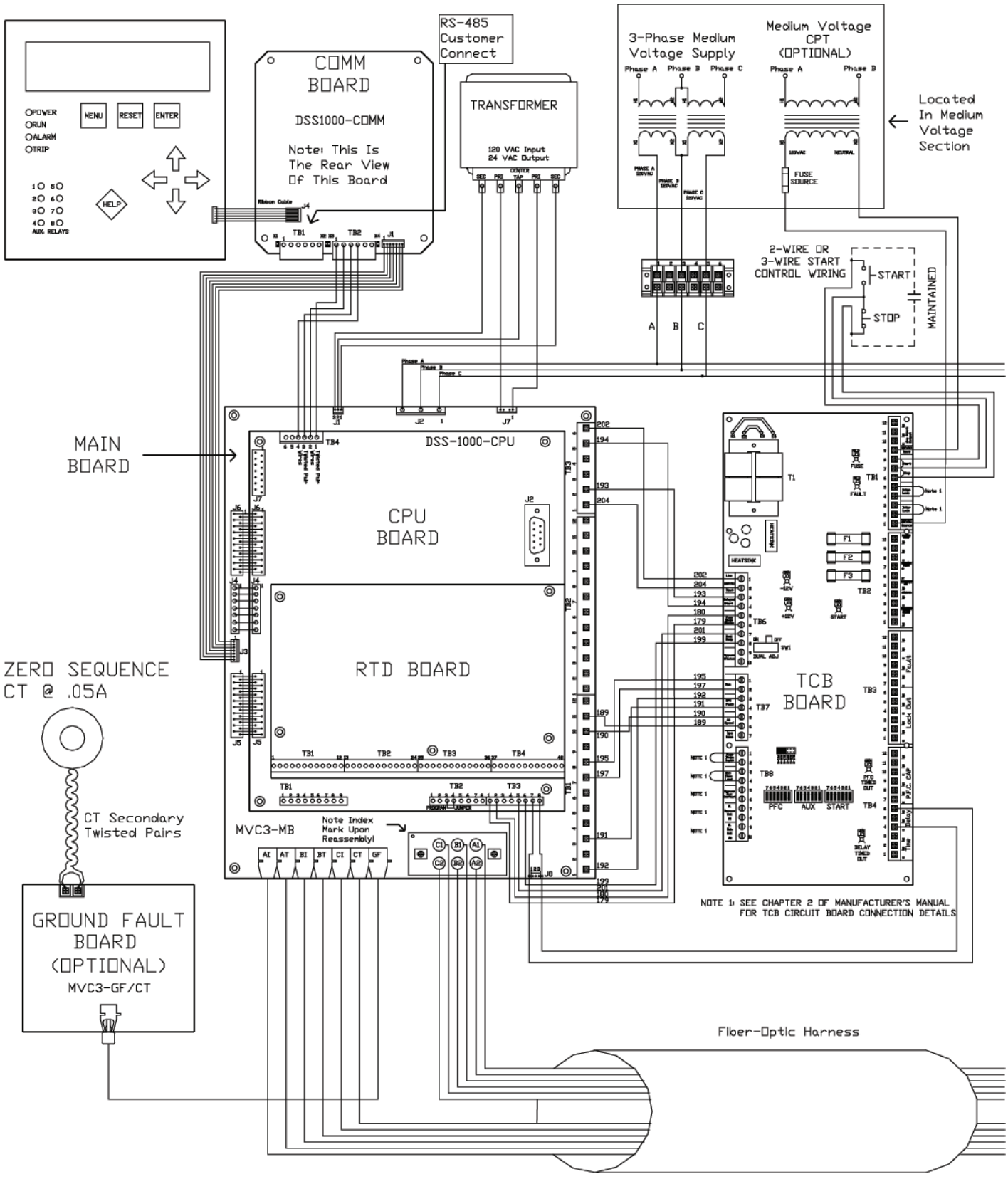
7.3 - Overload Curve Definition

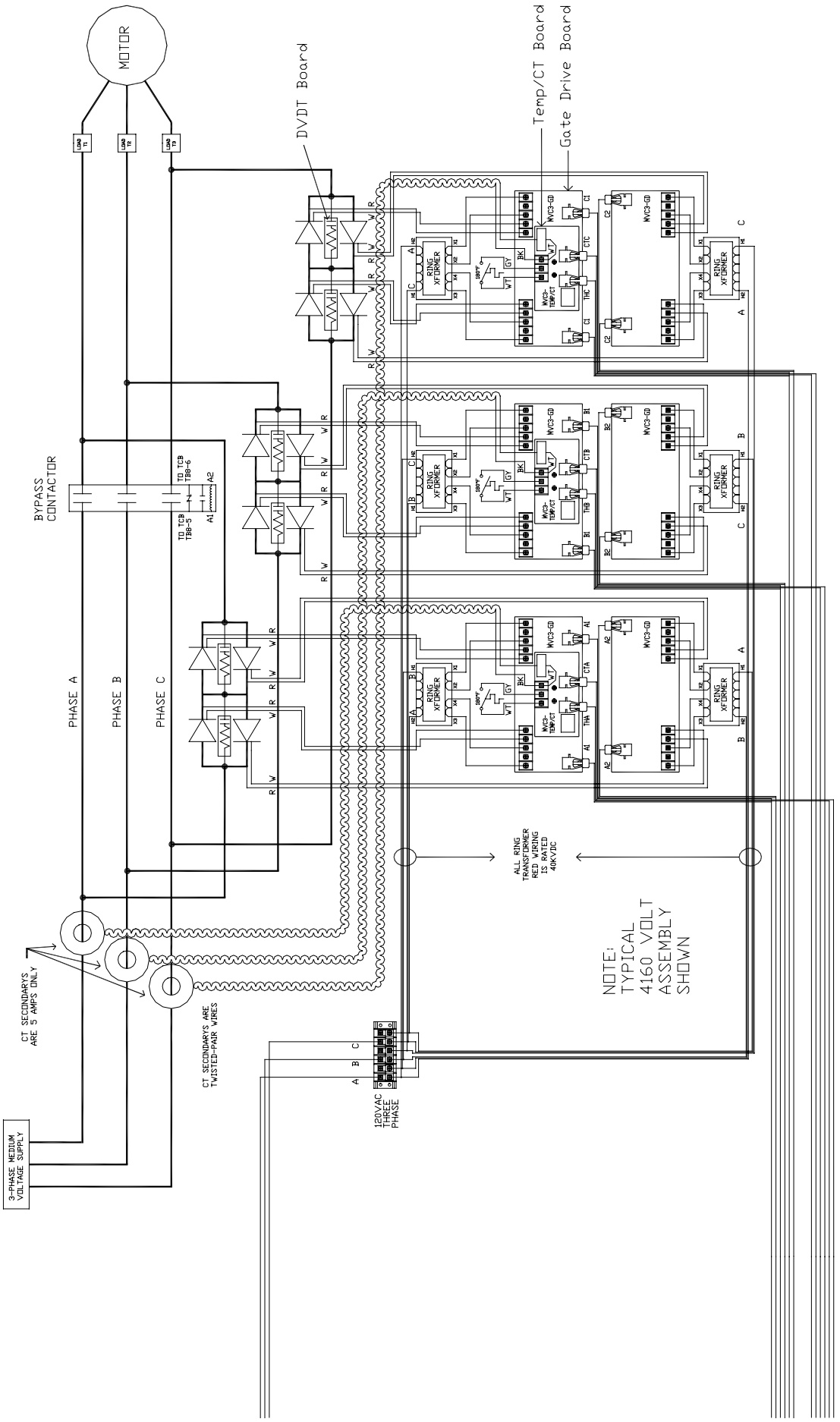


7.4 - TCB Diagram



7.5 - Typical Wiring Diagram

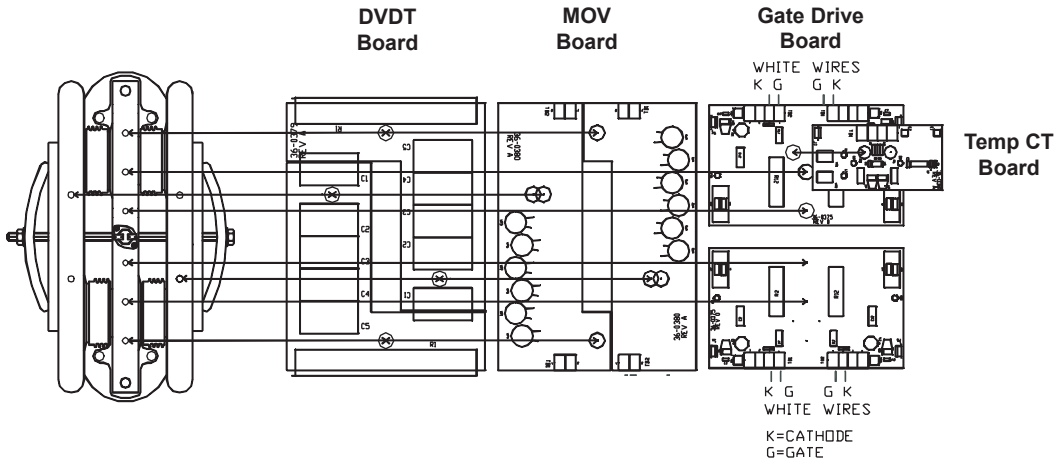



MOTOR
DVDT Board
Temp/CT Board
Gate Drive Board
BYPASS CONTACTOR
TO TCB TB8-6
TO TCB TB8-5
A2
A1
PHASE A
PHASE B
PHASE C
RING XFORMER
MVC3-GD
MVC3-TEMP/CT
ALL RING TRANSFORMER RELV WIRING IS RATED 4.0KVDC
NOTE: TYPICAL 4160 VOLT ASSEMBLY SHOWN
CT SECONDARYS ARE 5 AMPS ONLY
CT SECONDARYS ARE TWISTED-PAIR WIRES
120VAC THREE PHASE
3-PHASE MEDIUM VOLTAGE SUPPLY

7.6 - Spare Parts List

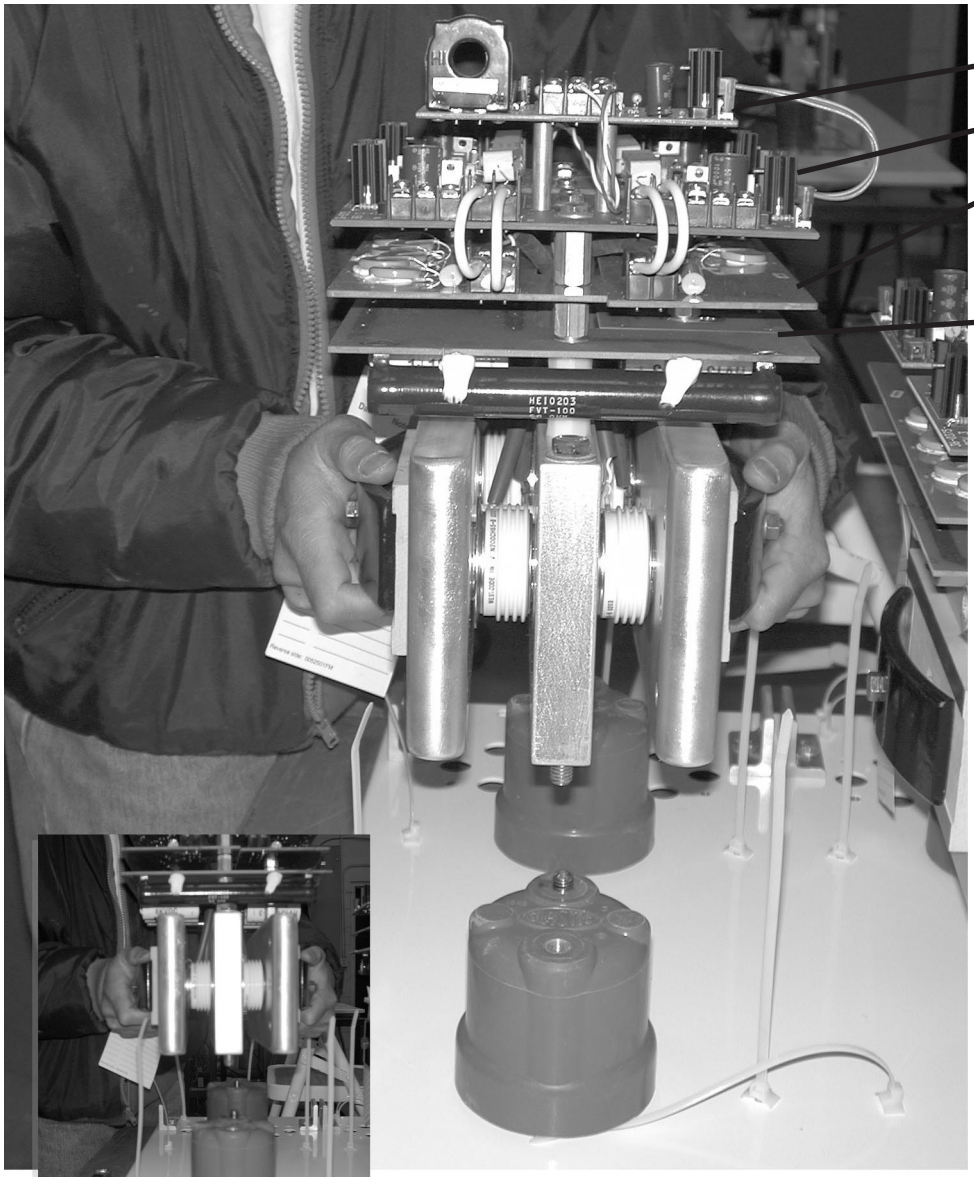
Description	Part Number	Unit Voltage and Amp Rating	Quantity Req./Unit
Current Transformer	Contact Factory	Specify model number	3
Heatsink Assembly with Boards (1 Phase)*	MVC3-STK23200	2300V, 200A	3
	MVC3-STK23400	2300V, 400A	3
	MVC3-STK23600	2300V, 600A	3
	MVC3-STK41200	3300/4160V, 200A	3
	MVC3-STK41400	3300/4160V, 400A	3
	MVC3-STK41600	3300/4160V, 600A	3
	MVC3-STK72200	6000 - 7200V, 200A	3
	MVC3-STK72400	6000 - 7200V, 400A	3
	MVC3-STK72600	6000 - 7200V, 600A	3
SCR(s) Clamped in Heat Sink Alone	25-0200-6500-23	2300V, 200A	3
	25-0400-6500-23	2300V, 400A	3
	25-0600-3500-23	2300V, 600A	3
	25-0200-6500-41	3300/4160V, 200A	3
	25-0400-6500-41	3300/4160V, 400A	3
	25-0600-3500-41	3300/4160V, 600A	3
	25-0200-6500-72	6000 - 7200V, 200A	3
	25-0400-6500-72	6000 - 7200V, 400A	3
	25-0600-3500-72	6000 - 7200V, 600A	3
Gate Drive Transfomer	10-0090	2300V, 200A & 400A	3
	10-0090	2300V, 600A	6
	10-0090	3300/4160V, 200A & 400A	6
	10-0090	3300/4160V, 600A	12
	10-0090	6000 - 7200V, 200A & 400A	9
	10-0090	6000 - 7200V, 600A	9
Temperature & Current Board	MVC3-Temp/CT-PS	All models	3

PCB Mounting Order

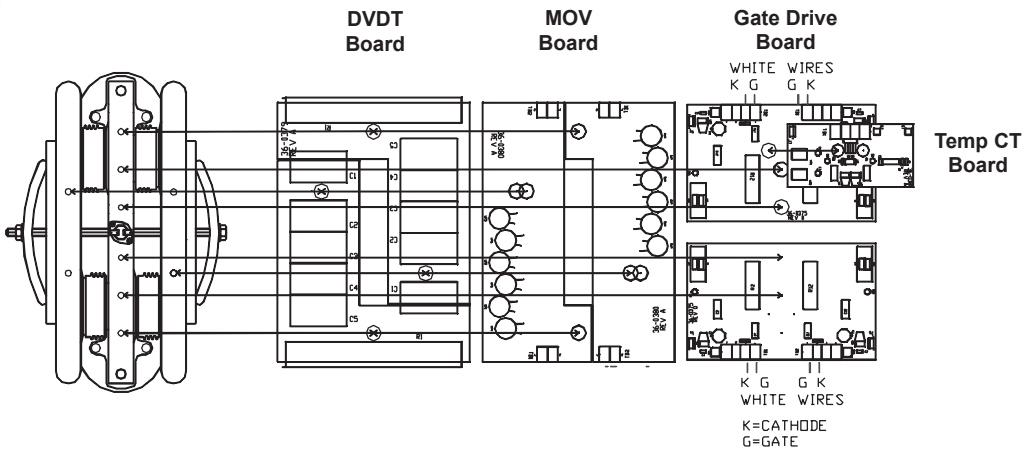


Description	Part Number	Unit Voltage and Amp Rating	Quantity Req./Unit
Gate Drive Boards	MVC3-GDF	2300V, 200A & 400A	3
	MVC3-GDFP	2300V, 600A	6
	MVC3-GDF	3300/4160 V, 200A & 400A	6
	MVC3-GDFP	3300/4160 V, 600A	12
	MVC3-GDF	6000 - 7200V, 200A & 400A	15
	MVC3-GDFP	6000 - 7200V, 600A	18
MOV Board	MVC3-MOV	2300V, 200A & 400A	3
	MVC3-MOV	2300V, 600A	6
	MVC3-MOV	3300/4160 V, 200A & 400A	6
	MVC3-MOV	3300/4160 V, 600A	12
	MVC3-MOV	6000 - 7200V, 200A & 400A	15
	MVC3-MOV	6000 - 7200V, 600A	18
dv/dt Board	MVC3-Dv/Dt	2300V, 200A & 400A	3
	MVC3-Dv/Dt	2300V, 600A	6
	MVC3-Dv/Dt	3300/4160 V, 200A & 400A	6
	MVC3-Dv/Dt	3300/4160 V, 600A	12
	MVC3-Dv/Dt	6000 - 7200V, 200A & 400A	15
	MVC3-Dv/Dt	6000 - 7200V, 600A	18
Main board, CPU board & digital controller assembly with lexan cover and harness	MVC3-MB/CPU-KIT*	All models	1
Control Board	MVC3-TCB	All models	1
RTD Board	DSS1000-RTD	All models	1
Ground fault (Option) Board	MVC3-GFCT	Option	1
Medium Voltage Fuses	Contact Factory	Specify FLA	Contact Factory

7.7 - Instructions for Stack Replacement
For Reference Only



PCB Mounting Order



7.7 - Instructions for Stack Replacement

⚠ DANGER

HAZARDOUS VOLTAGE

Disconnect all power supplying this equipment prior to working on it.

Failure to follow this instruction will result in death or serious injury.

Note: All power sources must be removed and a waiting period of at least 15 minutes must be observed before initiating any repairs to the unit(s) because DC voltage may still be present immediately after turning off power to the unit.

Note: It is good practice to disassemble and reassemble one stack at a time so you can have an assembled and wired stack in the unit as a reference.

Note: Toshiba recommends that the order include the SCR with the heat-sink assembly at a minimum. Only an experienced technician should attempt to replace the SCRs.

Tools:

- Phillips screwdriver
- 3/8" 12 point socket set
- 2 9/16" wrenches
- ½" wrench
- AC/DC Multimeter
- JKSSS+ manual (refer to drawings in this section)

Procedure:

1. Verify that no DC or AC voltage is present on any of the power components.
2. Disconnect all four wires connected to TB1 positions 1-3 on the temperature CT board.
3. Disconnect the 4 red transformer wires on each of the gate drive boards. These would be TB1, positions 3 and 5 for each gate drive board. Typically, the 2300V unit will have only 4 wires per phase to disconnect, a 4160V unit will have 8 wires per phase, and a 6000 - 7200V unit will have 12 wires per phase. (Note: the 7200V/600A unit will also have 24 wires.)
4. Use the 9/16 wrench and carefully unbolt all of the line and load power connections attached to the heat sinks. Note: If the unit is a 6000 - 7200V, remove the power strap connecting one side of the stack to the stack directly below it.
5. Before removing the fiber optic wiring, make a note of the label on the fiber cable to ensure they are placed exactly in the same socket they were removed from. Now remove all fiber optic connectors on the stack. Gently push on the connector tab and pull with a gentle left-to-right motion on the connector in the direction away from the fiber optic device. Two connectors will be found per gate drive board and one duplex connector will be found on the small Temp/CT board on top. Caution: Do not touch the tip of the connectors or contaminate the connection sockets with any dust or foreign material.
6. Remove the wires from the Temp/CT board terminal block (3 screws).
7. Use a 9/16" socket with a 6" extension to remove the lower bolt that routes through the front face of the heat sink and into the isolation standoff mounted to the white panel. Then carefully hold the heat sink in place with one hand and remove the top bolt from the heat sink.
8. Ensure the fiber optic connectors and all wires are positioned out of the way, and then the heat sink can be gently removed from the unit.

SCR Replacement:

CAUTION **FAILURE TO PERFORM THIS PROCEDURE CORRECTLY WILL DAMAGE THE SCR AND WILL NOT BE COVERED UNDER WARRANTY.**

1. Remove white jumper wires on the gate drive board and make a note of their placement.
2. Remove both 7/16 bolts and the singular 10 - 32 screw at the top of gate drive board and lift off the board.
3. To remove the MOV board, remove the SCR gate/cathode leads (thin red and white wires) and the white jumper wires attached to them. Make a note as to how they were connected. Unbolt the ½" fasteners as well.
4. At this point, all boards should now be removed from the aluminum heat sink assembly.
5. Make a note (or drawing) of how each of the SCRs are oriented within the heat sink. If factory supplied replacement SCRs and heatsinks are used, the following steps are not required.
6. Loosen and carefully remove the ½" feed-through bolt and two black springs that hold the assembly together and turn it on its side.
7. Remove the two (2) SCRs in the top layer, making certain to note that the SCRs are not facing the same direction.
8. Remove the two (2) SCRs in the bottom layer, also making certain to note that the SCRs are not facing the same direction.
9. Clean the heat sink surface area thoroughly and reapply some thermal heat sink grease sparingly to the SCRs mating surfaces.
10. Please note that replacement SCRs are in matched sets of four and as such, please try to keep the matched sets within the same phase.
11. Now, take any two SCRs from a set and place them on the heat sink in the same direction as the old SCRs were, ensuring that the dimple in the center of the SCR is properly placed onto the center pin of the heat sink assembly. Place the next level of heat sink bar on the mounted SCRs. Note: There is a difference in the heat sink bars. The center bar has more holes drilled in it for mounting the circuit boards on it.
12. Now replace the other two (2) SCRs by repeating steps 10 and 11.
13. Next, carefully sandwich the SCRs and turn the stack over so the heat sink bars are vertical and run the center bolt through the springs and hand tighten the nut on the center bolt assembly.
14. Then make approximately 3 and ½ full revolutions on the nut to create the appropriate amount of compression force. You can tell if there is enough compression force applied to the heat sink by the fact that the force needed to turn the nut will suddenly increase.
15. Finally, reinstall all boards in the same manner in which they were removed.
16 Refer to drawing PCB for disassembling and reassembling the stack assembly.

Reinstallation:

1. Hold the rebuilt or new stack assembly in the vertical position with the Temp/CT board on top (only the top stack assembly will have this board in a multi-stack phase) and place the stack on the positioning studs that protrude from the isolation standoffs.
2. While pressing on the stack to hold it on the positioning studs, place the feed-through bolt through the heat sink and finger-tighten the top bolt. Then repeat the process with the bottom feed-through bolt to ensure the stack is held against the isolation standoffs.
3. After verifying no wires or fibers have been pinched between the stack assembly and isolation standoffs, tighten the top bolt completely, then repeat the process for the bottom bolt. Now the stack assembly should be held firmly in place.
4. Using the 9/16” wrench reinstall the line and load power cables and tighten.
5. If needed, refer to the appropriate drawing to reconnect red transformer wires on each gate drive board. As an example, for the 4160V stack, reattach TB4-1 to X3, TB4-3 to X4, TB1-3 to X2 and TB1-1 to X1. Verify all X(#) wires are reconnected to their original position on the gate drive boards. Otherwise the SCRs will misfire.
6. Reconnect thermostat wires on TB1 positions 2 and 3 of the Temp/CT board.
7. Reconnect the main CT black wire to TB1-1. Then feed the white wire through the board mounted CT and connect to TB1-1 on the Temp/CT board. Please note that one each of the thick white wires from the encapsulated CT must be connected with the Main CTs wiring.
8. Ensure the same fiber optic routing is used as before. If the fiber optic wiring is positioned close to a heat source, (such as the 25-watt resistors on the gate drive board) melting or distortion of the plastic fiber may occur. Minimum distance is a ½ inch with a minimum bend radius of 2 inches. All gate drive boards require 2 single connectors per board and the Temp/CT connector is a duplex piece with a mating tab that faces away from the stack. If the tab is broken off, refer to an adjacent stack’s labels to see how the labels should be positioned when installing a duplex connector with a broken tab. Again, caution should be taken not to touch the fiber connector end or force it in with the tab facing down.

7.8 - Instructions for Low Voltage Test

⚠ DANGER

HAZARDOUS VOLTAGE

Disconnect all power supplying this equipment prior to working on it.

Failure to follow this instruction will result in death or serious injury.

Tools:

- Phillips screwdriver
- Medium voltage fuse pullers if available
- Two control power transformer (Test PT) 500 VA minimum
- 120Vac control power (Test plug)
- Low voltage motor strapped for the proper voltage (typically 5 HP or less)
- Oscilloscope if available
- Wire jumper
- Test switch (single pole i.e. - light switch)

⚠ DANGER

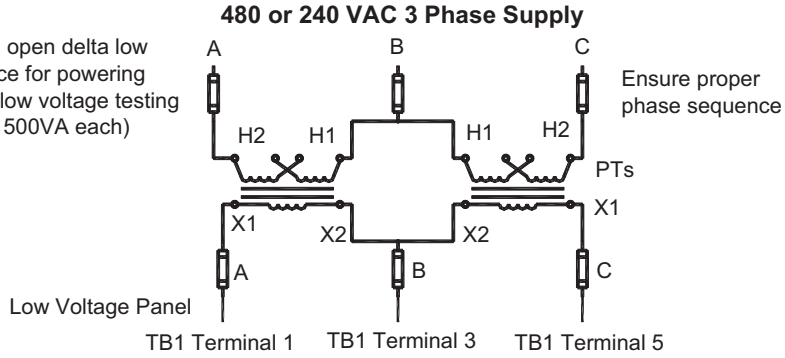
HAZARDOUS VOLTAGE

Remove all medium voltage fuses to prevent back-feeding transformers.

Failure to follow this instruction will result in death or serious injury.

- Manual (reference drawing above)

Construct an open delta low voltage source for powering the MVC for low voltage testing (Minimum of 500VA each)



Caution: Remove the three phase transformer PT fuses and CPT fuses on panel to prevent backfeed to the Medium Voltage

Procedure:

1. Verify that no DC or AC voltage is present on any of the power components.
2. Verify setup of control power transformers for the proper voltage. If using 480Vac or 240Vac 3 phase verify transformers are strapped for that voltage. See above drawing. Configure as an open delta for 3 phase as shown in drawing.
3. Verify medium voltage disconnect is open and pull medium voltage fuses including PT and CPT fuses.
4. Connect 3 phase power 480 or 240Vac to the down stream side of the fuses. Do not connect to disconnect side of fuses. Depending on the small test motor used will depend on what size cable or current that is required. Also, connect the Primaries of the TEST PT in the proper phase sequence of A-B-C.
5. Disconnect medium voltage motor.
6. Connect low voltage motor. (Typically 5 HP or less)
7. Connect a wire jumper between TB8 pins 1 and 2 on the TCB (control board) to bypass fuse blown and open disconnect fault. The TCB is located in the low voltage compartment.
8. Install a switch on TB1 pins 1 and 8 on the TCB (control board) to bypass all interlocks (TEST Switch).

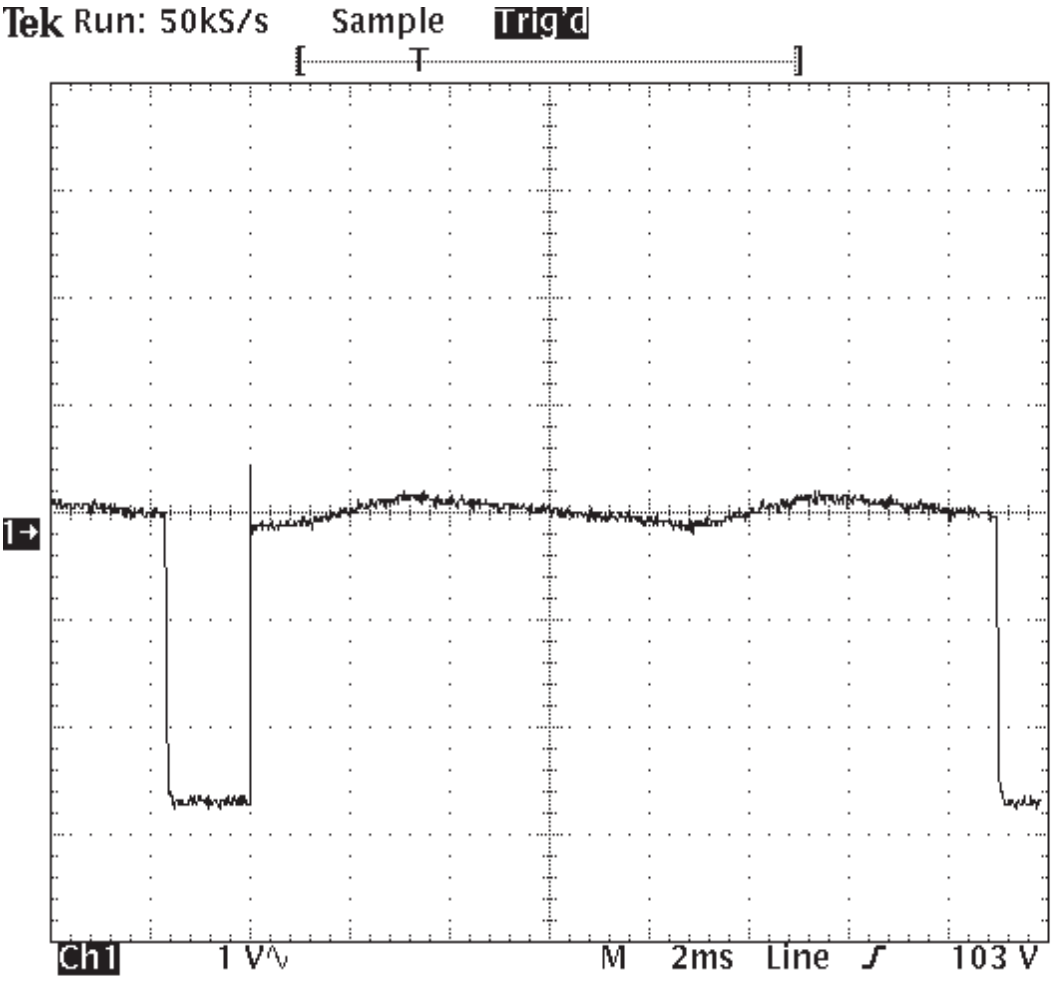
9. Verify or wire a 120Vac plug to the TEST plug supplied by the factory.
10. Remove all both power fuses on the medium voltage CPT (single phase control power transformer), if present..
11. Remove 3 fuses from the medium voltage potential transformer (PT).
12. Verify the 120-volt test switch is in the “NORMAL” position.
13. Connect test power to test plug connector and place the 120-volt test switch to the “TEST” position.
14. The keypad should be energized with the “Power LED,” Stop LED.
15. Close the temporary Start switch, which is connected to the control board.
16. The Main Vacuum contactor should close and the keypad should trip on “Under Voltage” Open temporary TEST switch and reset CPU fault.
17. Connect the Secondary of the TEST PT to Panel TB1 positions 1 - phase A, position 3- phase B, and position 5 - phase C on the main firing board (JKSSS+-MB). It is physically located behind the low voltage compartment door. (Screw terminal block)
18. Verify all connections are good and then energize the low voltage of either 480 or 240 volt, three phases.
19. Use the multimeter on the AC scale and verify 3 phase 120Vac (phase to phase) at TB1 pins 1, 3 and 5 of the main firing board.
20. If all 120Vac 3 phase is present then de-energize low voltage of 480 or 240Vac.
21. Re-energize the low voltage of 480 or 240Vac.
22. Now all test voltages should be present 480 or 240Vac and three phase 120Vac (TEST PT) and 120Vac single phase for control power.
23. Close the temporary Start switch and the test motor should spin up smoothly.
24. Use the Multimeter on the AC scale and check (phase to phase) voltages on T1, T2 and T3 motor leads. The voltages should be balanced.
25. If the motor doesn’t spin up smoothly the soft starter is malfunctioning. Proceed to step 27 for troubleshooting.
26. If the motor starts and runs smoothly then repeat this procedure in reverse to remove all test connect and reinstall all fuses.

Low Voltage Troubleshooting:

Tools: Ungrounded Oscilloscope

27. Open test switch and stop motor.
28. Change Setpoint Page 5 AUX4 is set at non-fail safe. Change it to fail safe.
29. Observe bypass contactor closes immediately.
30. Place the Oscilloscope on the 2msec time scale and 1 Volt per division.
31. Connect the Oscilloscope probe to the Gate and Cathode of the SCRs.

32. The gate and cathode leads are the white wires on the gate drive board in the medium voltage cabinet. See drawing below.
33. If waveform is inverted, swap Oscilloscope connections for proper polarity. Close the temporary Start switch and allow the test motor to reach full speed.
34. Then verify all gating signals to each SCR (two gating signals on every gate drive board). See drawing below for correct waveform.
35. Once the bad signal(s) are found; write down the location and call the factory for further guidance.



Correct Waveform

Waveform is the gating signal as measured with an ungrounded oscilloscope at the gate to cathode of the SCR. The waveform should be 1.7 to 2msec off time and approximately 1.5 to 3 Vdc. This signal is only present at full conduction or the motor is at speed. Each SCR gating signal should be checked in accordance with the low voltage test procedure.

7.9 - Maintenance Program/Servicing Equipment/Disposal/Storage

MAINTENANCE PROGRAM

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

DANGER **Contact with energized components can cause severe injury, death and property damage. Turn off and lock-out primary and control circuit power before servicing.**

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

WARNING **Grease is conductive. Do not allow grease or any other substances to contaminate insulating materials. Contaminated insulators can allow a short-circuit or ground fault to occur.**

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

MAINTENANCE RECORD

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

1) Items inspected
2) Reports of any testing
3) Equipment condition
4) Corrective actions or adjustments
5) Date of work
6) Comments

The degree of detail of the record will depend somewhat on the operating conditions.

SERVICING EQUIPMENT

For your safety, turn off and lock out main and control circuit power before servicing the starter. Certain minimum safety procedures must be followed:

1) Only **qualified personnel** should attempt this service.

2) **Never** perform service on or next to exposed components energized with line voltage.

WARNING **Failure to adhere to these safety procedures can result in severe injury, death and property damage.**

DISPOSAL

Contact your state environmental agency for details on disposal of electrical components and packaging in your particular area.

STORAGE

If the starter is to be stored for any length of time prior to installation, the following precautions should be taken:

1) The original packing should be restored, if possible.

2) Do not subject the equipment to moisture or sun rays. Store in cool, clean, and dry location.

3) Place a dust cover over the starter packaging to protect against dirt and moisture.

4) Store in an upright position.

INSPECTION DURING STORAGE

Routine scheduled inspection is necessary if storage is for an extended period. The unit should be checked for condensation, moisture, corrosion, and vermin.

Prior to installation, the starter should be carefully examined for evidence of physical damage, corrosion, or other deterioration.

The MAINTENANCE section of this manual describes various types of inspections recommended for this starter during the operation period.

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 TWENTY-FOUR (24) MONTHS AFTER SUCH EQUIPMENT AND PARTS (EXCLUDING REPAIRED OR REPLACEMENT EQUIPMENT AND PARTS FURNISHED PURSUANT TO THIS WARRANTY) ARE PLACED IN OPERATION OR THIRTY (30) MONTHS AFTER THE DATE ON WHICH SUCH EQUIPMENT AND PARTS (EXCLUDING REPAIRED OR REPLACEMENT EQUIPMENT AND PARTS FURNISHED PURSUANT TO THIS WARRANTY) ARE SHIPPED TO THE INITIAL PURCHASER, WHICHEVER PERIOD FIRST EXPIRES. THERE ARE NO OTHER WARRANTIES WHETHER EXPRESS, IMPLIED, STATUTORY OR OTHERWISE, INCLUDING THE IMPLIED WARRANTIES OR MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

The Company will, at its option, repair or replace or refund the purchase price paid for 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 current operating and maintenance instructions , and (4) has not been altered or modified in any manner without the written consent of the Company, and (5) 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 EXPRESS, STATUTORY AND IMPLIED WARRANTIES, SUCH AS MERCHANTIBILITY AND FITNESS FOR A PARTICULAR PURPOSE APPLICABLE TO ALL REPAIRED OR REPLACED EQUIPMENT AND PARTS FURNISHED PURSUANT TO THE FOREGOING WARRANTY.

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Purchaser shall provide this Limited Warranty and Limitation of Liability to its customers and users of the equipment and parts described herein prior to any sale to or use of the equipment and parts by such customer or user. Company does not authorize anyone to make any representations or warranties other than the express warranties contained herein.

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