# MOTORTRONICS™

Solid State AC Motor Control

# MVH

## MEDIUM VOLTAGE HEATER CONTROLLER

# INSTALLATION & STARTUP MANUAL

# Table of contents

## SAFETY PRECAUTIONS

**Throughout the MVH manual, these symbols will alert you to potential hazards. Safety precautions should be followed in order to reduce the risk of fire, electrical shock, injury and even death to persons.**

**Please read all instructions before operating your MVH Control Panel.**
**To avoid electrical shock or injury, always remove power before servicing a circuit. Personnel working with or near High Voltages should be familiar with modern methods of resuscitation. Contact an area supervisor or safety personnel for more information.**

**WARNING**

**HIGH VOLTAGE is used in the operation of this equipment.**
**DEATH ON CONTACT may result if personnel fail to observe safety precautions. Learn the areas containing High Voltage connections when installing or operating this equipment. Be careful not to contact High Voltage connections when installing or operating this equipment. Before working inside the equipment, turn the power off and ground all points of high potential before touching them.**

**NOTE: The overhead bus will be energized even when both local disconnect switches are open. A separate disconnecting means is required to de-energize the overhead bus.**

**ELECTRIC SHOCK HAZARD**

**Any installation involving control equipment must be performed by a qualified person, who is trained and certified with the proper Medium Voltage credentials and must be effectively grounded in accordance with the National Electrical Code to eliminate shock hazard.**

# Chapter 1 - General Information

## 1.1 Description

The Medium Voltage Heater (MVH) Series is used in many different heating applications across multiple industries, gas heaters, boilers, steam heaters, etc.

## 1.2 Features

**Medium Voltage**

Medium Voltage Heaters offer multiple benefits over Low Voltage Heaters, lower installation cost, improved efficiency, energy savings and lower maintenance cost.

**Ratings**

The standard MVH series controller is available for input voltages ranging from 2300V to 4160V, with amp ratings up to 200A. (Contact factory for 7200V)

**Start / Stop Control**

2 or 3 wire Start / Stop control (120VAC).

**Output Control**

Analog input signal (0-5VDC, 0-10VDC, 4-20mA) for 0 - 100% output.

**Signal Monitoring**

Four analog output signals (0-10VDC), one for each of the Three Phase Currents and one for voltage feedback.

**Fault Indication**

Two Fault Relays, one for Over Temperature (Form-C) and one for Over Current (Form-A).

**Certification**

UL ($5^{th}$ Edition) and ETL listed.

# Chapter 2 - Precautions and Warnings

## 2.1 Warning

**ALL PERSONNEL WORKING ON MEDIUM VOLTAGE ELECTRICAL EQUIPMENT SHALL ADHERE TO OSHA, NEC, NFPA 70E AND LOCAL SPECIFICATIONS AND STANDARDS. FAILURE TO ADHERE TO PROPER MEDIUM VOLTAGE SAFETY STANDARDS INCLUDING PROPER USE OF PPE MAY RESULT IN INJURY OR EVEN DEATH. MOTORTRONICS WILL NOT BE LIABLE FOR FAILURE OF CUSTOMER TO ADHERE TO GOVERNING STANDARDS.**

## 2.2 Deenergize

**DE-ENERGIZE ALL EQUIPMENT BEFORE OPENING JUNCTION BOXES AND CONTROL PANELS. DO NOT WORK ON LIVE CIRCUITS.**

**NOTE: The overhead bus will be energized even when the local disconnect switch is open. A separate disconnecting means is required to de-energize the overhead bus.**

Medium Voltage Heater Controllers and heater junction boxes should be equipped with a Kirk-Key (or approved equivalent) locking system that prevents the opening of certain compartments unless specific conditions are met. For example, the heater junction box lock requires a key that is captured in the disconnect door and is not released until disconnect is turned OFF, thus the output of Medium Voltage Heater Controller feeding the heater is disabled and safe.

The Medium Voltage Section of the control panel consists of a incoming feed section, a Disconnect switch compartment, a Contactor Fuse Section which is located below the switch compartment and the SCR section. The disconnect switch door is closed with screws and will require tools to open. The contactor / fuse section door is mechanically interlocked with the disconnect switch and cannot be opened until the switch is turned OFF.

Likewise, the SCR section is interlocked with the contactor / fuse and cannot be opened until the switch is turned OFF. This arrangement provides a complete and safe interlocking system. The hinged door in the low voltage section can be locked using the lock and key provided in the door handle.

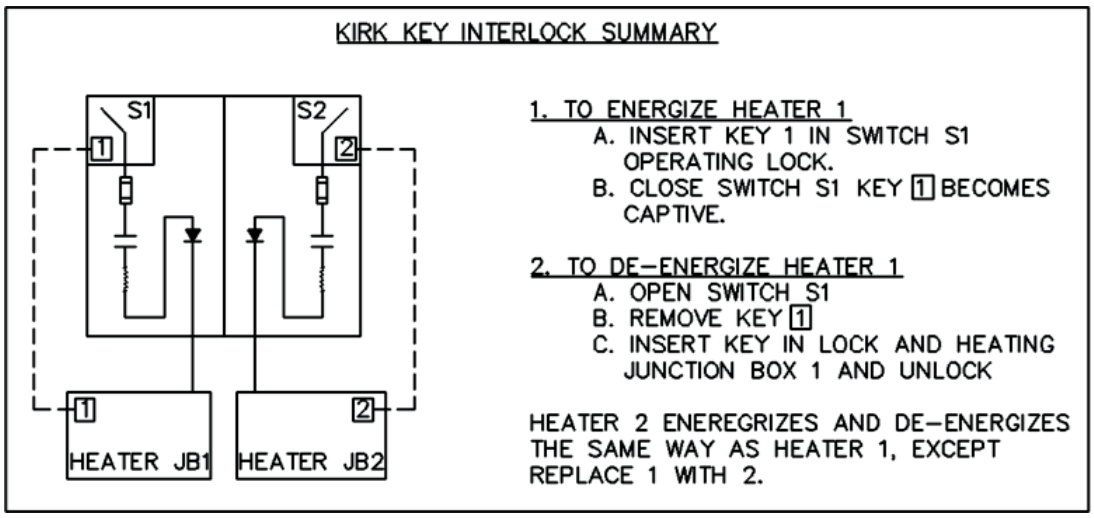



**Figure 2.1** Customer Responsibility Kirk Key Scheme

## 2.3 Design and Purpose

This equipment has been specifically designed for its intended purpose and should not be used for any other applications without a complete re-evaluation by the manufacturer. The operator should ensure these instructions are kept with the equipment to prevent any misuse for which the equipment has not been designed.

## 2.4 Complete System Only

The Motortronics Medium Voltage Heater Control is comprised of both a Medium Voltage SCR Section and a Motortronics Medium Voltage Switch/Contactor Section. One may not be employed without the other. All written and implied warranties are void if one component is used without using the other.

## 2.5 Startup/Commissioning

All Medium Voltage Systems and Medium Voltage Heater Controllers **SHOULD** have commissioning services performed by Motortronics Service Personnel OR a Factory Trained and Certified Technician. All written and implied warranties could be void if non-Motortronics Service personnel perform commissioning services and damage to the equipment result from those services. Certified Startup Commissioning provides you with an additional warranty on parts. Contact your Sales Representative for more information.

# Chapter 3 – Receiving & Handling

## 3.1 Handling

The modular design of Motortronics Medium Voltage Heater Controller makes installation easy. The modules are heavy and will require the right kind of equipment to move or they could tip over. Please make sure the equipment used to move them can manage their height and weight.

## 3.2 Inspection

When the equipment arrives at the site, please inspect the equipment for any concealed shipping damage. You have a very short window to report this damage with the carriers. Proceed only if there is no visible damage.

## 3.3 Lifting

Know the capabilities of the lifting equipment available to manage the weight of the system.

## 3.4 Securing System

Keep the system secured to the shipping skid to prevent distortion of the frame during moving and to minimize tipping.

## 3.5 Moving

Exercise care during any movement and placement operations to prevent falling or unintentional rolling or tipping.

# Chapter 4 – Storage

## 4.1 General

If you are not planning to install and energize your system within the first six months, it should be placed in storage. That storage should be a clean, dry space where a uniform temperature prevents condensation. It would be best to store the equipment in a conditioned building with adequate air circulation and protected from dirt and water. The equipment should remain on the pallets it came on and remain off the ground.

**4.1.1** In non-humidity-controlled environments, an anti-condensate heater or desiccant bags are recommended/preferred and placed in each section to prevent condensation on interior surfaces.

**4.1.2** Shipping containers are temporary protective covers. These systems should not be kept outdoors for more than 24-72 hours and never in the rain. If the system needs to remain outdoors for an extended time the system needs to be protected from the outdoor elements with appropriate coverings.

## 4.1 Short Term Storage of Medium Voltage Heater Controller

**4.2.1** The unit needs to be stored indoors, in a clean, climate-controlled dry environment.

**4.2.2** If the storage area is not heated, or climate controlled, a form of desiccant should be used to prevent the formation of condensate.

**4.2.3** Once a system is taken out of storage, all desiccant, internal packing, caps, plugs, wrappings, etc. should not be removed until the unit is ready for startup.

## 4.3 Long Term Storage of Medium Voltage Heater Controller

**4.3.1** Long term storage is the repeat of the short term, except the entire controller should be heat sealed in plastic barrier bag with the proper amount of desiccant included.

## 4.4 Warranties

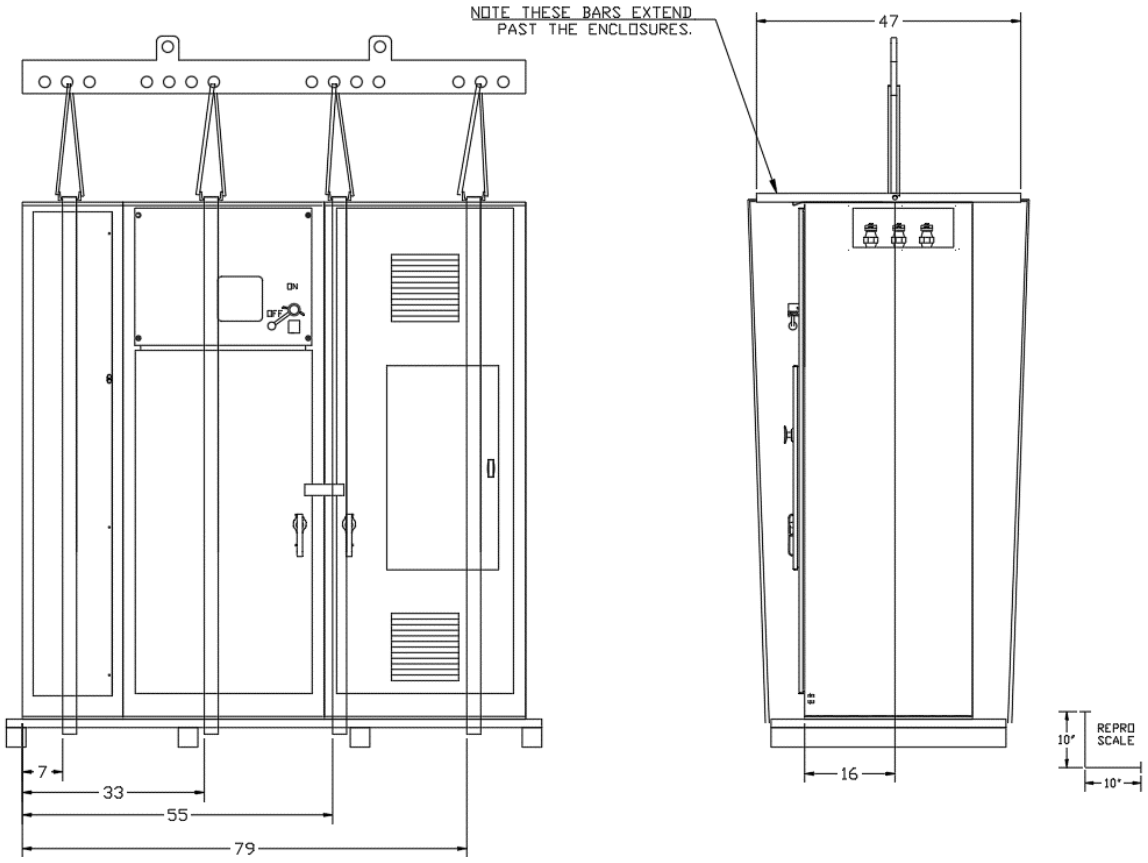
All written and implied warranties will be void should these storage guidelines above not be followed.

# Chapter 5 – Installation

## 5.1 Mechanical Installation

### 5.1.1 Lifting and moving provisions.

Medium Voltage Heater Controllers are shipped attached to heavy duty pallets and can be lifted and moved using fork trucks, electric pallet jacks or heavy-duty rollers. For installations where a solid flat moving surface is not available, the unit can be lifted by crane. Place the lifting c-channels longer than the unit across the top to hold the straps in place and away from the drip shields, and place the padded straps approximately as shown below.



## 5.2 Preparations

**5.2.1 Please ensure that** the Medium Voltage Heater Controller is protected from mechanical damage, extreme temperatures, and other adverse conditions.

**5.2.2 Once again, please** ensure that all precautions are taken regarding the weight of the equipment and moving it. Lifting equipment should have capacity for the given weight.

**5.2.3** The foundation must be sufficiently strong to withstand the load of equipment. Install the Medium Voltage Heater Controller on a solid foundation.

**5.2.4 The** Medium Voltage Heater Controller should be inspected for foreign material. Protective plugs, covers and silica gel desiccant should not be removed until immediately prior to startup. The entire system should be cleaned before startup.

**5.2.5** General safety precautions listed in the plant Safety Manual should be closely complied with to prevent injury to personnel or damage to equipment.

**5.2.6 The** Safety Supervisor and others must ensure that the area in the vicinity is made aware that installation work is starting and post warning notices. Ensure that the personnel working on the equipment wear proper PPE. Beware of wet or slippery ladder rungs and working areas if working aloft.

**5.2.7** Where possible, eliminate or reduce hazards as far as reasonably practicable by design. Additional warnings mentioned in this manual and on the equipment should also be followed to ensure continued safe use.

## 5.3 Medium Voltage Heater Controller Installation and Wiring

Medium Voltage Controllers consists of the following Sections (See Figure 5.3.1)

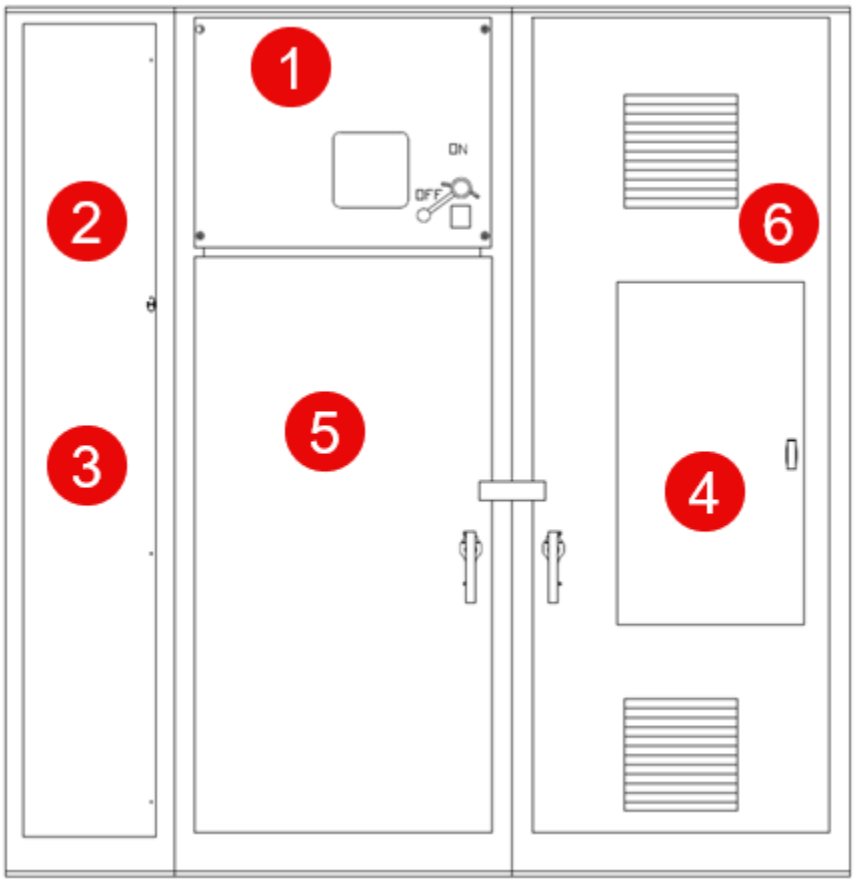



Figure describes all sections and major sub-sections of the MVH Controller.

**Figure 5.3.1** Medium Voltage Heater Controller Front View with Doors closed.

| Item | Description |
|---|---|
| **1** | Disconnect/Isolator Section |
| **2** | Recommended Kirk Key Lock Location<br>(Lock not provided with panel. Must be installed and locked before energizing the feed upstream |
| **3** | Incoming Section/Bus section |
| **4** | Low Voltage Control Section |
| **5** | Contactor / Fuse / Inductor Section |
| **6** | SCR Section with ventilation |

### 5.3.2 Incoming Power Section for Bus and Cable Termination

The Incoming Power Section is for your electrical contractor to access for easier termination of incoming power wiring. Space is available for wiring and the bending of cables suitable for load. Follow instructions listed in documents accompanying the Medium Voltage Heater Controller and/or by the terminal manufacturer.

**THIS SECTION IS LOCKED AND SHOULD ONLY BE OPENED WHEN THE POWER FEED IS TURNED OFF AND GROUNDED. A KIRK KEY INTERLOCK WITH THE MAIN FEED DISCONNECTING MEANS IS STRONGLY RECOMMENDED.**

### 5.3.3 Disconnect Switch, Contactor & Fuse Section

Main components in these sections are fuses, switches, inductors and shut down contactor.

### 5.3.4 SCR Section

SCR stacks and cooling fans will be in this section. This section is interlocked with the Disconnect Section and cannot open until the units disconnect switch is opened.

### 5.3.5 Low Voltage Section

SCR trigger circuit and all controls are in this section. This section is completely isolated from Medium Voltage Sections and can be opened without de-energizing the main power.

**Note:** Control voltage will be present in this section any time the disconnect switch is closed.

### 5.3.6 Wiring

The MVH series offers bottom entry and exit for all power and control cables. See Figure 5.3.7 for locations and typical dimensions. Run incoming power wires into the Incoming Section shown in Figures 5.3.8 and 5.4 torque properly for cable size and lugs. Run load cables from SCR Section shown in Figure 5.3.8 and 5.5 torque properly for cable sizes and lugs.

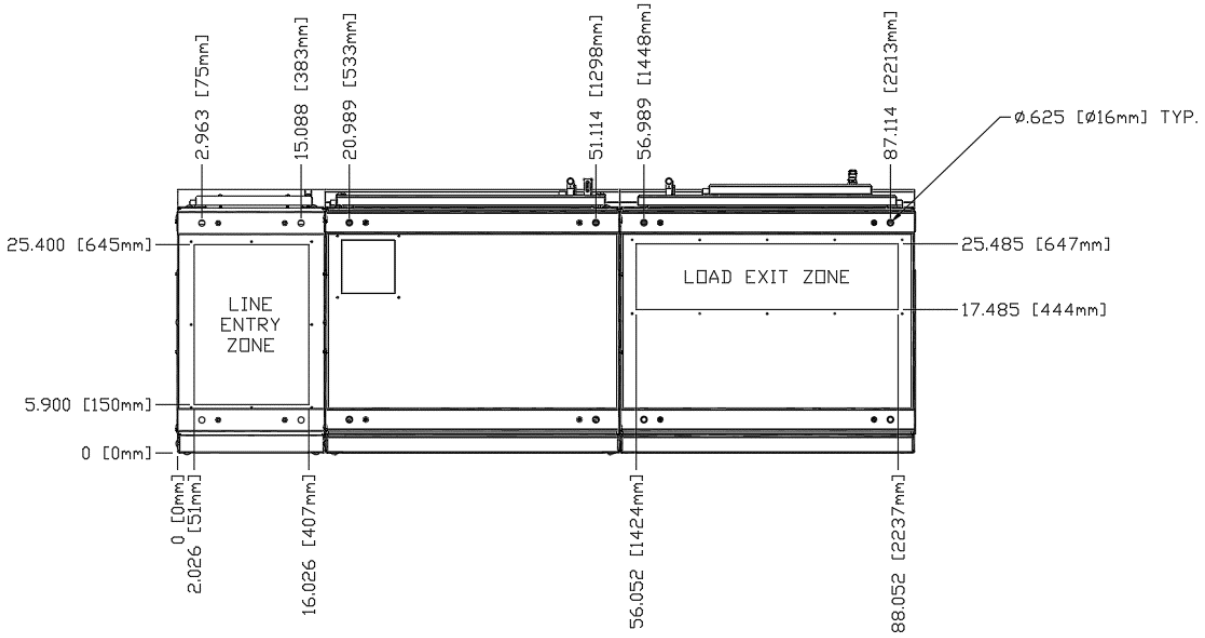



**Figure 5.3.7** Wire-ways for bottom Entry & Exit

**Incoming** **Switch/Fuse/Contactor** **SCR**

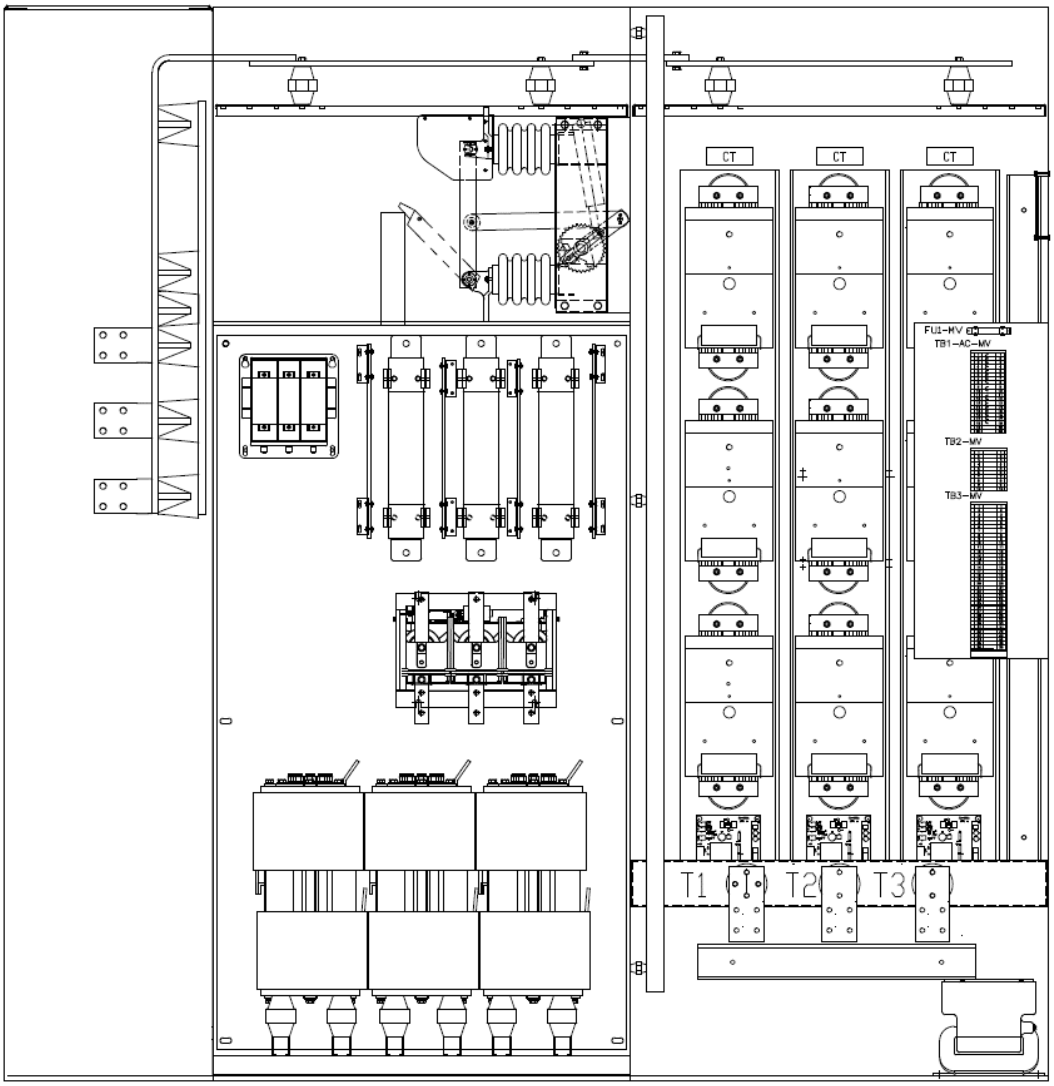



**Figure 5.3.8** Medium Voltage Heater Controller Front View.

**Figure 5.4** Incoming Power Termination Bus System

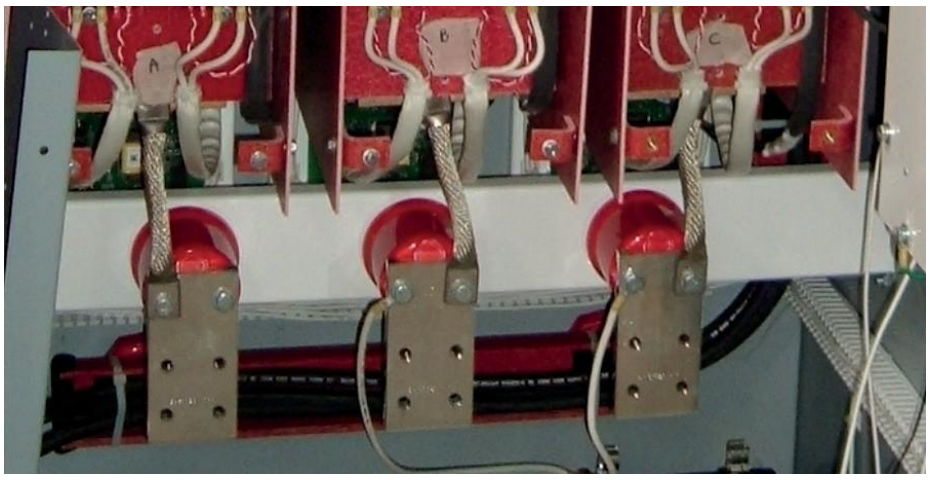


**Figure 5.5** Load Termination

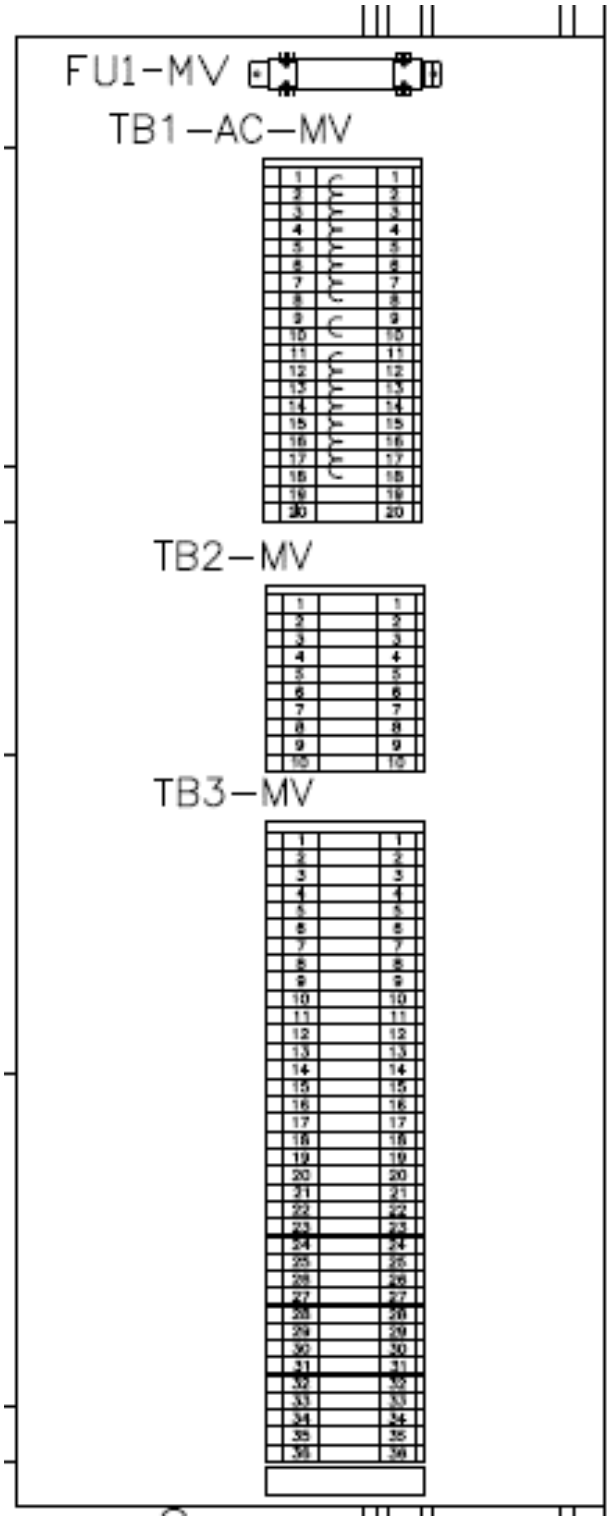



**Figure 5.6** Typical Control Terminal Layout

### 5.6.1 Control Connections

Control connections can be found on a grounded metal barrier located in the SCR section on the right hand side. These terminals provide both the low voltage compartment control connections, and the field wiring interface connections.

# Chapter 6 – Startup and Operation

## 6.1 Introduction

The Medium Voltage Controllers are designed and tested to meet UL347C specifications for Medium Voltage Heater Controllers. Successful operation of this equipment depends as much on proper installation and maintenance by the user as it does on careful design and testing. This document is provided to assist users with safe and efficient installation, maintenance, and operation of the equipment.

**NEVER WORK ON THIS EQUIPMENT WITHOUT DE- ENERGIZING AND GROUNDING THE OVERHEAD BUS SYSTEM.**

**NOTE: OVERHEAD BUS IS ELECTRICALLY LIVE EVEN WHEN DISCONNECT/ISOLATOR SWITCH IS TURNED OFF.**

Always de-energize and ground the system before performing tests, maintenance, or repair.

Always let the interlock devices provided with the system perform their intended function without forcing or defeating the devices.

### 6.1.1 Startup / Commissioning

All Medium Voltage Systems and Medium Voltage Heater Controllers **SHOULD** have commissioning services performed by Factory Service Personnel OR Factory Trained and Certified Technician. Certified Startup Commissioning provides you with an additional warranty on parts. Contact your Sales Representative for more information.

All written and implied warranties could be void if non-Factory Service personnel perform commissioning services and damage to the equipment result from those services.

## 6.2 Features

The Medium Voltage portion of the Heater Controller consists of up to five main sections:

1. Incoming Power Section
2. Disconnect Switch Section
3. Contactor and Fuse Section
4. SCR Power Controller Section
5. Low Voltage Section for instrumentation

The Low Voltage Section is located in the SCR Section, but it is completely isolated from Medium Voltage. A hinged door provides easy access to the Low Voltage Section.

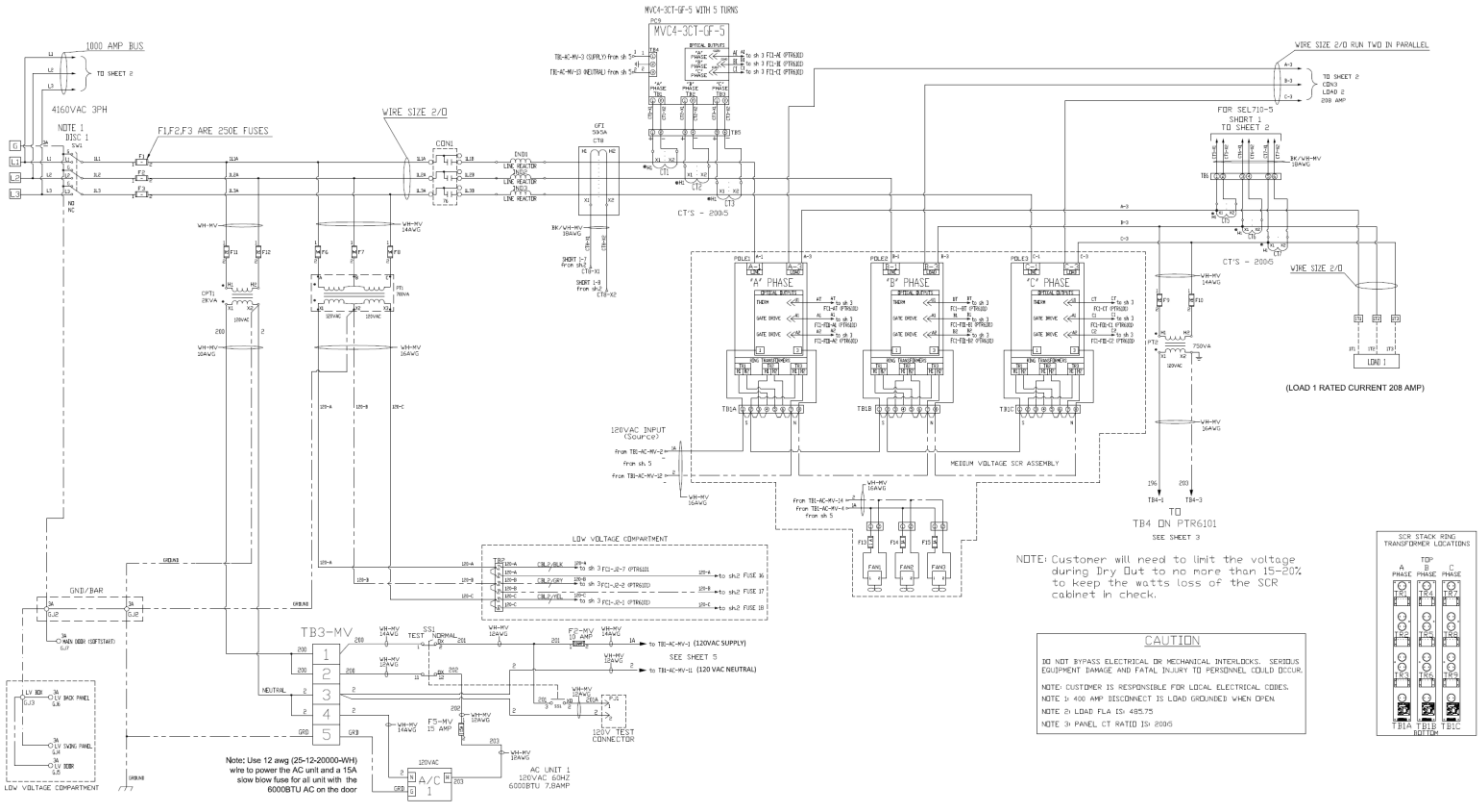



**Figure 6.1.1**

Figure 6-6.1 above shows electrical system

## 6.3 Theory of Operation

The controls system function automatically controls the heater output as demanded by the customer supplied 4-20 mA proportional demand signal. The power output of the heaters are controlled using solid state SCR (Silicon Controlled Rectifier) switches. Given that the demand signal is 12 mA (50% demand); the SCR switches would be “gated” into conduction to allow 50% of the available power to be sent to the heater. This power proportioning is controlled into two selectable methods:

**Phase Angle**

Phase angle-controlled gates the SCR switches into conduction at various angles of the incoming sine wave. Given a 50% demand, the SCR switches would be gated into conduction at 90 degrees into the positive sine wave and 90 degrees into the negative sine waves. This type of control is very precise but may cause harmonic distortion and electromagnetic interferences (EMI) problems. To minimize total harmonic distortion (THD) & EMI Motortronics recommends this control method only be used as needed in favor of the time proportional control scheme.

**Time Proportional Control**

Time Proportional Mode delivers power to the load by time proportioning full sine waves of power to the load. This is accomplished by gating the SCR switches into conduction at the zero volt point thus the di/dt is much lower resulting in much lower harmonic distortion & EMI. For example, if the ZC control is based on a 1 second time base at the 50% demand, the SCR switches would be conducting full Sine of power for ½ second and no power for ½ second resulting in 50% of the available power being delivered to the load. This feature can be customized to any scheme if installing your own PLC.

As mentioned above, there are two special modes of operation that the Medium Voltage Heater Controller provides:

**Soft Start**

Soft Start Capability (SS) as the name implies starts delivery of the power to the heater at an extremely low level and gradually increases it. In this mode, when the heater start sequence is initiated, the Medium Voltage Heater Controller starts in the PA mode and ramps the demand up over a 15 second interval until either 100% output is achieved or the ramping output level equals the power demand. At that time, the SS feature will shut down and the Medium Voltage Heater Controller will control to the demand signal to whichever control mode is chosen.

### 6.3.1 Interlocks

There are three basic interlocks that will disable the Medium Voltage Heater Controller output: One is the Disconnect Switch Auxiliary contact in the start permissive circuit which must be closed prior to starting. The second is the Blown Fuse Auxiliary contact in the start permissive circuit which also must be closed prior to starting and the third is the normally closed interlock input available on the control board at TB1. The interlock input at TB1 on the control board will also stop the unit if running/

### 6.4 Before Powering Up

Motortronics takes immense pride in knowing that we have provided you with a product of premium quality and workmanship. We have taken every precaution to ensure that your equipment arrives safely and securely.

However, vibration and temperature changes during shipping can cause some components to become loose. Additionally, throughout the life span of this product, other environmental and application conditions may have affected the mechanical and electrical continuity of some internal components. Therefore, for your safety and overall product performance, please take the time to familiarize yourself with the **GENERAL MAINTENANCE & PRESERVATION INSTRUCTIONS** found in Section 8 of this manual.

It is not uncommon for electrical wiring and mechanical connections to become slightly loosened during shipment. We ask that you pay particular attention to Section 8-3 Wiring and Connections

# Chapter 7 – Observations & Troubleshooting

## 7.1 The following critical components should be constantly monitored, and alarm conditions displayed.

- Disconnect/Isolator 1
- Disconnect/Isolator 2 (If present)
- Load Contactor 1
- Load Contactor 2 (If present)
- SCR Fuses Circuit 1
- SCR Fuses Circuit 2 (if present)
- All Overtemp Alarm Conditions
- GFI (Ground Fault Interrupt) (if present)
- E-Stop (Emergency Stop)
- Firing Circuit Fault Alarm

If any of the above goes into fault condition the associated load contactor **must be turned off.** Check the fault conditions disconnect all power and ground the bus system before making any attempt to repair or replace defective component.

# Chapter 8 – General Maintenance & Preservation

Preventive maintenance consists of inspections, testing and cleaning of equipment at scheduled intervals. It helps detect and correct conditions that could cause equipment malfunction. The scheduled maintenance instructions in this manual are intended to duplicate those furnished in the Preventative Maintenance Schedule. In case of conflicts, the maintenance schedule documentation takes precedence. Such conflicts should be logged onto the user comment sheet and reported immediately in accordance with the maintenance procedures for this manual.

**REMOVE ALL POWER**

**Preventive Maintenance Schedule**

The schedule for conducting preventive maintenance depends on how much the equipment is used. Table 8-1 lists the suggested maintenance schedule, which is based on average conditions. This schedule should be adjusted for each application or as experience requires.

| Term | Title | Applicable Paragraph |
|---|---|---|
| **6 months** | Enclosure Exterior | 8-1 |
| **6 months** | Enclosure Interior | 8-2 |
| **6 months** | Wiring and Connections | 8-3 |
| **6 months** | Lights and Fuses | 8-4 |
| **1 year** | Contactor | 8-5 |

Table 8.1

**8.1 Enclosure Exterior**

Inspect the panel and Medium Voltage Heater Controller exterior as follows:

a) Wipe off all dust, moisture, and oil with lint-free cloth. Remove corrosion with sandpaper.

b) Remove heavy dust or grease with a wooden scraper.

c) Touch up all bare spots with primer and paint.

d) Inspect door gaskets and replace them if worn and/or deteriorated.

e) Oil door hinges and latches with machine oil as needed.

**a. Enclosure Interior**

**Warning, only service the interior of the unit after proper lock out-tag out procedures have been done.**

Clean and inspect the panel and interior as follows:

a) Remove dust and dirt from electrical components with a vacuum cleaner.

b) Remove sticky dust, grease, and oil with a dry, lint- free rag or small paint brush dampened with cleaning solvent.

c) Inspect for corrosion on metal parts. Repair or replace if found.

d) Inspect for worn or broken parts. Repair or replace if found.

e) Inspect for evidence of dripping water or liquids falling on equipment parts. If found, determine the cause and correct.

f) Make sure that moving parts move freely and do not stick.

g) Replace or clean dirty ceiling fans and filters if present.

### 8.3 Wiring and Connections

Check wiring and connections as follows:

a) Inspect wiring for wear, fraying, chipping, nicks, and evidence of overheating. Repair minor defects with a good grade of electrical tape or replace them if needed.

b) Inspect for loose electrical and mechanical connections. Tighten or replace defective crimp-style lugs. Tighten or replace all loose or missing hardware.

### 8.4 Lights and Fuses

Check lights and fuses as follows:

a) Check indicating lights for burned out lamps. Replace as required.

b) Check fuses for correct ratings. Replace as required.

### 8.5 Contactors

Vacuum Contactor are sealed unit and require little maintenance. Refer to contactor manufacturer manual included in the document package for care and maintenance of contactors.

### 8.6 SCR Stacks

SCR Stacks and associated electronics boards and wiring harnesses are designed for long life and trouble-free operation.

Refer to manufacturer manual included in the document package for care and maintenance.

# Specifications

**MVH-7 MEDIUM VOLTAGE SCR HEATER POWER CONTROL**

VOLTAGE 2.3 - 7.2kV 3 Phase (+10% to -15%), 50Hz or 60HZ,

Maximum Current Rating 200A for 2.3-5kV and 150A for 7.2kV systems.

Ambient Temperature: 32F-104F (0-40C)

5-95% relative humidity (non-condensing)

0-3300 ft (1,000m above sea level without derating)

Designed to meet the requirements for 60kV BIL.

Design follows UL347C requirements.

PIV rating 9000V for 2300-4160V and 19500V for 6000-7200V systems

Transient Voltage Protection dV/dt network per SCR pair

NEMA Type 1 enclosure (IP20) Standard.

Forced air cooling (450CFM) SCR Section

Watt Loss 550W per phase assembly. The unit is approximately 2kW at full power.

**Disconnect Section (SWG)**

NEMA 1 Painted enclosure,

Main fused disconnect cabinet.

- Isolation Switch 7.2kV 400A disconnect with mechanical interlock for main enclosure door.
- Disconnect viewing window for position visual confirmation.

Max Fuse rating 250E

Inline Isolation Vacuum contactor, 7.2kV 400A

Potential Transformer (PT) Providing phase and voltage reference for SCR firing.

Control Power Transformer (CPT) for 120/1ph for MVH system use.

Di/Dt limiting Line Reactors / Inductors (Set of 3)

Approximate section dimensions: 36” W x 30” D x 92.5” H

**SCR Section**

NEMA 1 Painted enclosure with Low Voltage Section

The SCR Section is mechanically interlocked with the Disconnect Section.

SCR Section Fan ventilated (450CFM)

(3) SCR Power Pole Assemblies

Phase Monitoring CTs with 3CT PCB and Fiber Optic isolation

**Low Voltage Section**

- SCR Trigger / Control Board
- SCR Fiber Optic gate signals
- Fiber optic phase current and SCR power pole thermal sensing
- 3PH Inputs from PT
- 120Vac power from CPT
- SCR Trigger board Low Voltage Power Supply Transformer
- Start / Stop Control connections for customer use.
- SCR Power Pole Overtemp contacts for customer use
- Phase current feedback for customer use 0-10VDC =0-200A (150A for 7.2kV units)
- B-C Phase output voltage feedback for customer use 0-10VDC = 0-5000V (0-7500V for 7.2kV units)
- Customer Input for Automatic Signal SCR firing control connections for phase angle
- Based on a 4-20mA, 0-5VDC, or 0-10VDC input
    - Customer controlled SCR Burst Firing via the Inhibit Control 24VDC input.
    - Customer Input for Manual control by potentiometer

Sizes for Standard Models:
Approximate section dimensions: 36” W x 30” D x 92.5” H
Cable Exit BOTTOM

Sizes for Standard Models:
Approximate overall system dimensions 90” W x 30” D x 92.5” H

## Warranty

\Motortronics warrants its products to be free from defects in material and/or workmanship for a period of one year from the date of installation to a maximum of 18 months from the date of shipment as indicated by the unit's date code. The company reserves the right to repair or replace any malfunctioning units under warranty at their option. All warranty repairs will be done at the Company factory, unless otherwise agreed upon. On-site warranty repairs can only be performed by a Company Factory Service Technician or by a Company Factory, Trained, Certified and Approved technician/firm. The Company must first approve the on-site repair, prior to making any travel to the site.

Solid state controls have different operating characteristics from those of electro-mechanical equipment. Because of these differences and the wide variety of applications for solid state controls, each application designer must verify that the solid-state equipment is acceptable for his application. In no event will Motortronics be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment. The diagrams and illustrations in this document are included solely for illustrative purposes. Because of the number of different applications, Motortronics cannot be responsible or liable for actual use based on the examples or diagrams.

**California Customers:**

**California Proposition 65 Warning**

WARNING: this product and associated accessories may contain chemicals known to the State of California to cause cancer, birth defects, or other reproductive harm. For more information visit https://p65warnings.ca.gov

# MOTORTRONICS™

Solid State AC Motor Control

# MVH

## MEDIUM VOLTAGE HEATER CONTROLLER

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