

Installation & Operation Manual

CHROMALOX DIRECTCONNECT™ MEDIUM VOLTAGE CONVERTER SYSTEM



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Referenced Annexes available upon request after receipt of order and/or delivery.

A: INTRODUCTION & SAFETY

IMPORTANT SAFEGUARDS



The DirectConnect™ Converter System manual uses this symbol to alert personnel to potential hazards that may damage the equipment.



The DirectConnect™ Converter System manual uses this symbol to alert personnel to potential hazards that may cause injury or death.

⚠ WARNING

1. GENERAL

1.1 SCOPE

This manual provides instructions for receiving, handling, storage, installation, startup (commissioning), operation, and maintenance (including troubleshooting) of Chromalox Medium Voltage Converter Systems designed and built to IEC or UL standards.

⚠ WARNING

2. INTRODUCTION

2.1 KEY SAFETY PRACTICES



ALL PERSONNEL WORKING ON MEDIUM VOLTAGE ELECTRICAL EQUIPMENT MUST ADHERE TO ALL NATIONAL AND LOCAL REGULATIONS, CODES, AND STANDARDS.

ONLY SUITABLY QUALIFIED AND EXPERIENCED PERSONS, WHO ARE FAMILIAR WITH THIS EQUIPMENT, AND THE WORK THEY ARE TO DO, SHOULD CARRY OUT INSTALLATION, COMMISSIONING, OPERATION, OR MAINTENANCE OF THIS CONVERTER SYSTEM AND THE ASSOCIATED HEATER.

SUCH PERSONS SHALL ADHERE TO PROPER MEDIUM VOLTAGE SAFETY PROCEDURES, INCLUDING THE USE OF APPROPRIATE PERSONAL PROTECTIVE EQUIPMENT (PPE).

FAILURE TO ADHERE TO ANY OF THE ABOVE MAY RESULT IN EQUIPMENT DAMAGE, OPERATING LOSSES, INJURY, OR DEATH. CHROMALOX WILL NOT BE LIABLE FOR FAILURE TO ADHERE TO ALL GOVERNING REGULATIONS, CODES, STANDARDS, SITE PROCEDURES AND INFORMATION GIVEN IN THIS MANUAL.

IF IN DOUBT, CONTACT CHROMALOX.

2.2 DESCRIPTION

An MV DirectConnect™ Converter System will be made up of multiple 'Sections'.

The primary load control element is the three-phase line-commutated semiconductor (SCR) power 'Converter' section. This contains three SCR 'Stacks', each with three pairs of SCRs connected in series. Each pair of SCRs is mounted in 'anti-parallel' so that one SCR can

control the current flowing in one direction, and the other can control it when the current is flowing in the opposite direction.

The Converter section also contains an output voltage monitoring VT, three load current CTs, and a CT connected around all three phases to measure residual current leakage to earth [ground]. It will usually also contain the MV Load Terminals, though these could be supplied in a separate section. The Converter switches the supply voltage in such a way as to control (reduce) the amount of voltage that reaches the heater to provide the heating needed.

Power for the Converter is fed from the 'Controller' section. This contains an MV Disconnect Switch, fully rated Type E MV fuses, an MV Contactor, Inductors, and an input voltage monitoring VT. It can also contain a power supply Control Power Transformer (CPT), and the MV Supply Line terminals. Cooling for the Converter stacks is provided by a door mounted fan (for NEMA 1), or a side mounted Heat Exchanger (for NEMA 4). The Inductors, which are connected in circuit between the Contactor and the SCR stacks, limit the rate of rise (di/dt) of current flowing into the SCRs.

If the incoming MV supply line terminals are not mounted in the Controller section, a separate 'Direct-on-Line' ('DOL') section will be provided for these terminals.

If multiple Heaters are to be fed from a Converter, and separate switching control is required for each Heater, 'Load Switching' section(s) will be provided, each with up to two Contactors, and associated load terminals.

If the total Heater load exceeds the maximum that can be supplied by the Converter, the Converter System will be equipped with additional 'Stepper' sections that work in sequence with the Converter to ramp the Heater load up to the level required. 'Stepper' sections each have a Disconnect Switch, MV fuses, and output Power and Dry-out Contactors.

LV control is mounted in a separate 'LV Compartment' that is mounted on the front door of the Converter.

The doors for the various sections, and for the Low Voltage compartment can be locked closed using key locks provided in the door handle.

The Disconnect Switches mentioned above each provide an isolation gap between the Supply/Line power and the associated Heater(s). They can be padlocked open. A window is provided for each Disconnect Switch so that its status can be verified visually.

The Disconnect Switch and the Heater junction box(s) can be equipped with a key inter-locking system intended to prevent opening of certain compartments until specific conditions are met. For example, the Heater junction box lock may be equipped with a key that is captured in the Disconnect Switch mechanism and is not released until the Disconnect Switch is open.

Secondary compartmentalization may be provided, in which the Disconnect Switch(s) is segregated in its own compartment within the Controller or Stepper section. This compartment has its own door, and with this door closed, in some regions / applications, if the Disconnect Switch is open access to the associated MV fuses mounted in that section, is possible for replacement with MV power still connected to the primary side of Disconnect Switch. Appropriate PPE must be worn. However, it is strongly recommended that, if at all possible, the main incoming supply be switched off and locked off upstream of the Converter System before such work is carried out.

2.3 GENERAL SAFETY PRINCIPLES

All connections should be considered energized until proven to be de-energized, and until every possible precaution has been taken to ensure that they stay de-energized until work is complete.

Suitable visible warning devices should be placed around the Converter Systems, at a suitable distance from the equipment, if work is necessary when the System is still live.

Components inside the Converter System may stay physically hot for some time after supply has been switched off. SCR snubber capacitors will self-discharge in less time that is needed to remove the red-board covers.

2.4 DE-ENERGIZING & EARTHING/GROUNDING



BEFORE WORKING INSIDE THE EQUIPMENT, CONFIRM THAT ALL POWER HAS BEEN TURNED OFF, LOCKED OFF, AND PREFERABLY EARTHED [GROUNDED] AT ALL POINTS OF LOW AND HIGH POTENTIAL, ON BOTH THE SUPPLY LINE AND LOAD SIDE CIRCUITS, AS REQUIRED/ PERMITTED BY ALL CODES AND STANDARDS

Never assume: Use a properly rated voltage sensing device to verify that power is off.

The Disconnect Switches mentioned above provide an isolation gap between the Supply Line power and the associated Heater(s). They can be padlocked open. A window is provided so that its status can be verified visually.

NOTE: INCOMING POWER SUPPLIES, TERMINALS, AND CONNECTIONS TO THE DISCONNECTOR SWITCHES ARE STILL LIVE WHEN THE DISCONNECTOR IS OPEN

The Disconnect and the Heater junction box(s) can be equipped with a key inter-locking system intended to prevent opening of certain compartments until specific conditions are met. For example, the Heater junction box lock may be equipped with a key that is captured in the

Disconnect Switch mechanism and is not released until the Disconnect Switch is open.

The VTs and CPT mentioned in the descriptions above will all back feed medium voltage onto the MV circuits if an auxiliary LV control is connected to their secondary(s).

Therefore, care must be taken when connecting any test equipment to the LV circuits, and the voltage free status of the MV circuits must be verified by testing, and preferably ensured by connecting a cable from each circuit to the earth/ground before any work starts.

2.5 DESIGN PURPOSE

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

2.6 COMPLETE SYSTEM

The Chromalox DirectConnect™ system is comprised of both a Chromalox MV Converter System and a Chromalox MV Heater. One may not be employed without the other. All written and implied warranties are voided if one DirectConnect™ component is used without the other.

2.7 STARTUP/COMMISSIONING

All Chromalox DirectConnect™ MV Converter Systems MUST be commissioned by Chromalox Service Personnel. All written and implied warranties are voided if non-Chromalox Service personnel are utilized for DirectConnect™ System commissioning.

B: RECEIPT, HANDLING, STORAGE & INSTALLATION

3. RECEIVING & HANDLING

3.1 Care should be exercised when moving Converter Systems as they are heavy and can tip over. Do not attempt to handle systems without securing properly and using only proper equipment capable of handling heavy loads.

3.2 When first received, inspect for shipping and handling damage. Proceed only if there is no visible damage.

3.3 Ensure that lifting equipment can handle the weight of the system.

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

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

4. STORAGE

4.1.1 Any system that is not installed and energized immediately should be stored in a clean, dry space where a uniform temperature prevents condensation. It should be stored in a heated building with adequate air circulation and protected from dirt, pollutants (especially conductive dust, salt laden air, and Hydrogen Sulfide), water, rodents, insects and mold. The system should be stored off the ground. Doors should never be left open.

4.1.2 Shipping containers are temporary protective covers. The system should not be stored outdoors for more than 24 hours. If the system must be stored outdoors for longer periods it must be protected from the outdoor elements with appropriate coverings.

4.2 SHORT TERM STORAGE

4.2.1 In non-humidity-controlled environments, the anti-condensation heaters (if fitted) must be energized, equivalent temporary heating sources must be provided, or desiccant must be used to prevent condensation on interior surfaces.

4.2.2 Electronic components can be damaged if stored at low temperatures. If the system is to be stored in an environment of less than 0°C [32°F], the internal heaters (if fitted) must be energized, or equivalent temporary heating sources must be provided.

4.2.3 Unless the system is designed for use in direct sunlight, it should be stored away from direct sunlight, or be suitably covered.

4.2.4 Once the system is taken out of storage, all desiccant, internal packing, caps, plugs, wrappings, etc. must be removed just prior to the equipment being placed into operation.

4.3 LONG TERM STORAGE

4.3.1 For long term storage, in addition to the above precautions, it is recommended that the entire system should be heat sealed in plastic barrier bags with the proper amount of desiccant included.

Converter Systems in long term storage should be inspected periodically for any signs of deterioration.

4.4 All written and implied warranties are voided if these storage guidelines above are not followed.

5. INSTALLATION



**PRECAUTIONS & WARNINGS:
READ AND UNDERSTAND SECTION A
ABOVE BEFORE CARRYING OUT THE
WORK DETAILED BELOW**



5.1 PREPARATIONS

5.1.1 The Heater skid & Converter System should be adequately protected against mechanical damage, extreme temperatures and other adverse environmental conditions.

5.1.2 Ensure that all precautions are taken regarding the weight of the equipment. Lifting equipment should have capacity for the given weight.

5.1.3 The foundation must be sufficiently strong to withstand the load of equipment and should be flat.

5.1.4 Converter Systems should be inspected for foreign material, and the entire system should be cleaned before startup.

5.1.5 General safety precautions listed in the plant safety procedures should be closely complied with to prevent injury to personnel or damage to equipment.

5.1.6 Ensure that personnel responsible for site safety and others in the vicinity are aware that work is being undertaken and required post warning notices. Ensure that the appropriate PPE and clothing is worn. Take all required precautions if working at above ground level.

5.1.7 Where possible hazards have been eliminated or reduced as far as is reasonably practicable by design, but the additional warnings listed below should be

5.2 MECHANICAL INSTALLATION

5.2.1 Converter Systems are shipped on heavy duty pallet(s) and can be lifted and moved using forklift trucks, or heavy-duty rollers.

5.2.2 Converter Systems may be shipped in one or more Transport Units / Shipping Sections. Each section is equipped with lifting angles allowing the System or Transport Unit to be removed from the pallet. All four lifting angles in the corners of the System should be used.

For outdoor installations these lifting angles should be removed, and the fasteners should be replaced. Sealing washers, shipped with the System, should be installed under the heads of the fixing screws before reassembly. Do not discard the lifting angles. They may be needed for lifting or moving the System in the future.

5.2.3 All lifting should comply with local codes. In particular, if lifting chains are used, they should be attached individually to each lifting eyes (i.e. not in a loop run through 2 or more lifting eyes), and there should be an angle of at least 45 degrees between the lifting chain and the roof of the Converter System.

On IEC Systems, if adequate space is not available above the Converter System for a lifting crane to be used, and access will be available behind the System once installed, the plinth front and rear bottom plates may be removed, and a fork truck or palette truck(s) may be used to move the System into place. Very great care must be taken if this form of movement has to be used to avoid damage to the plinths. The front and rear bottom plates must be replaced once installed as they form a key part of the structural integrity of the base.

5.2.4 Typically a minimum of 300mm [1ft] is necessary to the sides and rear of the Converter System for cooling, and 1.8m [5.9ft] is necessary at the front to allow enough space for personnel to pass in front of an open door.

The ceiling above Systems that are not Arc-Resistant must be at least 2.5m [8.2ft] above the floor to allow 300mm [1ft] of space above the roof for cooling.

IEC Arc Resistant Converter Systems are for internal use only. The ceiling above these Systems must be at least 4.4m [14.4ft] above the floor to allow 2m [6.6ft] of space above the roof for explosive products to exit.

Do not install Arc Resistant Systems below catwalks or other elevated access routes.

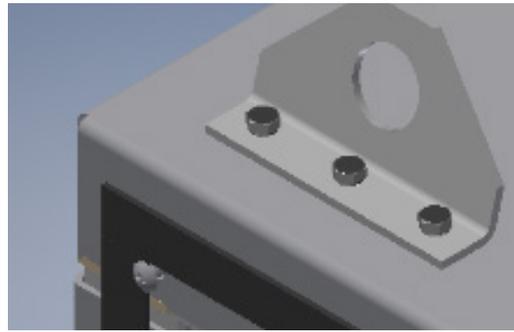
To ensure that water does not enter the System from below, adequate drainage should be provided around the System, and in cable trenches. Cable ducts should be sealed.

Avoid exposure to salt air, hydrogen sulfide, excessive dust, dripping water, falling dirt, or other similar conditions.

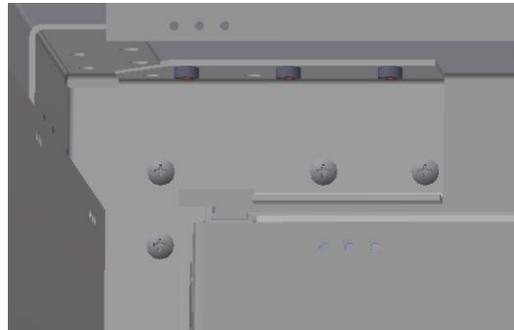
The equipment is not designed for seismic shock, or nuclear radiation hazards.

5.2.5 Once the Converter System is in place, it should be secured to the foundation by suitable means. On IEC Systems, the plinth front and rear bottom plates may be removed to access the plinth mounting holes. These plates must be replaced once the System is secured as they form a key part of the structural integrity of the base. On UL Systems, access to mounting holes can be found inside the enclosures.

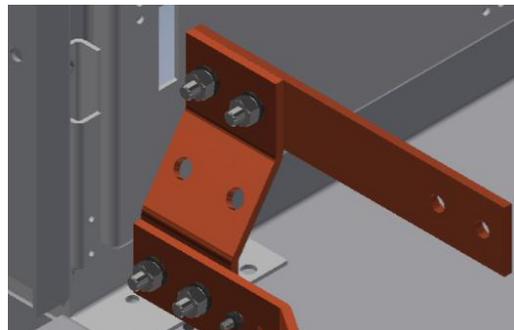
5.2.6 If IEC Converter System are supplied in shipping sections that have to be assembled together on site, the fasteners that are to be used to secure the shipping sections together, will be fastened to the left hand section of the each shipping section at the shipping split. There will be 24 such fasteners plus any associated washers at each shipping split, 6 per corner as shown below. Tighten the screws to 71lbs in [8.0 Nm].



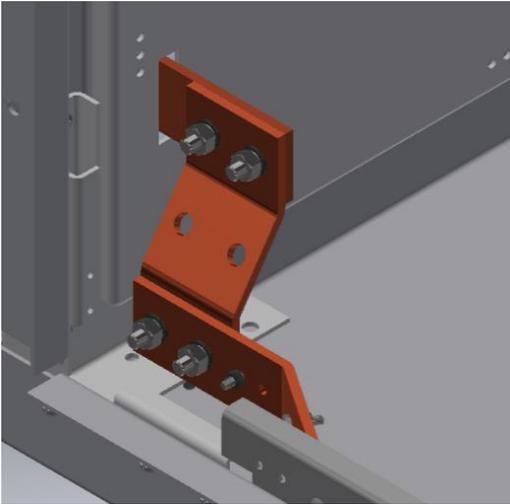
IEC sections must be brought together, and the fasteners (and any associated washers) must be installed from the inside of the section to the left of the slit through into holes where the fasteners were originally installed.



The ground bar link that connects the ground bars in the IEC sections either side of the shipping split will be mounted such that it faces into the section.



It should be detached from the vertical copper stub that it is attached to, turned through 180 degrees, and reassembled such that it passed through the slot in the adjacent steelwork.



It should be reconnected to the vertical stub it was removed from, and to the equivalent vertical stub in the section to the left of the shipping split with the hardware provided. Tighten the nuts 19.4lbs ft [26.3 Nm].

Consult the schematic diagram(s) and reconnect all LV wires at the interconnection terminal blocks or plugs and sockets provided at the split, and all the MV power cables.

5.2.7 On Arc-resistant IEC sections the additional parts used to create the arc shroud (that guides arc products exiting from the top of the system upwards) may be shipped separately, the instructions given in Annex 2 should be followed to assemble it on site. The shroud for each section consists of 4 parts plus all the fixing screws required. If rear access to the System is not possible, the rear and side pieces of the shroud should be assembled to the enclosure before the System is placed in its final position.

When complete, the shroud should form a wall around the top of the Converter System. Partitions between parts of the shroud above different sections have large opening in them to give arc products the maximum amount of space to expand into. It is important that all fasteners between parts of the shroud, and between shroud parts and the enclosure top are in place and securely tightened.

5.3 CABLING

ACCESS TO THE CABLE TERMINATIONS SHOULD ONLY BE MADE WHEN THE POWER FEEDS ARE ALL TURNED OFF, LOCKED OFF AND PREFERABLY EARTHED / GROUNDED.

5.3.1 Incoming MV cable terminals are mounted in the Controller section, or DOL section, and provide easy termination of incoming power wiring. Space is provided for the spreading, bending, and termination of over-size cables if these are needed to minimize voltage drops. Follow instruction provided by the cable or cable termination manufacturer.

The DOL and Controller doors are locked/bolted closed, and the Controller door cannot be opened if the Disconnect is not open.

The incoming power cable gland plate is mounted on the base, or roof, in line with the cable terminations.

5.3.2 Outgoing MV cable terminals are mounted in the Converter and/or Load Switching section, and any Stepper sections, and provide for easy termination of power wiring from the Converter System to the Heater(s). Plenty of space is provided for cable bending, and termination. Follow instruction provided by the cable or cable termination manufacturer.

The Converter, Load switching, and Stepper Sections are key locked, and the Converter door is blocked closed if the Disconnect is closed.

The outgoing power cable gland plate is mounted on the base, or roof, in line with the cable terminations.

5.3.3 Incoming and outgoing LV cable terminals are mounted in the LV compartment on the Converter front door. The main control board and all Temperature and Over-temperature controls are also located in the LV compartment. This compartment is segregated from Medium Voltage and can be opened without de-energizing the main power if local codes permit.

All required PPE should be worn.

The LV compartment door is key locked.

An LV cable gland plate is mounted on the base, or roof, to the right of the power cable gland plate.

C: COMMISSIONING

6. COMMISSIONING



**PRECAUTIONS & WARNINGS:
READ AND UNDERSTAND SECTION
A ABOVE BEFORE CARRYING OUT
THE WORK DETAILED BELOW**



6.1 BEFORE POWERING UP

Chromalox takes great pride in knowing that we have provided to you a product of premium quality and workmanship. We have taken every precaution to ensure that your equipment arrives safe and secure.

However, shock, vibration and temperature changes during shipping can cause some components to become loose.

Wiring and Connections:

Since electrical wiring and mechanical connections may be loosened during shipment, before first energizing the Converter System, inspect wiring for damage and repair or replace if needed.

Inspect for loose electrical and mechanical connections. Tighten or replace defective crimp-style lugs. Re-solder loose solder connections. Tighten or replace all loose or missing hardware – see page 17 for fastener torque values.

6.2 ELECTRICAL TESTING

Check that Supply Line cable connections to the Converter System match phasing rules for the site.

Disconnect Lightning Arresters if fitted.

Remove all fuses from VTs and CPTs. Label these so that they can be correctly placed back into service.

Close the Disconnecter.

Simulate a closed Contactor by shorting each of the Contactor Vacuum Interrupters (VI) using a slim wire connected between the terminals at each end of each VI.

Carry out Power Frequency (Hi-pot) tests to ensure that there is no hidden damage in the insulation system as follows:

Perform a phase to phase Power Frequency (Hi-pot) test, across the Supply Line terminals.

Perform a phase to earth / ground Power Frequency (Hi-pot) test, from each Supply Line terminal to the enclosure.

Perform a phase to phase Power Frequency (Hi-pot) test, across the Load terminals.

Perform a phase to earth / ground Power Frequency (Hi-pot) test, from each Load terminal to the enclosure.

| System Max Voltage kVac | Factory Test Voltage kVac | Site Test Voltage kVac |
|-------------------------|---------------------------|------------------------|
| 7.2 | 20 | 16 |

The voltage should be raised gradually to the Site Test voltage, then kept at that voltage for 1 minute, then reduced gradually to zero.

Remove the wires connected between the terminals at each end of the contactor VIs.

Replace all fuses in VTs and CPTs.

D: OPERATION

7. STARTUP & OPERATION



**PRECAUTIONS & WARNINGS:
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ABOVE BEFORE CARRYING OUT THE
WORK DETAILED BELOW**



7.1 THEORY OF OPERATION

The controls system uses a PLC to automatically control the Heater output to meet the 0-100% process demand signal (generated internally or customer supplied). There are 2 control methods: Full SCR, and SCR w/Trim.

In a full SCR system, the power output to the heaters is controlled using solid state SCRs (Silicon Controlled Rectifiers). If the process demand signal is at 50% (12 mA demand), the SCRs would be “gated” into conduction to allow 50% of the available power to be sent to the heater. Full SCR systems with multiple heater circuits all operate at the same demand level, they are not staged. For example, a 3 SCR system with a process demand of 45% will trigger all 3 SCR’s at 45%.

In an SCR w/Trim system, the first load utilizes an SCR, while all remaining loads are controlled by a contactor. The PLC looks at the process demand and calculates how many contactor loads need energized, and what the final SCR output will need to be. Some stepper systems may use different sized loads.

In either mode, this power proportioning is controlled by one of two methods: Zero Crossover, or Phase Angle.

ZERO CROSSOVER CONTROL

Zero Crossover control (ZC) proportions the amount of power to the load by supplying full sine waves of power to the load for a short period, then supplying no power for a short period, this sequence repeating. The ratio of on to off periods determines the average power to

the load. This is accomplished by gating the SCR switches into conduction at the zero volt point on the sine wave, resulting in much lower harmonic distortion & EMI. The ZC control is based on a 1 second time base so in the 50% demand example, 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 is the control mode used in normal operation of the Heater.

PHASE ANGLE CONTROL

Phase Angle control (PA) gates the SCRs 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 in the positive sine wave, and again in the negative sine wave. This type of control is very precise but can cause harmonic distortion issues, so it is restricted to use in the Dryout Mode only unless manually selected by the operator. When PA is manually selected, the main HMI screen will flash an indicator to alert that PA is active.

SLOW START MODE

In Slow Start mode (SS), zero crossover is used to start up to gradually increase the power over a 100 second interval, until either 100% output is achieved, or the ramping output reference equals the power demand. This mode is selectable.

DRY-OUT MODE

The Dry-out Mode (DM) feature, available on in systems with SCR’s, is used to “dry out” Heaters that may have accumulated moisture during long periods without power applied. Phase Angle firing mode is used to limit the voltage applied to the elements. This is required in HV heating systems due to the large amount of energy that can be delivered in a single burst. As a Heater that contains significant moisture could be damaged by full voltage, DM helps to minimize this risk.

Note that in SCR w/Trim systems, the Converter is used to dry-out the heater attached to the Stepper before it is connected to the supply line power.

Dry-out can be accomplished in two ways:

Manual: If Manual Dry-out is selected from the HMI, the system will dry out the selected Heater until it is turned off from the HMI.

Automatic: The Automatic Dry-out mode utilizes feedback from the residual current monitoring system, comparing the residual current with a preset value from the HMI. If this preset is exceeded, the controller will enter automatic dry-out mode and stay in that mode for the number of minutes set on the HMI.

If the system is unable to dry-out a Heater after the programmed number of attempts, the affected Heater will be disabled, and the HMI will display a dry-out fault condition.

In both dry-out modes, the maximum output is set using the HMI, up to a maximum of 20%. If the process demand signal is lower than the Max setting on the HMI, the lower of the two signals will be used to avoid damaging the process.

7.2 ELECTRICAL INTERLOCKS

There are seven basic electrical interlocks that will disable the Converter output:

Sheath or Flange Temperature Over-temp (OTC). The System can be equipped with multiple Over-temp Limit Controllers to protect the heater from failure. The OTC(s) indicate both an ALARM and a TRIP condition on the HMI. The ALARM condition is a warning and will self-reset when the temperature falls to a safe value. The TRIP condition must be manually reset (via HMI or remote input), after the temperature has lowered back to a safe value.

Residual leakage current. If the leakage current exceeds the trip point set on the relay, the relay will signal the PLC to trip the MV Contactor to

disable the affected load. The relay must be manually reset (via HMI or remote input), and the alarm condition cleared before the heater can be re-enabled.

The disconnect switch auxiliary contact must show that the disconnect switch is closed for each load before the heater can be energized.

The Blown Fuse Auxiliary contact must show that the MV fuses are all intact before the heater can be energized.

The local and external E-Stop circuits must be made before starting.

Any remote permissive inputs must be energized.

Each SCR is controlled by a firing card that has an alarm contact that must be clear, indicating the SCR is not overheating.

7.3 HMI SCREENS - GENERAL

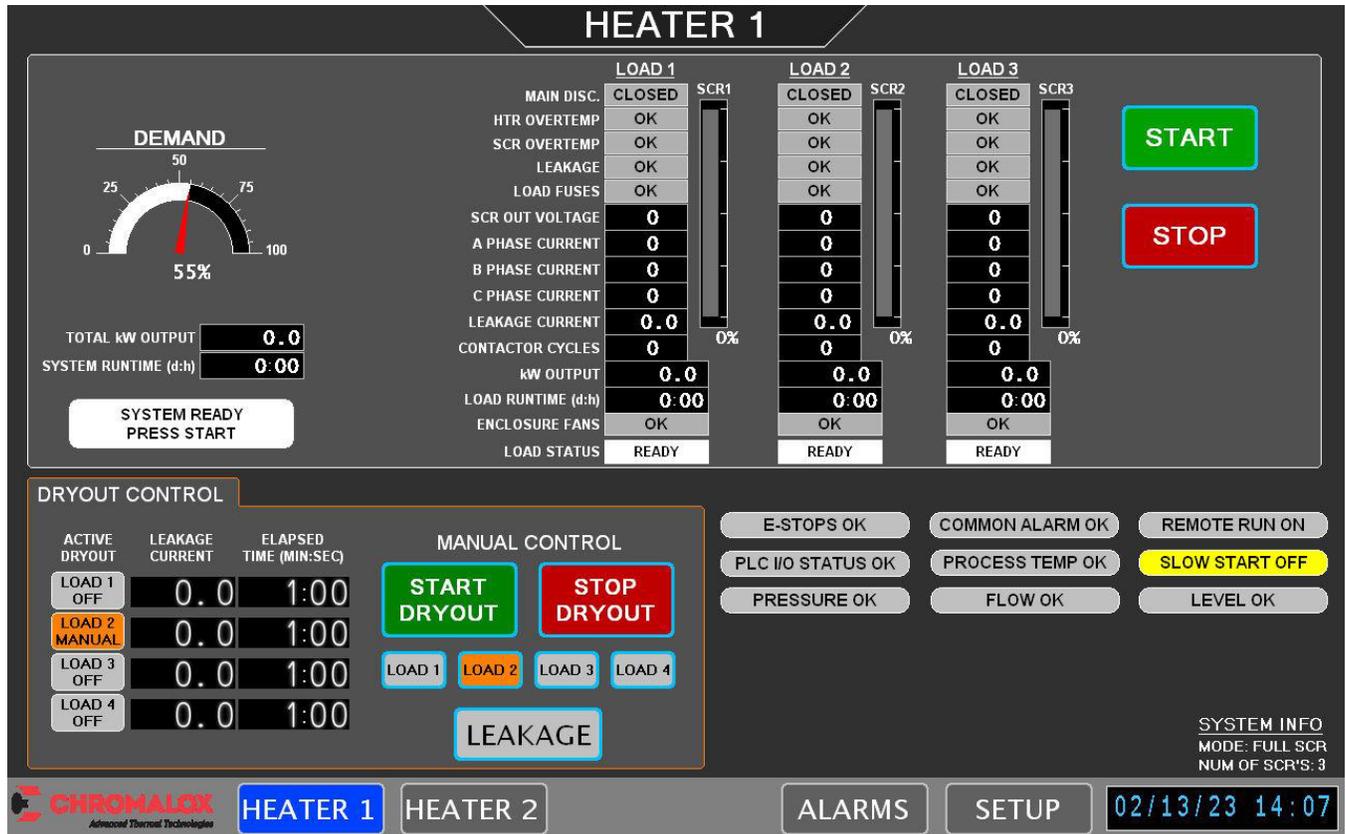
The HMI screens have a navigation bar across the bottom. This menu stays visible for most screens making navigation between screens easy, the leakage current screen being the only exception.

When the Converter System is first energized, it is important to set up the HMI using the SETUP screen before using any of the control screens.

The following sections show screens that are used in normal operation only. See 'Annex A' for more detailed explanations, and for additional set-up, dry-out, and diagnostic screens.

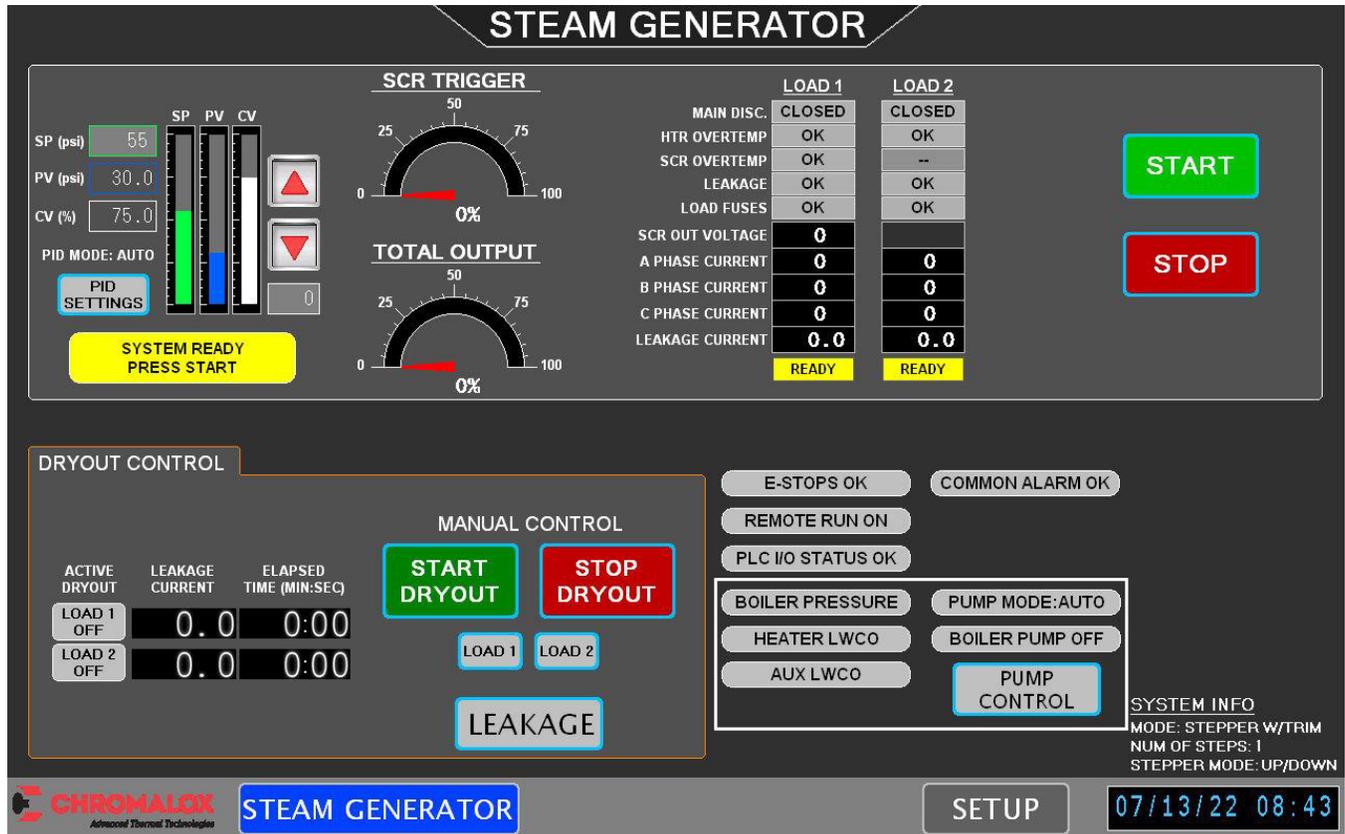
7.4 HMI SCREENS

The HEATER screen shows an overall view of the system, displaying system demand, permissive signals, measured output voltages, phase currents, leakage currents, and status for each heater load. This screen also displays DRYOUT control, as well as START/STOP functionality. The following shows an example of a 3 SCR system in AUTO mode, with the demand coming from a temperature controller or remote demand signal. The system is shown READY, pressing the START button would energize the heater. System permissive signals and indications (E-stop, Common Alarm, etc..) are shown on the bottom right. Some indications (Pressure, Flow, etc..) may not apply to all systems.



7.5 HMI SCREENS (STEAM GENERATOR SYSTEMS)

The STEAM GENERATOR screen shows an overall view of the system, displaying system demand, permissive signals, measured output voltages, phase currents, leakage currents, and status for each heater load. This screen also displays DRYOUT control, as well as START/STOP functionality. The following shows an example of a 2 circuit Stepper system with an internal PID loop in AUTO mode. The system is shown READY, pressing the START button would energize the heater. System permissive signals and indications (E-stop, Common Alarm, etc..) are shown on the bottom right. Steam Generator specific signals are shown in the white border (Pressure status, Pump Status, Low Water Cutoff).



E: INSPECTION & MAINTENANCE

8. INSPECTION & MAINTENANCE



**PRECAUTIONS & WARNINGS:
READ AND UNDERSTAND SECTION A
ABOVE BEFORE CARRYING OUT THE
WORK DETAILED BELOW**



8.1 MONITORING

Any one of the following will prevent the Converter starting:

- MV Disconnect open
- Emergency Stop engaged
- Remote Run off

If any of the following goes into a fault condition the MV Contactor will be turned off.

- MV Fuses
- Over-temp monitors
- Ground / Earth Fault monitors
- Firing Circuit

Determine and rectify the cause of the fault before making any attempt to re-energize the Converter System.

8.2 PREVENTIVE MAINTENANCE

Preventive maintenance consists of inspections, tests 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 enhance and form part of the site's planned maintenance program.

PREVENTIVE MAINTENANCE SCHEDULE

The schedule for conducting preventive maintenance depends on usage and site conditions.

Unless the site has a known environmental risk, it is recommended that maintenance be carried out annually until experience allows the schedule to be adjusted.

If the site has a known environmental risk, it is recommended that maintenance be carried out every six months until experience allows the schedule to be adjusted.

It is recommended that the maintenance interval should never exceed 5 years.

ENCLOSURE EXTERIOR

Inspect the Converter System's exterior:

- Inspect fan air inlet and air exhaust filters and replace if necessary.
- Touch up all chipped paint with primer and paint. Remove any corrosion with sandpaper.

ENCLOSURE INTERIOR

Before accessing the interior of the System, it is important to remove any materials from the outside surface that may enter the System.

- Wipe off all dust, and moisture from the exterior surface of the door and surrounding enclosure frame with a lint-free cloth.
- Remove oil, and grease from the exterior surface of the door and surrounding enclosure frame with an alcohol-free cleaner.

Clean and inspect the System interior:

- Remove loose dust and dirt with a vacuum cleaner.
- Wipe off all moisture, and all remaining dust, and dirt with a lint-free cloth.
- Remove any sticky residues with a dry, lint-free rag, using an alcohol-free cleaning solvent.
- Inspect for evidence of dripping water or liquids falling on equipment parts. If found, determine the cause and correct.
- Inspect for rust on metal parts. Repair or replace if found.
- Inspect for signs of insect or animal damage. Remove any spider's webs.
- Inspect for signs of mold.
- Inspect for hydrogen sulfide corrosion (black marks on plating) on conductive parts and electrical contacts. Repair or replace if found.

- j. Inspect for salt corrosion on metal parts and electrical contacts. Repair or replace if found.
- k. Inspect for partial discharge erosion on insulators (signs of tracking on insulating surfaces). Determine the cause of the damaged by full voltage, DM helps to minimize this risk.
- l. Inspect for signs of overheating. If found, determine the cause and correct. Repair or Replace damage parts.
- m. Inspect for worn or broken parts. If found, determine if there is an underlying cause, the repair or replace.
- n. Inspect door gaskets and replace if worn and/ or deteriorated. Repair or replace if found.
- p. Make sure that moving parts move freely and do not stick. Lubricate if necessary.
- r. Inspect for signs of foundation damage or movement.

LUBRICATION

Oil door hinges and latches with light machine oil.

The Disconnecter mechanism moving parts should be lubricated every five years with ISOFLEX TOPAS NB 52.

If necessary, Disconnecter contact knives should be lubricated with ISOFLEX TOPAS NCA 52.

The Contactor should not be lubricated.

EXERCISE MECHANISMS

After lubrication, exercise the hinges, latches, and Disconnecter mechanism to ensure free movement. Close the Controller door to exercise the Disconnecter mechanism.

8.3 WIRING AND CONNECTIONS

Check wiring and connections:

- a. Inspect wiring for wear, fraying, damage, and evidence of overheating. Replace if needed.
- b. Inspect for loose electrical and mechanical connections.
 - Replace damaged lugs.
 - Re-solder loose solder connections.
 - Replace all loose or missing hardware.
 - Tighten all connections. Special care should be taken to ensure that all power and earth / ground connections are fully tight – see page 17 for fastener torque values.

8.4 Contactors

Vacuum Contactor are sealed units and require very little maintenance. Refer to contactor manufacturer manual included in the document package for maintenance instructions.

8.5 Converter SCR Stacks

SCR Stacks and associated electronics boards and wiring harnesses are designed for long trouble-free operation. Refer to Chromalox for maintenance instructions.

8.6 Fault and abnormal Conditions Indications

MV FUSE BLOWN

If any of the main MV power fuses open, the blown fuse trip bar will open one or more micro-switches. The CONTROL screen (see above) gives a fuse open alarm. Following all safety precautions detailed above; determine the cause of the blown fuse and replace.

When removing a fuse, rotate the fuse body slightly to help ease the fuse ferrule out of the fuse clip. If necessary, lubricate the fuse clips with Mobil® 28 red grease as the fuse is rotated. Coat replacement fuses with this grease to ease future removal.

OVER-TEMP FAULT

If any of the heater Over-Temperature controllers trip, it will be indicated in red as “OTC TRIP”. Run mode can only be activated after the Over-Temperature is cleared and reset.

RESIDUAL CURRENT FAULT

A residual current monitoring relay monitors leakage current and sends the measured value to the PLC. If the leakage current is above the preset limit, the residual current relay will energize, and the affected load will shut off. The HEATER screen will indicate a fault condition.

FIRING CARD

If an SCR heatsink overtemp is detected the HEATER screen will indicate the fault condition.

CONTACTOR FAULT

If a Contactor is energized but no status is received, a timer will begin. If this timer completes, the system will stop, and the HMI will indicate the fault.

CONTACTOR WELDED

If a Contactor is released but the status remains, a timer will begin. If this timer completes, the system will stop, and the HMI will indicate the fault.

OVERCURRENT ALARM/TRIP

If an overcurrent condition is detected the HEATER screen will indicate the fault condition.

MAIN CONTACTOR CYCLE COUNT

The system counts the number of times each vacuum contactor is cycled. With an estimated lifecycle of 300,000 cycles, the system will alarm when 240,000 cycles (80%) have been counted.

8.7 TESTING

Conduct Power-Frequency (Hi-pot) tests to clause 6.2.

8.8 RENEWAL PARTS

See spares list supplied separately.

FASTENER TORQUES

All Torques +/- 10%

| | |
|---|-----------------------|
| M5 Torx Head Thread Rolling Screws | 19 lbs-in [2.1Nm] |
| M5 Stainless Steel Screws | 19 lbs-in [2.1Nm] |
| M5 Nuts for Securing Steelwork | 56 lbs in [6.3 Nm] |
| M6 Hex Nuts for Securing Ground Bars | 52 lbs-in [5.8 Nm] |
| M6 Truss Head Stainless Steel Screws | 71 lbs-in [8.0 Nm] |
| M6 Hex Head Bolts for Securing Gland Plates | 95 lbs-in [10.7 Nm] |
| M6 Pan Head Screws for Securing Door Lock Guides | 95 lbs in [10.7 Nm] |
| M6 Nuts for Securing Steelwork | 95 lbs in [10.7 Nm] |
| M8 Hex Nuts for Securing Contactor Cable Lugs & Copperwork Joints | 9.4ft lbs [12.7Nm] |
| M8 Hex Head Bolts for Securing the VTs, CPT, Contactor & Lifting Angles | 19.2 lbs-ft [26 Nm] |
| M10 Hex Nuts for Securing Inductor and SCR Cable Lugs & Fuse Copperwork | 19.4 lbs ft [26.3Nm] |
| M10 Hex Head Nuts for Securing Ground Bars | 19.4 lbs-ft [26.3 Nm] |
| M10 Hex Head Bolts for Securing the Moldings to the Sub-Panels | 38 lbs-ft [52 Nm] |
| M12 Hex Head Bolts for Securing the Disconnecter | 66 lbs-ft [90 Nm] |

Limited Warranty:

Please refer to the Chromalox limited warranty applicable to this product at
<http://www.chromalox.com/customer-service/policies/termsofsale.aspx>.

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