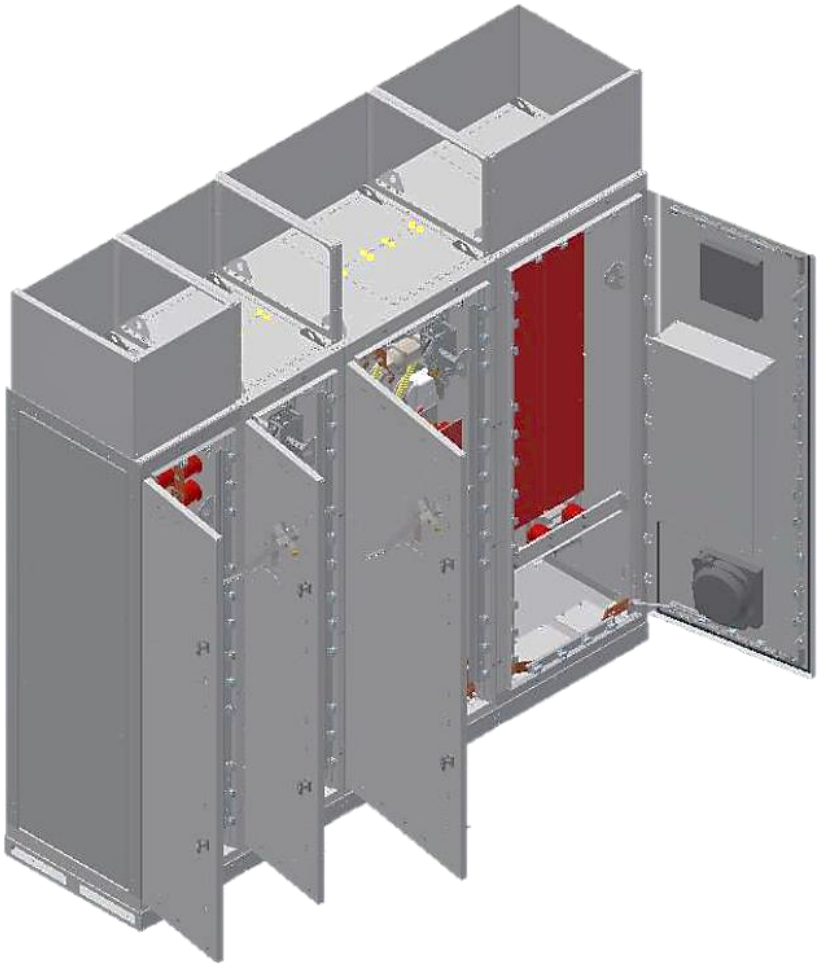
Installation and Operating Instructions

Chromalox DirectConnect™ High Voltage Converter System



CHROMALOX
Advanced Thermal Technologies

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A: INTRODUCTION AND SAFETY

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.

1...General

1.1 Scope

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

2...Introduction

2.1 Key Safety Practices

ALL PERSONNEL WORKING ON HIGH 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 HIGH 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 Disconnector 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 Disconnector 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 Disconnector 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 Disconnector so that its status can be verified visually.

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

Secondary compartmentalization may be provided, in which the Disconnector(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 Disconnector 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 Disconnector. 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, and 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 Disconnector 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 Disconnector 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 Disconnector 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 high 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 and INSTALLATION

3...Receiving & Handling

3.1
Care should be exercised when moving Converter Systems as they are heavy and can tip over. Do to 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 0ºC [32ºf], 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

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

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

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

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

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

5.2.6. 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.

5.2.7. Where possible hazards have been eliminated or reduced as far as is reasonably practicable by design, but the additional warnings listed below should be followed to ensure continued safe use

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.

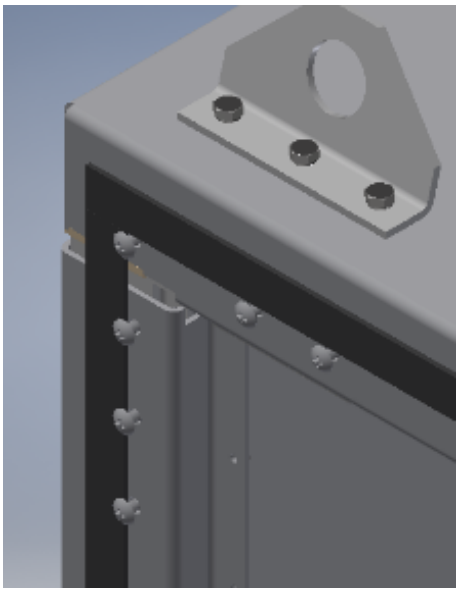
To ensure that water does not enter the System from below, adequate drainage should be provided around the System, and in cable trenches. Cable ducts should be sealed.

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.

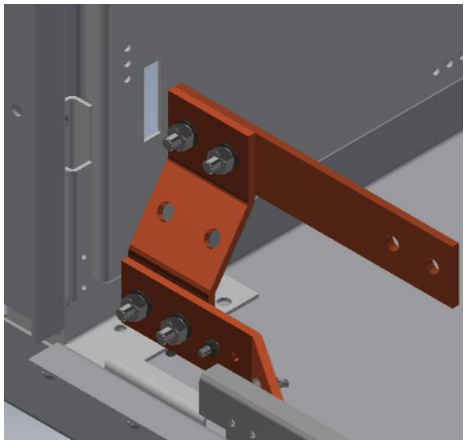
5.2.5. Once the Converter System is in place, it should be secured to the foundation by suitable means. On IEC Systems, the plinth front and rear bottom plates may be removed to access the plinth mounting holes. These plates must be replaced once the System is secured as they form a key part of the structural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

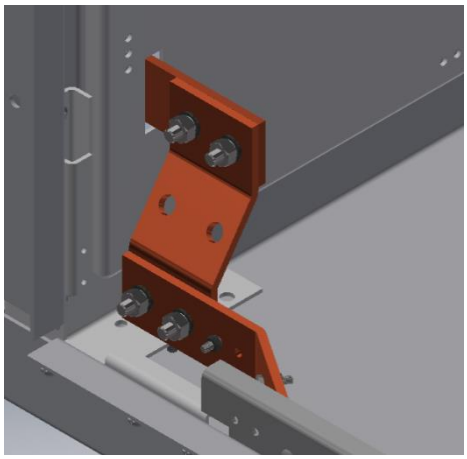


IEC sections must be brought together, and the fasteners (and any associated washers) must be installed from the inside of the section to the left of the slit through into holes where the fasteners were originally installed.

The ground bar link that connects the ground bars in the IEC sections either side of the shipping spilt 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 Disconnector 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 Disconnector 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 High 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 Lightening Arresters if fitted.

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

Close the Disconnector.

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.

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D: OPERATION

7...Startup and Operation

Precautions & Warnings

READ AND UNDERSTAND SECTION A 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, 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 disconnector switch auxiliary contact must show that the disconnector 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

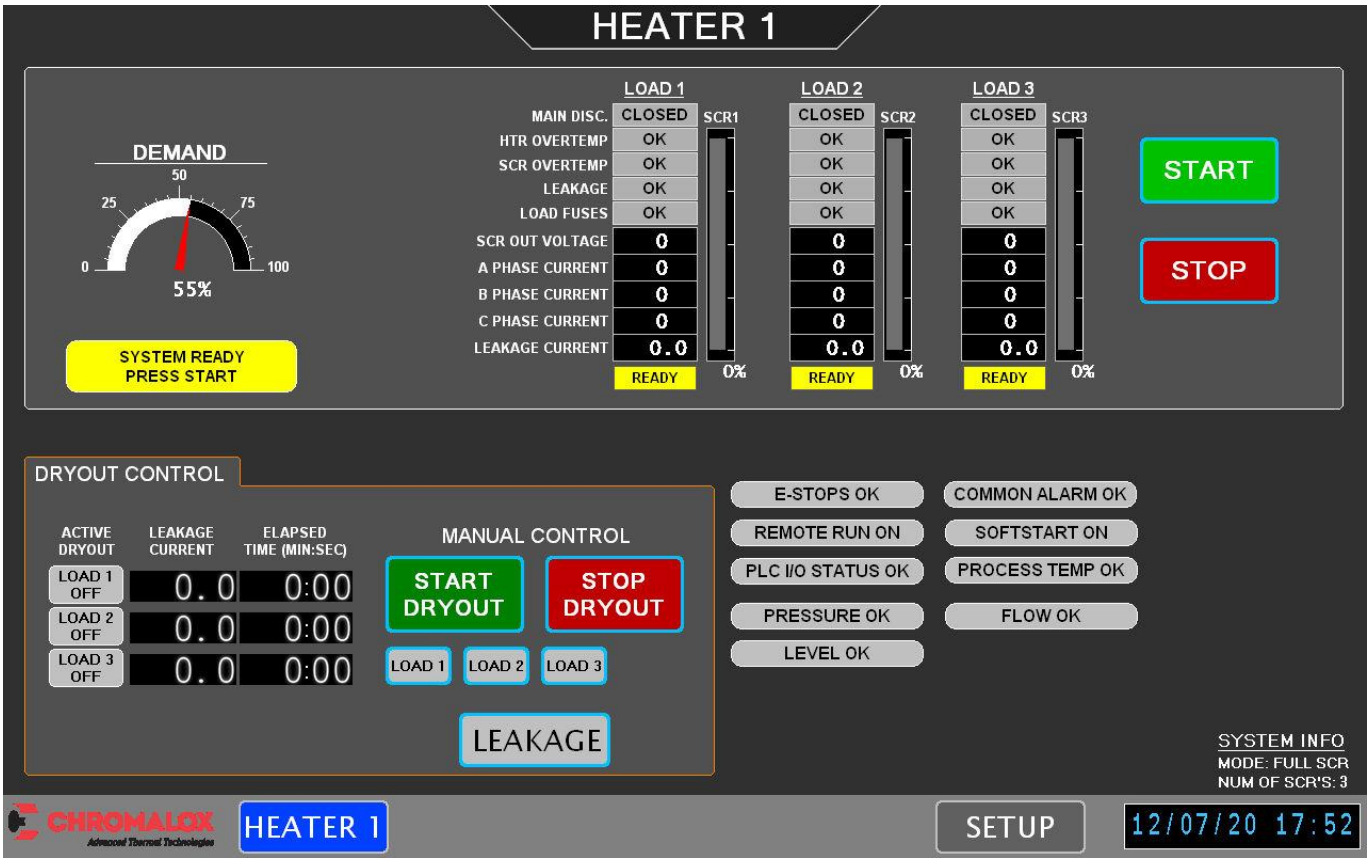
The HMI screens have a navigation bar across the bottom. This menu stays visible for most screens making navigation between screens easy, the leakage current screen being the only exception.

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.

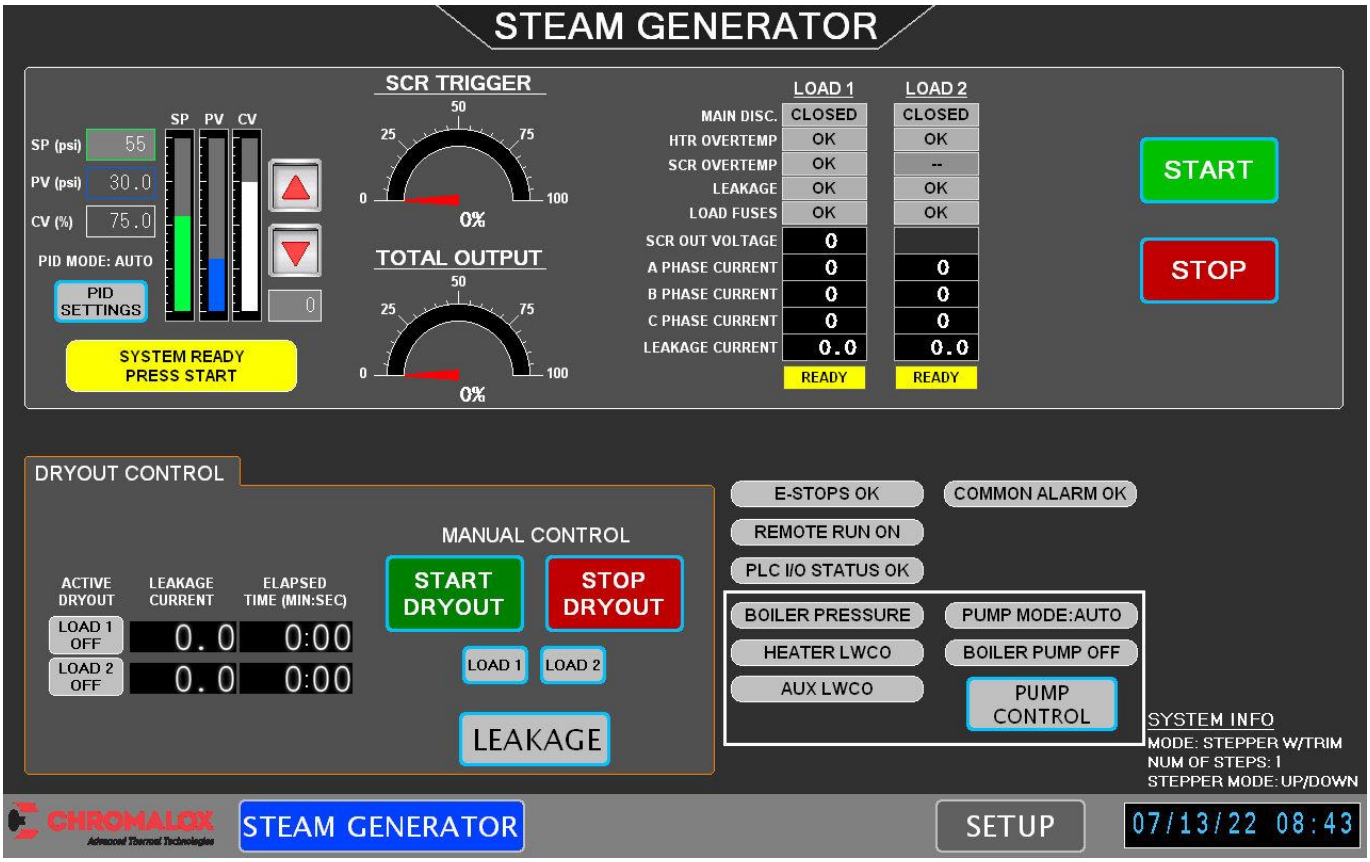
7.4 HMI Screens

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 and 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 Disconnector 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 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:

a. Inspect fan air inlet and air exhaust filters and replace if necessary.
b. 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.

a. Wipe off all dust, and moisture from the exterior surface of the door and surrounding enclosure frame with a lint-free cloth.
b. 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:

a. Remove loose dust and dirt with a vacuum cleaner.
b. Wipe off all moisture, and all remaining dust, and dirt with a lint-free cloth.
c. Remove any sticky residues with a dry, lint-free rag, using an alcohol-free cleaning solvent.
d. Inspect for evidence of dripping water or liquids falling on equipment parts. If found, determine the cause and correct.
e. Inspect for rust on metal parts. Repair or replace if found.
f. Inspect for signs of insect or animal damage. Remove any spider's webs.
g. Inspect for signs of mold.
h. 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

discharge, and repair or replace if found. Replace insulators that have been compromised by tracking.

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

If necessary, Disconnector contact knifes should be lubricated with ISOFLEX TOPAS NCA 52.

The Contactor should not be lubricated.

Exercise Mechanisms

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

8.3 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 Over-temperature controllers trip, it will be indicated in red as “OTC TRIP”. Run mode can only be activated after the overtemperature 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 CONTROL screen will indicate a fault condition.

Firing Card

If an SCR heatsink overtemp is detected the CONTROL 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.

8.7 Testing

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

8.4 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 Disconnector	66 lbs-ft [90 Nm]

ANNEX 1: HMI SCREENS

The following pages give a full description of all the screens available on the HMI for full SCR systems. Note that actual layout may vary slightly.

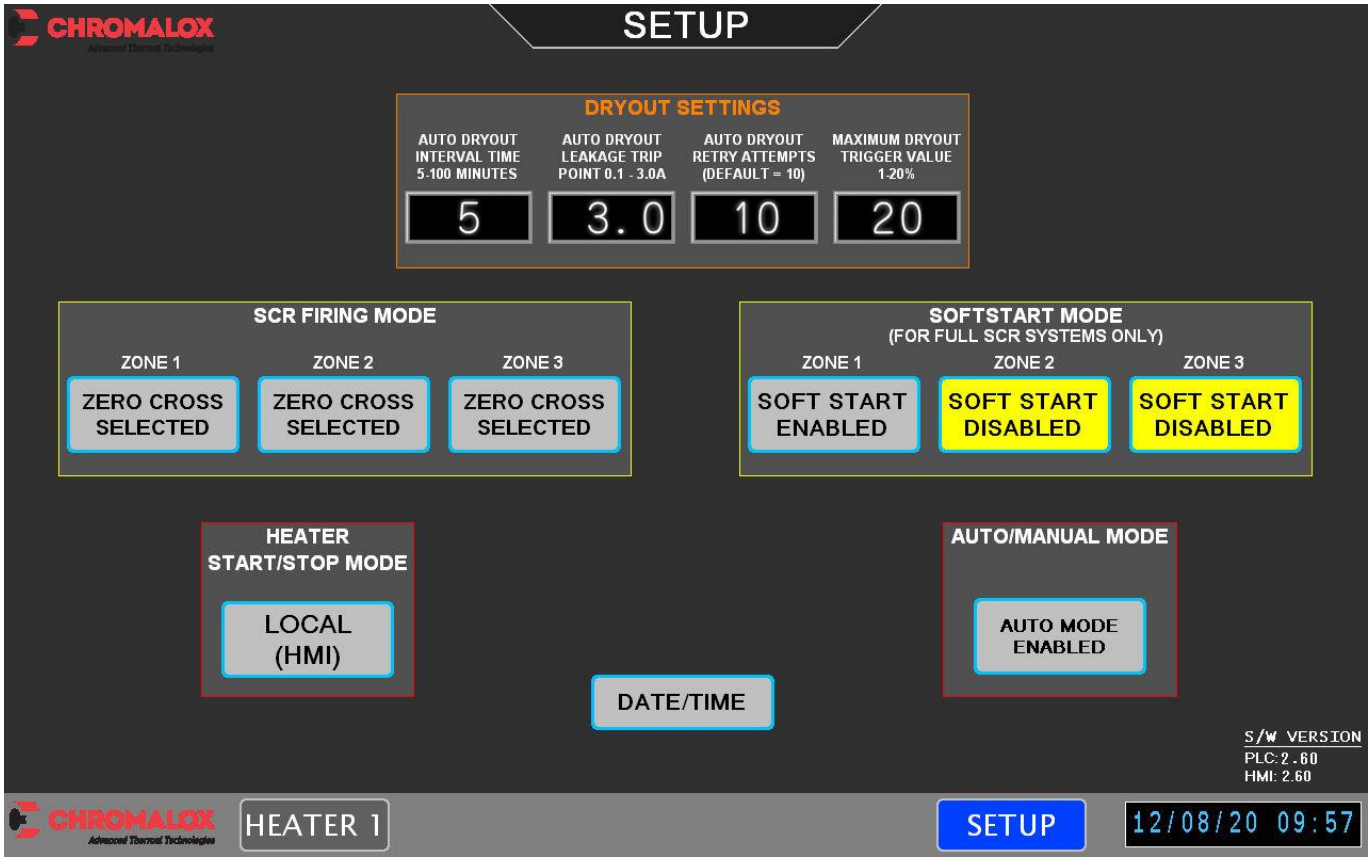
A1.1 Set-Up Screen

NOTE: The Low Voltage Section should be checked and verified, and the following settings should be set before energizing the High Voltage

Energize the Low Voltage Supply.

Touch (SETUP)

The SETUP screen is used to configure dry-out settings, select between Auto/Manual mode, enable Phase Angle or Zero Cross firing, toggle local/remote mode, and update the Date/Time.



Full SCR System

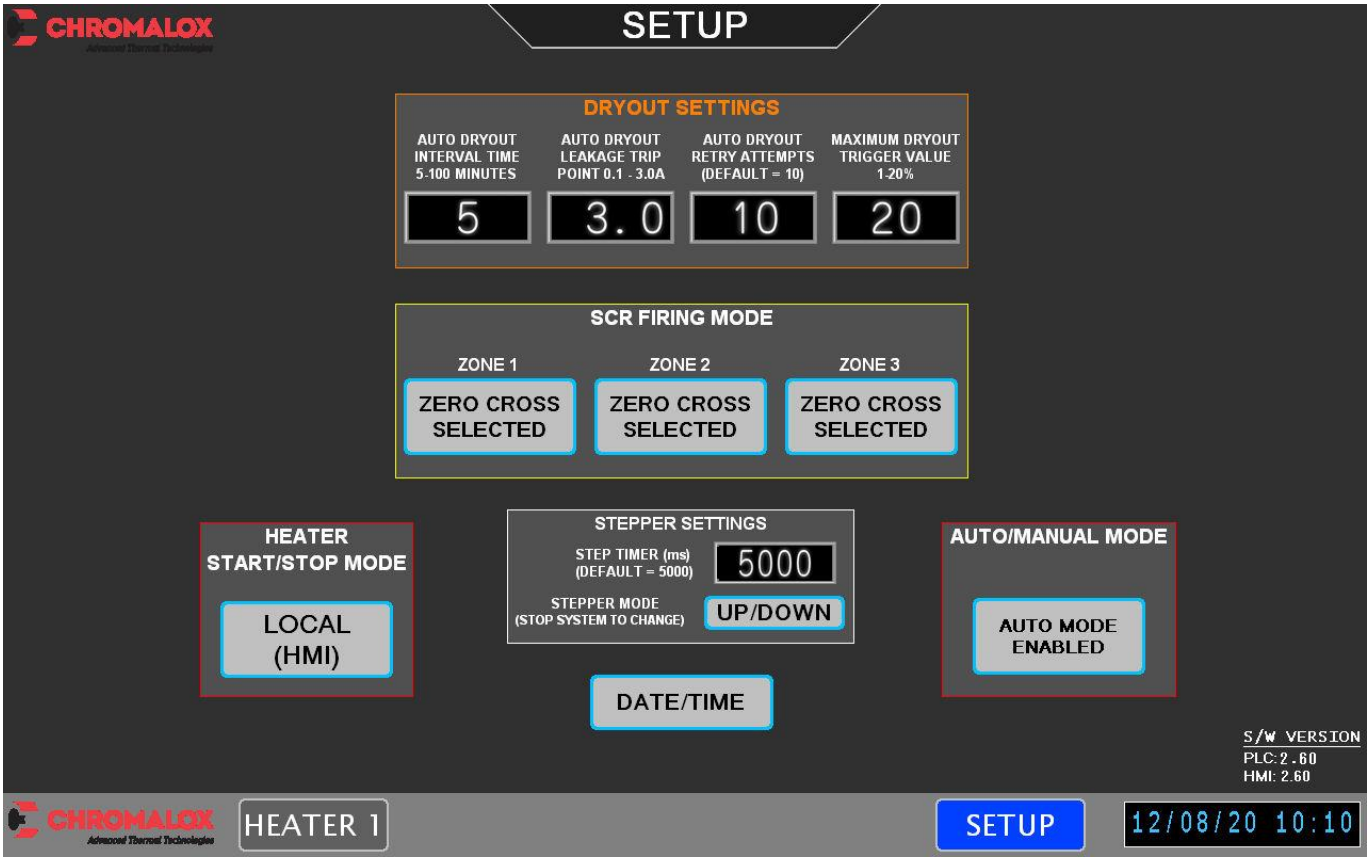
Notes:

"AUTO DRYOUT INTERVAL TIME": This configures how long an Auto-Dryout cycle will run. This is selected in minutes.

"AUTO DRYOUT LEAKAGE TRIP POINT": This is the amount of leakage current (Amps) that will trigger and Auto-Dryout sequence. The maximum allowed is 3.0A.

"AUTO DRYOUT RETRY ATTEMPTS": If the number of dry-out attempts for an element reaches this number and the element is still not dry, dry-out will be disabled for this load, preventing any further dry-out cycles, and a 'Dry-out Fault' will be indicated on the HMI.

"MAXIMUM DRYOUT TRIGGER VALUE": The maximum dry-out trigger % is restricted to a maximum of 20% of full load current to avoid heater damage and to limit harmonics caused by Phase Angle firing.



SCR Stepper System

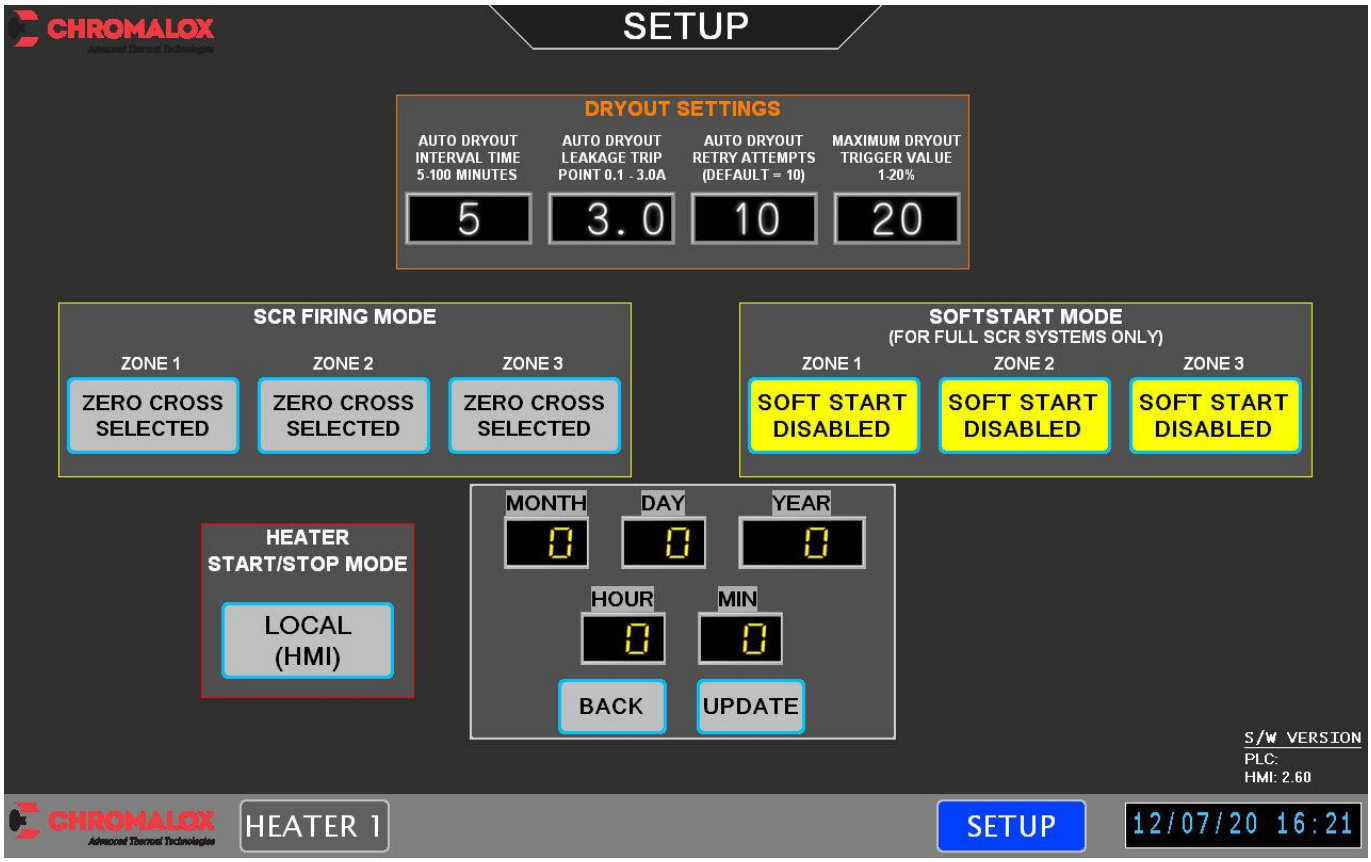
Stepper w/Trim Settings:

"STEP TIMER (ms)": This adjusts the time between steps when the system is turning on to meet the initial demand. Once the demand is met, this time is automatically reduced to allow quicker tracking of the demand signal.

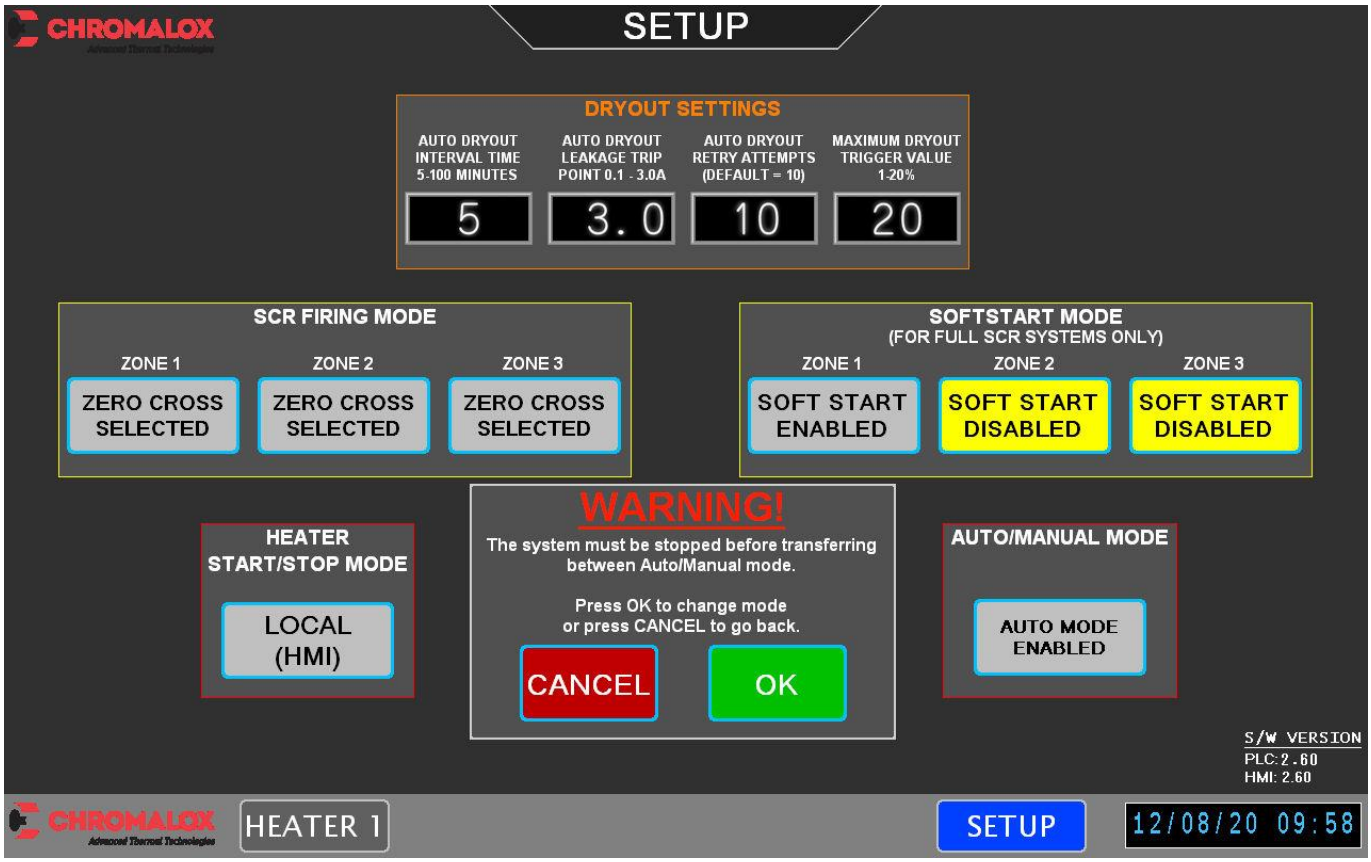
"STEPPER MODE": Two modes exist in stepper systems: Up/Down and Circular. These modes determine which loads are stepped on/off as demand goes up/down.

In Up/Down mode, the first load will always be the first to turn on and last to turn off.

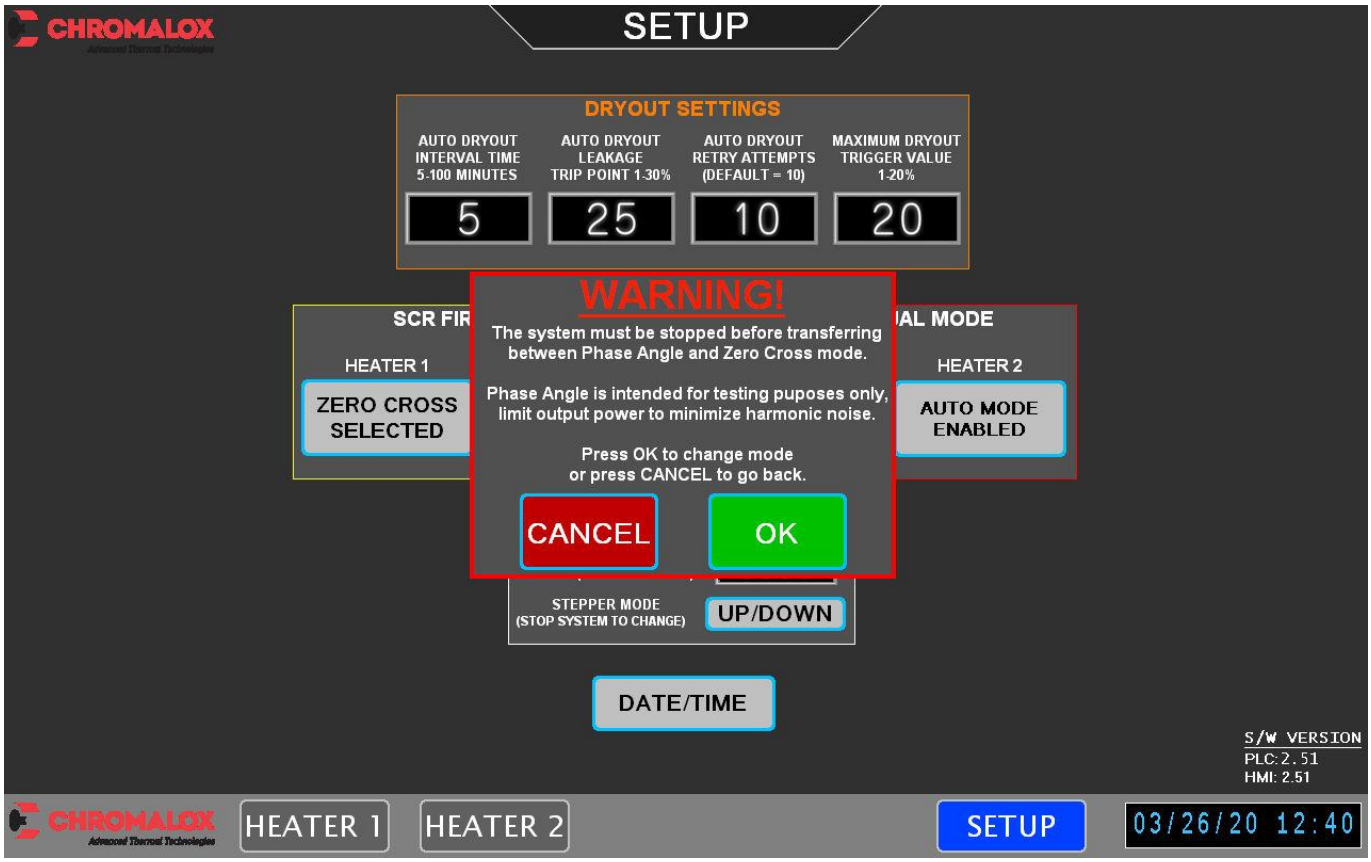
In Circular mode the system tracks the loads to help spread out the time that each load is energized. If load 3 is the first load energized, it will be the first load to turn off. Note: Circular mode is not available in Progressive Stepper systems.



Pressing the 'DATE/TIME' pushbutton will allow the user to adjust date and time settings as shown below. To update the system, touch one of the fields and enter the new value and press the UPDATE button. The clock on the bottom right will show the updated time.



Pressing the ‘AUTO(MANUAL) MODE ENABLED’ pushbutton allows the user to switch between AUTO mode (system demand is supplied by temperature controller) or MANUAL mode (system demand is controlled manually by the user on the MAIN screen). Note: the system must be stopped to switch between these modes. If the system is running, the OK button will not appear.



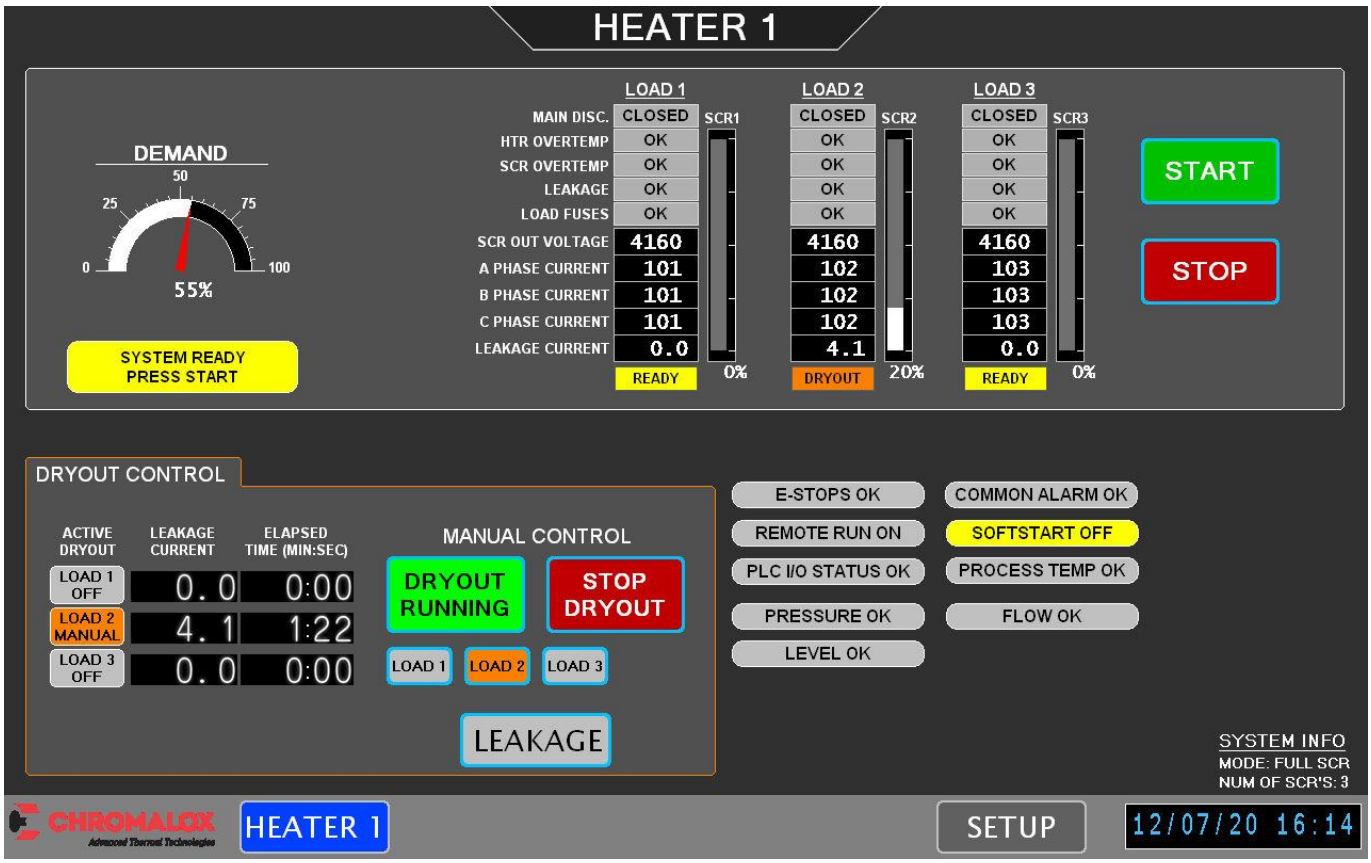
Selecting the SCR firing mode button displays a warning popup window. Read the warning and understand the potential dangers before selecting OK.

A1.2 Control Screens

A1.2.1 Dry-out Operation

Touch (HEATER)

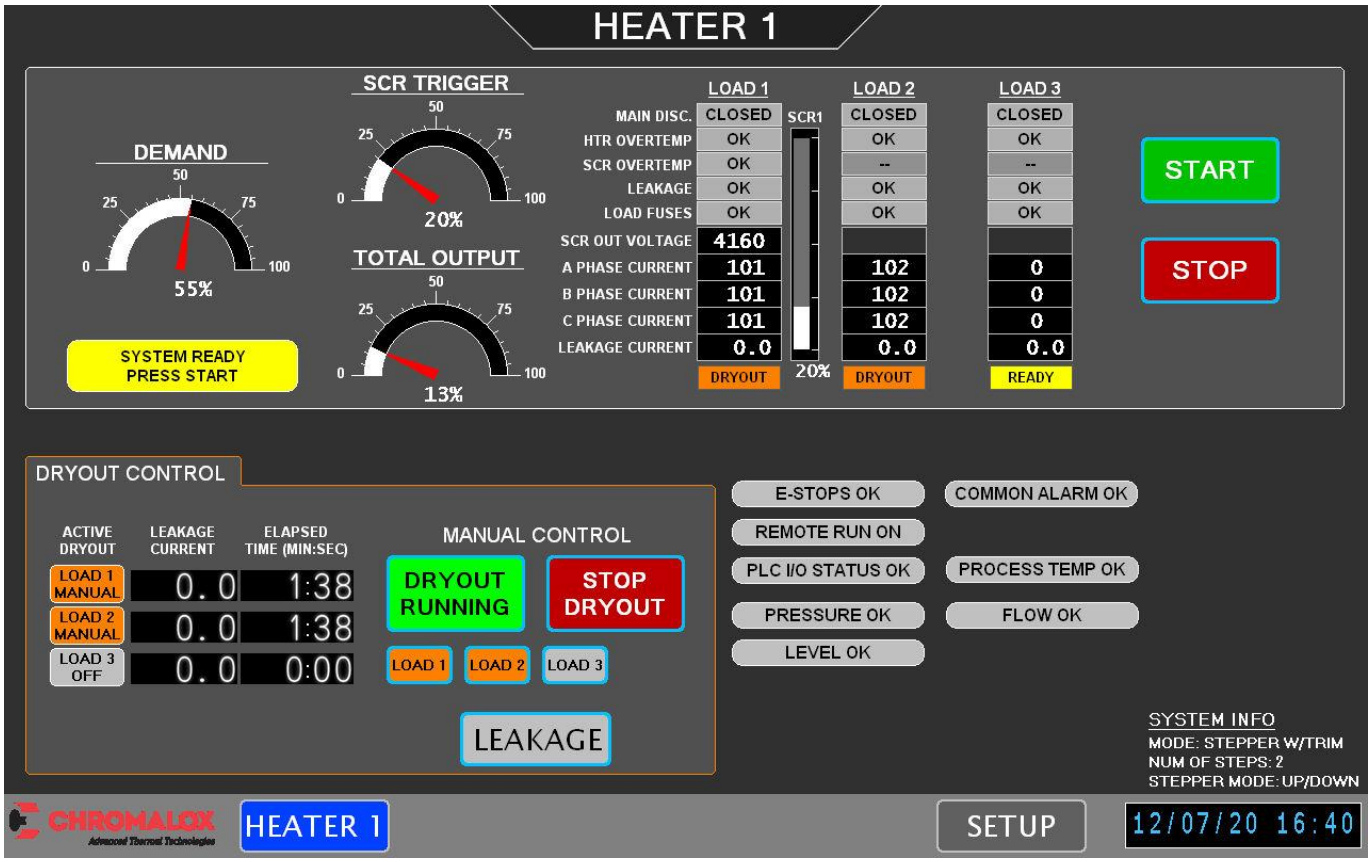
The DRYOUT CONTROL section is used to monitor and control Dry-out Mode. The leakage current values are displayed as well as the elapsed run time for each load.



Full SCR System

To manually dry-out a heater element, select the desired load(s) within the 'DRYOUT CONTROL' box, then press 'START DRYOUT'. The selected loads will begin to dry-out until 'STOP DRYOUT' is pressed. While in dry-out, the ACTIVE DRYOUT for the selected load will illuminate, and indicate 'LOAD x MANUAL' or 'LOAD x AUTO', and the load status displays shown above will change to orange and indicate accordingly. In the following example, load 2 is shown active in manual dry-out.

For SCR Stepper systems, the SCR is used to Dryout contactor loads. Therefore, if a contactor load is selected load 1 will automatically be selected as well. In the example below, load 2 was selected for MANUAL DRYOUT, which will automatically mean that load 1 will be in DRYOUT as well.

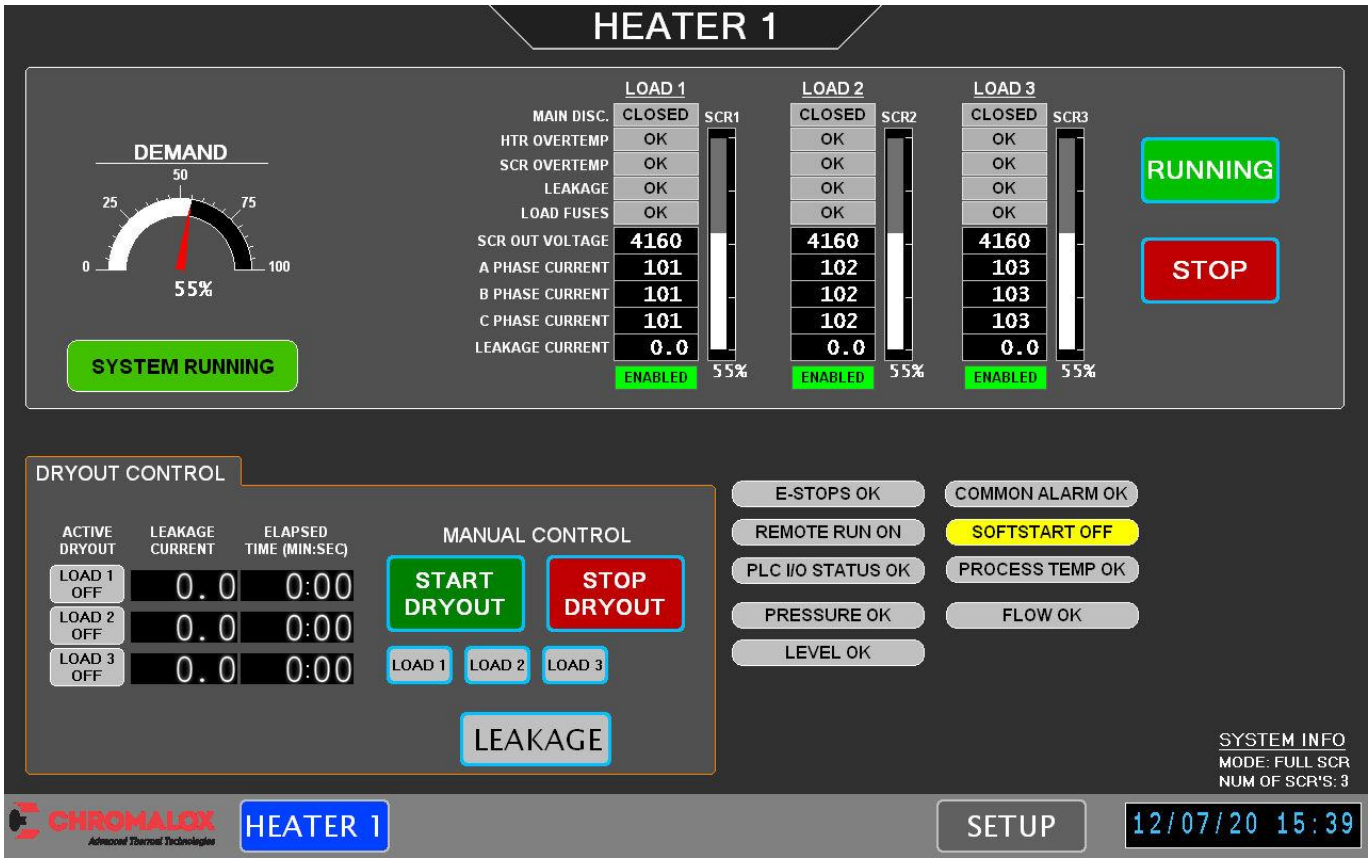


SCR Stepper System

A1.2.2 Heater Control

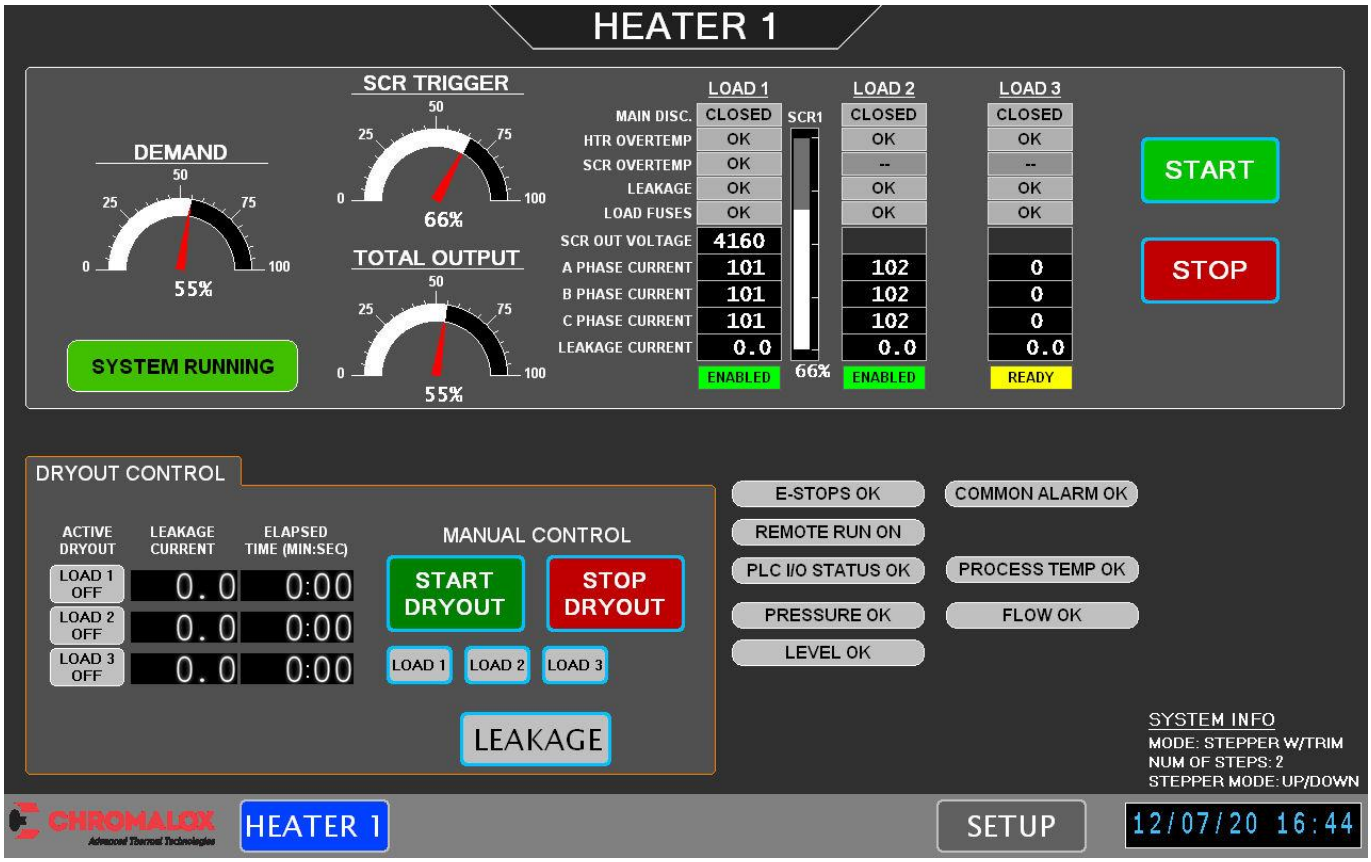
Touch (HEATER)

The HEATER screen below shows a system that has been energized. The status of each SCR and its current output (0-100%) is displayed, along with the system demand. The overall system status is displayed as well. The following shows the system in AUTO mode, with the demand coming from the temperature controller.



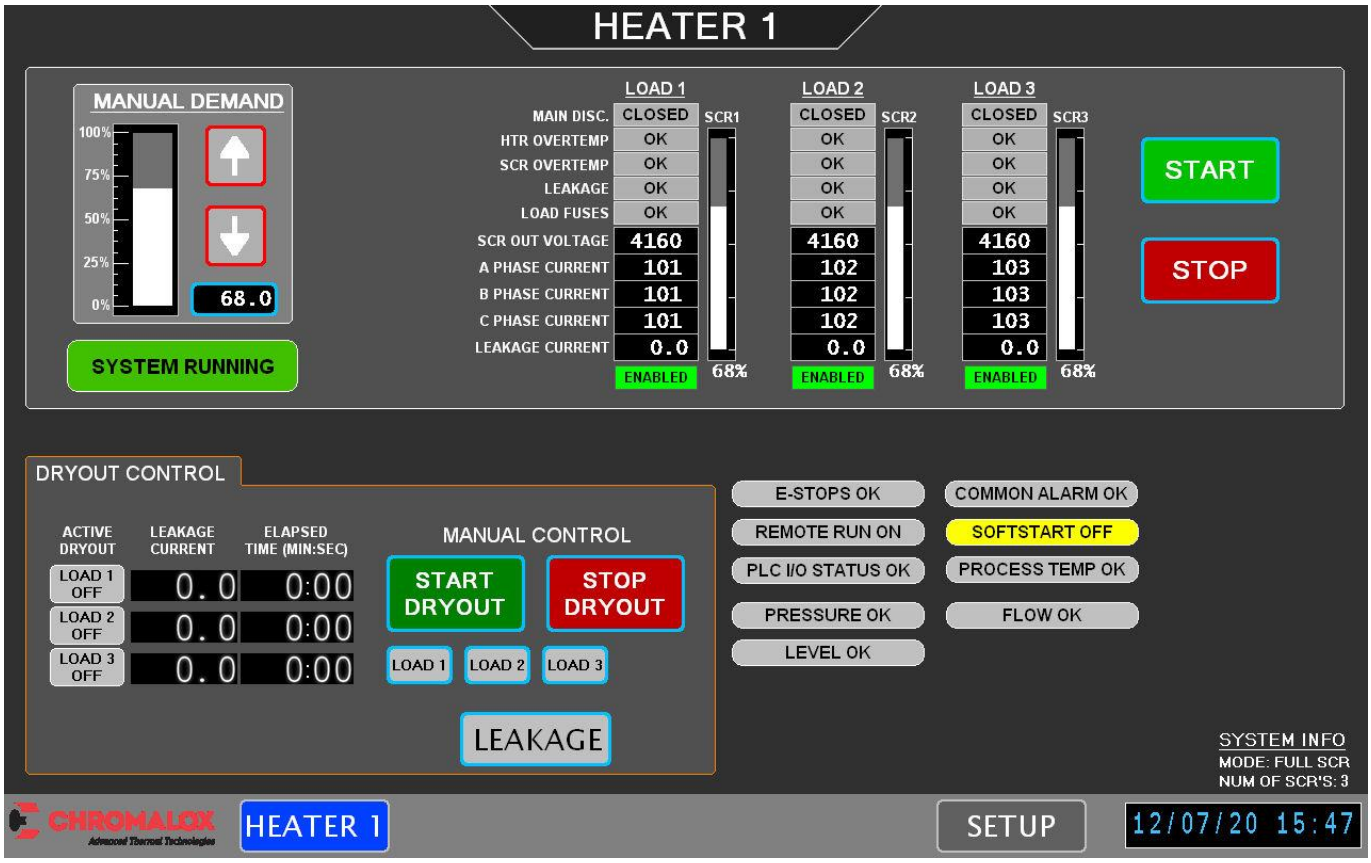
Full SCR system

For SCR Stepper systems, only the first heater load has an SCR, while the remaining loads are energized by a contactor. The contactor loads do not measure output voltage and do not display the % output, as they are fully on or fully off.



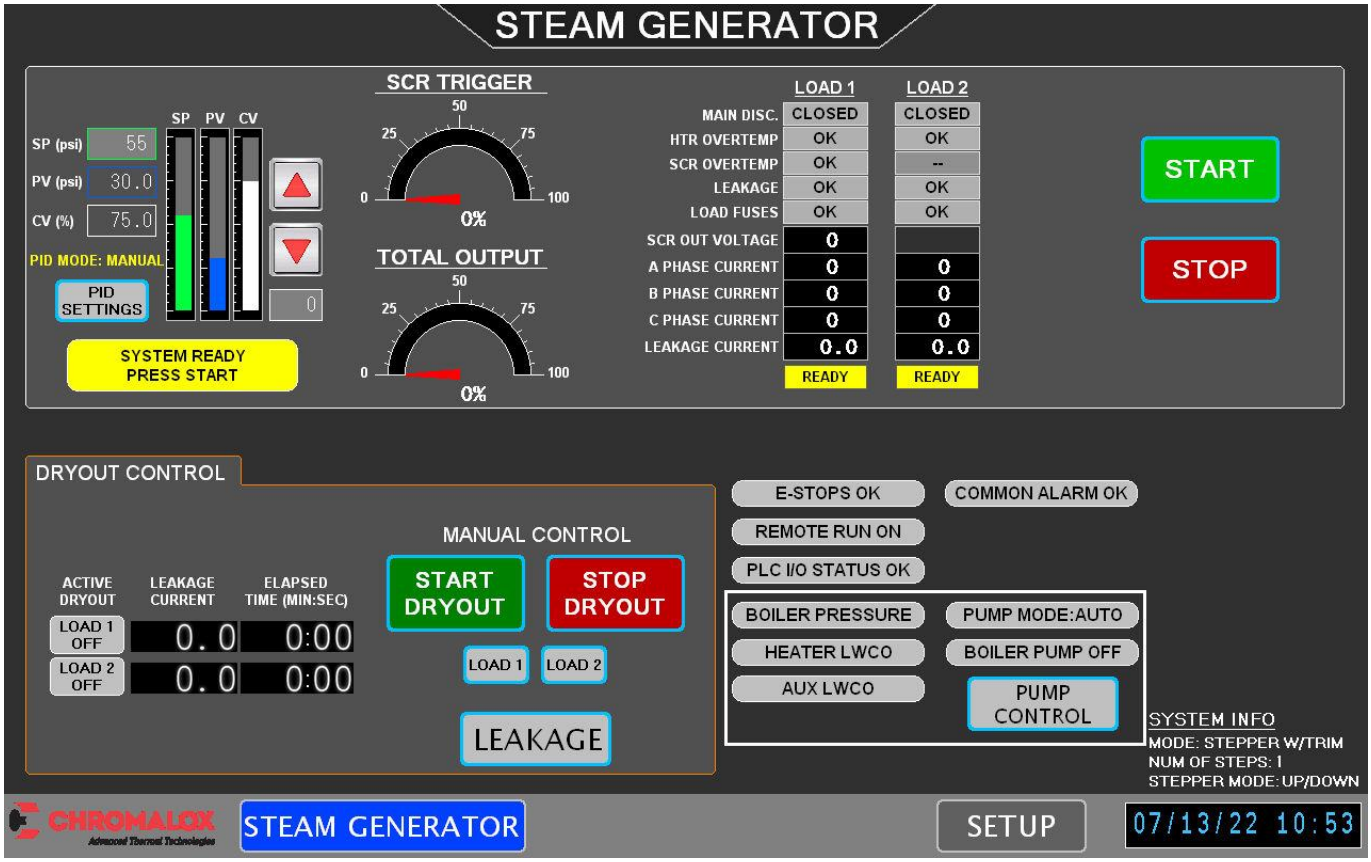
Stepper System

The following shows the system in MANUAL mode, where the demand is adjustable by the user. The demand signal is adjustable with the UP and DOWN arrow buttons, or by touching on the number (with blue border) and entering a number from 0-100.



Full SCR System with external PID control

For systems with an internal PID controller, MANUAL mode is displayed as follows. The red UP and DOWN arrows pop up and the PID MODE text changes to yellow.



Stepper system with internal PID control

Load Status Indicators: the following conditions are possible for each load.

“NOT READY”: A condition is present that will not permit this load to turn on. Check the CONTROL screen.

“READY”: All conditions are met for this load to turn on.

“ENABLED”: This is an SCR load that is currently on.

“IN DRYOUT”: This load is currently in dry-out mode (Auto or Manual).

“ACTIVE”: This is a contactor load that is currently energized.

“DRYOUT PENDING”: In a Stepper w/trim system, only 1 contactor load can dry-out at a time. This load is waiting to begin dry-out.

“DRYOUT FAULT”: The load has attempted to dry-out unsuccessfully.

“CON FAULT”: Contactor faulted, was told to energize but no status was received.

“CON WELDED”: Contactor welded, was told to release but status remained.

Zone Status Indicator: the following conditions show the status of the system.

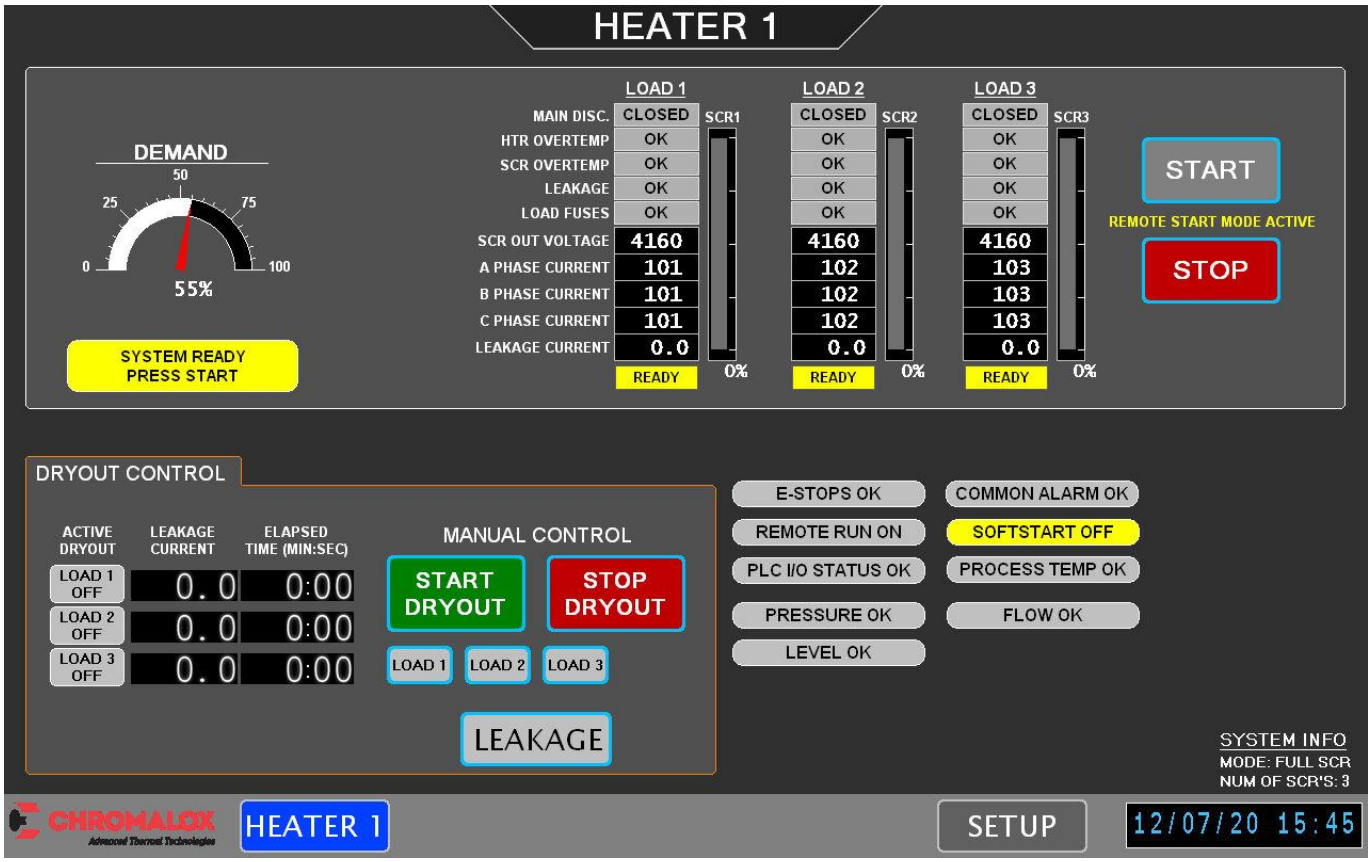
“SYSTEM NOT READY”: A condition is present that will not permit the system to turn on. Check the conditions.

“READY”: All conditions are met for the system to turn on.

“CHECK FAULTS”: The system experienced a fault, check the conditions.

“SYSTEM RUNNING”: This system is currently running.

The following shows the system in REMOTE mode (selected on the SETUP screen). In this mode, the local START button on the HMI is disabled, and the remote start command input from the customer will energize the heater. When this mode is active, text will be visible and the START button will be gray. Note that when this mode is active the STOP button will de-energize the heater.

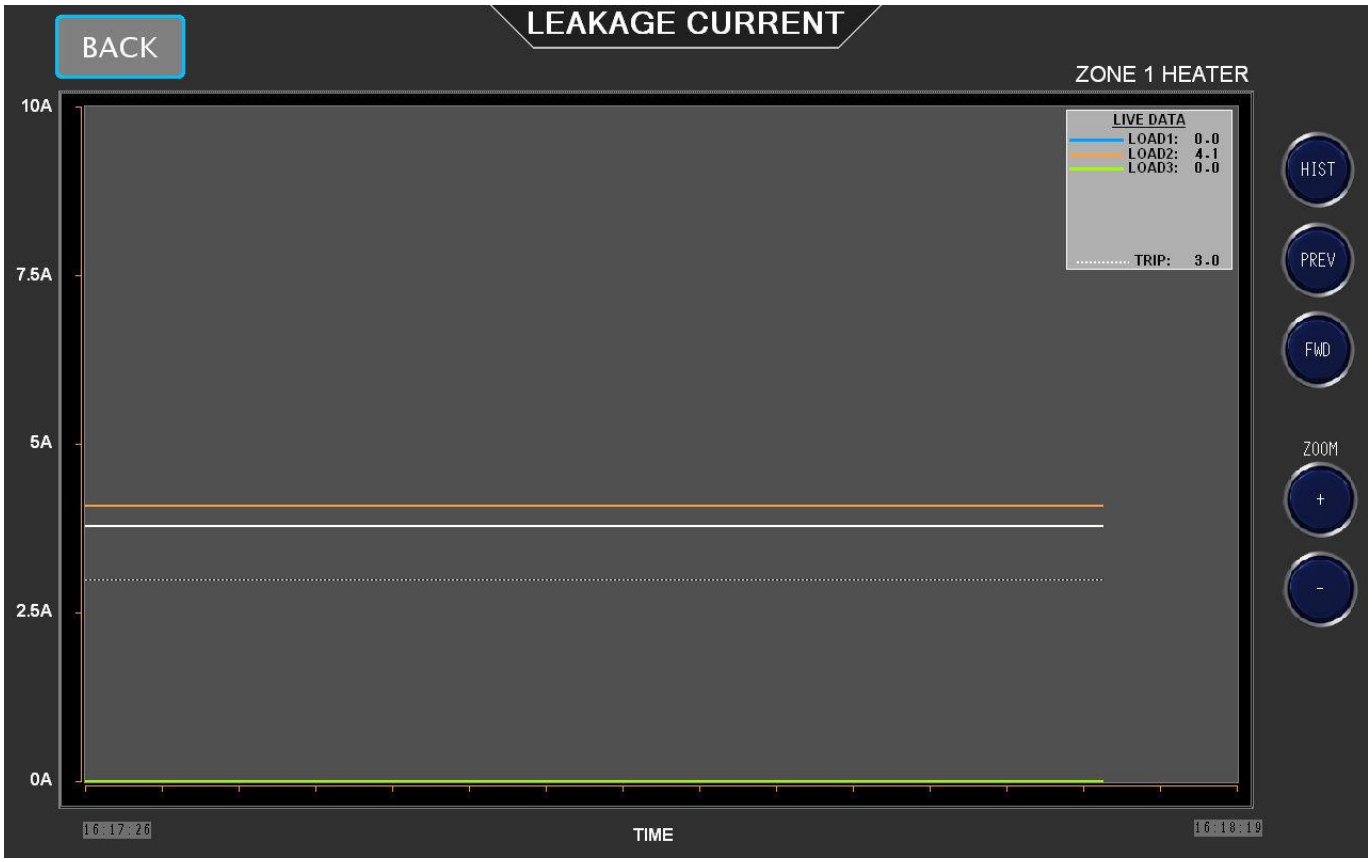


Full SCR System

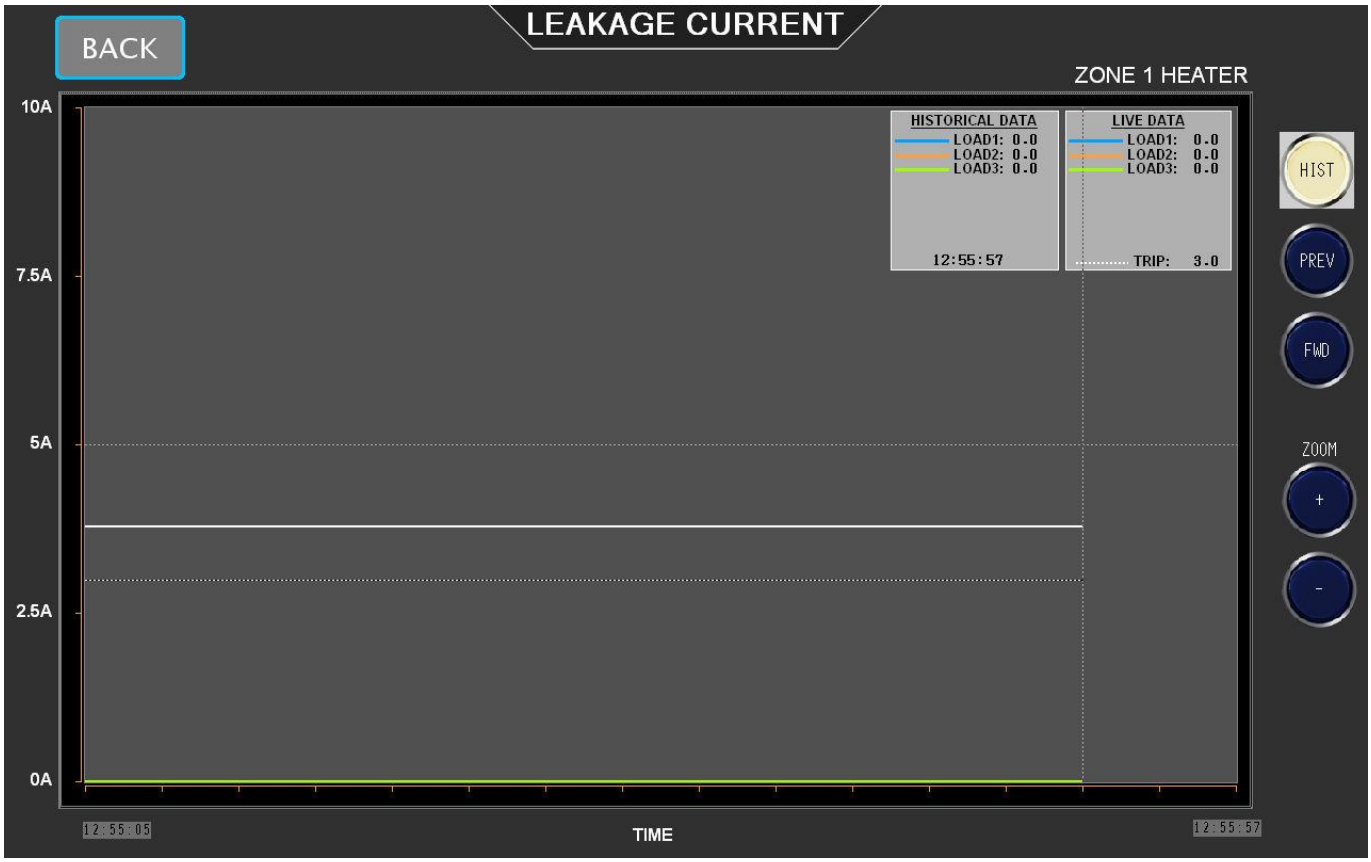
A1.2.3 Leakage Current Trend Screen

Touch (LEAKAGE)

This screen displays a live charted value of leakage current for all loads simultaneously. The trip point is displayed as well to show how close an element is to entering Automatic Dry-out Mode.



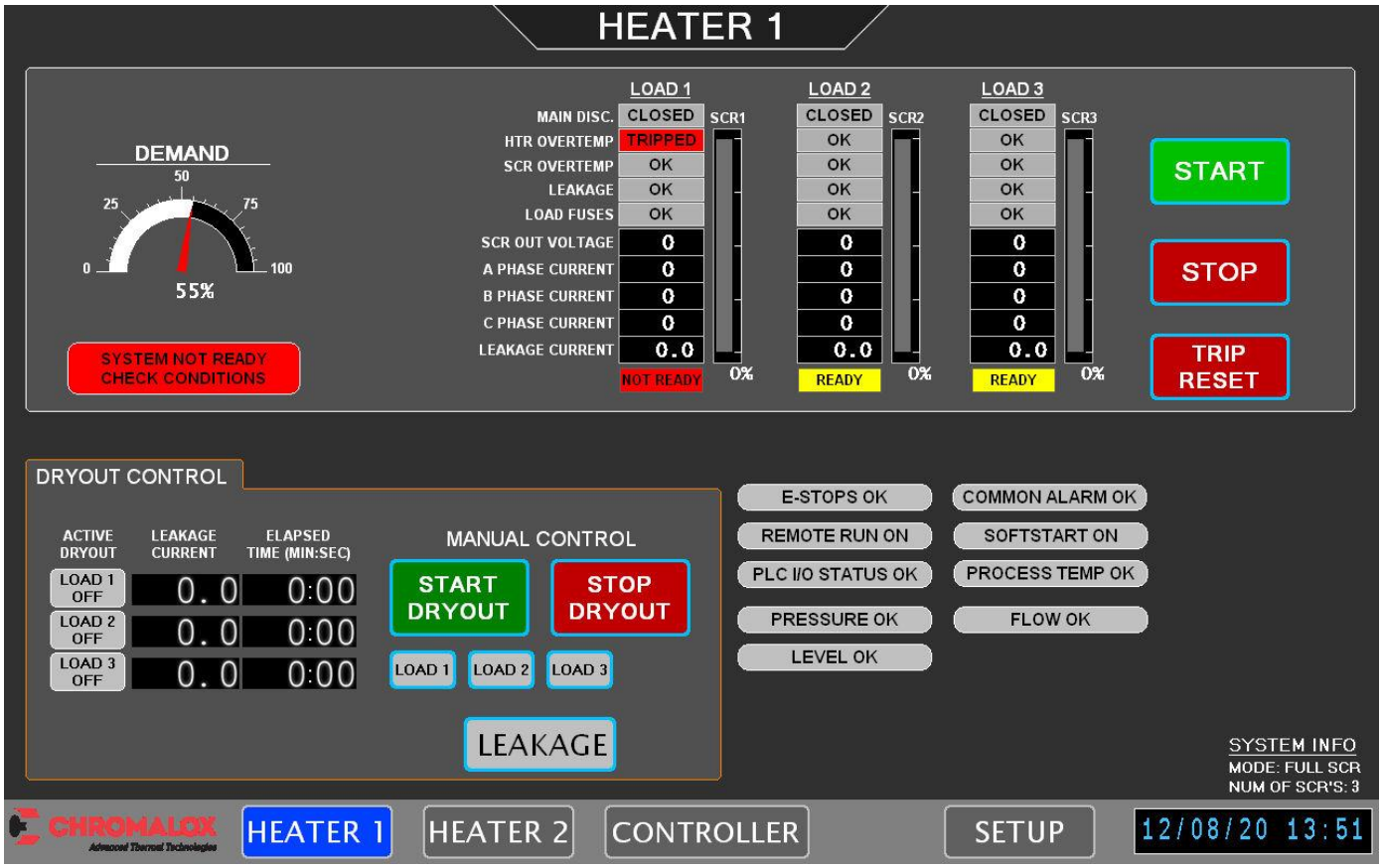
This is the only screen where access to other screens is not available from the left side menu. This is done to maximize the size of the display. On this screen, touch (BACK) to return to the previous screen.



Pressing the HIST button will switch to historical mode, where you can use the PREV, FWD, + and - buttons to look at previous trend data.

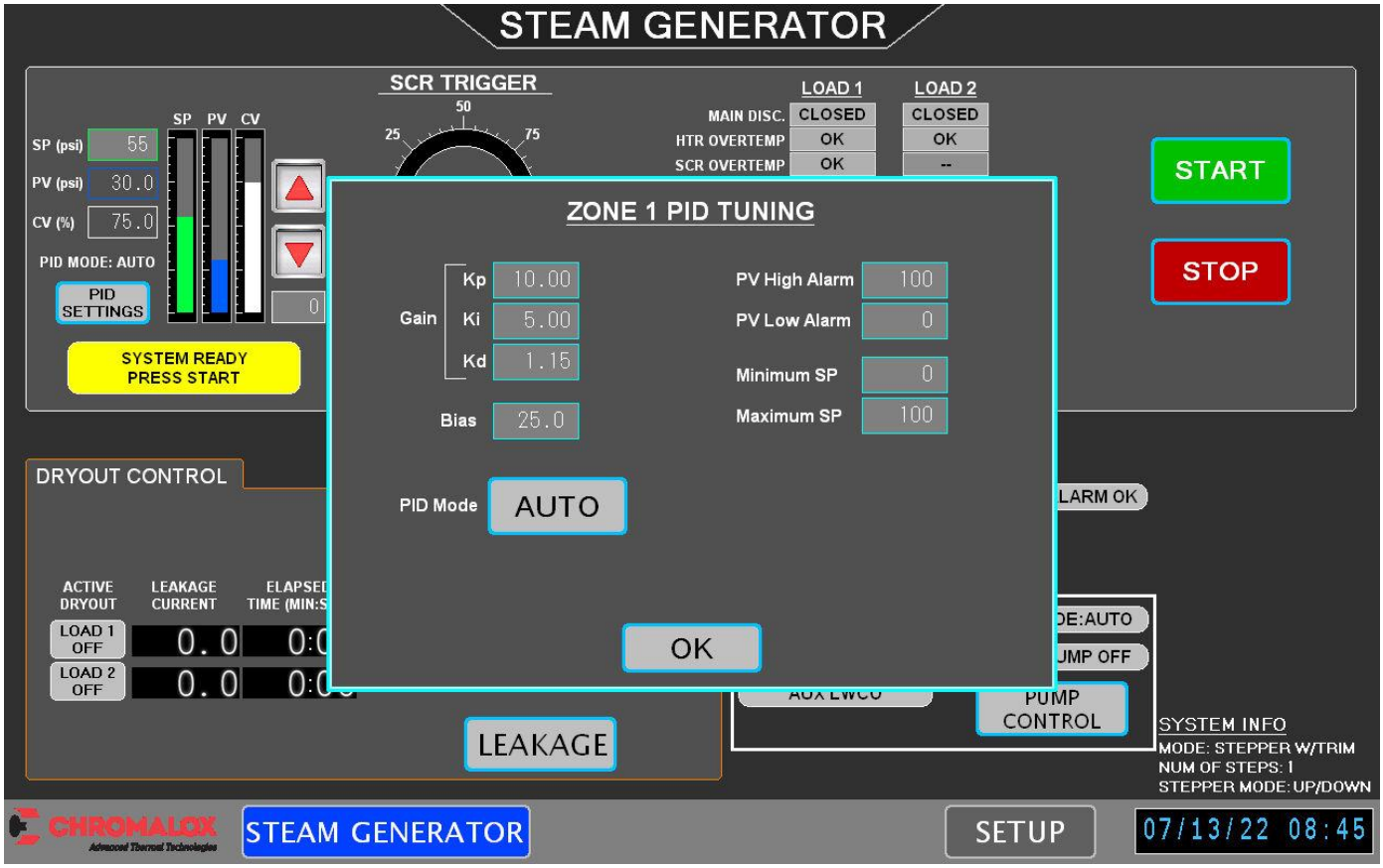
A1.2.4 Heater Trip

When a resettable alarm is present, the TRIP RESET button becomes available that will reset the alarm if the condition has been cleared. When the trip condition is cleared and the TRIP RESET button is pressed, the button will disappear.



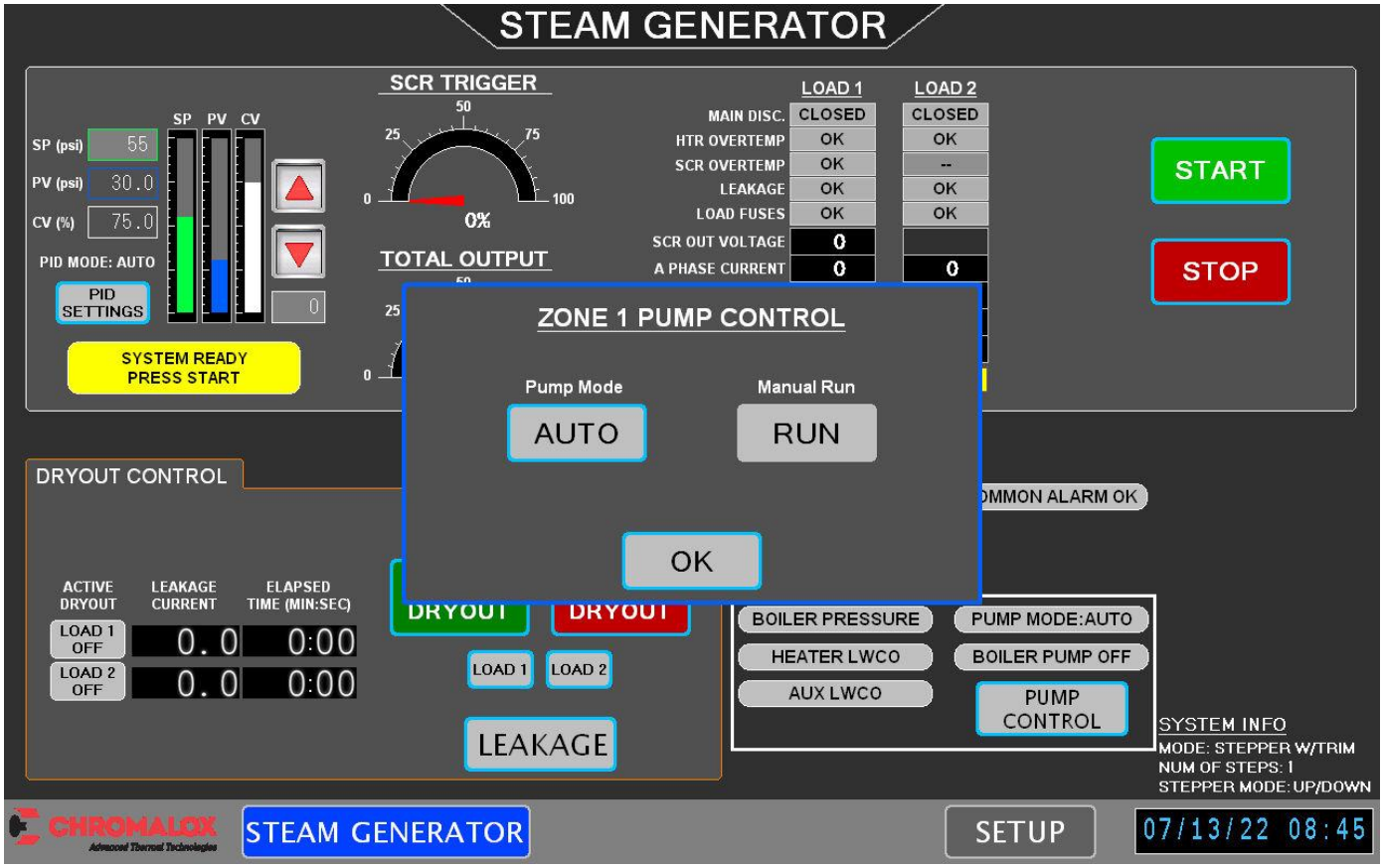
A1.2.5 PID Tuning

If the PID loop is internal to the PLC, the PID tuning settings can be adjusted by pressing the PID SETTINGS button on the main screen.



A1.2.6 Steam Generator Pump control

For Steam Generator systems, the pump settings can be accessed by pressing the PUMP CONTROL button on the main screen



A1.2.7 Screen Saver

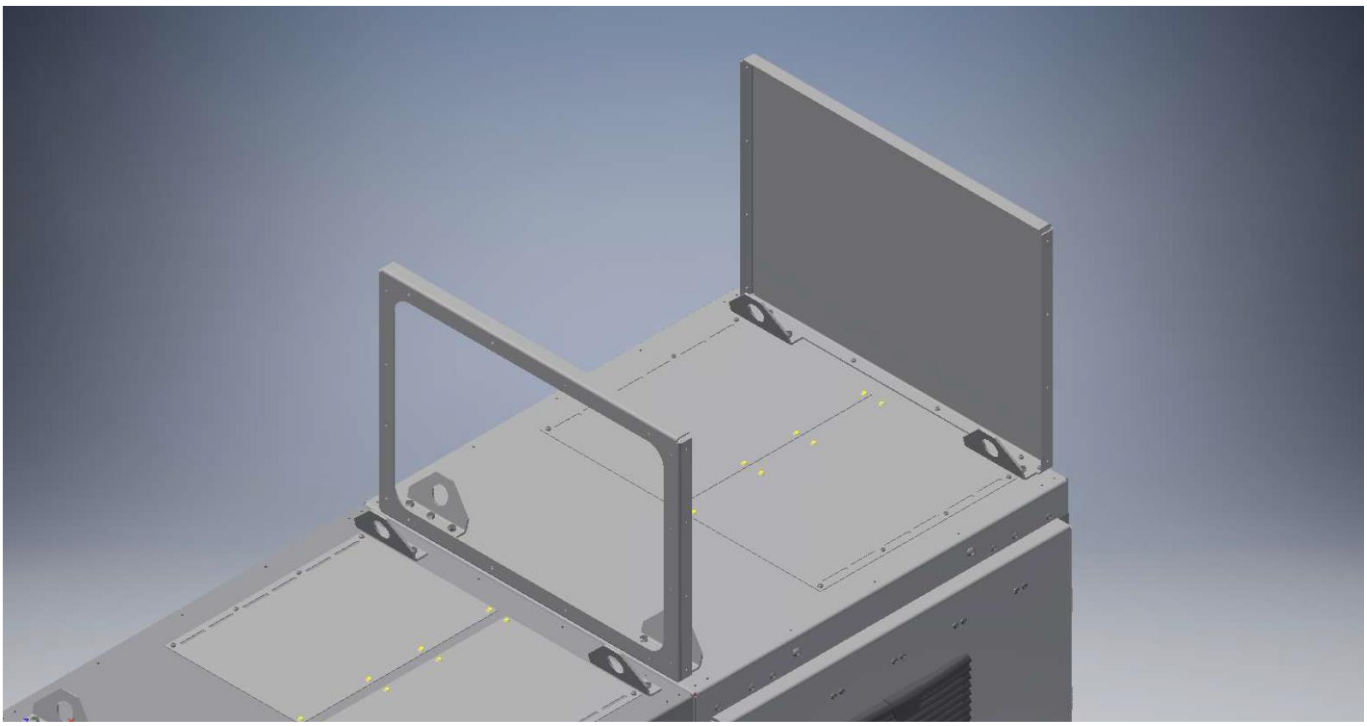
When no activity has been detected on the HMI for 15 minutes, the Screen Saver will activate. Normal operation can resume by touching anywhere on the screen.

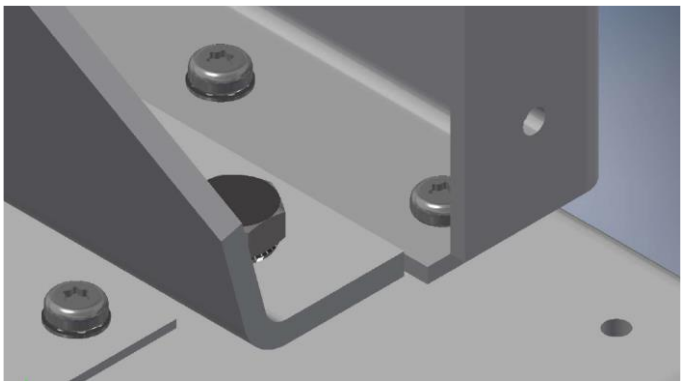
ANNEX 2: ARC CONTROL SHROUD

If the Converter System has parts for an arc control shroud supplied separately, the following procedure should be used to install the shroud. The purpose of the shroud is to ensure that arc products escaping through flaps on the roof of the system are guided upwards and do they don't roll over onto the heads of personnel standing around the system.

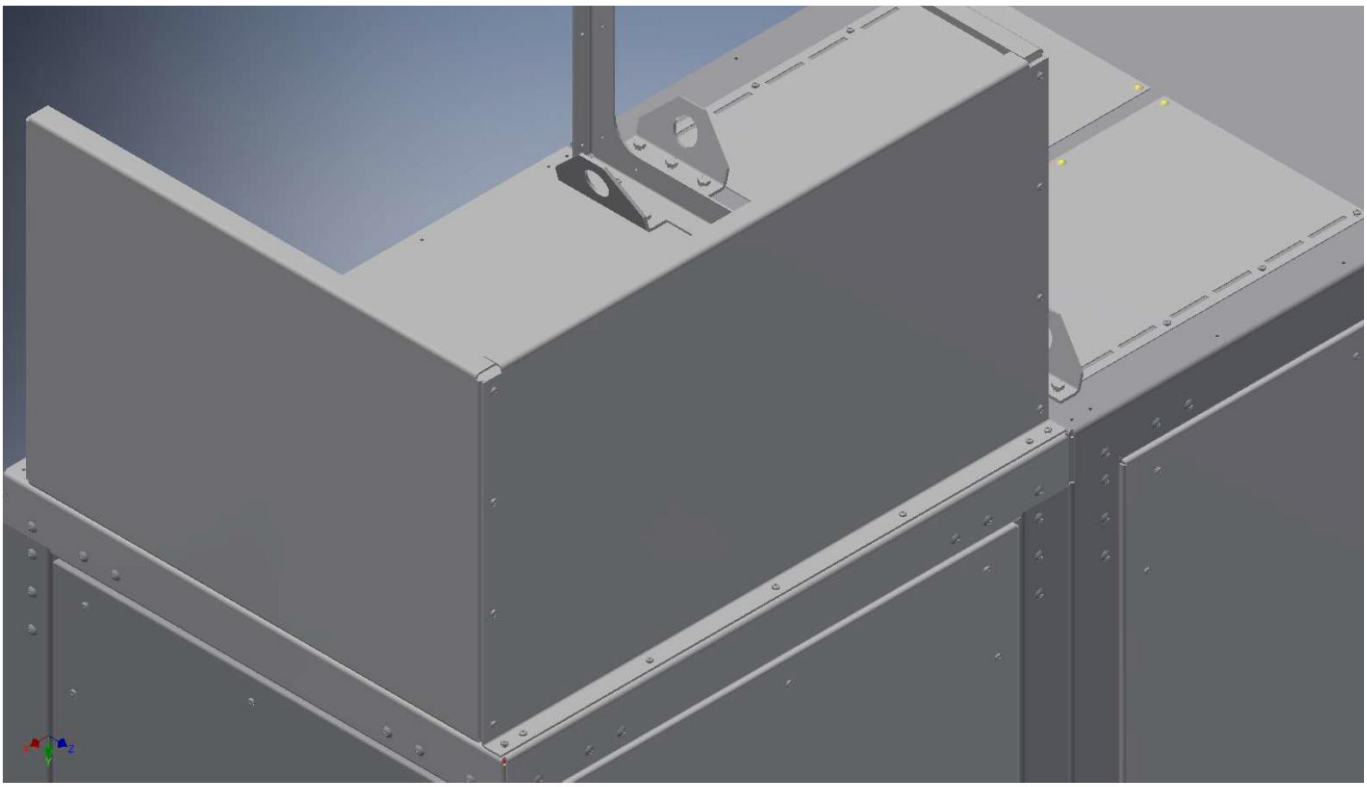
Starting at one end of the Converter System, install the end panel (with no cut-out) using 6 of the thread rolling screws provided. Two screws at the front and rear end should have internal star washers (provided) fitted under the head of the screw to ensure that the panel is electrically bonded to the section. The panel should be such that the vertical face is aligned with the end on the board.

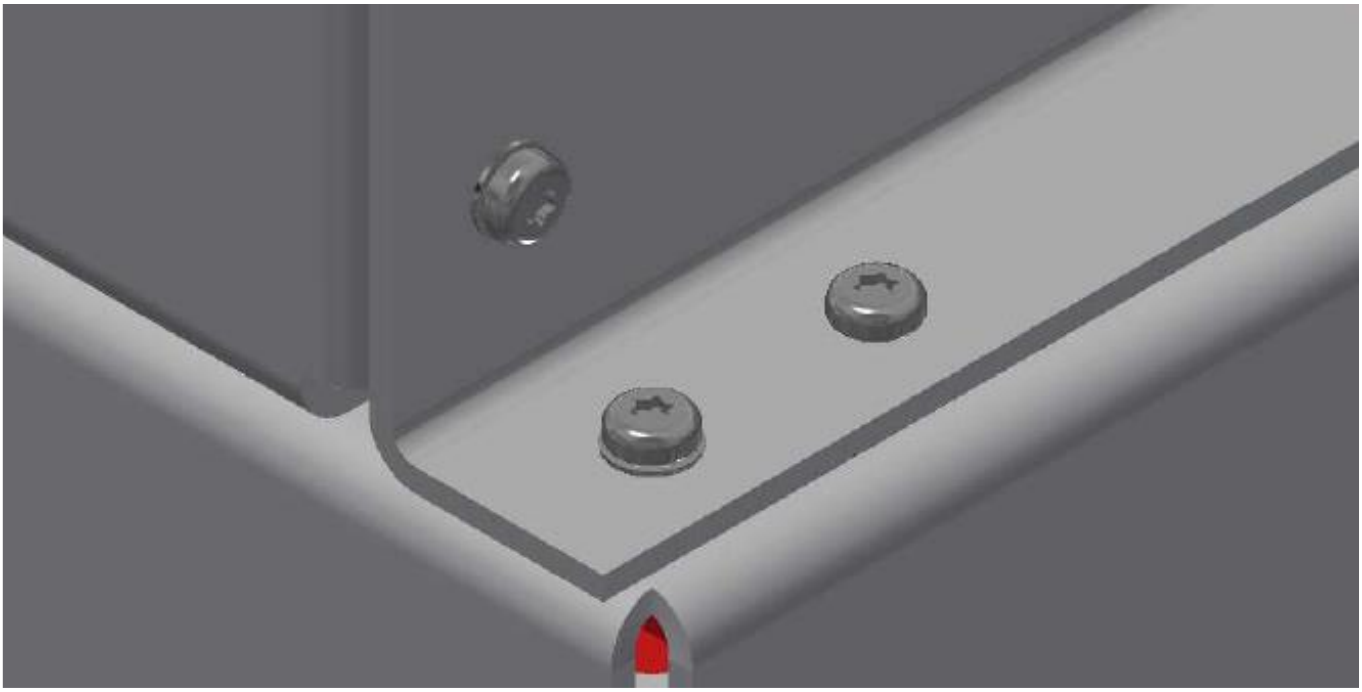
Install the first intermediate panel (with a cut-out) using 6 of the thread rolling screws provided. Leave the screws finger tight to allow the panel to move as other panels are attached. Two screws at the front and rear end should have internal star washers (provided) fitted under the head of the screw to ensure that the panel is electrically bonded to the section. The panel should be such that the vertical face is aligned with the interface between the sections.





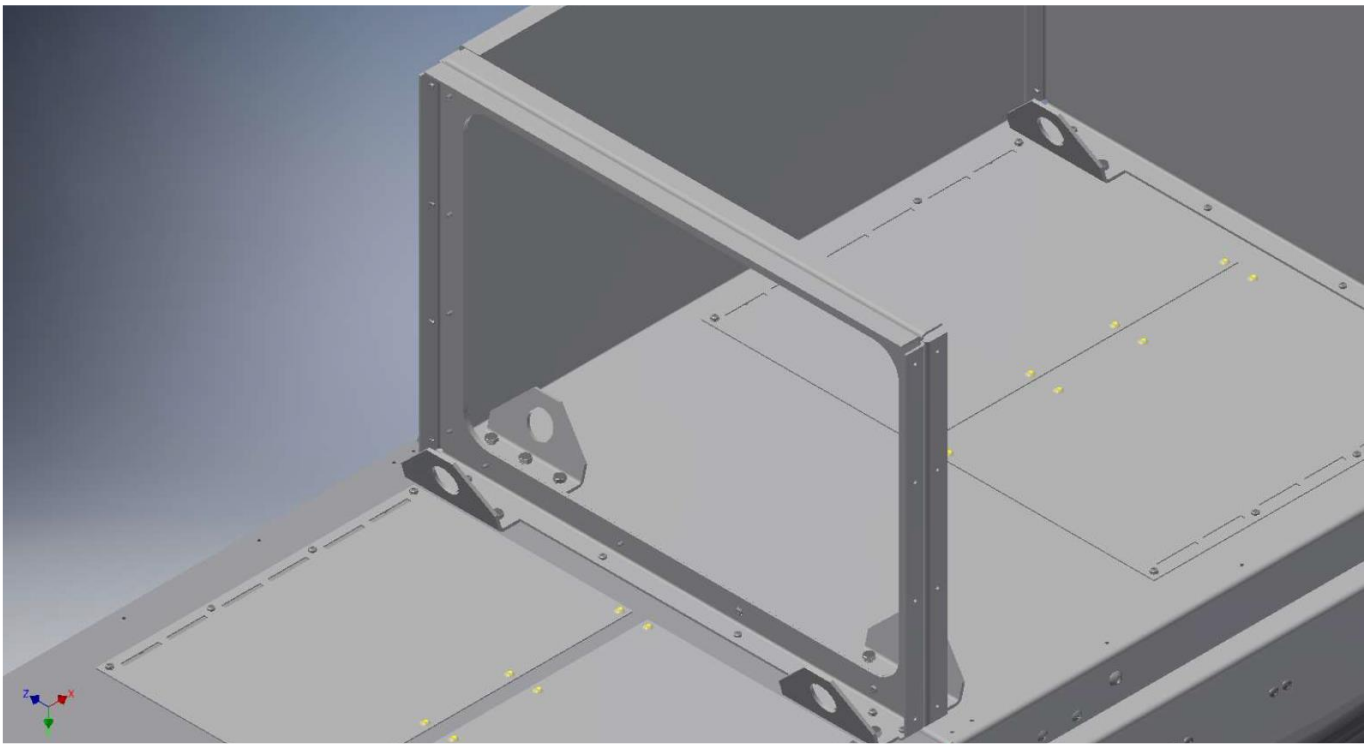
Install the rear of the shroud using 15 of the thread rolling screws provided. Leave the screws finger tight to allow the panel to move as other panels are attached. The screws at the top and bottom of each vertical flange, and at the left and right hand ends of the bottom flange should have internal star washers (provided) fitted under the head of the screw to ensure that the panel is electrically bonded to the section.

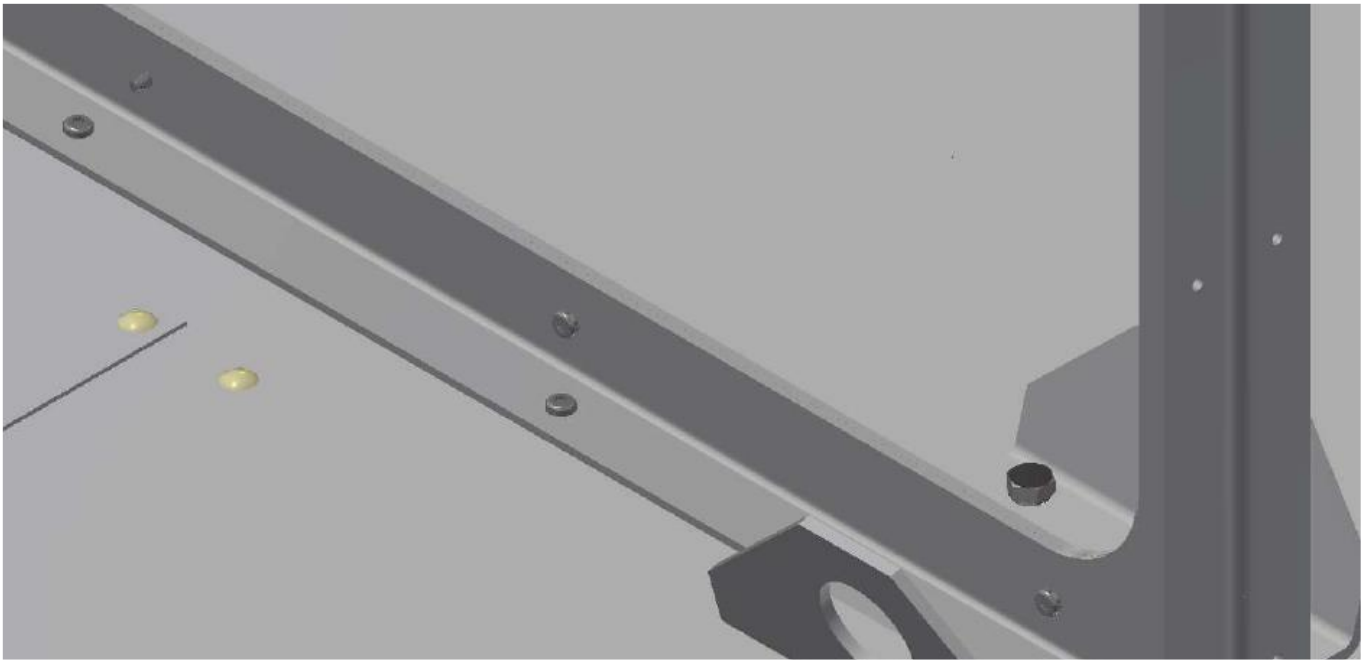




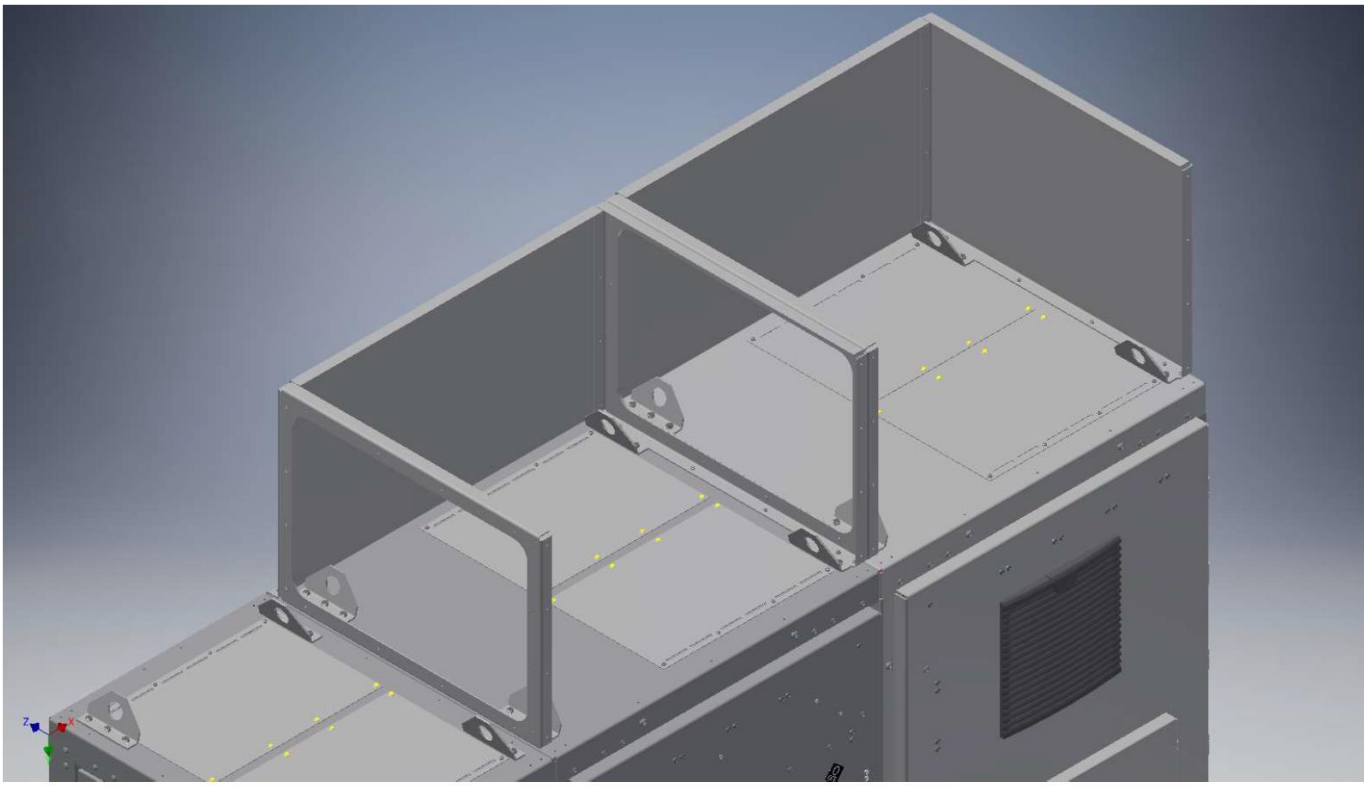
Install the second intermediate panel (with a cut-out) using 6 of the thread rolling screws provided. Leave the screws finger tight to allow the panel to move as other panels are attached. The screws at the front and rear end should have internal star washers (provided) fitted under the head of the screw to ensure that the panel is electrically bonded to the section. The panel should be such that its vertical face is aligned with the interface between the sections.

Secure the second intermediate panel to the first intermediate panel using 16 of the thread rolling screws provided, 8 installed from one side, 8 from the other. The screws at each end of each run of screws should have internal star washers (provided) fitted under the head of the screw to ensure that the panel is electrically bonded to the section, and the panels are bonded together. Tighten the screws to pull the two panels together, then tighten the screws attaching the intermediate panels to the roof of the section.

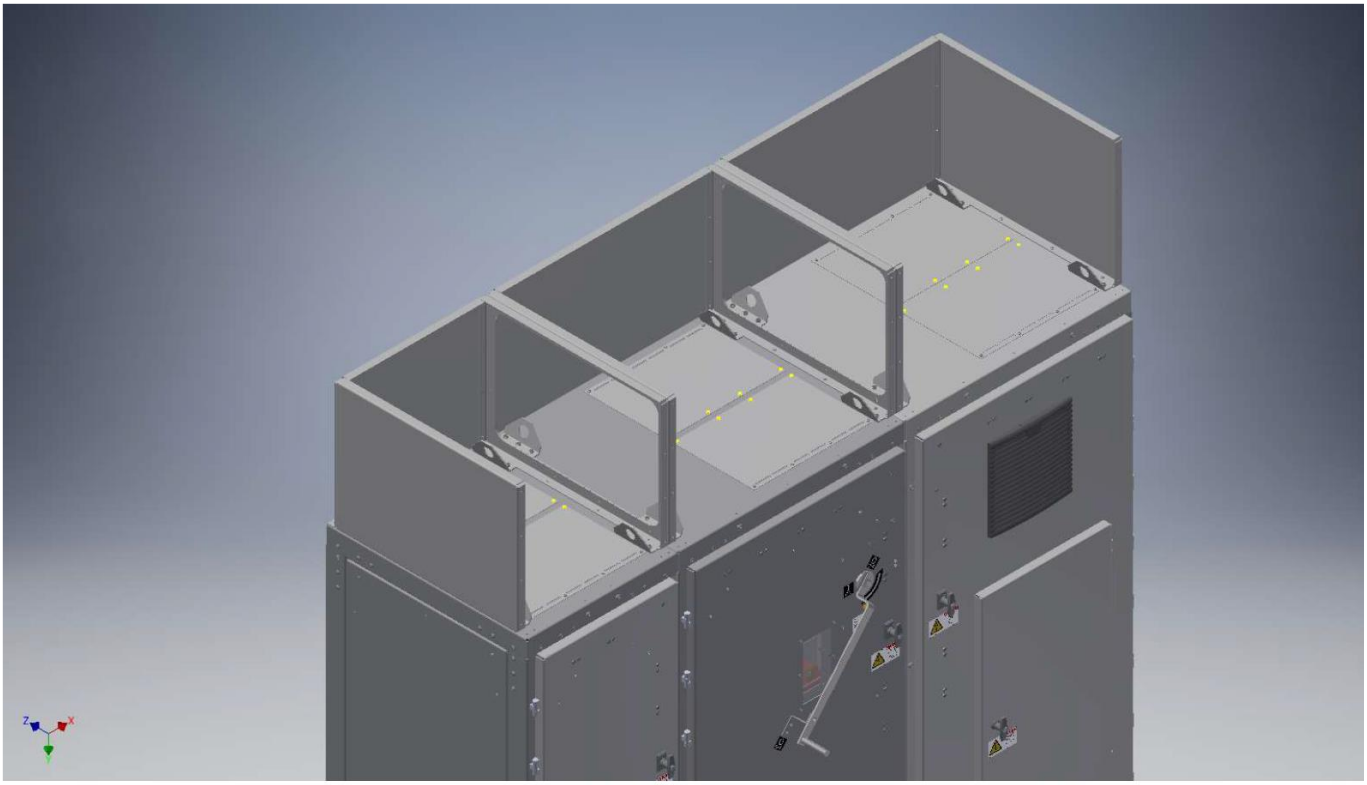




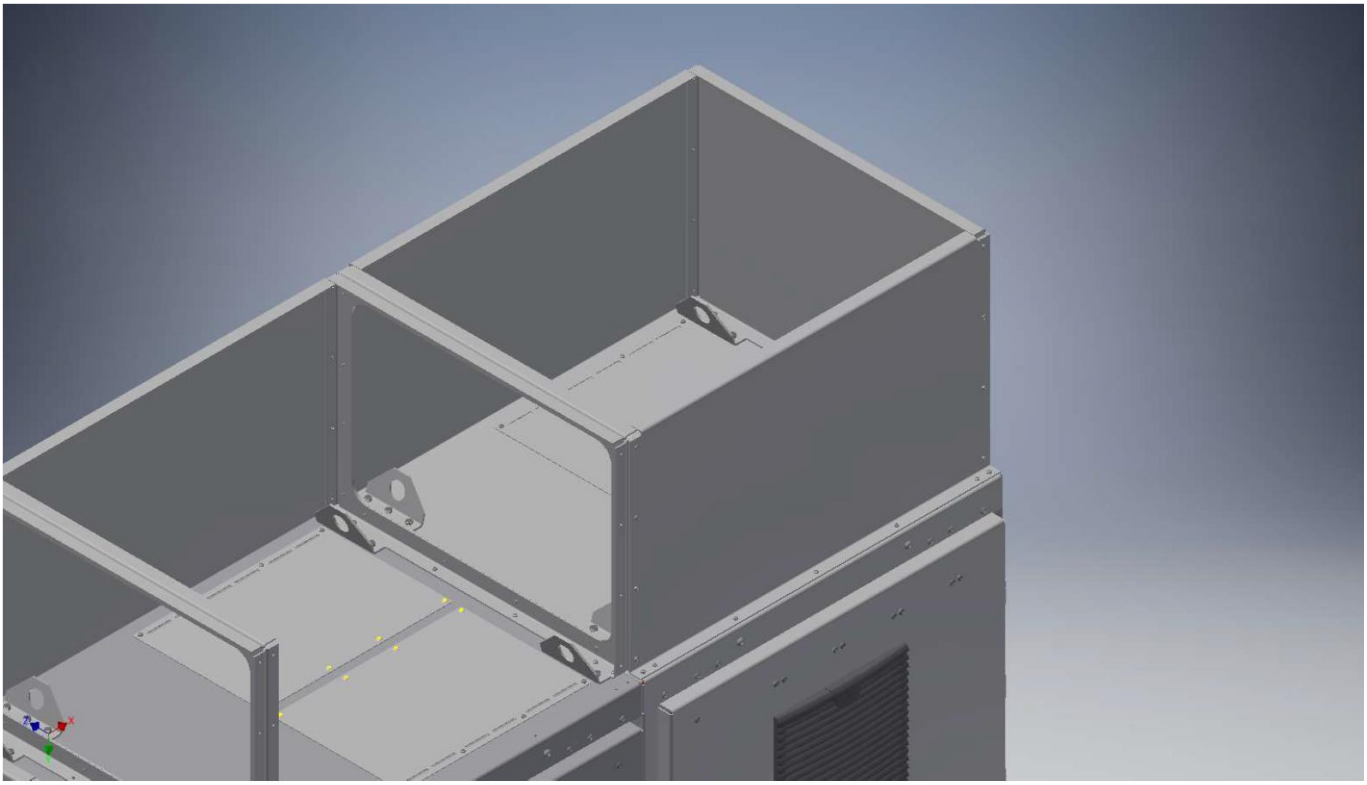
Install the third intermediate panel and the rear panel as for the first section. Leave the screws finger tight to allow the panel to move as other panels are attached.



Continue to the end of the board, leaving all the screws finger tight except for those securing the intermediate panels. Tighten the screws securing the end panels to the roofs of the sections at the end of the Converter System.

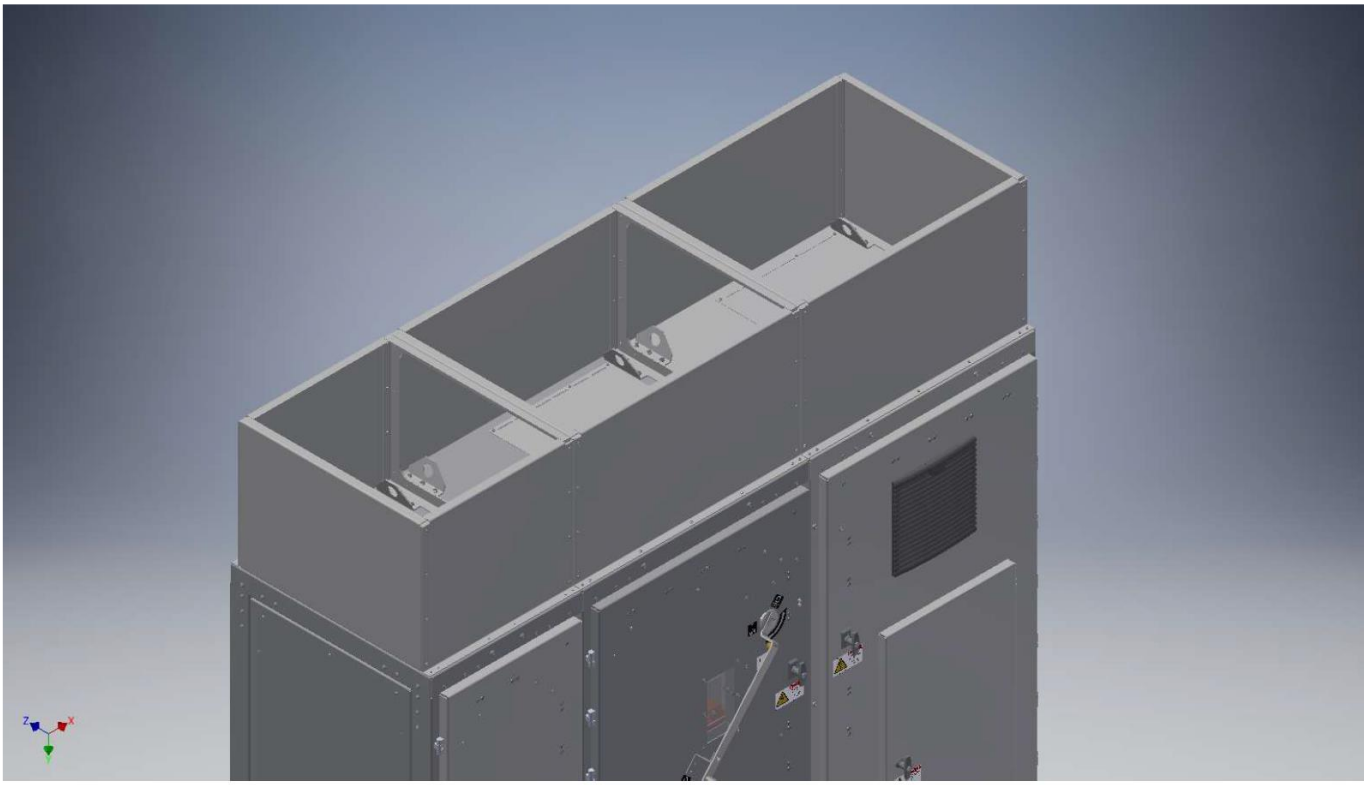


Install the front of the shroud for the section at one end of the system using 15 of the thread rolling screws provided. Leave the screws finger tight to allow the panel to move as other panels are attached. The screws at the top and bottom of each vertical flange, and at the left and right hand ends of the bottom flange should have internal star washers (provided) fitted under the head of the screw to ensure that the panel is electrically bonded to the section.



Continue attaching front panels until all sections have front panels in place.

Tighten all screws securing the front and rear panels.



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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