THERMAL CARE
PiovanGroup

Central Chillers

OPERATION, INSTALLATION AND MAINTENANCE MANUAL

Accuchiller **MX**

Where water means business.

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Foreword

The central chiller consists of a refrigeration circuit to provide cooling water to coolant.

This manual is to serve as a guide for installing, operating, and maintaining the equipment. Improper installation, operation, and maintenance can lead to poor performance and/or equipment damage. Use qualified installers and service technicians for all installation and maintenance of this equipment.

This manual is for our standard product. The information in this manual is general in nature. Unit-specific drawings and supplemental documents are included with the equipment as needed. Additional copies of documents are available upon request.

Due to the ever-changing nature of applicable codes, ordinances, and other local laws pertaining to the use and operation of this equipment, we do not reference them in this manual.

The equipment uses either a hydro fluorocarbon (HFC), trade named R-134a, or a hydrofluorolefin (HFO), trade named R-513A, as a chemical refrigerant for heat transfer purposes. No other refrigerant can be used in the system, nor can the refrigerants be mixed. This chemical is sealed and tested in a pressurized system containing ASME coded vessels; however, a system failure will release it. Refrigerant gas can cause toxic fumes if exposed to fire. Place these units in a well-ventilated area, especially if open flames are present. Failure to follow these instructions could result in a hazardous condition. We recommend the use of a refrigerant management program to document the type and quantity of refrigerant in the equipment. In addition, we recommend only licensed and EPA certified service technicians work on our refrigeration circuits.

Safety Guidelines

Observe all safety precautions during installation, start-up, and service of this equipment. The following is a list of symbols used in this manual and their meaning.

General Warning

Electricity Warning

Sharp Element Warning

Hot Surface Warning

Flammable Material Warning

Explosive Material Warning

General Mandatory Action

Wear Eye Protection

Wear Protective Gloves

Wear Ear Protection

Disconnect Before Carrying Out Maintenance or Repair

Connect an Earth Terminal to Ground

Only qualified personnel should install, start-up, and service this equipment. When working on this equipment, observe precautions in this manual as well as tags, stickers, and labels on the equipment.

WARNING: Any use or misuse of this equipment outside of the design intent may cause injury or harm.

WARNING: Vent all refrigerant relief valves in accordance to ANSI/ASHRAE Standard 15, Safety Code for Mechanical Refrigeration. Locate this equipment in a well-ventilated area. Inhalation of refrigerant can be hazardous to your health and the accumulation of refrigerant within an enclosed space can displace oxygen and cause suffocation.

WARNING: This equipment contains hazardous voltages that can cause severe injury or death.

WARNING: This equipment contains refrigerant under pressure. Accidental release of refrigerant under pressure can cause personal injury and or property damage.

WARNING: This equipment may contain fan blades or other sharp edges. Make sure all fan guards and other protective shields are securely in place.

WARNING: The exposed surfaces of motors, refrigerant piping, and other fluid circuit components can be very hot and can cause burns if touched with unprotected hands.

CAUTION: Disconnect and lock out incoming power before installing, servicing, or maintaining the equipment. Connecting power to the main terminal block energizes the entire electric circuitry of the unit. Shut off the electric power at the main disconnect before opening access panels for repair or maintenance.

CAUTION: Wear eye protection when installing, maintaining, or repairing the equipment to protect against any sparks, debris, or fluid leaks.

CAUTION: The equipment will exceed 70 dBA sound pressure at 1 meter distance and 1 meter elevation when operating. Wear ear protection as required for personal comfort when operating or working in close proximity to the chiller.

CAUTION: Wear protective gloves when installing, maintaining, or repairing the equipment to protect against any sparks, debris, or fluid leaks.

Pre-Installation

Receiving Inspection

When the unit arrives, verify the information on the unit nameplate agrees with the order acknowledgement and shipping papers. Inspect the equipment for any visible damage and verify all items shown on the bill of lading are present. If damage is evident, document it on the delivery receipt by clearly marking any item with damage as "unit damage" and notify the carrier. In addition, notify our Customer Service Department and they will provide assistance with preparing and filing freight damage claims, including arranging for an estimate on repair costs; however, filing the shipping damage claim is the responsibility of the receiving party. Do not install damaged equipment without getting the equipment repaired.

Shipping damage is the responsibility of the carrier. To protect against possible loss due to damage incurred during shipping and to expedite payment for damages, it is important to follow proper procedures and keep records. Photographs of damaged equipment are excellent documentation for your records.

Start unpacking the unit, inspect for concealed damage, and take photos of any damage found. Once received, equipment owners have the responsibility to provide reasonable evidence that the damage did not occur after delivery. Photos of the equipment damage while the equipment is still partially packed will help in this regard. Refrigerant lines can be susceptible to damage in transit. Check for broken lines, oil leaks, damaged controls, or any other major component torn loose from its mounting point.

Record any signs of concealed damage and file a shipping damage claim immediately with the shipping company. Most carriers require concealed damages be reported within 15 days of receipt of the equipment. In addition, notify our Customer Service Department and they will provide assistance with preparing and filing freight damage claims, including arranging for an estimate on repair costs; however, filing the shipping damage claim is the responsibility of the receiving party.

Chillers with an integral water-cooled ship with a full refrigerant charge. Chillers designed for use with a remote air-cooled condenser and the remote condensers themselves ship with a nitrogen holding charge. Check the remote condenser for signs of leaks prior to rigging. This will ensure no coil damage has occurred after the unit left the factory. The condenser ships with the legs removed. Mount the legs to the condenser using the provided nuts, bolts, and washers.

Unit Storage

When storing the unit it is important to protect it from damage. Blow out any water from the unit; cover it to keep dirt and debris from accumulating or getting in, and store in an indoor sheltered area that does not exceed 145°F.

Installation - Chiller

Foundation

Install the unit on a rigid, non-warping mounting pad, concrete foundation, or level floor suitable to support the full operating weight of the equipment. When installed the equipment must be level within ¼ inch over its length and width.

Unit Location

The unit is available in many different configurations for various environments. Refer to the proposal and order acknowledgement document for the equipment to verify the specific design conditions in which it can operate.

To ensure proper airflow and clearance space for proper operation and maintenance allow a minimum of 36 inches of clearance between the sides of the equipment and any walls or obstructions. Avoid locating piping or conduit over the unit to ensure easy access with an overhead crane or lift to lift out heavier components during replacement or service. In addition, ensure the condenser and evaporator refrigerant pressure relief valves can vent in accordance with all local and national codes.

Rigging

The chiller has a frame to facilitate easy movement and positioning with a crane or forklift. Follow proper rigging methods to prevent damage to components. Avoid impact loading caused by sudden jerking when lifting or lowering the chiller. Use pads where abrasive surface contact may occur.

Process Fluid Piping

Proper insulation of chilled process fluid piping is crucial to prevent condensation. The formation of condensation adds a substantial heat load to the chiller.

The importance of properly sized piping cannot be overemphasized. See the ASHRAE Handbook or other suitable design guide for proper pipe sizing. In general, run full size piping out to the process and reduce pipe size at connections as needed. One of the most common causes of unsatisfactory chiller performance is poor piping system design. Avoid long lengths of hoses, quick disconnect fittings, and manifolds wherever possible as they offer high resistance to water flow. When manifolds are required, install them as close to the use point as possible. Provide flow-balancing valves at each machine to assure adequate water distribution in the entire system.

Condenser Water Piping

(Water-Cooled Condenser Units Only)
The performance of a water-cooled condenser is dependent on the flow and temperature of the cooling water used. Insufficient cooling of the condenser will result in the reduction of cooling capacity of the chiller and under extreme conditions may result in the chiller shutting down due to high refrigerant pressure. Allowing the condenser to plug up from contaminants in the condenser water stream adversely affects performance. In order to reduce maintenance costs and chiller downtime, a water treatment program is highly recommended for the condenser cooling water. Contact our Customer Service Department for assistance in the proper procedure for cleaning out any plugged condenser.

The nominal water-cooled condenser is design for 85°F condenser cooling water supply. Under normal operation there will be about a 10°F rise through the condenser resulting in 95°F exiting water. To ensure proper water flow through the condenser, ensure the condenser water pump provides at least 25 psi or water at a flow rate of 3 gpm per ton of chiller capacity.

Each condenser has a two-way condenser water-regulating valve. The condenser water-regulating valve controls the amount of water allowed to pass through the condenser in order to maintain proper refrigeration pressures in the circuit.

To prevent damage to the condenser and/or water-regulating valve, the water pressure should not exceed 150 psig.

Water Pressure Gauges

Install pressure gauges in the inlet and outlet of both the condenser and evaporator chilled water piping to provide the ability to read the pressure drop across the chiller and aid in preventive maintenance and troubleshooting.

WARNING: Vent all refrigerant relief valves in accordance to ANSI/ASHRAE Standard 15, Safety Code for Mechanical Refrigeration. Locate this equipment in a well-ventilated area. Inhalation of refrigerant can be hazardous to your health and the accumulation of refrigerant within an enclosed space can displace oxygen and cause suffocation.

WARNING: This equipment contains hazardous voltages that can cause severe injury or death.

WARNING: This equipment contains refrigerant under pressure. Accidental release of refrigerant under pressure can cause personal injury and or property damage.

WARNING: This equipment may contain fan blades or other sharp edges. Make sure all fan guards and other protective shields are securely in place.

WARNING: The exposed surfaces of motors, refrigerant piping, and other fluid circuit components can be very hot and can cause burns if touched with unprotected hands.

CAUTION: Disconnect and lock out incoming power before installing, servicing, or maintaining the equipment. Connecting power to the main terminal block energizes the entire electric circuitry of the unit. A power supply provides 24 VDC control power. Shut off the electric power at the main disconnect before opening access panels for repair or maintenance.

CAUTION: Wear eye protection when installing, maintaining, or repairing the equipment to protect against any sparks, debris, or fluid leaks.

CAUTION: The equipment will exceed 70 dBA sound pressure at 1 meter distance and 1 meter elevation when operating. Wear ear protection as required for personal comfort when operating or working in close proximity to the chiller.

CAUTION: Wear protective gloves when installing, maintaining, or repairing the equipment to protect against any sparks, debris, or fluid leaks.

Primary Temperature Sensor

This section only applies to installations where multiple chillers are in a common system where one chiller is the primary with the other chillers serving as secondary. In those situations, a field-installed primary fluid-temperature transmitter is required in the common process fluid supply and return piping. Install the sensor downstream of all individual chilled water supply streams. Position the temperature transmitter to read the mixed supply temperature. The supply temperature transmitter is normally the control sensor for the chiller system set point and determines the loading/unloading of the compressors of the system.

Mount the temperature transmitter in a ½" NPT coupling in a minimum pipe size of 3". The probe sheath is ¼" OD x 3" in length and is equipped with a ½" NPT male fitting for direct mounting in a coupling. Use direct immersion mounting for the most accurate reading and quickest response time. If direct immersion mounting is not possible, mount the sensor inside a thermowell to aid in maintenance and or repair of the sensor if opening of the process piping is not possible. Use a suitable heat transfer compound with a thermowell. Wire from the temperature transmitter to the chiller electrical enclosure and landed at the designated terminal blocks within the enclosure. Please see the chiller electrical schematic provided for further detail.

Installation - Remote Condenser

Chillers designed for use with a remote air-cooled condenser include a factory-selected remote condenser. The remote air-cooled condenser typically ships separately from a different location than the chiller.

Location

The remote air-cooled condenser is for outdoor use. Locate the remote condenser in an accessible area. The vertical air discharge must be unobstructed. Allow a minimum of 48 inches of clearance between the sides and ends of the condenser and any walls or obstructions. For installations with multiple condensers, allow a minimum of 96 inches between condensers placed side-by-side or 48 inches for condensers placed end-to-end.

When locating the condenser it is important to consider accessibility to the components to allow for proper maintenance and servicing of the unit. Avoid locating piping or conduit over the unit to ensure easy access with an overhead crane or lift to lift out heavier components during replacement or service.

Proper ventilation is another important consideration when locating the condenser. In general, locate the unit in an area that will not rise above 110°F.

Install the unit on a firm, level base no closer than its width from walls or other condensers. Avoid locations near exhaust fans, plumbing vents, flues, or chimneys. Fasten the mounting legs at their base to the steel or concrete of the supporting structure. For units mounted on a roof structure, the steel support base holding the condenser should be elevated above the roof and attached to the building.

Avoid areas that can create a "micro-climate" such as an alcove with east, north, and west walls that can be significantly warmer than surrounding areas. The condenser needs to have unrestricted airways so it can easily move cool air in and heated air away. Consider locating the condenser where fan noise and vibration transmission into nearby workspaces is unlikely.

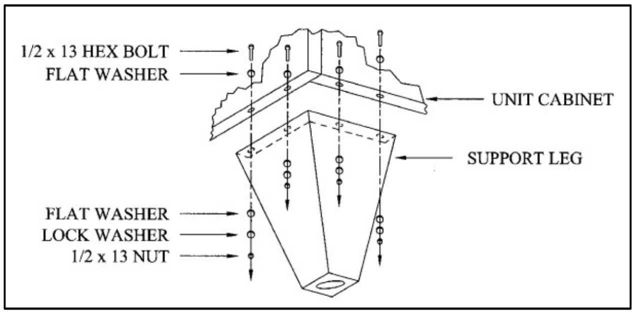
The unit ships on its side with the legs removed to reduce shipping dimensions and provide more protection to the coil from possible damage caused by impact loading over rough roads and transit conditions.

Lifting

Use only qualified personnel using the proper equipment when lifting and positioning the condenser. Lift the remote condenser using the leg support channels or the side lifting brackets. Use spreader bars when lifting to apply the lifting force vertically. Under no circumstances use the coil headers or return bends in the lifting or moving of the condenser.

Mounting Legs

Before rigging the unit, install the legs using the hardware provided. The standard legs are 22 inches. Optional 48 or 60 inches legs require a leg between every fan section and gusset for stability. 60 inch legs also require cross bracing, see the diagram provided with the unit for details. The following shows a typical leg mounting arrangement.



Interconnecting Refrigerant Piping

The chiller and remote condenser ship with a nitrogen holding charge. Evacuation of this charge is required before charging with refrigerant. The chiller is for use only with the air-cooled condenser provided with the unit. The following section covers the required piping between the chiller and the provided air-cooled condenser.

The discharge and liquid lines leaving the chiller have caps. These line sizes do not necessarily reflect the actual line sizes required for the piping between the chiller and the air-cooled condenser.

Refrigerant piping size and piping design have a significant impact on system performance and reliability. All piping should conform to the applicable local and state codes.

CAUTION: Use refrigerant grade copper tubing ASTM B280 only and isolate the refrigeration lines from building structures to prevent transfer of vibration. All copper tubing must have a pressure rating suitable for R-134a: tubing that is 3/4" OD or larger must be Type K rigid tubing. ACR annealed tubing coil may be used for sizes 5/8" ODS or smaller.

Do not use a saw to remove end caps. This might allow copper chips to contaminate the system. Use a tube cutter or heat to remove the caps. When sweating copper joints it is important to evacuate all refrigerant present and flow dry nitrogen through the system. This prevents the formation of toxic gases, corrosive acids, and scale.

CAUTION: Do not use soft solders. For copper-to-copper joints use a copper-phosphorus braze alloy (BCuP per the American Welding Society) with 5% (BCuP-3) to 15% (BCuP-5) silver content. Only use a high silver content brazing alloy (BAg per AWS) for copper-to-brass or copper-to-steel joints such as a 45% (BAg-5) silver content. Only use oxy-acetylene brazing.

Refrigeration Piping Design

The system is configurable as shown in Figure 1, Figure 2, and Figure 3. The configuration and its associated elevation, along with the total distance between the chiller and the air-cooled condenser, are important factors in determining the liquid line and discharge line sizes. This will also affect the field refrigerant charges. Consequently, it is important to adhere to certain physical limitations to ensure the system operates as designed.

General Design Considerations

1. The total distance between the chiller and the remote air-cooled condenser must not exceed 200 actual feet or 300 equivalent feet. Keep the distance as short as possible.
2. Liquid line risers must not exceed 15 feet in height from the condenser liquid line connection.
3. Discharge line risers cannot exceed an elevation difference greater than 100 actual feet without a minimum of 2% efficiency decrease.
4. To form a proper liquid seal at the condenser, immediately drop at least 15 inches down from the liquid outlet before routing the piping to the chiller. Make the drop leg before any bends or angles connecting to the remainder of the liquid connection piping.

Figure 1 – Condenser at Chiller Level

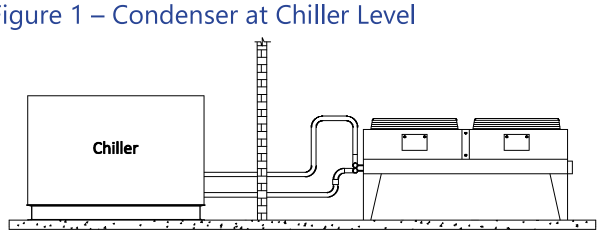


Figure 2 – Condenser Located Above Chiller Unit

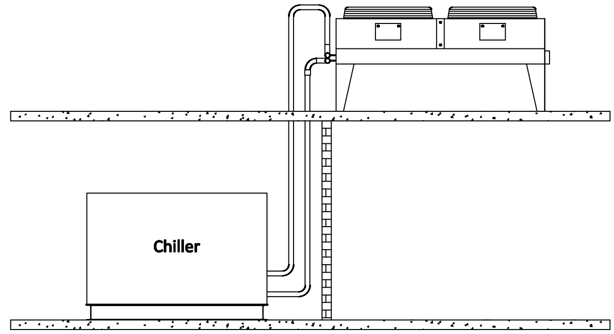
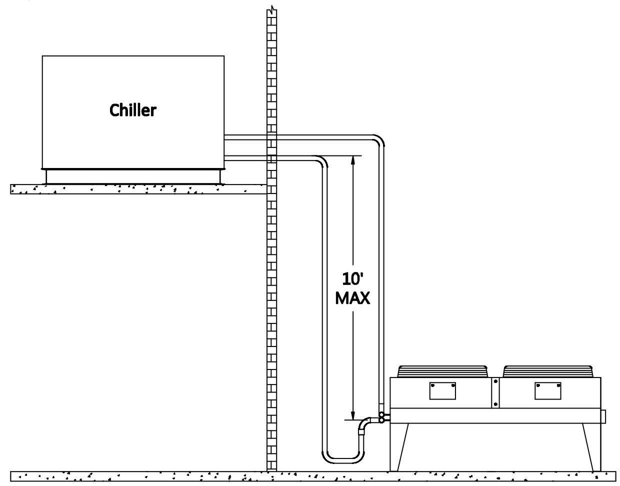


Figure 3 - Condenser Located Below Chiller Unit



Note: Liquid line sizing for each chiller capacity is in Table 10. These line sizes are listed per circuit and apply where leaving water temperature (LWT) is 40°F or higher. For applications where the LWT is below 40°F, size lines using the ASHRAE Refrigeration Handbook or other suitable design guide.

Determining Equivalent Line Length

To determine the appropriate size for field installed liquid and discharge lines, it is first necessary to establish the equivalent length of pipe for each line. The equivalent length is the approximate friction loss from the combined linear run of pipe and the equivalent feet of elbows, valves, and other components in the refrigeration piping. The sum total is the equivalent length of pipe that would have the same pressure loss. See the ASHRAE Refrigeration Handbook for more information.

Follow these steps when calculating line size

1. Start with an initial approximation of equivalent length by assuming that the equivalent length of pipe is 1.5 times the actual pipe length.

2. Determine approximate line sizes by referring to Table 10 for liquid lines and Table 11 for discharge lines.
3. Check the line size by calculating the actual equivalent length using the equivalent lengths as shown in Table 9.

CAUTION: When calculating the equivalent length, do not include piping of the chiller unit. Only field piping must be considered.

Table 1 – Equivalent Lengths of Elbows

Line Size OD (in)	Equivalent Lengths of Refrigerant Pipe (feet)				
	90° Standard	90° Long Radius	90° Street	45° Standard	45° Street
7/8	2.0	1.4	3.2	0.9	1.6
1 1/8	2.6	1.7	4.1	1.3	2.1
1 3/8	3.3	2.3	5.6	1.7	3.0
1 5/8	4.0	2.6	6.3	2.1	3.4
2 1/8	5.0	3.3	8.2	2.6	4.5
2 1/8	6.0	4.1	10.0	3.2	5.2
3 1/8	7.5	5.0	12.0	4.0	6.4
3 5/8	9.0	5.9	15.0	4.7	7.3
4 1/8	10.0	6.7	17.0	5.2	8.5

Liquid Line Sizing

The liquid line diameter should be as small as possible while maintaining acceptable pressure drop. This is necessary to minimize refrigerant charge. The total length between the chiller unit and the air-cooled condenser must not exceed 200 actual feet or 300 equivalent feet. It is best to pipe the liquid line so that there is an immediate drop of at least 15 inches at the condenser outlets to make a liquid seal.

Liquid line risers in the system will require an additional 0.5 psig pressure drop per foot of vertical rise. When it is necessary to have a liquid line riser, make the vertical run immediately after the condenser before any additional restrictions. The liquid line risers must not exceed 10 feet in height from the condenser liquid line connection. The liquid line does not require pitching. Install a pressure tap valve at the condenser to facilitate measuring pressure for service.

Liquid lines do not typically require insulation. However, if exposing the lines to solar heat gain or temperatures exceeding 110 °F, there is a negative effect on sub-cooling. In these situations, insulate the liquid lines.

Table 2 – Liquid Line Size/Circuit (inches OD)

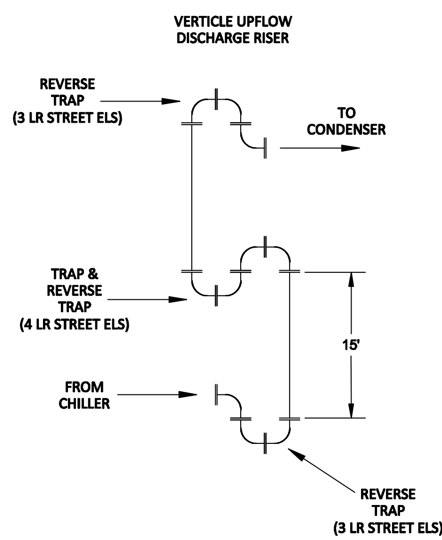
Total Equivalent Length (Ft)	Systems Designed for 20°F to 39°F Set Point				Systems Designed for 40°F to 80°F Set Point			
	50 Ton	75 Ton	100 Ton	125 Ton	50 Ton	75 Ton	100 Ton	125 Ton
25	1 3/8	1 3/8	1 5/8	1 5/8	1 3/8	1 5/8	2 1/8	2 1/8
50	1 3/8	1 3/8	1 5/8	1 5/8	1 3/8	1 5/8	2 1/8	2 1/8
75	1 3/8	1 3/8	1 5/8	1 5/8	1 3/8	1 5/8	2 1/8	2 1/8
100	1 3/8	1 3/8	1 5/8	1 5/8	1 3/8	1 5/8	2 1/8	2 1/8
125	1 3/8	1 3/8	1 5/8	1 5/8	1 3/8	1 5/8	2 1/8	2 1/8
150	1 3/8	1 ⅝	1 5/8	1 5/8	1 3/8	1 5/8	2 1/8	2 1/8
175	1 3/8	1 ⅝	1 5/8	1 5/8	1 5/8	2 1/8	2 1/8	2 1/8
200	1 3/8	1 5/8	1 5/8	2 1/8	1 5/8	2 1/8	2 1/8	2 1/8
225	1 3/8	1 5/8	1 5/8	2 1/8	1 5/8	2 1/8	2 1/8	2 1/8
250	1 3/8	1 5/8	2 1/8	2 1/8	1 5/8	2 1/8	2 1/8	2 1/8
275	1 3/8	1 5/8	2 1/8	2 1/8	1 5/8	2 1/8	2 1/8	2 5/8
300	1 3/8	1 5/8	2 1/8	2 1/8	1 5/8	2 1/8	2 1/8	2 5/8

Discharge (Hot Gas) Line Sizing

The discharge line sizes depend on the velocity needed to obtain sufficient oil return. It is very important to minimize line length and restrictions to reduce pressure drop and maximize capacity.

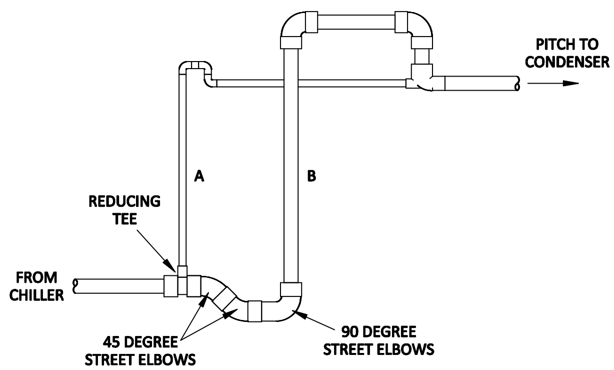
Upflow hot gas risers need to have a trap at the bottom and reverse trap at the top. In addition, a trap and reverse trap arrangement needs to be spaced every 15 feet in the rise for oil management.

Figure 4 – Vertical Riser Traps



The discharge lines should pitch downward, in the direction of the hot gas flow, at the rate of ½ inch per each 10 foot of horizontal run. If the chiller unit is below the condenser, loop the discharge line to at least 1 inch above the top of the condenser. Install a pressure tap valve at the condenser to facilitate measuring pressure for service. All chillers have unloading capabilities via compressor unloading; therefore, they all require a double discharge riser for proper oil management.

Figure 5 - Double Discharge Riser



Note: Discharge line sizing for each chiller circuit capacity is in Table 11. Line sizing shown is listed per circuit and applies where leaving water temperature (LWT) is 40°F or higher. For applications where LWT is below 40°F, size lines using the ASHRAE Refrigeration Handbook or other suitable design guide.

Table 3 – Horizontal or Downflow Discharge Line Size

Total Equivalent Length (Ft)	Line Size/Circuit (inches OD)							
	Systems Designed for 20°F to 39°F Set Point				Systems Designed for 40°F to 80°F Set Point			
	50 Ton	75 Ton	100 Ton	125 Ton	50 Ton	75 Ton	100 Ton	125 Ton
25	2 1/8	2 5/8	2 5/8	3 1/8	2 1/8	2 5/8	2 5/8	3 1/8
50	2 1/8	2 5/8	2 5/8	3 1/8	2 1/8	2 5/8	2 5/8	3 1/8
75	2 1/8	2 5/8	2 5/8	3 1/8	2 1/8	2 5/8	2 5/8	3 1/8
100	2 1/8	2 5/8	2 5/8	3 1/8	2 1/8	2 5/8	3 1/8	3 1/8
125	2 1/8	2 5/8	2 5/8	3 1/8	2 5/8	2 5/8	3 1/8	3 1/8
150	2 1/8	2 5/8	2 5/8	3 1/8	2 5/8	3 1/8	3 1/8	3 5/8
175	2 1/8	2 5/8	2 5/8	3 1/8	2 5/8	3 1/8	3 1/8	3 5/8
200	2 1/8	2 5/8	2 5/8	3 1/8	2 5/8	3 1/8	3 1/8	3 5/8
225	2 1/8	2 5/8	2 5/8	3 1/8	2 5/8	3 1/8	3 1/8	3 5/8
250	2 1/8	2 5/8	2 5/8	3 1/8	2 5/8	3 1/8	3 1/8	3 5/8
275	2 1/8	2 5/8	2 5/8	3 1/8	2 5/8	3 1/8	3 1/8	3 5/8
300	2 1/8	2 5/8	2 5/8	3 1/8	2 5/8	3 1/8	3 1/8	3 5/8

Table 4 – Upflow Discharge Line Size

Total Equivalent Length (Ft)		Line Size/Circuit (inches OD)							
		Systems Designed for 20°F to 39°F Set Point				Systems Designed for 40°F to 80°F Set Point			
		50 Ton	75 Ton	100 Ton	125 Ton	50 Ton	75 Ton	100 Ton	125 Ton
25	A	1 3/8	1 5/8	1 5/8	1 5/8	1 3/8	1 5/8	1 5/8	2 1/8
	B	1 5/8	2 1/8	2 1/8	2 5/8	1 5/8	2 1/8	2 1/8	2 5/8
50	A	1 3/8	1 5/8	1 5/8	1 5/8	1 3/8	1 5/8	1 5/8	2 1/8
	B	1 5/8	2 1/8	2 1/8	2 5/8	1 5/8	2 1/8	2 1/8	2 5/8
75	A	1 3/8	1 5/8	1 5/8	1 5/8	1 3/8	1 5/8	1 5/8	2 1/8
	B	1 5/8	2 1/8	2 1/8	2 5/8	1 5/8	2 1/8	2 1/8	2 5/8
100	A	1 3/8	1 5/8	1 5/8	1 5/8	1 3/8	1 5/8	1 5/8	2 1/8
	B	1 5/8	2 1/8	2 1/8	2 5/8	1 5/8	2 1/8	2 5/8	2 5/8
125	A	1 3/8	1 5/8	1 5/8	1 5/8	1 3/8	1 5/8	1 5/8	2 1/8
	B	1 5/8	2 1/8	2 1/8	2 5/8	2 1/8	2 1/8	2 5/8	2 5/8
150	A	1 3/8	1 5/8	1 5/8	1 5/8	1 3/8	1 5/8	1 5/8	2 1/8
	B	1 5/8	2 1/8	2 1/8	2 5/8	2 1/8	2 5/8	2 5/8	3 1/8
175	A	1 3/8	1 5/8	1 5/8	1 5/8	1 3/8	1 5/8	1 5/8	2 1/8
	B	1 5/8	2 1/8	2 1/8	2 5/8	2 1/8	2 5/8	2 5/8	3 1/8
200	A	1 3/8	1 5/8	1 5/8	1 5/8	1 3/8	1 5/8	1 5/8	2 1/8
	B	1 5/8	2 1/8	2 1/8	2 5/8	2 1/8	2 5/8	2 5/8	3 1/8
225	A	1 3/8	1 5/8	1 5/8	1 5/8	1 3/8	1 5/8	1 5/8	2 1/8
	B	1 5/8	2 1/8	2 1/8	2 5/8	2 1/8	2 5/8	2 5/8	3 1/8
250	A	1 3/8	1 5/8	1 5/8	1 5/8	1 3/8	1 5/8	1 5/8	2 1/8
	B	1 5/8	2 1/8	2 1/8	2 5/8	2 1/8	2 5/8	2 5/8	3 1/8
275	A	1 3/8	1 5/8	1 5/8	1 5/8	1 3/8	1 5/8	1 5/8	2 1/8
	B	1 5/8	2 1/8	2 1/8	2 5/8	2 1/8	2 5/8	2 5/8	3 1/8
300	A	1 3/8	1 5/8	1 5/8	1 5/8	1 3/8	1 5/8	1 5/8	2 1/8
	B	1 5/8	2 1/8	2 1/8	2 5/8	2 1/8	2 5/8	2 5/8	3 1/8

Calculating Refrigerant Charge

To determine the approximate charge, first refer to Table 5 and establish the required charge for the condenser and chiller. Then refer to Table 6 to determine the charge required for the field-installed piping per circuit. The approximate charge per circuit is therefore the sum of the values from Table 5 and Table 6.

The charge required for an air-cooled condenser using fan cycling and variable speed for head pressure control is indeterminate due to site and environmental variances. Because refrigerant density increases with decreasing temperatures, the low ambient operating charge is more (compared to the summer charge). In the worst case of -20°F, the charge may nearly double. The best way to assure proper charging is, on the coldest day of the year under full load, the charge should be up to the second sight glass from the bottom of the receiver with the electric expansion valves (EXV) sight glass clear. Prolonged periods of foaming in the sight glass may indicate a low refrigerant condition or a restriction in the liquid line.

Note: Occasional bubbling in a sight glass may occur at a time when load conditions are changing and the expansion valve is adjusting to the new conditions. This momentary occurrence is a result of normal chiller operation.

Use the sight glass to check if there is moisture in the refrigeration circuit. If there is moisture in the circuit, the green ring around the perimeter of the sight glass will turn yellow. If this occurs, service immediately.

Table 5 – Chiller & Condenser Refrigerant Charge

Chiller Model	Total Combined Chiller and Condenser Summertime Refrigerant Charge	
	(Lbs. of R134a @ 60°F)	(Lbs. of R513A @ 60°F)
MXR50	115	109
MXR75	187	177
MXR100	223	210
MXR125	265	250

Table 6 - Field Piping Refrigerant Charges

Line Size OD (inches)	Discharge Line (Lbs./100’ run)		Liquid Line (Lbs./100’ run)	
	R134a	R513A	R134a	R513A
1 3/8	3.0	3.5	63.4	59.5
1 5/8	4.2	4.9	89.7	84.2
2 1/8	7.4	8.5	156.9	147.3
2 5/8	11.4	13.1	242.5	227.6
3 1/8	16.3	18.8	345.6	324.3

Installation - Electrical

All wiring must comply with local codes and the National Electric Code. Minimum circuit amps (MCA) and other unit electrical data are on the unit nameplate. A unit specific electrical schematic ships with the unit. Measure each leg of the main power supply voltage at the main power source. Voltage must be within the voltage utilization range given on the drawings included with the unit. If the measured voltage on any leg is not within the specified range, notify the supplier and correct before operating the unit. Voltage imbalance must not exceed two percent. Excessive voltage imbalance between the phases of a three-phase system can cause motors to overheat and eventually fail. Voltage imbalance is determined using the following calculations.

% Imbalance = (Vavg – Vx) x 100 / Vavg

Vavg = (V1 + V2 + V3) / 3

Vx = phase with greatest difference from Vavg

For example, if the three measured voltages were 442, 460, and 454 volts, the average would be:

(442 + 460 + 454) / 3 = 452
The percentage of imbalance is then:

(452 – 442) x 100 / 452 = 2.2 %

This exceeds the maximum allowable of 2%.

There is a terminal block for main power connection to the main power source. The main power source should be connected to the terminal block through an appropriate disconnect switch. There is a separate lug in the main control panel for grounding the unit. Check the electrical phase sequence at installation and prior to start-up. Operation of the compressor with incorrect electrical phase sequencing will result in mechanical damage to the compressors. Check the phasing with a phase sequence meter prior to applying power. The proper sequence should read “ABC” on the meter. If the meter reads “CBA”, open the main power disconnect and switch two line leads on the line power terminal blocks (or the unit mounted disconnect). Do not interchange any load leads that are from the unit contactors or the motor terminals.

WARNING: This equipment contains hazardous voltages that can cause severe injury or death.

WARNING: This equipment contains refrigerant under pressure. Accidental release of refrigerant under pressure can cause personal injury and or property damage.

WARNING: This equipment may contain fan blades or other sharp edges. Make sure all fan guards and other protective shields are securely in place.

WARNING: The exposed surfaces of motors, refrigerant piping, and other fluid circuit components can be very hot and can cause burns if touched with unprotected hands.

CAUTION: Disconnect and lock out incoming power before installing, servicing, or maintaining the equipment. Connecting power to the main terminal block energizes the entire electric circuitry of the unit. Electric power at the main disconnect should be shut off before opening access panels for repair or maintenance.

CAUTION: Wear eye protection when installing, maintaining, or repairing the equipment to protect against any sparks, debris, or fluid leaks.

CAUTION: Wear protective gloves when installing, maintaining, or repairing the equipment to protect against any sparks, debris, or fluid leaks.

CAUTION: Wire the unit ground in compliance with local and national codes.

CAUTION: The unit requires the main power to remain connected during off-hours to energize the compressor's crankcase heater. Disconnect main power only when servicing the chiller. The crankcase heater should remain on when the compressor is off to ensure liquid refrigerant does not accumulate in the compressor crankcase. Connect main power at least 24 hours prior to initial startup.

Compressor Control Logic

The chiller uses variable capacity control. The compressor has a slide valve to provide variable capacity control from 25-100% by directly controlling the amount of refrigerant gas taken in by the compressor rotors. The amount of gas taken in depends on the valve position. The loader and unloader solenoid valves control the slide valve position. These valves are pulsed in short time increments to balance compressor capacity with the chiller load. The chiller has a minimum compressor recycle timer to protect the compressor from rapid cycling. The recycle timer begins once a compressor starts and will not let that compressor restart until the recycle timer has timed-out.

When the start button is pressed any pumps controlled by the chiller will turn on, any condenser water-regulating valves will open, and the electronic expansion valve and liquid line solenoid valve for the lead chiller circuit will open and that compressor will start. The compressor will run unloaded for approximately two minutes after which it will load/unload as required to maintain the fluid set point temperature. If there are multiple chillers in a primary/secondary arrangement, additional compressors will start and then load/unload as needed.

After pressing the stop button all compressors run unloaded for approximately 60 seconds and then shutdown one at a time with a two-second time delay between compressors. After all compressors are stopped, all liquid line solenoid valves, condenser water regulating valves, and electronic expansion valves in the system close. Any pumps controlled by the chiller run for 60 seconds and then stop. The system is now ready to begin the next startup sequence.

Primary/Secondary

It is possible to link together multiple chillers to form a single system, using single or dual compressor chillers with a maximum of six compressors connected. Any chiller can be setup to be a primary or a secondary. The primary chiller controls the staging order of the compressors and the running demand of all the compressors in the system in order to maintain the common chilled water set point. A secondary chiller becomes dependent on the primray only for its compressor staging order and running demand. The secondary chiller PLC performs all other operations. The chilled water piping must be connected using a manifold and the supply sensor must be positioned downstream of all individual chilled water streams to read a mixed water temperature. Wire the supply and return water temperature sensors in the common return chilled water piping to the chiller PLC designated as the primary.

General Control Operation

Graphical representations presented in this manual may vary slightly based on special unit customization or modification; however, the operation of the chiller is consistent and the principles presented are applicable to all chillers.

Before operating your chiller, take a few moments to familiarize yourself with this operator manual. The Human Machine Interface (HMI) screens use common icon buttons throughout for navigational purposes.

System Initialization

Upon power-up, the first screen to appear is the Start-up Splash Screen. This screen displays for 5 seconds after the Programmable Logic Controller (PLC) and Human-Machine Interface (HMI) establish communications. The control system version is located on this start-up screen.

Figure 6 – Start-Up Splash Screen

Once the HMI has completed its power on sequence and PLC to HMI communication is established, the HMI should automatically switch to the System Overview Home screen as shown in Figure 7 for remote air-cooled condenser chillers and Figure 8 for water-cooled condenser chillers.

Home - System Overview

System Overview

The System Overview Screen provides an overall synopsis of the chiller system. It also provides quick links to other views as well as additional useful information.

Figure 7 – MXR System Overview

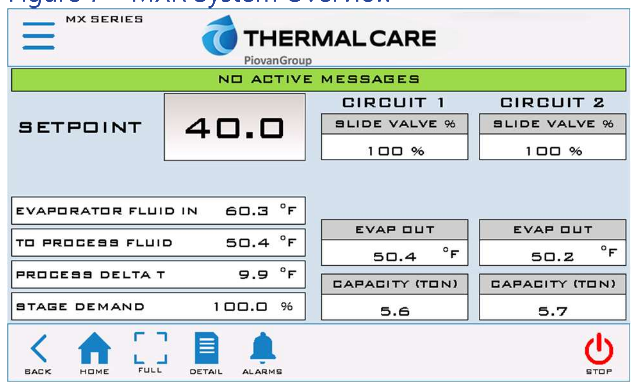


Figure 8 – MXW System Overview

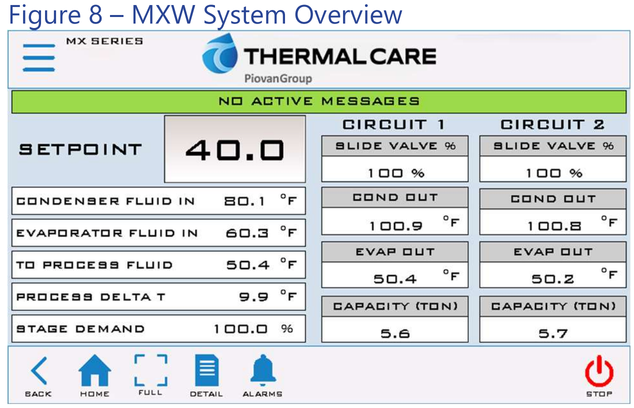


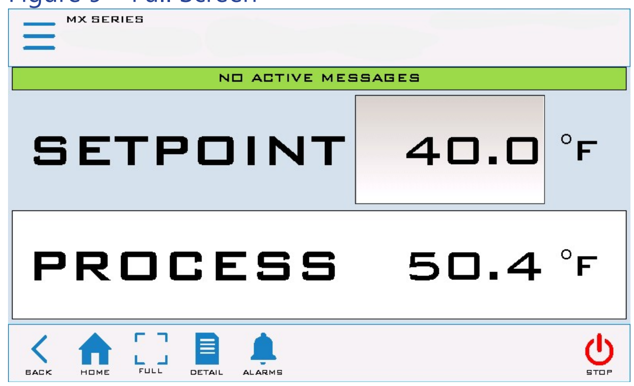
Table 7 – System Overview Functions

Function	Description	Screen Reference
Alarm Messaging	Provides information about any warnings or alarms which may have occurred.	N/A
Setpoint	This is the Set Point temperature. Touch the temperature to change. An authorized security level password is required to enter a new Setpoint.	N/A
Evaporator Fluid In	This is the chiller entering fluid temperature.	N/A
To Process Fluid	This is the chiller leaving fluid temperature.	N/A
Process Delta T	This is the difference between entering and leaving temperatures.	N/A
Evap Out	This shows the Evaporator leaving coolant temperature.	N/A
Slide Valve %	This shows the compressor Slide Valve capacity	N/A
Menu Button	Touching this button navigates to the Menu 1 screen	Figure 10
Full Screen Display	Pressing this button displays the set point and process temperatures in a large font.	Figure 9
Alarms Button	A listing of active and prior alarm history	Figure 11 Figure 12 Figure 13
Detail	Provide additional circuit and compressor information.	Multiple
Start/Stop	Pressing the green Start button to start the chiller and any secondary units connected to the chiller. Once started, the Start button disappears. Pressing the red stop button to stop the chiller and any secondary units connected to the chiller.	N/A

Home – Full Screen

The Full Screen Display Screen provides a simplified view of the chiller. The *SETPOINT* and *PROCESS* temperatures display in a large font easily seen from a distance, providing a "quick glance" look to validate proper operation.

Figure 9 – Full Screen



Pressing the *SETPOINT* value shown will allow for quick set point modification. Once the new set point has been entered press the Enter button to confirm set point. Proper security level must be valid prior to entering a new set point.

Menu 1 - Overview

Menu 1 provides a common location for most adjustments or settings.

Figure 10 – Menu 1

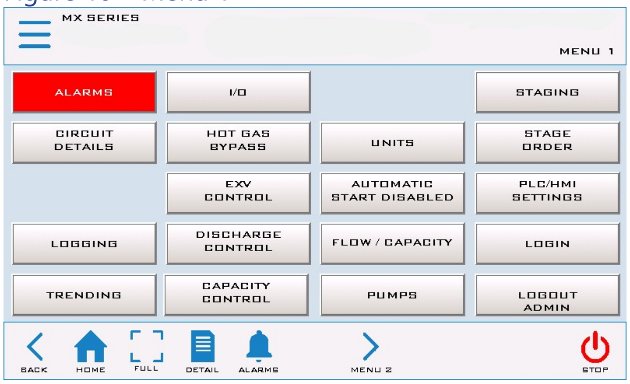


Table 8 – Menu 1 Functions

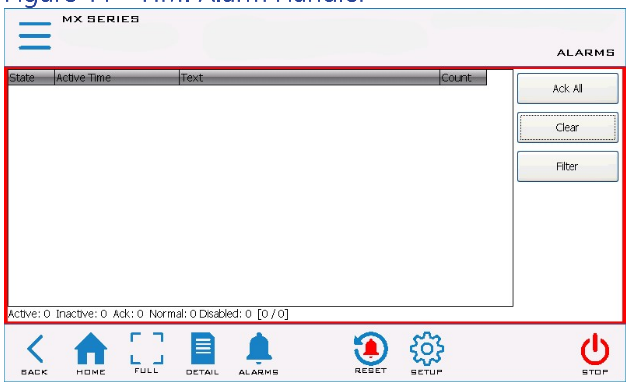
Function	Description	Screen Reference
Alarms	A listing of all active, history, and frequency of system alarms.	Figure 8 Figure 12 Figure 13
Circuit Details	Additional circuit and compressor related information	Figure 14 Figure 15
Logging	Start / Stop logs data / alarm and export to thumb drive	Figure 18
Trending	Graphical display of critical process values	Figure 19
Input / Output	The Input / Output screens provide the status of all digital inputs, outputs, RTD inputs and analog outputs.	Figure 20 Figure 21 Figure 22 Figure 23 Figure 24
Hot Gas Bypass	Hot Gas Bypass Setup (Load Balance Valve) (Optional)	Figure 25
EXV Control	Electric Expansion Valve Setup	Figure 26
Discharge Control	Water Regulating Valve Setup (Discharge Pressure Control)	Figure 27 Figure 28
Capacity Control	This shows the compressor Slide Valve capacity control setup.	Figure 29
Units	Imperial or Metric units can be selected directly from this screen. Touch the UNITS button to toggle the selection between Imperial or Metric units.	N/A
Auto Start	Touch this button to enable or disable the automatic start. If the option is enable, the chiller is set to start automatically.	N/A
Flow / Capacity	Provides information about the process fluid flow.	Figure 30
Pumps	This shows the configuration of the pumps and timers.	Figure 31
Staging	Compressor staging options.	Figure 32Figure 33
Stage Order	Stage order setup.	Figure 33
PLC / HMI Settings	IP addresses HMI and PLC Setup	N/A
Login	Touch this button to access the different user-level.	N/A
Logout	Sign out session.	N/A

Menu 1 - Alarms

Alarms Active

When a critical system fault occurs, the controller activates the HMI alarm handler. This forces the alarm screen to appear and will display any current faults.

Figure 11 – HMI Alarm Handler



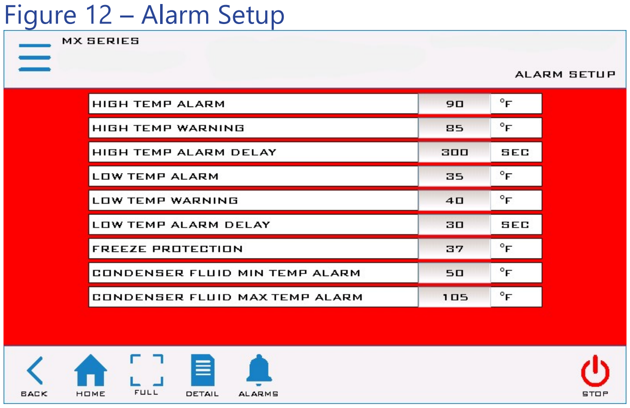
Note: The above shows there are no alarms; if an alarm condition were present, it would appear in this window.

Associated with an active alarm is an alarm horn that sounds on and off every second. To silence this alarm, press the ALARM SILENT button. If multiple alarms are active at once, use the DOWN and UP buttons to view all alarms. When no alarms are active, the white portion of the display will be blank. All alarms must be resolved and reset using the RESET ALARM button.

Alarm Setup

The Alarm Setup screen allows changes to alarm settings.

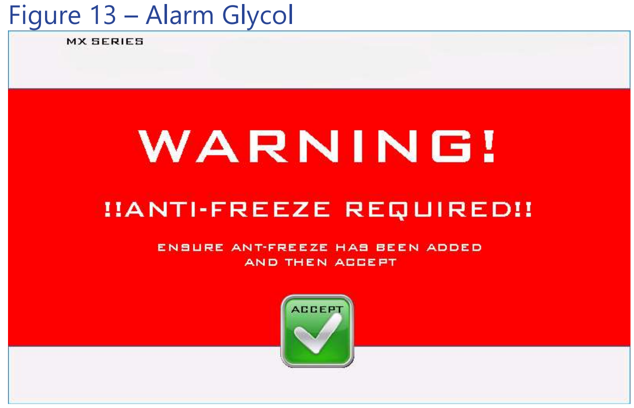
Figure 12 – Alarm Setup



Alarm Glycol

If the Chiller set point goes below 40°F (4.4°C), the Glycol Warning screen will appear. The amount of antifreeze will vary depending on the actual desired operating conditions and should be enough to provide freeze protection to temperatures 15°F (8.3°C) colder than the coldest temperature anticipated. Use only antifreeze solutions designed for heat exchanger duty. Do not use automotive antifreeze due to the potential for fouling that can occur once its relatively short-lived inhibitors break down. Please verify that proper Glycol is added and "Accept" the Warning.

Figure 13 – Alarm Glycol



Menu 1 – Circuit Details

Circuit Details Screen

The Circuit Details Screen can be accessed directly from Menu 1 or by touching the option. Details on the Home screen. This screen provides addition information relative to the particular circuit.

Figure 14 – Circuit Details Screen (MXR)

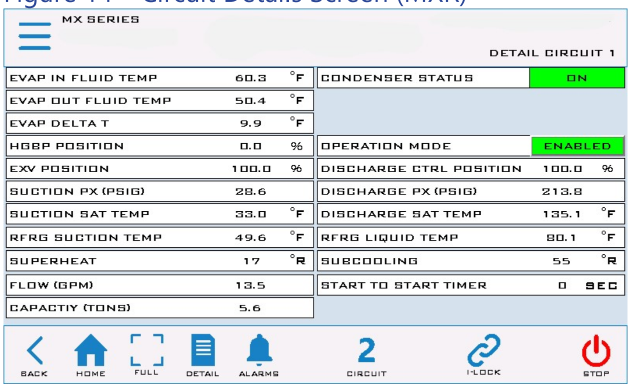
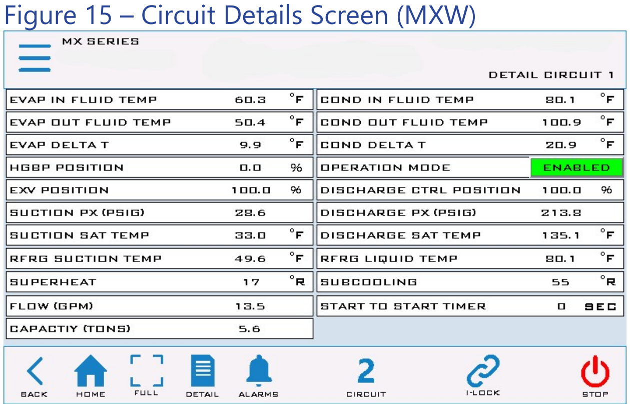


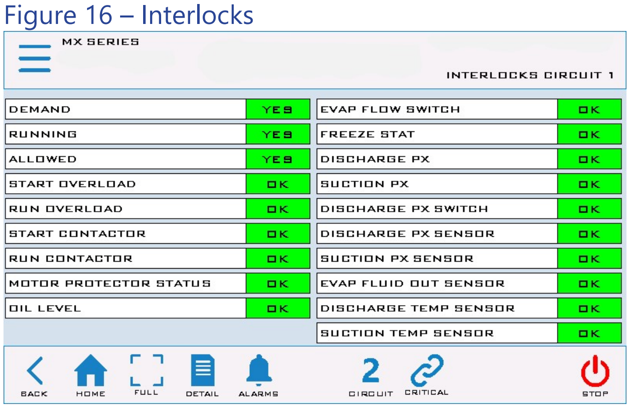
Figure 15 – Circuit Details Screen (MXW)



Circuit Details Screen – Interlocks

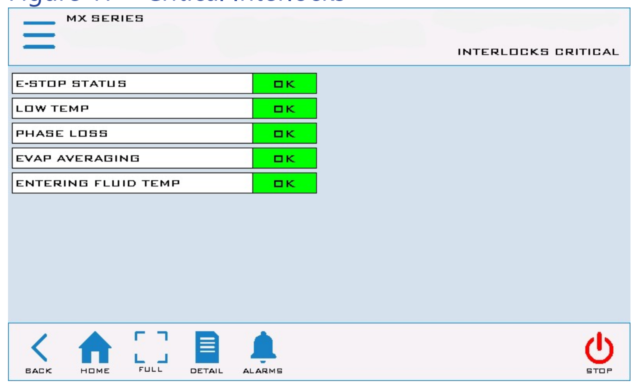
Touching the I-LOCK button on the bottom of the Circuit Details Screen will display the Interlock Screen. If the compressor is not starting, the reason for the fault will clearly be visible on this screen.

Figure 16 – Interlocks



Touching the CRITICAL button opens the Critical Interlocks Screen (Figure 17). A critical interlock fault shuts down the entire system and must be resolved prior to a restart.

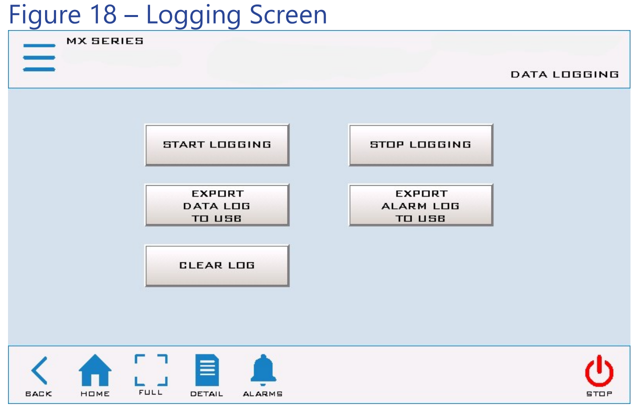
Figure 17 – Critical Interlocks



Menu 1 – Logging

The HMI is constantly logging key registers internal to the HMI. It is possible to export the data to an external thumb drive. Data logging occurs every two seconds in a FIFO methodology up to a total of 24 hours.

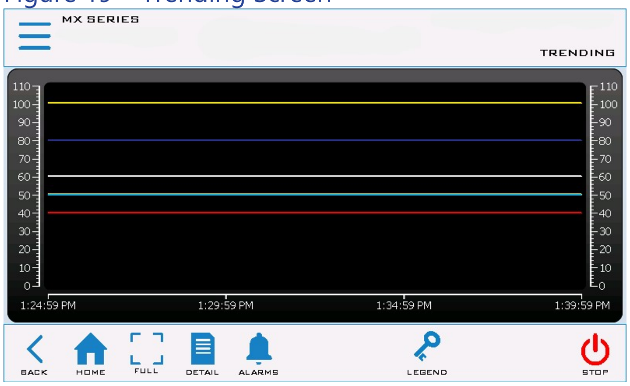
Figure 18 – Logging Screen



Menu 1 – Trending

The trending screen (Figure 19) displays the setpoint temperature, process temperature, demand, expansion valve, and optional hot gas bypass valve (if present) resisters for easy analysis of the system operation. Trending is always enabled and always running.

Figure 19 – Trending Screen



Menu 1 – Inputs / Outputs

Inputs / Outputs Screens

The Inputs/Outputs screens provide the status of all digital inputs, digital outputs, analog inputs, and outputs. When the PLC input LED is on the corresponding input or output is on. The inputs and outputs numbers are hex base numbering system. The following screens show a full complement of inputs and outputs. Note: Your screen may differ depending on machine type and options.

Figure 20 – Digital Inputs Screen

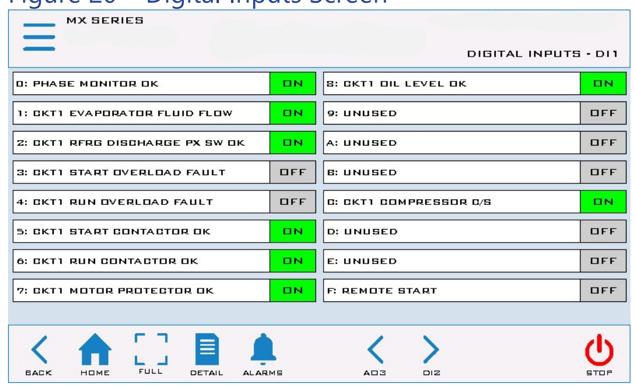


Figure 21 – Digital Outputs Screen

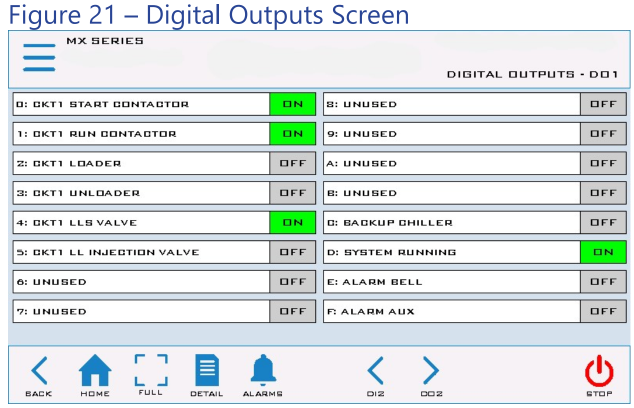


Figure 22 – Analog Inputs Screen

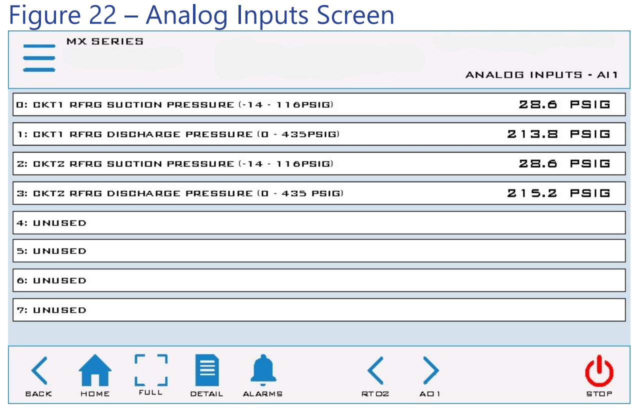


Figure 23 – Analog Outputs Screen

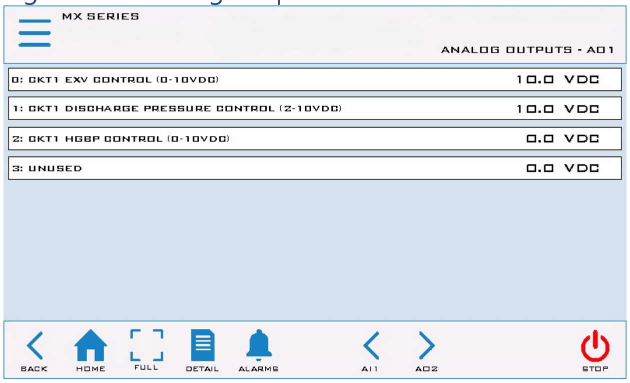
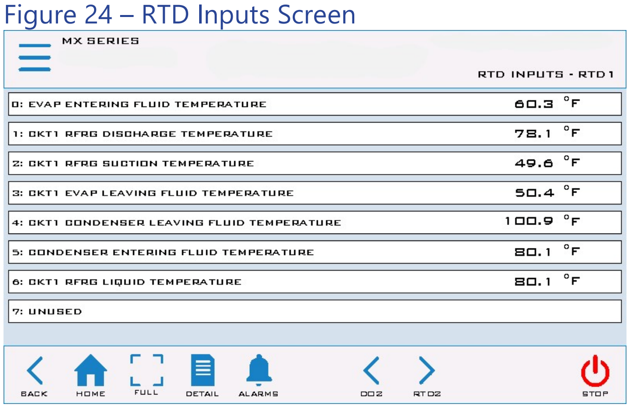


Figure 24 – RTD Inputs Screen



Menu 1 – Hot Gas Bypass

Hot Gas Bypass Setup Screen

Figure 25 – Hot Gas Bypass Screen

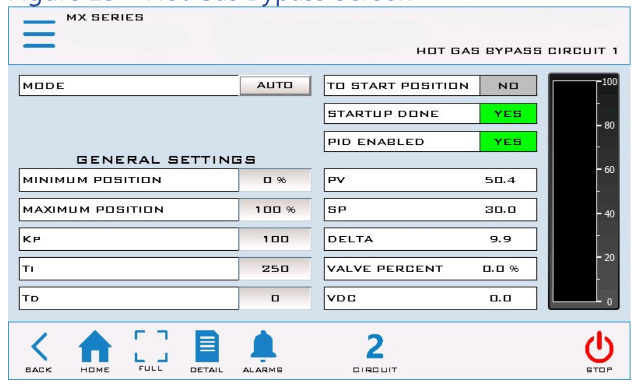


Table 9 – Hot Gas Bypass Valve Setup Parameters

Menu Item	Description	Default Value
Mode Selection	AUTO MODE: The valve will always respond relative to the demand PID regardless of how many compressors are running. MANUAL MODE: The manual mode value percent will be the output to the valve.	AUTO ON
Minimum Position	The minimum percent the valve will go to.	0%
Maximum Position	The maximum percent the valve will go to.	100%
Kp	Proportional PID value	100
Ti	Integral PID value	250
Td	Derivative PID value	0

Menu 1 – Expansion Valve Setup

EXV Control Setup Screen

Figure 26 – EXV Control Screen

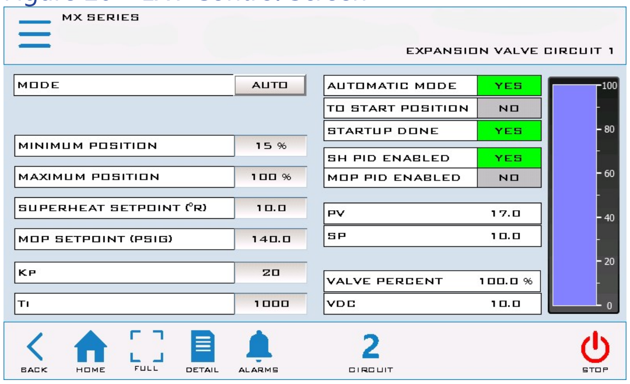


Table 10 – EXV Setup Parameters

Menu Item	Description	Default Value
Mode Control	In Auto Mode, the control system adjusts the valve to maintain discharge pressure. In manual mode, the system drives the valve to a fixed position and holds it there for service diagnostic purposes.	AUTO MODE
Minimum Position	The minimum percent the expansion valve will go to.	15%
Maximum Position	The maximum percent the expansion valve will go to.	100%
Superheat Setpoint	The valve meters the amount of refrigerant into the evaporator in the precise quantity in order to maintain superheat. The difference between the saturated suction temperature and the suction line temperature is the superheat. The superheat is factory set for 10°F and should never exceed 15°F or go below 4°F. Only a trained refrigeration service technician should adjust this valve.	10.0
MOP Mode Setpoint (Suction Pressure Mode)	The EXV behaves as a high limit suction pressure regulator when the suction pressure rises above a preset suction pressure. The valve regulates to maintain suction pressure instead of superheat. The suction pressure set point is factory set to allow the compressor to run at the highest allowable suction pressure. The valve control automatically reverts to superheat control if the suction pressure falls below the maximum limit or if the superheat becomes dangerously low.	140 PSI
Kp	Proportional PID value	20
Ti	Integral PID value	1000

Menu 1 – Discharge Control Setup

Discharge Control Setup Screen

An electric condenser water-regulating valve is standard on chillers with a water-cooled condenser. The valve is a butterfly type valve with a modulating actuator and is located in the condenser water piping at the outlet of the condenser. The valve regulates the flow of cooling water through the condenser in order to maintain the discharge refrigerant pressure set point.

Figure 27 – Discharge Control Screen

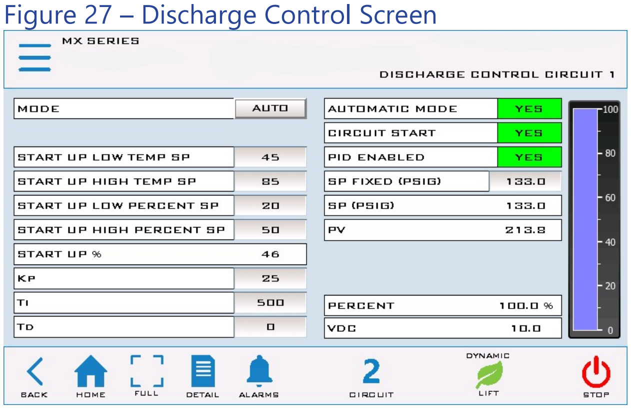


Figure 28 – Dynamic Lift Screen

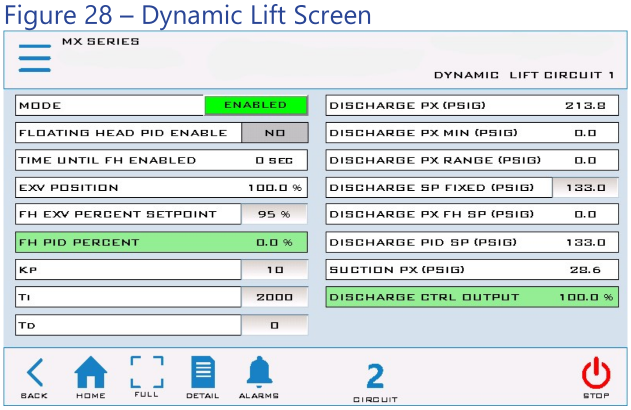


Table 11 – Discharge Control Setup Parameters

Menu Item	Description	Default Value
Mode	In Auto Mode, the valve adjusts to maintain optimum performance. In manual mode, it holds to the input valve.	AUTOMATIC
Discharge Setpoint	Discharge Setpoint Value	133 PSIG
Low Temp Setpoint	Low temp setpoint relating to low percent setpoint – (During the start sequence)	45°F (7°C)
High Temp Setpoint	High temp setpoint relating to high percent setpoint – (During the start sequence)	85°F (29°C)
Low Percent Setpoint	The low percent value during startup if the condenser water temperature is at or below the low temp setpoint	20%
High Percent Setpoint	The high percent value during startup if the condenser water temperature is at or above the high temp setpoint	50%
Kp	Proportional PID value	25
Ti	Integral PID value	500
Td	Derivative PID value	0

Menu 1 – Capacity Control Setup

Capacity Control Screen

The compressor is equipped with four solenoid valves flange mounted to the compressor. These solenoid valves control the location of the slide valve, which determines the cooling capacity of the compressor. The loader valve increases cooling capacity, and three unloader valves decrease cooling capacity. With the combination of these valves, it is possible to control cooling capacity either in four finite stages or in infinite capacity control. The current setup of the chiller employs infinite capacity control with the use of two solenoids. The cooling capacity of the compressor can vary from 25-100% of full capacity.

Figure 29 – Capacity Control Screen

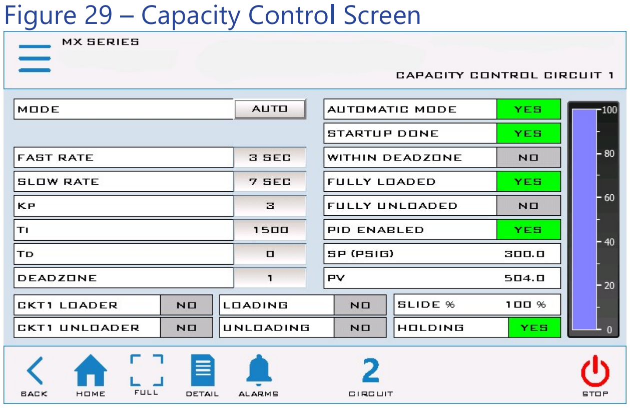


Table 12 - Capacity Control Parameters

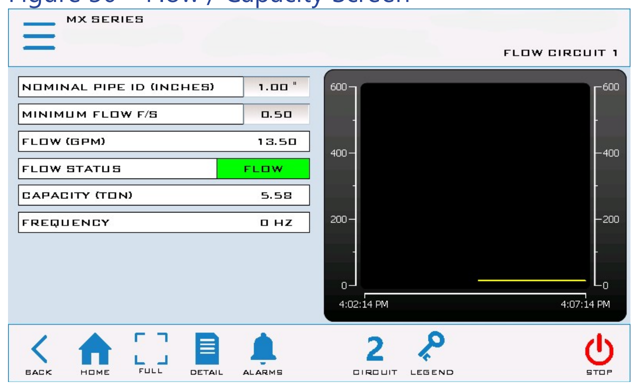
Menu Item	Description	Default Value
Automatic or Manual Mode	In Auto Mode, the control system adjusts the slide valve for optimum performance.	AUTOMATIC
Fast Rate	Maximum Delay Time between pulses when the demand is at its highest	3 Seconds
Slow Rate	Minimum Delay Time between on pulses when the Demand is at its lowest	7 Seconds
Kp	Proportional PID value	3
Ti	Integral PID value	1500
Td	Derivative PID value	0

Menu 1 – Flow / Capacity

Flow/Capacity Screen

The graph displays trend data for the process fluid flow rate measured at the outlet of the evaporator on each chiller circuit. In addition, an approximation of chiller cooling capacity is displayed as calculated by the process fluid flow rate and temperature difference.

Figure 30 – Flow / Capacity Screen



Menu 1 – Pump Control

Pump Control Screen

This screen displays pertinent pump status information for a system with the optional integral pump controls and provides the ability to change mode selection.

Figure 31 – Pump Control Screen

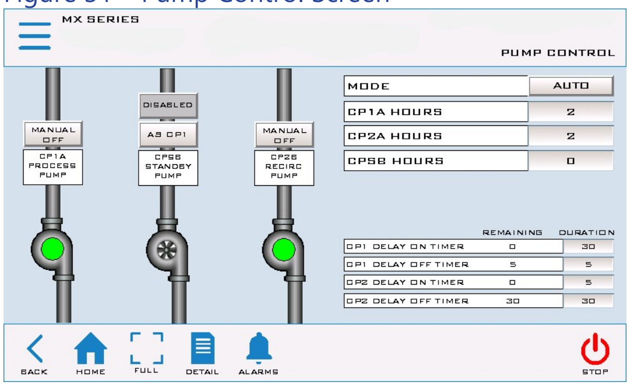


Table 13 – Pump Setup Parameters

Menu Item	Description	Default Value
Mode	AUTOMATIC: Allows for automatic timer enable of the pumps. MANUAL: Requires manual enable of the pumps.	AUTOMATIC
Recirc On Delay	Delay duration before the Recirculation Pump starts.	5 sec
Recirc Off Delay	Delay duration before stopping the Recirculation Pump after initiation of a system stop.	30 sec
Process On Delay	Delay duration before the Process Pump starts.	5 sec
Process Off Delay	Delay duration before stopping the Process Pump after initiation of a system stop.	30 sec

Menu 1 – Staging

Compressor Staging Setup Screen

Figure 32 – Compressor Staging Screen

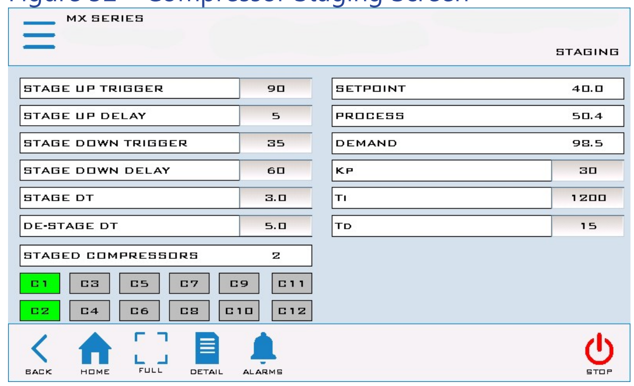


Table 14 – Compressor Staging Parameters

Menu Item	Description	Default Value
Stage Up Trigger	This parameter in conjunction with the Stage Up Delay determines at what percent the next compressor will stage.	90%
Stage Up Delay	Once the demand reaches the Stage Up Trigger, this value determines the time delay before staging the next compressor.	5 sec.
Stage Down Trigger	This parameter in conjunction with the Stage Down Delay determines when a compressor will de-stage.	35%
Stage Down Delay	Once the demand reaches the Stage Down Trigger, this value determines the time delay before de-staging a compressor.	60 sec.
Stage DT	This set point works in conjunction with the Chilled Water Set Point to limit short cycling. The first compressor will not stage until the Chilled Water Set Point + ΔT Stage Set Point is satisfied. Only applies if one compressor is running.	3°F
De-stage DT	This parameter de-stages a compressor when the Chilled Water Set Point less the ΔT De-stage Set Point is met. This only applies if one compressor is running.	5°F

Menu 1 – Stage Order

Compressor Staging Setup Screen

Figure 33 – Compressor Stage Order Screen

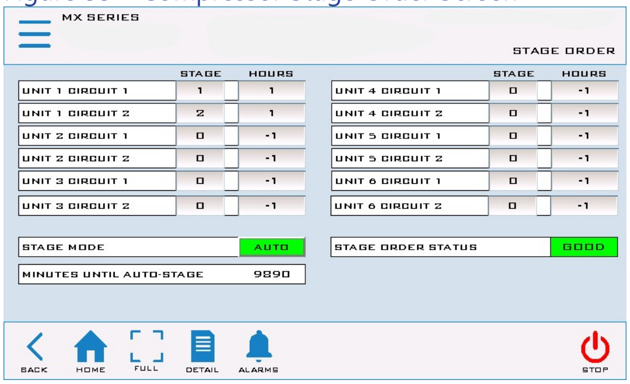


Table 15 – Compressor Staging Local Parameters

Menu Item	Description	Default Value
Stage Mode	Automatic: calculates the stage order by the AUTO STAGE HOURS parameter Manual: Manually enter the stage order	AUTOMATIC
Trigger	Trigger will immediately recalculate the stage order instead of waiting for the automatic trigger to occur.	None
Minutes Until Auto stage	Minutes remaining until the stage calculation occurs	None

Menu 2 – Overview

Figure 34 – Menu 2 Screen

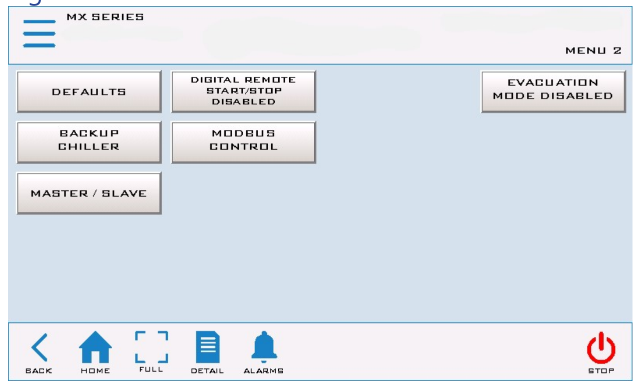


Table 16 – Menu 2 Functions

Function	Description	Screen Reference
Defaults	Provides the ability to restore the control system back to factory defaults in the case that an unknown setting occurred and the system now behaves unexpectedly.	Figure 35 Figure 36
Backup Chiller		Figure 37
Remote Mode	Touch this button to enable or disable external digital remote START/STOP	N/A
PrimarySecondary	Touch this button to access to the primary/secondar configuration.	
Modbus Control	Modbus RTU (Building Automation System) Setup Default Modbus Settings: Baud-115200, Data Length-8, Parity-Odd, Stop Bits-1	Figure 38
Evacuation Mode	Allow a full equalization of refrigerant pressure during a remote startup evacuation.	N/A

Menu 2 – Defaults

CAUTION: The Defaults screen provides the ability to restore the control system back to factory defaults in the case that an unknown setting modification occurred and the system now behaves unexpectedly.

Touching "LOAD" on Figure 35 will restore all the system parameters to a factory stable state and indicate that the process has finished as shown in Figure 36.

Figure 35 – Restore Factory Settings

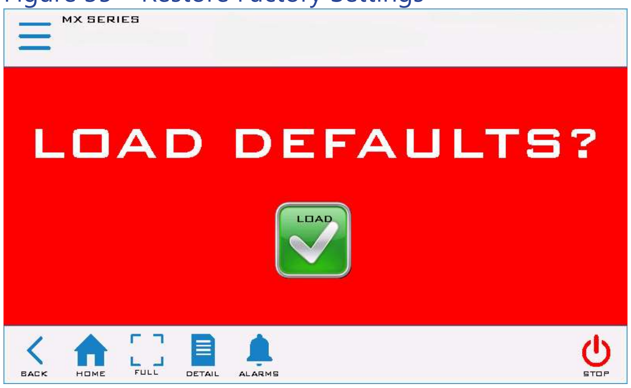


Figure 36 – Factory Settings Restored

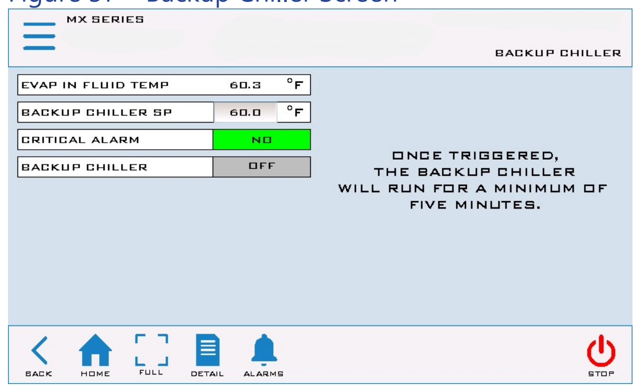
Menu 2 – Remote Mode

The Remote Mode toggle indicates if the chiller is set to use a remote contact closure for remote start/stop. When active, the Remote Mode toggle will indicate Remote Start/Stop Enabled and when not active it will indicate Remote Start/Stop Disabled.

Menu 2 – Backup Chiller

If this feature has been enabled from the factory, the system has the capability of enabling a backup chiller in the event that the primary chiller has a fault and/or cannot meet demand. If the process temperature rises above the backup chiller setpoint or and circuit has an interlock fault, the backup chiller is enabled via a digital output from the controller.

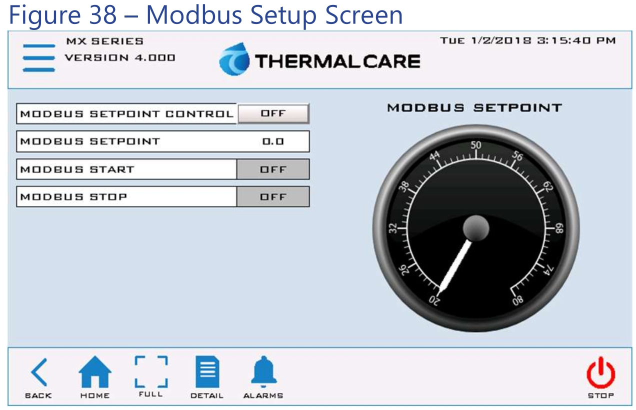
Figure 37 – Backup Chiller Screen



Menu 2 – Modbus/BAS

This Modbus BAS Setup Screen (Figure 38) can enable or disable the Modbus RTU capability. Default Modbus Settings: Baud-115200, Data Length-8, Parity-Odd, Stop Bits-1.

Figure 38 – Modbus Setup Screen



Start-Up

Every unit is factory set to deliver chilled water in accordance with the standard operating specifications for that particular chiller. Due to variables involved with different applications and different installations, minor adjustments may be required during the initial start-up to ensure proper operation. Use a qualified refrigeration technician to perform the start-up procedure in sequence. The following serves as a checklist for the initial start-up and for subsequent start-ups if the chiller is out of service for a prolonged time.

WARNING: This equipment contains hazardous voltages that can cause severe injury or death.

WARNING: This equipment contains refrigerant under pressure. Accidental release of refrigerant under pressure can cause personal injury and or property damage.

WARNING: This equipment may contain fan blades or other sharp edges. Make sure all fan guards and other protective shields are securely in place.

WARNING: The exposed surfaces of motors, refrigerant piping, and other fluid circuit components can be very hot and can cause burns if touched with unprotected hands.

CAUTION: Disconnect and lock out incoming power before installing, servicing, or maintaining the equipment. Connecting power to the main terminal block energizes the entire electric circuitry of the unit. Electric power at the main disconnect should be shut off before opening access panels for repair or maintenance.

CAUTION: Wear eye protection when installing, maintaining, or repairing the equipment to protect against any sparks, debris, or fluid leaks.

CAUTION: Wear protective gloves when installing, maintaining, or repairing the equipment to protect against any sparks, debris, or fluid leaks.

CAUTION: Wire the unit ground in compliance with local and national codes.

CAUTION: The unit requires the main power to remain connected during off-hours to energize the compressor's crankcase heater. Disconnect main power only when servicing the chiller. The crankcase heater should remain on when the compressor is off to ensure liquid refrigerant does not accumulate in the compressor crankcase. Connect main power at least 24 hours prior to initial startup.

Step 1 – Connect Main Power

Connect main power properly ensuring it matches the voltage shown on the nameplate of the unit. Check the electrical phase sequence prior to start-up. Operation of the compressor with incorrect electrical phase sequencing will cause damage to the compressors. Check the phasing prior to applying power. The proper sequence is "ABC." If the phasing is incorrect, open the main power disconnect and switch two line leads on the main power terminal blocks (or the unit mounted disconnect). All electrical components are in-phase at the factory. Do not interchange any load leads that are from the unit contactors or the motor terminals. After making proper power connection and grounding, turn the main power on.

Step 2 – Fill Coolant Circuit

Check to make sure all process chilled-water piping connections are secure. Open the chiller cabinet and fill the coolant reservoir with the proper water or water/glycol solution following the guidelines shown below. When using a glycol solution only use glycol with a corrosion inhibitor.

System Fill Water Chemistry Requirements

The properties of water make it ideal for heat transfer applications. It is safe, non-flammable, non-poisonous, easy to handle, widely available, and inexpensive in most industrialized areas.

When using water as a heat transfer fluid it is important to keep it within certain chemistry limits to avoid unwanted side effects. Water is a "universal solvent" because it can dissolve many solid substances and absorb gases. As a result, water can cause the corrosion of metals used in a cooling system. Often water is in an open system (exposed to air) and when the water evaporates, the dissolved minerals remain in the process fluid. When the concentration exceeds the solubility of some minerals, scale forms. The life giving properties of water can also encourage biological growth that can foul heat transfer surfaces.

To avoid the unwanted side effects associated with water cooling, proper chemical treatment and preventive maintenance is required for continuous plant productivity.

Unwanted Side Effects of Improper Water Quality

- Corrosion
- Scale
- Fouling
- Biological Contamination

Cooling Water Chemistry Properties

- Electrical Conductivity
- pH
- Alkalinity
- Total Hardness
- Dissolved gases

Chillers at their simplest have two main heat exchangers: one that absorbs the heat from the process (evaporator) and one that removes the heat from the chiller (condenser). All our chillers use stainless steel brazed plate evaporators. Our air-cooled chillers use air to remove heat from the chiller; however, our water-cooled chillers use either a tube-in-tube or shell-in-tube condenser which has copper refrigerant tubes and a steel shell. These, as are all heat exchangers, are susceptible to fouling of heat transfer surfaces due to scale or debris. Fouling of these surfaces reduces the heat-transfer surface area while increasing the fluid velocities and pressure drop through the heat exchanger. All of these effects reduce the heat transfer and affect the efficiency of the chiller.

The complex nature of water chemistry requires a specialist to evaluate and implement appropriate sensing, measurement and treatment needed for satisfactory performance and life. The recommendations of the specialist may include filtration, monitoring, treatment and control devices. With the ever-changing regulations on water usage and treatment chemicals, the information is usually up-to-date when a specialist in the industry is involved. Table 17 shows the list of water characteristics and quality limitations.

Table 17 – Fill Water Chemistry Requirements

Water Characteristic	Quality Limitation
Alkalinity (HCO_3^-)	70-300 ppm
Aluminum (Al)	Less than 0.2 ppm
Ammonium (NH_3)	Less than 2 ppm
Chlorides (Cl^-)	Less than 300 ppm
Electrical Conductivity	10-500µS/cm
Free (aggressive) Carbon Dioxide (CO_2)†	Less than 5 ppm
Free Chlorine(Cl_2)	Less than 1 PPM
HCO_3^-/SO_4^{2-}	Greater than 1.0
Hydrogen Sulfide (H_2S)	Less than 0.05 ppm
Iron (Fe)	Less than 0.2 ppm
Manganese (Mn)	Less than 0.1 ppm
Nitrate (NO_3)	Less than 100 ppm
pH	7.5-9.0
Sulfate (SO_4^{2-})	Less than 70 ppm
Total Hardness (dH)k	4.0-8.5

† Dissolved carbon dioxide calculation is from the pH and total alkalinity values shown below or measured on the site using a test kit. Dissolved Carbon Dioxide, PPM = TA x $2^{[(6.3-pH)/0.3]}$ where TA = Total Alkalinity, PPM as $CaCO_3$

Table 18 - Recommended Glycol Solutions

Chilled Water Temperature	Percent Glycol By Volume
50°F (10°C)	Not required
45°F (7.2°C)	5 %
40°F (4.4°C)	10 %
35°F (1.7°C)	15 %
30°F (-1.1°C)	20 %
25°F (-3.9°C)	25 %
20°F (-6.7°C)	30 %

CAUTION: When your application requires the use of glycol, use industrial grade glycol specifically designed for heat transfer systems and equipment. Never use glycol designed for automotive applications. Automotive glycols typically have additives engineered to benefit the materials and conditions found in an automotive engine; however, these additives can gel and foul heat exchange surfaces and result in loss of performance or even failure of the chiller. In addition, these additives can react with the materials of the pump shaft seals resulting in leaks or premature pump failures.

WARNING: Ethylene Glycol is flammable at higher temperatures in a vapor state. Carefully handle this material and keep away from open flames or other possible ignition sources.

Step 3 - Check Condenser

There are two possible types of condensers present in the chiller: water-cooled and remote air-cooled. It is important to verify the chiller will have adequate condenser cooling for proper chiller operation.

Water-Cooled Condenser Check

Check the condenser water lines to make sure all connections are secure. Make sure sufficient condenser water flow and pressure are available, the condenser water supply is on, and all shut-off valves are open. The electronic water regulating valves ship in the closed position and opens after enabling the circuit.

Remote Air-Cooled Condenser Check

Check the refrigerant lines to make sure all connections are secure and the refrigeration is as described in the installation section of this manual. Check the remote condenser main power and control wiring to ensure all connections are secure.

Step 4 – Check Refrigerant Valves

During shipment or installation it is possibe valves were closed. Verify that all refrigerant valves are open.

Step 5 – Check Low Temperature Alarm

Make sure the Low Temperature Alarm Set Point is set appropriately for the operating conditions of the chiller. The Low Temperature Alarm setting is in a password protected menu of the chiller controller. Refer to the control section of this manual for instructions on how to access this menu. The Low Temperature Alarm should be set at 10°F below the minimum chilled water temperature setting that the chiller will be operating. Also ensure the process coolant has sufficient freeze protection (glycol) to handle at least 5°F below the Low Temperature Alarm setting. All chillers are shipped from the factory with the Low Temperature Alarm set at 35°F. This is done to protect against a possible freeze-up if no glycol has been added to the coolant. Once the proper glycol solution has been added, the Low Temperature Alarm can be adjusted to the appropriate setting.

CAUTION: The manufacturer's warranty does not cover the evaporator from freezing. It is vital that the Freezestat is set properly.

Step 6 – Turn On Control Power

Turn on the control power by turning the control power switch to "On". The panel displays should now be illuminated. Due to extreme ambient temperatures that the unit may be exposed to during shipment and installation, you may encounter a High Refrigerant Pressure alarm when you turn on the control power. If this is the case, reset the alarm. Do not proceed until all alarms have been reset and no further alarm conditions are present.

Step 7 – Establish Coolant Flow

Establish flow through the chiller.

Note: The compressor will not start as long as the flow switch is open. A positive flow must be established through the evaporator before the compressor can operate.

Set water flow using a discharge throttling valve or flow control valve (by others). The valve should be the same size as the To Process connection of the chiller. Standard chillers are designed for approximately 2.4 gpm/ton of nominal capacity. A significant increase in flow beyond this in a standard chiller may result in excessive pressure loss and negatively impact chiller efficiency and in extreme cases may cause premature wear or damage of internal components.

Step 8 – Initial Unit Operation

Enter the desired leaving fuid temperature on the chiller HMI. Unless otherwise specified, the chiller is factory set to deliver coolant at 50°F. Adjust to the desired operating temperature. The chiller should now be controlling to the selected temperature. Please note that if there is insufficient load the compressor may cycle on and off causing swings in temperature.

WARNING: Under no circumstance should the High Refrigerant Pressure or the Low Compressor Pressure switch be deactivated. Failure to heed this warning can cause serious compressor damage, severe personal injury or death.

Operate the system for approximately 30 minutes. Check the liquid line sight glass. The refrigerant flow past the sight glass should be clear. Bubbles in the refrigerant indicate either low refrigerant charge or excessive pressure drop in the liquid line. A shortage of refrigerant is indicated if operating pressures are low and subcooling is low. Normal subcooling ranges are from 10°F to 20°F. If subcooling is not within this range, check the superheat and adjust if required. The superheat should be approximately 10°F. If the operating pressures, sight glass, superheat, and subcooling readings indicate a refrigerant shortage, charge refrigerant as required. With the unit running, add refrigerant using industry best practices until operating conditions become normal.

CAUTION: A clear sight glass alone does not mean that the system is properly charged. Also check system superheat, subcooling, and unit operating pressures. If both suction and discharge pressures are low but subcooling is normal, a problem other than refrigerant shortage exists. Do not add refrigerant, as this may result in overcharging the circuit.

Once proper flow and temperature are achieved, press the Stop button. The unit is now ready to be placed into service.

Preventive Maintenance

Once your chiller is in service, follow the maintenance procedures as closely as possible. Specific site conditions may require repeating certain tasks more frequently. The importance of a properly established preventive maintenance program cannot be overemphasized. Taking the time to follow these simple procedures will result in substantially reduced downtime, reduced repair costs, and an extended useful lifetime for the chiller. Any monetary costs of implementing these procedures will usually more than pay for itself.

To make this as simple as possible, prepare a checklist with the recommended service operations and record the date and time when performed. At the end of this manual, you will find a checklist for this purpose. Please notice that there are locations for voltage readings, amperages, etc. for monitoring over time. With this information, maintenance personnel may be able to correct a potential problem before it causes any downtime. For best results, take these readings with a full heat load from process, preferably with similar operating conditions each time. The following is a list of suggested periodic maintenance.

Once a Week

1. Check to make sure the To Process temperature is close to the Set Point temperature. If the temperature stays more than 5°F away from the set point, there may be a problem with the chiller. If this is the case, refer to the Troubleshooting chart or contact our Customer Service Department.

2. Check the suction and discharge refrigerant pressure at the compressor.

3. Check each refrigerant sight glass for bubbles or moisture indication. Bubbles in the refrigerant indicate either a low refrigerant charge or an excessive pressure drop in the liquid line. If the sight glass indicates that there is a refrigeration problem, have the unit serviced as soon as possible.

4. Check the compressor oil level in the sight glass. View the oil level through the sight glass while the compressor is running. The level will vary as the compressor loads and unloads.

Once a Month

Repeat items 1 through 4 and continue with the following.

5. Check the Y strainer between the return connection and the evaporator inlet. Open the blow-down valve attached to the strainer to flush the screen free of debris.

6. Check the flow sensor tip visually for signs of build-up and clean with a soft cloth. Is there is some suborn calcium build-up that is not easily removed with a soft cloth use household vinegar as a cleaning agent to remove the deposit.

7. Shut off the power disconnect. Check the condition of electrical connections at all controls. Check for loose or frayed wires.

8. Check the main power supply to ensure it is acceptable, connected properly, and the unit has a proper ground (see Installation section of this manual for details).

9. Check the amp draws to each leg of the compressor(s) to confirm that it is drawing the proper current.

10. Check the system superheat and sub-cooling. The normal superheat is approximately 10°F and should not be more than 15°F. The normal sub-cooling range is from 10°F to 20°F.

Once Every 6 Months

Repeat items 1 through 10 and continue with the following.

11. Check for visible mechanical damage to the compressor.

12. Check for excessive vibration from other rotating equipment.

13. Check for signs of hot spot/discoloration on power cables.

14. Check all communication cables are secure and tight.

15. Check all electrical modules are secure.

16. Check system refrigerant charge and verify the system is still full charged.

17. Check the operation of the compressor crankcase heater. Energize the heater while the compressor is off. Taking an amp reading of the heater leads is the best way to determine the correct operation. Another way is to feel if there is localized heat around the crankcase heater when the heater is on.

Once a Year

Repeat items 1 through 17 land continue with the following.

18. Check the condition of the chilled water for algae and particulate fouling. Back flush the evaporator with water or another suitable cleaning agent. The frequency at which this task is required depends on specific site conditions.

19. (MXW Models) Check the condition of the condenser water for algae, scale, and particulate fouling. Rod out the tubes and back flush the condensers. If scaling exists on the condenser tubes, chemical cleaning of the tubes may also be necessary. If a chemical cleaning agent is used, it should be suitable with the internal components composed of copper, steel, and cast iron. The frequency at which this task is required depends on specific site conditions.

20. (MXR Models) Check the condition of the air coils of the remote condensers for dirt and debris. If the coils are dirty or clogged, use a compressed air source to blow the contaminants out of the air coil. The frequency at which this task is required depends on specific site conditions.

21. Have a qualified laboratory perform a compressor oil analysis to determine system moisture content and acid level.

Maintenance

Checking Compressor Oil Level

The oil level should be visible in the sight glass while the compressor is running. If adding oil, use only approved Polyol Ester oil, or Solest 170.

Cleaning the Operator Interface

Use of abrasive cleaners or solvents may damage the window. Do not scrub or use brushes. To clean the display window:

1. Disconnect power from the terminal at the power source.

2. Using a clean sponge or a soft cloth, clean the display with a mild soap or detergent. If paint or grease splash is present, remove before drying by rubbing lightly with isopropyl alcohol. Afterward, provide a final wash using a mild soap or detergent solution. Rinse with clean water.

3. Dry the display with a chamois or moist cellulose sponge to avoid water spots.

General Troubleshooting

Problem	Possible Cause	Remedy
Compressor will not start	Compressor Motor Protection Module	Reset module, cycle power for five seconds
	Incorrect three-phase rotation	Correct phasing of incoming power
	Loss of phase	Check incoming power
	High motor temperature	Check oil level, superheat, liquid injection
	High oil / discharge temperature	Check oil level, superheat, liquid injection
	Low compressor oil level	Add oil as required
		Replace oil level switch if faulty
	Three-phase power monitor tripped	Correct phasing of incoming power
	Compressor overload	Check supply voltage, amperage, contactor, wiring, and overload set point
	Compressor contactor	Replace if faulty
	Microprocessor output relay	Replace if faulty
	Compressor failure	Contact Customer Service Department for assistance
No flow	Low flow through evaporator	Adjust flow to proper level
	Clogged Y-Strainer	Clean Y-Strainer
	Clogged evaporator	Back flush / clean evaporator
	Flow Switch	Replace if faulty
Freezestat	Low flow through evaporator	Adjust flow to proper level
	Clogged Y-strainer	Clean Y-Strainer
	Clogged evaporator	Back flush / clean evaporator
	Freezestat setting	Check for proper setting
	Sensor	Replace if faulty
	Microprocessor sensor input	Replace if faulty

General Troubleshooting (continued)

Problem	Possible Cause	Remedy
Low refrigerant pressure	Low refrigerant charge	Contact refrigeration service technician
	Refrigerant leak	Contact refrigeration service technician
	Low flow through evaporator	Adjust flow to proper level
	Clogged Y-strainer	Clean Y-strainer
	Clogged evaporator	Back flush / clean evaporator
	Expansion valve	Check start-up settings
		Check control power to IB board, check fuse
		Check control signal output from Microprocessor
		Replace IB board if faulty
		Replace expansion valve if faulty
	Liquid line solenoid valve	Check Microprocessor output for control power
		Check interface relay, replace if faulty
		Check solenoid coil, replace if faulty
	Liquid line service valve	Open valve
	Compressor suction service valve	Open valve all the way
	Low refrigerant pressure transducer	Replace if faulty
	Microprocessor sensor input	Replace if faulty
High refrigerant pressure	Plugged condenser	Clean condenser
	Insufficient condenser water flow (MXW models only)	Check flow is in range
	High condenser water temperature (MXW models only)	Maximum temperature is 105°F
	Condenser water regulating valve (MXW models only)	Replace if faulty
	High condenser air temperature (MXR models only)	Maximum temperature is 115°F
	Condenser fans inoperable (MXR models only)	Check operation of all condenser fans
	Compressor discharge service valve is not open fully	Open valve all the way
	Refrigerant circuit overcharged	Contact refrigeration service technician
	High refrigerant pressure transducer	Replace if faulty
	Microprocessor sensor input	Replace if faulty
Low differential pressure	Condenser overcooling	Check operation of WRV (MXW units)
		Check operation of fans (MXW units)
		Adjust discharge pressure set point
	Discharge pressure set point	Increase discharge pressure set point
	High suction pressure	Check operation of expansion valve
		Max suction pressure is 55 psig
	PLC sensor input, suction/discharge pressure transducers	Replace if faulty
High oil temperature or high discharge temperature	Liquid injection	Check for proper operation
	Oil temperature sensor	Replace if faulty
	Discharge temperature sensor	Replace if faulty
	Low oil level	Contact the Service Department for assistance
	Microprocessor input card	Replace if faulty

General Troubleshooting (continued)

Problem	Possible Cause	Remedy
Insufficient cooling (temperature continues to rise above set point)	Process load too high	Check to make sure chiller is properly sized for process load
	Coolant flow through evaporator out of range	Adjust flow to proper level
	Insufficient condenser cooling	See high refrigerant pressure
	Compressor loader solenoid valve	Check microprocessor output
		Replace compressor loader solenoid
		Replace control relay
	Refrigeration circuit problem	Contact refrigeration service technician
	Thermocouple	Replace if faulty
	Microprocessor input card, process sensor	Replace if faulty
Erratic temperature control	Low coolant flow through evaporators	Adjust flow to proper level
	Overloading of chiller capacity	Check to make sure chiller is properly sized for process load
	Thermocouple	Replace if faulty
	Microprocessor input card, process sensor	Replace if faulty
Temperature values unsteady or out of range	Loose thermocouple wire connections	Tighten terminal screw
	Microprocessor input card	Replace if faulty
LEDs on OKC not on	Control power not available at power supply	Check power at power supply, check power supply
Display not updating	Loss of communication	Check communication cable.
	Microprocessor fault	Replace if faulty
Screen objects not working	Microprocessor/display fault	Replace if faulty
Screen objects are not visible	Correct power is not applied	Verify power connections
	Microprocessor/display fault	Replace if faulty
Chiller will not start	No demand	Increase load on chiller
	Compressor Anti-Cycle Timer Active	Allow timer to expire
	Alarm fault active	Clear alarm condition and reset alarm
		If compressor motor module fault, cycle power

Preventive Maintenance Checklist

Maintenance Activity	Week Number											
	1	2	3	4	5	6	7	8	9	10	11	12
Date												
Chilled Water Set Point												
Temperature Control												
Chiller % Loading												
Condenser Water Temperature												
Condenser Ambient Temperature												
Refrigerant Suction Pressure												
Refrigerant Discharge Pressure												
Refrigerant Sight Glass												
Compressor Oil Level												
Electrical Connections												
Incoming Voltage												
Compressor L1 Amps												
Compressor L2 Amps												
Compressor L3 Amps												
Refrigerant Superheat												
Refrigerant Subcooling												
Compressor Discharge Check Valve												
Compressor Crankcase Heater												
Evaporator PSID												
Condenser PSID												
*Clean Condenser												
*Clean Evaporator												
*Oil Analysis												

* Once a year

Drawings

We have prepared a custom set of drawings for your unit and placed them inside the control panel prior to shipment. Please refer to these drawings when troubleshooting, servicing, and installing the unit. If you cannot find these drawings or wish to have additional copies sent, please contact our Customer Service Department and reference the serial number of your unit.

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