THERMAL CARE

Superior equipment, Exceptional service

Portable Chiller

OPERATION, INSTALLATION, AND MAINTENANCE MANUAL

Accuchiller NQ

Where water means business.

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Foreword

The portable chiller is a packaged unit that typically includes a refrigeration circuit, coolant reservoir, and pumping system in a cabinet. The purpose is to provide cooling water or 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 a hydro fluorocarbon (HFC), trade named R-410A, as a chemical refrigerant for heat transfer purposes. 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 or air-cooled condenser 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 chiller 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.

Air-cooled chillers use the surrounding air for cooling the condenser and require free passage of air in and out of the chiller and provision for remove of the warm air from the area.

Rigging

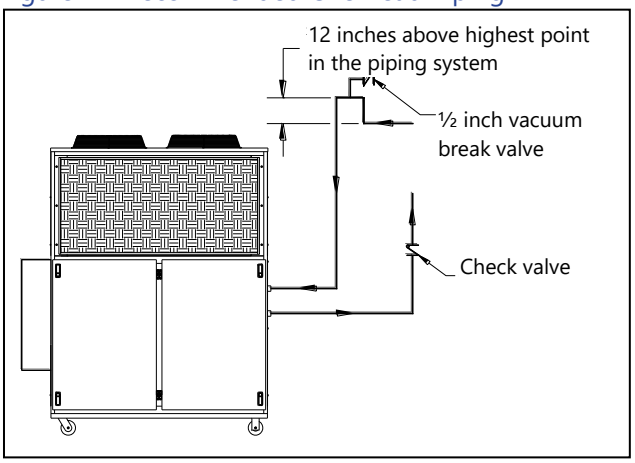
The chiller has a frame to facilitate easy movement and positioning with a crane or forklift. Follow proper rigging methods to prevent damage to components. Avoid impact loading caused by sudden jerking when lifting or lowering the chiller. Use pads where abrasive surface contact may occur.

Chilled 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. Typically, when piping is overhead with a total run length over 90 feet there should be a valve in the supply line and an inverted P trap with a vacuum break valve installed as shown in Figure 1.

Figure 1 – Recommended Overhead Piping



All standard portable chillers include an internal coolant pump and reservoir. Nominal coolant flow rates assume a 10°F rise across the evaporator at 50°F set point and 85°F entering condenser water for

water-cooled chillers or 95°F entering air for integral air-cooled or remote air-cooled condenser chillers.

Condenser Water Piping

(Water-Cooled Condenser Chillers 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 designed 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.

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. 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 access 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

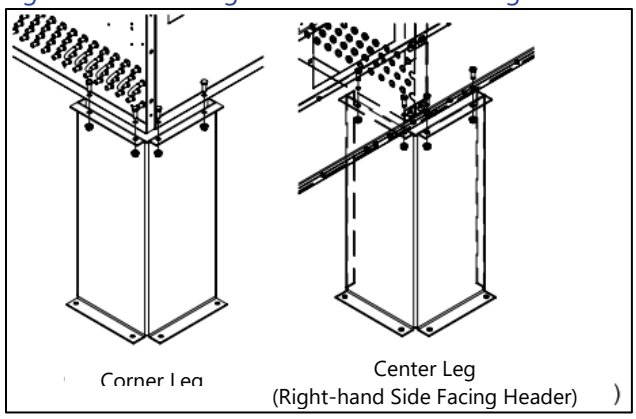
Use only qualified personnel using the proper equipment when lifting and positioning the condenser. Lifting brackets or holes are at the corners for attaching lifting slings. Use spreader bars when lifting to apply the lifting force vertically.

Under no circumstances use the coil headers or return bends in the lifting or moving of the condenser.

Mounting Legs

Assemble the corner legs to the bottom flanges on the unit side panels and end panels using the hardware provided and the matching mounting hole-patterns. All corner legs are the same. For units that are longer than three fans, assemble the center leg. Remove two bolts from the bottom flange of the unit side panels that match the hole-pattern on the top flanges of both legs. Attached the center legs using the hardware provide at the center-divider panel location. Replace the bolts removed from the side panels to secure the leg assembly to the bottom flanges of the condenser side panels.

Figure 2 - Mounting Remote Condenser Legs



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: Only use refrigerant grade copper tubing ASTM B280 and isolate the refrigeration lines from building structures to prevent transfer of vibration. All copper tubing must have a pressure rating suitable for R-410A: 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.

WARNING: The POE oil contained within the compressor is hygroscopic and has the ability to absorb water vapor from the atmosphere. Take necessary steps to prevent an open system from exposure to the atmosphere for extended periods while installing the interconnecting refrigerant tubing.

Refrigeration Piping Design

The system is configurable in any of the arrangements as shown in Figure 3, Figure 4, and Figure 5. 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 are:

1. The total distance between the chiller and the 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 3 – Condenser Located at Chiller Level

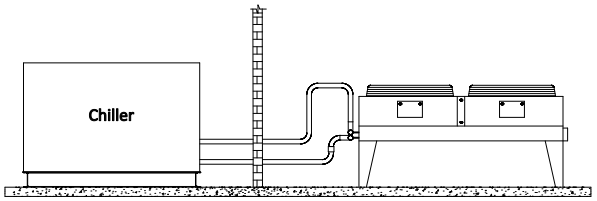


Figure 4 – Condenser Located Above Chiller Unit

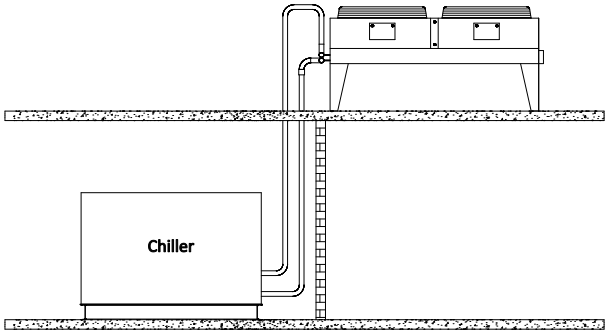
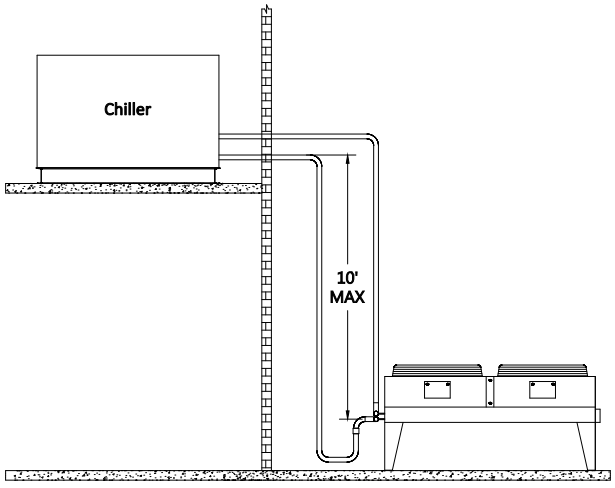


Figure 5 - Condenser Located Below Chiller Unit



Caution: Liquid line sizing for each chiller capacity is shown in Table 2. 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 2 for liquid lines, Table 3 and Table 4 for the discharge lines.
3. Check the line size by calculating the actual equivalent length using the equivalent lengths as shown in Table 1.

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
⅞	2.0	1.4	3.2	0.9	1.6
1⅛	2.6	1.7	4.1	1.3	2.1
1⅜	3.3	2.3	5.6	1.7	3.0
1⅝	4.0	2.6	6.3	2.1	3.4
2⅛	5.0	3.3	8.2	2.6	4.5
2⅝	6.0	4.1	10.0	3.2	5.2
3⅛	7.5	5.0	12.0	4.0	6.4
3⅝	9.0	5.9	15.0	4.7	7.3
4⅛	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 Sizes for R410A

5 Ton Circuit (R410A) Liquid Line Size (Inch OD)					7½ Ton Circuit (R410A) Liquid Line Size (Inch OD)				
Equivalent Length (Ft)	Horizontal or Down Flow	Up Flow (Feet of Run)			Equivalent Length (Ft)	Horizontal or Down Flow	Up Flow (Feet of Run)		
		0 to 5	6 to 10	11 to 15			0 to 5	6 to 10	11 to 15
25	1/2	1/2	1/2	1/2	25	5/8	5/8	5/8	5/8
50	1/2	1/2	1/2	5/8	50	5/8	5/8	5/8	5/8
75	1/2	1/2	1/2	5/8	75	5/8	5/8	5/8	3/4
100	1/2	1/2	5/8	5/8	100	5/8	5/8	5/8	3/4
125	1/2	1/2	5/8	3/4	125	5/8	5/8	3/4	3/4
150	1/2	5/8	5/8	3/4	150	5/8	5/8	3/4	7/8
175	5/8	5/8	5/8	3/4	175	5/8	5/8	3/4	7/8
200	5/8	5/8	5/8	3/4	200	5/8	3/4	3/4	7/8
225	5/8	5/8	5/8	3/4	225	5/8	3/4	3/4	7/8
250	5/8	5/8	5/8	3/4	250	5/8	3/4	3/4	7/8
275	5/8	5/8	3/4	3/4	275	3/4	3/4	3/4	7/8
300	5/8	5/8	3/4	7/8	300	3/4	3/4	3/4	7/8
10 Ton Circuit (R410A) Liquid Line Size (Inch OD)					15 Ton Circuit (R410A) Liquid Line Size (Inch OD)				
Equivalent Length (Ft)	Horizontal or Down Flow	Up Flow (Feet of Run)			Equivalent Length (Ft)	Horizontal or Down Flow	Up Flow (Feet of Run)		
		0 to 5	6 to 10	11 to 15			0 to 5	6 to 10	11 to 15
25	3/4	3/4	3/4	3/4	25	7/8	7/8	7/8	7/8
50	3/4	3/4	3/4	3/4	50	7/8	7/8	7/8	7/8
75	3/4	3/4	3/4	3/4	75	7/8	7/8	7/8	7/8
100	3/4	3/4	3/4	7/8	100	7/8	7/8	7/8	1 1/8
125	3/4	3/4	3/4	7/8	125	7/8	7/8	7/8	1 1/8
150	3/4	3/4	3/4	7/8	150	7/8	7/8	7/8	1 1/8
175	3/4	3/4	3/4	7/8	175	7/8	7/8	7/8	1 1/8
200	3/4	3/4	7/8	1 1/8	200	7/8	7/8	1 1/8	1 1/8
225	3/4	3/4	7/8	1 1/8	225	7/8	7/8	1 1/8	1 1/8
250	3/4	3/4	7/8	1 1/8	250	7/8	7/8	1 1/8	1 1/8
275	3/4	3/4	7/8	1 1/8	275	7/8	7/8	1 1/8	1 1/8
300	3/4	7/8	7/8	1 1/8	300	7/8	7/8	1 1/8	1 1/8

Table 2 – Liquid Line Sizes for R410A (continued)

20 Ton Circuit (R410A) Liquid Line Size (Inch OD)					25 Ton Circuit (R410A) Liquid Line Size (Inch OD)				
Equivalent Length (Ft)	Horizontal or Down Flow	Up Flow (Feet of Run)			Equivalent Length (Ft)	Horizontal or Down Flow	Up Flow (Feet of Run)		
		0 to 5	6 to 10	11 to 15			0 to 5	6 to 10	11 to 15
25	1 1/8	1 1/8	1 1/8	1 1/8	25	1 1/8	1 1/8	1 1/8	1 1/8
50	1 1/8	1 1/8	1 1/8	1 1/8	50	1 1/8	1 1/8	1 1/8	1 1/8
75	1 1/8	1 1/8	1 1/8	1 1/8	75	1 1/8	1 1/8	1 1/8	1 1/8
100	1 1/8	1 1/8	1 1/8	1 1/8	100	1 1/8	1 1/8	1 1/8	1 1/8
125	1 1/8	1 1/8	1 1/8	1 1/8	125	1 1/8	1 1/8	1 1/8	1 1/8
150	1 1/8	1 1/8	1 1/8	1 1/8	150	1 1/8	1 1/8	1 1/8	1 3/8
175	1 1/8	1 1/8	1 1/8	1 1/8	175	1 1/8	1 1/8	1 1/8	1 3/8
200	1 1/8	1 1/8	1 1/8	1 3/8	200	1 1/8	1 1/8	1 1/8	1 3/8
225	1 1/8	1 1/8	1 1/8	1 3/8	225	1 1/8	1 1/8	1 1/8	1 3/8
250	1 1/8	1 1/8	1 1/8	1 3/8	250	1 1/8	1 1/8	1 1/8	1 3/8
275	1 1/8	1 1/8	1 1/8	1 3/8	275	1 1/8	1 1/8	1 1/8	1 3/8
300	1 1/8	1 1/8	1 1/8	1 3/8	300	1 1/8	1 1/8	1 3/8	1 3/8
30 Ton Circuit (R410A) Liquid Line Size (Inch OD)					35 Ton Circuit (R410A) Liquid Line Size (Inch OD)				
Equivalent Length (Ft)	Horizontal or Down Flow	Up Flow (Feet of Run)			Equivalent Length (Ft)	Horizontal or Down Flow	Up Flow (Feet of Run)		
		0 to 5	6 to 10	11 to 15			0 to 5	6 to 10	11 to 15
25	1 1/8	1 1/8	1 1/8	1 1/8	25	1 3/8	1 3/8	1 3/8	1 3/8
50	1 1/8	1 1/8	1 1/8	1 1/8	50	1 3/8	1 3/8	1 3/8	1 3/8
75	1 1/8	1 1/8	1 1/8	1 1/8	75	1 3/8	1 3/8	1 3/8	1 3/8
100	1 1/8	1 1/8	1 1/8	1 3/8	100	1 3/8	1 3/8	1 3/8	1 3/8
125	1 1/8	1 1/8	1 1/8	1 3/8	125	1 3/8	1 3/8	1 3/8	1 3/8
150	1 1/8	1 1/8	1 1/8	1 3/8	150	1 3/8	1 3/8	1 3/8	1 3/8
175	1 1/8	1 1/8	1 1/8	1 3/8	175	1 3/8	1 3/8	1 3/8	1 3/8
200	1 1/8	1 1/8	1 1/8	1 3/8	200	1 3/8	1 3/8	1 3/8	1 5/8
225	1 1/8	1 1/8	1 3/8	1 3/8	225	1 3/8	1 3/8	1 3/8	1 5/8
250	1 1/8	1 1/8	1 3/8	1 5/8	250	1 3/8	1 3/8	1 3/8	1 5/8
275	1 1/8	1 1/8	1 3/8	1 5/8	275	1 3/8	1 3/8	1 3/8	1 5/8
300	1 1/8	1 1/8	1 3/8	1 5/8	300	1 3/8	1 3/8	1 3/8	1 5/8

Table 2 – Liquid Line Sizes for R410A (continued)

40 Ton Circuit (R410A) Liquid Line Size (Inch OD)				
Equivalent Length (Ft)	Horizontal or Down Flow	Up Flow (Feet of Run)		
		0 to 5	6 to 10	11 to 15
25	1 3/8	1 3/8	1 3/8	1 3/8
50	1 3/8	1 3/8	1 3/8	1 3/8
75	1 3/8	1 3/8	1 3/8	1 3/8
100	1 3/8	1 3/8	1 3/8	1 3/8
125	1 3/8	1 3/8	1 3/8	1 3/8
150	1 3/8	1 3/8	1 3/8	1 5/8
175	1 3/8	1 3/8	1 3/8	1 5/8
200	1 3/8	1 3/8	1 3/8	1 5/8
225	1 3/8	1 3/8	1 3/8	1 5/8
250	1 3/8	1 3/8	1 3/8	1 5/8
275	1 3/8	1 3/8	1 3/8	1 5/8
300	1 3/8	1 3/8	1 3/8	1 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 (see Figure 6).

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. Take careful consideration in the design of the discharge gas riser.

Check the oil-level sight glass in the compressor to ensure it is at the appropriate level to verify there is no trapping of oil in the piping. Use a double riser system to ensure proper oil return under low load operation. See Figure 7 and Table 4 for double riser constructions.

Figure 6 – Vertical Riser Traps

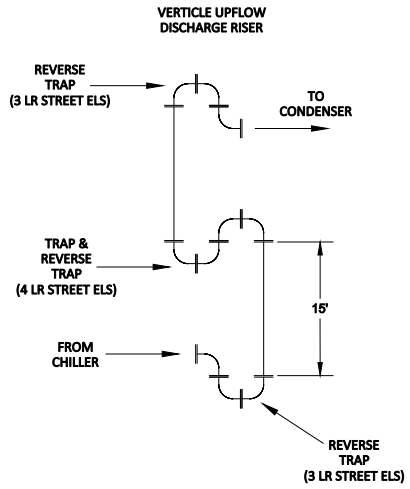
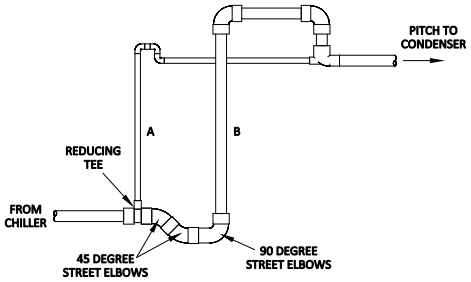


Figure 7 - Double Discharge Riser



Note: Discharge line sizing shown in Table 3and Table 4 are listed per circuit and apply 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 Sizes for R410A (inches OD)

Circuit Tons	Total Equivalent Length (Ft)											
	25	50	75	100	125	150	175	200	225	250	275	300
5	5/8	5/8	5/8	5/8	3/4	3/4	3/4	3/4	3/4	3/4	3/4	7/8
7.5	7/8	7/8	7/8	7/8	7/8	7/8	7/8	7/8	7/8	7/8	7/8	7/8
10	7/8	7/8	7/8	7/8	7/8	7/8	7/8	1 1/8	1 1/8	1 1/8	1 1/8	1 1/8
15	7/8	7/8	1 1/8	1 1/8	1 1/8	1 1/8	1 1/8	1 1/8	1 1/8	1 1/8	1 3/8	1 3/8
20	7/8	1 1/8	1 1/8	1 3/8	1 3/8	1 3/8	1 3/8	1 3/8	1 3/8	1 3/8	1 5/8	1 5/8
25	1 1/8	1 1/8	1 1/8	1 3/8	1 3/8	1 3/8	1 3/8	1 3/8	1 3/8	1 3/8	1 5/8	1 5/8
30	1 1/8	1 1/8	1 1/8	1 3/8	1 3/8	1 3/8	1 3/8	1 3/8	1 3/8	1 5/8	1 5/8	1 5/8
35	1 3/8	1 3/8	1 3/8	1 5/8	1 5/8	1 5/8	1 5/8	2 1/8	2 1/8	2 1/8	2 1/8	2 1/8
40	1 5/8	1 5/8	1 5/8	1 5/8	1 5/8	1 5/8	2 1/8	2 1/8	2 1/8	2 1/8	2 1/8	2 1/8

Table 4 - Upflow Discharge Line Sizes for R410A (inches OD)

Circuit Tons	Total Equivalent Length (Ft)											
	25	50	75	100	125	150	175	200	225	250	275	300
5	A – 3/8 B – 1/2	A – 3/8 B – 1/2	A – 3/8 B – 1/2	A – 3/8 B – 1/2	A – 3/8 B – 5/8	A – 3/8 B – 5/8	A – 3/8 B – 5/8	A – 3/8 B – 5/8	A – 3/8 B – 5/8	A – 3/8 B – 5/8	A – 3/8 B – 5/8	A – 3/8 B – 3/4
7.5	A – 3/8 B – 3/4	A – 3/8 B – 3/4	A – 3/8 B – 3/4	A – 3/8 B – 3/4	A – 3/8 B – 3/4	A – 3/8 B – 3/4	A – 3/8 B – 3/4	A – 3/8 B – 3/4	A – 3/8 B – 3/4	A – 3/8 B – 3/4	A – 3/8 B – 3/4	A – 3/8 B – 3/4
10	A – 3/8 B – 3/4	A – 3/8 B – 3/4	A – 3/8 B – 3/4	A – 3/8 B – 3/4	A – 3/8 B – 3/4	A – 3/8 B – 3/4	A – 3/8 B – 3/4	A – 3/8 B – 7/8	A – 3/8 B – 7/8	A – 3/8 B – 7/8	A – 3/8 B – 7/8	A – 3/8 B – 7/8
15	A – 3/8 B – 3/4	A – 3/8 B – 3/4	A – 3/8 B – 7/8	A – 3/8 B – 7/8	A – 3/8 B – 7/8	A – 3/8 B – 7/8	A – 3/8 B – 7/8	A – 3/8 B – 7/8	A – 3/8 B – 7/8	A – 3/8 B – 7/8	A – 1/2 B – 1 1/8	A – 1/2 B – 1 1/8
20	A – 3/8 B – 3/4	A – 3/8 B – 7/8	A – 3/8 B – 7/8	A – 1/2 B – 1 1/8	A – 1/2 B – 1 1/8	A – 1/2 B – 1 1/8	A – 1/2 B – 1 1/8	A – 1/2 B – 1 1/8	A – 1/2 B – 1 1/8	A – 1/2 B – 1 1/8	A – 5/8 B – 1 3/8	A – 5/8 B – 1 3/8
25	A – 3/8 B – 7/8	A – 3/8 B – 7/8	A – 3/8 B – 7/8	A – 1/2 B – 1 1/8	A – 1/2 B – 1 1/8	A – 1/2 B – 1 1/8	A – 1/2 B – 1 1/8	A – 1/2 B – 1 1/8	A – 1/2 B – 1 1/8	A – 1/2 B – 1 1/8	A – 5/8 B – 1 3/8	A – 5/8 B – 1 3/8
30	A – 1/2 B – 7/8	A – 1/2 B – 7/8	A – 1/2 B – 7/8	A – 3/4 B – 1 1/8	A – 3/4 B – 1 1/8	A – 3/4 B – 1 1/8	A – 3/4 B – 1 1/8	A – 3/4 B – 1 1/8	A – 3/4 B – 1 1/8	A – 3/4 B – 1 3/8	A – 3/4 B – 1 3/8	A – 3/4 B – 1 3/8
35	A – 3/4 B – 1 1/8	A – 3/4 B – 1 1/8	A – 3/4 B – 1 1/8	A – 3/4 B – 1 3/8	A – 3/4 B – 1 3/8	A – 3/4 B – 1 3/8	A – 3/4 B – 1 3/8	A – 3/4 B – 1 5/8	A – 3/4 B – 1 5/8	A – 3/4 B – 1 5/8	A – 3/4 B – 1 5/8	A – 3/4 B – 1 5/8
40	A – 3/4 B – 1 3/8	A – 3/4 B – 1 3/8	A – 3/4 B – 1 3/8	A – 3/4 B – 1 3/8	A – 3/4 B – 1 3/8	A – 3/4 B – 1 3/8	A – 3/4 B – 1 5/8	A – 3/4 B – 1 5/8	A – 3/4 B – 1 5/8	A – 3/4 B – 1 5/8	A – 3/4 B – 1 5/8	A – 3/4 B – 1 5/8

Calculating Refrigerant and Oil Charge

To determine the approximate charge, first refer to Table 12 and establish the required charge for the condenser and chiller. Then refer to Table 13 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 12 and Table 13.

Table 5 – Chiller & Condenser Refrigerant Charge

Circuit Capacity (tons)	Total Combined Chiller and Condenser Summertime Refrigerant Charge (lbs of R410A)
5	7.6
7.5	11.1
10	15.3
15	22.2
20	30.2
25	37.2
30	44.3
35	51.9
40	59.4

Table 6 - Field Piping R-410A Refrigerant Charges

Line Size OD (inches)	Lbs of R410A per 100 Foot of Line Length	
	Discharge Line	Liquid Line
3/8	0.4	3.7
1/2	0.7	6.8
5/8	1.1	11
3/4	1.6	16.4
7/8	2.2	22.8
1 1/8	3.6	36.7
1 3/8	5.6	57.4
1 5/8	7.9	81.2
2 1/8	13.9	142.1
2 5/8	21.4	219.5

Oil Charge Determination

The chiller is factory charged with the amount of oil required by the chiller only and not the total system. The amount of oil required is dependent upon the amount of refrigerant added to the system for the field-installed piping. Use the following to determine the amount of oil needed for the system.

Pints of Oil = Pounds of refrigerant in system / 100

Oil level should be checked after the chiller has run for 15 minutes.

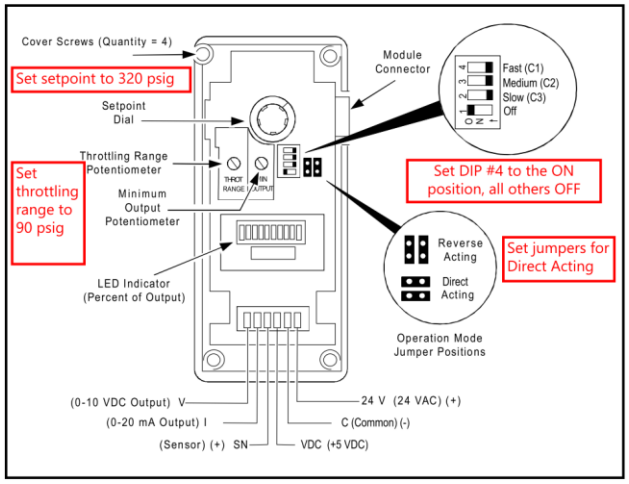
Setting Condenser Fan Controls

Depending on the number of condenser fans present there will be different fan cycling pressure control setting requirements. It is important that these settings be correct in order to maintain proper capacity control and operation of the system. Each refrigerant circuit has a separate head-pressure control circuit. Refer to Table 7 for the proper pressure settings.

Table 7 - Condenser Fan Pressure Settings (psig)

Stage Number	Setting	Number of Fan Stages			
		1	2	3	4
Stage 1	Max Speed	410	410	410	410
	Min Speed	320	320	320	320
Stage 2	Fan On		400	400	370
	Fan Off		340	340	305
Stage 3	Fan On			435	385
	Fan Off			375	325
Stage 4	Fan On				400
	Fan Off				340

To do this open the remote condenser control panel, remove the cover from the pressure control module, and make sure everything is set as shown below.



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 2%. Excessive voltage imbalance between the phases of a three-phase system can cause motors to overheat and eventually fail.

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.

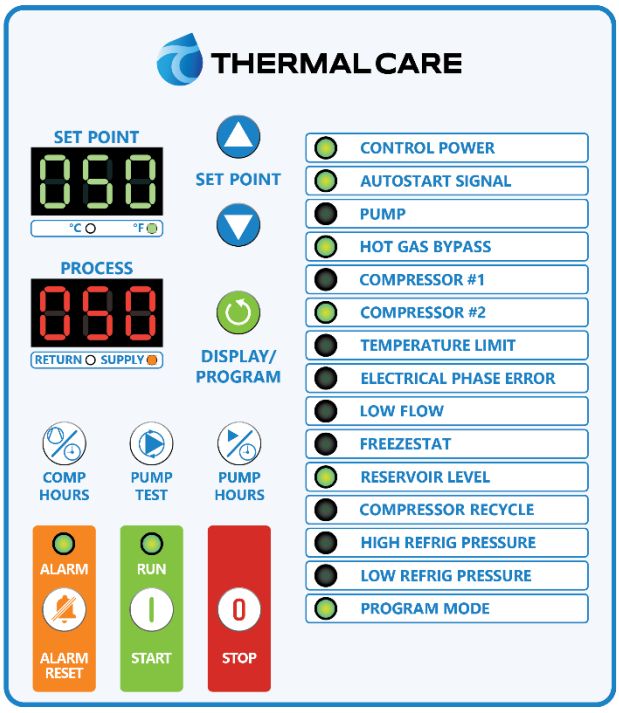
CAUTION: Wear eye protection when installing, maintaining, or repairing the equipment to protect against any sparks, debris, or fluid leaks.

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.

Standard Controller Operation



The chiller includes a controller to perform all control functions directly from the front panel. When Control Power is applied, the controller initiates a diagnostic test of each indicating light and display segments by briefly lighting each sequentially. As part of this initial diagnostic test, the program revision level displays for a moment. After the initial diagnostic sequence is completed, the controller is ready for operation.

Table 8 - Operating Buttons

Button	Description of Operation
Start	Depressing the Start button will start the pump and enable the compressor. The compressor (and condenser fans if the chiller is air-cooled) will start only if the microprocessor is calling for cooling because the actual To Process temperature is higher than the Set Point temperature. If the Autostart feature is enabled the Autostart signal will have precedence over the Start Button. See the Program Menu section for instructions on how to enable or disable the Autostart feature. The Start button also performs an "Enter" function while in the programming menu.
Stop	Depressing the Stop button will shut off the compressor, pump, condenser fans (if the chiller is air-cooled), and clear all fault signals. If the Autostart feature is enabled and an Autostart signal is present, the Stop button will not stop the chiller. See the Program Menu section for instructions on how to enable or disable the Autostart feature. The Start button also performs a "Cancel" function while in the programming menu.
Alarm Silence / Alarm Reset	When an alarm condition is present, the alarm light is on and red. The first Alarm Silence/Reset button press will silence the alarm horn (optional), open the remote alarm contact (optional), and the alarm light changes from red to yellow. The alarm horn and/or remote alarm contact remain disabled until a subsequent alarm occurs. A second press of the Alarm Silence/Reset button resets the state from Alarm to Normal Operation. The High Refrigerant Pressure and Pump Overload require a mechanical safety manual reset before the control board reset. If the fault is still present, the unit will immediately go into a new alarm state.
Compressor Running Hours	Press and hold the Compressor Running Hours Button to display the amount of time that each compressor in the system has run. The Set Point window will show which compressor's usage is being displayed (for units with two compressors). The running hours show in the process display window. Display of running hours is in units of hundreds so a display value of 10 would mean 1,000 hours. The running hours show while holding the button. For units with two compressors, the display will toggle between the two compressors every three seconds. The hours show while holding the button. Control is not disturbed while displaying the running hours.
Pump Running Hours	Press and hold the Pump Running Hours Button to display the amount of time the pump has run. The running hours show in the process display window. Display of running hours is in units of hundreds so a display value of 10 would mean 1,000 hours. The running hours will show while holding the button. Control is not disturbed while displaying the pump running hours.

Table 8 – Operating Buttons (continued)

Button	Description of Operation
Pump Test	With the chiller stopped, pressing this button briefly engages the pump to test its operation. The pump will not run if there are any active alarms. The pump shuts down by either pressing the Stop button or pressing the Pump Test button a second time. The pump will shut down after one minute of operation.
Display/Program	The Display/Program button will change the temperature displayed in the Process screen from Supply to Return. When the display is set to supply temperature, there will be an orange indicating light in the lower right corner of the Process temperature display. When the display is set to return temperature, there will be no orange indicating light in the lower right corner of the Process temperature display. To toggle the process temperature display from supply to return temperature, press and release the Display/Program button. The display will return to the default Supply temperature automatically after 5 seconds without a button press. In addition to switching between the supply and return process temperature displays, the Display/Program button will initiate and navigate through the program menu. See the Program Menu section for more detail.
Up	The Up button raises the set point temperature. Pressing the Up button and releasing it increases the set point temperature by one degree. Pressing the Up button and holding it increases the set point temperature until reaching the maximum allowable set point temperature. In addition to adjusting the set point temperature, the Up button adjusts various alarms and set point values when the unit in the programming mode.
Down	The Down button decreases the set point temperature. Pressing the Down button and releasing it decreases the set point temperature by one degree. Pressing the Down button and holding it decreases the set point temperature until reaching the minimum allowable set point temperature. In addition to adjusting the set point temperature, the Down button adjusts various alarms and set point values when the unit is in the programming mode.

Table 9 - Temperature Displays

Display	Description of Operation
Set Point	The Set Point display normally shows the set point temperature. A decimal point in the lower right corner of this display indicates the temperature unit of measure is set to °F, no decimal point indicates the temperature unit of measure is set to °C. See the Program Menu section to change the temperature scale units of measure. This display also shows alarm codes and programming information.
Process	The Process Temperature display normally shows supply temperature. A decimal point in the lower right corner of the display indicates the temperature displayed is the supply temperature, no decimal point indicates the temperature displayed is the return temperature. To change the display from supply to return temperature, press and release the Display/Program button. The display will return to the default Supply temperature automatically after 5 seconds without a button press. This display also shows alarm codes and programming information.

Table 10 - Operating Lights

Light	Description of Operation
Control Power	The Control Power light is green when 24VDC control voltage is present.
Autostart Signal	The Autostart Signal light is green when closed (run), yellow when open (stop), and unlit if this feature is disabled. This feature allows starting and stopping of the unit by a remote contact closure. From the factory, the Autostart feature is disabled. See the Program Menu section for instructions on how to enable or disable the Autostart feature. Do not introduce any external voltage to the Autostart contacts, as this will result in damage to the controller.
Pump	The Pump light is solid green when the pump is running and flashes red if the pump motor overload trips.
Hot Gas Bypass	The Hot Gas Bypass light will pulse or light solidly when the chiller is operating at partial load and the hot gas bypass valve opens. The light stays on for longer periods of time when the chiller is under smaller loads. If the light stays off the chiller is under full load. If the light stays on the chiller is fully unloaded. If this condition persists, the To Process temperature may begin to drop below the Set Point temperature, eventually cycling off compressor(s).
Compressor #1	The Compressor #1 light is solid green when Compressor #1 is running, flashes red if a compressor overload or fault occurs, and is solid red if the controller is attempting to start the compressor before the anti-recycle timer has timed out. Compressor #1 is enabled when the temperature of the coolant leaving the chiller rises above the Set Point by an amount equal to the control parameter PS1 (Compressor #1 Positive Spread). PS1 is equal to 2 °F by default. The compressor is disabled if the temperature of the coolant leaving the chiller drops below the Set Point by an amount equal to the control parameter nS1 (Compressor #1 Negative Spread). The parameter nS1 is set to 4 °F by default. See the Program Menu section for instructions on how to adjust PS1 and nS1.

Table 10 – Operating Lights (continued)

Light	Description of Operation
Compressor #2	The Compressor #2 light is solid green when Compressor #2 is running, flashes red if a compressor overload or fault occurs, and is solid red if the controller is attempting to start the compressor before the anti-recycle timer has timed out. Compressor #2 is enabled when the temperature of the coolant leaving the chiller rises above the Set Point by an amount equal to the control parameter PS2 (Compressor #2 Positive Spread). PS2 is equal to 3 °F by default. The compressor is disabled if the temperature of the coolant leaving the chiller drops below the Set Point by an amount equal to the control parameter nS2 (Compressor #2 Negative Spread). The parameter nS2 is set to 5 °F by default. See the Program Menu section for instructions on how to adjust PS2 and nS2.
Temperature Limit	The Temperature Limit light flashes yellow if a high or low temperature limit warning occurs and flashes red if a high or low temperature limit safety occurs. A temperature limit safety stops all compressors and pumps. Pushing the Alarm Reset button will reset this alarm.
Electrical Phase Error	The Electrical Phase Error light flashes red when a line voltage problem exists (loss of phase, phase reversal, or phase imbalance). This safety stops all compressors and pumps. Pushing the Alarm Reset button will reset this alarm.
Low Flow	The Low Flow light is red if the flow through the chiller is too low. This safety is defeated for 5 seconds after starting the chiller to allow the pump to establish flow. This safety stops all compressors and pumps. Pressing the Start button resets the safety and restarts the chiller.
Freezestat	The Freezstat light is red if the coolant leaving the chiller drops below the Freezestat Limit (FLS) setting. This safety stops all compressors but allows pumps to continue running. Set the Freezestat Limit 10°F above the freezing point of the coolant in the chiller. The Freezestat is factory set at 38°F. Pressing the Alarm Reset button resets the Freezestat fault if the coolant temperature has risen 5°F above the Freezestat Limit. See the Program Menu section for instructions on how to adjust FLS.
Reservoir Level	The Low Reservoir Level light is red when the water level in the reservoir drops below the lower limit of the float switch. This safety stops all compressors and pumps. Pressing the Alarm Reset button resets the Low Reservoir Level fault if the coolant level in the reservoir has risen about the lower limit of the float switch.
Compressor Recycle	The Compressor Recycle light is yellow when the number of compressor starts per hour exceeds the number allowed. This limit maximizes compressor life and ensures proper return of oil to the compressor crankcase. This light is illuminated yellow whenever there is a wait period before a compressor can start.
High Refrig Pressure	The High Refrigerant Pressure light is red when the compressor discharge refrigerant pressure exceeds the setting of the high refrigerant pressure safety. This safety stops all compressors but allows pumps to continue running. Pressing the Alarm Reset button resets the fault if the compressor discharge refrigerant pressure is less than the setting of the high refrigerant pressure safety.
Low Refrig Pressure	The Low Refrigerant Pressure light is red when the compressor suction pressure drops below the setting on the low refrigerant pressure safety. This safety stops all compressors but allows pumps to continue running. Pressing the Alarm Reset button resets the fault if the compressor suction pressure is above the setting of the low refrigerant pressure safety.
Program Mode	The Program Mode LED flashes yellow when the control system is in the programming menu.

Program Menu

The program menu is password protected to prevent unintended alteration to the program settings and parameters. The unit must be in a stopped state for menu access.

To enter the password press and hold the Display/Program button for 5 seconds. The Program Mode light flashes yellow, the Set Point display shows “000”, and the Process display shows “PAS.” The unit is now ready to have the password entered. Use the up and down arrows to change the number to the correct password and press the Start button to enter. The default password is “000.”

If the password entered is incorrect, the Set Point displays “no” and the Process display shows "PAS" for 5 seconds and then waits for another attempt to enter the correct password. If no activity occurs for 5 seconds, the controller exits the programming mode and returns to the Stopped state.

Once in the program menu, use the Display/Program button to scroll through the different adjustable parameter as shown in Table 11.

To change an item, press the Display/Program button until the item code displays in the Process display. Pressing the Alarm Reset button and Display/Program button at the same time reverses the direction the Display/Program button indexes through the menu items. Once the desired menu item code shows in the Process display, use the Up and Down arrow buttons to adjust the value shown

in the Set Point display until the desired value shows. Press the Start button to enter the new value. Press the Stop button to cancel and revert to the previous value.

There is a Master Reset function to restore all User menu parameters to their factory default values. The unit must be in a stopped state for this function to work. To initiate a Master Reset press and hold the Alarm Silence/Reset button and Stop button simultaneously for 10 consecutive seconds until “PRG” shows on the Set Point display and "RSt" shows on the Process display. Release all buttons and press the Start button within 10 seconds. Failure to push the Start button within 10 seconds aborts the Master Reset.

Table 11 - Controller Program Menu

Item Name	Item Code	Default Value	Range
Alarm delay for high deviation alarm	AdH	30	0 to 60 minutes (10 to 60 minutes on program versions prior to version 1.33)
Alarm delay for low deviation	AdL	30	0 to 60 minutes (10 to 60 minutes on program versions prior to version 1.33)
Alarm deviation alarm delay after start	AdS	30	0 to 30 minutes on program version 1.33 and later only
Alarm output	AdO	dIS	Disabled (dIS) or Enabled (ENA) on program versions 1.33 and later only
Autostart enable	ASE	ENA	Disabled (dIS) or Enabled (ENA)
Brownout monitor	brn	ENA	Disabled (dIS) or Enabled (ENA)
Communications Baud Rate[1]	bAU	96	12 to 96
Communications Modbus ID[1]	Id	1	1 to 247
Communications SPI Address[1]	SPA	32	32 to 63
Communications type[1]	COT	OFF	OFF, Retransmit (rE T), SPI (SP I), ModBus (bUS), Handheld Remote (hAn)
Compressor 1 negative spread	nS1	4	1 to 10
Compressor 1 positive spread	PS1	2	1 to 10
Compressor 2 enabled	C02	dIS	Disabled (dIS) or Enabled (ENA)
Compressor 2 negative spread	nS2	5	1 to 10
Compressor 2 positive spread	PS2	3	1 to 10
Derivative	dEr	3	0 to 200
Display units	UnT	F	F to C
Freezestat limit	FSL	40	-50 to 40
High deviation alarm limit	h Id	10	5 to 100 degrees about set point
Integral	InT	25	1 to 800
Low deviation alarm limit	LOd	10	5 to 100 degrees below set point
Panel temperature alarm	PAE	ENA	Disabled (dIS) or Enabled (ENA)
Panel temperature readout	P TE	-	Display only
Proportional band	bnd	8	1 to 300
Remote Setpoint High limit[1]	rSh	65	Between rSL and 999
Remote Setpoint Low limit[1]	rSL	20	Between -99 and rSh
Remote Setpoint Enable[1]	rSE	dIS	Disabled (dIS) or Enabled (ENA)
Retransmit Range High[1]	rEh	150	Between 999 and rEL
Retransmit Range Low[1]	rEL	0	Between -99 and rEh
User High Safety limit	hSU	140	Between factory low and high limits
User Low Safety limit	LSU	10	Between factory low and high limits
User password	UPA	000	0 to 999

[1]Optional, requires additional hardware to be functional.

Table 12 – Controller Control Fault Logic

Fault[1]	Alarm Indication	Component Shut-Off		Required Resets	
		Pump	Compressor	Panel[2]	Sensor[3]
Low Reservoir Level	Reservoir Level Light flashes red	Yes	Yes	Yes	Yes
Temperature Limit Safety	Set Point and Process Displays Flash, Temperature Limit Light flashes red	Yes	Yes	Yes	No
Temperature Limit Warning	Temperature Limit Light flashes yellow	No	No	Yes	No
Pump Motor Overload	Pump Light flashes red	Yes	Yes	Yes	Yes
Compressor Motor Overload	Compressor Light flashes red	No	Yes	Yes	No
High Refrigerant Pressure	High Refrig Pressure Light flashes red	No	Yes	Yes	Yes
Low Refrigerant Pressure	Low Refrig Pressure Light flashes red	No	Yes	Yes	No
Low Evaporator Temperature	Freezestat Light flashes red	No	Yes	Yes	No
Supply Probe Fault Hi	Set Point Display shows PrS, Process Display shows Ehi	Yes	Yes	Yes	No
Supply Probe Fault Lo	Set Point Display shows PrS, Process Display shows ELO	Yes	Yes	Yes	No
Return Probe Fault Hi	Set Point Display shows Prr, Process Display shows Ehi	Yes	Yes	Yes	No
Return Probe Fault Lo	Set Point Display shows Prr, Process Display shows ELO	Yes	Yes	Yes	No
Freezestat Probe Fault Hi	Set Point Display shows PrF , Process Display shows Ehi	Yes	Yes	Yes	No
Freezestat Probe Fault Lo	Set Point Display shows PrF , Process Display shows ELO	Yes	Yes	Yes	No
Brownout	Set Point Display shows bPn, Process Display shows Out	Yes	Yes	Yes	No
3-Phase Power Error	Electrical Phase Error list flashes red	Yes	Yes	Yes	No
Low Flow	Low Flow Light flashes red	Yes	Yes	No	No

[1] Activates the alarm horn (optional) and closes the alarm contact (optional) if these options have been purchased.
[2] Alarm Silence/Reset button on control panel must be pressed.
[3] Safety control device must be manually reset before the controller can be reset.

SPI Communications (Optional)

Several years ago, a number of members of The Plastics Industry Association developed a standard for various pieces of plastic processing equipment to communicate. They chose to adopt the Serial Peripheral Interface bus (SPI bus). To allow our unit to operate as a slave unit in a plastic processing system using this protocol, we offer an option that includes an expansion module for the control board and a RS-485 communication port on the unit. The communication hardware firmware is SPI 3.01 standard compliant.

Units ordered with this option will have this feature activated at the factory. Use the program menu Communication Type function as shown in Table 11 to activate or deactivate this feature. In addition to activating the communication type a baud rate and SPI address must be set. These are set using the Communication Baud Rate and SPI Address functions as shown in Table 13.

If multiple pieces of equipment are going to be on the same SPI communications network, the base addresses of each machine has to be unique. The communication baud rate may also need adjustment.

Table 13 - SPI Parameters

Command	Poll	Select	Description
Echo	20 20	20 21	This is the controller integrity command used to accept and retain data and provide it in response to a poll inquiry. This is an open 4-byte ASCII format with ASCII units.
Version	20 22		This is the controller version command used to provide a version number following format: AABB, where AA = SPI assigned version level, BB = vendor assigned version level. This is in an open 4-byte ASCII format with ASCII units.
Setpoint Process Temperature	20 30	20 31	This is the temperature target for the supply coolant leaving the chiller. This is a numeric format in °F.
Alarm, High Temperature Deviation	20 32	20 33	This is the value in conjunction with the process setpoint that determines the high alarm temperature. This value must always be positive. This is a numeric format in °F.
Alarm, Low Temperature Deviation	20 34	20 35	This is the value in conjunction with the process setpoint that determines the low alarm temperature. This value must always be positive. This is a numeric format in °F.
Status, Process	20 40		This is the process status in a 16 bit format as follows: 0 = Controlling 1 = An alarm is present 2 = An alarm affecting the process has occurred (high or low temperature deviation) 3 = An alarm affecting the machine has occurred (probe fault or pump fault) 4 = The controller has exceeded its over setpoint deviation 5 = The controller has exceeded its below setpoint deviation
Status, Machine 1	20 42		This is the machine status in a 16 bit format as follows: 0 = Controlling 1 = An alarm is present 2 = An alarm affecting the process has occurred (high or low temperature deviation) 3 = An alarm affecting the machine operation has occurred (probe fault or pump fault) 4 = The controller has exceeded its over setpoint deviation 5 = The controller has exceeded its below setpoint deviation
Status, Machine 2	20 44		This is the machine status in a 16 bit format as follows: 0 = Controlling 1 = An alarm is present 2 = An alarm affecting the process has occurred (high or low temperature deviation) 3 = A sensor error has been detected 4 = An alarm affecting the machine operation has occurred
Mode, Machine	20 48	20 40	This is the machine mode in two 8-bit bytes. When polling 20 48 bit 0 indicates the machine is off. 20 40 bit 0 commands the unit to be turned on or off (on when high or off when low), 20 40 bit 1 is used to recognized the alarm condition
Temperature, To Process (Supply)	20 70		Returns the process supply temperature. This is a numeric format in °F.
Temperature, To Process (Return)	20 72		Returns the process return temperature. This is a numeric format in °F.

Modbus RTU (Optional)

This option provides a RS-485 communications port for Modbus RTU communications. See Table 11 for details on how to enable this feature. Note the ModBus Parity = None, Stop Bits = 1, and default Baud Rate = 9,600.

Table 14 – Standard Controller Modbus RTU Option Parameters

Register	Description	Read/Write	Format	Notes
4002	Machine State	R	Integer	0 = Off, 1 = Stop, 2 = Run, 3 = Run Fault 2, 4 = Run Fault 3, 5 = Fault 1, 6 = Factory Menu, 7 = User Menu, 8 = Get User Password, 9 = Master Reset
4007	Derivative	R/W	Integer	
4008	Integral	R/W	Integer	

Table 14 – Standard Controller Modbus RTU Option Parameters (continued)

Register	Description	Read/Write	Format	Notes
4011	Low Alarm Delay	R	Integer	
4012	High Alarm Delay	R	Integer	
4013	Temperature Display Units	R	Integer	0 = °F, 1 = °C
4015	Brownout Enabled	R	Integer	0 = Disabled, 1 = Enabled
4024	Remote Setpoint Enabled	R	Integer	0 = Disabled, 1 = Enabled
4025	Autostart Enabled	R	Integer	0 = Disabled, 1 = Enabled
4027	Communication BAUD Rate	R/W	Integer	0 = 1200, 1 = 2400, 2 = 4800, 3 = 9600
4028	MODBUS Identification	R/W	Integer	
4030	SPI Communications Address	R/W	Integer	
4033	Compressor 2 Enabled	R	Integer	0 = Disabled, 1 = Enabled
4038	Hot Gas Bypass PID Output	R	Integer	-100 to 100 PID algorithm output
4039	MODBUS Command	R/W	Integer	0 = Do Nothing, 1 = Start, 2 = Stop
8000	Freezestat Temperature (°C)	R	Floating Point	Error Hi = 9.9E05, Error Low = -9.9E05
8002	Supply Fluid Temperature (°C)	R	Floating Point	Error Hi = 9.9E05, Error Low = -9.9E05
8004	Return Fluid Temperature (°C)	R	Floating Point	Error Hi = 9.9E05, Error Low = -9.9E05
8010	Low Temperature Deviation (°C)	R/W	Floating Point	
8012	High Temperature Deviation (°C)	R/W	Floating Point	
8014	Low Setpoint Limit Temperature (°C)	R	Floating Point	
8016	High Setpoint Limit Temperature (°C)	R	Floating Point	
8018	Supply Temperature Retransmit Range Low (°C)	R	Floating Point	
8020	Supply Temperature Retransmit Range High (°C)	R	Floating Point	
8022	Low Temperature Safety – User Set (°C)	R/W	Floating Point	
8024	High Temperature Safety – User Set (°C)	R/W	Floating Point	
8026	Proportional Band (°C)	R/W	Floating Point	
8052	Pump Running Hours	R	Floating Point	
8054	Setpoint Temperature (°C)	R/W	Floating Point	
8056	Low Temperature Safety – Factory Set (°C)	R	Floating Point	
8058	High Temperature Safety – Factory Set (°C)	R	Floating Point	
8060	Negative Compressor 1 Spread (°C)	R	Floating Point	
8062	Negative Compressor 2 Spread (°C)	R	Floating Point	
8064	Positive Compressor 1 Spread (°C)	R	Floating Point	
8066	Positive Compressor 2 Spread (°C)	R	Floating Point	
8068	Freezestat Limit Temperature (°C)	R	Floating Point	
8070	Supply Temperature Input Offset	R	Floating Point	
8072	Return Temperature Input Offset	R	Floating Point	
8074	Remote Setpoint Temperature Input Offset	R	Floating Point	
8078	Freezestat Temperature Input Offset	R	Floating Point	
8080	Remote Setpoint Limit Temperature (°C)	R	Floating Point	
8082	Remote Setpoint High Temperature Limit (°C)	R	Floating Point	
8110	Compressor 1 Running Hours	R	Floating Point	
8112	Compressor 2 Running Hours	R	Floating Point	

Note: All temperatures are in °C regardless of unit display configuration.

Optional PLC Operation

As an option on fixed-speed compressor chillers (standard on units with the variable-speed compressor option), there is a Programmable Logic Controller (PLC) and touch-screen operator interface display (this is standard control for chillers with the variable-speed compressor option). There are a number of different screens for each option and configuration to allow for extensive monitoring and control of various aspects of the chiller operation. Due to the vast number of screens and variations possible, we have not attempted to capture all possible screens in this manual and instead have included some of main screens with some general comments. We are confident you will find the menus and items are straightforward and easy to understand and use.

Some screens are password protected to prevent unintended changes. There are two levels of passwords:

User Level Password	= 9999
Technician Level Password	= 7720

When navigating to a screen, any areas that are user adjustable appear in a slightly different color or are sunken. Touching one of these areas brings up a keypad. Use the keypad to enter the appropriate password as shown above.

In most cases, the user-level password is sufficient because it allows access to the most common functions; however, there are a few screens protected with a technician-level password. We strongly recommend you refrain from making changes in the technician-level menus unless you fully understand the impact as it may lead to improper or poor performance of the chiller. Please consult our Customer Service department for assistance if you have any question about the impact of any changes before you make them.

If you suspect changes were made to parameters that caused poor or improper performance, there is a master reset function on Menu 2, which will allow you to restore the unit to factory default settings. When this is done you will need to follow the on-screen prompts to reconfigure the chiller based on the options present. For assistance with this process please contact the Customer Service Department and have the unit Serial Number ready for reference so they can pull up the details of your unit.

System Initialization

Upon power-up, the first screen to appear is the Start-Up Screen as shown in Figure 8. This screen will display while the Programmable Logic Controller (PLC) and Human Machine Interface (HMI) establish communications. The PLC and HMI version shows on the screen and must match.

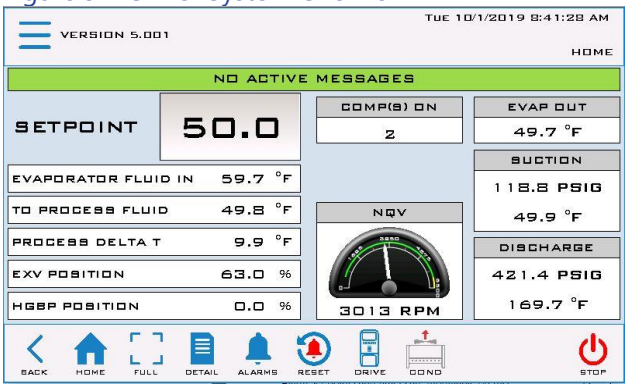
Figure 8 – Start-Up Splash Screen

Once control communication is established, the HMI screen automatically switches to the Home Screen as shown in Figure 9.

Home - System Overview

This screen provides an overall synopsis of the chiller system, quick links to other views, as well as other additional information.

Figure 9 – Chiller System Overview



Note: This is an example of a chiller with the most extensive set of options; your screen may appear slightly differently based on your actual chiller configuration.

When power is applied, you will see the main screen similar to the above. From the main screen, you can

navigate to other screens and menus, each of which may have several sub-screens or menus depending on your chiller's configuration. The menu and screen buttons are located at the bottom of all screens. Touch any one of these to navigate to that menu or screen.

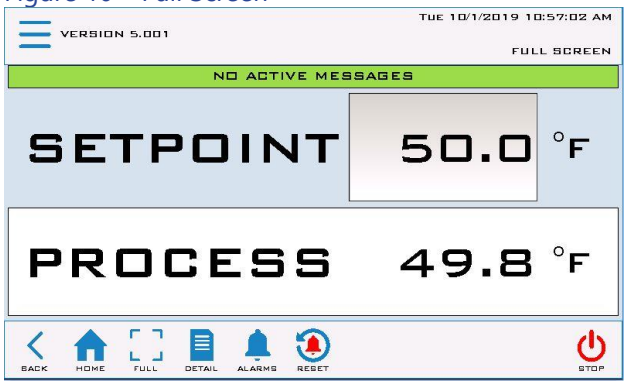
Table 15 – System Overview Functions

Function	Description	Screen Reference
Comp(s) ON	Informs the operator of the compressors in operation in each circuit	None
Alarm Messaging	Provides information about any warnings or alarms which may have occurred.	None
Setpoint	Modify the Setpoint by touching the current Setpoint on the HMI. An authorized security level password is required to enter a new Setpoint.	None
Menu Button	Changes to the Menu 1 screen	Figure 11 Figure 17
Full Screen Display	Will display only the Setpoint and process temperature in a large visible font	Figure 10
Alarms	A listing of active and prior alarm history	Figure 12 Figure 13
Detail	Additional circuit related information	Figure 14
Start / Stop	Pressing the Start button will start the chiller as well as any other networked chillers attached to this system. The Start button will disappear at this point. Pressing the Stop button will stop all chillers.	None

Home – Full Screen

The Full Screen (Figure 10) provides a simplified view of the chiller. The SETPOINT and PROCESS temperatures appear in a large font easily seen from a distance, providing a "quick glance" look to validate proper operation.

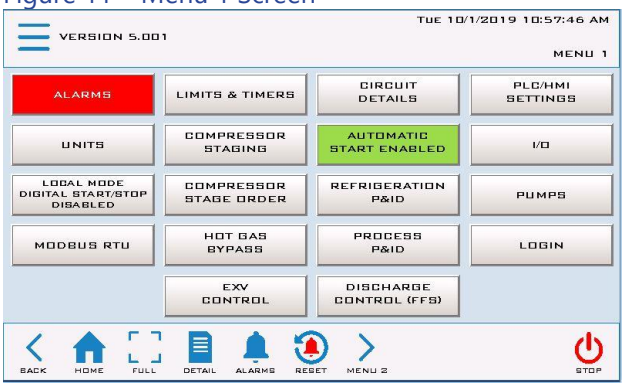
Figure 10 – Full Screen



Menu 1 - Overview

The Menu 1 Screen (Figure 11) contains a central menu of menu links to most common adjustment and setting screens. Some parameters are password protected. The main user-level password is 9999 used for gaining access to changing the main system set point and various other warning and alarm settings. A few higher-level areas require a high-level user password that is 7720. If you are attempting to access an area where neither of these passwords is accepted, you may require a technician level password. For access to these areas of the program, contact our Customer Service Department for assistance.

Figure 11 – Menu 1 Screen

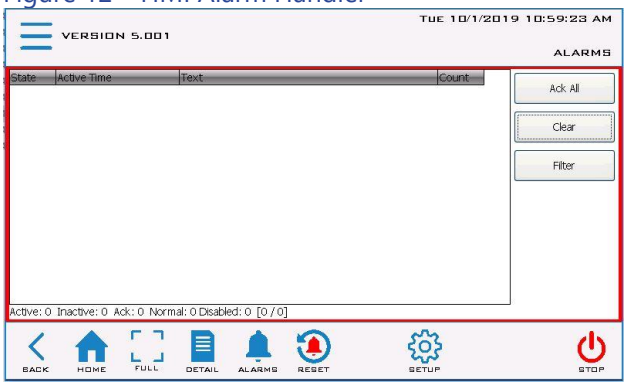


To return to the Home screen simply touch the Home button. Some screens have links to sub-screens or menus but all have a Home button to allow you to return to the Home screen.

Menu 1 - Alarms Active

When a critical system fault occurs, the controller activates the HMI alarm handler (Figure 12). This forces the alarm screen to appear and will display the current faults. To silence this alarm, press the ALARM SILENCE 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.

Figure 12 – HMI Alarm Handler

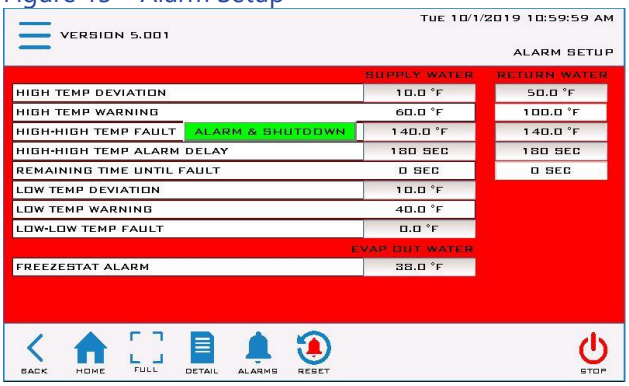


Note: The above shows there are no alarms; if an alarm condition were present, it would appear in this window.

Alarm Setup

Alarm set points and timers are modifiable on this screen.

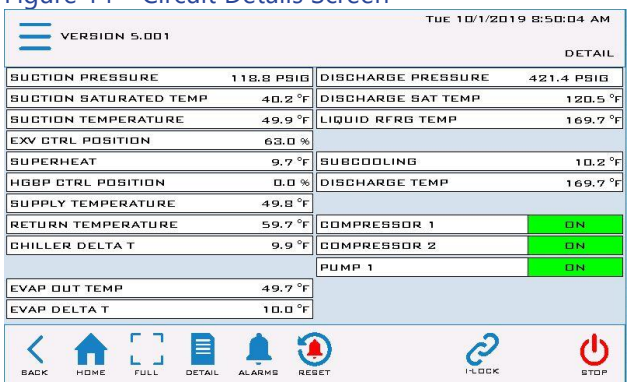
Figure 13 – Alarm Setup



Menu 1 – Circuit Details Screen

To access the Circuit Details Screen (Figure 14) use Menu 1 (Figure 11) or touch the option Details on the Home Screen (Figure 9). This screen provides additional information relative to the circuit.

Figure 14 – Circuit Details Screen

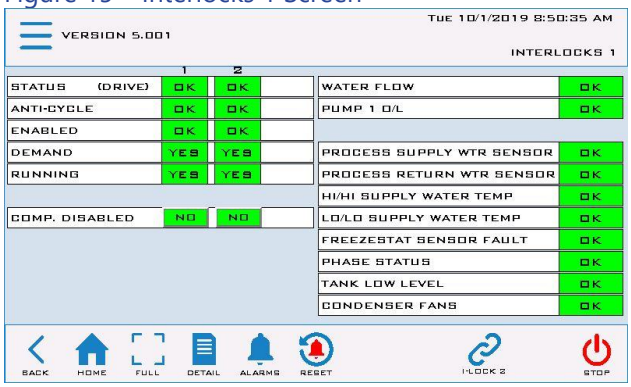


In the process of navigating through the various screens, you will find various menu and screen buttons appear at the bottom of the screen to allow quick access to related screens or menus. In all cases, there is a Home button to allow for quick and easy access to the main Home screen.

Circuit Details Screen – Interlocks

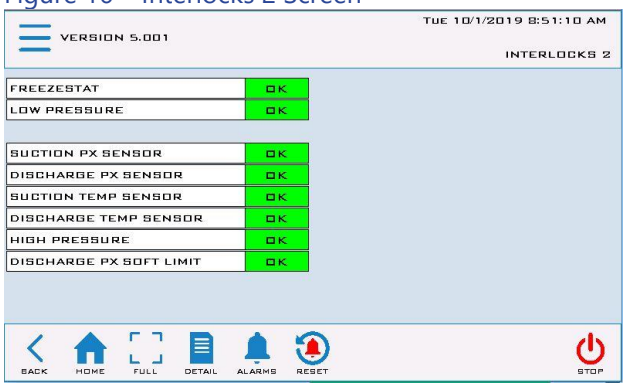
Touching the I-LOCK button on the bottom of the Circuit Detail Screen (Figure 14) displays the Interlock Screen shown in Figure 15. If the compressor is not starting, the reason for the fault will clearly be visible on this screen. On the right side of the screen, you will find the critical interlock fault. A critical interlock fault shuts down the entire system and must be resolved prior to a restart.

Figure 15 – Interlocks 1 Screen



Touching the I-LOCK 2 button opens the next Interlocks Screen (Figure 16).

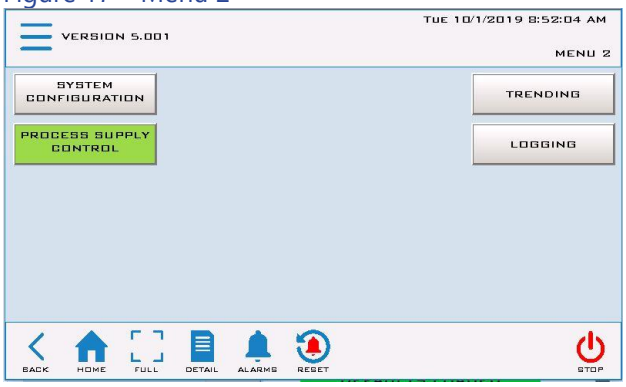
Figure 16 – Interlocks 2 Screen



Menu 2 – Overview

To access the Menu 2 Screen (Figure 17) use the button related on the Menu 1 Screen (Figure 11).

Figure 17 – Menu 2



Menu 2 – Default

CAUTION: The system configuration 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. This **will shut down** all operation of the chiller.

Touching SYSTEM CONFIGURATION on MENU 2 will present Figure 18. This screen will provide the ability to either review the existing factory build or restore the configuration back to a known factory state. Touch "REVIEW" to enter the system configuration screen. *WARNING: This will shut down all operation of the chiller.*

Figure 18 – Review System Build

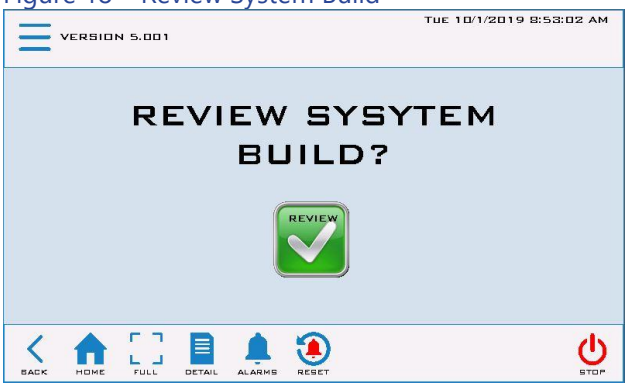
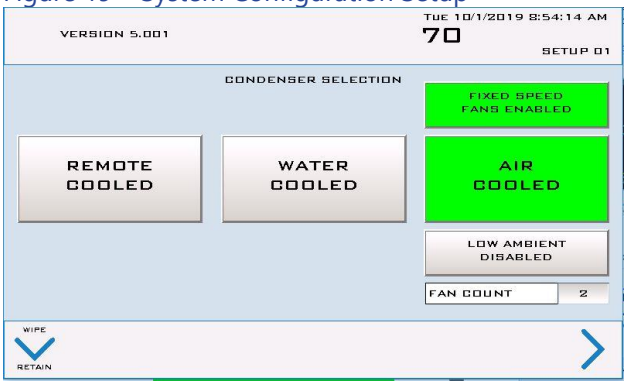


Figure 19 – System Configuration Setup

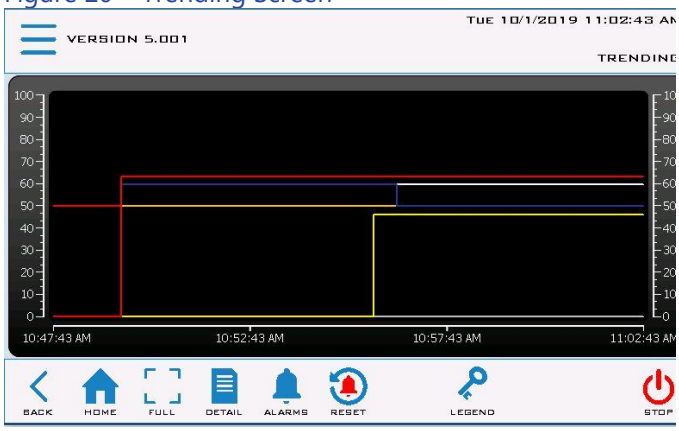


If the decision is to restore the system to factory defaults, press the WIPE RETAIN button in the lower left hand corner of the screen. If the choice is to verify/review the existing configuration, arrow right until the setup process completes itself. Once completed, the Home screen will automatically present itself.

Menu 2 – Trending

The trending screen (Figure 20) displays the setpoint temperature, process temperature, 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 20 – Trending Screen

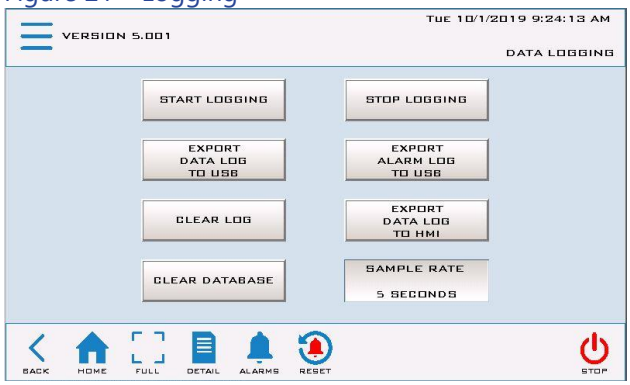


Menu 2 – Logging

The HMI is constantly logging key registers internal to the HMI. To analyze the data and/or alarm logs the data can be exported to an external thumb drive or extracted via FTP.

Data logging occurs every 5 seconds (adjustable) in a FIFO methodology with a range of 2 to 3,600 second sample rate.

Figure 21 – Logging



Modbus RTU and TCP /IP

The controller is available with Modbus RTU and Modbus TCP/IP. The Modbus RTU default set up uses a Baud Rate: 57,600, Data Length: 8 bits, Parity: Odd, Stop Bit: 1 and Station ID: 1. The default IP address of Modbus TCP/IP is 192.168.1.1.

Table 16 – Controller Modbus Registers

Modbus Register	Data Format	Type	Access Level	Description
0	BOOL	Coil	R/W	Start Chiller
1	BOOL	Coil	R	System Running
2	BOOL	Coil	R/W	Stop Chiller
3	BOOL	Coil	R	System Stopping
4	BOOL	Coil	R	Compressor(s) Running
5	BOOL	Coil	R/W	Temperature Display Units (0: °C, 1: °F)
6	BOOL	Coil	R/W	Pressure Display Units (0: KPAG, 1: PSIG)
7	BOOL	Coil	R/W	Flow Display Units (0: LPM, 1: GPM)
8	BOOL	Coil	R/W	Capacity Display Units (0: KW, 1: TON)
10	BOOL	Coil	R	Phase OK
11	BOOL	Coil	R	Evaporator Flow OK
12	BOOL	Coil	R	Low Refrigerant Pressure OK
13	BOOL	Coil	R	Low-Low Refrigerant Pressure OK
14	BOOL	Coil	R	High Refrigerant Pressure OK
15	BOOL	Coil	R	Condenser Fan 1 Exists
16	BOOL	Coil	R	Condenser Fan 1 Overload OK
17	BOOL	Coil	R	Condenser Fan 1 Enabled
18	BOOL	Coil	R	Condenser Fan 2 Exists
19	BOOL	Coil	R	Condenser Fan 2 Overload OK
20	BOOL	Coil	R	Condenser Fan 2 Enabled
21	BOOL	Coil	R	Condenser Fan 3 Exists
22	BOOL	Coil	R	Condenser Fan 3 Overload OK
23	BOOL	Coil	R	Condenser Fan 3 Enabled
24	BOOL	Coil	R	Refrigerant Liquid Line Solenoid Valve Enabled
25	BOOL	Coil	R	Controller Heart Beat (2 second pulse)
30	BOOL	Coil	R	Compressor 1 Exists
31	BOOL	Coil	R	Compressor 1 Internal Overload
32	BOOL	Coil	R/W	Compressor 1 Disable (0: Enable, 1: Disable)
33	BOOL	Coil	R	Compressor 1 Demand
34	BOOL	Coil	R	Compressor 1 Interlock Status OK
35	BOOL	Coil	R	Compressor 1 Overload Status OK
36	BOOL	Coil	R	Compressor 1 Anti-cycle Timer Done
37	BOOL	Coil	R	Compressor 1 Enabled

Table 16 – Controller Modbus Registers (continued)

Modbus Register	Data Format	Type	Access Level	Description
40	BOOL	Coil	R	Compressor 2 Exists
41	BOOL	Coil	R	Compressor 2 Internal Overload
42	BOOL	Coil	R/W	Compressor 2 Disable (0: Enable, 1: Disable)
43	BOOL	Coil	R	Compressor 2 Demand
44	BOOL	Coil	R	Compressor 2 Interlock Status OK
45	BOOL	Coil	R	Compressor 2 Overload Status OK
46	BOOL	Coil	R	Compressor 2 Anti-cycle Timer Done
47	BOOL	Coil	R	Compressor 2 Enabled
50	BOOL	Coil	R	Compressor 3 Exists
51	BOOL	Coil	R	Compressor 3 Internal Overload
52	BOOL	Coil	R/W	Compressor 3 Disable (0: Enable, 1: Disable)
53	BOOL	Coil	R	Compressor 3 Demand
54	BOOL	Coil	R	Compressor 3 Interlock Status OK
55	BOOL	Coil	R	Compressor 3 Overload Status OK
56	BOOL	Coil	R	Compressor 3 Anti-cycle Timer Done
57	BOOL	Coil	R	Compressor 3 Enabled
60	BOOL	Coil	R	Alarm – Phase Loss
61	BOOL	Coil	R	Alarm – Process Pump Overload
62	BOOL	Coil	R	Alarm – Recirculation Pump Overload
63	BOOL	Coil	R	Alarm – Tank Low Level
64	BOOL	Coil	R	Alarm - Freezestat
65	BOOL	Coil	R	Alarm – Evaporator Flow
66	BOOL	Coil	R	Fault – Freezestat Temperature Sensor
67	BOOL	Coil	R	Fault – Refrigeration Suction Temperature Sensor
68	BOOL	Coil	R	Fault – Refrigeration Suction Pressure Sensor
69	BOOL	Coil	R	Alarm – Refrigeration Suction Pressure Low
70	BOOL	Coil	R	Alarm – Refrigeration Suction Pressure Low-Low
75	BOOL	Coil	R	Fault – Refrigeration Discharge Temperature Sensor
76	BOOL	Coil	R	Fault – Refrigeration Discharge Pressure Sensor
77	BOOL	Coil	R	Alarm – Refrigeration Discharge Pressure
78	BOOL	Coil	R	Alarm – Refrigeration Discharge Pressure (Manual Reset Required)
79	BOOL	Coil	R	Alarm – Condenser Fan 1 Overload
80	BOOL	Coil	R	Alarm – Condenser Fan 2 Overload
81	BOOL	Coil	R	Alarm – Condenser Fan 3 Overload
82	BOOL	Coil	R	Alarm – Condenser Fans Failure
83	BOOL	Coil	R	Fault – Modulating Valve Control Temperature Sensor
84	BOOL	Coil	R	Alarm – Compressor 1 Overload
85	BOOL	Coil	R	Alarm – Compressor 2 Overload
86	BOOL	Coil	R	Alarm – Compressor 3 Overload
87	BOOL	Coil	R	Fault – Ambient Temperature Sensor

Table 16 – Controller Modbus Registers (continued)

Modbus Register	Data Format	Type	Access Level	Description
88	BOOL	Coil	R	Alarm – Process Return Fluid High-High Temperature
89	BOOL	Coil	R	Fault – Process Return Fluid Sensor
90	BOOL	Coil	R	Alarm – Process Supply Fluid High-High Temperature
91	BOOL	Coil	R	Alarm – Process Supply Fluid Low-Low Temperature
92	BOOL	Coil	R	Fault – Process Supply Fluid Sensor
93	BOOL	Coil	R	Alarm – Variable Speed Compressor Drive Communication
94	BOOL	Coil	R	Fault – Refrigeration Liquid Temperature Sensor
110	BOOL	Coil	R	Warning – Process Supply Fluid High Temperature
111	BOOL	Coil	R	Warning – Process Supply Fluid Low Temperature
112	BOOL	Coil	R	Warning – Process Return Fluid High Temperature
130	BOOL	Coil	R/W	Hot Gas Bypass Manual Mode
131	BOOL	Coil	R	Hot Gas Bypass Active
140	BOOL	Coil	R/W	Electronic Expansion Valve Manual Mode
141	BOOL	Coil	R	Electronic Expansion Valve To Start Position
142	BOOL	Coil	R	Electronic Expansion Valve Startup Complete
143	BOOL	Coil	R	Electronic Expansion Valve Superheat Control Mode Active
144	BOOL	Coil	R	Electronic Expansion Valve MOP Control Mode Active
160	BOOL	Coil	R	Process Pump Enabled
161	BOOL	Coil	R	Process Pump Overload OK
170	BOOL	Coil	R	Recirculation Pump Enabled
171	BOOL	Coil	R	Recirculation Pump Overload OK
180	BOOL	Coil	R	Tank Low Fluid Level OK
181	BOOL	Coil	R	Tank Mid Fluid Level OK
182	BOOL	Coil	R	Tank High Fluid Level OK
183	BOOL	Coil	R	Tank Water Makeup Enabled
30001	REAL	Input Register	R	Controller Version
30003	INTEGER	Input Register	R	Controller Startup Time Remaining
30006	REAL	Input Register	R	Controller Processor Temperature
30020	REAL	Input Register	R	Refrigeration Suction Temperature
30022	REAL	Input Register	R	Refrigeration Suction Pressure
30025	REAL	Input Register	R	Refrigeration Suction Saturated Temperature
30027	REAL	Input Register	R	Refrigeration Superheat
30030	REAL	Input Register	R	Refrigeration Discharge Temperature
30032	REAL	Input Register	R	Refrigeration Discharge Pressure
30034	REAL	Input Register	R	Refrigeration Discharge Saturated Temperature
30036	REAL	Input Register	R	Refrigeration Subcooling
30038	REAL	Input Register	R	Refrigeration Liquid Temperature

Table 16 – Controller Modbus Registers (continued)

Modbus Register	Data Format	Type	Access Level	Description
30040	REAL	Input Register	R	Process Supply Fluid Temperature
30042	REAL	Input Register	R	Process Return Fluid Temperature
30044	REAL	Input Register	R	Process Delta Temperature
30050	REAL	Input Register	R	Evaporator Fluid Out Temperature
30052	REAL	Input Register	R	Evaporator Fluid Delta Temperature
30054	REAL	Input Register	R	Evaporator Flow
30058	REAL	Input Register	R	Chiller Capacity
30070	INTEGER	Input Register	R	Message Center
30090	REAL	Input Register	R	Refrigeration Discharge Control Percent
30100	REAL	Input Register	R	Hot Gas Bypass Control Percent
30110	REAL	Input Register	R	Electronic Expansion Valve Control Percent
30120	INTEGER	Input Register	R	Variable Speed Drive Actual Speed (RPM)
30122	INTEGER	Input Register	R	Variable Speed Drive Requested Speed (RPM)
30123	INTEGER	Input Register	R	Variable Speed Drive Demand Percent
30124	INTEGER	Input Register	R	Variable Speed Drive Bus Voltage
30125	INTEGER	Input Register	R	Variable Speed Drive AC Input Voltage
30126	INTEGER	Input Register	R	Variable Speed Drive AC Input Current
30127	INTEGER	Input Register	R	Variable Speed Drive AC Input Power
30128	INTEGER	Input Register	R	Variable Speed Drive Compressor Phase Current
30154	INTEGER	Input Register	R	Compressor 1 Anti-Cycle Time
30155	INTEGER	Input Register	R	Compressor 2 Anti-Cycle Time
30156	INTEGER	Input Register	R	Compressor 3 Anti-Cycle Time
30160	REAL	Input Register	R	Process Supply Pump Fluid Pressure
30162	REAL	Input Register	R	Process Supply Pump Control Percent
30182	REAL	Input Register	R	Modulating Valve Control Percent
40000	REAL	Holding Register	R/W	Chiller Setpoint
40026	INTEGER	Holding Register	R/W	Data Logging Sample Rate
40165	UDINT	Holding Register	R	Run Hours – Process Pump
40167	UDINT	Holding Register	R	Run Hours – Recirculation Pump
40205	UDINT	Holding Register	R	Run Hours – Compressor 1
40207	UDINT	Holding Register	R	Run Hours – Compressor 2
40209	UDINT	Holding Register	R	Run Hours – Compressor 3

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: 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 start-up.

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

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 three possible types of condenser present in the chiller: Integral air-cooled, water-cooled, or remote air-cooled. It is important to verify the chiller will have adequate condenser cooling for proper chiller operation.

Integral Air-Cooled Condenser Check

Verify the installation is as described in the mechanical installation section of this manual. Check to make sure the chiller condenser is clear of obstructions and has at least 36 inches of open air on the air inlet and outlets for proper airflow.

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 and all shut-off valves are open.

Remote Air-Cooled Condenser Check

Check the refrigerant lines to make sure all connections are secure and that a proper evacuation of the chiller, the field piping, and the remote condenser has occurred. Verify the installation of the refrigeration piping 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 possible valves where closed. Verify that all refrigerant valves are open.

CAUTION: Do not operate the unit with the compressor, oil line, or liquid line service valves closed. Failure to have these open may cause serious compressor damage.

Step 5 – Verify Freezestat Setting

Make sure the Freezestat setting is appropriate for the operating conditions of the chiller. The Freezestat setting is in a password-protected menu of the chiller controller. It should be set at 10°F below the minimum chilled water temperature setting that the chiller will be operating. Reference Table 18 to be sure the coolant solution has sufficient freeze protection (glycol) to handle at least 5°F below the Freezestat setting. All chillers ship from the factory with the Freezestat set at 38°F to

protect against a possible freeze-up if no glycol is in the coolant. Once the proper glycol solution is present, adjust the Freezstat 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

Some chillers may have a control power switch. If present, turn the control power switch on. If not present, turning the main power on should turn the control power on. When the control power is on, the panel displays are illuminated. Due to extreme ambient temperatures that may occur during shipment, the High Refrigerant Pressure switch may have tripped. If this is the case, disconnect the main power and reset the High Refrigerant Pressure by depressing the manual reset button located on the switch. Reconnect the main power, turn the control power on, and clear the alarm condition by pressing the Alarm Reset button.

Step 7 – Establish Coolant Flow

Standard units have an internal pump. To energize the pump press the Start button. If the unit does not have an internal pump, energize the external pump to establish flow through the chiller.

Note: The compressor will not start as long as the flow switch is open. A positive flow through the evaporator is required 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 require 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 – Intial Unit Operation

Enter the desired leaving fluid temperature on the control panel. 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.

Note: For chillers with the variable-speed compressor option operating under low load conditions with the compressor speed at its minimum, the hot gas system will maintain temperature 1° below setpoint.

WARNING: Never deactivate the High Refrigerant Pressure or the Low Compressor Pressure switch. Failure to heed this warning can cause serious compressor damage, severe personal injury, or death.

Note: For chillers with the variable-speed compressor option there is an initial startup routine that will run the compressor at a fixed speed for 2 minutes. After this routine the chiller will actively manage the system to maintain desired set point.

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. Indications of a shortage of refrigerant are low operating pressures or subcooling.

Normal subcooling ranges are from 10°F to 20°F. If it is not, 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, sub-cooling, and unit operating pressures. If both suction and discharge pressures are low but sub-cooling is normal, a problem other than refrigerant shortage exists. Do not add refrigerant, as this may result in overcharging the circuit.

After achieving proper flows and temperatures, press the Stop button. The unit is now ready for service.

Preventive Maintenance

Once your portable chiller is in service, follow the maintenance procedures shown below as closely as possible. 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 normally more than pay for it. The preventive maintenance checklist in this manual is a great way to log and keep track of maintenance.

Once a Week

1. (Air-Cooled Units Only) Check the surface of the air-cooled condenser coil for dirt and debris. To clean, rinse thoroughly with water and use a mild detergent to remove smoke and or grease stains.

2. Check to make sure that the To Process temperature is reasonably 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 the Customer Service Department.

3. Check the pump discharge pressure on the gauge on the back panel of the chiller. Investigate further if the pressure starts to stray away from the normal operating pressure.

4. Check the coolant level in the reservoir. Replenish if necessary making sure to take proper precautions to maintain the appropriate glycol concentration.

5. Check the coolant circulation pump for leaks in the seal area. Replace pump seal if necessary.

6. Check the refrigerant sight glass for air bubbles or moisture indication. If the sight glass indicates that there is a refrigeration problem, have the unit serviced as soon as possible.

Once a Month

Repeat items 1 through 6 listed above and continue with the following

7. With the main disconnect shut off and locked out, check the condition of electrical connections at all contactors, starters and controls. Check for loose or frayed wires.

8. Check the incoming voltage to make sure it is within 10% of the design voltage for the chiller.

9. Check the amp draws to each leg of the compressor (fans or blowers on air-cooled units) and pump to confirm that they are drawing the proper current.

Every Three Months

Repeat items 1 through 9 listed above and continue with the following.

10. Units are equipped with a Y-strainer between the return connection and the evaporator inlet. Remove and clean the strainer basket if necessary. This may be required more often if contaminants can easily get into the coolant.

11. Have a qualified refrigeration technician inspect the operation of the entire unit to ensure that everything is operating properly. Have the condenser cleaned out if necessary.

12. Ensure the variable speed drive remains dust-free and check the heat sink of the drive and make sure it and the ventilation fan of the drive are not gathering duct. Gently clean as necessary.

Preventive Maintenance Checklist

Maintenance Activity	Week Number												
	1	2	3	4	5	6	7	8	9	10	11	12	13
Date													
Clean Air Coils and Inlet Filters													
Temperature Control													
Pump Discharge Pressure													
Coolant Level													
Glycol Concentration													
Pump Seal													
Refrigerant Sight Glass													
Electrical Connections													
Incoming Voltage													
Compressor #1 L1 Amps													
Compressor #1 L2 Amps													
Compressor #1 L3 Amps													
Compressor #2 L1 Amps													
Compressor #2 L2 Amps													
Compressor #2 L3 Amps													
Pump L1 Amps													
Pump L2 Amps													
Pump L3 Amps													
Fan #1 L1 Amps													
Fan #1 L1 Amps													
Fan #1 L3 Amps													
Fan #2 L1 Amps													
Fan #2 L2 Amps													
Fan #2 L3 Amps													
Fan #3 L1 Amps													
Fan #3 L2 Amps													
Fan #3 L3 Amps													
Clean Y-Strainer													
Refrigerant Circuit Check													
Refrigerant Suction Pressure													
Refrigerant Discharge Pressure													
Refrigerant Superheat													

General Troubleshooting

Problem	Possible Cause	Remedy
Compressor will not start	Compressor overload	Check supply voltage, amperage of each leg, contactor and wiring, and overload set point
	Compressor contactor	Replace if faulty
	Compressor failure	Contact Customer Service for assistance
Pump will not start	Pump overload	Check supply voltage, amperage of each leg, contactor and wiring, and overload set point
	Pump contactor	Replace if faulty
	Pump failure	Replace if faulty
Low refrigerant pressure	Low refrigerant charge	Contact refrigeration service technician
	Refrigerant leak	Contact refrigeration service technician
	Low refrigeration pressure sensor	Check for proper range, replace if faulty
High refrigerant pressure	Dirty air filters (air-cooled units only)	Clean filters
	Air flow obstruction (air-cooled units only)	Make sure chiller is installed in accordance with recommendations in this manual
	High ambient air temperature (air-cooled units only)	Ambient temperature must be reduced below 110°F
	Condenser fan motor (air-cooled units only)	Replace if faulty
	Condenser fan cycling control (air-cooled units only)	Confirm proper operation, replace if faulty
	Plugged condenser (water-cooled units only)	Clean out tubes
	Insufficient condenser water flow (water-cooled units only)	Make sure chiller is installed in accordance with the recommendations of this manual
	High condenser water temperature (water-cooled units only)	Condenser water temperature must be reduced below 100°F
	Condenser water regulating valve	Check setting, replace if faulty
	Refrigerant circuit overcharged	Contact a refrigeration service technician
	High refrigerant pressure sensor	Replace if faulty
Freezestat	Low flow through evaporator	Adjust flow to proper level
	Freezestat control module	Check for proper setting (Protected Setting)
	Freezestat sensor	Replace if faulty
Low pump discharge pressure	Pump running backwards	Switch 2 legs of the incoming power
	Pump pressure gauge	Replace if faulty
	Pump failure	Replace if faulty
	Excessive flow	Reduce flow
High pump discharge pressure	Closed valves in process piping	Open valves
	Obstruction in piping or process	Remove obstruction
	Clogged Y-strainer	Clean strainer
	Pressure gauge	Replace if faulty
Erratic temperature control	Low coolant flow through evaporator	Adjust flow to proper level
	Intermittent overloading of chiller capacity	Check to make sure chiller is properly sized for process load
	Hot gas bypass valve	Contact refrigeration service technician
	Temperature sensor	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 too high or low	Adjust flow to proper level
	Insufficient condenser cooling	See “High Refrigerant Pressure”
	Hot gas bypass valve stuck open	Contact refrigeration service technician
	Refrigeration circuit problem	Contact refrigeration service technician
	Temperature sensor	Replace if faulty

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, please contact our Customer Service Department and reference the serial number of your unit.

Notes

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