



# Installation, Operation, and Maintenance

# Thermafit™ Modular Air-Source

# Multipipe

## Model MAS



### ⚠ SAFETY WARNING

Only qualified personnel should install and service the equipment. The installation, starting up, and servicing of heating, ventilating, and air-conditioning equipment can be hazardous and requires specific knowledge and training. Improperly installed, adjusted or altered equipment by an unqualified person could result in death or serious injury. When working on the equipment, observe all precautions in the literature and on the tags, stickers, and labels that are attached to the equipment.

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TRANE  
TECHNOLOGIES



# Introduction

Read this manual thoroughly before operating or servicing this unit.

## Warnings, Cautions, and Notices

Safety advisories appear throughout this manual as required. Your personal safety and the proper operation of this machine depend upon the strict observance of these precautions.

The three types of advisories are defined as follows:



Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.



Indicates a potentially hazardous situation which, if not avoided, could result in minor or moderate injury. It could also be used to alert against unsafe practices.



Indicates a situation that could result in equipment or property-damage only accidents.

## Important Environmental Concerns

Scientific research has shown that certain man-made chemicals can affect the earth's naturally occurring stratospheric ozone layer when released to the atmosphere. In particular, several of the identified chemicals that may affect the ozone layer are refrigerants that contain Chlorine, Fluorine and Carbon (CFCs) and those containing Hydrogen, Chlorine, Fluorine and Carbon (HCFCs). Not all refrigerants containing these compounds have the same potential impact to the environment. Trane advocates the responsible handling of all refrigerants.

## Important Responsible Refrigerant Practices

Trane believes that responsible refrigerant practices are important to the environment, our customers, and the air conditioning industry. All technicians who handle refrigerants must be certified according to local rules. For the USA, the Federal Clean Air Act (Section 608) sets forth the requirements for handling, reclaiming, recovering and recycling of certain refrigerants and the equipment that is used in these service procedures. In addition, some states or municipalities may have additional requirements that must also be adhered to for responsible management of refrigerants. Know the applicable laws and follow them.

### **⚠ WARNING**

#### **Proper Field Wiring and Grounding Required!**

Failure to follow code could result in death or serious injury.

All field wiring **MUST** be performed by qualified personnel. Improperly installed and grounded field wiring poses **FIRE** and **ELECTROCUTION** hazards. To avoid these hazards, you **MUST** follow requirements for field wiring installation and grounding as described in **NEC** and your local/state/national electrical codes.

### **⚠ WARNING**

#### **Personal Protective Equipment (PPE) Required!**

Failure to wear proper PPE for the job being undertaken could result in death or serious injury.

Technicians, in order to protect themselves from potential electrical, mechanical, and chemical hazards, **MUST** follow precautions in this manual and on the tags, stickers, and labels, as well as the instructions below:

- **Before installing/servicing this unit, technicians MUST put on all PPE required for the work being undertaken (Examples; cut resistant gloves/sleeves, butyl gloves, safety glasses, hard hat/bump cap, fall protection, electrical PPE and arc flash clothing). ALWAYS refer to appropriate Safety Data Sheets (SDS) and OSHA guidelines for proper PPE.**
- **When working with or around hazardous chemicals, ALWAYS refer to the appropriate SDS and OSHA/GHS (Global Harmonized System of Classification and Labelling of Chemicals) guidelines for information on allowable personal exposure levels, proper respiratory protection and handling instructions.**
- **If there is a risk of energized electrical contact, arc, or flash, technicians MUST put on all PPE in accordance with OSHA, NFPA 70E, or other country-specific requirements for arc flash protection, PRIOR to servicing the unit. NEVER PERFORM ANY SWITCHING, DISCONNECTING, OR VOLTAGE TESTING WITHOUT PROPER ELECTRICAL PPE AND ARC FLASH CLOTHING. ENSURE ELECTRICAL METERS AND EQUIPMENT ARE PROPERLY RATED FOR INTENDED VOLTAGE.**

**⚠ WARNING****Follow EHS Policies!**

Failure to follow instructions below could result in death or serious injury.

- All Trane personnel must follow the company's Environmental, Health and Safety (EHS) policies when performing work such as hot work, electrical, fall protection, lockout/tagout, refrigerant handling, etc. Where local regulations are more stringent than these policies, those regulations supersede these policies.
- Non-Trane personnel should always follow local regulations.

**⚠ WARNING****R-454B Flammable A2L Refrigerant!**

Failure to use proper equipment or components as described below could result in equipment failure, and possibly fire, which could result in death, serious injury, or equipment damage.

The equipment described in this manual uses R-454B refrigerant which is flammable (A2L). Use ONLY R-454B rated service equipment and components. For specific handling concerns with R-454B, contact your local representative.

**⚠ WARNING****Electrical Shock Hazard!**

Failure to follow instructions below could result in death or serious injury.

Properly connect the system's oversized protective earthing (grounding) terminal(s).

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## Trademarks

All trademarks referenced in this document are the trademarks of their respective owners.

## Product Safety Information

This appliance is not intended for use by persons (including children) with reduced physical, sensory or mental capabilities, or lack of experience and knowledge, unless they have been given supervision or instruction concerning use of the appliance by a person responsible for their safety. Children should be supervised to ensure that they do not play with the appliance.

Maximum altitude of use 3000 meters.

This appliance incorporates an earth connection for functional purposes only.



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# Model Number and Coding

When contacting Trane for technical support, customer service, or parts information, be prepared to provide the model number and serial number of the multipipe modules in question. This information is located on the nameplate that is affixed to each module.

## Multipipe Model and Serial Numbers

For future reference, record the model number and serial number for each module in the air-source multipipe system in the table below. Refer to the Trane nameplate on each module in the installed unit for the serial number and model number.

**Table 1. Air-source multipipe reference data**

Module	Model Number	Serial Number
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

### Model Number

Critical information for contacting Trane technical support. Reference to the actual multipipe module serial number may also be beneficial. Each module has its own unique serial number.

### Model Coding Key

Model numbers assigned to Trane systems provide a wealth of information about the features for a multipipes **as built** configuration.



# Air-Source Multipipe Description

## Multipipe Scope

This manual provides relevant data to properly operate, maintain, and troubleshoot the Trane MAS air-source modular multipipe. Operator and maintenance personnel must be a qualified refrigeration technician and have a working knowledge of high voltage systems, low voltage control circuits, and components and functions.

## Multipipe Capacities

The MAS multipipe model is available in 30 nominal ton capacity modules. A minimum of three and up to 10 modules may connect together in a standard primary/secondary control system. The system consists of a primary multipipe module that contains the primary microprocessor controller, the power distribution panel (if equipped), and one or more secondary modules. It is important to connect modules in the correct sequence as detailed in “Handling of the Modules,” p. 17.

The air-source multipipe uses independent single refrigeration circuits in each module with vapor injected scroll compressors. The brazed-plate heat exchanger is typically made of SAE Grade 316 stainless steel and 99.9% copper brazing materials. Standard interconnecting headers are composed of carbon steel.

## Vapor Injected Scroll Compressor



An enhanced vapor injection scroll compressor in a tandem set is provided on a single refrigeration circuit for greater heating performance in low ambient temperatures.

Single circuit, independent, cold and hot fluid brazed-plate heat exchanger is provided in each module each with oil level sight glass, suction gas-cooled motor with solid-state sensors in the windings for overload protection, and circuit breaker protection. There is a dual tandem compressor set in each module. Compressors are mounted to the formed sheet metal frame with rubber-in-shear vibration isolators.

## Load Heat Exchanger



The Thermafit™ MAS uses two single circuit, brazed-plate heat exchangers that function as an evaporator or condenser depending on the operational mode. They are constructed of 316 stainless steel plates and copper brazing and is insulated with 3/4-inch closed cell insulation. The supply and return fluid piping from each heat exchanger includes a manual and an electronic valve for servicing each module individually while the remaining modules continue to operate, to allow for variable flow. The fluid connections to each heat exchanger use roll-grooved couplings for service convenience and ease of installation.

Water quality must be monitored and maintained by a water treatment professional familiar with the materials of construction and operation of the equipment. As required under Federal regulations, installation, initial start-up, and technical servicing should only be performed by fully qualified personnel.

**⚠ WARNING**

**Hazardous Voltage!**

Failure to disconnect power before servicing could result in death or serious injury.

Disconnect all electric power, including remote disconnects before servicing. Follow proper lockout/tagout procedures to ensure the power can not be inadvertently energized. Verify that no power is present with a voltmeter.

## Component Description

Every multipipe module is comprised of four basic components: compressor, heat exchanger, expansion valve, and air coils. Each module contains one or more of these primary refrigeration components.



## Air-Source Multipipe Description

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### Air Coils and Fans

The air coils have aluminum fins mechanically bonded to copper tubes that functions as an evaporator or condenser depending on the operational mode. The coils are factory tested to a minimum of 600 psig.

The fan motors are maintenance free, highly efficient Electronically Commutated Motors (ECM) with energy-reduction capabilities. The fan motors vary speed to maintain the refrigeration head pressure.





# General Data

**Table 2. General data – Thermafit™ MAS air-source multipipe**

Capacity (Nominal Tons)	30
<b>Compressor</b>	
Type	Vapor Injected Scroll
Quantity	1 Tandem Set of 2 Compressors
<b>Refrigerant</b>	
R-454B Charge (lbs/module)	87
<b>Load Heat Exchanger</b>	
Type	Brazed Plate
Quantity	2
Fluid Volume (gal/BPHE)	3.45
Fluid Volume (gal/module)	33.2
Number of Circuits	1
<b>Fans</b>	
Motor Type	EC
HP	4.35
Fan Type	Axial
Air Flow (cfm/module)	23,000
<b>Air Coils</b>	
Fin Material	Aluminum
Fin/in (FPI)	12
Tube Material	Copper
Tube Diameter (mm)	0.375 (9.5)
Number of Rows	4
Coil Dimensions (qty)	40" x 88" (2)

# Unit Dimensions and Weights

Figure 1. MAS air-source multipipe - 30 tons

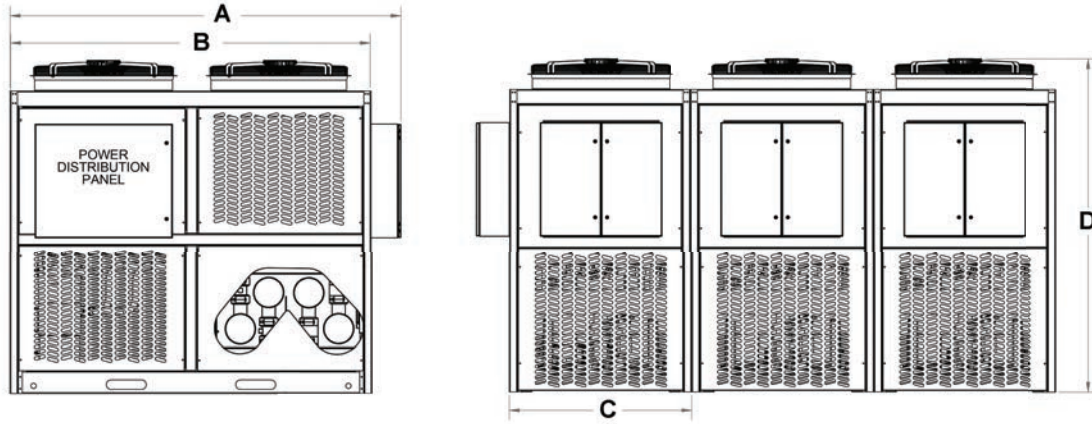


Table 3. Unit dimensions and weight - 30 tons (MAS)

Dim	Units	Unit Sizes and Weights Per Module
A	inch	103
B		95
C		48
D		90
Operating Weight	lbs	~3000



# Pre-Installation

## Unit Connections

See “[Connecting Module Power and Control Wires](#),” p. 20 to determine the method of the connection of this unit.

## Site Preparation and Clearances

Air-source multipipe modules be installed on a 4-inch tubing or a 6-inch I beams on a level surface that has been checked by a qualified structural engineer to support the weight of the fluid-filled modules and the connective piping to and from the multipipe. Installations must account for minimum service access clearances as may be practical or required by local building codes.

### Multipipe Clearances

One of the most critical factors affecting the performance of air-source multipipe is airflow above and around the modules. Walls, roofs, overhangs, and nearby mechanical heat sources can all degrade the systems performance. The further the multipipe is from such obstacles, the more efficiently it will operate.

### Minimum Clearances

The unit must maintain a minimum of 36 inches clearance on all sides. No obstructions are allowed above units. See [Figure 2](#), p. 12.

The air coils are designed for outdoor installation and must be mounted level on a roof or concrete slab that is strong enough to support the total equipment operating weight. Consult a professional structural engineer to determine safe mounting loads.

Unrestricted airflow must be provided to air coils. Avoid air recirculation from other nearby equipment. Locate the air coils away from building air vents and heat sources such as exhaust fans.

The unit should be located far enough away from any wall or other obstruction to provide adequate clearance for ambient air intake and discharge:

There should be no obstruction above the module to interfere with fan discharge of heated air. Even a partial overhang of an eave or awning can trap hot air and significantly degrade system performance.

Each module must be as far away from any wall or barrier as space allows. Sufficient clearance must be maintained between the modules and any walls or other objects that can interfere with the free flow of air to the air coils.

Screening fences must have 50% open surface area, with one foot of bottom clearance, and must not extend higher than the top of the fan grill. Modules must be a minimum of 36 inches away from any fence. Failure to follow these minimum requirements may result in performance degradation.

Modules located in a sub-level or pit require special considerations to avoid air recirculation.

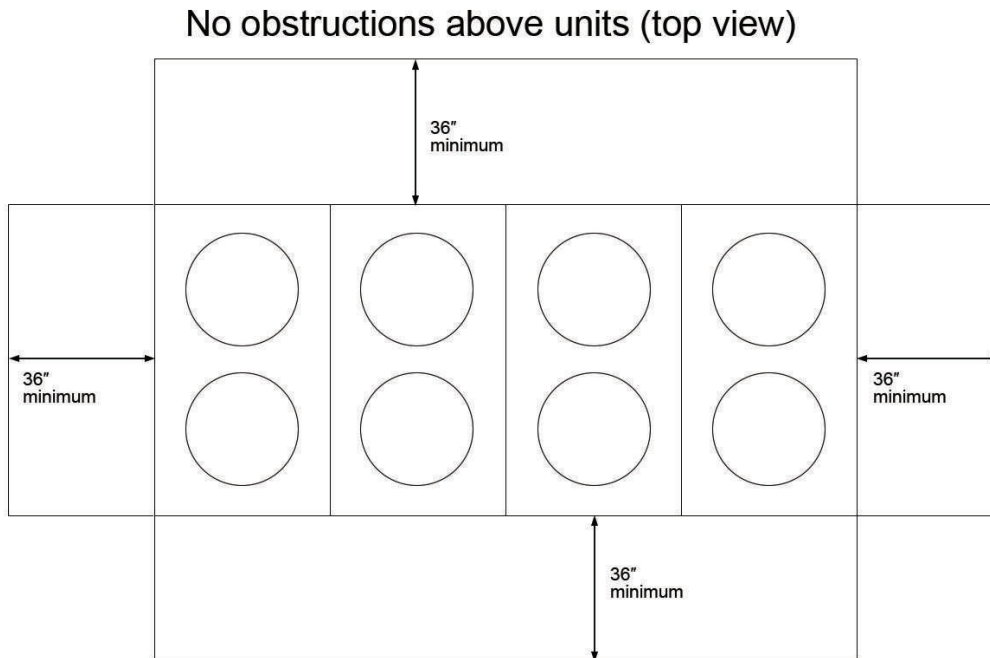
Do not attach ductwork to any fan or fan shroud.

If the desired location for the air-source multipipe is confined by walls, fences, overhanging roof eaves, or is located in a pit (sub-level site), contact Trane to discuss potential impact on equipment performance.

The National Electric Code or local, state, and regional building codes may require greater clearance for the equipment than the figures listed in this publication. Always consult local regulatory agencies to ensure additional clearances are not required by building codes.

### Service Access

Clearance must be maintained between the module and any nearby wall or impediment to provide sufficient room to open power distribution panel and electrical and control panel doors for routine maintenance and servicing. In general, 36 inches of space is required to allow panel doors to fully swing open and to meet local and national electrical codes. Compressors, filter-strainers, and liquid line shutoff valves are accessible on each side or end of each chiller.

**Figure 2. Recommended clearances**


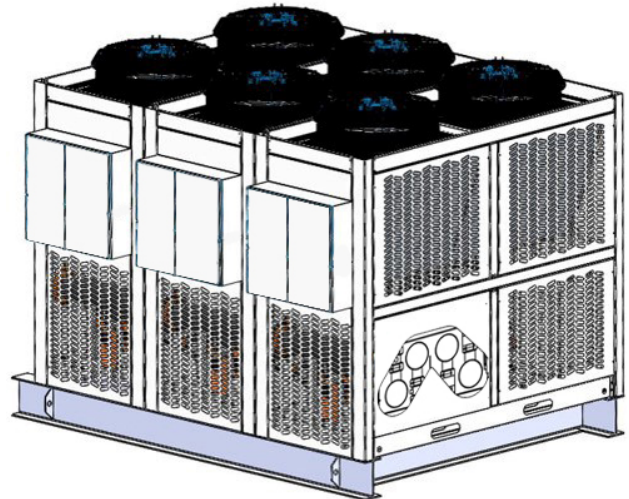
Note: If unit is surrounded by a fence, the minimum clearance is 36 inches. The fence must allow 50% airflow.

**Note:** These clearances are general recommendations. Each installation has specific considerations. Contact Trane for guidance.

## Mounting Rails

The equipment must be positioned on a firm, level surface. When modules are installed onto structural steel rails, the rails must be level such that the modules are properly aligned. Mounting rails must be a minimum of four inches wide. Custom modules may have different requirements. Consult submittal drawings to confirm dimensions. See [Figure 3, p. 12](#).

After setting and lubricating the mounting rails, begin installing the modules. All modules arrive with labels on the electrical and control panel. Review the installation drawings to determine which is the first, primary, module. Typically, the primary module also has the power distribution panel attached to it.

**Figure 3. Multipipe installation on mounting rails**


When installing modules directly on a concrete pad, spring isolators or rubber-in-shear isolator pads must be installed under the structural steel mounting rails for vibration isolation. After setting each module, remove front or rear access panels to improve access to components when making connections.



## A2L Work Procedures

### **⚠ WARNING**

#### **Risk of Fire — Flammable Refrigerant!**

Failure to follow instructions below could result in death or serious injury, and equipment damage.

- To be repaired only by trained service personnel.
- Do not puncture refrigerant tubing.
- Dispose of properly in accordance with federal or local regulations.

### **⚠ WARNING**

#### **Refrigerant under High Pressure!**

Failure to follow instructions below could result in an explosion which could result in death or serious injury or equipment damage.

System contains refrigerant under high pressure. Recover refrigerant to relieve pressure before opening the system. See unit nameplate for refrigerant type. Do not use non-approved refrigerants, refrigerant substitutes, or refrigerant additives.

### **⚠ WARNING**

#### **Hazardous Voltage!**

Failure to disconnect power before servicing could result in death or serious injury.

Disconnect all electric power, including remote disconnects before servicing. Follow proper lockout/tagout procedures to ensure the power can not be inadvertently energized. Verify that no power is present with a voltmeter.

The units described in this manual use R-454B refrigerant. Use ONLY R-454B rated service equipment or components with these units. For specific handling concerns with R-454B, contact your local Trane representative.

Installation, repair, removal, or disposal should be performed by trained service personnel.

At all times, Trane's maintenance and service guidelines shall be followed. If in doubt, contact Trane technical support for assistance.

## Serviceing

Prior to initiating work on equipment, check the area with an appropriate refrigerant detector. Ensure the service personnel are properly trained regarding work in potentially toxic or flammable atmospheres. Ensure that the leak detection equipment being used is suitable for use with all applicable refrigerants, i.e. non-sparking, adequately

sealed, or intrinsically safe. Be aware that the refrigerant does not contain an odor.

If any hot work is to be conducted on the refrigerating equipment or any associated parts, appropriate fire extinguishing equipment shall be available on hand. A dry powder or CO<sub>2</sub> fire extinguisher should be located adjacent to the charging area.

At all times, Trane's maintenance and service guidelines shall be followed. In in doubt, contact Trane technical support for assistance.

All maintenance staff and others working in the local area shall be instructed on the nature of the work being carried out. Work in confined spaces shall be avoided.

## Ignition Source Mitigation

Do not use any sources of ignition when working on the refrigeration system.

Keep all ignition sources, including cigarette smoking, away from the site of installation, repair, removal or disposal, during which refrigerant can potentially be released to the surrounding space.

Survey the area around the equipment before initiating work to ensure no flammable hazards or ignition risks are present.

"No Smoking" signs shall be displayed.

Do not use devices that can be a source of ignition to accelerate defrosting of components. Use only defrost and cleaning procedures recommended by Trane. Do not pierce or burn.

## Ventilation

Ensure that the area is in the open or that it is adequately ventilated before breaking into the system or conducting any hot work. A degree of ventilation shall continue during the period that the work is carried out. The ventilation should safely disperse any released refrigerant and preferably expel it externally into the atmosphere. If present, check that the ventilation system, including outlets, are operating adequately and are not obstructed.

## Refrigerating Equipment

Refrigerant piping or components should not be installed in locations where substances which may corrode them are present.

Check that equipment hazard markings are visible and legible. Replace them if they are not.

For equipment using secondary fluids, like water or glycol, check that refrigerant is not present in the secondary fluid loop before conducting any hot work.

## Electrical Devices

Do not apply power to the circuit if a fault exists which compromises safety. If the fault cannot be corrected



## A2L Work Procedures

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immediately, but it is necessary to continue operation, an adequate temporary solution shall be used. This shall be reported to the owner of the equipment, so all parties are advised.

Initial safety checks shall include:

- Cabling is not subject to wear, corrosion, excessive pressure, vibration, sharp edges, or any other adverse environmental effects. Account for the effects of aging or continual vibration from sources such as compressors or fans.
- Capacitors are discharged. This shall be done in a safe manner to avoid possibility of sparking.
- No live electrical components and wiring are exposed while charging, recovering, or purging the system.
- Verify continuity of earth bonding.
- Replace electrical components with Trane replacement parts, or those meeting the same ratings and qualified for flame arrest protection, UL LZGH2 category.

### Leak Detection

Never use an open flame to detect leaks. A halide torch should not be used. Use only approved leak detection methods per this instruction manual.

The following leak detection methods are deemed acceptable for all refrigerant systems.

Electronic leak detectors may be used to detect refrigerant leaks but, in the case of flammable refrigerants, the sensitivity may not be adequate, or may need re-calibration. (Detection equipment shall be calibrated in a refrigerant-free area.) Ensure that the detector is not a potential source of ignition and is suitable for the refrigerant used. Leak detection equipment shall be set at a percentage of the LFL gas (25% maximum) is confirmed.

Leak detection fluids are also suitable for use with most refrigerants but the use of detergents containing chlorine shall be avoided as the chlorine may react with the refrigerant and corrode the copper pipe-work.

Examples of leak detection fluids are:

- Bubble method
- Fluorescent method agents

If a leak is suspected, all naked flames shall be removed/ extinguished.

If a refrigerant leak is found which requires brazing, all refrigerant shall be recovered from the system, or isolated (by means of shut off valves) in a part of the system remote from the leak.

### Refrigerant Removal and Evacuation

When breaking into the refrigerant circuit to make repairs – or for any other purpose – conventional procedures shall be used. However, for flammable refrigerants it is important

that best practice be followed, since flammability is a consideration.

The following procedure shall be adhered to:

1. Safely remove refrigerant following local and national regulations.
2. Evacuate.
3. Purge the circuit with inert gas.
4. Evacuate (optional for A2L).
5. Continuously flush or purge with inert gas when using flame to open circuit.
6. Open the circuit.

Prior to refrigerant removal, open all appropriate valves, including solenoid and electronic expansion valves (EXVs). Use control settings, where available. When not available, manually open all electronically controlled valves using acceptable service procedures.

The recovery equipment shall be in good working order with instructions available. Equipment shall be suitable for the recovery of the flammable refrigerant. For specific handling concerns, contact the manufacturer. Ensure all hose connections are checked for tightness to avoid refrigerant leaks.

The refrigerant shall be recovered into the correct recovery cylinders if venting is not allowed by local and national codes. Do not mix refrigerants in recovery unit and especially not in cylinders.

Refrigerant recovery unit should be purged with an inert gas after each use or before using with a different refrigerant Class – for example, A2L to A1.

If compressors or compressor oils are to be removed, ensure that they have been evacuated to an acceptable level to make certain that flammable refrigerant does not remain within the lubricant. The compressor body shall not be heated by an open flame or other ignition sources to accelerate this process. When oil is drained from a system, it shall be carried out safely.

The system shall be purged with oxygen-free nitrogen to render the appliance safe for flammable refrigerants. This process might need to be repeated several times. Compressed air or oxygen shall not be used for purging refrigerant systems.

The system shall be vented down to atmospheric pressure to enable work to take place.

The outlet for the vacuum pump shall not be close to any potential ignition sources, and ventilation shall be available.

### Refrigerant Charging

In addition to conventional charging procedures, the following requirements shall be followed.

- Ensure that contamination of different refrigerants does not occur when using charging equipment.
- Hoses or lines shall be as short as possible to minimize the amount of refrigerant contained in them.

- Cylinders shall be kept in an appropriate position according to the instructions.
- Ensure that the refrigerating system is earthed prior to charging the system with refrigerant.
- Label the system when charging is complete (if not already).
- Extreme care shall be taken not to overfill the refrigerating system.

Prior to recharging the system, it shall be pressure-tested with the appropriate purging gas. The system shall be leak-tested on completion of charging but prior to commissioning. A follow up leak test shall be carried out prior to leaving the site.

Prior to refrigerant charging, open all appropriate valves, including solenoid and electronic expansion valves (EXVs). Use control settings, where available. When not available, manually open all electronically controlled valves using acceptable service procedures.

## Decommissioning

Before carrying out the decommissioning procedure, it is essential that the trained service personnel is completely familiar with the equipment and all its details. It is recommended good practice that all refrigerants are recovered safely. Prior to the task being carried out, an oil and refrigerant sample shall be taken in case analysis is required prior to re-use of recovered refrigerant. It is essential that electrical power is available before the task is commenced.

1. Become familiar with the equipment and its operation.
2. Isolate system electrically.
3. Before attempting the procedure, ensure that:
  - a. Mechanical handling equipment is available, if required, for handling refrigerant cylinders.
  - b. All personal protective equipment is available and being used correctly.
  - c. The recovery process is supervised at all times by a competent person.
  - d. Recovery equipment and cylinders conform to the appropriate standards.
4. Pump down refrigerant system, if possible.
5. If a vacuum is not possible, make a manifold so that refrigerant can be removed from various parts of the system.
6. Make sure that cylinder is situated on the scales before recovery takes place.
7. Start the recovery machine and operate in accordance with instructions.
8. Do not overfill cylinders (no more than 80% volume liquid charge).
9. Do not exceed the maximum working pressure of the cylinder, even temporarily.
10. When the cylinders have been filled correctly and the process completed, make sure that the cylinders and the equipment are removed from site promptly and all isolation valves on the equipment are closed off.
11. Recovered refrigerant shall not be charged into another refrigerating system unless it has been cleaned and checked. When equipment has been decommissioned, attach a signed label which includes the date of decommissioning.
12. When equipment has been decommissioned, attach a signed label which includes the date of decommissioning.



# Installation Mechanical

## Inspect and Report Damage

Upon receipt, inventory the shipment against the Trane bill of lading to ensure all modules and components have been delivered.

Inspect each package in the shipment for visible damage. Verify the correct model number and that all skids and cartons have been delivered. Any damage must be reported to the motor carrier and Trane within five days of receipt of the shipment.

Inspect all exterior components for concealed damage as soon as possible. Do not proceed with the installation of damaged equipment without prior approval of Trane.

Do not refuse delivery of damaged goods without prior authorization.

## Inspection of Delivered Equipment

To report damage incurred in transit, complete the following:

1. Inspect each piece of equipment for visible damage before accepting delivery. Check for torn cartons, broken skids, bent metal and torn shrink wrap.
2. Ensure the delivery driver notes any damage on the bill of lading and completes a Carrier Inspection Report. Failure to comply may result in difficulties in resolving any claims for damage.
3. Inspect each piece of equipment for concealed damage before storage or as soon as possible after delivery.
4. In the event of suspected concealed damage, ask the driver to wait until you inspect the equipment. Concealed damage must be reported within five days of receipt of equipment.
5. If concealed damage is found, stop unpacking the shipment. Do not remove damaged material from the receiving location, take photos of the damage. The owner must provide reasonable evidence that the damage did not occur after delivery.
6. Notify the carrier of the damage as soon as possible. Request an immediate joint inspection by the carrier and consignee. A determination of responsibility will be made and the carrier will authorize repairs in the event of admission of fault.
7. Notify your local Trane CSO immediately. Trane will coordinate repairs with the carrier. Do not attempt to make repairs locally without permission.

## Warranty Issues

Trane is not responsible for damages or for filing damage claims. It is the customers responsibility to ensure that the necessary long term storage procedures have been completed and any deviations are reported to Trane immediately.

## Long Term Storage Requirements

Appropriate preparation and storage of Trane air-source multipipe components during extended periods of dormancy is essential to ensure the equipment does not sustain damage or degradation due to inactivity and operates properly after installation.

The customer must notify Trane during the sales process that the multipipe system may be transported by ocean freight or placed in long-term storage under any of these conditions:

- The equipment will not be placed into operation for a period exceeding six months after leaving the Trane factory. That is, the initial start-up date will not occur within a six-month maximum dormancy window.
- The system will be shipped using ocean transit for all or part of the delivery process.
- Cold temperature storage conditions fall below -20 °F (-29 °C).
- Ambient temperatures from -4°F (-20 °C) to 145°F (63 °C) with relative humidity from 0% to 100%.
- The glycol should be removed from the multipipe if the unit is to be stored for extended periods.

## Factory Preparation

Upon confirmation of an order requiring long-term storage or protection against extreme environments, Trane will inspect and protect vendor-supplied components before installation.

Prior to shipment, Trane will prepare each multipipe system for long-term storage in coastal or tropical environments by:

- Placing silica gel packs in all electrical panels and variable speed drive panels to prevent corrosion of electrical contacts and moisture from degrading sensitive controllers.
- Shrink-wrapping equipment using polyethylene film to limit environmental exposure and protect the system from damage during shipping.
- For multiple modular system assemblies shipped on a common skid, shrink wrap the entire skid rather than the individual modules.

Trane will document and photograph the status of the unit prior to shipment and carry out the instructions detailed in the factory order regarding in-shop preparation of units for long-term storage.

## Customer Responsibilities

Upon receipt of the equipment, the customer must conduct thorough internal and external inspections, removing packaging material as needed for access to all components.



Visible damage must be noted on the signed and dated bill of lading. The customer may request a carrier inspection by telephone or in person, but any such request should be confirmed in writing. It is recommended that the customer request that the carrier inspect the damage within 72 hours of notification.

The customer must store the system in a dry, non-corrosive, dust- and vibration-free environment due to the exposure sensitivities of the microprocessor controllers and to prevent electrical terminations from deteriorating from non-use. Conditions in storage locations should not fall below -20 °F (-29 °C) or exceed 150 °F (66 °C).

Components sealed in plastic shrink-wrap are not exempt from these storage requirements. Moisture can potentially collect inside the plastic film, resulting in corrosion of the cabinet and electronic components. Any packaging that is removed from the equipment must be replaced with similar protective covering as soon as possible.

Failure to adhere to these long-term storage requirements may void the Trane warranty. Any component that is damaged or inoperable due to improper storage may have its warranty voided.

## Handling of the Modules

The packaging from the factory permits lifting with a suitable crane. Ensure straps are in good working condition and that they are rated for the weight of the machines. Spreader bars may be required for effective rigging and to avoid damage to the multipipe modules.

The modules arrive fully charged with refrigerant. As required under Federal regulations, installation, start-up, and service should be performed by fully-qualified, factory-certified personnel.

**Note:** *Damage from improper handling will not be covered by warranty.*

### **⚠ WARNING**

#### **Proper Field Wiring and Grounding Required!**

**Failure to follow code could result in death or serious injury.**

**All field wiring MUST be performed by qualified personnel. Improperly installed and grounded field wiring poses FIRE and ELECTROCUTION hazards. To avoid these hazards, you MUST follow requirements for field wiring installation and grounding as described in NEC and your local/state/national electrical codes.**

### **⚠ WARNING**

#### **Electrical Shock, Explosion, or Arc Flash Hazard!**

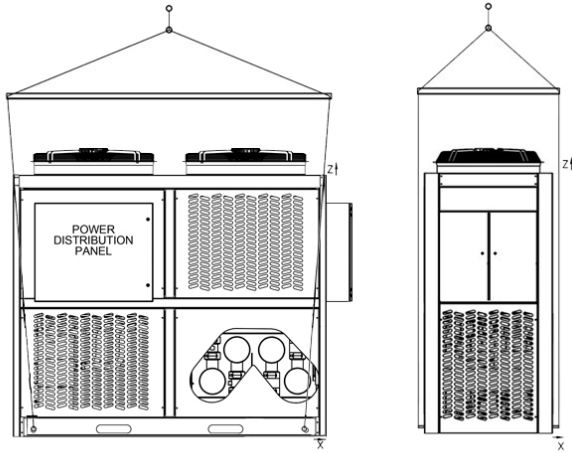
**Failure to follow these instructions could result in death or serious injury.**

- **Install the product in an appropriate electrical/fire enclosure per local regulations. Do not install the product in hazardous or classified locations.**
- **Do not use the product for life or safety applications.**
- **Do not exceed the product ratings or maximum limits. Products rated only for basic insulation must be installed on insulated conductors.**
- **Current transformer secondaries (current mode) must be shorted or connected to a burden at all times.**
- **Remove all wire scraps, tools, replace all doors, covers and protective devices before powering the equipment.**

## Rigging, Lifting, and Moving the Multipipe

The air-source multipipe can be delivered to the customers site as individual modules. Limitations on the methods and materials that can be used to rig, lift, or move a multipipe system or an individual module include:

- Maintain the module in an upright position at all times.
- Certain configurations of modules can be top-heavy. Move modules slowly with consideration for each modules center-of-gravity.
- Rig, lift, and move by strapping and lifting using a properly configured floor jack or fork lift or by overhead means.
- Position lifting beams or spreader beams to prevent lifting straps from rubbing or contacting module side panels or electrical boxes. Attach rigging bar on each end of module where 1 3/8-inch holes are provided.
- Do not use cables, chains, or any other type of metalized strapping to lift a module.
- Do not push a module while directly in contact with the floor using manual or mechanical means.

**Figure 4. Recommended multipipe rigging**



# Installation Piping

## Install Piping and External Components

Proper support of piping and pipe hangers must consider the weight of the piping as well as the water weight inside the pipes. A 40-mesh screen strainer must be installed in each fluid system piping inlet for proper filtration and protection of the heat exchangers. Connect fluid piping with factory supplied roll grooved connections and insulate connections after assembly.

## Initial Flushing of Piping

After installation of system piping and before connection to the air-source multipipe system, it is important to clean and remove debris, weld slag, and other contamination deposited during fabrication of the piping system.

**Important:** Do not flush through the modules.

Typical flushing includes hot water with mild detergent followed by a dilute phosphoric acid solution until all visible residue is removed.

Only cleaning liquids, acids, and detergents compatible with SAE Grade 316 stainless steel, copper, and carbon steel should be used. Consult a professional water treatment specialist when in doubt.

Flushing should take place across a filter/strainer with a maximum 30 mesh screen and continue for a minimum of six hours with frequent removal of the screen to capture residue or until the strainer is clean.

After detergent and chemical cleaning, flush the water piping with fresh water for one hour to remove any remaining cleaning compounds.

## Fill with Water/Glycol Solution

The installing contractor is responsible for charging glycol into the equipment's hydronic system.

1. Mix the concentrate of propylene glycol in a tank or drum for transfer into the multipipe. Use [Table 10, p. 43](#) to determine the appropriate glycol concentration for the system.
2. Mix the glycol and water externally before filling the unit to prevent clogging of the piping with a heavy concentrate.

Only after the above steps have been completed should the water piping be connected to the air-source multipipe system.

## Dowfrost

**Important:** Dowfrost inhibited propylene glycol-based solution is listed as chemically acceptable by the US Department of Agriculture (USDA). The two ingredients in Dowfrost water/glycol mixture are generally recognized by the FDA as safe food additives under Parts 182 and 184 of the Food Additive Regulations.

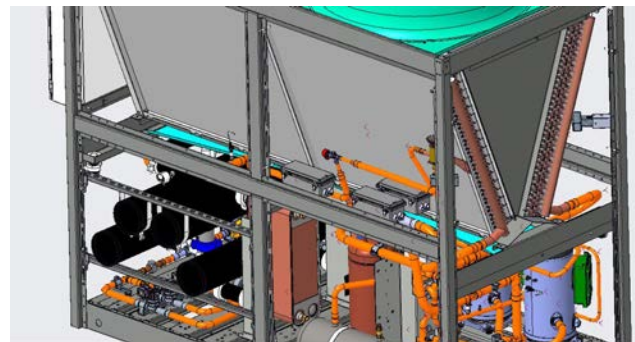
## Connecting Module Couplings

Install each module according to its position number indicated on its electrical distribution cabinet. Install the primary module first. Each secondary module has the same installation procedure as the previous module.

## Drain Pans

The drain pan collects the water from the coil during defrost mode and diverts it to two drain tubes in each module. The drain tubes should be manifolded together by the customer and discharged to a local roof drain or other suitable drainage system to eliminate water and ice buildup near the unit. Drain pan comes with 1-inch PVC connections for field piping.

**Note:** Drain pan heat tracing or heat tape application is required in ambient subject to freezing.





# Installation Electrical

## Connecting Module Power and Control Wires

Connections are typically made at the power distribution panel located on one end of the system.

Labeled control and communication cables are coiled inside each module and are connected to an Ethernet switch. The Ethernet cable turns from the switch to each module's microprocessor controller at the J30 connector.

This unit is equipped with a flow switch. The multipipe will not run unless the pump is circulating fluid through the system.

Customer-installed incoming disconnect switches should be designed for all pole disconnection and should be able to disconnect during overvoltage category III.

### **⚠ WARNING**

#### **Proper Field Wiring and Grounding Required!**

**Failure to follow code could result in death or serious injury.**

**All field wiring MUST be performed by qualified personnel. Improperly installed and grounded field wiring poses FIRE and ELECTROCUTION hazards. To avoid these hazards, you MUST follow requirements for field wiring installation and grounding as described in NEC and your local/state/national electrical codes.**

## Multipipe Module Main Power

Modular systems feature single-point power connection from the utility service to the power distribution panel on the primary module as standard. Main power phases A, B, and C are connected to terminals A, B, and C respectively from left to right. Some systems have individual power supplied to each module in lieu of single point power.

## Phase Monitor Installation

The air-source multipipe is equipped with a phase monitor on the power distribution panel. It communicates with the primary microprocessor controller on the primary module electrical and control panel via the ID8 terminal. Ensure that the wiring from the primary microprocessor controller and terminal blocks to the phase monitor are connected and secure.

The phase monitor continuously monitors each of the three phases. The microprocessor receives input from the phase monitor indicating whether the voltage is within acceptable values. The phase monitor is designed to protect against under-voltage, voltage imbalance, phase loss, and phase reversal.

Set voltage adjustment knob at the desired operating line voltage for the equipment. This adjustment automatically

sets the under-voltage trip point. Check the phase monitor after initial start-up. If it fails to energize, (the LED glows red or blinks) check the wiring of all three phases, voltage, and phase sequence. If phase sequence is incorrect, the LED flashes green/red. To correct this, swap any two line voltage connections at the mounting socket. No further adjustment should be required.

## Optional Disconnect Switch

Some air-source multipipe systems are optionally equipped with a panel-mounted disconnect switch installed on the outside of the power distribution panel. The disconnect switch must be turned to the off position before the panel can be opened for service.

### **⚠ WARNING**

#### **Hazardous Voltage!**

**Failure to disconnect power before servicing could result in death or serious injury.**

**Disconnect all electric power, including remote disconnects before servicing. Follow proper lockout/tagout procedures to ensure the power can not be inadvertently energized. Verify that no power is present with a voltmeter.**

## Single Point Connections

1. Open the power distribution panel. Power cable holes are accessible from inside module.
2. Remove cable strain relief from back of cabinet, feed cable end through strain relief.
3. Feed cable end through left most open cable access hole.
4. Push conduit sleeve to engage strain relief. Re-attach strain relief and tighten.
5. Attach and tighten cable ends to its numbered breaker. Each wire is labeled 1, 2, and 3.
6. After installing the cable, attach conduit to a frame member near the coil using a wire tie.
7. Attach ground to lug/bar inside cabinet. Tighten after all grounds have been run.
8. Control wires are in series. Attach the control wires to the correct module microprocessor.
9. Feed control wire through rear of cabinet of the next module control cabinet. Note labels.
10. Connect the Ethernet cable to the J30 port on the microprocessor.

## Module Control Wiring

The primary controller communicates with the secondary controller in each multipipe module via a communication circuit. Each secondary controller via an Ethernet cable

wired to the Ethernet switch is typically in the primary module.



## Operating Principles

A typical HVAC system has a cooling requirement in summer and shoulder seasons and a heating requirement in winter and shoulder seasons. Often there is both a simultaneous heating and cooling demand to satisfy all of which are within the functional capability of an MAS modular system. MAS uses an air coil and the ambient as a heat source and heat sink when the system is in heating only and cooling only modes respectively. An integral brazed-plate evaporator and brazed-plate condenser is used to simultaneously heat and cool.

The ambient air provides heat source in heating mode where the air coil operates as an evaporator and a heat sink in cooling mode when the air coil operates as a condenser.

When the HVAC system demands switches between heating, cooling, and simultaneous modes, refrigerant is redirected to the appropriate heat exchanger loops to satisfy the required heating or cooling requirement.

The system can be sized for the greater of the cooling or heating demand.

When the smaller of the demands is operating, all modules are likely not being used thereby saving energy costs and improving efficiency. This allows for the non-operating modules to be on standby if any of the operating modules require servicing.

When operating in heating mode in colder climates, frost may form on the air coils. The MAS module will periodically defrost the coils by redirecting the refrigerant to operate in cooling mode.

Modules are sequentially defrosted to minimize the impact to heating capacity.

The defrost cycle must be considered when sizing the hydronic system volume to ensure heating supply capacity.

Adequate system fluid volume is an important system design parameter because it provides for stable fluid

temperature control and helps limit unacceptable short cycling of compressors.

A minimum of 50 times a module's nominal capacity or four-minute full load water circulation, whichever is greater, is the recommended fluid system volume. So, as an example, for five 30 nominal ton bank,  $30T \times 50 = 1,500$  gallons. Assuming 2.4 gpm per ton for full load flow rate,  $150 \times 2.4 \times 4 = 1,440$  gallons. So, the greater value of 1,500 gallons is recommended.

Ensure the system fluid volume equals or exceeds the minimum required.

For systems with a rapidly changing load profile, the volume should be increased beyond the minimum.

If the installed system volume does not meet the above recommendations, a buffer tank should be installed in the return fluid piping.

If there is not a sufficient volume of fluid in the system to provide an adequate buffer, temperature control can suffer resulting in erratic system operation and excessive compressor cycling.

The situation can be more significant during the heating only mode when individual modules switch to defrost mode.

The modules in defrost mode operate in cooling only mode thereby cooling down the circulating hot fluid, increasing the heating demand, and causing a drop in the system hot fluid temperature.

The defrost cycle can take 3 to 5 minutes to complete.

The multipipe system temperature control sensors are located in the evaporator and condenser inlet and outlet fluid pipe connections to the building.

This location allows the building piping system volume to act as a buffer to slow the rate of change of the system fluid temperature.

# Operating Procedures

## Operator Interface

The modular air-source systems, whether they are composed of three modules or up to 10, are automated systems that use a main electrical panel to monitor, report, and modify critical system functions.

## Multipipe Power Panels

There are two different electrical panels used in the air-source multipipe system. The main power distribution panel receives power from the building source and distributes it to individual modules. The electrical and control panel on each secondary module receives power from the power distribution panel that powers the individual electrical components.

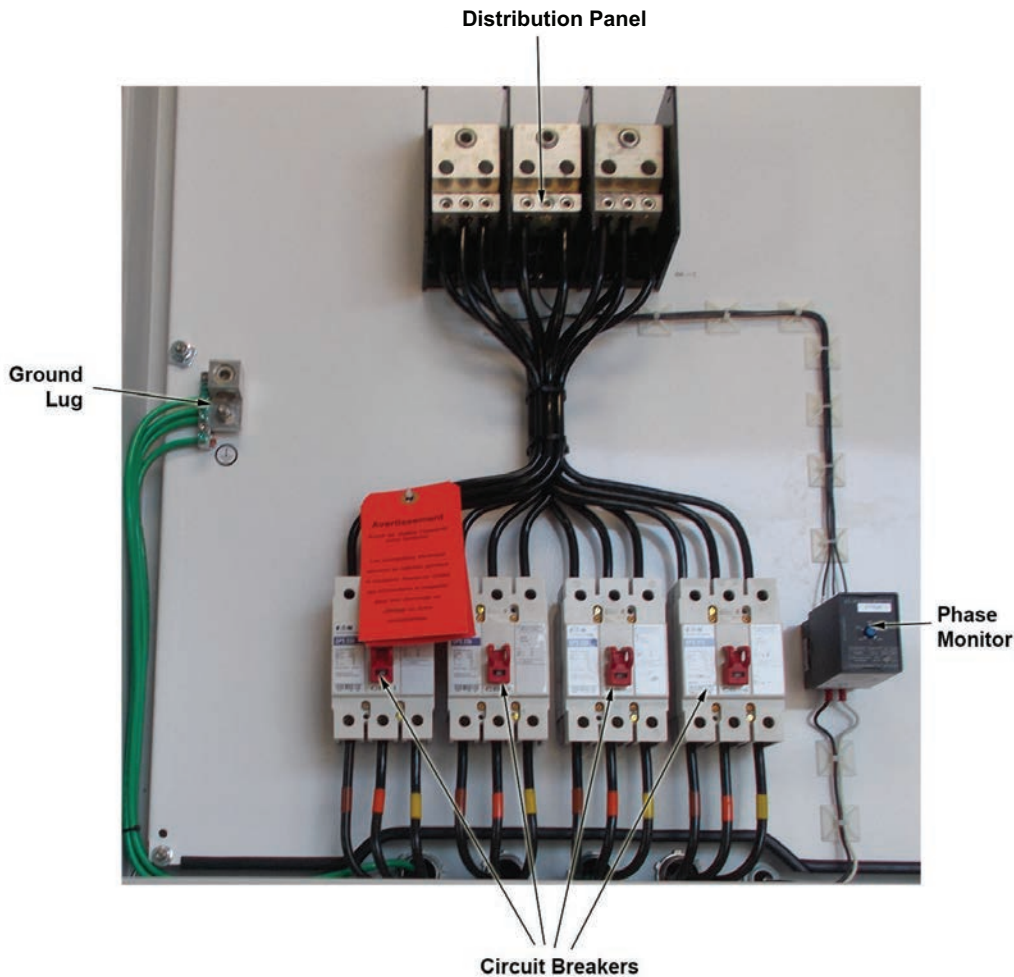
## Panel-Mounted Disconnect Switch

Some systems are optionally equipped with a panel-mounted disconnect switch installed on the outside of the power distribution panel (or on each module's electrical and control panel if the multipipe has power supplied to each individual module). The disconnect switch must be turned to the OFF position before the panel can be opened for service. When the panel door is open, the power is disengaged.

## Power Distribution Panels

The power distribution panel receives power from the building source and distributes it to individual modules. It also houses a circuit breaker for each module, a phase monitor, and an optional main power disconnect switch. See following figure.

Figure 5. Power distribution panel





## Module Electrical and Control Panel

The electrical and control panel receives power from the power distribution panel and provides power to the individual electrical components in that module. Each module has its own high voltage electrical panel and low voltage control panel that distributes electricity to individual components. It also has fuses and breakers and microprocessor controller.

## Electronic Control

The modular air-source multipipe models use Carel c.pCO series microprocessor controllers to monitor and report critical operating parameters. See [Figure 7, p. 24](#). A primary controller is used to control and coordinate the functioning of all secondary modules that make up the system. Each secondary module has its own controller.

There are five BMS communication options:

**Note:** BMS is not included as standard, but available as an option.

1. BACnet® MS/TP - Connection through built-in BMS2 port.
2. BACnet IP - BACnet router is used.
3. Modbus® RTU - Connection through built-in BMS2 port.
4. Modbus IP - Modbus router is used.
5. LonWorks® - LonWorks router is used.

## Controllers

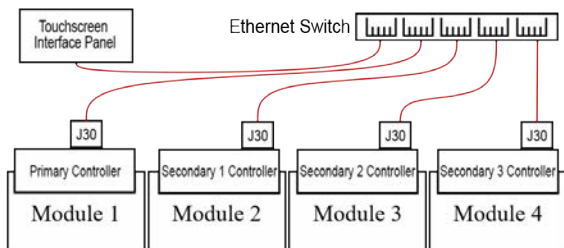
The distributed primary microprocessor control system enables all secondary modules to operate independently in the event that the primary microprocessor controller fails. All multipipe safeties including temperature set point, refrigerant pressures, and freeze protection are preserved.

In a normal configuration, a secondary controller controls the single module to which it is dedicated.

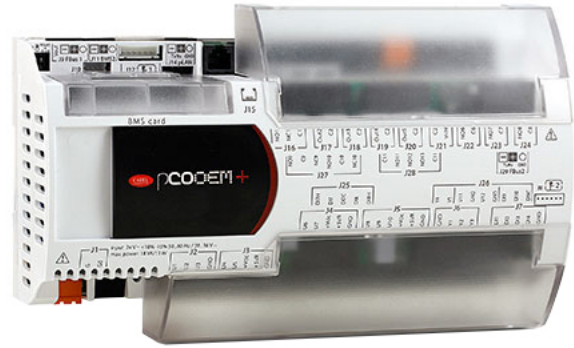
The secondary controller monitors key performance parameters for its module and sends real-time information to the primary controller. The primary controller monitors the performance of the system, activating and deactivating modules as needed to maintain the leaving fluid temperature for the air-source multipipe system.

See the following figure for a simplified example of a typical microprocessor controller network.

**Figure 6. Typical controller network**



**Figure 7. Carel medium c.pCO primary controller**



## Operating the Microprocessor

The touchscreen interface panel is ready to use when it is connected to the Ethernet switch and the multipipe power is ON.

Upon initial start-up, the status line will indicate that the system is OFF. Press and hold the ON/OFF button on the touchscreen interface panel for a few seconds to turn the system ON.

Press and hold ON-OFF button to toggle the multipipe ON and OFF.

## Microprocessor Functions

For practical purposes, all essential control information and operator actions are read and responded to using the touchscreen interface panel. The touchscreen interface panel is connected to the primary microprocessor controller and is the only way to access many primary controller functions.

### NOTICE

#### **Component Damage!**

**Failure to follow instructions could damage sensitive electronic components beyond repair.**

**To prevent arcing or surges of electrical current, do not use wires or cables to jump components or bypass the manufacturer's safety systems.**

## Password Protection

There are three levels of access to the functions displayed on the interface. The basic level, 'user,' does not require a password. The higher access levels are the technician ('tech') and administrator ('admin') levels that can only be accessed by Trane technical personnel. Contact Trane technical support regarding the possibility of any potential issues involving the higher-level functions.

## Operator Control

A touchscreen interface panel is the primary means for the operator or maintainer to monitor and modify a host of



functions involving temperatures, pressures, set points, alarms, operating schedules, elapsed operating hours, etc. This touchscreen interface panel can be located within proximity of the primary microprocessor controller. It is typically located in the primary module.

The touchscreen interface is connected to and communicates with all module controllers via the Ethernet switch. It accesses overall system functions and settings as well as individual module settings.

In this manual, all functions, procedures, checklists, system information, and changes in system parameters (set points, alarms, primary controls, and so forth) are written assuming the operator is using the touchscreen interface panel.

When connected to the Ethernet switch, the touchscreen interface panel displays current, real-time, information about the chiller, as well as the status of critical parameters within each module of the multipipe system.

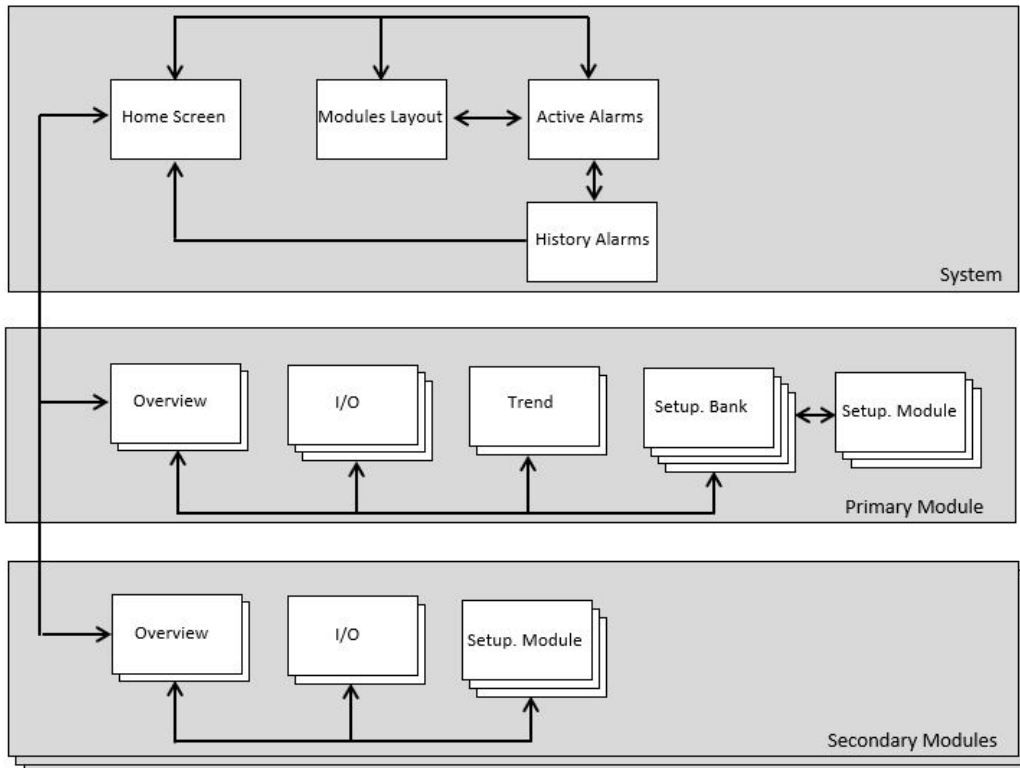
### Touchscreen Interface Panel

The touchscreen interface panel is used to adjust set points, clear alarms, and perform detailed setup of the microprocessor controllers.

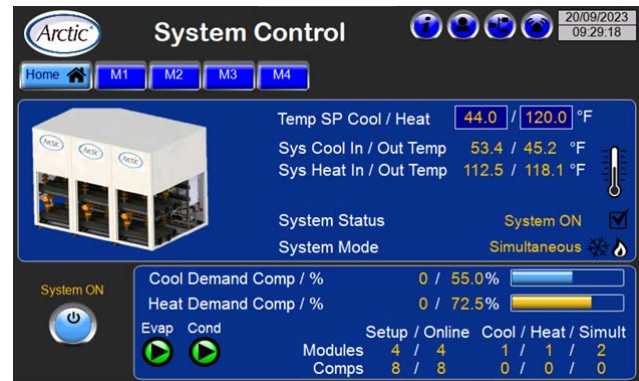
The touchscreen interface panel displays information on its touchscreen whenever specific keys and buttons are pressed by the operator. See following figure.

Basic operator tasks are described in the following sequence of illustrations that comprise a controller tutorial.

**Figure 9. Interface navigation scheme**



**Figure 8. Touchscreen interface panel**



## Touchscreen Interface Tutorial

This section consists of a tutorial that first-time personnel can use to navigate through the various functions and features that are available in the interface.

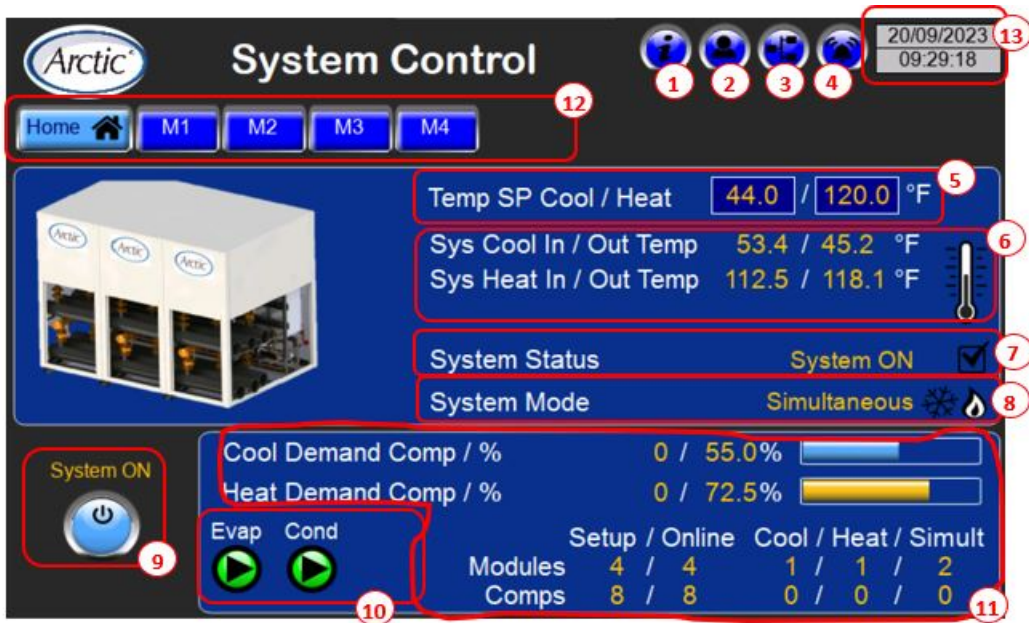
Each of the main screens in the interface contains active hot spots to activate virtual buttons and switches by simply touching the screen.

## Interface Menu Structure

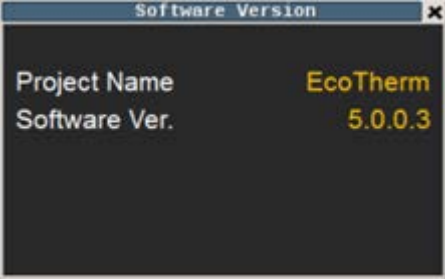
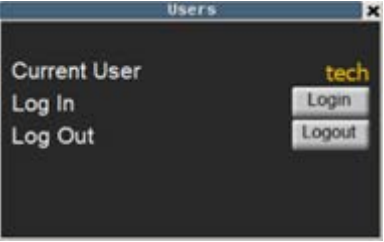
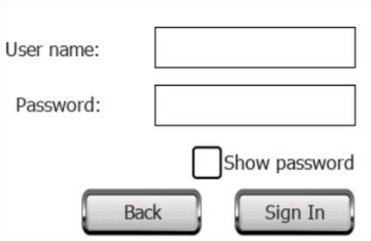
Key interface screens are organized according to system, primary module, and secondary modules functions. See the following figure.

# Home Screen Features

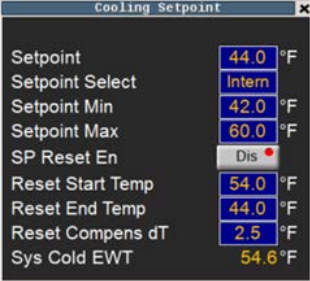
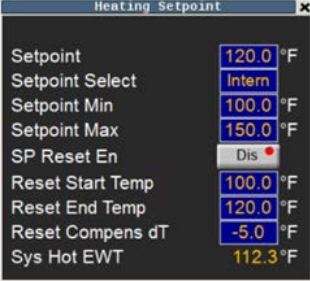
Figure 10. HMI home screen





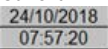
**Table 4. Home screen features**

Feature	Description
<b>1 - HMI Software Version</b>	<p>Calls up the pop-up window</p> <ul style="list-style-type: none"> <li>• Project Name: HMI software project name</li> <li>• Software Version: HMI software version</li> <li>• Consists of 4 two-digit numbers               <ul style="list-style-type: none"> <li>– First two numbers stand for major and minor software revision.</li> <li>– Third number stands for special software revision. If any project has the special software, this number would be different from '00'.</li> <li>– Fourth number stands for beta software revision.</li> </ul> </li> </ul> 
<b>2 - HMI User Management / Login</b>	<ul style="list-style-type: none"> <li>• Current User: indicates which user is currently logged in. There are three users for the HMI: 'user', 'tech' and 'admin'.           <ul style="list-style-type: none"> <li>– user - (default user) has access to viewing data mostly. The only allowed controls for this user are: turning the bank on/off and turning compressors on/off (described below). There is no password for this user;</li> <li>– tech - higher access than user but still limited. Beyond 'user' 'tech' can adjust cooling / heating setpoints, turn separate modules on/off and has access to some machine basic temperature control settings (described below). Password is 'tech2';</li> <li>– admin - full access to all the settings.</li> </ul> </li> <li>• Log in: Calls up user logging screen where user name and password have to be entered</li> <li>• Log Out: unhidden for 'admin' and 'tech' users only. It logs out from 'admin' or 'tech' user to a default user, which is 'user.'</li> </ul>  <p><b>Figure 11. User logging screen</b></p> 
<b>3 - Module Layout Access</b>	<p>The module layout access button provides fast access to the module layout screen.</p>
<b>4 - Active Alarm Access</b>	<p>The active alarm access button provides fast access to a list of currently active system alarms. Flashing red bell icon indicates unacknowledged/active alarms in the HMI. If not, it is static black.</p>

**Table 4. Home screen features (continued)**

Feature	Description
<b>5 - Setpoint</b>	<p>Calls up cooling/heating setpoint pop-up screens respectively depending on the mode. Accessible for 'tech' only. The other settings are viewable only. These dialog boxes display the resulting cooling/heating setpoint used for machine temperature control.</p> <p><b>Figure 12. Cooling setpoint</b></p>  <p><b>Figure 13. Heating setpoint</b></p>  <p><i>Note: Each control box calls up numeric keypad (if corresponding user can access it) where modified value can be entered. For text boxes, selection list is called up.</i></p>
<b>6- System Temperature Sensors Reading</b>	<p>System temperatures sensors are used for the chilled water and hot water loops.</p>
<b>7- System Status</b>	<p>Possible Options:</p> <ul style="list-style-type: none"> <li>• <b>System ON</b> – system is operational and is not off by any of the conditions listed below.</li> <li>• <b>Phase Alarm</b> – system is off by Phase Alarm.</li> <li>• <b>OFF by DI</b> – System is off by opened state of primary PLC DI1 if corresponding option applies.</li> <li>• <b>OFF by Switch</b> – System is off by software switch. It can be turned on/off either from Home Screen, which all users have access to. It can also be turned on/off from BAS (Building Automation System).</li> <li>• <b>OFF by switching to Cooling</b> – System is off and is switching over to Cooling Mode.</li> <li>• <b>OFF by switching to Heating</b> – System is off and is switching over to Heating Mode.</li> <li>• <b>OFF by switching to Simultaneous mode</b> – System is off and is switching over to Simultaneous mode.</li> <li>• <b>OFF by switching mode</b> – System is off and is going through a change of a major parameter.</li> <li>• <b>OFF by Low Ambient</b> – System is off due to ambient temperature being below operational limit.</li> <li>• <b>OFF by Hot Water</b> – System is off due to system hot water exceeding operational limit.</li> <li>• <b>OFF by BMS</b> – System is off by Building Management System.</li> <li>• <b>OFF by Transformer Overheat</b> – System is off due to overheated bank power transformer condition.</li> </ul>
<b>8- System Mode</b>	<p>Indicates multipipe thermal mode: Simultaneous, Cooling, or Heating.</p>

**Table 4. Home screen features (continued)**

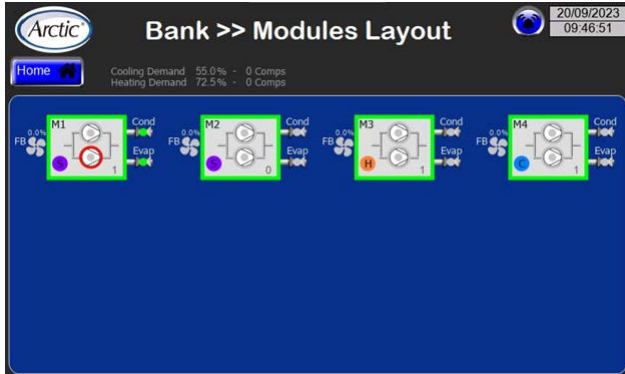
Feature	Description
<b>9- System ON/OFF</b>	<p>The system on and off options are as follows:</p> <ul style="list-style-type: none"> <li>• <b>OFF</b> – turn off multipipe bank.</li> <li>• <b>ON</b> – turn on multipipe bank</li> <li>• <b>BMS</b> – multipipe bank is turned on/off by BMS.</li> </ul> 
<b>10- Pumps Operation States</b>	<p><b>Evaporator/Condenser Pumps operation state</b> - green LED indicates that corresponding set of pumps is enabled; otherwise, pumps are disabled.</p>
<b>11- Module/Compressor Status</b>	<p><b>Cool/Heat Demand Comp%</b></p> <ul style="list-style-type: none"> <li>• Cooling/Heating Demand value in number of requested compressors as well as continuous value in %. There is also a bar graph representation of Cooling/Heating Demand beside the % value.</li> </ul> <p><b>Modules</b></p> <ul style="list-style-type: none"> <li>• <b>Setup</b> – number of multipipe modules set up.</li> <li>• <b>Online</b> – number of multipipe modules currently communicating with Primary PLC including Primary module.</li> <li>• <b>Cool/Heat/Simult</b> – number of modules currently running in Cooling, Heating, or Simultaneous mode.</li> </ul> <p><b>Comps</b></p> <ul style="list-style-type: none"> <li>• <b>Cool/Heat/Simult</b> – number of compressors currently running in Cooling, Heating, or Simultaneous mode.</li> </ul>
<b>12 - Module Access</b>	<p>The module access buttons display the overview screen for each module. These buttons provide access to all multipipe modules screens individually. The number on the Mx button stands for the module number in the multipipe bank. Buttons are viewable (modules accessible) for modules that communicate to HMI only.</p> 
<b>13 - Date/Time</b>	<p>Current HMI date/time as set up in HMI system settings.</p> 

## Modules Layout Screen

The air-source multipipe system can be composed of up to a maximum of ten modules. Pressing the LAYOUT button displays the screen showing the status of compressors and valves in each module. See figure below.

This screen is a graphical representation of modules available in the bank. Only modules are visible that communicate to HMI. See figure below.

**Figure 14. Modules layout screen showing four compressors on four modules**



## Module Layout Screen Status Conditions

Each module picture is a set of images that show real-time color-coded state of compressor, refrigeration circuit, isolation valves, fans, and module.

**Table 5. Module status conditions**

<p>Module is available and running</p>	<p>Module is unavailable</p>	<p>Module turned off by alarm and unavailable</p>
<p>Module in Simultaneous mode</p>	<p>Module in Heating mode</p>	<p>Module in Cooling mode</p>
<p>Refrigeration circuit - normal state</p>	<p>Refrigeration circuit - circuit in alarm</p>	<p>Isolation Valves: Valve LED is green = valve is open Valve LED is gray = valve is closed</p>
<p>Compressor 1 is running; Compressor 2 is not running</p>	<p>Compressor 1 is running; Compressor 2 is in alarm</p>	
<p>Fan bank running</p>	<p>Fan bank not running</p>	<p>Fan bank in alarm</p>



## Active Alarms Screen



Figure 15. Active alarms for the multipipe

Select	Action	Name	Status	State	Time	
<input type="checkbox"/>		M1 CoreSns 1 Offline	Not Triggered Not Ac...	0	2 Aug 2022 15:15:11	Module 1 CoreSense 1
<input type="checkbox"/>		M1 EVD Offline	Triggered Acked	1	2 Aug 2022 11:58:08	Module 1 EVD Offline
<input type="checkbox"/>		M1 LP	Not Triggered Not Ac...	0	2 Aug 2022 15:11:52	HP=192.7; LP=78.1; M...
<input type="checkbox"/>		M2 EVD Offline	Triggered Acked	1	2 Aug 2022 11:58:08	Module 2 EVD Offline
<input type="checkbox"/>		M3 EVD Offline	Triggered Acked	1	2 Aug 2022 11:54:05	Module 3 EVD Offline
<input type="checkbox"/>		M4 EVD Offline	Triggered Acked	1	2 Aug 2022 11:54:05	Module 4 EVD Offline

The active alarms screen lists all Active (Triggered) alarms as a table.

- Alarm is considered 'Active' (Triggered) if State Value = 1, other words it's still active in the PLC
- If alarm is 'Not Active' (Not Triggered), its State Value = 0 and it can be reset using Reset button.
- Both 'Active' and 'Not Active' alarms can be acknowledged. When 'Not Active' alarm is acknowledged, it can be reset, which will remove it from the list to show only 'Active' alarms in the list.

### Select

This column indicates if the alarm is selected or unselected for acknowledgment or resetting.

### Action

This column gives alarm details if applicable.

### Name

This column gives alarm name.

### Alarm Status

This column displays the alarm status. There are five possible states for any alarm:

- **Triggered Not Acked** – Alarm triggered (active) but not acknowledged.
- **Triggered Acked** – Alarm triggered (still active) and has been acknowledged.
- **Not Triggered Not Acked** – Alarm no longer appears (inactive) but not acknowledged.
- **Not Triggered Acked** – Alarm no longer appears (inactive) and acknowledged.
- **Not Triggered** – Alarm no longer appears (inactive), acknowledged and reset (removed from Active Alarms list).

### State

Alarm is Active (Triggered) if State Value = 1 (still active in the PLC).

Alarm is Not Active (Not Triggered) if State Value = 0 (can be reset using Reset button).

Both Active and Non Active alarms can be acknowledged. When a Non Active alarm is acknowledged, it can be reset which will remove it from the list to show only 'Active' alarms in the list.

### Description

This column provides alarm description or for certain alarms, snapshots of module parameters values.

### Time

This column is the date-time stamp indicating exactly when the alarm occurred.

### Check/Uncheck All

This button is used for selecting and deselecting all listed alarms.

### Drop-Down Menu

This is used to either list all the alarms, both active and non-active, or only active alarms (the default selection).

### Reset PLC

This button is – used to reset 'Active' alarms in the PLC, so they can be further acknowledged/reset on the HMI.

Only alarms which alarm condition is false can be reset in the PLC otherwise Reset PLC will have no effect on it.

## History Alarms Screen

On the active alarms screen, pressing the history button displays the history of alarms record.



Figure 16. Alarm history

Time	Name	Status	State	
2023/06/26 - 10:13:12 AM	M4 UI2 Sensor ...	Not Triggered	0	Module 4 UI2 Sensor Fault
2023/06/26 - 10:13:12 AM	M4 UI1 Sensor ...	Not Triggered	0	Module 4 UI1 Sensor Fault
2023/06/26 - 10:13:12 AM	M3 HP Switch	Not Triggered	0	HP=162.4; LP=162.4; Mode=Cool; SSR
2023/06/26 - 10:13:12 AM	M3 Phase Monitor	Not Triggered	0	Module 3 Phase Monitor Alarm
2023/06/26 - 10:13:12 AM	M3 EVD E Alarm	Not Triggered	0	Module 3 EVD Driver E Alarm
2023/06/26 - 10:13:12 AM	M3 CoreSns 2 ...	Not Triggered	0	Module 3 CoreSense 2 Module Offline
2023/06/26 - 10:13:12 AM	M3 CoreSns 2 Fail	Not Triggered	0	Module 3 CoreSense 2 Module Failure
2023/06/26 - 10:13:12 AM	M3 CoreSns 1	Not Triggered	0	Module 3 CoreSense 1 Module Offline

## Sorting

The alarm history list can be sorted by any column in ascending or descending order by tapping the corresponding column heading. The triangle that appears next to the heading indicates which column is being sorted and the direction of sorting.

Sorting is applied to the alarm time column in ascending order by default, which is indicated when the triangle is pointing up. Ascending order for the alarm time column requires that earlier records appear on the list first. For all other columns, alphabetical sorting applies.

History Alarms CSV Export – generates history alarms log as CSV file that can be stored.

## Duration

Allows the selection of the time period for which the alarm history is displayed. Once the selection is made from the drop-down menu, pressing the REFRESH button updates the list and then 'From' and 'To' timestamps get updated accordingly.

## Time

This is the time stamp that is displayed when the alarm state was changed.

## Name

This column gives alarm name.

## Status

This column displays the alarm status. There are five possible states for any alarm:

1. **Triggered Not Acked** – Alarm triggered (active) but not acknowledged
2. **Triggered Acked** – Alarm triggered (still active) and has been acknowledged
3. **Not Triggered Not Acked** – Alarm no longer appears (inactive) but not acknowledged
4. **Not Triggered Acked** – Alarm no longer appears (inactive) and acknowledged
5. **Not Triggered** – Alarm no longer appears (inactive), acknowledged, and reset (removed from Active Alarms list)

## State

Alarm is Active (Triggered) if State Value = 1 (still active in the PLC)

Alarm is Not Active (Not Triggered), its State Value = 0 (can be reset using Reset button)

Both Active and Non Active alarms can be acknowledged. When a Non Active alarm is acknowledged, it can be reset which will remove it from the list to show only Active alarms in the list.

## Description

This column provides alarm description or for certain alarms, snapshots of module parameters values.

## Alarms Filtering

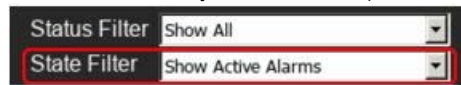
State Filter applies to Alarm State.



Alarm State '0' – Alarm is inactive.

Alarm State '1' – Alarm is active (even if it has been acknowledged).

When Show Active Alarms is selected from the State Filter drop-down list, inactive alarms (State = '0') will be hidden on the list, and only active alarms (State = "1") will appear.



For example: High Pressure switch alarm records *before* filter is applied.

Time	Name	Status	State	Des
2021/11/15 - 09:22:20 AM	M1 HP Switch Ckt1	Not Triggered	0	HP1=189.1; Amb=78.8; CEWT=0.0; CLWT
2021/11/15 - 09:22:05 AM	M1 HP Switch Ckt1	Not Triggered Acked	0	HP1=189.1; Amb=78.8; CEWT=0.0; CLWT
2021/11/15 - 09:21:56 AM	M1 HP Switch Ckt1	Triggered Acked	1	HP1=189.1; Amb=78.8; CEWT=0.0; CLWT
2021/11/15 - 09:21:48 AM	M1 HP Switch Ckt1	Triggered Not Acked	1	HP1=189.1; Amb=78.8; CEWT=0.0; CLWT

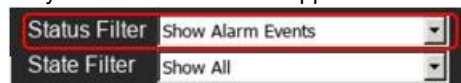
High Pressure switch alarm records *after* filter is applied.

Time	Name	Status	State	Des
2021/11/15 - 09:21:56 AM	M1 HP Switch Ckt1	Triggered Acked	1	HP1=189.1; Amb=78.8; CEWT=0.0; CLWT
2021/11/15 - 09:21:48 AM	M1 HP Switch Ckt1	Triggered Not Acked	1	HP1=189.1; Amb=78.8; CEWT=0.0; CLWT

Status Filter applies to Alarm Status.



When Show Alarm Event is selected from the Status Filter drop-down list, any non-alarm events pertaining to user action (acknowledgement and reset) is filtered off the list. Only alarm-related events appear.



For example: High Pressure switch alarm records *before* filter is applied.

Time	Name	Status	State	Des
2021/11/15 - 09:22:20 AM	M1 HP Switch Ckt1	Not Triggered	0	HP1=189.1; Amb=78.8; CEWT=0.0; CLWT
2021/11/15 - 09:22:05 AM	M1 HP Switch Ckt1	Not Triggered Acked	0	HP1=189.1; Amb=78.8; CEWT=0.0; CLWT
2021/11/15 - 09:21:56 AM	M1 HP Switch Ckt1	Triggered Acked	1	HP1=189.1; Amb=78.8; CEWT=0.0; CLWT
2021/11/15 - 09:21:48 AM	M1 HP Switch Ckt1	Triggered Not Acked	1	HP1=189.1; Amb=78.8; CEWT=0.0; CLWT

High Pressure switch alarm records *after* filter is applied.

Time	Name	Status	State	Des
2021/11/15 - 09:22:05 AM	M1 HP Switch Ckt1	Not Triggered Acked	0	HP1=189.1; Amb=78.8; CEWT=0.0; CLWT
2021/11/15 - 09:21:48 AM	M1 HP Switch Ckt1	Triggered Not Acked	1	HP1=189.1; Amb=78.8; CEWT=0.0; CLWT



Combining both State Filter and Status Filter can enhance alarms viewing even more.

For instance, one needs to view only events when alarms occurred and hide all other ones (aka one alarm event for each alarm).

For example: Alarms record *before* filters are applied.

Time	Name	Status	State	
2021/11/15 - 09:22:20 AM	M1 HP Switch Ckt1	Not Triggered	0	HP1=189.1; Amb=78.8; CEWT=0.0; CL
2021/11/15 - 09:22:05 AM	M1 HP Switch Ckt1	Not Triggered Acked	0	HP1=189.1; Amb=78.8; CEWT=0.0; CL
2021/11/15 - 09:21:56 AM	M1 HP Switch Ckt1	Triggered Acked	1	HP1=189.1; Amb=78.8; CEWT=0.0; CL
2021/11/15 - 09:21:48 AM	M1 HP Switch Ckt1	Triggered Not Acked	1	HP1=189.1; Amb=78.8; CEWT=0.0; CL
2021/11/15 - 09:21:03 AM	M1 Evap LWT High	Triggered Not Acked	1	Module 1 Evap LWT High Alarm
2021/11/15 - 09:05:23 AM	M4 LP Lockout Ckt1	Not Triggered	0	Module 4 LP Lockout Ckt1 Alarm
2021/11/15 - 09:05:23 AM	M4 LP Ckt1	Not Triggered	0	LP1=115.0; EXV=0.0; SSH1=0.0; EEW

Alarms record *after* filters are applied.

Time	Name	Status	State	
2021/11/15 - 09:21:48 AM	M1 HP Switch Ckt1	Triggered Not Acked	1	HP1=189.1; Amb=78.8; CEWT=0.0; CL
2021/11/15 - 09:21:03 AM	M1 Evap LWT High	Triggered Not Acked	1	Module 1 Evap LWT High Alarm

## Module Access

Buttons to access all modules screens individually. Number on the button “M(X)” stands for the module number in the

bank. Buttons are viewable (modules accessible) for modules that communicate to HMI only. Each module menu includes the following set of screens.

- **Overview** - overview of main multipipe module refrigeration parameters and status of its components — refrigeration circuit, heat exchangers, compressors, and module itself.
- **I/O** - state and description of module PLC digital/analog inputs and outputs including expansion IO (Inputs Outputs) module.
- **Trend** - trending curves for Cooling or Heating Demand are displayed.
- **Setup** - setup screens contain all the multipipe settings applied to system and is available for primary module as well as module settings. All setup screens are available for ‘admin’ user only.

## Overview Module Screens

Each module controlled by the microprocessor controller has its own module screen within which the operator can monitor and maintain conditions affecting that module. Primary module access is made through the system control screen containing multiple controls and indicators:

On the home screen, pressing the **M1** button displays the Module #1 (primary module) screens.

The overview menu is comprised of two screens Overview 1 and Overview 2:

These two screens are different for primary and secondary module.

**Table 6. The overview screens**

<p><b>Module 1 &gt;&gt; Overview 1</b></p> <p>Module En/Dis: En</p> <p>Module Status: Module ON</p> <p>Cntrl Status: Primary</p> <p>Primary Status: Primary On</p> <p>Lead Module: Yes</p> <p>Mode Status: Simultaneous</p> <p>Refrigeration Circuit:</p> <ul style="list-style-type: none"> <li>Suction Pressure: 120.3PSI</li> <li>Discharge Pressure: 255.0PSI</li> <li>SST / SDT: 40.9 / 85.1 °F</li> <li>Solenoid 'E'/S'/C'/LLB: Cls / Cls / Cls</li> <li>D1/D2/S1/S2/S3: Opn/ Cls / Opn/ Cls / Cls</li> </ul> <p>Heat Exchangers:</p> <ul style="list-style-type: none"> <li>Evap In / Out Temp: 78.9 / 76.8 °F</li> <li>Evap Iso Valve: 100.0 %</li> <li>Cond In / Out Temp: 56.2 / 116.3 °F</li> <li>Cond Iso Valve: 100.0 %</li> <li>Ambient Temp: 49.2 °F</li> <li>Fans Speed: 0.0 %</li> </ul>	<p><b>Module 2 &gt;&gt; Overview 1</b></p> <p>Module En/Dis: En</p> <p>Module Status: OFF by Alarm</p> <p>Cntrl Status: ON</p> <p>Primary Online: Stand-alone</p> <p>Lead Module: No</p> <p>Mode Status: Switching to Heat</p> <p>Refrigeration Circuit:</p> <ul style="list-style-type: none"> <li>Suction Pressure: 124.3PSI</li> <li>Discharge Pressure: 252.2PSI</li> <li>SST / SDT: 42.6 / 84.4 °F</li> <li>Solenoid 'E'/S'/C'/LLB: Cls / Cls / Cls</li> <li>D1/D2/S1/S2/S3: Opn/ Cls / Opn/ Cls / Cls</li> </ul> <p>Heat Exchangers:</p> <ul style="list-style-type: none"> <li>Evap In / Out Temp: 78.7 / 78.9 °F</li> <li>Evap Iso Valve: 0.0 %</li> <li>Cond In / Out Temp: 53.7 / 114.8 °F</li> <li>Cond Iso Valve: 100.0 %</li> <li>Ambient Temp: 49.4 °F</li> <li>Fans Speed: 0.0 %</li> </ul>
<p>Primary Overview 1 Module Screen</p>	<p>Secondary Overview 1 Module Screen</p>
<p><b>Module 1 &gt;&gt; Overview 2</b></p> <p>Compressor 1 En/Dis: En</p> <p>Compressor 2 En/Dis: En</p> <p>Comp Status: Commanded ON</p> <p>Communication: Off</p> <p>Vapour Injection: On</p> <p>Local Temp Cntrl:</p> <ul style="list-style-type: none"> <li>Cntrl Temp Heat / Cold: 116.1 / 48.2 °F</li> <li>Temp SP Heat / Cold: 120.0 / 44.0 °F</li> <li>Demand Cooling: 1</li> <li>Demand Heating: 1</li> </ul> <p>Temp Cntrl Settings:</p> <ul style="list-style-type: none"> <li>Cool Temp Diff +/-: 3.0 1.0 °F</li> <li>Cool Delay +/-: 45 30 s</li> <li>Heat Temp Diff +/-: 3.0 1.0 °F</li> <li>Heat Delay +/-: 45 30 s</li> </ul>	<p><b>Module 2 &gt;&gt; Overview 2</b></p> <p>Compressor 1 En/Dis: En</p> <p>Compressor 2 En/Dis: En</p> <p>Comp Status: Comp OFF</p> <p>Communication: Off</p> <p>Vapour Injection: Off</p> <p>Local Temp Cntrl:</p> <ul style="list-style-type: none"> <li>Cntrl Temp Heat / Cold: 114.8 / 78.8 °F</li> <li>Temp SP Heat / Cold: 120.0 / 44.0 °F</li> <li>Demand Cooling: 0</li> <li>Demand Heating: 0</li> </ul>
<p>Primary Overview 2 Module Screen</p>	<p>Secondary Overview 2 Module Screen</p>

## Overview 1 - Module

### Module En/Dis

Pressing this button enables or disables a module. If module is disabled, it is excluded from primary control compressors sequence.

### Module Status

Possible options:

- **Module ON** - Module is ready to run.
- **OFF by DI** - Module is off by opened state of PLC DI1.
- **OFF by Switch** - Module is off by Module En/Dis button.
- **OFF by Alarm** - Module is locked out by one of the major alarms.
- **OFF by Primary** - Module is switching between control states Primary/Secondary/Stand-alone.
- **OFF by System** - Module is off by one of the System Off conditions.
- **OFF by switching Mode** - Module is off and is going through a change of a major parameter. Such as, module number change and control mode change.
- **OFF by Low Ambient** - Module is off due to ambient temperature being below operational limit.

### Module Cntrl Status

Possible options:

- **Primary** - Module acts as a primary module. Primary module performs temperature control for either heating or cooling loads. It also acts as a Supervisor when communicating with secondary modules and defines how many modules need to run its compressors in order to satisfy heating or cooling controlled temperatures.
  - Note:** Primary module is defined by its PLC IP address. So in the multipipe, Primary PLC IP address is always 192.168.1.11. All Secondary IP addresses go from 192.168.1.12 to 192.168.1.20 which amounts to nine Secondaries. Each IP address must be unique for all the devices to communicate properly, including HMI whose IP address is 192.168.1.10.
- **Secondary** - Module acts as a secondary module. Conditions for the module to be a secondary module:
  - Its PLC has been assigned IP address from secondaries addresses range.
  - It is communicating with primary module
  - Primary module exists on the network, in other words Primary PLC meets primary module conditions (see Primary Status below).
  - Stand-alone. Module does not meet either primary module or secondary module conditions.

**Note:** Stand-alone module operates as independent multipipe module and controls cooling/heating temperatures locally based on its Evaporator/Condenser EWT/LWT depending on cooling/heating/simultaneous mode and control temperature sensor selections. Stand-alone is rather failsafe mode than intended mode. So, module runs temporarily in this mode until normal Primary/Secondary operation is restored. This applies except for systems that consist of one module only. In such a case it always operates in Stand-alone mode, since Primary PLC will not have any subordinate Secondary modules to communicate to.

## Primary Status

Applies to primary PLC only. Possible options:

- **Primary ON** - All primary modules conditions are satisfied by module.
- **Waiting** - All primary modules conditions are satisfied and module is counting down a delay before acquiring primary ON status.
- **OFF by Cool Sensor** - System cooling temperature sensor failed.
- **OFF by Heat Sensor** - System heating temperature sensor failed.
- **OFF by no secondaries** - Primary PLC communicates with no secondaries.

## Primary Online

Applies to secondary PLC only. Possible options:

- **LED is green** - secondary PLC is communicating with primary PLC.
- **LED is gray** - secondary PLC is not communicating with primary PLC.

## Lead Module

Indicates which module is currently a Lead Module in the multipipe bank.

**Note:** Lead Module is the module which always starts first. When there are no compressors running, Lead Module always keeps its Isolation Valves open. (depending on the mode) to allow for chilled/hot water circulation. By default, Primary Module is the Lead Module. Next time when last running compressor turns off because cooling/heating temperatures are satisfied, Lead Module 'marker' is passed on to the next module. As a result, next time, compressors sequence starts off from that module. The idea is to equalize compressors running hours.

## Mode Status

- **Simultaneous** - Module is in Simultaneous Mode.
- **Heating** - Module is in Heating Mode.
- **Cooling** - Module is in Cooling Mode.

- **Switching to Simult** - Module is switching to Simultaneous Mode.
- **Switching to Heat** - Module is switching to Heating Mode.
- **Switching to Cool** - Module is switching to Cooling Mode.
- **Defrost** - Module is in Defrost Mode.
- **Switching to Defrost** - Module is switching to Defrost Mode.

## On/Off Button

Applies to secondary stand-alone modules only. Used to turn on/off secondary stand-alone modules to exclude it from consuming flow on variable flow systems.

## Heat Exchangers

Displays each heat exchanger Evaporator/Condenser heat exchanger inlet and outlet temperatures as well as opening status of its Isolation Valves. It also displays ambient temperature and fans speed.

## Refrigeration Circuit

Refrigerant temperatures/pressures are displayed: suction pressure, discharge pressure, saturated suction temperature, and saturated discharge temperature.

- **Solenoid E** – Solenoid valve installed at the evaporator heat exchanger inlet. It opens when compressors are running in Simultaneous or Cooling mode.
- **Solenoid S** – Solenoid valve installed at the source heat exchanger inlet. It opens when compressors are running in Heating mode.
- **Solenoid C** – Solenoid valve installed at the condenser heat exchanger inlet. It gets opened when compressors are running in Defrost mode.
- **D1/D2/S1/S2/S3** – Discharge and Suction refrigerant valves. Depending on the Module Thermal Mode, valves are automatically positioned as follows:

Valve	Mode			
	Simultaneous	Cooling Only	Heating Only	Defrost
Discharge 1 (D1)	Open	Closed	Open	Closed
Discharge 2 (D2)	Closed	Open	Closed	Open
Suction 1 (S1)	Open	Open	Closed	Closed
Suction 2 (S2)	Closed	Closed	Open	Closed
Suction 3 (S3)	Closed	Closed	Closed	Open

If module is going through Thermal Mode switchover, corresponding valves would be stroking to open/closed position displaying the following symbols:



valve is opening.



valve is closing.

### Vapor Injection Controller Screen



calls up Vapor Injection controller popup screen. Visible if Vapor Injection Controller is communicating to the PLC.

Vapour Injection	
Controller Status	Alarm
Suction Pressure	4752.PSI
SST / Suction Temp	621.8 / 75.7 °F
SSH Temp / SP	589.8 / 12.6 °F
Disch Temp 1 / 2	184.7 / 621.8 °F
EX Valve 1 / 2	0.0 / 0.0 %

Vapour Injection (VI) parameters are displayed such as Vapour Injection Controller status, VI suction pressure, VI saturated suction pressure and suction temperature, VI Superheat temperature and Superheat setpoint, both discharge temperatures and positions of both VI expansion valves.

### EXV Controller Screen



calls up EXV controller popup screen. Visible if applicable EXV Controller is communicating to the PLC.

EXV Parameters	
Suction Pressure	112.1 PSI
SST	37.2 °F
Suction Temp	82.5 °F
SSH Temp / SP	45.3 / 10.0 °F
EX Valve	100.0%

EXV controller parameters are displayed specific to the current Thermal Mode such as EXV suction pressure, saturated suction temperature, EXV suction temperature, EXV Superheat and Superheat setpoint, and EXV position.

## Overview 2 – Compressor 1/Compressor 2

### Compressor En/Dis

Button to enable/disable compressor. It is used for testing or maintenance purposes.

### Comp Status

- **Comp OFF** - Compressor is off and cannot be turned on.
- **Ready** - Compressor is ready to run.
- N/A
- **OFF by Cond Flow** - Compressor is waiting for Condenser Flow confirmation.
- **OFF by Evap Flow** - Compressor is waiting for Evaporator Flow confirmation.
- **OFF by Min Off** - Compressor is cycling through safety Minimum Off Time.
- **OFF by Switch** - Compressor is off by En/Dis Switch.
- **OFF by Alarm** - Compressor is off by Alarm.
- **Running** - Compressor is running.
- **ON by Min On** - Compressor is commanded off but running cycling through a safety Minimum On Time.
- **Start Delayed** - Waiting for EXV positioning or going through second compressor start-up delay.
- **Off by LP** - Capacity limited to a single running compressor due to a low suction pressure.
- **Off by HP** - Capacity limited to a single running compressor due to a high discharge pressure.
- **Commanded On** – Compressor commanded on by PLC but not running as confirmed by external compressor control device.
- **OFF by Low Ambient** – Compressor can not start due to low ambient temperature.
- **OFF by Source Approach** – Compressor is off by high Source Approach.

### Communication

Comm LED indicates if PLC is communicating to compressor control device.

### Vapor Injection On / Off

Indicates whether Vapor Injection is running or not.

### Local Temp Cntrl

Applies only if module is running in stand-alone mode.

- **Cntrl Temp Heat/Cold** – Local module hot/chilled water temperature control sensors.
- **Temp SP Heat/Cold** – Local module heating or cooling temperature control setpoint. Can be adjusted by **tech** user only.
- **Demand Cooling** – Local Cooling Demand value in number of requested compressors.
- **Demand Heating** – Local Heating Demand value in number of requested compressors.

### Temp Cntrl Settings

Viewable/adjustable for 'tech' user only.

- **Cool Temp Diff +/-** – Cooling temperature control differential above/below setpoint or positive/negative dead band (DB).
- **Cool Delay +/-** – Cooling compressor Stage-Up/Stage-Down Delays. (When next compressor has been staged up, Stage-Up Delay has to elapse before next compressor is allowed to stage up. When next compressor has been staged down, Stage-Down Delay has to elapse before next compressor is allowed to stage down.)
- **Heat Temp Diff +/-** – Heating temperature control differential above/below setpoint or positive/negative dead band (DB).

## Module I/O Screens



Data is collected by sensors as either analog or digital signals and displayed on the IO Status screens.

When the module screen is displayed, pressing the I/O button displays the I/O menu.

I/O menu is comprised of five screens for Primary Module and four screens for Secondary Module.

Both Primary and Secondary have Analog I/O (AI, AO) and Digital I/O (DI, DO) screens. Primary Module, however, has three Expansion I/O screens Exp IO #1, Exp IO #2 and Exp IO #3, whereas Secondary Module has Exp IO #1 and Exp IO #2 screens only.

When in the I/O menu switching between I/O screens is made by the means of respective buttons.





**Table 7. The input/output screens**

<p><b>Primary/Secondary I/O Analog Screen</b></p>	<p><b>Primary/Secondary I/O Digital Screen</b></p>
<p><b>Primary/Secondary I/O Expansion Screen#1</b></p>	<p><b>Primary/Secondary I/O Expansion Screen#2</b></p>
<p><b>Primary I/O Expansion Screen #3</b></p>	

When an I/O screen is displayed, switching to other I/O screens is accomplished by pressing their respective buttons:

- The ANALOG button displays the analog screen.
- The DIGITAL button displays the digital screen.

## Digital LEDs



There is an LED for each digital input that indicates its current state. For all inputs, the color of the LED signifies its current state:

**Green LED** — This digital input is energized; the connected device is closed.

**Gray LED** — This digital input is de-energized; the connected device is open.

## Analog Inputs



Analog input (AI) data includes these parameters:

### AI1 – AI3, AI6

Inlet/outlet temperatures for Evaporator and Condenser heat exchangers.

## AI4

Suction Pressure

## AI5

Discharge Pressure

## AI7

Ambient Temperature

## AI9

Panel Temperature (optional). It is used when temperature control inside control panel is required either heating (for cold environment) or cooling (for hot environment).

## AI11

Liquid Line Temperature

## AI12

Liquid Line Pressure

## Analog Outputs

Analog output (AO) data includes these parameters:

### AO1

Condenser Isolation Valve position

### AO2

Fans Speed

### AO3

Evaporator Isolation Valve position

## Digital Inputs



Digital input (DI) data includes these parameters:

### DI1

**Remote On/Off** – Used to turn module on/off via digital input. For Primary Module toggling DI1 will turn on/off the entire system if respective option selected.

### DI2, DI3

Shows the state of Evaporator and Condenser flow switch

- **DI closed** – flow present
- **DI opened** – flow absent

### DI7, DI8

Discharge/Suction Pressure switches

- **DI closed** – pressure is in the normal range
- **DI opened** – pressure is exceeding normal range threshold (faulty state).

### DI9, DI10

Compressor 1 and 2 external alarms

- **DI closed** – compressors are in no-alarm state
- **DI opened** – compressors are in alarm state

## UI10

**Phase Monitor** – Three phase power supply protection module feedback.

- **DI closed** – no power supply issues.
- **DI opened** – power supply failure has been detected. If common power supply protection module is used for the system, its failure will affect each module. In such a case this DI is optional for Secondary Module.

## Digital Outputs

Digital output (DO) data includes these parameters:

### DO1, DO2

**Comp On/Off** – It turns compressor on/off.

### DO3

**Liq Line Solenoid E** – It energizes/deenergizes liquid line solenoid valve 'E'.

### DO4

**Liq Line Solenoid S** – It energizes/deenergizes liquid line solenoid valve 'S'.

### DO5

**Liq Line Solenoid C** – It energizes/deenergizes liquid line solenoid valve 'C'.

### DO6, DO7

**Comp 1/2 Vap Inj Solenoid** – It energizes/deenergizes Compressor 1/2 vapour injection solenoid valve.

### DO9

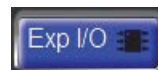
**Liq Line Bypass Solenoid** – It energizes/deenergizes liquid line bypass solenoid valve. DO10 General Alarm. It comes on when any of the following alarms occur:

- Alarm that shuts down/locks out compressor 1 or 2.
- Alarm that shuts down / locks out module.

### DO11

**Panel Heater/Fan (optional)** – It is used when temperature control inside control panel is required (the same as AI9).

## Expansion IO Screen 1



This screen applies to the primary and secondary module. This screen controls analog inputs and digital requests.

### DI1 – DI10

Status of the Discharge/Suction refrigerant valves D1, D2, S1, S2, S3.

## Operating Procedures

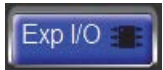
- **Green LED** – valve has reached the respective position.
- **Grey LED** – specified valve position has not been reached.

### DO1 – DO5

Discharge/Suction refrigerant valves D1, D2, S1, S2, S3 on/off control signals.

- **Green LED** – valve is commanded to open.
- **Grey LED** – valve is commanded to close.

### Expansion IO Screen 2



This screen applies to the primary and secondary module. This screen controls analog inputs and digital requests.

#### AI1, AI2

Compressor 1/2 crankcase heater temperatures.

#### AI3, AI5

Suction Temperature in Cooling/Heating Mode.

#### AI4, AI6

Suction Pressure in Cooling/Heating Mode.

#### DI8

UPS Ready

- **DI Closed** – UPS battery is charged and UPS is ready to operate.
- **DI Open** – UPS is not operational.

#### DI9, DI10

Comp 1/2 Oil Level.

- **DI Closed** – compressor oil level is satisfactory.
- **DI Open** – compressor oil level is insufficient.

### Expansion IO Screen 3

This screen is only applicable to the primary module. This screen controls analog inputs and digital requests.

#### AI1 – AI4

Inlet/outlet temperatures for Chilled and Hot water loops.

#### AI7, AI8

Cool SP/Heat SP (optional). External cooling/heating setpoints. Used when cooling/heating setpoints are coming to chiller control system from BMS as hard-wired AI signals.

#### DI5

Transformer T Switch. Bank power Transformer Temperature Relay.

- **DI Closed** – Transformer temperature is within normal range.
- **DI Open** – Transformer temperature is exceeding normal range.

### DI10

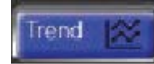
Hot Water Alarm.

- **DI Closed** – Hot Water Temperature is within normal range.
- **DI Open** – Hot Water Temperature is exceeding normal range.


### DO3, DO4

**Evap/Cond Pumps** – Used to turn on/off pumps in both Chilled and Hot water loops. These are hard-wired outputs that have to be wired into BMS for pumps control.

### Trend Screen



When in the primary module screen, pressing the trend button displays the trend screen. There are three trend screens: cooling trend screen, heating trend screen, and

simultaneous trend screen. Use  to navigate through trend screens.

Since system variables are trended, trend screens apply to primary module only.

Both Cooling/Heating Screens display five trends: Chilled Water Inlet/Outlet Temperatures, Hot Water Inlet/Outlet Temperatures, Cooling Demand, Heating Demand, and Number of Requested Compressors.

Simultaneous Trend displays five trends as well: number of requested cooling/heating compressors and number of actually running simultaneous/cooling/heating compressors.

Trends can be viewed in real time as well as for the last four days. Each variable is trended every three seconds. Trending data is stored in HMI internal memory.

Cooling, Heating, and Simultaneous Trend Screens have similar but independently-managed controls and trends viewing such as scrolling, zooming, and deleting.



Figure 17. Cooling trend screen



Table 8. Trend screen labels

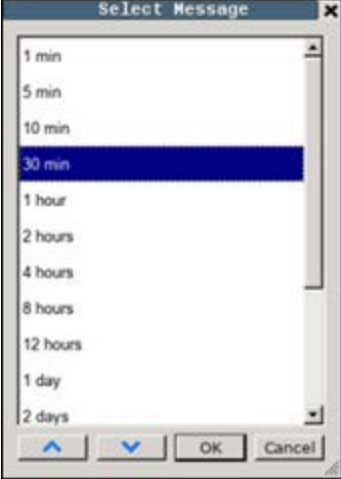
Label	Description
1	According to where the cursor is placed, it is capturing real time values of in and out water temperatures. Current cursor timestamps are displayed as well.
2	Text box to select viewing time span. It is used for zooming in on trends time axis. Options for selection: 
3	Maximum and Minimum thresholds for trends viewing. Used for zooming in on trends variables axis. Both Maximum and Minimum thresholds are adjustable via respective numeric boxes. Default Min/Max values: -10.0/160.0.. Default Span button is used to revert to defaults to reset longitudinal zooming.
4	Scroll to Time button is used to return to real time viewing.
5	Cursor positioning buttons.
6	Buttons used to scroll back and forth in time. They implement time axis trends pages scrolling.
7	Buttons used to scroll back and forth in time. High resolution time axis scrolling.
8	Button used to pause/resume real-time trending.

Figure 18. Heating trend screen

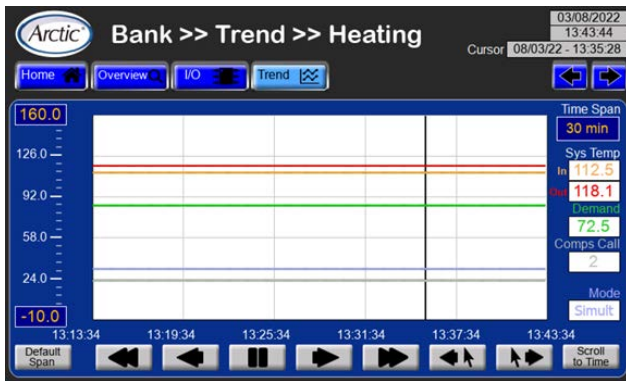


Figure 19. Simultaneous trend screen



## Operator Tasks

Before operating the unit, ensure that all compressor refrigeration service valves are fully back-seated counterclockwise.

### NOTICE

#### Compressor Failure!

Failure to properly back-seat rotalock valves can cause compressor failure.

Verify the circuit breakers on the module electrical panel are turned to OFF position prior to applying power.

## Normal Power Up

The following procedure is used for a start-up resulting from scheduled seasonal or programmed cold shut down of the air-source multipipe.

### ⚠ WARNING

#### Hazardous Voltage!

Failure to disconnect power before servicing could result in death or serious injury.

Disconnect all electric power, including remote disconnects before servicing. Follow proper lockout/tagout procedures to ensure the power can not be inadvertently energized. Verify that no power is present with a voltmeter.

*Important:* This start-up procedure is not to be used for the first-time initial startup for a newly installed system. See Preparation for Initial Start-up in the Installation section of this manual for instructions regarding that situation.

1. De-energize the system using standard lockout/tagout procedures.
2. Using a known operational voltage meter, test and confirm the unit is de-energized before proceeding further.
3. Inspect power distribution fuses and overload settings to verify they are correct.
4. Verify that the oil level is correct in each compressor using the compressor sight glass.

*Note:* See recommended inspection interval in the maintenance section of this manual.

### NOTICE

#### Compressor Failure!

Failure to follow instructions below could result in catastrophic compressor failure.

Do not operate with insufficient oil.

5. Verify that pressure and temperature switches are closed.
6. Restore power to all modules.
7. Inspect refrigerant pressures for each module using the touchscreen interface panel.
8. Verify that pressure switches and thermostats have the correct cut-in and cut-out settings using the touchscreen interface panel.
9. Verify water flow to condenser and evaporator.
10. Monitor and record temperature and refrigerant pressures registering on the touchscreen interface panel.

## Emergency Power Shutdown

The equipment does not include a disconnect switch as standard to turn off the high voltage to the modules. As per NFPA 70, The National Electrical Code, a disconnect must be installed within the line of sight of the electrical and control panel. Should an emergency condition arise, the disconnect switch must be opened to shut down all voltage to the multipipe.

There are several ways to interrupt power to all or part of the modular system:

- Disconnect the primary power source from the building that feeds electricity to the multipipe. This occurs in sudden emergencies (usually weather-related) or planned maintenance shut-downs.
- If equipped, press the panel disconnect switch on the exterior door of the multipipes main power distribution panel.
- Move the circuit breaker switch to the OFF position (CB-1 and CB-2, etc.) on the power distribution panel. This cuts power to all of the modules.
- Move the circuit breaker switch to the OFF position (CB-1 and CB-2) on a modules electrical and control panel. This cuts power to the compressors in a single module. It does not cut power to electrical and control panel or other multipipe modules.
- Press the SYSTEM ON button on the touchscreen interface panel that is built into the power distribution panel door.

**Note:** Pressing the button on the touchscreen interface panel does not de-energize the equipment or the high voltage current into each modules electrical and control panel. This action sends a command to the controller in each modules compressors to discontinue electrical current to that component.

## Water Quality Guidelines

The multipipe is equipped with high efficiency compact brazed plate heat exchangers (BPHE). Water quality must be maintained periodically by the end user to avoid scaling and corrosion inside the heat exchangers.

**Table 9. Water quality guidelines**

Element /Compound/Property	Value/Unit
pH	7.5 - 9.0
Conductivity	< 500 µS/cm
Total Hardness	4.5 - 8.5 dH°
Free Chlorine	< 1.0 ppm
Ammonia (NH <sub>3</sub> )	< 0.5 ppm
Sulphate (SO <sub>4</sub> <sup>2-</sup> )	< 100 ppm
Hydrogen Carbonate (HCO <sub>3</sub> <sup>-</sup> )	60 – 200 ppm

**Table 10. Glycol performance impact factors**

Range Factor	Glycol Concentration Percentages and Performance Impact		
	30%	40%	50%
Propylene Glycol Concentration	30%	40%	50%
Lowest Ambient Temperature	10 °F (-12 °C)	-4 °F (-20 °C)	-20 °F (-29 °C)
Recommended Minimum Leaving Fluid Temperature	25 °F (-4 °C)	10 °F (-12 °C)	-10 °F (-23 °C)

**Table 9. Water quality guidelines (continued)**

Element /Compound/Property	Value/Unit
(HCO <sub>3</sub> <sup>-</sup> ) / (SO <sub>4</sub> <sup>2-</sup> )	> 1.5
(Ca + Mg) / (HCO <sub>3</sub> <sup>-</sup> )	> 0.5
Chloride (Cl <sup>-</sup> )	< 200 ppm

**Notes:**

1. Total Hardness/corrosion: Water with high hardness can cause corrosion problems due to its high ion content (Ca+2, Mg+2, Fe+2) which also means a high electrical conductivity and a high total dissolved solid (TDS). For this reason, too high hardness values should be avoided, not only due to higher risk of scaling, but also for corrosion risk. On the other hand, soft water, but not necessarily cation exchange softened water, may in contrast have a low buffering capacity and so be more corrosive. If the hardness values are outside the recommended range, other parameters such as oxygen content, conductivity, and pH values should be considered to evaluate the corrosion risk
2. Fe3+ and Mn4+ are strong oxidants and may increase the risk for localized corrosion on stainless steels in combination with brazing material copper.

## Monitor Water Quality

Maintaining water/glycol mixture quality and cleanliness is critical to equipments health and maintainability. Strainers should be checked and cleaned on a regular basis. Water/ glycol mixture samples should be taken and tested by a professional lab. The results will enable the accurate adjustment of quality thereby increasing the operational life of the system.

**Note:** Trane will not validate the equipments warranty if the proper water/glycol mixture composition and quality is not maintained.

## Maintain Glycol Level

The temperature of the refrigerant in a brazed-plate evaporator is not uniform throughout the heat exchanger. The refrigerant temperature is approximately 6 °F to 12 °F colder than the corresponding fluid temperature depending on many factors such as the heat exchanger design, glycol percentage, operating fluid temperatures, refrigerant, system flow rate, etc. When the multipipe has a set point that is within 12 °F (6.7 °C) of the freezing point of the water/glycol in use, take precautions against freezing. See table below for the recommended glycol concentrations and performance impact.

**Table 10. Glycol performance impact factors (continued)**

Range Factor	Glycol Concentration Percentages and Performance Impact					
	Capacity Reduction Factor	Pressure Drop Factor	Capacity Reduction Factor	Pressure Drop Factor	Capacity Reduction Factor	Pressure Drop Factor
Leaving Temperature						
70 °F (21 °C)	0.96	1.27	0.93	1.43	0.91	1.63
60 °F (15.6 °C)	0.95	1.31	0.92	1.47	0.90	1.68
55 °F (13 °C)	0.95	1.31	0.92	1.50	0.89	1.73
50 °F (10 °C)	0.94	1.33	0.91	1.51	0.88	1.75

A 20% to 50% solution of glycol should be added to prevent pipe corrosion regardless of the fluid temperature. Propylene glycol has corrosion inhibitors that protect piping and components from corrosion and buildup of rust and other deposits. Trane recommends against using water/glycol solution in excess of 40% regardless of the ambient temperature conditions.

To assure inhibitor effectiveness, the levels of chlorides and sulfates in the water should not exceed 25 ppm each. The total hardness in terms of calcium carbonate should be less than 100 ppm. For best long-term results, de-ionized or distilled water is recommended. Trane can provide concentrated solutions of Dowfrost, propylene glycol, or premixed solutions for use with the multipipe.

### NOTICE

#### **Equipment Damage!**

**Failure to follow instructions below could result in permanent damage to pump and internal cooling surfaces.**

**Do not use automotive antifreeze.**

### NOTICE

#### **Equipment Damage!**

**Failure to follow instructions below could result in permanent damage to pump and internal cooling surfaces.**

**Do not use automotive antifreeze.**

*Note: If glycol-free solutions are mandated at the equipment site, special inhibitors are available for rust prevention, mineral deposit inhibition, and biological suppression. Adding these inhibitors to the water solution is strongly recommended.*

Heaters, heat tracing cable, and closed cell insulation can be installed on any exposed **wet** components for protection against freezing in low ambient temperature and low refrigerant pressure conditions. However, the best freeze prevention is using the appropriate concentration of glycol. Trane does not warranty any component that fails due to freezing.

## Prevent Freezing

Many liquids expand in volume upon cooling. This expansion may cause pipes and other enclosed systems containing a liquid to rupture or burst when exposed to low temperature conditions. Burst protection is needed to protect piping and other enclosed systems when they are inactive as they could rupture due to expansion during cold weather or low refrigerant pressure.

Freeze points and burst points of glycol-water solutions are shown in [Table 11, p. 45](#).

In order to maintain a high quality glycol solution, the water used in the glycol mixture must have very few impurities. Impurities in the water can increase metal corrosion, aggravate pitting of cast iron and steel, reduce the effectiveness of the corrosion inhibitors, and increase the depletion rate of the inhibitor package.

## Propylene Glycol

Glycol-based fluids provide such burst protection in water solutions due to their low freezing points. As a glycol-based fluid cools below the solutions freezing point, ice crystals begin to form, and the remaining solution becomes more concentrated in glycol. This ice/water/glycol mixture results in a flowable slush, and remains fluid, even as the temperature continues to cool.

The fluid volume increases as this slush forms and the temperature cools, flowing into available expansion volume in the system. If the concentration of glycol is sufficient, no damage to the multipipe from fluid expansion should occur within the temperature range indicated in [Figure 20, p. 45](#). When liquids are cooled they eventually either crystallize like ice or become increasingly viscous until they fail to flow and set up like glass. The first type of behavior represents true freezing. The second is known as supercooling. Glycols do not have sharp freezing points. Under normal conditions, propylene glycol sets to a glass-like solid, rather than freezing.

The addition of glycol to water yields a solution with a freezing point below that of water. This has led to the extensive use of glycol-water solutions as cooling media at temperatures appreciably below the freezing point of water. Instead of having sharp freezing points, glycol-water solutions become slushy during freezing. As the temperature falls, the slush becomes more and more viscous and finally fails to flow.

**Table 11. Freeze and burst protection chart**

Water/Glycol Temperature	Freeze Protection	Burst Protection
20 °F (-7 °C)	18% glycol mixture	12% glycol mixture
10 °F (-12 °C)	29% glycol mixture	20% glycol mixture
0 °F (-17.8 °C)	36% glycol mixture	24% glycol mixture
-10 °F (-23 °C)	42% glycol mixture	28% glycol mixture
-20 °F (-29 °C)	46% glycol mixture	30% glycol mixture

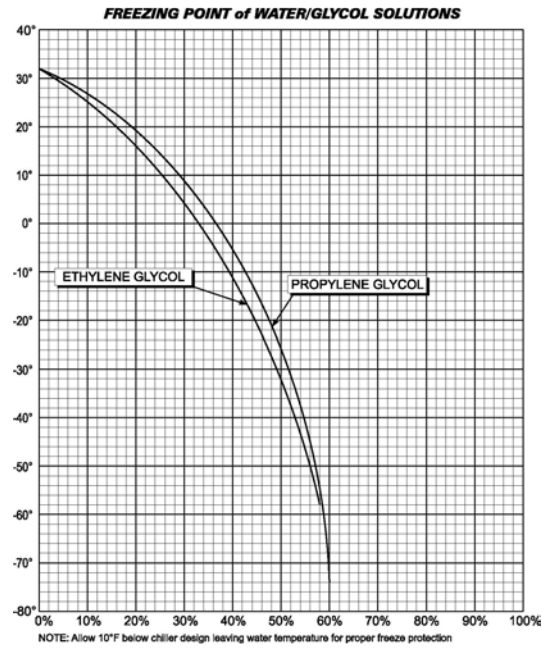
The precise concentration of glycol for a particular multipipe is affected by several key factors such as ambient temperature extremes, entering and leaving water temperatures, and multipipe size. A multipipes optimum glycol concentration is modified by these considerations as reflected in Table 10, p. 43. These capacity correction factors are the **best informed estimates** for a multipipe with copper load heat exchangers. The percentages may vary depending on the materials and alloys of the heat exchangers, total surface area, the amount of present or future fouling, and the brand of glycol used.

**Storage Provisions**

The air-source multipipes controls are designed for storage in ambient temperatures from -20 °F (-29 °C) to 145 °F (63 °C) with relative humidity from 0% to 100%. The glycol should be removed from the system if the unit is to be stored for extended periods. Although fluids can be drained via the plug in the bottom of the brazed plate heat

exchanger, the inhibitors are an approved glycol solution will best protect the surfaces of the load heat exchanger against oxidation if the glycol remains inside the unit during storage.

**Figure 20. Water/Glycol concentration freezing points (in degrees fahrenheit)**





# Controls Interface

## Microprocessor Control System

MAS air-source multipipe models employ a Carel c.pCO all-digital data control system to control and report key system settings and indicators.

### Primary Microprocessor Controller

Both the primary and secondary modules use a Carel c.pCO medium microprocessor controller.

Figure 21. c.pCO primary controller



### Secondary Microprocessor Controller

In a normal configuration, a secondary controller controls the single module to which it is dedicated. The distributed primary microprocessor controller system enables the multipipe to operate in the event the primary microprocessor controller fails. The system automatically fails over to distributed primary control where each secondary controller operates its own module but lacks the ability to communicate with the BMS and rotate the lead compressors every 168 system operating hours.

### Touchscreen Interface Panel

The touchscreen interface panel is the primary means for controlling and monitoring the system. See the following figure.

Figure 22. Touch interface panel



### Operator Control and Monitoring

Each system is provided with a touchscreen interface panel that is used to turn the system on and off, adjust set points, clear alarms, and perform detailed set-up of the microprocessor controllers.

### Multipipe Control

The operator uses three different types of controls and indicators to monitor and maintain the desired operating parameters in the multipipe - Power Distribution, Electrical Controls, and Refrigeration Controls. These controls and indicators are located in the power panels and the microprocessor controllers.

### Power Distribution

There are two different types of electrical panels used in the multipipe. The main power distribution panel receives power from the building source and distributes it to the individual modules. The individual module electrical and control panel receives power from the power distribution panel and provides power to modules electrical components.

**⚠ WARNING**

**Hazardous Voltage!**  
 Failure to disconnect power before servicing could result in death or serious injury.  
 Disconnect all electric power, including remote disconnects before servicing. Follow proper lockout/tagout procedures to ensure the power can not be inadvertently energized. Verify that no power is present with a voltmeter.



### Main Power Distribution

The power distribution panel distributes electricity from the external building power supply. It also houses a circuit breaker for each module, a phase monitor, and an optional main power disconnect switch. See below figure.

**Figure 23. Power distribution panel**



### Panel Disconnect

Some systems are optionally equipped with a panel-mounted disconnect switch installed on the outside of the power distribution panel. The disconnect switch must be turned to the OFF position before the panel can be opened for service.

#### **⚠ WARNING**

#### **PPE for Arc/Flash Required!**

Failure to wear appropriate PPE could result in death or serious injury.

On this unit, if the handle shield is cracked the circuit breaker could arc/flash when reset. To avoid being injured, technicians **MUST** put on all necessary Personal Protective Equipment (PPE), in accordance with NFPA70E for arc/flash protection, **PRIOR** to entering the starter panel cabinet.

#### **NOTICE**

#### **Component Damage!**

Failure to follow instructions could damage sensitive electronic components beyond repair.

To prevent arcing or surges of electrical current, do not use wires or cables to jump components or bypass the manufacturer's safety systems.

### Module Electrical and Control Panel

The Electrical and Control Panel receives power from the power distribution panel and provides power to the individual electrical components in that module.

Each module has its own high voltage electrical panel and low voltage control panel that distributes electricity to individual components. It also has fuses and breakers, compressor switches, and the microprocessor controller.

### Electrical Controls

The MAS multipipe is provided with controls and indicators to monitor the electrical activity and notify operators if problems arise.

### Flow Switch

A flow switch is wired into the low voltage control circuitry used to detect the flow of liquid throughout the hydronic system. Flow switches are found on all brazed plate heat exchangers with isolation valves. Flow switches close when flow is detected allowing compressors to start. If there is no flow, compressors cannot operate.

After every multipipe powers on, all LEDs on the flow switch illuminate and go out again in sequence. The switch is ready for operation when an amber LED is visible on the switch display:



#### **NOTICE**

#### **Proof of Flow Switch!**

Failure to provide flow switches or jumping-out of switches could result in severe equipment damage. Evaporator and condenser water circuits require proof of flow switches.

- Failure to include the proof of flow devices and/or jumping out these devices could cause the unit to stop on a secondary level of protection.
- Frequent cycling on these higher level diagnostic devices could cause excessive thermal and pressure cycling of unit components (O-rings, gaskets, sensors, motors, controls, etc.) and/or freeze damage, resulting in premature failure of the chiller.

### Phase Monitor

A compressor can fail if operated in reverse for more than a minute. A phase monitor is used on three phase power systems to ensure that the electricity supplying the multipipe is configured appropriately. A phase monitor





## Controls Interface

prevents a motor from operating in reverse—if any of the three legs of power are landed incorrectly—and will shut the system down upon detection of a reversed phase condition.



### Refrigeration Controls

Mechanical controls on the refrigeration system are designed to provide safety for the major components and for proper operation of the system.

Pressure transducers convert pressure into an electronic signal that the microprocessor displays in pounds per square inch (psi). Transducers vary in pressure ranges that depend on the type of refrigerant used.

Temperature sensors transmit temperature data electronically to the microprocessor for display in either Fahrenheit (°F) or Celsius (°C).

### Expansion Valve

An expansion valve is a metering device controlling the flow of refrigerant to the load heat exchanger based on the superheat.

Superheat is factory-set for around 12 °F (6.7 °C). Close the valve to increase superheat. To accurately read superheat, install a temperature sensor at the load heat exchanger outlet. The sensor bulb should be located at the 4 o'clock or 8 o'clock positions on the pipe for the most accurate pressure measurement.

Ensure that the closed cell insulation covers the thermal expansion valve sensing bulb. If insulation is missing, the bulb will tend to feed more refrigerant to satisfy the superheat setting.

### Solenoid Valve

The liquid-line solenoid valve is used in the refrigeration cycle to prevent refrigerant from entering or migrating to an idle circuit, which helps avoid compressor failure.

### Actuating Ball Valves

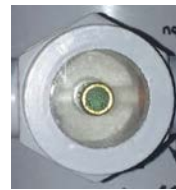
A flow control device which uses a hollow, perforated and pivoting ball to control liquid flowing through it. It is open when the ball's hole is in line with the flow inlet and closed when it is pivoted 90-degrees by the valve handle, blocking the flow. The handle lies flat in alignment with the flow when open, and is perpendicular to it when closed, making for easy visual confirmation of the valve's status.

### Electronic and Manual Isolation Valves

Each evaporator and condenser branch line includes a manual inlet and an electronic discharge butterfly valve that allows system flow to each active module to match the cooling or heating requirements of the system. By isolating individual modules that are not operating, the hydronic system can have variable primary flow to the modules. The valves are the slow opening type - to minimize the sudden change in flow to the previously active modules and have a minimum opening cycle time of 30 seconds between the fully closed and open position. The valves have a minimum close off pressure of 75 psi, have a maximum working pressure of 200 psi, and have roll grooved connections. The actuators are rated for 24 Vac.

### Sight Glass

A sight glass is located on the liquid line of the refrigeration piping on each circuit to view the condition of the refrigerant. When the sight glass shows a green indicator, no moisture is present. When the sight glass shows a yellow indicator, there is moisture in the refrigerant line. If the liquid line has bubbles – there is a liquid/vapor mix.



## NOTICE

### Equipment Damage!

**Failure to remove moisture from system could cause corrosion within the chiller/heater components, and degrade performance.**  
**Perform vacuum evacuation of system to remove moisture.**

### Low Pressure Bypass

A control that uses a time delay that temporarily bypasses the low-pressure switch for cold weather start up. Once the delay opens (times out) the normal controls are put back on line within the control circuit.

### High and Low Ambient Controls

Multipipe systems are designed to work efficiently across a wide range of ambient temperatures, both high and low. To maintain proper operation of the compressor in varying ambient temperatures, a head pressure control system has been developed. The head pressure control system helps to regulate the pressure of the refrigerant in the system, which in turn helps to maintain proper compressor operation. By controlling the head pressure, the compressor can operate within its designed envelope, which helps to ensure that the system is working at its highest level of efficiency.

### **Thermal Capacity**

The thermal capacity of the multipipe modules is dependent on the leaving temperature of the fluid maintaining a minimum fluid flow rate through the brazed

plate heat exchanger and keeping debris out of the aircoil. In applications where it is desired to operate with a lower flow rate or higher temperature change, consult technical support for recommendations.



# Sequence of Operations

This manual describes a typical air-source multipipe system with few, if any, optional components or devices attached.

## Bank Controls Sequence

MAS Bank consists of minimum of three and up to ten modules. First module always acts as a primary module for the Bank and the rest modules are secondary modules.

MAS Bank can operate in one of the thermal modes: Simultaneous, Cooling, and Heating

- **Simultaneous mode** – Modules are running to satisfy both cooling and heating loads. Simultaneous Mode is a preferable and recommended operational mode for the Bank, so the best efficiency can be achieved in this mode.
- **Cooling mode** – All the heating energy produced by running compressors is rejected to the atmosphere. Heating Demand is disabled.
- **Heating mode** – All the cooling energy produced by running compressors is absorbed by the atmosphere. Cooling Demand disabled.

Thermal Mode can be commanded from BMS or local display user interface.

- MAS Bank can be turned on and off from BMS via communication channel or via digital input signal DI 1 on the primary controller. Additionally, each module can be turned on and off individually by the same means.
- When MAS Bank turns on, primary module tries to identify the required number of secondary modules on the communication network according to the MAS Bank number of modules. secondary modules that respond to the primary controller, will become the part of the Bank, otherwise, non-responding modules, will run in stand-alone mode if corresponding conditions are met.

In addition to secondary modules communication conditions, primary controller has to meet other conditions to be able to act as a primary module, such as, Hot/Chilled System temperature control sensors have to be intact (depending on the Bank Thermal Mode) and primary controller itself has to communicate with other secondary controllers as well. When mentioned conditions are not met, all MAS modules will switch automatically to stand-alone mode.

Once primary and secondary modules have been claimed, primary controller defines the lead module which will keep its evaporator/condenser (if option selected and depending on the Bank Thermal Mode) isolation valves opened at all times to allow for flow circulation.

- Lead Module is rotated through MAS Bank based on time period or based on the chiller demand. Both options can be enabled/disabled individually. When

time rotation is enabled, rotation period has to expire before lead is rotated. Demand rotation rotates lead when the last compressor is staged off.

- When Bank is running in simultaneous mode, system cooling and heating demands are constantly updated based on system temperature sensors measurements and temperature setpoints.

Cooling/Heating demands are converted into called cooling/heating compressors respectively, which are distributed across the Bank, so modules will run in the following modes:

- Simultaneous Mode if number of called heating and cooling compressors are equal.
  - Simultaneous and Heating Mode or Heating dominant, if number of called heating compressors is higher than number of called cooling compressors.
  - Simultaneous and Cooling Mode or Cooling dominant, if number of called cooling compressors is higher than number of called heating compressors.
- When first cooling and heating compressors are called, first module starts up in simultaneous mode. By the time first module starts up, evaporator/condenser pumps are running at minimum speed providing minimum chilled/hot water flows sufficient for one module.
    - When number of cooling/heating compressors is high enough, next module is called to operate and so on.
    - Every time next module starts up, pumps are first allowed to ramp up to a required speed before verifying flow in corresponding loops for that module through local flow switches and then compressors are allowed to run.
  - This sequence will be followed until imbalance between cooling and heating loads occurs.
  - Heating prevalence occurs when heating demand gets ahead of cooling demand. This happens when either heating demand increases or cooling demand decreases.

If heating demand increases, all subsequent chiller modules will run in heating mode until heating load is satisfied.

If cooling demand decreases, available modules start running in heating mode accommodating **released** heating compressors until decreased number of simultaneous modules will match cooling load.

If cooling demand keeps decreasing further, it is possible that at some point cooling is no longer required. However, as long as MAS Bank remains in simultaneous mode, chilled water pumps will

maintain minimum speed standing by for cooling demand increase any time.

The same operational state can be achieved by switching MAS Bank in heating mode. The only difference is that chilled water pumps will be disabled since heating mode implies that no cooling is required.

- Cooling prevalence occurs when cooling demand gets ahead of heating demand. This happens when either cooling demand increases or heating demand decreases.

If cooling demand increases, all subsequent chiller modules will run in cooling mode until cooling load is satisfied.

If heating demand decreases, available modules start running in cooling mode accommodating **released** cooling compressors until decreased number of simultaneous modules will match heating load.

If heating is no longer required, all modules have switched over to cooling mode. Hot Water pumps, however, stay running maintaining minimum flow

and ready for heating demand increase any time.

Alternatively, MAS Bank switches over to cooling mode where hot water pumps will no longer run due to heating load being disabled.

- When Module is running in heating mode at low ambient temperature, Air-Source Coils of the module tend to frost up. The lower the ambient temperature, the faster frosting can develop. To avoid Air-Source Coils frosting, module intermittently goes in defrost mode when respective conditions are met.

When module runs in defrost mode, not only MAS Bank loses some heating capacity, that module runs a suction side refrigerant through condenser heat exchanger diminishing heating capacity even further.

To balance that out, only limited number of modules is allowed to run in defrost mode at the same time compared against number of modules running in heating or simultaneous mode. Besides, unbalanced heating capacity can be compensated by running additional modules in heating mode as driven by increased heating demand.



# Start-Up

## Preparation for Initial Start-Up

After the system is completely installed with all wires connected and all piping securely coupled, the air-source multipipe can be prepared for initial start-up.

Ensure there is a sufficient cooling or heating load available for proper testing of the multipipe system.

### **⚠ WARNING**

#### **Hazardous Voltage!**

Failure to disconnect power before servicing could result in death or serious injury.

Disconnect all electric power, including remote disconnects before servicing. Follow proper lockout/tagout procedures to ensure the power can not be inadvertently energized. Verify that no power is present with a voltmeter.

## Initial Start-Up

1. Close all drain valves and header purge valves.
2. Fill the module with clean fluid mixture.
3. Inspect all connections for leaks during the filling process.
4. De-energize the multipipe using industry-standard lockout/tagout procedures. Verify main power is turned off at the power distribution panel. Validate de-energization using voltage meter.

5. Inspect all electrical connections to ensure terminals are secure.
6. Inspect all fuses and overload settings to ensure they conform to specifications.
7. Inspect all refrigerant pressures for each module to ensure no refrigerant has been lost.
8. Confirm the oil level is correct in each compressor.

### **NOTICE**

#### **Compressor Failure!**

Failure to follow instructions below could result in catastrophic compressor failure.

**Do not operate with insufficient oil.**

9. Connect phase monitor wiring, if required.
10. Ensure refrigerant valves, if equipped, are open at the compressors.
11. Confirm that pressure and temperature switches are in the closed position.
12. Apply power to all modules in the system.
13. Turn on the load fluid pumps and ensure there is proper flow and the pressure drop across the system is as expected.

**Table 12. Initial start-up readiness checklist**

<input type="checkbox"/>	<b>Start-up Readiness Dimension</b>
<input type="checkbox"/>	Describe voltage service: <input type="checkbox"/> Fused disconnect <input type="checkbox"/> Non-fused disconnect <input type="checkbox"/> 50 Hz <input type="checkbox"/> 60 Hz
<input type="checkbox"/>	Record rated power supply: _____volts_____ phase • Circuit breaker rating: _____
<input type="checkbox"/>	Record supply voltage on the equipments nameplate: _____
<input type="checkbox"/>	Record power supply voltage to ground: L-1= _____, L-2 = _____, L-3 = _____
<input type="checkbox"/>	Record voltage between each phase: L-1 to L-2 = _____, L-2 to L-3 = _____, L-1 to L-3 = _____ <input type="checkbox"/> Agrees with nameplate values? <input type="checkbox"/> Voltages must be within 2%.
<input type="checkbox"/>	Check the box if all electrical connections inside the power distribution panel are tight.
<input type="checkbox"/>	Check the box if all electrical connections inside each module electrical and control panel are tight. Ensure all components inside each module are securely mounted and have not shifted during shipment.
<input type="checkbox"/>	Record the control voltage between TB-1-1 and TB-2-1: _____
<input type="checkbox"/>	Check the box if system includes any remote panels (city water switchover, remote control panel, or customer supplied control devices). If so, voltage drops are likely to occur. Measure and record all control voltages: List devices: Voltage 1= _____ Voltage 2= _____ Voltage 3= _____
<input type="checkbox"/>	Check the box if there are any field-supplied wiring junction boxes located between the multipipe and any remote panels.
<input type="checkbox"/>	Check the box if there are any splices made in the field-supplied wiring junction boxes.
<input type="checkbox"/>	Check the box if there are any customer-supplied devices connected to the multipipe wiring. List devices: _____
<input type="checkbox"/>	Check the box if there are any Trane remote devices connected to the multipipe wiring.
<input type="checkbox"/>	Check the box if voltage drops are detected.
<input type="checkbox"/>	Check the box if the appropriate water/glycol mixture has been added to the unit.
<input type="checkbox"/>	Check the box if all multipipe modules are installed with minimum clearances available from all sides.
<input type="checkbox"/>	Check the box if refrigeration gauges are indicating equal refrigerant pressures.
<input type="checkbox"/>	Check the box if chilled water lines from the multipipe to customers equipment are permanently connected.
<input type="checkbox"/>	Check the box if chilled water lines have been flushed clean of mud, slag, and other construction debris.
<input type="checkbox"/>	Check the box if all chilled water line filters and strainers are clean.
<input type="checkbox"/>	Check the box if chilled water lines have been leak tested according to pre-startup instructions.
<input type="checkbox"/>	Check the box if the multipipe reservoir (if included) is at operating level with correct water/glycol mixture.



## Start-Up

**Table 12. Initial start-up readiness checklist (continued)**

<input type="checkbox"/>	<b>Start-up Readiness Dimension</b>
<input type="checkbox"/>	Check the box if high voltage wiring is installed, tested, and functional.
<input type="checkbox"/>	Check the box if all water, refrigeration, and electrical connections between modules are completed.
<input type="checkbox"/>	Check the box if all control wiring between modules is installed, tested, and functional.
<input type="checkbox"/>	Check the box if control wiring is complete, including any remote interface panel or special-purpose wiring.
<input type="checkbox"/>	Check the box if all responsible installing contractors and sub-contractors have been notified to have representatives available on site to provide technical support for the initial start-up procedure.
<input type="checkbox"/>	Check the box if full load will be available for the multipipe on the initial start-up date.
<input type="checkbox"/>	Touchscreen Interface Panel: Record version and date of the software loaded into the touchscreen interface panel: Version: _____ Date: _____ <b>Note:</b> <i>To view the software version, from the home screen, press the software button on the System Control screen.</i>

## Start-Up

As part of a continuous commitment to quality, initial start-up of this system must be done by Trane.





# Maintenance Procedures

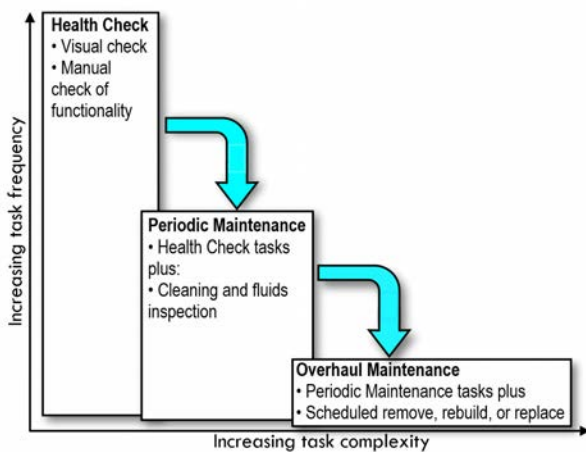
## Maintenance Strategy

The primary goal of preventive maintenance is to avoid the consequences of equipment failure. Trane chillers are designed for ease of access with a premium placed on locating key components to facilitate visual inspection and hands-on verification. One approach to chiller maintenance envisions three levels of maintenance effort reflecting frequent, periodic, and scheduled maintenance tasks, with each level building on the previous level. See below figure.

- A daily or weekly **health check** involves habitual visual and manual inspections of the components of the chiller so that anomalies become evident when they occur.
- Weekly or monthly periodic maintenance involves cleaning specific components and inspecting glycol and lubrication fluids.
- Prudent maintenance strategy will anticipate and schedule replacement or rebuilding of critical components before they fail and require emergency response to keep chillers operational.

Maintenance for HVAC equipment and facilities can include a **preventive maintenance checklist** which includes small checks which can significantly extend service life. Other considerations such as weather and equipment age are taken into account; maintenance and equipment replacement is often performed before the hottest time of the year.

**Figure 24. An approach to multipipe maintenance**



**Table 13. Recommended multipipe service intervals**

Task	Frequency
Visually inspect the equipment	Daily
Log pressure and temperatures	Daily
Inspect touchscreen interface panel for alarm history	Weekly

## Federal Clean Air Act

Responsible refrigerant practices are important to the environment, our customers, and the air conditioning industry. All technicians who handle refrigerants must be properly certified. The Federal Clean Air Act prescribes procedures for handling, reclaiming, recovering, and recycling of refrigerants and the equipment that must be used in maintenance procedures involving potential leakage of HVAC refrigerants. State and local governments may have additional requirements that must be followed to responsibly handle HVAC refrigerants.

## Inspection and Maintenance Schedule

Proactive measures should be taken to prevent potential problems with the system. These include maintaining an operational log and conducting weekly, quarterly, and annual inspections of the equipment. See following table.

### Daily

A daily visual inspection can reveal obvious problems. Keep notes of the multipipes performance:

- Log pressures and temperatures.
- Visual inspect of the unit.



## Maintenance Procedures

**Table 13. Recommended multipipe service intervals (continued)**

Task	Frequency
Clean strainers on the inlet water pipe	Monthly
Check the compressor oil level sight glass	Monthly
Confirm the glycol concentration	Monthly
Confirm the refrigeration pressures	Monthly
Check the refrigeration liquid line sight glass	Monthly
Inspect refrigerant pressures and temperature set points	Quarterly
Inspect superheat (10 °F to 12 °F [5°C to 6°C]) and sub-cooling temperatures (10°F to 15°F [5°C to 8°C])	Quarterly
Inspect the load heat exchanger entering and leaving evaporator temperature	Quarterly
Collect fluid mixture sample for analysis	Quarterly
Inspect crankcase heaters	Quarterly
Inspect piping for signs of leaks	Quarterly
Inspect refrigerant piping for oil or refrigerant leaks	Quarterly
Observe refrigeration operating pressures	Quarterly
Confirm motor amperage draw and voltage	Quarterly
Confirm multipipe superheat and sub-cooling	Quarterly
Check for worn or burned contactors	Quarterly
Inspect all electrical connections and fuses	Annually
Inspect each compressor for refrigerant pressures, overheating, oil leaks	Annually
Inspect compressor terminals for pitting, corrosion, and loose connections	Annually
Inspect compressor oil level	Annually
Confirm and record compressor amperage draw and voltage	Annually
Compare water/glycol flow against design specifications	Annually

### Weekly

Weekly inspection is a continuation and elaboration of daily best practice:

- Inspect touchscreen interface panel for alarm status and additions to the alarm history. (Do not clear alarms as this is a very important performance record if troubleshooting problems occur.)
- Notate and record any excessive vibrations or motor noise.
- Measure all refrigerant static pressure on any idle circuits. Record any significant changes or reductions in pressure.
- Initially, clean strainers weekly after start-up. Thereafter, inspect and clean strainers as needed.

### Monthly

The monthly maintenance inspection examines many items that generally require frequent attention. This routine event identifies small problems early before they can become big problems requiring serious repair and refurbishment:

1. Verify that the strainer(s) are clean.
2. Check the compressor oil level sight glass. The oil should always be clear and free-flowing. Any milky appearance indicates that liquid refrigerant is making its way back into the compressor and will cause premature compressor failure.

### NOTICE

#### Equipment Damage!

**Failure to remove moisture from system could cause corrosion within the chiller/heater components, and degrade performance.**

**Perform vacuum evacuation of system to remove moisture.**

3. When the compressor is not operating, the oil level should be at least at the bottom of the sight glass, up to two-thirds full. When the compressor is operating, the oil level will normally be at the bottom of the sight glass, or even below, but it must be visible.

### NOTICE

#### Compressor Failure!

Failure to follow instructions below could result in catastrophic compressor failure.

Do not operate with insufficient oil.

- Low oil sight glass conditions could signify an undercharged multipipe that lacks proper refrigerant velocity to return oil to the compressor sump. Eventually, dry compressor starts could occur causing premature compressor failure. This may indicate that some oil has been lost from a previous refrigerant leak repair. The compressor data label indicates the correct oil type and quantity with which it should be filled.

**Note:** A flashlight may be required to see the oil churning in the sump of the compressor. Adjusting the line of sight may be necessary to visually inspect the oil in the compressor sump during operation. At a minimum, the oil must be seen churning in the compressor sump. It should be clear.

### NOTICE

#### Compressor Failure!

Failure to follow instructions below could result in catastrophic compressor failure.

Do not operate with insufficient oil.

- Check the glycol concentration using a refractometer.
- Check the refrigeration pressures. For R454B refrigerant, low pressure refrigeration gauge must read 100 psi to 160 psi and high pressure refrigeration gauge must read 270 psi to 570 psi.

### NOTICE

#### Compressor Damage!

Failure to follow instructions below could result in extensive compressor damage.

Verify that suction pressure is sufficient. Secure the circuit or module offline until status can be examined in detail.

**Important:** Extended operation with suction pressures below 80 psi is a clear sign of insufficient refrigerant charge, refrigeration obstruction, or valve closed. This can cause extensive damage to a compressor.

- Check the refrigeration liquid line sight glass for persistent bubbles (**flashing**).

**Note:** Bubbles in the sight glass do not necessarily indicate loss or lack of refrigerant charge. Bubbles (commonly known as **flashing**) will occur whenever the condenser fans cycle until the expansion valve settles out the refrigerant flow. Occasional bubbles also form when the condenser head pressure control valve bypasses hot gas around the condenser coil in low ambient operation. If the refrigeration pressures are in the normal range, the unit is most likely adequately charged.

## Quarterly

The quarterly maintenance inspection is a comprehensive event that examines all aspects of the multipipe to identify early problems before they can cause damage and require major repair or refurbishment:

- Inspect alarm log, refrigerant operating/static pressures and temperature set points of each module independently.
- Inspect multipipe superheat and sub-cooling. System superheat should be 10 °F to 12 °F (5 °C to 6 °C). System sub-cooling should be 10+ °F (5 °C) depending on the ambient conditions.
- Inspect the approach delta T - entering heat exchanger fluid mixture temperature and leaving refrigerant temperature.
- Inspect strainers.
- Collect chilled fluid mixture sample for professional analysis. Check for cleanliness. Drain and refill with clean solution if excessive sludge or dirt is present. Flush the multipipe prior to refilling.
- Inspect fluid mixture levels. Add glycol as required.
- If equipped, inspect crankcase heaters for proper operation.
- Inspect the water piping for signs of leaks at joints and fittings.
- Inspect refrigerant piping circuit for signs of oil or refrigerant leakage. Conduct "sniffer test" to find refrigerant leaks. Inspect all pressure switch bellows.
- Tighten all refrigeration piping connections (e.g. Schrader valves, caps, and ball valves).
- Install a manifold and gauge set to observe refrigeration operating pressures.
  - Verify that the pressure controls (low pressure and high pressure switches) are **cutting in** and **cutting out** at the appropriate pressures.
  - Verify refrigerant charge by recording the superheat and sub-cooling temperatures.
  - Observe head pressure for signs of improper condensing from clogged strainers, or a modulating expansion valve issue.
- Check compressor motor amperage draws and voltage supplies and maintain a record of those values. Verify that they are within the name plate rating. Also, check for voltage imbalance. The phase monitor will open if the voltage imbalance exceeds 4%.
- Check for chattering, excessive wear or burned contacts. Replace contacts, if in doubt.

## Annually

The annual multipipe maintenance inspection is critical to the long-term performance of the system. Whether the equipment has a service life of 15 years or 30 years is almost entirely dependent upon how consistently and how



## Maintenance Procedures

diligently the annual maintenance inspection and tasks are performed. The annual event is a comprehensive inspection that examines all aspect of the multipipe to identify and repair small problems before they can become major issues that damage the system and require significant repair or refurbishment.

1. Inspect all electrical connections for damage and ensure terminals are tight. Inspect all contactors for pitting and corrosion and replace as necessary.

### **⚠ WARNING**

#### **Hazardous Voltage!**

**Failure to disconnect power before servicing could result in death or serious injury.**

**Disconnect all electric power, including remote disconnects before servicing. Follow proper lockout/tagout procedures to ensure the power can not be inadvertently energized. Verify that no power is present with a voltmeter.**

2. Inspect fuses to ensure they are secure, of correct amperage rating, undamaged and functioning.
3. Energize each compressor and check refrigerant pressures, signs of overheating, and oil leaks. Check for noises and for leaks with an electronic or bubble leak detector. Inspect flared fittings, refrigeration gauges, compressor connections, braze joints, pressure switches, and access ports on Schrader valves.

### **⚠ WARNING**

#### **Refrigerant under High Pressure!**

**Failure to follow instructions below could result in an explosion which could result in death or serious injury or equipment damage.**

**System contains refrigerant under high pressure. Recover refrigerant to relieve pressure before opening the system. See unit nameplate for refrigerant type. Do not use non-approved refrigerants, refrigerant substitutes, or refrigerant additives.**

4. Follow proper LOTO procedures to de-energize each module and inspect terminals for pitting, corrosion, and loose connections.
5. Inspect that the oil level is visible in each compressor and not discolored. Annual oil samples should be taken to be analyzed for destructive acids, corrosive materials, or metal deposits.
6. Inspect and record the compressor amperage draws and voltage.
7. Record fluid mixture flow to ensure it meets design specifications.
8. If equipped, tighten Rotalock fittings. The recommended torque is 80 ft-lbs for 2 inch and larger and 60 ft-lbs for Rotalock fittings smaller than 2 inches.

9. Inspect all copper lines and control capillary tubing to ensure that the lines are separated and not vibrating against one another or the frame or housing.
10. Ensure all refrigeration lines are properly supported to prevent vibration from causing premature failure of copper piping.
11. Inspect all insulation on piping and control sensors. Repair and replace as necessary.
12. Inspect entire plumbing system for leaks.
13. Review logged alarms and look for repetitive trends.
14. If equipped, inspect crankcase heaters to verify proper operation.
15. Sample refrigerant to analyze for moisture or acid.
16. Inspect operating pressures and temperatures and confirm the unit has a full refrigerant charge.

## Maintenance Tasks

The maintenance tasks described herein present the basic, minimal, steps required to successfully complete a task. Local policies and protocols may require more elaborate procedures with additional checks and inspections.

## Inspection Methods

Appropriate inspection for modern multipipe systems can be described as **hands on**. Where possible and appropriate, visual inspection should include touching the component or apparatus being inspected. The sense of touch provides additional feedback regarding temperature, texture, tightness, and dryness that **eyes only** inspection cannot match. Habitually touching each item to be inspected also ensures that items are not subconsciously skipped during the inspection process. For a summary of tasks, see [Table 13, p. 55](#).

### **⚠ WARNING**

#### **Hazardous Voltage!**

**Failure to disconnect power before servicing could result in death or serious injury.**

**Disconnect all electric power, including remote disconnects before servicing. Follow proper lockout/tagout procedures to ensure the power can not be inadvertently energized. Verify that no power is present with a voltmeter.**

## Critical Cleaning Tasks

Monitor temperature change and pressure drops across the load heat exchanger circuit to determine the frequency for strainer cleaning. Monitor water quality in the multipipes closed system to determine the optimum frequency for heat exchanger cleaning.

On multiple module multipipes, Trane provides service isolation valves on each load heat exchanger to isolate each strainer for cleaning without disrupting the operation of any remaining modules in the bank.

## Strainer Cleaning Procedure

Strainers at each load heat exchanger are critical for protecting the brazed plate heat exchangers small water passages as well as maintaining fluid mixture cleanliness. Service valves on the heat exchanger isolate each strainer for cleaning without interrupting the operation of other modules in the multipipe bank.

### **NOTICE**

#### **Equipment Damage!**

**Failure to follow instructions could result in equipment damage.**

**Do not operate without strainers in place.**

1. De-energize power to the module containing the strainer by turning the power OFF at the breaker and/or disconnect (follow proper LOTO procedure).
2. Close the electronic and manual isolation valves between the pipe headers and heat exchangers.
3. Remove the insulation to expose the roll grooved blind end cap or service cap on the end of the strainer housing. Utilize a short section of hose to connect to the valve on the end cap to relieve pressure and capture fluid. (Dispose of or re-utilize fluid mixture according to local protocols.)

### **CAUTION**

#### **Explosion Hazard!**

**Failure to relieve pressure gradually could result in minor to moderate injury and equipment damage. Water/glycol mixture can be under considerable hydraulic pressure in the strainer housing. Close isolation valves fully. Relieve pressure using a boiler vale. Use extreme care to slowly remove the end cap and release pressure gradually.**

4. Inspect the gasket and service cap for abrasions, tears, excessive dirt, or deterioration. Replace gasket if necessary.
5. Remove the strainer from the housing.
6. Clean the strainer inside and out using a soft natural bristle brush and water.
7. Clean the interior of the end cap (or service cap), and the gasket using a soft natural bristle brush and water. Apply a light coating of lubrication to the gasket.
8. Re-install the strainer in the housing (large end first). Replace the gasket and end cap and tighten coupling collar securely.
9. Ensure the fluid make-up system is operational to replenish the fluid mixture lost during the cleaning process.
10. Energize power to the module containing the strainer by turning power ON at the breaker and/or disconnect.

## Air Coil Cleaning Procedure

Fouling of air coil will result in a gradual decline in performance of the multipipe and is particularly significant during high ambient operation:

1. Turn off and **lock out** the power to the multipipe module (follow proper LOTO procedure).

### **WARNING**

#### **Hazardous Voltage!**

**Failure to disconnect power before servicing could result in death or serious injury.**

**Disconnect all electric power, including remote disconnects before servicing. Follow proper lockout/tagout procedures to ensure the power can not be inadvertently energized. Verify that no power is present with a voltmeter.**

2. Remove fan assembly to improve access to air coils.
3. Use a garden hose with spray nozzle or a long spray wand with a 90° turn spray head. (DO NOT use a pressure washer on air coils).

**Note:** *If the multipipe is equipped with EC-type fan motors, remove the compressor-side V-baffle end cap, instead.*

### **NOTICE**

#### **Coil Damage!**

**High pressure water from a power washer can damage and distort the cooling fins on the coil.**

**Using a pressure washer on condenser coils is not recommended. Damaged fins can adversely affect chiller efficiency.**

4. Clean coils by spraying water in the opposite direction of the air flow, from top of the coil to the bottom. Spray in a consistent pattern to work the dirt and debris from the top to the lower part of the coil.
5. For extremely dirty coils, chemical soaking may be required to loosen debris build-up. Apply chemicals with a hand-held pump sprayer following a similar pattern used in the water cleaning.
6. Let the chemical mixture soak in the heat exchanger for a short period of time to loosen sediment and scale build-up. Trane recommends using straight tap water except in extreme cases. (Take extra precautions by covering electrical components with plastic bags, etc.)
7. After chemical cleaning, all surfaces must be flushed thoroughly with clean water to remove residual chemicals. Trace chemical residue may result in premature aluminum fin breakdown and deterioration requiring coil replacement.
8. Securely reinstall fan grill assembly (or V-baffle end cap).
9. Turn power back on individual unit after ensuring all electrical connections are wiped dry.

10. Ensure that each units panels are clean and clear of debris.

### Heat Exchanger Cleaning Procedure



Trane recommends using SWEP Goodway® Technologies ScaleBreak-MP, an industrial biodegradable descaler which will quickly and effectively dissolve calcium, lime, rust and other water formed deposits from water cooled/ heated equipment.

- When applying ScaleBreak-MP in your equipment, it should be circulated through the water passages.
- As the product comes in contact with the deposits, they are dissolved into a liquid suspension.
- Upon completion of the cleaning, the used solution is freely flushed from the system along with the dissolved deposits leaving no residual solution.
- Optimal results are achieved when you pump into the bottom of the equipment and out the top. This method ensures the area to be cleaned was flooded, allowing ScaleBreak-MP to come in contact with all the deposits.

## Controller Tasks

### Replace PLC Logic Controller

Prior to servicing the controller, verify that the power to the system is disconnected.

1. Remove all quick-connect black plugs and the one orange plug (power supply 24 Vac).

#### **⚠ WARNING**

#### **Hazardous Voltage!**

**Failure to disconnect power before servicing could result in death or serious injury.**

**Disconnect all electric power, including remote disconnects before servicing. Follow proper lockout/tagout procedures to ensure the power can not be inadvertently energized. Verify that no power is present with a voltmeter.**

2. The PLC logic controller is DIN rail-mounted. Once plugs are removed, this will expose the gray secure tabs on the bottom rear of the PLC.
  3. Using a flathead screwdriver, insert screwdriver into the slotted holes on the gray tabs and use downward force to release PLC.
  4. Remove the PLC by lifting the bottom out and then up, off of the DIN rail.
  5. Replace new controller in reverse fashion.
- Note:** *On a multiple modular system with multiple PLCs, it is imperative that the new PLC has the exact same programming as the remaining PLCs or it will not be compatible and would create havoc within the other PLCs.*
6. Energize power to the module by turning power ON at the breaker and/or disconnect.



# Multipipe Troubleshooting

## General Approach to Fault Isolation

Trane manufactures equipment with embedded fault detection and diagnostics in each module's controller that offers continuous dedicated monitoring to record and report faults as they occur in real time allowing repairs to be performed in a timely manner.

Various faults occurring in a building's HVAC system can lead to unnecessary energy consumption and poor thermal comfort for a building's occupants. Fault detection and isolation plays a significant role in monitoring, maintaining,

and repairing components to improve operator safety and minimize operating costs.

Fault detection is recognizing that a problem has occurred, even if the root cause is not yet known. Fault isolation is the process of reducing potential causes to determine the most likely source of equipment failure.

## Controller Diagnostic Codes

The following table assists in explaining the alarm codes that appear in the remote interface panel in the event of an alarm. The alarm history is accessed by pressing the alarm log key.

Alarm	Type	Action
Secondary 1 communication lost	Auto Reset	Warning
Secondary 2 communication lost	Auto Reset	Warning
Secondary 3 communication lost	Auto Reset	Warning
Secondary 4 communication lost	Auto Reset	Warning
Secondary 5 communication lost	Auto Reset	Warning
Secondary 6 communication lost	Auto Reset	Warning
Secondary 7 communication lost	Auto Reset	Warning
Secondary 8 communication lost	Auto Reset	Warning
Secondary 9 communication lost	Auto Reset	Warning
System Chilled LWT too high	Auto Reset	Warning
System Hot LWT too low	Auto Reset	Warning
Wrong Primary rotation control parameters	Auto Reset	Warning
BMS offline	Auto Reset	Warning
cpCOe #1 UI1 sensor failure	Auto Reset	Switches Primary Module and Secondary Modules in Stand-alone Mode <sup>(a)</sup>
cpCOe #1 UI2 sensor failure	Auto Reset	Switches Primary Module and Secondary Modules in Stand-alone Mode <sup>(b)</sup>
cpCOe #1 UI3 sensor failure	Auto Reset	Switches Primary Module and Secondary Modules in Stand-alone Mode <sup>(a)</sup>
cpCOe #1 UI4 sensor failure	Auto Reset	Switches Primary Module and Secondary Modules in Stand-alone Mode <sup>(b)</sup>
cpCOe #1 UI7 sensor failure	Auto Reset	Switches to Internal Cooling Setpoint if External is selected
cpCOe #1 UI8 sensor failure	Auto Reset	Switches to Internal Heating Setpoint if External is selected
cpCOe #1 Offline Alarm	Auto Reset	Switches Primary Module and Secondary Modules in Stand-alone Mode
cpCOe #1 wrong config Alarm	Auto Reset	Warning
UI1 sensor failure	Auto Reset	Shuts down local cooling control <sup>(c)</sup>
UI2 sensor failure	Auto Reset	Shuts down local cooling control <sup>(d)</sup>
UI3 sensor failure	Auto Reset	Shuts down local heating control <sup>(c)</sup>





## Multipipe Troubleshooting

Alarm	Type	Action
UI4 sensor failure	Auto Reset	Shuts down module if LP Alarm Mode = Sensor (detailed under Setup)
UI5 sensor failure	Auto Reset	Shuts down module
UI6 sensor failure	Auto Reset	Shuts down local heating control <sup>(d)</sup>
UI7 sensor failure	Auto Reset	Warning
UI8 sensor failure	Auto Reset	Locks out module if it is running in Heating Mode
UI9 sensor failure	Auto Reset	Warning
UI10 sensor failure	Auto Reset	Warning
UI11 sensor failure	Auto Reset	Warning
UI12 sensor failure	Auto Reset	Warning
CoreSense 1 Warning	Auto Reset	Warning
CoreSense 1 Fault	Auto Reset	Shuts down compressor 1
CoreSense 1 Lockout	Auto Reset	Shuts down compressor 1 <sup>(e)</sup>
CoreSense 1 Failure	Auto Reset	Shuts down compressor 1
CoreSense 1 communication lost	Auto Reset	Shuts down compressor 1
CoreSense 2 Warning	Auto Reset	Warning
CoreSense 2 Fault	Auto Reset	Shuts down compressor 2
CoreSense 2 Lockout	Auto Reset	Shuts down compressor 2 <sup>(e)</sup>
CoreSense 2 Failure	Auto Reset	Shuts down compressor 2
CoreSense 2 communication lost	Auto Reset	Shuts down compressor 2
EVD #1 offline	Auto Reset	Warning
EVD #1 System Alarm	Auto Reset	Warning
EVD #1 Driver A Alarm	Auto Reset	Warning
EVD #1 Driver B Alarm	Auto Reset	Warning
EVD #2 offline	Auto Reset	Warning
EVD #2 System Alarm	Auto Reset	Warning
EVD #2 Driver A Alarm	Auto Reset	Warning
EVD #2 Driver B Alarm	Auto Reset	Warning
Evaporator Freezing Alarm	User Reset	Locks out module
Phase Monitor Alarm	Auto Reset	Locks out module
Evaporator Flow Alarm	User Reset	Locks out module
Condenser Flow Alarm	User Reset	Locks out module
Condenser LWT too low	Auto Reset	Warning
Evaporator LWT too high	Auto Reset	Warning
HP Alarm	User Reset	Locks out module
HP Switch Alarm	Auto Reset	Locks out module
LP Alarm	Auto Reset	Shuts down module
LP Lockout Alarm	User Reset	Locks out module
Error in the number of retain memory writings	User Reset	Warning

Alarm	Type	Action
Error in retain memory writings	User Reset	Warning
Wrong temperature control parameters	Auto Reset	Warning
Primary communication lost	Auto Reset	Switches Secondary Modules in Stand-alone Mode
cpCOe #2 Offline Alarm	Auto Reset	Locks out module
cpCOe #2 wrong config Alarm	Auto Reset	Warning
Valve D1 Opening Failure	User Reset	Locks out module
Valve D1 Closing Failure	User Reset	Locks out module
Valve D2 Opening Failure	User Reset	Locks out module
Valve D2 Closing Failure	User Reset	Locks out module
Valve S1 Opening Failure	User Reset	Locks out module
Valve S1 Closing Failure	User Reset	Locks out module
Valve S2 Opening Failure	User Reset	Locks out module
Valve S2 Closing Failure	User Reset	Locks out module
Valve S3 Opening Failure	User Reset	Locks out module
Valve S3 Closing Failure	User Reset	Locks out module
Differential Pressure low	User Reset	Locks out module
Incomplete Defrost Cycle	User Reset	Warning
Incomplete Defrost Cycle Lockout	User Reset	Locks out module
Ebm Papst Fan 1 Warning	Auto Reset	Warning
Ebm Papst Fan 1 Failure	User Reset	Shuts down Fan 1
Ebm Papst Fan 1 Offline	Auto Reset	Shuts down Fan 1
Ebm Papst Fan 2 Warning	Auto Reset	Warning
Ebm Papst Fan 2 Failure	User Reset	Shuts down Fan 2
Ebm Papst Fan 2 Offline	Auto Reset	Shuts down Fan 2
Ebm Papst Fan 3 Warning	Auto Reset	Warning
Ebm Papst Fan 3 Failure	User Reset	Shuts down Fan 3
Ebm Papst Fan 3 Offline	Auto Reset	Shuts down Fan 3
Ebm Papst Fan 4 Warning	Auto Reset	Warning
Ebm Papst Fan 4 Failure	User Reset	Shuts down Fan 4
Ebm Papst Fan 4 Offline	Auto Reset	Shuts down Fan 4

- (a) If EWT is selected as the cooling / heating temperature control sensor
- (b) If LWT is selected as the cooling / heating temperature control sensor
- (c) If EWT is selected as the cooling / heating temperature control sensor and module is running in stand-alone mode
- (d) If LWT is selected as the cooling / heating temperature control sensor and module is running in stand-alone mode
- (e) If both compressors are in lockout, that will in turn lock out the module

## Compressor Diagnostic Codes

Compressors used in Trane air-source multipipes use solid state protection and have PTC (Positive Temperature Coefficient) internal sensors with an avalanching resistance in the event of high temperatures. The sensors are calibrated for proper motor protection.

When any resistance of the thermistor chain reaches the tripping value, the module interrupts the control line and causes the compressor to switch off. After the thermistor has cooled sufficiently, its resistance drops to the reset value but the module itself resets after a time delay of 30 minutes and restarts the compressor.

## Multipipe Troubleshooting

### KRIWAN Flash Codes

The KRIWAN flash code allows for a quick and easy status display and troubleshooting.

The error code consists of a red and orange pulse frequency. They are continually displayed after each other.

There is a 1.5 second pause before the red pulse sequence. There is a 0.8 second pause between the red and orange pulse sequences. The error code can be determined from the number of pulsing flashes.

**Table 14. KRIWAN flash codes**



Error Category	1 <sup>st</sup> Flashing Sequence (red LED)	2 <sup>nd</sup> Flashing Sequence (orange LED)	Error Status
Motor temperature	1	1	Nominal response temperature of motor was exceeded
		2	Switch off due to blocked rotor
		3	Time delay active after motor temperature default
		4	Sensor fault motor PTC
		5	Time delay active after blocked rotor
General	3	1	Module undervoltage
		5	Time delay active, category general

### Phase Monitor Protection



If the system fails to power up, eliminate electrical phase issues by inspecting the phase monitor device located in the power distribution panel.

When all voltages are acceptable and the phase sequence is correct the output relay is energized and the LED glows green. Under-voltages and unbalanced voltages must be sensed for a continuous trip delay period before the relay de-energizes. Reset is automatic upon correction of the fault condition. The output relay will not energize if a fault condition is sensed as power is applied. The LED flashes red during the trip delay, then glows red when the output de-energizes. The LED flashes green/red if phase reversal is sensed.

**Table 15. LED phase monitor diagnostic codes**

LED Display	Indication
	Glowing green: All voltages are acceptable and phase sequence is correct.
	Flashing red: Trip delay prior to de-energizing. Glowing red: Output has been de-energized upon fault detection.

**Table 15. LED phase monitor diagnostic codes (continued)**

LED Display	Indication
	Flashing red and green: Phase reversal is detected.
	No power to phase monitor.

If the phase monitor fails to energize (the LED glows red) check wiring of all three phases, voltage, and phase sequence. If phase sequence is incorrect, the LED flashes green/red. To correct this, swap any two line voltage connections at the mounting socket. No further adjustment should be required.

### Symptoms and Solutions

This section lists the most common troubleshooting symptoms and the closest potential solution for each. This is not an exhaustive listing of all potential causes or resolutions, but represents the best direction in which to initiate a solution.

**Note:** An anti-short cycle timer is included in the primary microprocessor controller to prevent the compressors from starting until the delay has elapsed. The microprocessor also provides

minimum compressor run timers. Take these fixed timer parameters into consideration when conducting a fault isolation process.

<b>1. Symptom: Compressor will not start</b>	
<b>Possible Causes</b>	<b>Potential Solutions</b>
Temperature control not in demand	Check setpoint.
Flow switch open due to low water flow	Check flow switch functionality; check flow rate.
Low pressure, high pressure sensor open	Low/high pressure event has occurred; obstructed BPHE or coil; check fan settings and functionality; check sensor functionality.
High pressure switch open	High pressure event has occurred; check fan settings and functionality; check obstructed coils; check pressure switch functionality.
Compressor overload opened	Allow motor to cool and reset; High amp load/floodback; compressor operates outside of operating envelope.
No power to module	Check breakers and fuses; energize from module electrical and control panel.
Phase monitor open or tripped	Check phase sequence, unbalanced voltage, overvoltage, undervoltage; loss of phase.
Breaker tripped	Reset breaker; check amp draw, high refrigeration pressure, low voltage, and loose connection.
Overcurrent	Check overload (circuit breaker, compressor grounded).
Ambient temperature is lower than 0° F	Ambient temperature should be above 0° F.

<b>2. Symptom: Compressor will not run</b>	
<b>Possible Causes</b>	<b>Potential Solutions</b>
Ambient temperature is lower than -5° F	Ambient temperature should be above -5° F.
Main switch open or circuit breakers open	Check circuits and motor winding for shorts or grounds.
Fuse is blown	Replace fuse or reset breakers.
Investigate for possible overloading	Overloads are auto-reset. Monitor to assure the overload does not re-occur.
Defective contactor or coil	Determine type and cause. Correct fault before resetting safety.

<b>3. Symptom: Compressor has excessive noise or vibration</b>	
<b>Possible Causes</b>	<b>Potential Solutions</b>
Flooding of refrigerant back to compressor	Check setting of expansion valve; check crankcase heater.
Improper phase sequence	Check phase sequence.
Improper or worn compressor support (vibration-isolating mounting)	Replace support.
Faulty crankcase heater	Replace crankcase heater.

<b>4. Symptom: Compressor Loading/Unloading Cycles Too Short</b>	
<b>Possible Causes</b>	<b>Potential Solutions</b>
Temperature differential set too low	Ramp/set temperature differential setpoint; check stage up/down settings.
Incorrect liquid temperature settings	Select proper control settings.
Insufficient evaporator water flow	Check flow rate.
Low system liquid/water volume	Water system volume needs to be increased.



## Multipipe Troubleshooting

<b>5. Symptom: Compressor loses oil</b>	
<b>Possible Causes</b>	<b>Potential Solutions</b>
Low refrigerant charge	Check for leaks and repair. Add refrigerant to proper charge.
Oil trapped in the system	Low refrigerant velocity caused by operation outside operating envelope; check fan settings and functionality in heating mode.
Defective crankcase heater	Replace crankcase heater.
Compressor short cycling	Adjust proper control settings for Min. ON/OFF runtime.
Liquid refrigerant	Check compressor superheat. Superheat at the compressor suction should be approximately 12° F.

<b>6. Symptom: Low refrigeration suction pressure</b>	
<b>Possible Causes</b>	<b>Potential Solutions</b>
Lack of refrigerant	Check for leaks. repair and add charge.
Evaporator dirty	Clean with chemical.
Suction line blockage	Check suction line for any obstacle.
Condensing temperature too low	Check fan settings.
Low water temperature	Raise set point; Check design specification.
Low discharge pressure	Refrigerant charge; Replace compressor; check fan settings.
Improper expansion valve settings or defective EXV	Check EXV functionality and settings.
Compressor service valves closed	Dangerous! Turn counterclockwise completely.
Clogged liquid line filter-drier	Replace filter drier or cartridges.
Excessive glycol concentration	Charge to proper glycol concentration.
Liquid line solenoid restricted or faulty	Replace solenoid valve, coil, or internals as necessary.
Insufficient chilled water	Adjust flow rate through heat exchanger.
Restricted water/glycol line	Clean strainers; check manual and electronic valves.
Water/glycol mixture contaminated	Intensive cleanup effort needed to identify source of contamination; external filter may be required.
Evaporator clogged or fouled	Reverse flush with appropriate chemical solutions.
LP alarm: Heating to defrost	Check solenoid valve; check EXV start-up position settings on HMI (80%).
LP alarm: at the end of defrost	Check fan settings at defrost mode.
LP alarm: start at low ambient in heating mode	Checking EXV start-up delay (needs to be set at 12s).
Incorrect fan speed	Check fan settings.

<b>7. Symptom: High refrigeration suction pressure</b>	
<b>Possible Causes</b>	<b>Potential Solutions</b>
Incorrect fan speed in heating mode	Check fan settings.
Leakage refrigeration through solenoid bypass (from receiver to evaporator entrance in cooling mode)	Check bypass solenoid valve to be close completely when system gets stable in cooling mode.
High water temperature in heating mode	Check refrigerant charge, excessive load, and design specification.

<b>8. Symptom: Low refrigerant discharge pressure</b>	
<b>Possible Causes</b>	<b>Potential Solutions</b>
Insufficient refrigerant in the system ; Improper charge	Check for leaks, repair, and add refrigerant as needed.
Faulty compressor	Check compressor.
Low ambient conditions in cooling mode	Check design condition.
Low suction pressure	See 'Low refrigeration suction pressure'.
Incorrect fan control settings	Check fan settings.

<b>9. Symptom: High refrigerant discharge pressure</b>	
<b>Possible Causes</b>	<b>Potential Solutions</b>
System overcharged with refrigerant (especially at low ambient temperature in heating mode)	Remove excess refrigerant.
Dirty tube and fin surface	Clean with compressed air or water spray; use fin comb if fins are bent.
Non-condensables in heating mode	Purge non-condensables.
Incorrect fan control settings	Check fan functionality and settings.
Condensing fans not operating in cooling mode	Check fan functionality and settings.
Discharge shut off valve partially closed	Open valve.
EXV does not function properly (especially at low ambient in heating mode)	Check EXV functions; check SSH settings.
Overshooting LWT temperature in heating mode	Water system volume needs to increase; check stage band control settings.

<b>10. Symptom: Low chilled water temperature</b>	
<b>Possible Causes</b>	<b>Potential Solutions</b>
Temperature controllers set too low	Reset temperature setpoint.
Low water flow	Clean strainer; check pump, VFD, and differential pressure settings; check to ensure electric and manual water valves are fully open.
Faulty system temperature sensor	Replace temperature sensor.

<b>11. Symptom: High chilled water temperature</b>	
<b>Possible Causes</b>	<b>Potential Solutions</b>
Load higher than capacity of units	Refer to unit design specifications.
Loss of refrigeration charge	Check refrigerant charge.
Fouled evaporator	Reverse flush evaporator; check strainer for debris.
High water flow rate	Check pump, VFD and differential pressure settings.
Faulty system temperature sensor	Replace temperature sensor.

<b>12. Symptom: Compressor thermal protector switch open</b>	
<b>Possible Causes</b>	<b>Potential Solutions</b>
Operating beyond design conditions	Check fan switch or fan pressure settings as appropriate.
Discharge valve partially shut	Open valve.
Faulty compressor overload	Replace overload if external type provided.



## Multipipe Troubleshooting

13. Symptom: No low voltage (24 Vac)	
Possible Causes	Potential Solutions
Transformer primary side fuse open	Check fuse prong contact points; Replace fuse.
Transformer defective	Replace transformer.
No primary voltage on transformer	Check breakers, fuses; check power supply specifications.

14. Symptom: Thermal Expansion valve superheat too high	
Possible Causes	Potential Solutions
Water/glycol temperature too warm	Check setpoints; check charge.
Obstructed filter dryer	Replace dryer core.
Low refrigerant charge	Recharge refrigerant as per nameplate.
Improper and not enough heat transfer at air coil	Check tube and fin surface; check fan settings.
Sensing bulb not properly located	Check if secured to pipe or insulated; check sensor position on pipe.
Defective or improper settings of EXV	Check EXV functions; check EXV settings.

15. Symptom: Thermal expansion valve superheat too low	
Possible Causes	Potential Solutions
Sensing bulb not properly located	Check if secured to pipe or insulated; check sensor position on pipe.
EXV valve superheat setting is too low or not functioning properly	Check EXV settings and functionality.

16. Symptom: Contactor/relay inoperative	
Possible Causes	Potential Solutions
Coil shorted or open	Replace coil.
Mechanical parts broken or jammed	Replace assembly.
Contacts pitted or burned	Replace contactors.
No 24 Vac to coil	Replace secondary fuse to transformer; check transformer.

17. Symptom: Freeze protection safety activated	
Possible Causes	Potential Solutions
System setpoint is too low	Use a proper setpoint.
Low water flow	Clean strainer; check pump, VFD and differential pressure settings.
Low suction pressure	See "low suction pressure".





# Appendix A. Request for Initial Start-Up

## MAS Air-Source Multipipe

As part of a continuous commitment to quality, initial start-up of this equipment by a factory-certified technician may be purchased from Trane. No initial start-up will be scheduled without a Request for Initial Start-Up form completed and on file with the Trane customer service department. Submitting this form indicates that all critical

work described on the form has been completed. To prevent additional charges for aborted startups, the following items must be completely functional and operating and this form signed and returned to Trane at least 10 working days prior to the scheduled initial start-up date.

### Multipipe Initial Start-Up Data

Model Number:	Primary Module Serial Number:
Primary Contact Name:	Primary Contact Phone:
Primary Contact FAX:	Primary Contact Mobile:
Name of Job Site:	
Physical Location of Equipment:	
Requested Date for Initial Start-Up: Requested Time for Initial Start-Up:	

### Mandatory Initial Start-Up Requirements

Mandatory Tasks	Date Completed	Completed By (Initials)
All modules are installed with minimum clearances available from all sides.		
Refrigeration gauges are indicating equal pressures.		
Chilled water lines from system to customers equipment are permanently connected.		
Chilled water lines have been flushed clean of mud, slag, and other construction debris.		
All chilled water line filters and strainers are clean.		
Chilled water lines have been leak tested according to prestart instructions.		
Equipment reservoir (if included) is at operating level with correct water/glycol mixture.		
High voltage wiring is installed, tested, and functional.		
All water, refrigeration, electrical, and control connections between modules are completed.		
All control wiring between modular units is installed, tested, and functional.		
Control wiring is complete, including any remote interface panel or special-purpose module wiring.		
Automatic City Water Switchover (if included) is installed, flushed, and leak-tested.		
Condenser, if applicable, is installed, piped, wired, and leak-tested.		
All responsible installing contractors and sub-contractors are notified to have representatives available on site to provide technical support for the initial start-up procedure.		
Full load shall be available for equipment on the initial start-up date.		



## Request for Initial Start-Up

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# Initial Start-Up Agreement

By signing this form, you agree the system is ready for initial start-up. It is understood that, if the equipment is not ready for initial start-up due to site problems, the initial start-up will be aborted at the discretion of the designated

start-up technician. Payment for an aborted start-up will be forfeited. Rescheduled initial start-ups are subject to any additional costs that may have been incurred by the technician. An approved purchase order or payment in advance will be required to reschedule an aborted initial start-up.

Name (Printed): \_\_\_\_\_

Date: \_\_\_\_\_

Signature: \_\_\_\_\_

Company: \_\_\_\_\_



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