A NIBE GROUP MEMBER

Tranquility® Fluid Coolers (TFC) Series IOM

97B0091N02

TFC 036-060

Installation, Operation & Maintenance Instructions

Revised: November 9, 2023

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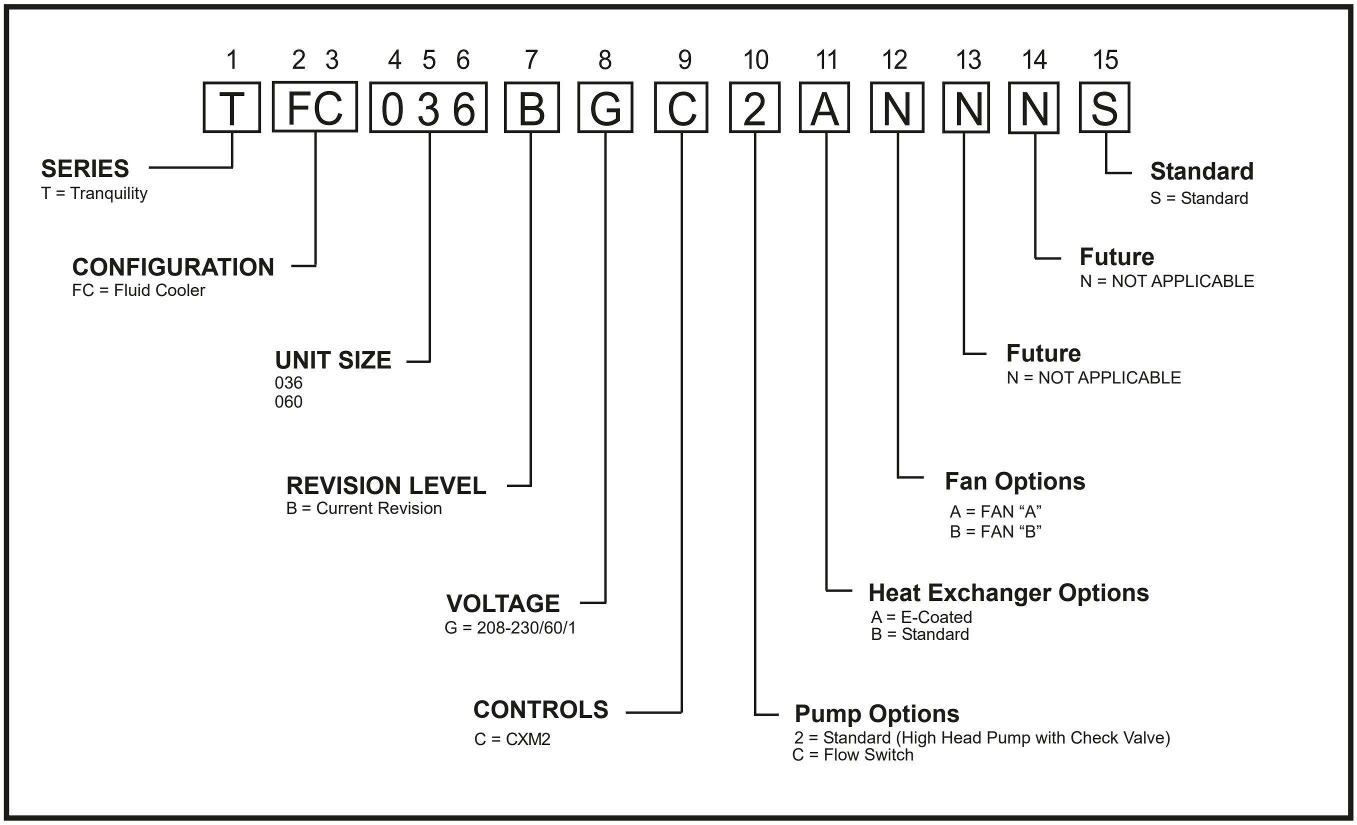
Model Nomenclature: Fluid Cooler



Safety

Safety
Warnings, cautions and notices appear throughout this manual. Read these items carefully before attempting any installation, service, or troubleshooting of the equipment.

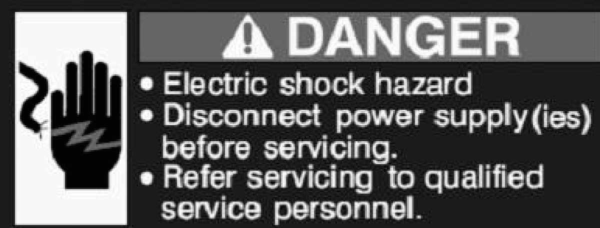
DANGER: Indicates an immediate hazardous situation, which if not avoided will result in death or serious injury. DANGER labels on unit access panels must be observed.

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

CAUTION: Indicates a potentially hazardous situation or an unsafe practice, which if not avoided could result in minor or moderate injury or product or property damage.

NOTICE: Notification of installation, operation or maintenance information, which is important, but which is not hazard-related.

The following warning complies with State of California law, Proposition 65.



CAUTION!

CAUTION! To avoid equipment damage, DO NOT use these units as a source of heating or cooling during the construction process. The mechanical components and filters can quickly become clogged with construction dirt and debris, which may cause system damage and void product warranty.

WARNING!

WARNING! This product can expose you to chemicals including Carbon Black, which is known to the State of California to cause cancer and Methanol, which is known to the State of California to cause birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov

General Information

Inspection
Upon receipt of the equipment, carefully check the shipment against the bill of lading. Make sure all units have been received. Inspect the packaging of each unit, and inspect each unit for damage. Insure that the carrier makes proper notation of any shortages or damage on all copies of the freight bill and completes a common carrier inspection report. Concealed damage not discovered during unloading must be reported within 60 days of receipt of shipment. To file a freight claim contact your ClimateMaster Customer Service Representative immediately upon discovery of damage or missing parts, but not more than 60 days after shipment. Contact ClimateMaster by telephone (800) 299-9747.

Storage
Equipment should be stored in its original packaging in a clean, dry area. Store units in an upright position at all times. Stack units a maximum of 2 units high.

Unit Protection
Cover units on the job site with either the original packaging or an equivalent protective covering. Cap the open ends of pipes stored on the job site. In areas where painting, plastering, and/or spraying has not been completed, precautions must be taken to avoid physical damage to the units and contamination by foreign material. Physical damage and contamination may prevent proper start-up and may result in costly equipment clean-up.

Examine all pipes, fittings, and valves before installing any of the system components. Remove any dirt or debris found in or on these components.

Pre-Installation
Installation, Operation, and Maintenance instructions are provided with each unit. The installation site chosen should include adequate service clearance around the unit. Before unit start-up, read all manuals and become familiar with the unit and its operation. Thoroughly check the system before operation.

⚠ CAUTION! ⚠

CAUTION! DO NOT store or install units in corrosive environments or in locations subject to temperature or humidity extremes (e.g., attics, garages, rooftops, etc.). Corrosive conditions and high temperature or humidity can significantly reduce performance, reliability, and service life. Always move and store units in an upright position. Tilting units on their sides will cause equipment damage.

⚠ CAUTION! ⚠

CAUTION! CUT HAZARD - Failure to follow this caution may result in personal injury. Sheet metal parts may have sharp edges or burrs. Use care and wear appropriate protective clothing, safety glasses and gloves when handling parts and servicing equipment.

Prepare units for installation as follows:
1. Compare the electrical data on the unit nameplate with ordering and shipping information to verify that the correct unit has been shipped.
2. Keep the cabinet covered with the original packaging until installation is complete and all plastering, painting, etc. is finished.
3. Verify tubing is free of kinks or dents and that it does not touch other unit components.
4. Inspect all electrical connections. Connections must be clean and tight at the terminals.
5. Locate and verify any accessory items that may be packaged inside the unit.

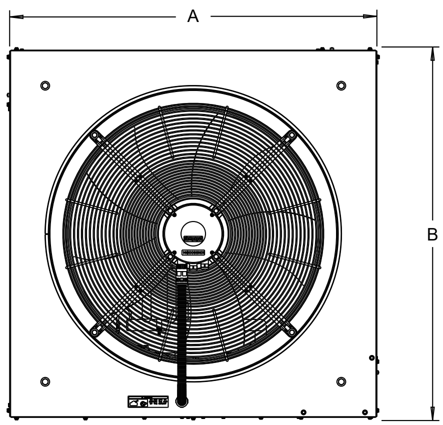
Unit Physical Data

Model	036	060
EC Axial Fan Motor		
Fan Size (in.)	20	25
Water Connection Size		
FPT (in.)	1 (Swivel)	
Air Coil		
Dimensions (H x W)	35” x 29”	
Rows	3	
FPI	12	
Weights		
Operating, lbs [kg]	304 [138]	315 [143]
Packaged, lbs [kg]	349 [158]	360 [163]
Total Fluid Volume, gal [L]	7.4 [28]	

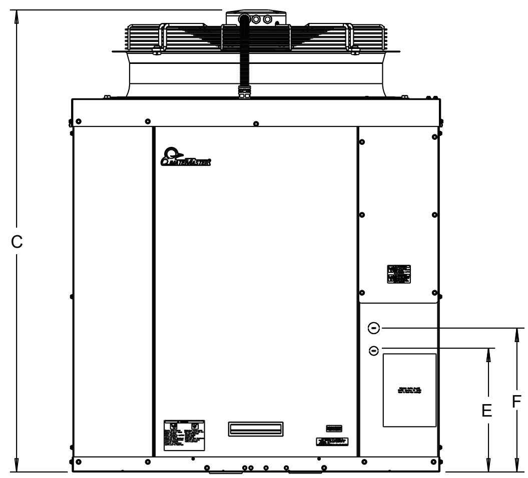
Unit Maximum Water Working Pressure	Max Pressure PSIG [kPa]
Pump Option	145 [1000]
Flow Switch Option	160 [1103]

Dimensional Data

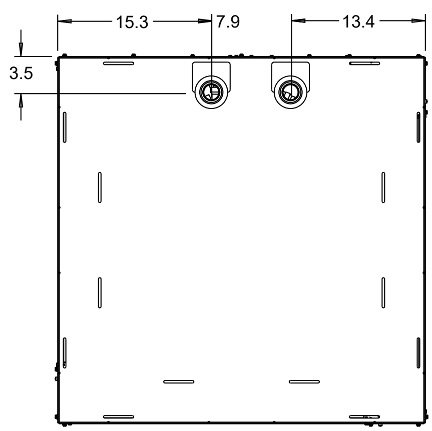
Model		Overall Cabinet			Electrical Knockouts	
		A	B	C	E	F
		Width	Depth	Height	1/2”	3/4”
036	in	36.5	36.5	44.1	12.1	14.3
	cm	92.7	92.7	112.0	30.7	36.3
060	in	36.5	36.5	45.9	12.1	14.3
	cm	92.7	92.7	116.6	30.7	36.3



TOP VIEW



FRONT VIEW



BOTTOM VIEW

Unit Application and Fluid Connections

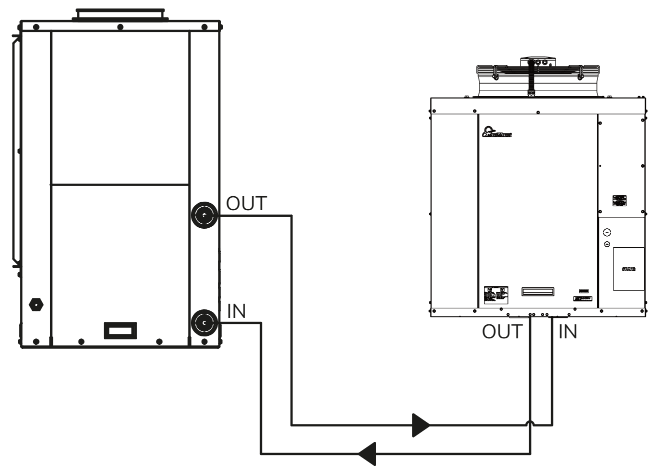
System Application and Configuration:
There are several different applications where a fluid cooler can be utilized when combined with a water-source or geothermal system. Two applications with their configurations are detailed below:

Stand-Alone
In a stand-alone application the fluid cooler is the only device utilized to reject or extract heat from the ambient air to a circulating fluid loop. Within this application there are two sub-applications. The first would be for an installation that doesn't want to have a refrigerant containing compressor section placed outdoors. The fluid cooler would be placed outdoors on a permanent installation pad much like a traditional air-source compressor section. The second is for a non-scheduled change-out where an owner wants to have a geothermal heat pump installed but there is a lead time for the geothermal loop to be installed. A fluid cooler would be temporarily installed with the new heat pump so the owners can have space conditioning while waiting for the loop installation to be completed. The fluid cooler would then be removed upon installation of the loop.

The TFC system has two different fluid circulation options for these applications. The first option has an internal flow switch inside the unit to validate flow in the system. The water source heat pump will contain a pump to circulate fluid throughout the system when a call is given from an indoor thermostat. The second option provides an internal pump in the TFC in installations where the water source heat pump does not have a circulator. As water circulates in both options, the fluid cooler recognizes flow and runs the fan at the appropriate speeds. This requires a performance match from the fluid cooler with the water source heat pump.

An example of this fluid circuit installation can be seen in Figure 1.

Figure 1: Stand Alone Circuit Schematic



Hybrid
In a hybrid application the fluid cooler is utilized as a supplementary device with a geothermal well field to extract heat in a circulating fluid loop. The hybrid system can allow for a reduction in total loop length to balance out the loads in a system over an annual basis. The geothermal loop acts as a "thermal battery" that can be recharged by the fluid cooler. The most common use for a hybrid system is in buildings which reject more heat to the ground annually. In this system, the geothermal loop will slowly warm up the far field ground temperature creating a "hot loop" condition. A fluid cooler allows for this excess heat to be rejected during favorable conditions which typically occur during the fall, spring and winter as the ambient temperatures will be less than the ground temperature.

Unit Application and Fluid Connections

The TFC fluid circulation options allow for three different installation types:

1. Series

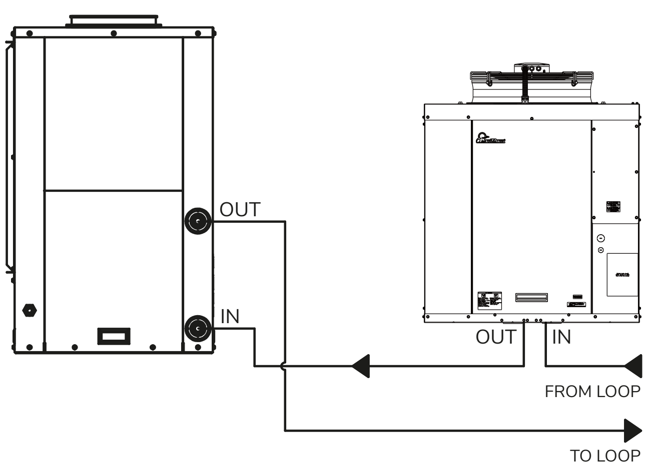
The fluid cooler is installed in series with the water source heat pump. Either fluid circulation option on the TFC can be used depending on the preference of the installer. As water circulates in both options, the fluid cooler recognizes flow and if conditions are favorable for heat rejection the fan runs at the appropriate speed.

When installed in a series configuration, the following conditions must be addressed:

- Piping into a larger tonnage system or a system with multiple units can negatively affect pump performance as the pressure drop through the fluid cooler becomes too large. Each system design should be reviewed to validate the pressure drop and flow requirements.
- The fluid cooler is only able to transfer heat to and from the loop when the heat pump circulator is in operation. This can limit favorable hours for which heat transfer can occur with the ambient air.

An example of this fluid circuit can be seen in Figure 2.

Figure 2: Series Piping Schematic



The fluid cooler above is shown to be placed on the leaving side of the loop field. This placement is ideal for maximum annual heat rejection but not for "peak temperature" reduction. For instance, if a hot loop condition is present in the system most of the annual rejection by the fluid cooler occurs during fall, winter and spring. This means the unit will be operating in space heating and the warmest water in the system would then be leaving the ground loop and returning to the unit.

2. Parallel

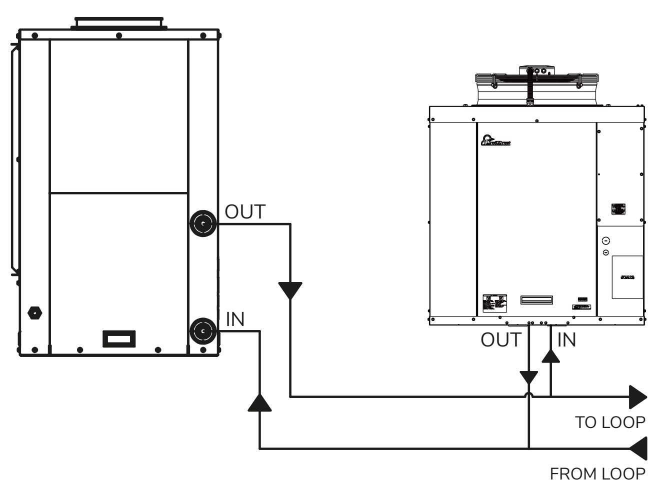
The fluid cooler is installed in parallel with the water source heat pump. The flow switch option is required for this installation option. As water is circulated from heat pump, the fluid cooler recognizes flow and if conditions are favorable for heat rejection the fan runs at the appropriate speed.

This application has an advantage and disadvantage:

- There is a reduced concern with added pressure drop when installed in parallel for larger tonnage system or a system with multiple units. Each system design should be reviewed to see if the pressure drop and flow with the system in parallel will create any potential risks.
- Flow is now split between the ground loop and fluid cooler. If the fluid cooler is not in operation the fluid that is bypassed will not be rejecting heat creating a slight inefficiency in the total system.
- The fluid cooler is only able to transfer heat to and from the loop when the heat pump circulator is in operation. This can limit favorable hours for which heat transfer can occur with the ambient air.

An example of this fluid circuit can be seen in Figure 3.

Figure 3: Parallel Piping Schematic



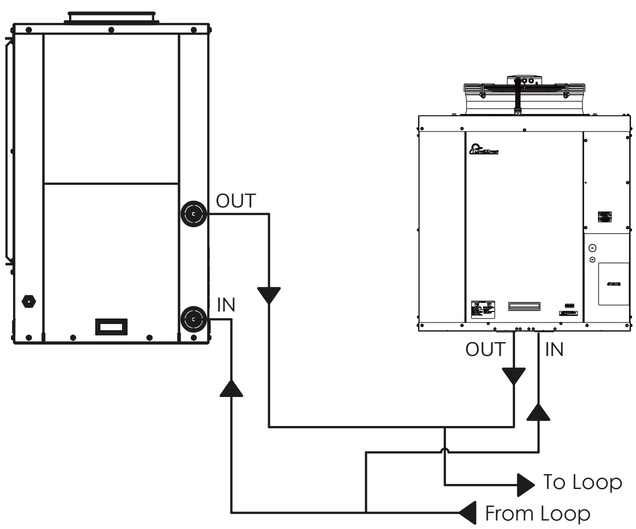
Unit Application and Fluid Connections

3. Pumped Parallel

Similar to the previous installation option, the fluid cooler is installed in parallel with the water source heat pump. The biggest change is the fluid cooler now requires the internal pump option and is now piped so the outlet of the fluid cooler and heat pump is on a common line. The fluid cooler monitors a signal from the heat pump and will turn on the circulating pump. If conditions are favorable for heat rejection the fan runs at the appropriate speed.

An example of this fluid circuit can be seen in Figure 4.

Figure 4: Pumped Parallel Piping Schematic



Installation

The installation of fluid cooler units and all associated components, parts and accessories which make up the installation shall be in accordance with the regulations of ALL authorities having jurisdiction and MUST conform to all applicable codes. It is the responsibility of the installing contractor to determine and comply with ALL applicable codes and regulations.

Pre-Installation

Prior to installation, locate and mark all existing underground utilities, piping, etc. Install loops for new construction before sidewalks, patios, driveways, and other construction has begun. During construction, accurately mark all ground loop piping on the plot plan as an aid in avoiding potential future damage to the installation.

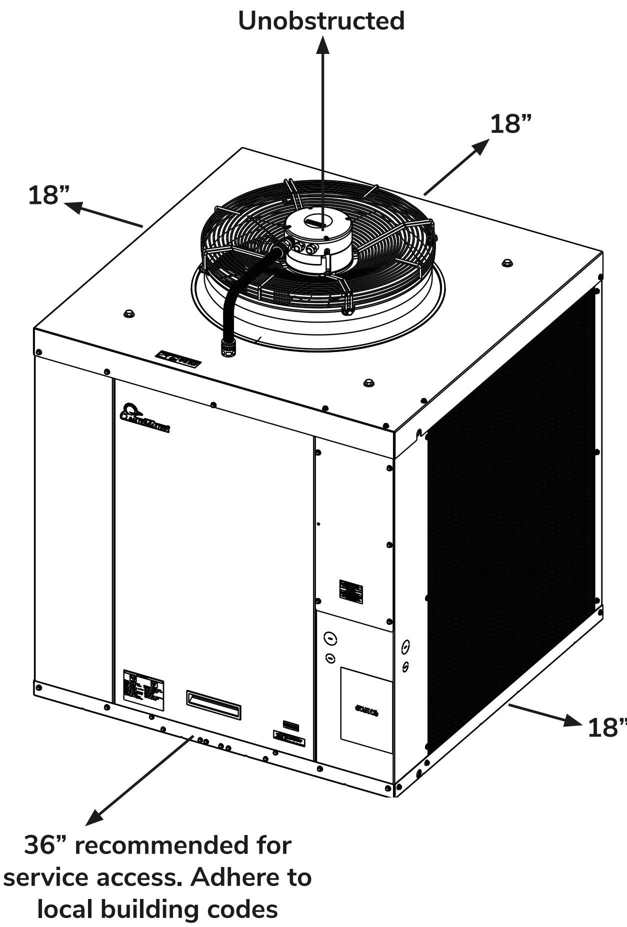
Unit Location

Locate the unit in an outdoor area that allows for adequate access for loop installation and also has appropriate space for service personnel to perform typical maintenance and repairs. The unit should be located away from buildings, landscaping, and other units by the dimensions given in Figure 5. Installation within six feet of a dryer or kitchen vent is not recommended. When possible do not install near occupied spaces like bedrooms or family rooms.

⚠ CAUTION! ⚠

CAUTION! To avoid equipment damage to units with a pump, DO NOT allow system water pressure to exceed 145 psi [1000 kPa]. The pump has a maximum working water pressure of 145 psi [1000 kPa]. Any pressure in excess of 145 psi [1000 kPa] may damage the pump.

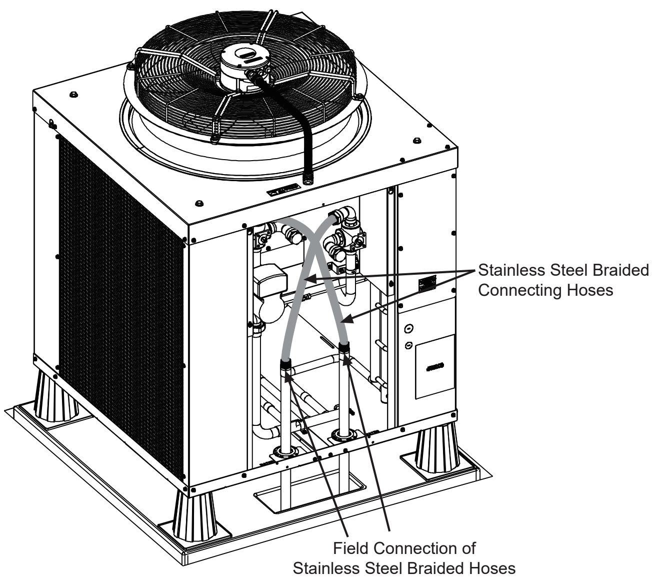
Figure 5: Unit with Clearance Dimensions in inches



Installation

Unit mounting
The unit should be mounted on a vibration isolation pad with loop access holes as shown in Figure 6. It is recommended that this pad extend past all four edges of the TFC unit. When mounting on an existing concrete pad, 3-inch holes should be bored through the pad to accommodate the pipe. The dimension for these holes can be found with unit dimensional data on Page 7.
In addition, risers should be installed per local code requirements.

Figure 6: Unit with Mounting Pad and Risers



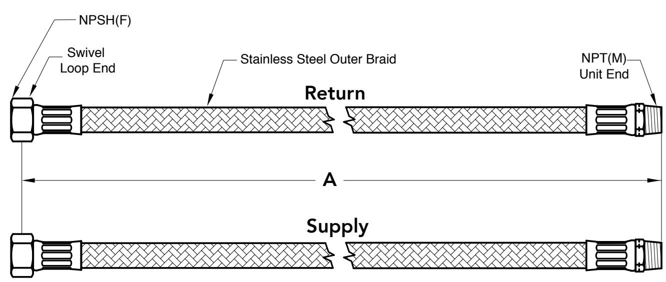
Risers are field supplied and should be installed per local code requirements.

Piping/Loop Installation
All earth loop piping materials should be polyethylene fusion only for in-ground sections of the loop and it is also recommended for inside piping. Galvanized or steel fittings should not be used at any time due to their tendency to corrode. All plastic to metal threaded fittings should be avoided due to their potential to leak over time.

The earth loop piping should be brought through the loop access holes in the mounting pad. The unit should then be placed onto the pad with the piping going through the provided bottom opening holes. Install the supplied pipe grommets and fitting plates. The polyethylene pipe can then be cut to the appropriate length and brass adapters fused for connection to the provided stainless steel braided hoses.

Piping Connections
TFC036 and 060 units are shipped with 1-inch stainless steel braided hoses connected to unit piping. Field connection end of hoses are gasketed female swivel.

Figure 7: Hose Kit



Flushing the Loop

Once piping is completed between the unit and the loop, final purging and charging of the loop is needed.

All air and debris must be removed from the loop piping system before operation.

A flush cart (at least a 1.5 hp [1.1 kW] pump) is needed to achieve adequate flow velocity in the loop to purge air and debris from the loop itself. Flush the loop with a high volume of water at a high velocity (2 fps [0.6 m/s] in all piping). Use a filter in the loop return line of the flush cart to remove debris from the system. Filtration of at least 100 microns should be used during the flushing process to ensure all debris is removed. See Table 1 to determine the flow rate required to attain 2 fps [0.6 m/s]. The TFC requires a minimum flow rate of 16 gpm [60.6 l/m] to achieve 2 fps. The steps below must be followed to ensure proper flushing.

Table 1: Minimum Flow Required to Achieve 2 ft/sec (0.6 m/s) Velocity

PE Pipe Size	Flow GPM [l/m]
3/4"	4 [15.14]
1"	6 [22.71]
1 1/4"	10 [37.85]
1 1/2"	13 [49.21]
2"	21 [79.49]

Units with internal variable speed pumps also include a check valve internal to the pump. It is not possible to flush backwards through this pump. Care must be taken to connect the flush cart hoses so that the flush cart discharge is connected to the “water in” flushing valve of the fluid cooler.

Loop Fill

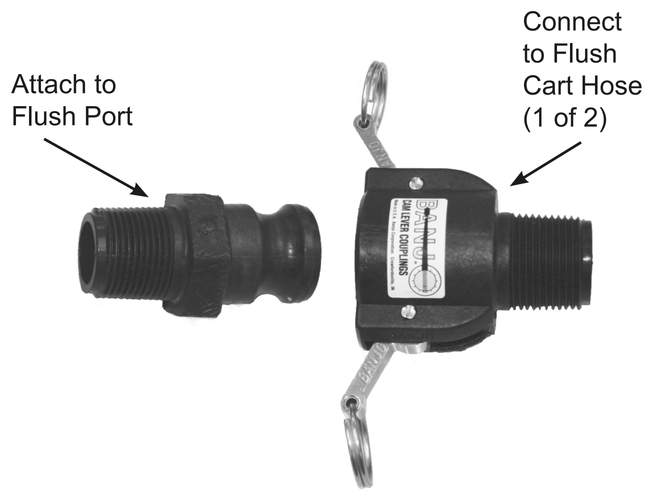
Place the water in and water out valves on the fluid cooler in valve position A, shown in Figure 9a. Connect a garden hose to the flush cart and fill the loop with water. The flush cart will ensure an even fill and increase flushing speed. When water consistently returns back to the flush reservoir, switch the valves to position B (Figure 9b).

⚠ WARNING! ⚠

WARNING! Disconnect electrical power source to prevent injury or death from electrical shock.

Figure 8a: Typical Cleanable Flush Cart Strainer (100 mesh [0.149 mm])

Figure 8b: Cam Fittings for Flush Cart Hoses



NOTICE: A hydrostatic pressure test is required on ALL piping, especially underground piping before final backfill per IGSHPA and the pipe manufacturers recommendations.

Flushing the Loop

Figure 9a: Valve Position A - Loop Fill/Flush

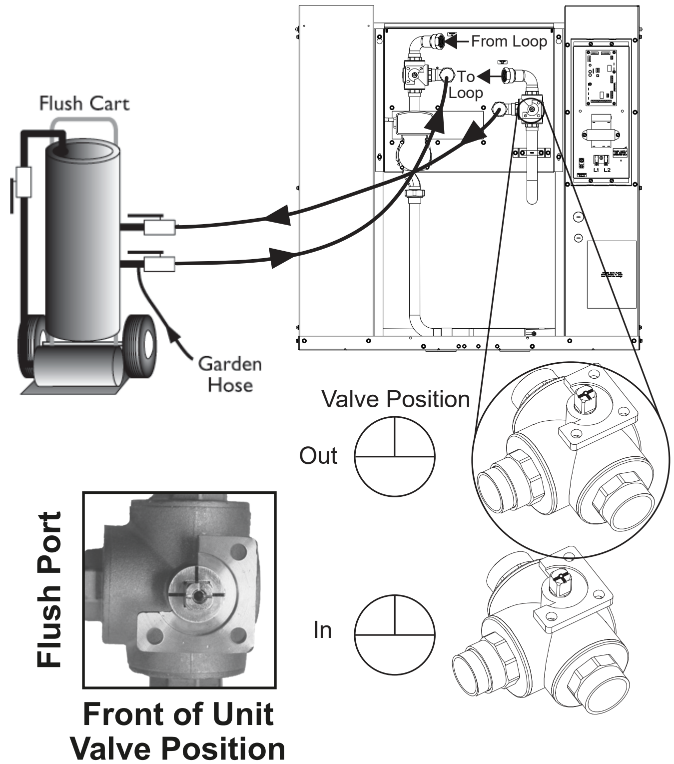
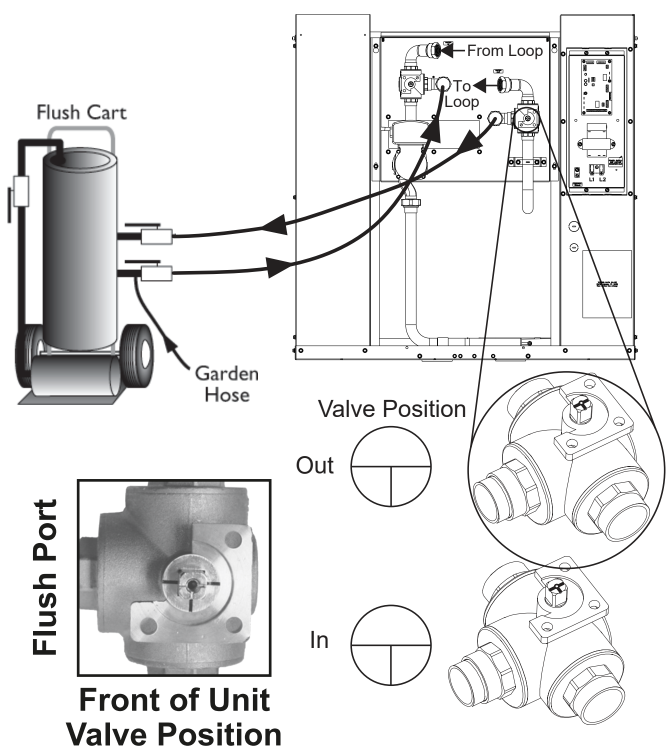


Figure 9b: Valve Position B - Unit Fill / Flush



With the valves still in position B, allow the flush cart to pump water into the system until water is consistently returned to the flush reservoir.

Return the valves to position A. To begin flushing, turn off the water from the garden hose and turn on the flush cart. Once the flush reservoir is full, do not allow the water level in the flush cart tank to drop below the pump inlet line, as this can result in air being pumped back into the system.

To purge air from the system, close the valve going into the flush cart reservoir. This should dead head the pump to max pumping pressure. Open the valve back up and a pressure surge will be sent through the loop, which forces air out of the piping system. Notice the drop in the fluid level in the flush cart tank. If all air is purged from the system, the level will only drop ⅜-inch in 10-inch diameter PVC flush tank (approximately 0.5 gallon [1.9 liters]). If the level drops more than this, flushing should continue until all air is removed from the loop.

NOTICE: Actual flushing time require will vary for each installation due to piping length, configuration, and flush cart pump capacity. ⅜-inch or less fluid level drop is the ONLY indication that flushing is complete.

Switch valves to Position B to flush the unit. Flush through the unit until all air pockets have been removed.

Move valves to position C. By switching both valves to this position, water will flow through the loop and the unit heat exchanger. Bleed air from the system using the three ports connected to the top of each coil header. The location of the ports can be seen in Figure 10. Finally, the dead head test should be checked again for an indication of air in the loop. Fluid level drop is your only indication of air in the loop.

Flushing the Loop.

Figure 9c: Valve Position C - Full Flush

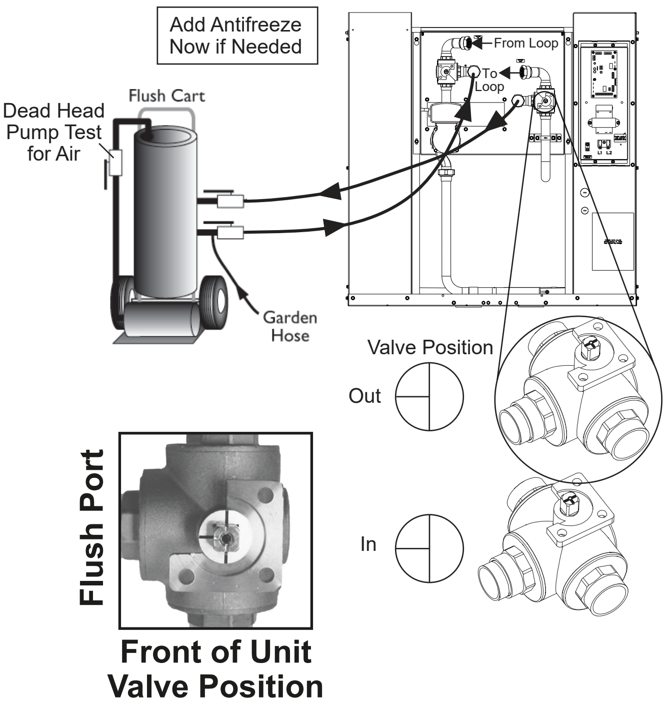
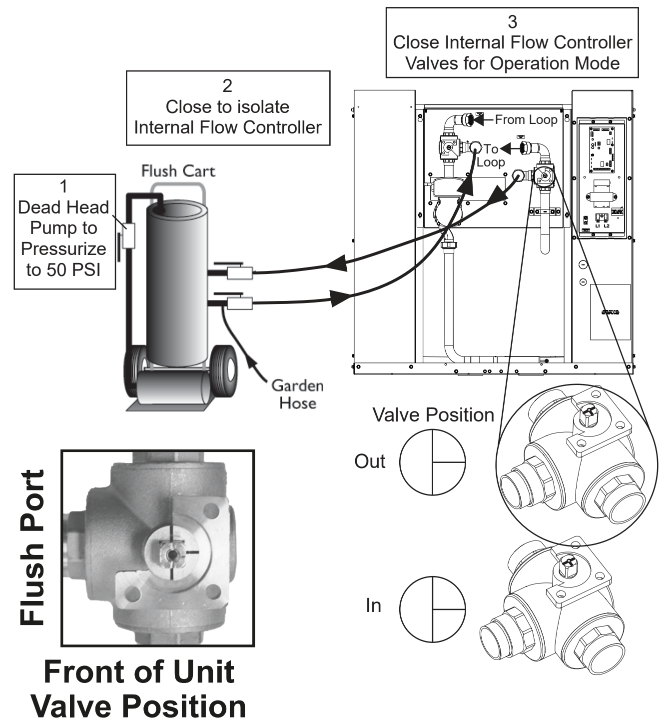


Figure 9d: Valve Position D - Pressurize and Operation



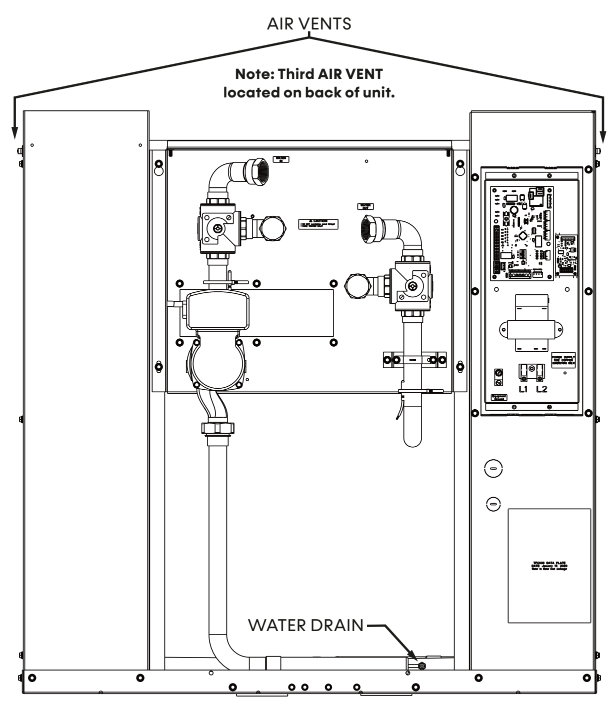
Pressurize and Operate
As shown in Figure 9d, close the flush cart return valve to pressurize the loop to at least 50 psi [517 kPA]. After pressurizing, close the flush cart supply valve to isolate the flush cart. Move the Fluid cooler water in and water out valves to position D.

If the loop pressure is between 50 and 75 psi [345 to 517 kPa] upon completion of flushing, pressure should be sufficient for all seasons.

Unhook the flush cart from the fluid cooler. Install caps on the fluid cooler water inlet and outlet to prevent and leaks.

NOTICE: It is recommended to run the unit for 15-20 minutes to 'temper' the fluid temperature and prepare it for pressurization. This procedure helps prevent the periodic "flat" loop condition of no pressure.

Figure 10: Air Bleed Vents



Loop Antifreeze Protection

Antifreeze Selection - General
Antifreeze is required if the system can be subjected to ambient temperatures below 35°F. Alcohols and glycols are commonly used as antifreeze solutions. Your local representative should be consulted for the antifreeze best suited to your area. In the event of a power outage, low temperature protection should be maintained in the system to the lowest subjected ambient conditions.

Initially calculate the total volume of fluid in the piping system using Table 2. Then use the percentage by volume shown in Table 3 for the amount of antifreeze. If the minimum ambient temperature that can be reached is less than shown in Table 3 please contact your local representative for the appropriate percentage to protect the system. Antifreeze concentration should be checked from a well mixed sample using a hydrometer to measure specific gravity.

Table 2: Fluid Volume

Fluid Volume (gal [liters] per 100' [30 meters] Pipe)		
Pipe	Size	Volume (gal) [liters]
Copper	1"	4.1 [15.3]
	1.25"	6.4 [23.8]
	2.5"	9.2 [34.3]
Polyethylene	3/4" IPS SDR11	2.8 [10.4]
	1" IPS SDR11	4.5 [16.7]
	1.25" IPS SDR11	8.0 [29.8]
	1.5" IPS SDR11	10.9 [40.7]
	2" IPS SDR11	18.0 [67.0]
Fluid Cooler	036/060	7.4 [28]
Flush Cart Tank	10" Dia x 3ft tall [25.4cm x 91.4cm tall]	10 [37.9]

⚠ WARNING! ⚠

WARNING! Always dilute alcohols with water (at least 50% solution) before using. Alcohol fumes are flammable and can cause serious injury or death if not handled properly.

When handling methanol (or any alcohol), always wear eye protection and rubber gloves as alcohols are easily absorbed through the skin.

Table 3: Antifreeze Percentages by Volume

Type	Minimum Temperature for Low Temperature Protection			
	10°F [-12.2°C]	15°F [-9.4°C]	20°F [-6.7°C]	25°F [-3.9°C]
Methanol	21%	17%	13%	8%
Propylene Glycol	29%	24%	18%	12%
Ethanol*	23%	20%	16%	11%

* Must not be denatured with any petroleum based product

Contact your ClimateMaster distributor if you have any questions as to antifreeze selection.

⚠ WARNING! ⚠

WARNING! Always use properly marked vehicles (D.O.T. placards), and clean/suitable/properly identified containers for handling flammable antifreeze mixtures. Post and advise those on the jobsite of chemical use and potential dangers of handling and storage.

NOTICE: DO NOT use automotive windshield washer fluid as antifreeze. Washer fluid contains chemicals that will cause foaming.

⚠ CAUTION! ⚠

CAUTION! Always obtain MSDS safety sheets for all chemicals used in ground loop applications including chemicals used as antifreeze.

Antifreeze Charging
It is highly recommended to utilize premixed antifreeze fluid where possible to alleviate many installation problems and extra labor.

The following procedure is based upon pure antifreeze and can be implemented during the Full Flush procedure with three way valves in the Figure 10c - Valve Position C. If a premixed mixture of 15°F [-9.4°C] low temperature protection is used, the system can be filled and flushed with the premix directly to prevent handling pure antifreeze during the installation.

1. Flush loop until all air has been purged from system and pressurize to check for leaks before adding any antifreeze.
2. Run discharge line to a drain and hook up antifreeze drum to suction side of pump (if not adding below water level through approved container). Drain flush cart reservoir down to pump suction inlet so reservoir can accept the volume of antifreeze to be added.
3. Calculate the amount of antifreeze required by first calculating the total fluid volume of the loop from Table 2. Then calculate the amount of antifreeze needed using Table 3 for the appropriate low temperature protection level. Many southern applications require low temperature protection because of exposed piping to ambient conditions.
4. Isolate unit and prepare to flush only through loop (see Figure 10a). Start flush cart, and gradually introduce the required amount of liquid to the flush cart tank (always introduce alcohols under water or use suction of pump to draw in directly to prevent fuming) until attaining the proper antifreeze protection. The rise

Loop Antifreeze Protection

in flush reservoir level indicates amount of antifreeze added (some carts are marked with measurements in gallons or liters). A ten inch [25.4 cm] diameter cylinder, 3 foot [91.4 cm] tall holds approximately 8 gallons [30.3 liters] of fluid plus the hoses (approx. 2 gallons, [7.6 liters], which equals about 10 gallons [37.9 liters] total. If more than one tankful is required, the tank should be drained immediately by opening the waste valve of the flush cart noting the color of the discharge fluid. Adding food coloring to the antifreeze can help indicate where the antifreeze is in the circuit and prevents the dumping of antifreeze out the waste port. Repeat if necessary.

5. Open flush valves to flush through both the unit and the loop and flush until fluid is homogenous and mixed. It is recommended to run the unit for 15-20 minutes to ‘temper’ the fluid temperature and prepare it for pressurization. Devoting this time to clean up can be useful. This procedure helps prevent the periodic “flat” loop condition.
6. Close the flush cart return valve; and immediately thereafter, close the flush cart supply valve, leaving a positive pressure in the loop of approximately 50 psi [345 kPa]. This is a good time to pressure check the system as well. Check the low temperature protection of the fluid with the proper hydrometer to ensure that the correct amount of antifreeze has been added to the system. The hydrometer can be dropped into the flush reservoir and the reading compared to Chart 1a for Methanol, 1b for Propylene Glycol, and 1c for Ethanol to indicate the level of low temperature protection. Do not antifreeze more than a +10°F [-12.2°C] freeze point. Specific gravity hydrometers are available in the residential price list. Repeat after reopening and flushing for a minute to ensure good second sample of fluid. Inadequate antifreeze protection can cause nuisance low temperature lockouts during cold weather.
7. Close the flush cart return valve; immediately thereafter, close the flush cart supply valve, shut off the flush cart leaving a positive pressure in the loop of approximately 50-75 psi [345-517 kPa]. Refer to Figure 10d for more details.

⚠ WARNING! ⚠

WARNING! Always dilute alcohols with water (at least 50% solution) before using. Alcohol fumes are flammable and can cause serious injury or death if not handled properly.

When handling methanol (or any alcohol), always wear eye protection and rubber gloves as alcohols are easily absorbed through the skin.

Chart 1a: Methanol Specific Gravity

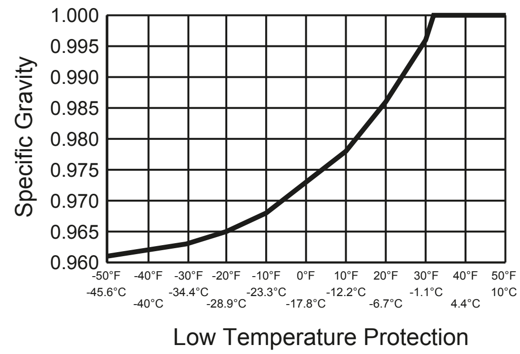


Chart 1b: Propylene Glycol Specific Gravity

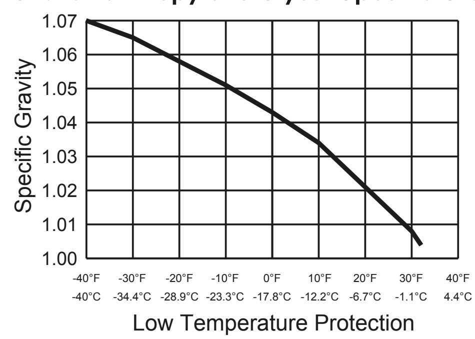
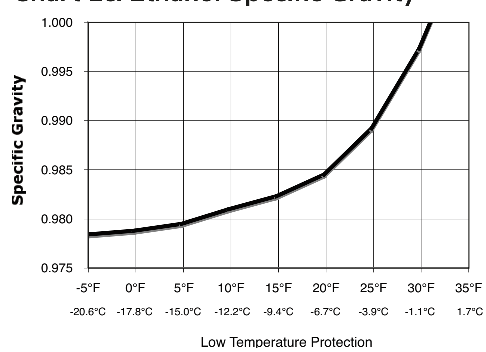


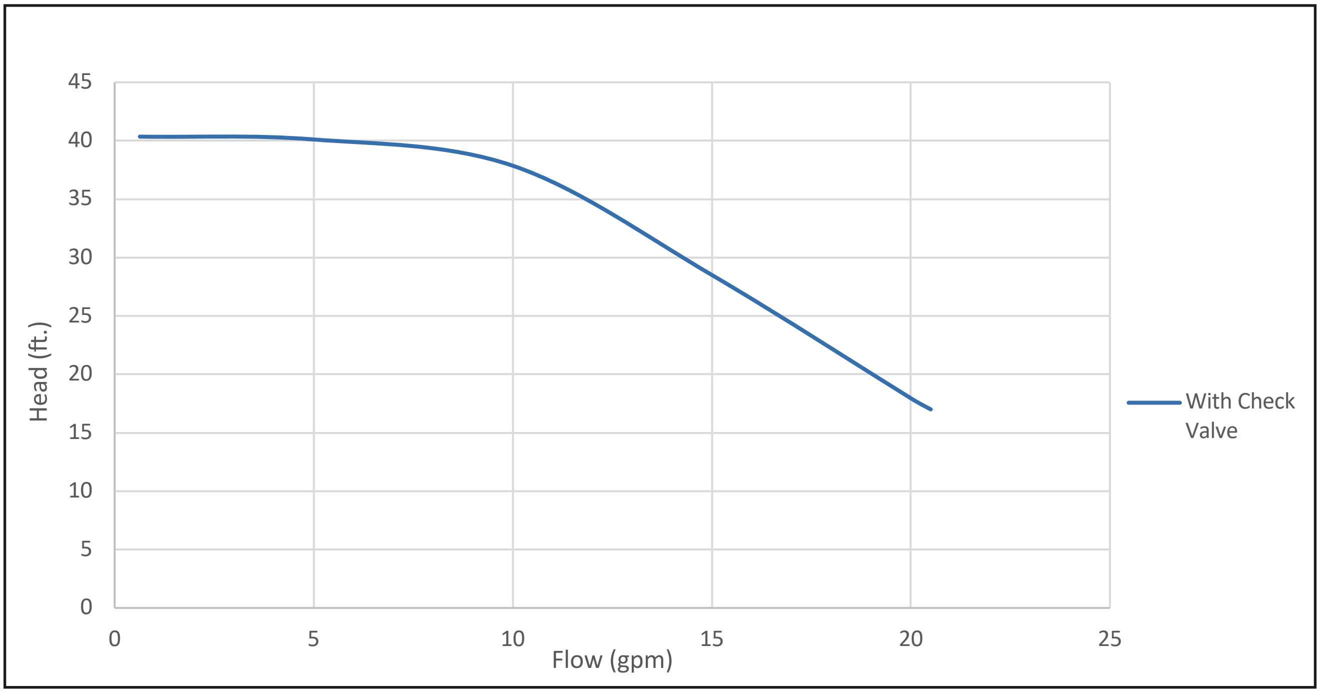
Chart 1c: Ethanol Specific Gravity



Low Water Temperature Cutout Setting - CXM2 Control
When antifreeze is selected, the Target Leaving Water Temperature setting can be adjusted below the default (45°F). (see “Low Water Temperature Operation” in this manual for further details).

Optional Internal Pump

Figure 11: High Head Variable Pump Performance



Determine overall system pressure drop and compare to Figure 11 to ensure that adequate fluid flow can be provided. Unit pressure drop is shown on the Performance/Pressure Drop pages of this manual.

***Note: If head pressure required exceeds pump capacity, then a external pump may be required.**

Water Quality Standards

Table 4: Water Quality Standards

Clean water is essential to the performance and life span of water source heat pumps. Contaminants, chemicals, and minerals all have the potential to cause damage to the water heat heat exchanger if not treated properly. All closed water loop systems should undergo water quality testing and be maintained to the water quality standards listed in this table.

WATER QUALITY REQUIREMENTS

For Closed-Loop and Open-Loop Systems

				Heat Exchanger Type			
				Closed Loop Recirculating	**Open Loop, Tower, Ground Source Well**		
	Description	**Symbol**	**Units**	**All Heat Exchanger Types**	**COAXIAL HX Copper** Tube in Tube	**COAXIAL HX Cupronickel**	**Brazed Plate HX 316 SS**
Scaling Potential	pH - Chilled Water <85°F			7.0 to 9.0	7.0 to 9.0	7.0 to 9.0	7.0 to 9.0
	pH - Heated Water >85°F			8.0 to 10.0	8.0 to 10.0	8.0 to 10.0	8.0 to 10.0
	Alkalinity	$(HCO3^-)$	ppm - $CaCO_3$ equiv.	50 to 500	50 to 500	50 to 500	50 to 500
	Calcium	(Ca)	ppm	<100	<100	<100	<100
	Magnesium	(Mg)	ppm	<100	<100	<100	<100
	Total Hardness	(CaCO3)	ppm - CaCO3 equiv.	30 to 150	150 to 450	150 to 450	150 to 450
	Langelier Saturation Index	LSI		-0.5 to +0.5	-0.5 to +0.5	-0.5 to +0.5	-0.5 to +0.5
	Ryznar Stability Index	RSI		6.5 to 8.0	6.5 to 8.0	6.5 to 8.0	6.5 to 8.0
Corrosion Prevention	Total Dissolved Solids	(TDS)	ppm - $CaCO_3$ equiv.	<1000	<1000	<1000	<1500
	Sulfate	(SO_4^{2-})	ppm	<200	<200	<200	<200
	Nitrate	(NO_3^-)	ppm	<100	<100	<100	<100
	Chlorine (free)	(Cl)	ppm	<0.5	<0.5	<0.5	<0.5
	Chloride (water < 80°F)	(Cl^-)	ppm	<20	<20	<150	<150
	Chloride (water > 120°F)		ppm	<20	<20	<125	<125
	Hydrogen Sulfide[α]	(H_2S)	ppb	<0.5	<0.5	<0.5	<0.5
	Carbon Dioxide	(CO_2)	ppm	0	<50	10 to 50	10 to 50
	Iron Oxide	(Fe)	ppm	<1.0	<1.0	<1.0	<0.2
	Manganese	(Mn)	ppm	< 0.4	<0.4	<0.4	<0.4
	Ammonia	(NH_3)	ppm	<0.05	<0.1	<0.1	<0.1
	Chloramine	(NH_2CL)	ppm	0	0	0	0
Fouling & Biological	Iron Bacteria		cells/mL	0	0	0	0
	Slime Forming Bacteria		cells/mL	0	0	0	0
	Sulfate reducing bacteria		cells/mL	0	0	0	0
	Suspended Solids[β]	(TSS)	ppm	<10	<10	<10	<10
Electrolysis All HX types	Earth Ground Resistance[χ]		Ohms	0	Consult NEC & local electrical codes for grounding requirements		
	Electrolysis Voltage[δ]		mV	<300	Measure voltage internal water loop to HP ground		
	Leakage Current[δ]		mA	<15	Measure current in water loop pipe		
	Building Primary Electrical Ground to unit, must meet local diameter and penetration length requirements						
	Do not connect heat pump to steel pipe unless dissimilar materials are separated by using Di-electric unions. Galvanic corrosion of heat pump water pipe will occur.						

Water Quality Standards

1. The ClimateMaster Water Quality Table provides water quality requirements for coaxial & brazed plate heat exchangers.
2. The water must be evaluated by an independent testing facility comparing site samples against this Table. When water properties are outside of these parameters, the water must either be treated by a professional water treatment specialist to bring the water quality within the boundaries of this specification, or an external secondary heat exchanger must be used to isolate the heat pump water system from the unsuitable water. Failure to do so will void the warranty of the heat pump system and will limit liability for damage caused by leaks or system failure.
3. Regular sampling, testing and treatment of the water is necessary to assure that the water quality remains within acceptable levels thereby allowing the heat pump to operate at optimum levels.
4. If closed-loop systems are turned off for extended periods, water samples must be tested prior to operating the system.
5. For optimal performance, it is recommended that the closed-loop piping systems are initially filled with de-ionized water.
6. Well water with chemistry outside of these boundaries, and salt water or brackish water requires an external secondary heat exchanger. Surface/Pond water should not be used.
7. If water temperature is expected to fall below 40°F, antifreeze is required. Refer to the heat pump IOM for the correct solution ratios to prevent freezing.

Strainer / Filter Sizing			
Mesh Size	Particle Size		
	Microns	mm	Inch
20	840	0.840	0.0340
30	533	0.533	0.0210
60	250	0.250	0.0100
100	149	0.149	0.0060
150	100	0.100	0.0040
200	74	0.074	0.0029

α Hydrogen Sulfide has an odor of rotten eggs. If one detects this smell, a test for H2S must be performed. If H2S is detected above the limit indicated, remediation is necessary (Consult with your Water Testing/Treatment Professional) or a secondary heat exchanger is required using appropriate materials as recommended by the heat exchanger supplier.

β Suspended solids and particulates must be filtered to prevent fouling and failure of heat exchangers. Strainers or particulate filters must be installed to provide a maximum particle size of 600 micron (0.60 mm, 0.023 in.) using a 20 to 30 mesh screen size. When a loop is installed in areas with fine material such as sand or clay, further filtration is required to a maximum of 100 micron. Refer to the Strainer / Filter Sizing Chart to capture the particle sizes encountered on the site.

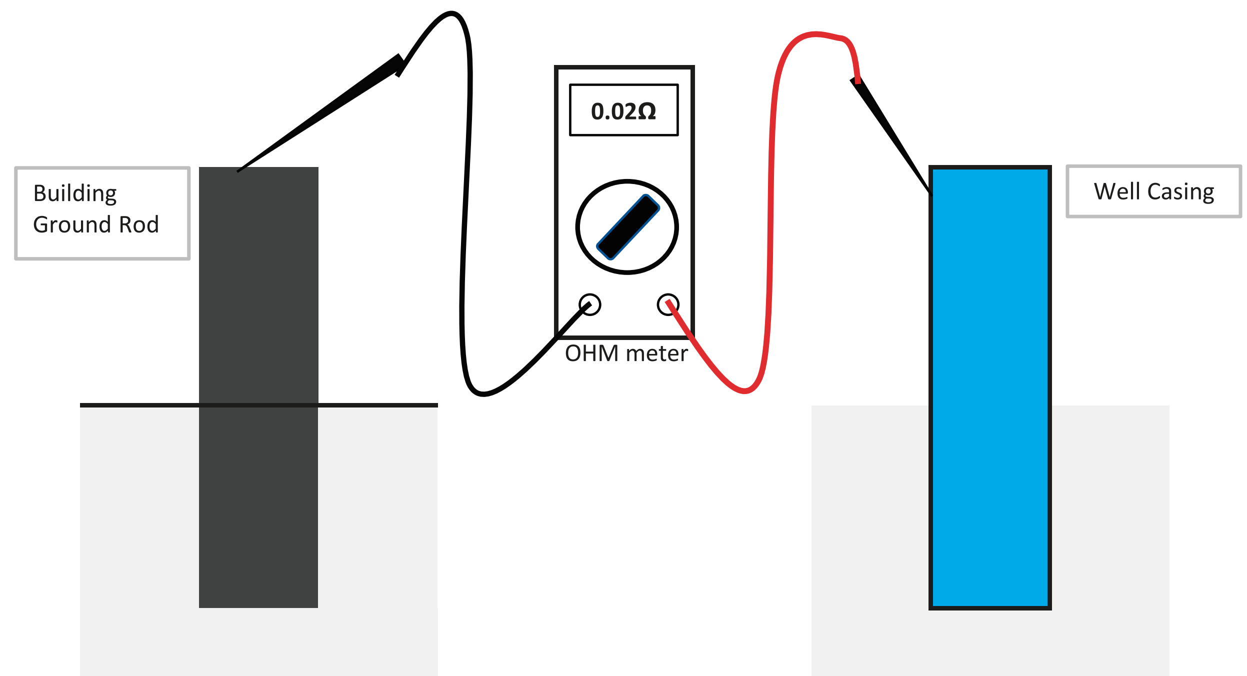
χ An electrical grounding system using a dedicated ground rod meeting NEC and Local Electrical codes must be installed. Building Ground must not be connected the WSHP piping system or other plumbing pipes.

δ Refer to IOM for instructions on measuring resistance and leakage currents within water loops.

Do not use PVC pipe for water loop (compressor POE oil and glycols damage PVC) use of HDPE pipe is recommended.

Earth Ground Resistance Measurement

Measuring Earth Ground Resistance



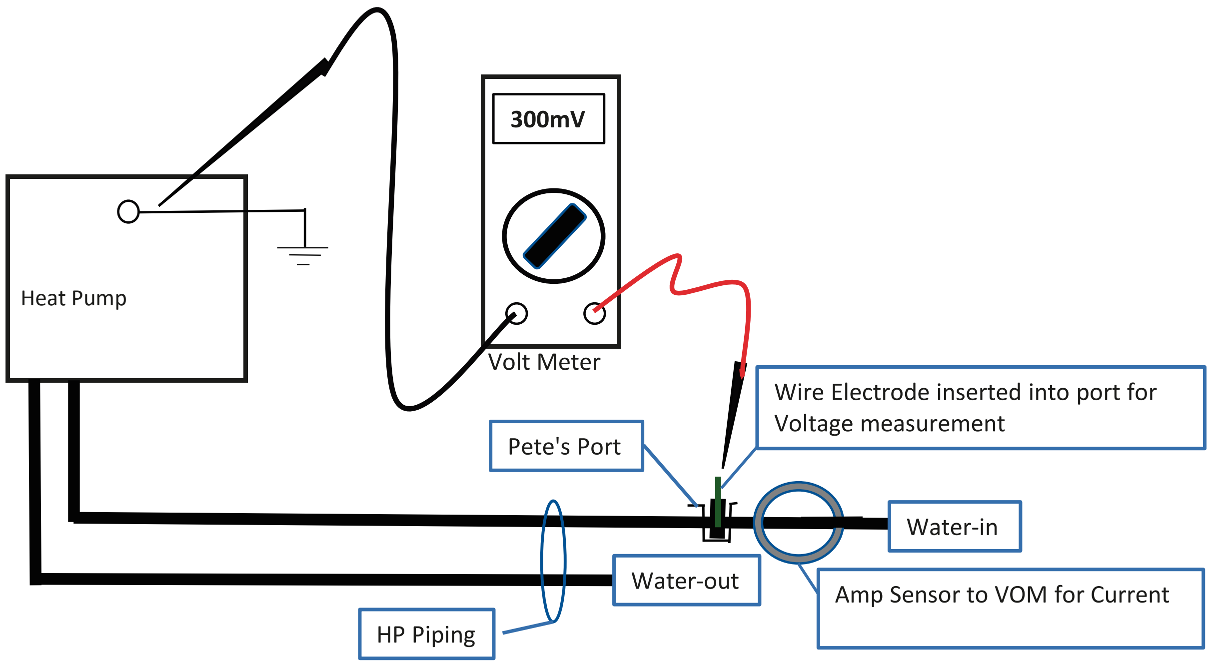
Measure the earth ground bond using an Ohm meter between the building's ground rod and the steel well casing.

The resistance measured should be zero Ohms. The NEC allows a resistance to ground up to 20 Ohms. Any resistance above zero, indicates a poor earth ground which may be the result of a hot neutral line or that conductive water is present. Both of these may lead to electrolysis and corrosion of the heat pump piping. A check for both should be performed and resolved.

Note if the well casing is plastic, a conductive path can be achieved by inserting a #6 AWG bare copper wire into the well water. Remove the temporary conductor when finished.

Electrolysis Voltage and Current

Measuring Electrolysis Voltage and Current



Measure the electrolysis voltage using a volt meter between the heat pump ground and a #14 AWG solid copper wire electrode inserted into the water using a Pete's style access port.

The HP must be operating and the water stream flowing.

The <u>voltage® measured should be less than 300mV (0.300 V)</u>. If higher than 500mV electrolysis will occure and corrosion will result.

If voltage is measured, the cause is a high resistance earth ground or current on the neutral conductor. Remedial measures should be performed.

Measure the current flowing through the piping system by using an amp clamp probe on the water-in line. The HP must be operating and the water stream flowing.

There <u>should be zero amps measured</u>. If current is present, there is leakage current to the plumbing system and it must be rectified to prevent pipe corrosion.

Electrical – Line Voltage

⚠ WARNING! ⚠

WARNING! To avoid possible injury or death due to electrical shock, open the power supply disconnect switch and secure it in an open position during installation.

⚠ CAUTION! ⚠

CAUTION! Use only copper conductors for field installed electrical wiring. Unit terminals are not designed to accept other types of conductors.

Electrical - Line Voltage

All field installed wiring, including electrical ground, must comply with the National Electrical Code as well as all applicable local codes. Refer to the unit electrical data for fuse sizes. Consult wiring diagram for field connections that must be made by the installing (or electrical) contractor.

Electrical disconnect must be capable of electrically de-energizing all power bearing conductors feeding the TFC unit.

Table 5a: TFC with Flow Switch

Model	Fan Motor FLA	Total Unit FLA	Min Circuit AMP	Max Fuse/HACR
036	2.2	2.2	2.8	15A
060	1.0	1.3	1.3	15A

Rated Voltage of 208/230/60/1 Min/Max Voltage of 197/252
All fuses Class RK-5

Table 5b: TFC with Internal Pump

Model	Fan Motor FLA	Loop Pump FLA	Total Unit FLA	Min Circuit AMP	Max Fuse/HACR
036	2.2	1.4	3.6	4.2	15A
060	1.0	1.4	2.4	2.7	15A

Rated Voltage of 208/230/60/1 Min/Max Voltage of 197/252
All fuses Class RK-5

All final electrical connections must be made with a length of flexible conduit to minimize vibration and sound transmission to the building.

General Line Voltage Wiring

Be sure the available power is the same voltage and phase shown on the unit serial plate. Line and low voltage wiring must be done in accordance with local codes or the National Electric Code, whichever is applicable.

Power Connection

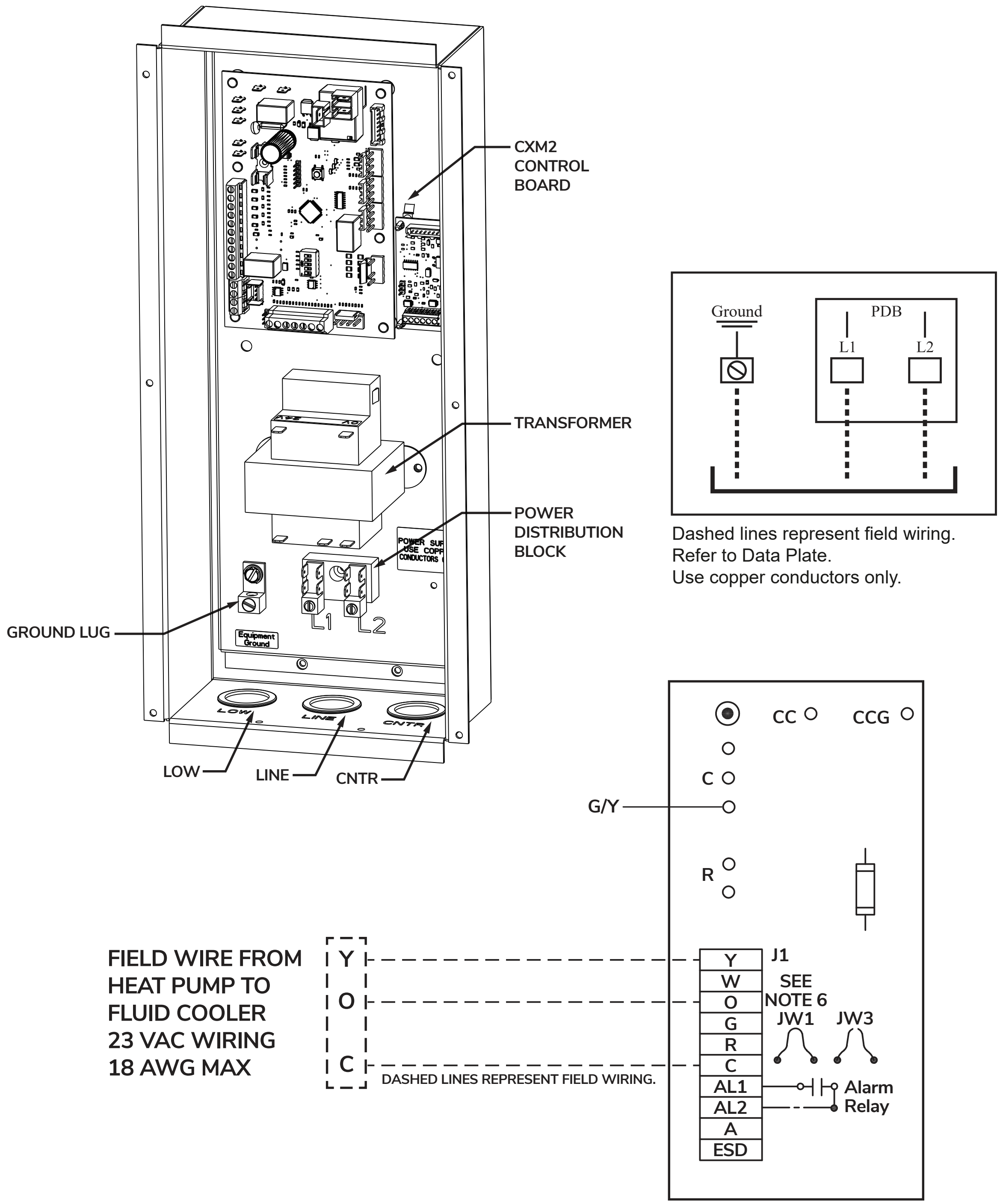
Line voltage connection is made by connecting the incoming line voltage wires to the "L" side of the power distribution block as shown in Figure 12. Consult Table 5a and 5b for electrical ratings and maximum fuse size.

208/230 Volt Operation

Verify transformer tap with unit wiring diagram to ensure that the transformer tap is set to the correct voltage, 208 V or 230 V.

Electrical – Field Wiring Installation

Figure 12: Control Wiring



Electrical – Low Voltage Wiring

The TFC is equipped with an CXM2 board to control pump and fan operation. Unit configuration setting are set at the factory for unit size and pump option. The dip switch setting are shown in Table 6.

Figure 13: Control Board

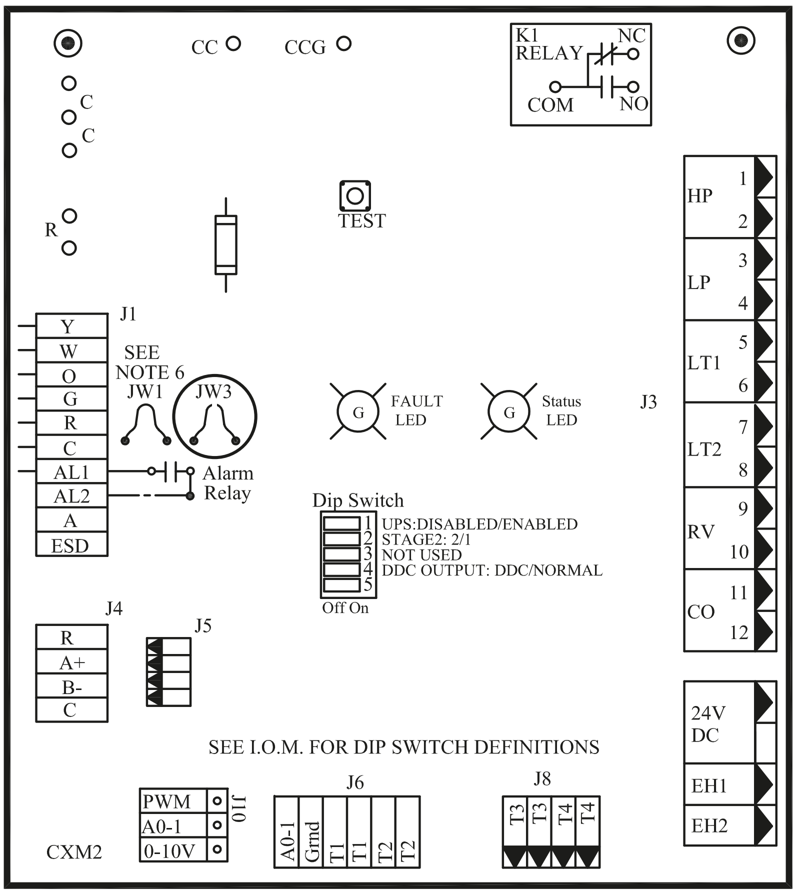


Table 6: Dip Switch Settings

S1 Dip Switch	On	Off
S1-1	Master	Slave
S1-2	Stand-Alone	Hybrid
S1-3	N/A	N/A
S1-4	N/A	N/A

CXM2 Controls

Stand-Alone Operation
If DIP1-2 is in the ON position for Standalone operation: If the system is configured with an internal pump and has demand or has flow and the entering air is above the minimum entering air temperature:

When the system is in cooling:

When the entering water temperature is below the minimum entering water temperature for cooling, the unit will run at the designated minimum blower speed. When the entering water temperature is above the maximum entering water temperature for cooling, the unit will run at the occupied or unoccupied maximum blower speed depending on occupancy status.

When the entering water temperature is between the minimum entering water temperature for cooling and the maximum entering water temperature for cooling, the blower will modulate its blower speed in a linear relation between entering water temperate and the effecting minimum and maximum blower speeds.

When the system is in heating:

When the entering water temperature is below the minimum entering water temperature for heating, the unit will run at the occupied or unoccupied maximum blower speed depending on occupancy status.

When the entering water temperature is above the maximum entering water temperature for heating, the unit will run at the designated minimum blower speed.

When the entering water temperature is between the minimum entering water temperature for heating and the maximum entering water temperature for heating, the blower will modulate its blower speed in a linear relation between entering water temperate and the effecting minimum and maximum blower speeds. Modulation is limited to a field determined duration which has a default of 15 seconds.

Loop Condition Operation:
If DIP1-2 is in the OFF position for Hybrid Operation:

If the system is configured with an internal pump or has sensed flow, the entering air temperature is above the minimum entering air temperature value, the entering water temperature is above the target entering water value, and the delta between entering water and entering air temperatures is greater than the target delta:

If the Leaving Water Temperature is above the target leaving water temperature value, the system will operate at the occupied or unoccupied maximum blower speed depending on occupancy status.

During Hybrid Operation, any time we are operating the blower, in addition to enabling an internal pump (if configured) a bypass value option is activated on the CC output.

Low Water Temperature Operation:
If the Leaving Water Temperature is below the target leaving water temperature value, the system will begin to reduce the blower speed. A reduction of 1% occurs every cycle with a field determined duration (default to 15 seconds). If the system has been operating in Low Water Temperature Operation and the leaving water temperature goes above the target leaving water temperature value, the blower speed will continue to be reduced until the leaving water temperature is 1 degree above the target leaving water temperature value. Once the LWT is 1 degree above the target LWT, the system will increase by 1% every cycle until blower speed has been restored to the maximum blower speed. If the system has been restoring the blower speed and the LWT drops below the 1 degree target LWT offset, the unit will hold at the current blower speed until the LWT either increases 1 degree above the target LWT or falls below the target LWT.

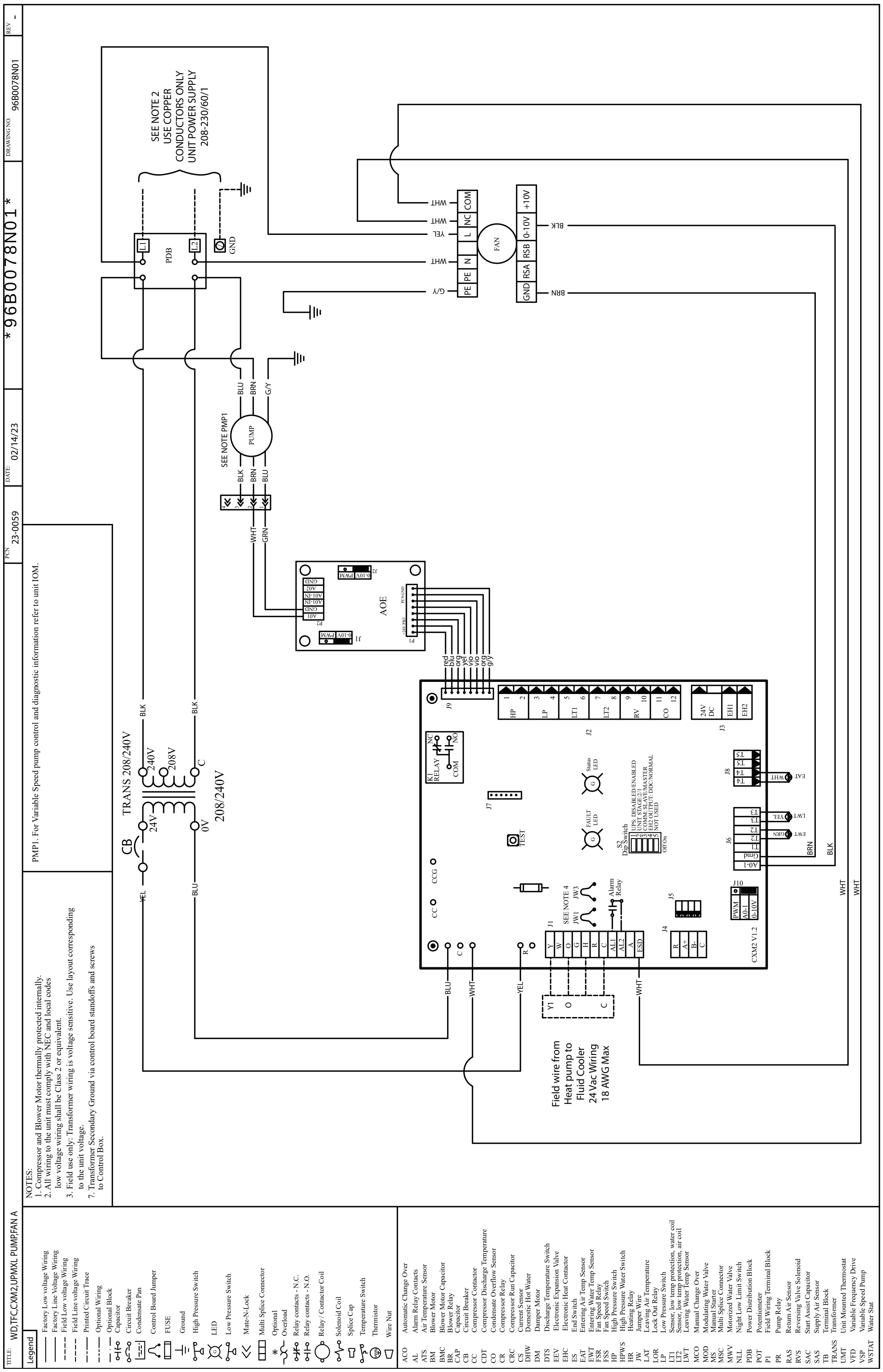
Low Ambient Air Operation:
The operation for low ambient air monitors the EAT sensor. When the ambient temperature measured by the EAT sensor is below the current minimum entering air protection setpoint the outdoor fan operation will stop. In addition, if the unit comes with the loop pump option the loop pump output will be operated based on the ambient temperature, measured using entering air temperature sensor (T4).

Table 7: LED Operations

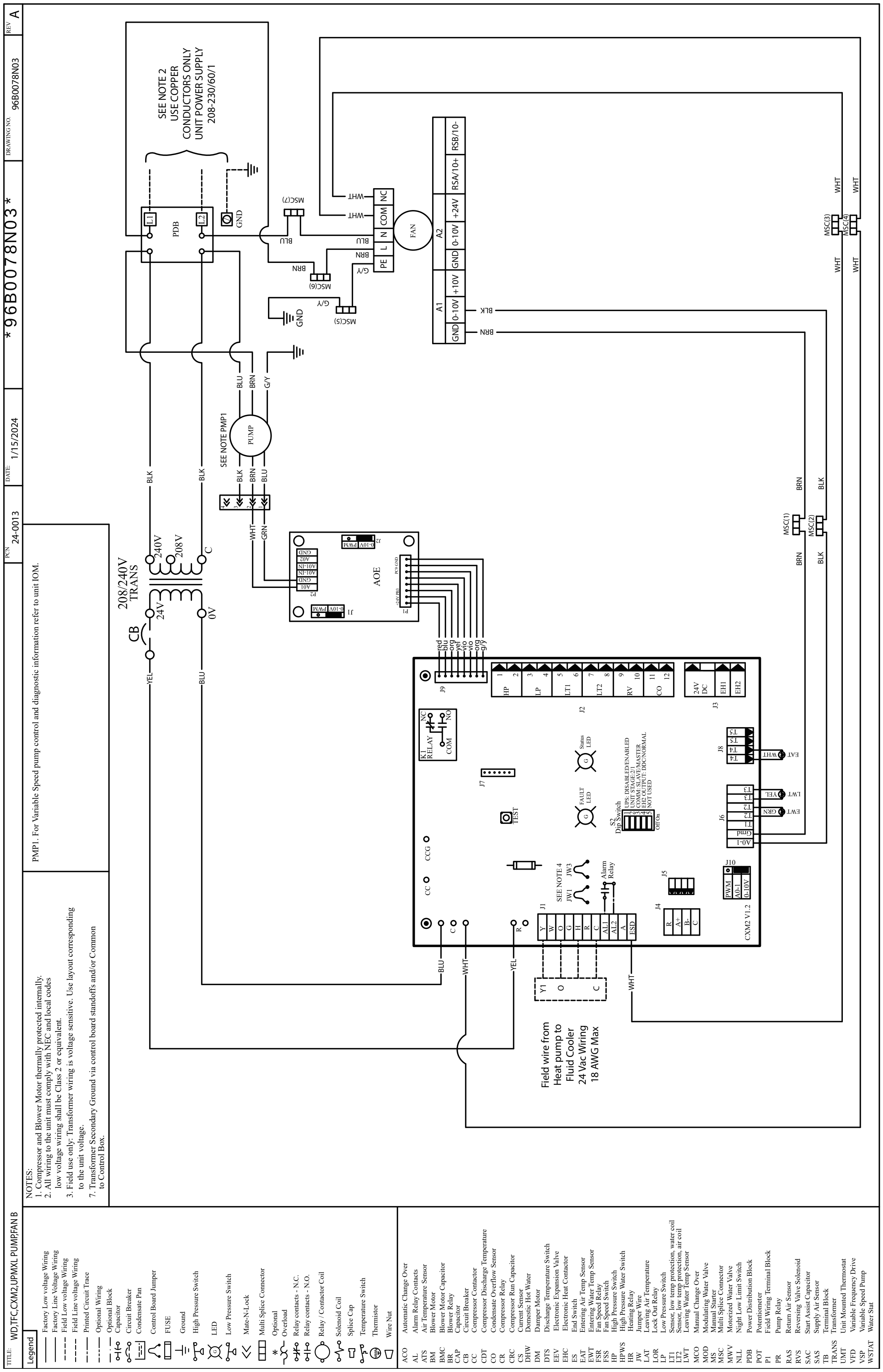
Description of Operation	Status LED	Fault LED
TFC Control is non-functional	Off	Off
Normal Operation - no active communications with blower	On	On
Normal Operation - active communications with blower	On	Very Slow Flash
EWT out of range	Off	Fast Flash
EAT out of range	Off	Fast Flash
Blower Fault	Off	Fast Flash
Low Temperature Protection Active	Fast Flash	On

Very Slow Flash – 1 flash every five seconds (1 second on, 4 second off)
Slow Flash – 1 flash every two seconds (1 second on, 1 second off)
Fast Flash – 2 flashes per second (¼ second on, ¼ second off)

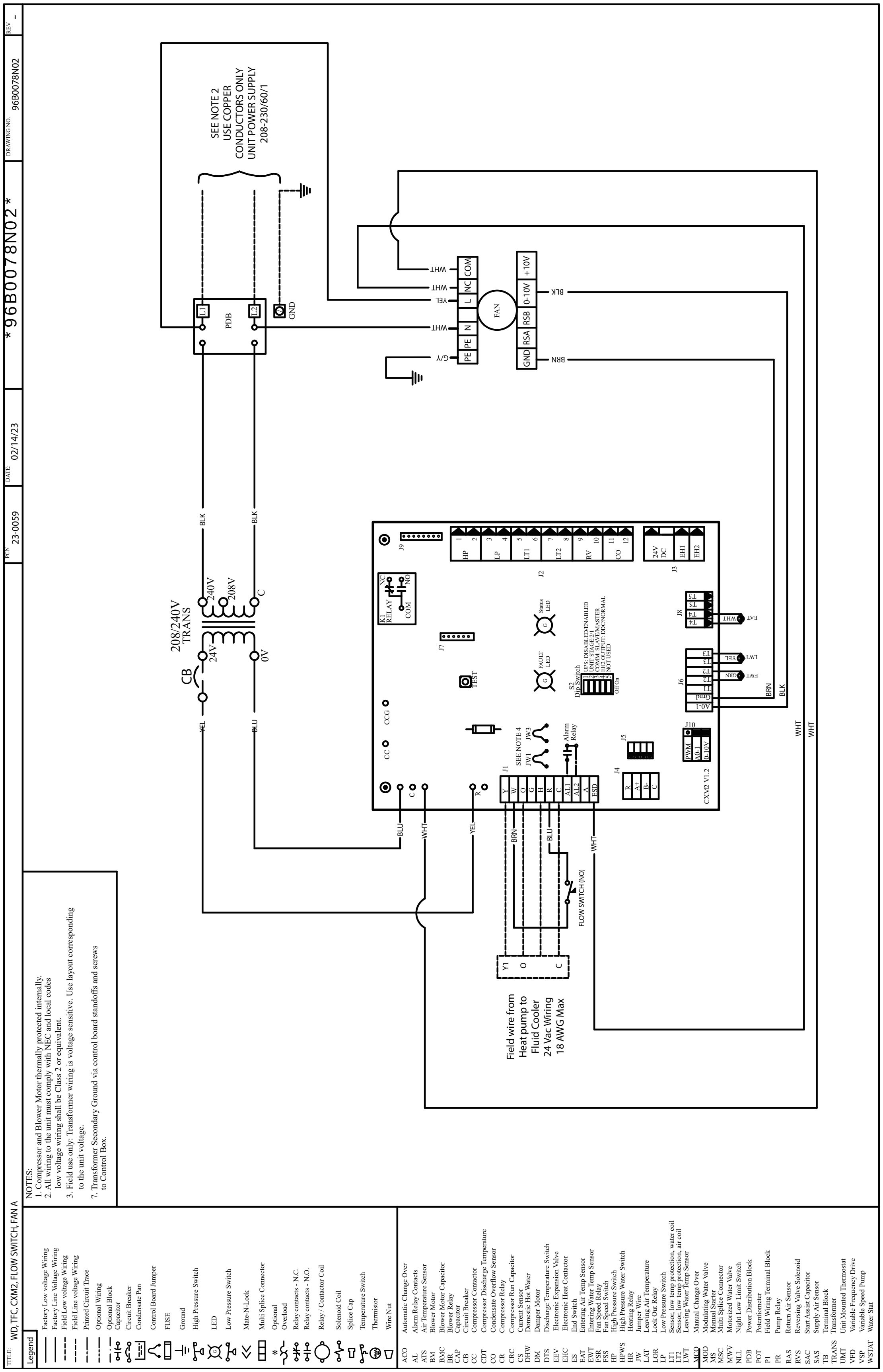
TFC with Pump Wiring Diagram, Fan A – 96B0078N01



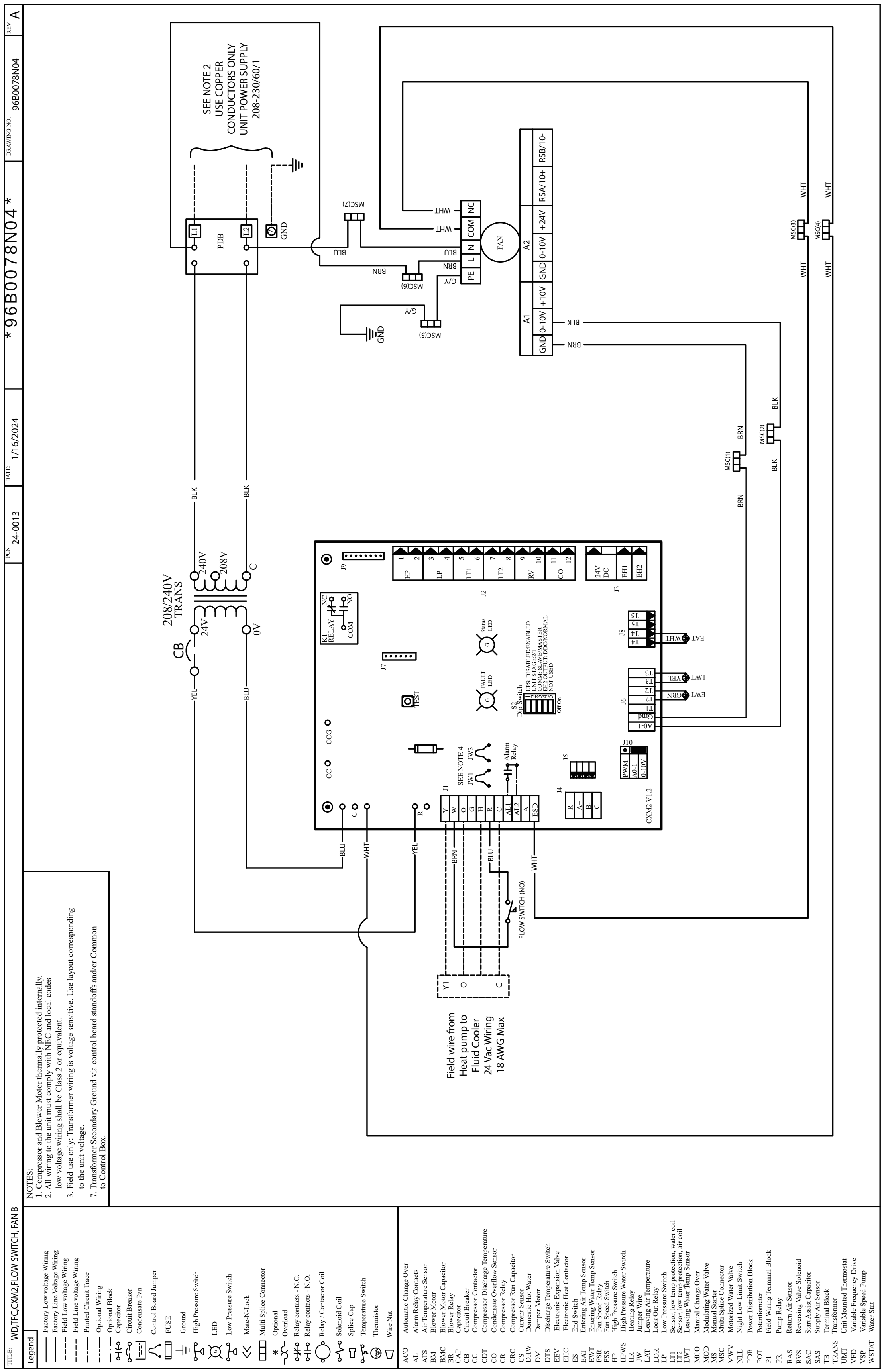
TFC with Pump Wiring Diagram, Fan B – 96B0078N03



TFC with Flow Switch Wiring Diagram, Fan A – 96B0077N02



TFC with Flow Switch Wiring Diagram, Fan B – 96B0077N04



Unit Starting and Operating Checklist

Unit and System Checkout

BEFORE POWERING SYSTEM, please check the following:

UNIT CHECKOUT

- ❑ Shutoff valves: Insure that all isolation valves are open.
- ❑ Line voltage and wiring: Verify that voltage is within an acceptable range for the unit and wiring and fuses/breakers are properly sized. Verify that low voltage wiring is complete.
- ❑ Unit control transformer: Insure that transformer has the properly selected voltage tap. Residential 208/230 V units are factory wired for 230 V operation unless specified otherwise.
- ❑ Loop/water piping is complete and purged of air. Water/piping is clean. If equipped with optional internal pump, the pump shaft has been "burped".
- ❑ Antifreeze has been added if necessary. Refer to Loop Antifreeze Protection section of this document for information on antifreeze selection and charging.
- ❑ Entering water and air: Insure that entering water and air temperatures are within operating limits
- ❑ Unit controls: Verify that controller field selection options are properly set. Refer to unit wiring diagram.
- ❑ Service/access panels are in place.

SYSTEM CHECKOUT

- ❑ System water temperature: Check water temperature for proper range.
- ❑ System pH: Check and adjust water pH if necessary to maintain a proper level. Proper pH promotes system longevity (see Table 4).
- ❑ System flushing: Verify that all air is purged from the system. Air in the system can cause poor operation or system corrosion. Water used in the system must be potable quality initially and clean of dirt, piping slag, and strong chemical cleaning agents. Some antifreeze solutions may require distilled water.
- ❑ Optional Internal Pump: Verify that it is purged of air and in operating condition ("burp" the shaft).
- ❑ Miscellaneous: Note any questionable aspects of the installation.

Table 8: Operating Limits

Operating Limits	Temperature, °F [°C]
Air Limits	
Min. entering air, DB	25 [-4]
Max entering air, DB	105 [41]
Water Limits	
Min. entering water	20 [-6.7]
Max entering water	120 [49]

⚠ CAUTION! ⚠

CAUTION! To avoid equipment damage, DO NOT leave system filled in a TFC unit during the winter unless antifreeze is added to the water loop. Heat exchangers never fully drain by themselves and will freeze unless winterized with antifreeze.

Unit Start-up Procedure

The TFC unit will operate in conjunction with a call from the heat pump and if fluid/air temperatures are favorable for heat transfer. Should the TFC fail to operate, verify power and wiring connections. Refer to the heat pump Installation, Operation, and Maintenance manual for additional start-up details.

⚠ WARNING! ⚠

WARNING! When the disconnect switch is closed, high voltage is present in some areas of the electrical panel. Exercise caution when working with energized equipment.

Performance Data – TFC036

Low Speed

Heat Rejection Capacity	Air Temp Entering Fluid Cooler (DB)	Air ΔT	Water Flow Rate	Water Temp Entering Fluid Cooler	Water ΔT through Fluid Cooler	Approach Temp	Fan Power
Btuh	°F	°F	GPM	°F	°F	°F	Watts
20412	70	12	9	85	5	11	44
27450	70	16		90	6	14	44
34433	70	20		95	8	17	44
21680	90	12		105	5	10	44
28634	90	16		110	6	14	45
35212	90	20		115	8	17	45
20097	105	12		120	4	11	45
27891	105	16		125	6	14	47
35067	105	20		130	8	17	47

Interpolation is permissable, extrapolation is not.
All performance data is based upon the lower voltage of dual voltage rated units.

High Speed

Heat Rejection Capacity	Air Temp Entering Fluid Cooler (DB)	Air ΔT	Water Flow Rate	Water Temp Entering Fluid Cooler	Water ΔT through Fluid Cooler	Approach Temp	Fan Power
Btuh	°F	°F	GPM	°F	°F	°F	Watts
28900	70	10	9	85	6	9	121
38700	70	14		90	9	12	121
48600	70	17		95	11	14	121
29600	90	10		105	7	9	126
39800	90	14		110	9	11	126
49800	90	18		115	11	14	126
29300	105	11		120	6	9	133
39400	105	14		125	9	11	134
49500	105	18		130	11	14	133

Interpolation is permissable, extrapolation is not.
All performance data is based upon the lower voltage of dual voltage rated units.

Pressure Drop

EAT	EWT	GPM	Water ΔP, PSI
70	85	9	2.1
70	90	9	2.1
70	95	9	2.1
90	105	9	2.1
90	110	9	2.1
90	115	9	2.2
105	120	9	2.2
105	125	9	2.2
105	130	9	2.2

Performance Data – TFC060

Low Speed

Heat Rejection Capacity	Air Temp Entering Fluid Cooler (DB)	Air ΔT	Water Flow Rate	Water Temp Entering Fluid Cooler	Water ΔT through Fluid Cooler	Approach Temp	Fan Power
Btuh	°F	°F	GPM	°F	°F	°F	Watts
35000	70	10	15	85	5	10	87
47800	70	14		90	6	14	87
60200	70	18		95	8	17	88
36100	90	11		105	5	10	88
48100	90	14		110	6	14	88
60200	90	18		115	8	17	88
35300	105	11		120	5	10	88
47300	105	15		125	6	14	88
59400	105	18		130	8	17	88

Interpolation is permissable, extrapolation is not.
All performance data is based upon the lower voltage of dual voltage rated units.

High Speed

Heat Rejection Capacity	Air Temp Entering Fluid Cooler (DB)	Air ΔT	Water Flow Rate	Water Temp Entering Fluid Cooler	Water ΔT through Fluid Cooler	Approach Temp	Fan Power
Btuh	°F	°F	GPM	°F	°F	°F	Watts
44100	70	9	15	85	6	9	187
59400	70	13		90	8	12	187
74500	70	16		95	10	15	186
44500	90	10		105	6	9	184
59300	90	13		110	8	12	184
74000	90	17		115	10	15	183
43500	105	10		120	6	9	180
58000	105	13		125	8	12	181
72600	105	17		130	10	15	180

Interpolation is permissable, extrapolation is not.
All performance data is based upon the lower voltage of dual voltage rated units.

Pressure Drop

EAT	EWT	GPM	Water ΔP, PSI
70	85	15	5.6
70	90	15	5.6
70	95	15	5.6
90	105	15	5.7
90	110	15	5.7
90	115	15	5.7
105	120	15	5.8
105	125	15	5.8
105	130	15	5.8

Sound Data

TFC Series (60 Hz)
Tested in accordance with AHRI 270
Octave Band Sound Power Level, (db re 1pW)

Model	Mode	Octave Band Frequency, Hz							Overall
		125	250	500	1000	2000	4000	8000	dBA
TFC36	Fan Only: Low Speed	62	60	57	53	48	43	46	59
	Fan Only: High Speed	68	70	66	63	58	51	48	68
TFC60	Fan Only: Low Speed	69	73	67	64	58	52	48	69
	Fan Only: High Speed	84	86	80	77	69	64	57	83

Preventive Maintenance

Water Circuit Maintenance
Generally water circuit maintenance is not needed for closed loop systems. However, if the piping is known to have high dirt or debris content, it is best to establish a periodic maintenance schedule with the owner so the water circuit can be checked regularly. Dirty installations are typically the result of deterioration of iron or galvanized piping or components in the system. Should periodic cleaning be necessary, use standard cleaning procedures, which are compatible with both the heat exchanger material and copper water lines. Generally, the more water flowing through the unit, the less chance for scaling. However, flow rates over 3 gpm per ton (3.9 l/m per kW) can produce water (or debris) velocities that can erode the heat exchanger wall and ultimately produce leaks.

Generally, cabinets are set up from the ground to prevent water from entering the cabinet. The cabinet can be cleaned using a mild detergent. Six inch riser pads are recommended.

Fan
Inspect the fan blade for blockage, debris, or damage. Clean the blade or replace the fan as necessary. Fan blade is not replaceable.

Coils/Coil Guards
Periodically inspect the unit coils and coil guards. Remove any foliage or debris from around the unit that can restrict airflow. If required, disconnect power from the unit and utilize a garden hose with low pressure water to remove any remaining dirt and debris.

⚠ WARNING! ⚠

WARNING! Always shut off electrical power to the fluid cooler fan motor prior to performing any inspections that may involve physical contact with the mechanical or electrical equipment in or on the tower. Lock out and tag out any electrical switches to prevent others from turning the power back on. Service personnel must wear proper personal protective clothing and equipment.

Troubleshooting

General

If operational difficulties are encountered, perform the preliminary checks below before referring to the troubleshooting charts.

- Verify that the unit is receiving electrical supply power.
- Make sure the fuses in the fused disconnect switches are intact.

After completing the preliminary checks described above, inspect for other obvious problems such as leaking connections, broken or disconnected wires, etc. If everything appears to be in order, but the unit still fails to operate properly, verify inputs from the heat pump and from the internal sensors.

CXM2 Board

CXM2 board troubleshooting in general is best accomplished by first verifying inputs and outputs. After these have been verified, board operation is confirmed and the problem must be elsewhere. Below are some general guidelines for troubleshooting the CXM2 control.

Field Inputs

A 24 VAC signal is supplied from the heat pump to the control board contained in the TFC unit. Verify that 24 VAC is present between Y1 and C, and between O and C at the control board.

Sensor Inputs

All sensor inputs are 'paired wires' connecting each component to the board. The thermistor resistance should be measured with the connector removed from the control board so that only the impedance of the thermistor is measured. If desired, this reading can be compared to the thermistor resistance chart shown in Table 9. An ice bath can be used to check the calibration of the thermistor.

Table 9: Nominal resistance at various temperatures

Temp (ºC)	Temp (ºF)	Resistance (kOhm)
-17.8	0.0	85.34
-17.5	0.5	84.00
-16.9	1.5	81.38
-12	10.4	61.70
-11	12.2	58.40
-10	14.0	55.30
-9	15.8	52.38
-8	17.6	49.64
-7	19.4	47.05
-6	21.2	44.61
-5	23.0	42.32
-4	24.8	40.15
-3	26.6	38.11
-2	28.4	36.18
-1	30.2	34.37
0	32.0	32.65
1	33.8	31.03
2	35.6	29.50
3	37.4	28.05
4	39.2	26.69
5	41.0	25.39
6	42.8	24.17
7	44.6	23.02
8	46.4	21.92
9	48.2	20.88
10	50.0	19.90
11	51.8	18.97
12	53.6	18.09
13	55.4	17.26
14	57.2	16.46
15	59.0	15.71
16	60.8	15.00
17	62.6	14.32
18	64.4	13.68
19	66.2	13.07
20	68.0	12.49
21	69.8	11.94
22	71.6	11.42
23	73.4	10.92
24	75.2	10.45
25	77.0	10.00
26	78.8	9.57
27	80.6	9.16
28	82.4	8.78
29	84.2	8.41
30	86.0	8.06
31	87.8	7.72
32	89.6	7.40
33	91.4	7.10
34	93.2	6.81
35	95.0	6.53
36	96.8	6.27
37	98.6	6.01
38	100.4	5.77
39	102.2	5.54
40	104.0	5.33
41	105.8	5.12
42	107.6	4.92
43	109.4	4.72
44	111.2	4.54
45	113.0	4.37
46	114.8	4.20
47	116.6	4.04
48	118.4	3.89
49	120.2	3.74
50	122.0	3.60
51	123.8	3.47
52	125.6	3.34
53	127.4	3.22
54	129.2	3.10
55	131.0	2.99
56	132.8	2.88
57	134.6	2.77
58	136.4	2.67
59	138.2	2.58
60	140.0	2.49
61	141.8	2.40
62	143.6	2.32
63	145.4	2.23
64	147.2	2.16
65	149.0	2.08
66	150.8	2.01
67	152.6	1.94
68	154.4	1.88
69	156.2	1.81
70	158.0	1.75
71	159.8	1.69
72	161.6	1.64
73	163.4	1.58
74	165.2	1.53
75	167.0	1.48
76	168.8	1.43
77	170.6	1.39
78	172.4	1.34
79	174.2	1.30
80	176.0	1.26
81	177.8	1.22
82	179.6	1.18
83	181.4	1.14
84	183.2	1.10
85	185.0	1.07
86	186.8	1.04
87	188.6	1.01
88	190.4	0.97
89	192.2	0.94
90	194.0	0.92
91	195.8	0.89
92	197.6	0.86
93	199.4	0.84
94	201.2	0.81
95	203.0	0.79
96	204.8	0.76
97	206.6	0.74
98	208.4	0.72
99	210.2	0.70
100	212.0	0.68
101	213.8	0.66
102	215.6	0.64
103	217.4	0.62
104	219.2	0.60
105	221.0	0.59
106	222.8	0.57
107	224.6	0.55
108	226.4	0.54
109	228.2	0.52
110	230.0	0.51
111	231.8	0.50
112	233.6	0.48
113	235.4	0.47
114	237.2	0.46
115	239.0	0.44
116	240.8	0.43
117	242.6	0.42
118	244.4	0.41
119	246.2	0.40
120	248.0	0.39
121	249.8	0.38
122	251.6	0.37
123	253.4	0.36

Revision History

Date:	Item:	Action:
11/10/23	Pages 15-17, 24-28, 33	Updated to CXM2 Control board
6/9/22	Pages 30-32	Updated pressure drop tables, added sound data
2/22/22	New Document	

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