ThermoFlex
Recirculating Chiller

Thermo Manual P/N U00934 Rev. 07/11/06

Service

Visit our Web site at:

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Contents

Section I Safety

Warnings

Warnings are posted throughout the manual. These warnings are designated by an exclamation mark inside an equilateral triangle and text highlighted in bold. Read and follow these important instructions. Failure to observe these instructions can result in permanent damage to the unit, significant property damage, or personal injury or death.

The lightning flash with arrow symbol, within an equilateral triangle, is intended to alert you to the presence of non-insulated "dangerous voltage" within the unit's enclosure. The voltage may be of significant magnitude to constitute a risk of electrical shock.

Make sure you read and understand all instructions and safety precautions listed in this manual before installing or operating your unit. If you have any questions concerning the operation of your unit or the information in this manual, please contact our Sales Department.

- **Never place the unit in a location where excessive heat, moisture, inadequate ventilation, or corrosive materials are present.**
- **The unit construction provides protection against the risk of electrical shock by grounding accessible metal parts. The protection may be compromised unless the power cord is connected to a properly grounded outlet. It is the user's responsibility to ensure a proper earth-grounding connection is provided.**
- **Always turn the unit off and disconnect the supply voltage from its power source before moving the unit.**
- **The circuit protector located on the rear of the unit is not intended to be used as a disconnecting means.**
- **Never connect the process fluid lines to your facility water supply or any pressurized liquid source.**
- **Never use flammable or corrosive fluids with this unit. Use of these fluids will void the manufacturer’s warranty.**
- **Do not use automotive antifreeze. Commercial antifreeze contains silicates that can damage the pump seals. Use of automotive antifreeze will void the manufacturer’s warranty.**

- **Before using any fluid or performing maintenance where contact with the fluid is likely refer to the manufacturer’s MSDS for handling precautions.**

- **Performance of installation, operation, or maintenance procedures other than those described in this manual may result in a hazardous situation and may void the manufacturer's warranty.**

- **Transport the unit with care. Sudden jolts or drops can damage the refrigeration lines.**

- **If the unit is to be transported and/or stored in near or below freezing temperatures it needs to be drained, see Draining in this Section. The unit can be stored in the temperature range -25°C to 60°C (with packaging), and <80% relative humidity.**

- **Observe all warning labels.**

- **Never remove warning labels.**

- **Never operate damaged or leaking equipment.**

- **Never operate the unit without process fluid in the reservoir.**

- **Never operate the unit with panels removed.**

- **Never operate the unit with damaged power cords.**

- **Refer service and repairs to a qualified technician.**

Section II Theory of Operation

Abbreviations

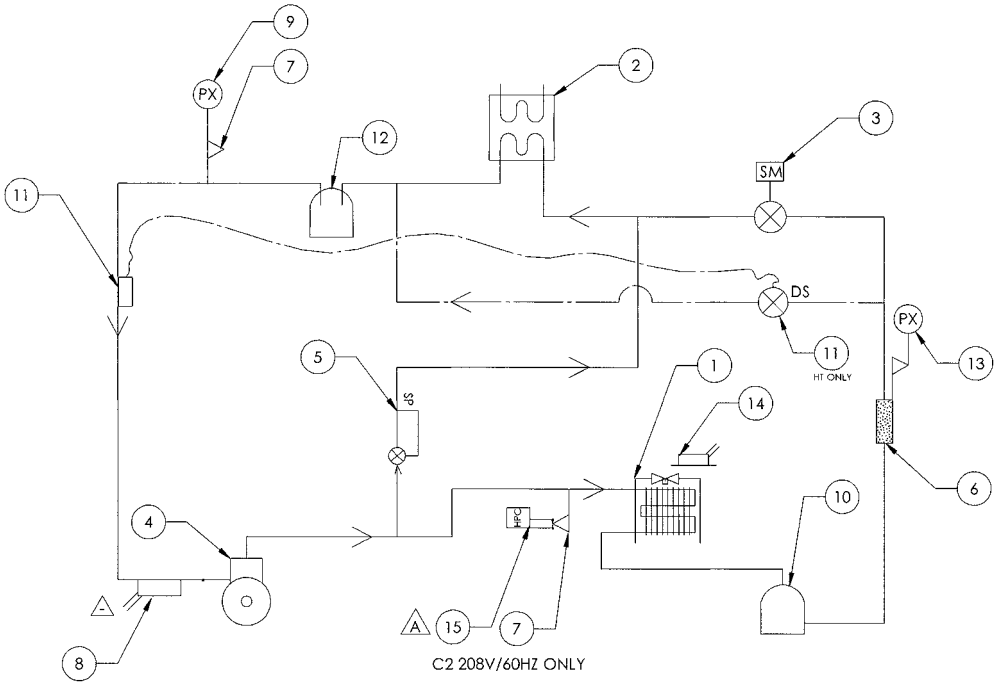
In	Nominal Amperage
Id	Start Amperage
Imax	Maximum Current
TBD	To be defined
TBC	To be confirmed
AC	Air-cooled
WC	Water-cooled
#	Number of configuration
MOP	Maximum operating pressure
HT	High Temperature
STD	Standard
CU	Condensing unit
RTD	Resistance Temperature Detector

RA Process Data Dictionary

Components and signals, names and abbreviations.

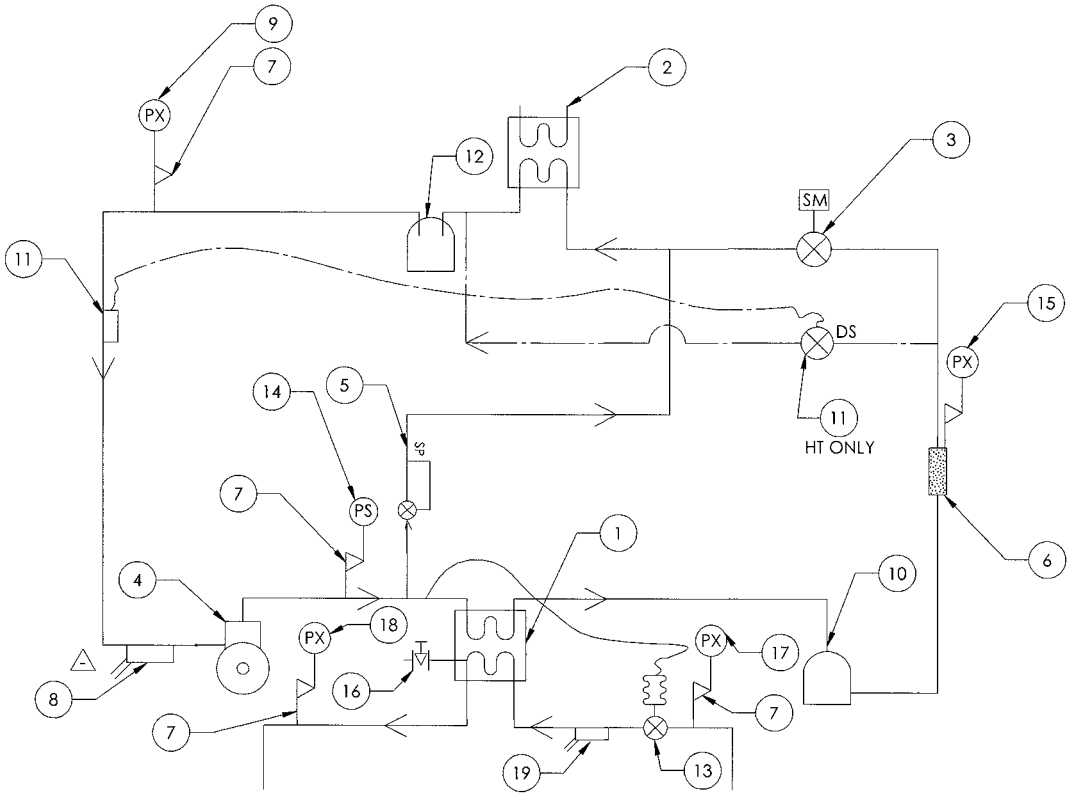
Component Name	Signal Name	Description
T1_RA	T1_RAS	Measure the evaporating temperature
T2_RA temperature	T2_RAS	Measure the entering air or facility water
P1_RA	P1_RAS	Measure the evaporating pressure
P2_RA	P2_RAS	Measure the condensing pressure
P3_RA	P3_RAS	Measure the facility water inlet pressure
P4_RA	P4_RAS	Measure the facility water outlet pressure
PS1_RA	PS1_RAS	Overpressure safety switch
COMP		Compressor
FAN		Fan
LL Stepper		Expansion valve

Flow Diagram, Air-Cooled



1	Condenser	De-superheating, condensing, sub-cooling refrigerant
2	Evaporator	Vaporizing, superheating refrigerant
3	Stepper motor driven expansion valve	Meters liquid refrigerant to the evaporator & creates pressure drop.
4	Compressor	Compress refrigerant vapor
5	Hot gas line	Meter hot refrigerant gas
6	Filter dryer	Eliminates moisture, acid and dust in the refrigerant circuit
7	Service valve	Allows access to the hermetic refrigerant circuit for servicing Note: also included on item (6)
8	Temperature sensor	Measures the suction gas temperature
9	Pressure transducer	Measures the suction side (evaporating) pressure
10	Receiver	Refrigerant storage
11	De-superheating expansion valve DXF (high-temp only)	Meters liquid refrigerant to suction side to remove excess superheat from refrigerant gas exiting evaporator
12	Accumulator (high-temp only)	Traps any liquid refrigerant exiting evaporator; provides mixing tank for refrigerant metered by DTXV
13	Pressure transducer	Measures the discharge side (evaporating) pressure (Deluxe only)
14	Temperature sensor	Measures the entering air temperature (Deluxe only)
15	Fixed High Pressure Switch	Thermoflex 1400 (208/60 units only)

Flow Diagram, Water-Cooled



1	Condenser	De-superheating, condensing, sub-cooling refrigerant
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4	Compressor	Compress refrigerant vapor
5	Hot gas line	Meter hot refrigerant gas
6	Filter dryer	Eliminates moisture, acid and dust in the refrigerant circuit
7	Service valve	Allows access to the hermetic refrigerant circuit for servicing Note: also included on item (6)
8	Temperature sensor	Measures the suction gas temperature
9	Pressure transducer	Measures the suction side (evaporating) pressure
10	Receiver	Refrigerant storage
11	De-superheating expansion valve (DTXV) (high temp only)	Meters liquid refrigerant to suction side to remove excess superheat from refrigerant gas exiting evaporator
12	Accumulator (high temp only)	Traps any liquid refrigerant exiting evaporator; provides mixing tank for refrigerant metered by DTXV
13	Pressure regulating valve	Meters facility water flow to maintain refrigerant condensing temperature
14	High pressure switch	Turns off system in the event of an overpressure occurrence
15	Pressure transducer	Measures the discharge side (evaporating) pressure (Deluxe only)
16	Drain valve	Drains condenser for shipment purposes
17	Pressure transducer	Measures the facility inlet pressure
18	Pressure transducer	Measures the facility outlet pressure (Deluxe only)
19	Temperature sensor	Measures the entering facility water temperature (Deluxe only)

Components

Compressor

The compressor is one of the four basic components required in a vapor compression system. It compresses and circulates the refrigerant. Refrigerant enters the compressor as a low pressure, superheated vapor and is discharged as a high pressure, superheated vapor. The pressure is elevated to a level that corresponds to a saturation temperature (known as the condensing temperature) that allows for a state change (vapor to liquid) in the condenser. The condensing temperature is dictated by the efficiency of the condenser.

The cooling module uses a reciprocating style, high back pressure compressor. A reciprocating compressor is basically a piston style compressor with inlet and outlet reed valves that control the direction of flow into and out of the compression cylinder. High back pressure relates to the allowable pressure range.

Process tubes and **service ports**

Process tubes and service ports provide access to the refrigeration system for evacuating, charging, recharging and measuring pressure. The process tube is used strictly for improving the charging and evacuation processes in production.

The service port on the suction side of the compressor uses a Shrader valve for shut-off purposes. The port is used for the installation site for the suction side pressure transducer. It is also intended as the reclaim, evacuation and re-charge site for service.

The service port on the dryer uses a Shrader valve for shut-off purposes. The port is used for the installation site for the discharge side pressure transducer (in the DELUXE unit only). It is also intended as the reclaim, evacuation and re-charge site for service.

Isolation valves

Isolation valves are used to manually secure a portion of the refrigeration system for service or repair. A secondary function is to allow a system pressure measurement at a particular point in the refrigeration system. These devices are only used in systems with refrigerant charges greater than 2.5 kg. The cost of reclaiming the refrigerant during service work is deemed to be less than the cost of these valves when the charge mass is less than 2.5 kg (5 lbs).

Discharge pressure sensor

The discharge pressure sensor is only used in the DELUXE units. This sensor is a ratiometric pressure transducer used to measure refrigerant discharge (compressor outlet) pressure. The purpose of this sensor is to provide feedback for condenser air filter condition (for AC units), low facility water flow to the condenser (for WC units), pre-failure notification, field troubleshooting and service diagnosis.

High pressure switch

The high pressure switch (also referred to as the HPC) is a safety device to protect against over-pressurization of the refrigeration system components beyond their ratings. Should the pressure limit be reached, the switch opens and disables refrigeration operation. UL regulations require the use of a High Pressure Switch when system charge is greater than 10 kg (22 lbs) and in all WC units. The setting of this device must be 90% of lowest working pressure of any of the discharge side components. The switch does not need to have a manual reset to comply with the UL requirement and therefore was an automatic reset device is used. The controller will require the user to reset the fault prior to restarting of the refrigeration system.

AC condenser

The AC condenser is one of the four components required in a vapor compression system. It is a heat exchanger used to reject heat from the discharge refrigerant vapor to the ambient air. As noted above, the condenser's efficiency drives the refrigerant saturation temperature for condensation to occur.

The refrigerant pressure is dictated by the efficiency of the condenser and the entering air (ambient) temperature. A temperature difference must exist between the refrigerant's saturation temperature and the entering air for heat transfer to take place.

Additional heat is rejected once the refrigerant is fully condensed to achieve what is known as sub-cooling. Sub-cooling is required to prevent a state change prior to the expansion device as a result of the pressure drop in the refrigerant components between the condenser and expansion device.

Factors that result in an increase in pressure from nominal values are: elevation increases, entering air temperature increases, debris on the condenser face, and restricted air flow (typically when units as installed too close to other devices). Excessive discharge pressures can lead to premature compressor failure.

Condenser air filter

The condenser air filter prevents dust and dirt particles from accumulating on the condenser coil.

Ambient air temperature sensor

The ambient air temperature sensor is used in DELUXE units only. It is located in the inlet air stream to the condenser to monitor condenser sir filter condition in conjunction with the discharge pressure sensor. An increase in discharge pressure without an increase in suction pressure or entering air temperature will indicate that either the filter is becoming clogged with debris, the unit is operating at high altitude or a problem with the fan assembly. The unit must first initialize to eliminate false indications associated with operation at higher elevations. The failure mode noted here can also be an indication of a fan motor failure, but is believed to be a lower probability failure than the clogged filter.

Fan assembly

The fan assembly circulates ambient air (cooling medium) through the condenser coil and around its tubes to absorb heat from the refrigerant.

Receiver

The receiver is a storage tank to hold liquid refrigerant. When the condenser is exposed to lower entering air (ambient) temperatures, it becomes highly efficient and there is a need to reduce the effective surface area (number of tubes) to prevent condensing pressure from dropping below a minimum value (usually dictated by the expansion device). When the entering air temperature increases, the surface area is needed due to the reduction in condenser efficiency. Without a place to store the excess refrigerant used for the minimum ambient condition, the discharge pressure will approach or exceed the compressor's allowable range.

Filter/dryer

The filter/dryer is a device filled with a desiccant or drying agent, with a filter screen at each end used to collect small amounts of particulate and moisture that may be in the refrigeration system after assembly and evacuation. Moisture in the refrigeration system can lead to plugging of the expansion device or to acid formation in the refrigerant oil.

Main liquid line control valve

The main liquid line control valve or expansion device is one of the four basic components of a vapor compression system. An expansion valve effectively creates a pressure drop that changes the high pressure liquid exiting the condenser into a low pressure liquid that enters the evaporator.

The valve employed in the platform is known as an electronic expansion valve. The valve is electrically pulsed to open or closed. Each pulse incrementally adjusts the position of the valve to achieve the desired response. As a result, the valve can provide a level of diagnostic capability as the number of pulses can be monitored to determine capacity regulates the flow of liquid refrigerant to the evaporator for cooling and maintaining process fluid set-point. The limits are set in the software as superheat and maximum operating pressure.

Valve hysteresis and backlash result in the potential inaccuracies in step or pulse counting. As a result, duty cycle or step counting is not advised in the platform as a main form of control. It can, however, be used to note if the valve is being over-driven. Overdriving some styles of electronic expansion valves can result in valve failure.

Hot gas control valve

The hot gas control valve is a mechanical valve that operates much like a relief valve. When outlet (suction) side pressure drops below the valve's setting, then the valve open allowing superheated gas to by-pass the condenser and enter directly to the evaporator. When the valve opens, the superheated (hot) gas is cooled by the process fluid and thereby heats the process fluid.

The valve's setting is below the lowest operating temperature seen in the evaporator to prevent condensation from occurring in the evaporator. Depending on the setting, the valve can be set such that water (when used as the process fluid) cannot freeze in the evaporator.

The platform uses a preset, mechanical hot gas valve to reduce test labor requirements. The valve has a gas charge that fixes its setting. As a result, lowering settings than that allowed by the standard temperature range requires a different valve.

Evaporator

The evaporator is where heat transfer occurs between the process fluid and the cooling module. It is the last of the four basic components in vapor compression systems. Low pressure liquid enters the evaporator and is heated by the process fluid until it changes state (boils).

The refrigerant pressure is dictated by the efficiency of the evaporator and the desired process fluid temperature. Like the condenser, a temperature difference must exist between the refrigerant's saturation temperature and the process fluid for heat transfer to take place. Minimizing the temperature difference in the evaporator allows for higher capacities as the refrigerant has higher density at warmer temperatures.

Maximum evaporating pressures are dictated by the compressor used in the system. The minimum pressure is set either as a limit of the compressor or the evaporator range limit of the hot gas device.

Factors that result in a decrease in efficiency from nominal values are: fluid changes (i.e. going to ethylene glycol from water), lower process fluid temperatures, and increase in process flow.

Accumulator

The accumulator is a trap to collect any liquid refrigerant that has spilled out of the evaporator, and prevent it from reaching the compressor. Liquids are incompressible fluids and therefore result in a myriad of problems on the compressor when present. It is typically sized to hold about 50% of the total running charge in the system.

As the platform uses an electronic expansion device with sensor feedback, the BASIC cooling module has the ability to eliminate the need for this device. However the HIGH TEMPERATURE DELUXE uses a mechanical de-superheating device. In these configurations, the accumulator serves as a mixing chamber for liquid injected into the suction line.

De-superheating expansion valve

The de-superheating expansion valve is used to lower return gas exiting the evaporator to a temperature that is within the acceptable limits of the compressor. Since the compressor does not do additional work, the amount of heat removed by this valve results in a reduction of capacity for the module. Only the HIGH TEMPERATURE DELUXE configuration requires the use of this device.

The valve used in the platform is a preset mechanical expansion valve. It uses a sensing bulb that is attached to the suction (compressor inlet) line. The bulb has a gas inside it that expands (on increased) or contracts (on decrease) dependent on the suction temperature. An expansion results in an increase of opening force on the valve body that opens the valve. Similarly, the valve is driven to close when the gas contracts. The temperature is controlled by the preset spring inside the valve that works against the bulb force.

Suction pressure sensor

The suction pressure sensor is located on the compressor inlet line to provide feedback for controlling the main liquid line electronic control valve. This sensor in conjunction with the suction temperature sensor provides superheat information on the cooling module to determine if the valve should/could be opened or closed. Additionally, it monitors suction side pressure to prevent (high or low) pressures from exceeding the limits of the compressor.

Suction temperature sensor

The suction temperature sensor is located on the compressor inlet line to provide feedback for controlling the main liquid line electronic control valve. As noted above, this sensor, in conjunction with the suction pressure sensor, provides superheat information on the cooling module to determine if the valve should/could be opened or closed. The sensor is mounted on the suction line. Some inaccuracy is present in this type of mount, however refrigerant boundary effects are believed to be negligible given the fact that it's in the gas state. Additionally, tube wall thickness is not considered to be significant due to it thickness and it high conductivity (copper).

WC condenser

The WC condenser is one of the four components required in a vapor compression system. It is a plate heat exchanger used to reject heat from the discharge refrigerant vapor to the secondary (facility) fluid. As noted above, the condenser's efficiency drives the refrigerant saturation temperature.

The refrigerant pressure is dictated by the efficiency of the condenser and the entering facility water temperature. A temperature difference must exist between the refrigerant's saturation temperature and the entering water for heat transfer to take place.

Additional heat is rejected once the refrigerant is fully condensed to achieve what is known as sub-cooling. Sub-cooling is required to prevent a state change prior to the expansion device as a result of the pressure drop in the refrigerant components between the condenser and expansion device.

Factors that result in an increase in pressure from nominal values are: entering facility water temperature increases and debris on the condenser face. Excessive discharge pressures can lead to premature compressor failure.

Pressure regulating valve

The pressure regulating valve is a mechanical device that regulates (controls) the flow of cooling medium (facility water) to the condenser. The valve employs a bellows that is directly coupled to the refrigerant discharge (outlet) pressure via a capillary tube. This pressure port applies pressure to the bottom of the bellows that works against a spring force. As condenser pressure rises, the valve is driven to open provided the spring force is overridden. As the condenser pressure drops, the valve is driven closed by the spring. The spring force effectively dictates the nominal condensing pressure. As the valve is a two port (inlet and outlet), it stops facility flow when closed.

Facility water inlet and **outlet pressure sensors**

The facility water inlet and outlet pressure sensors are only used in the DELUXE units. These devices measure facility inlet and outlet pressure so that a differential pressure can be calculated. This differential pressure will correlate to a flow rate through the system. Since the pressure regulating valve can adjust its position based on the demands of the condenser, the differential is ignored unless the discharge pressure continues to rise. The differential calculation can also be used to detect if user is exceeding differential pressure limits of the pressure regulating valve.

Facility temperature sensor

The facility temperature sensor is used in DELUXE units only. It is located in the inlet facility stream to the condenser to monitor condenser sir filter condition in conjunction with the discharge pressure sensor. An increase in discharge pressure without an increase in suction pressure or entering air temperature will indicate that either the condenser or pressure regulating valve is becoming clogged with debris. The unit must first initialize to eliminate false indications associated with operation with secondary fluids other than water.

Section III General Information

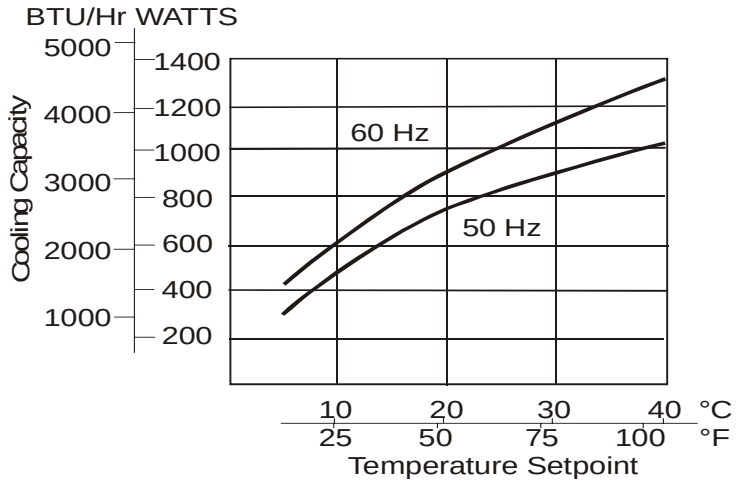
Specifications

	ThermoFlex 900	ThermoFlex 1400
Process Fluid Temperature Range	+ 5°C to +40°C +41°F to +104°F	+5°C to +40°C +41°F to +104°F
Ambient Temperature Range	+ 10°C to +40°C + 50°F to +104°F	+10°C to +40°C +50°F to +104°F
Temperature Stability	+/- 0.1°C	+/- 0.1°C
Cooling capacity at 20°C		
60 Hz	900W (3072 BTU)	1400W (4778 BTU)
50 Hz	750W (2560 BTU)	1170W (3996 BTU)
Reservoir Volume		
Gallons	1.9	1.9
Liters	7.6	7.6
Unit Weight		
lb	126	126
kg	57.2	57.2
Pumps		
PD 1 - Positive Displacement		
60 Hz	2.1 gpm @ 60 psi	
50 Hz	1.7 gpm @ 60 psi	
PD 2 - Positive Displacement		
60 Hz	4.1 gpm @ 60 psi	
50 Hz	3.3 gpm @ 60 psi	
Compliance	NRTL Certified to CSA and UL Standards; CE Marked	

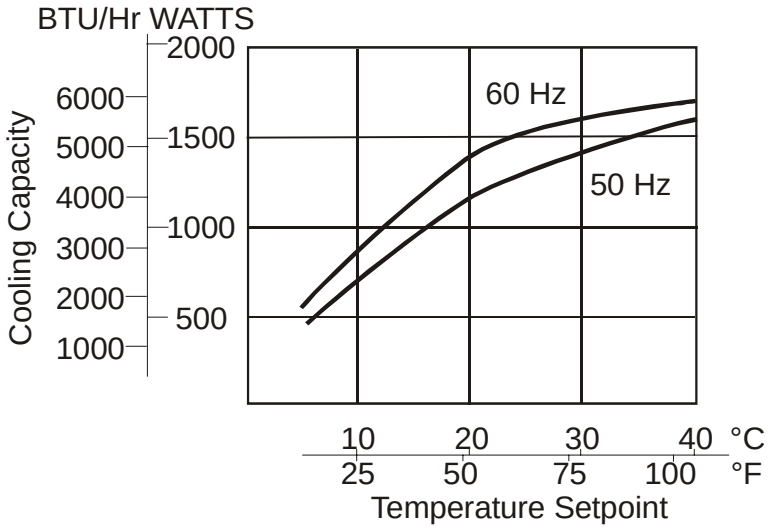
- Specifications obtained at sea level using water as the recirculating fluid, at a 20°C process setpoint, 25°C ambient condition, at nominal operating voltage. Other fluids, fluid temperatures, ambient temperatures, altitude or operating voltages will affect performance.
- Thermo Electron reserves the right to change specifications without notice.

Performance Curves

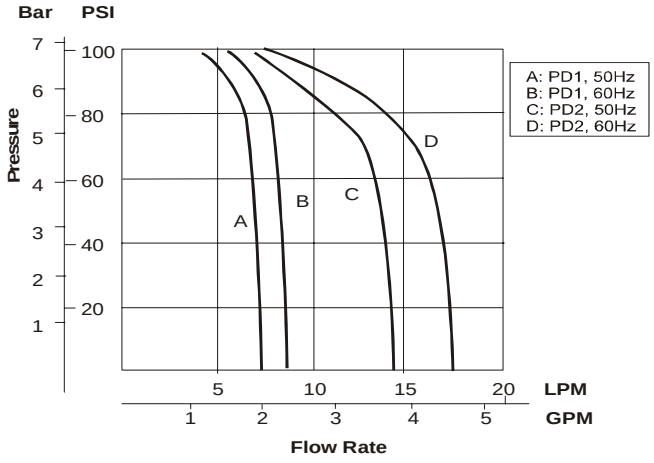
ThermoFlex 900 Cooling Capacity



ThermoFlex 1400 Cooling Capacity



Pumping Capacity



- Pump performance results were obtained with no restrictions on the return to the system.
- Specifications obtained at sea level using water as the recirculating fluid, at a 20°C process setpoint, 25°C ambient condition, at nominal operating voltage. Other fluids, fluid temperatures, ambient temperatures, altitude or operating voltages will affect performance.
- Thermo Electron reserves the right to change specifications without notice.

Section IV Installation

Site Requirements

Ambient Temperature Range*	10°C to 40°C (50°F to 104°F)
Relative Humidity Range	10% to 80% (non-condensing)
Operating Altitude*	Sea Level to 8000 feet (2438 meters)
Overvoltage Category	II
Pollution Degree	2

*Because of the decrease in air density, maximum temperature for the air entering the ThermoFlex must be reduced by 1°C per 1,000 feet above sea level. In addition, cooling capacity is reduced 1.2% per 1,000 feet above sea level.

Never place the unit in a location where excessive heat, moisture, inadequate ventilation, or corrosive materials are present.

NOTE: Fluid temperatures at the application may differ from the chiller due to environmental heat loss/gain. Heat is also lost through the plumbing when the setpoint is at or below room temperature. Applications with long lengths of plumbing may need to be insulated accordingly.

Units installed below the end-user application may enable system fluid to drain back into the chiller and cause spillage. Thermo offers an anti-drainback kit to prevent any spillage, see Section V.

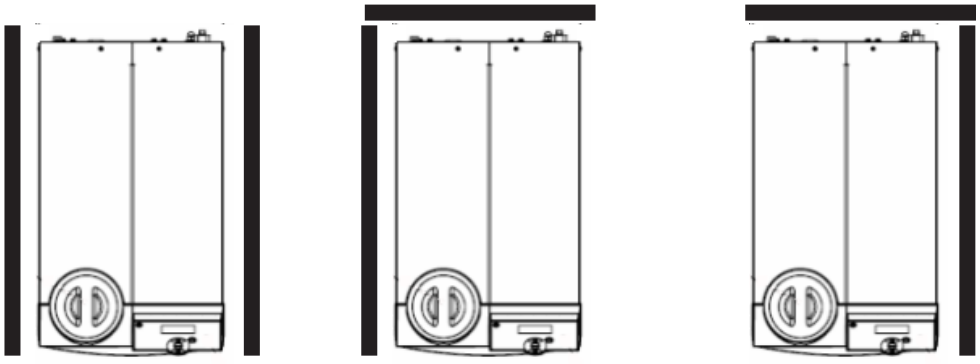
Air-cooled units can be installed with both sides blocked, or one side and the rear. See illustration below. The front of the unit needs a minimum clearance of 24". Air will enter the front of the system and exit through the sides and rear.

NOTE: Having two sides blocked can impact the unit's performance due to changes in air flow. If your installation requires two blocked sides please ensure that the following requirements are met:

Process Setpoint Temperature: Below 30°C

Ambient: Below 40°C

If your setpoint and/or ambient temperatures are above these numbers please contact Thermo Electron's Sales, Service and Customer Support to review your installation.



Electrical Requirements

The unit construction provides protection against the risk of electrical shock by grounding appropriate metal parts. The protection may be compromised unless the power cord is connected to a properly grounded outlet. It is the user's responsibility to ensure that a proper earth-grounding connection is provided.

Electrical Service Required:

ThermoFlex 900			
Voltage	**Frequency**	**Phase**	**Receptacle Rating**
100 VAC	50 Hz	1Ø	15A
100 VAC	60 Hz	1Ø	15A
115 VAC	60 Hz	1Ø	15A
230 VAC	50 Hz	1Ø	*16A[1], 15A[2], 13A[3]
208-230 VAC	60 Hz	1Ø	15A
ThermoFlex 1400			
Voltage	**Frequency**	**Phase**	**Receptacle Rating**
100 VAC	50 Hz	1Ø	20A
100 VAC	60 Hz	1Ø	20A
115 VAC	60 Hz	1Ø	20A
208-230 VAC	60 Hz	1Ø	15A
230 VAC	50 Hz	1Ø	16A*

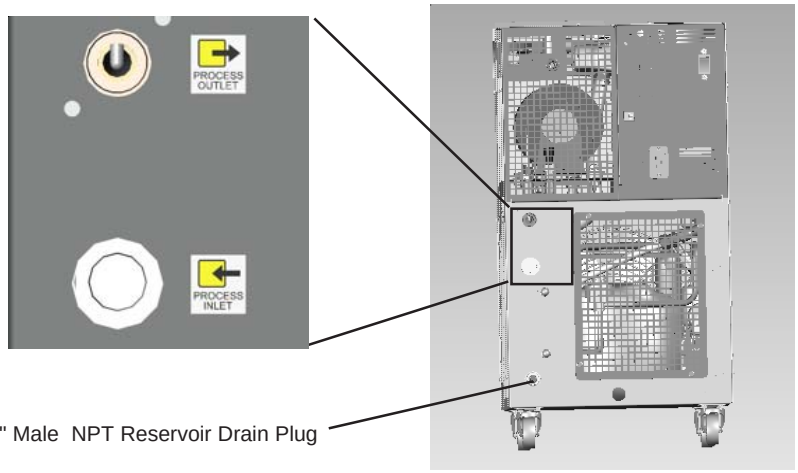
* Refer to Appendix A for country specific requirements.

Refer to the nameplate label located on the rear of the unit for specific electrical requirements.

Plumbing Requirements

Ensure that the shipping plugs are removed from all fittings before installation.

Never connect the process fluid lines to your facility water supply or any pressurized liquid source.

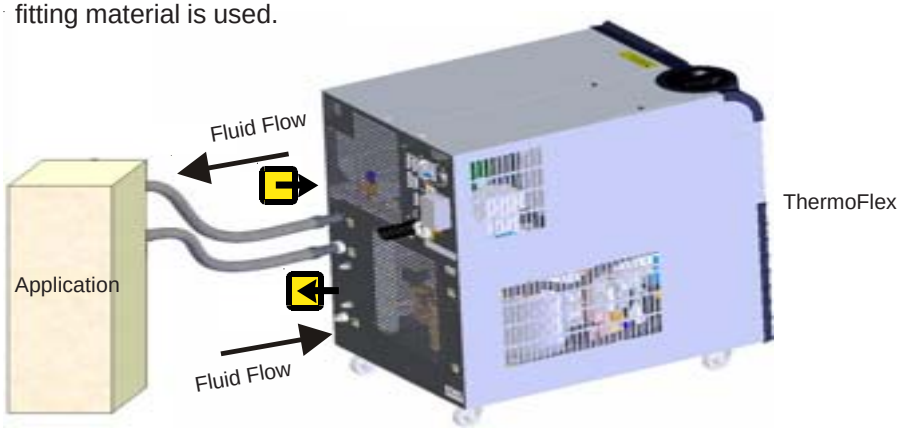


The process fluid plumbing connections are located on the rear of the unit and are labeled (PROCESS OUTLET) and (PROCESS INLET). The connections are ½" Female NPT. The process outlet connection is cast bronze, the process inlet connection is stainless steel.

Connect the PROCESS OUTLET to the fluid inlet on your application.

Connect the PROCESS INLET to the fluid outlet on your application.

Ensure all connections are secure and that the proper sealant/lubricant for the fitting material is used.



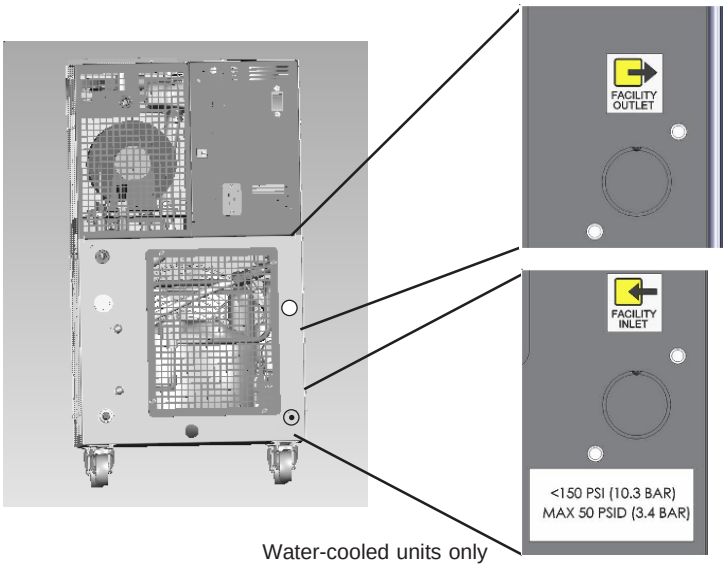
NOTE: PD pumps are capable of producing 110 psi. Ensure your plumbing is rated to withstand this pressure. An external pressure relief valve is available, see Section V.

Keep the distance between the unit and the instrument being cooled as short as possible. Tubing should be straight and without bends. If diameter reductions must be made, they should be made at the inlet and outlet of your application, not at the ThermoFlex.

Water-Cooled Units

For water-cooled units the facility water plumbing connections are also located on the rear of the unit and are labeled FACILITY INLET and FACILITY OUTLET. The connections are also ½" Female NPT. Both connections are cast bronze.

Connect the FACILITY INLET to your facility water supply. Connect the FACILITY OUTLET to your facility water return or drain. Ensure all connections are secure and that the proper sealant/lubricant for the fitting material is used.

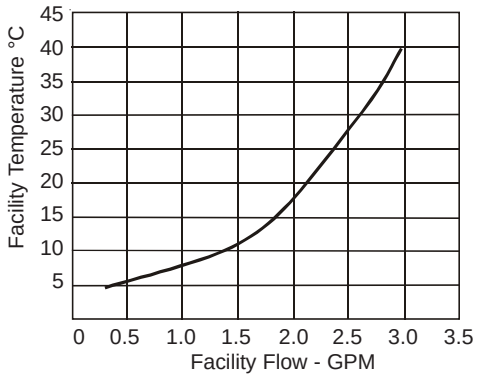


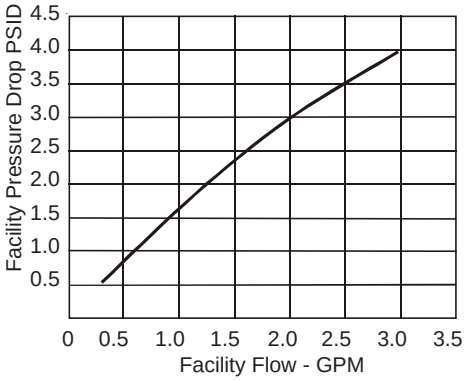
Water-cooled units only

Facility Water Maximum Inlet Pressure must not exceed 150 PSIG.

Facility Water Maximum Pressure Differential must not exceed 50 PSID under any condition.
(Pressure Differential = Inlet Pressure - Outlet Pressure)

The facility water must meet the following conditions for the unit to maintain its full rated capacity.





Fluid Requirements

Never use flammable or corrosive fluids with this unit. Do not use automotive antifreeze. Commercial antifreeze contains silicates that can damage the pump seals. Use of these fluids will void the manufacturer's warranty.

Acceptable fluids are:

Filtered/Single Distilled Water
Deionized water (1 - 3 megohm, compensated)
0 - 95% Ethylene Glycol/Water
0 - 95% Propylene Glycol/Water

Check the fluid concentration on a regular basis. Changes in concentration can impact system performance.

Before using any fluid or performing maintenance where contact with the fluid is likely refer to the manufacturer's MSDS for handling precautions.

Ethylene glycol (EG) is hygroscopic, it will absorb water from its environment. This can affect the freezing point and boiling point of the fluid over time. This may result in system failure.

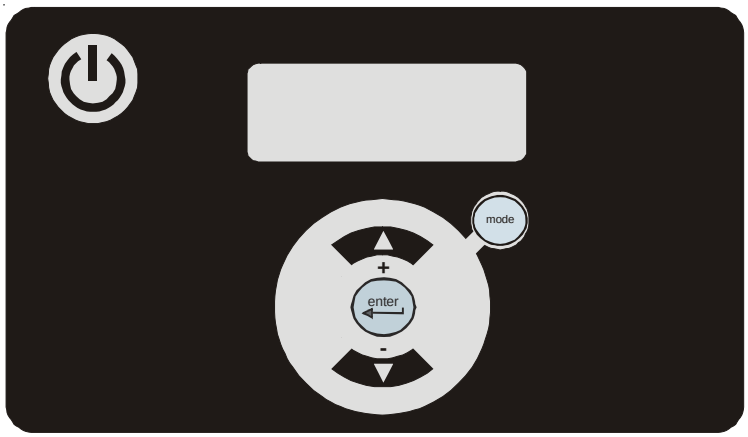
When using EG/water or PG/water, top-off with EG/water or PG/water. Do not top-off with plain water. Topping-off with plain water can severely effect the freezing point and boiling point of the fluid. This may result in system failure.

Do not use a Deionization (DI) filter cartridge with Inhibited EG or Inhibited PG. A DI filter will remove inhibitors from the solution rendering the fluid ineffective against corrosion protection. Also, inhibitors increase fluid conductivity.

Section V Operation

Basic Controller

The controller controls temperature using a Proportional-Integral-Derivative (PID) algorithm, and is designed with self-diagnostic features and an easy to use operator interface.



Basic Controller

The  key is used to start and stop the unit.

The  key is used to navigate through the controller displays and to increase adjustable values.

The  key is used to navigate through the controller displays and to decrease adjustable values.

The  key has two functions. Pressing it once allows changes to be made, pressing it again after the changes are made allows you to continue to other displays.

The  key is used to change the controller modes of operation.

Prestart

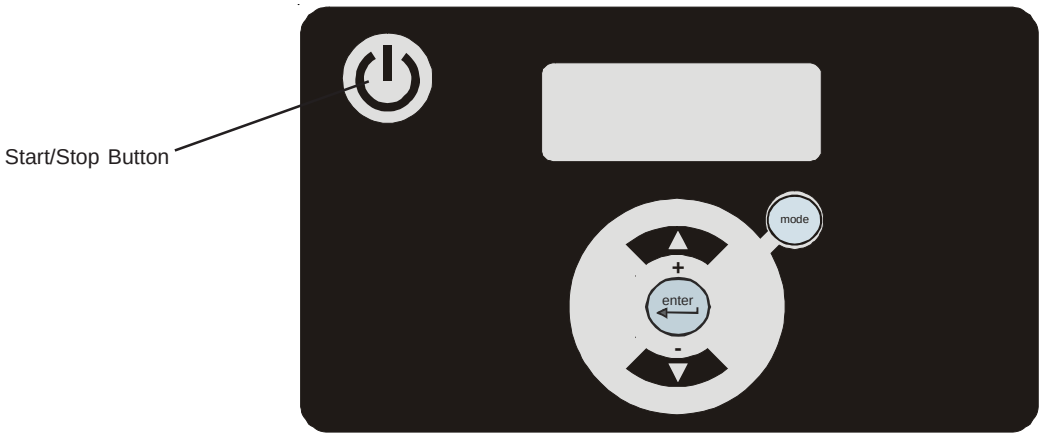
Before starting the unit, double check all electrical and plumbing connections. Have extra recirculating fluid on hand. If the unit will not start refer to Section VII Troubleshooting.

NOTE: For first time use, please refer to the quick start instructions included with your unit.

Start Up

- Place the circuit breaker located on the rear of the unit to the on (**I**) position. The display will indicate .
- The bars will scroll upward indicating the controller is doing a self-test. The self-test takes approximately 15 seconds.
- When the bars disappear the controller display will go blank.
- Press the key. The display will show the process fluid temperature. The pump and refrigeration system will also start.

If the auto restart is enabled and the unit shuts down as a result of a power failure, when power is restored the unit will automatically restart. If the unit was shut down using the circuit breaker located on the rear of the unit, the circuit breaker must be reset to the on (I) position before you can restart the unit. Auto restart is enabled using the Setup Loop.

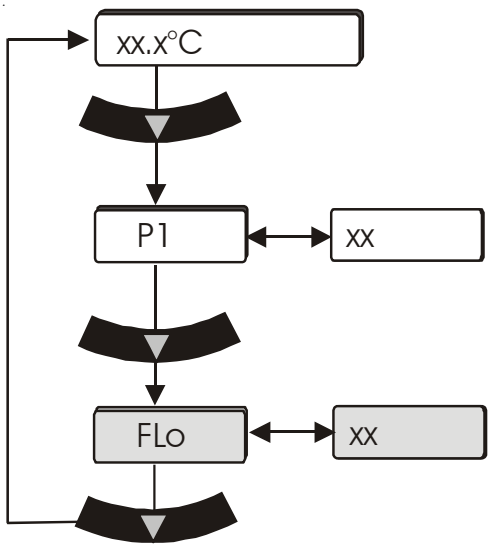


Basic Controller

If desired, press the key to display the pump's discharge pressure - **P1**. The display will alternate (↔) between **P1** and the pump's discharge pressure value.

If the unit is equipped with an optional flow transducer, pressing the key again will display the flow rate - **FLo**. The display will alternate (↔) between **FLo** and the flow rate value.

Press the key again to display the process fluid temperature.



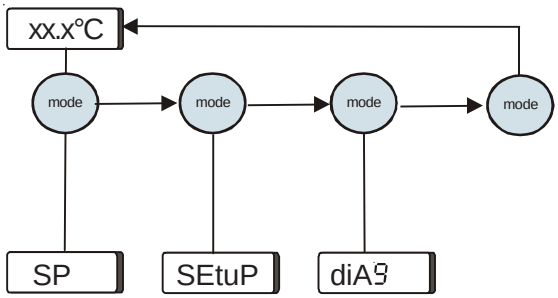
P1 - Pump discharge pressure.

FLo - Flow rate (optional feature).

Controller Loops

The controller has the capability to display various loops which indicate operating conditions and parameters within the unit. The loops are selected and changed by pressing the appropriate keys.

When the controller is first powered up it goes through a short self-test and then displays the process fluid temperature. Use the key combination shown below to scroll through the loops.

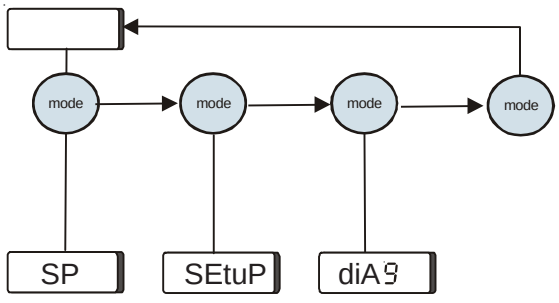


SP is the Setpoint Loop and is used to display and change the setpoint. The setpoint is the desired process fluid temperature needed for your application. The Setpoint Loop is accessed by pressing the **mode** key, see next page.

SEtuP is the Setup Loop. The Setup Loop allows you to display and/or alter different parameters of the controller. The Setup Loop is accessed from the Setpoint Loop by pressing the **mode** key.

diA9 is the Diagnostic Loop. The Diagnostic Loop allows you to display the operating times for various components within the unit. The Diagnostic Loop is accessed from the Setup Loop by pressing the **mode** key.

NOTE: The loops can be accessed and changed without the unit running as long as the circuit protector is in the on (**I**) position.

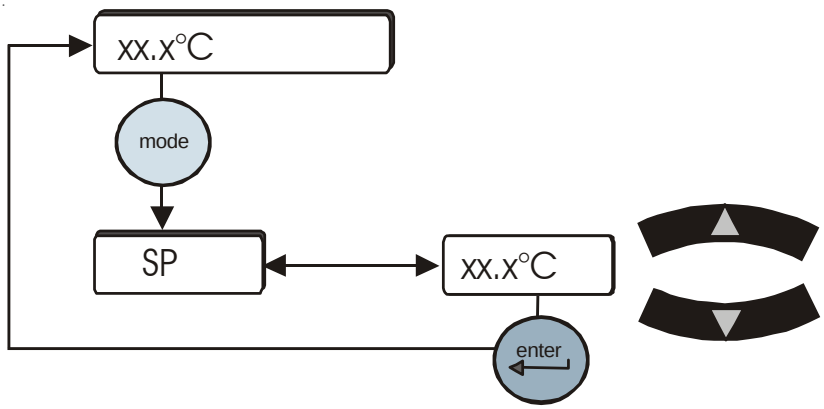


Setpoint Loop

- Ensure the controller is displaying the process fluid temperature.
- Press the mode key and the controller display will alternate between **SP** and the setpoint value.
- If no change is required press the enter key to return the display to the process fluid temperature.
- If a setpoint change is required, use the keys.

  The setpoint range is +5°C to +40°C.

  NOTE: If the are not used within two minutes the controller will time out and return to the process fluid temperature display.
- Once the desired value is displayed press the enter key to confirm the change.
- The display will return to the process fluid temperature.



Setpoint Loop

Setup Loop

The Setup Loop is used to adjust/verify the following controller software settings.

- High and low temperature alarm limits
- High and low pump discharge pressure alarm limits and time delays
- Fault reaction to a temperature, pressure or flow (optional) alarm limit (continue to run or shut down)
- Audible alarm enabled/disabled
- Auto restart feature enabled/disabled
- Preventative care cleaning frequency reminder for air and fluid filters

  Optional Features:

  - Auto refill alarm
  - DI filter cartridge preventative maintenance interval
  - High/low flow alarm limits
  - Serial communications feature enabled/disabled
  - Anti drainback valve position

- **Save/abort all changes**

To enter the Setup Loop ensure the controller display is either a blank screen (unit off) or displaying the process fluid temperature. Press the key and the display will indicate **SP**, press it again to display **SEtuP**.

Press the 

key to continue, or press 

twice to return to the process fluid temperature or blank display.

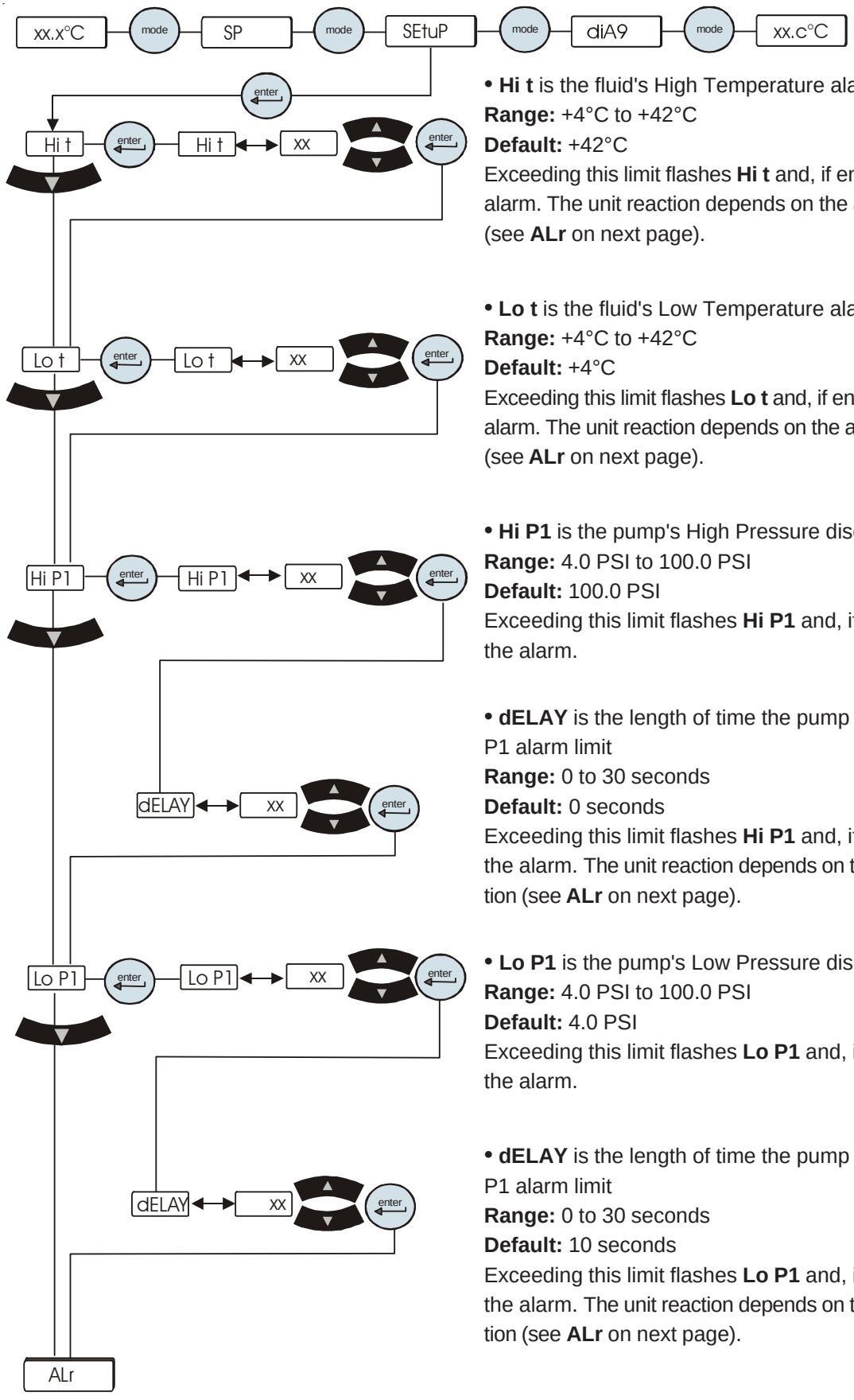
Use the  key to sequence through the loop. To change any parameter:

- Press the 

key.
- Use the  keys to change a displayed value.
- Press 

key to confirm the change.

Setup Loop (All Units)



Setup Loop (1 of 3)

• **Hi t** is the fluid's High Temperature alarm limit.
Range: +4°C to +42°C
Default: +42°C
Exceeding this limit flashes **Hi t** and, if enabled, sounds the alarm. The unit reaction depends on the alarm configuration (see **ALr** on next page).

• **Lo t** is the fluid's Low Temperature alarm limit.
Range: +4°C to +42°C
Default: +4°C
Exceeding this limit flashes **Lo t** and, if enabled, sounds the alarm. The unit reaction depends on the alarm configuration (see **ALr** on next page).

• **Hi P1** is the pump's High Pressure discharge alarm limit.
Range: 4.0 PSI to 100.0 PSI
Default: 100.0 PSI
Exceeding this limit flashes **Hi P1** and, if enabled, sounds the alarm.

• **dELAY** is the length of time the pump can exceed the Hi P1 alarm limit
Range: 0 to 30 seconds
Default: 0 seconds
Exceeding this limit flashes **Hi P1** and, if enabled, sounds the alarm. The unit reaction depends on the alarm configuration (see **ALr** on next page).

• **Lo P1** is the pump's Low Pressure discharge alarm limit.
Range: 4.0 PSI to 100.0 PSI
Default: 4.0 PSI
Exceeding this limit flashes **Lo P1** and, if enabled, sounds the alarm.

• **dELAY** is the length of time the pump can exceed the Lo P1 alarm limit
Range: 0 to 30 seconds
Default: 10 seconds
Exceeding this limit flashes **Lo P1** and, if enabled, sounds the alarm. The unit reaction depends on the alarm configuration (see **ALr** on next page).

Setup Loop (All Units)

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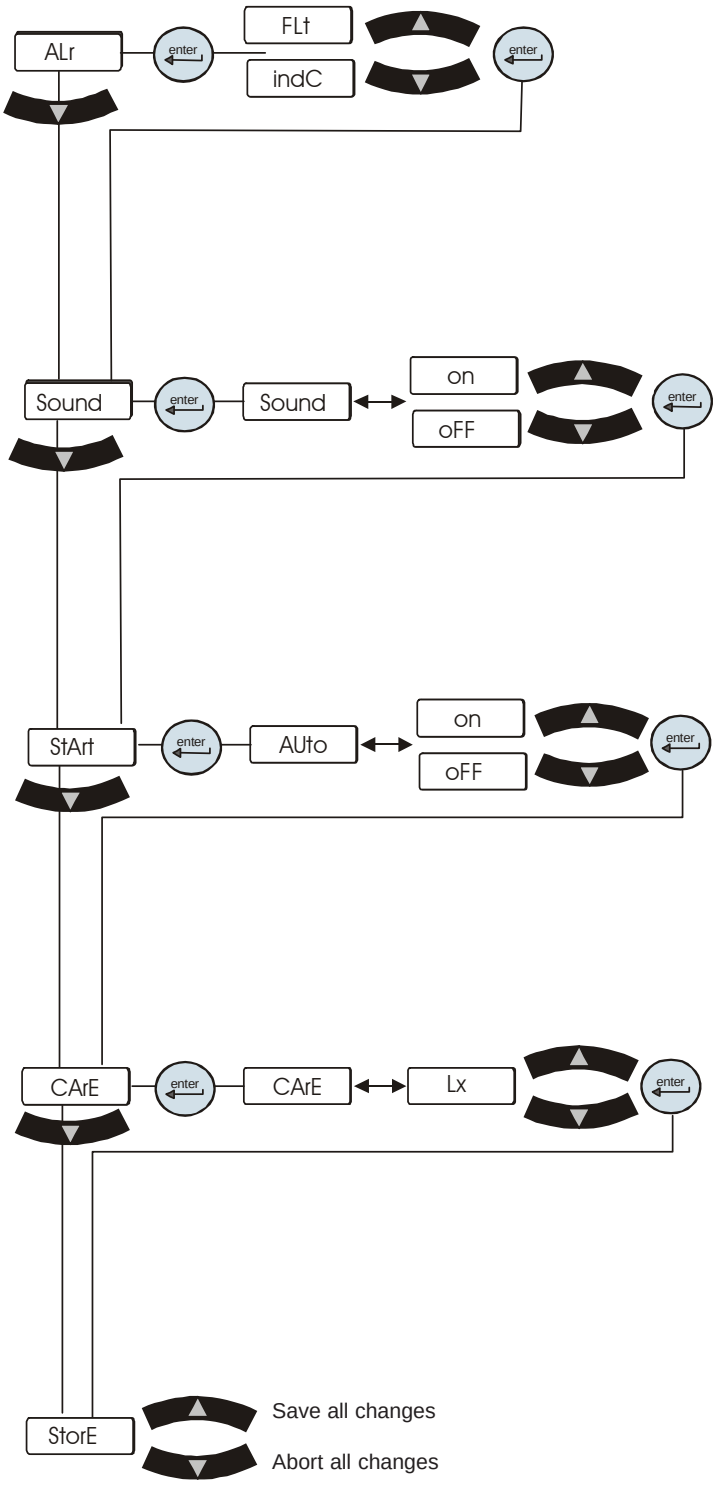


Setup Loop (2 of 3)

NOTE: If your unit is equipped with any of the **Optional Features** refer to the next page.

• **ALr** configures the unit's fault reaction to a temperature, pressure or flow (optional) alarm limit (continue to run or shut down).
Range: Shut down (**FLt**) or continue to run (**indC**).
Default: FLt

• **Sound** is used to turn the audible alarm on or off.
Range: on or off
Default: on

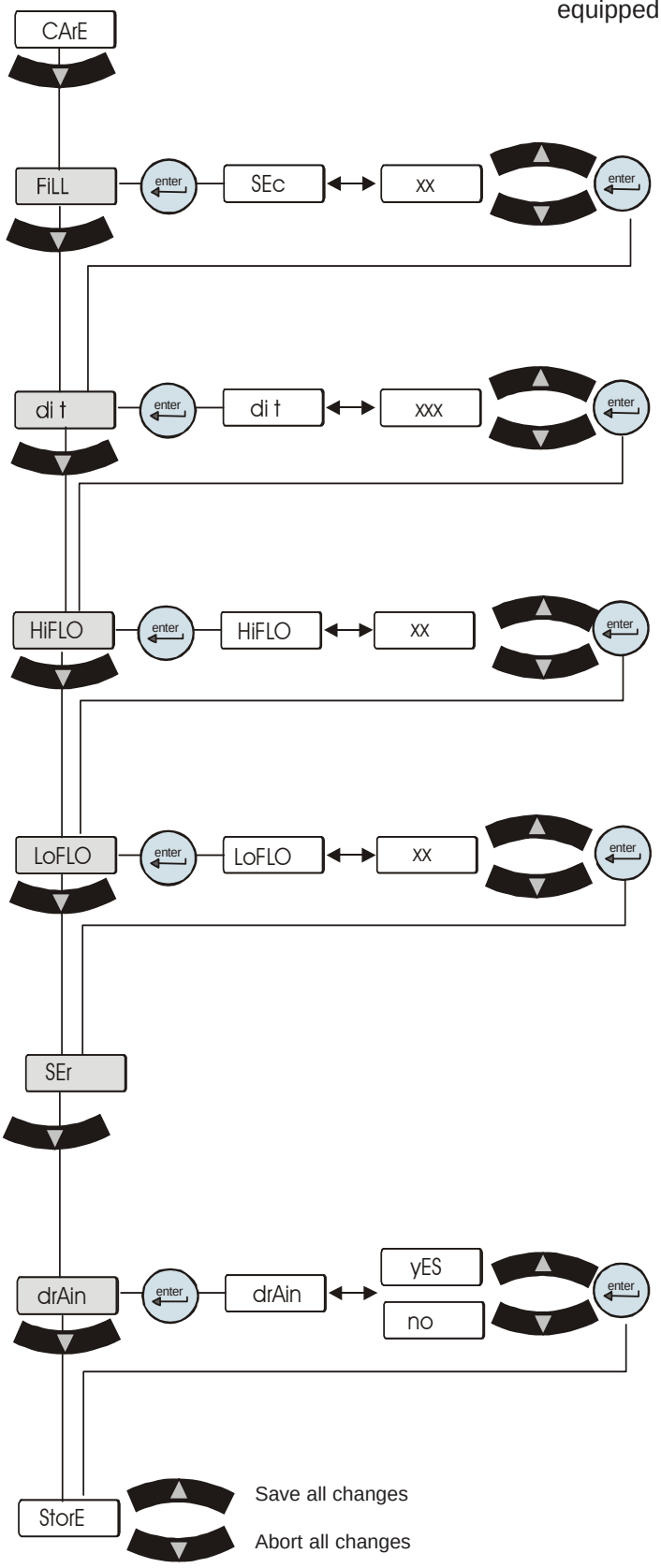
• **StArt** is used to enable/disable the auto restart.
Range: on or off
Default: off

• **CArE** is used to set the preventative care cleaning frequency reminder for the unit's air and fluid filters, in hours. The time selected is based on your operating environment, see Section VI.
Range: L1 (1000 hours), L2 (2000 hours), or L3 (3000 hours)
Default: L1
Exceeding this limit flashes **FLtrS,** see Section VI.

When the display indicates **StorE** press to save *all* changes or press to abort *all* changes. The display will return either the process fluid temperature or, if the unit was off when you entered the loop, a blank screen.

Setup Loop (Optional Features)

CONTINUED FROM PREVIOUS PAGE



Setup Loop (3 of 3)

Shaded displays appear only on units equipped with that option.

• **FiLL** is used to set the time limit the auto refill has for filling the unit's reservoir to the normal operating level.
Range: 0 to 900 seconds
Default: 45 seconds
Exceeding the time limit flashes **rEFiL** and the auto refill will shut down.

• **di t** is used to set the preventative care cleaning frequency reminder for the unit's DI filter cartridge.
Range: 0 to 9999 hours
Default: 448 hours
Exceeding the limit flashes **Di,** see Section VI.

• **HiFLO** is used to set the high flow alarm limit.
Range: 0.5 to 5.0 GPM
Default: 5.0 GPM
Exceeding this limit flashes **HiFLO** and, if enabled, sounds the alarm. The unit's reaction depends on the alarm (**ALr**) setting.

• **LoFLO** is used to set the low flow alarm limit.
Range: 0.5 to 5.0 GPM
Default: 0.5 GPM
Exceeding this limit flashes **LoFLO** and, if enabled, sounds the alarm. The unit's reaction depends on the alarm (**ALr**) setting.

• **SEr** is used to configure the serial communications mode of operation.

• **drAin** is used to open and close the unit's anti drainback valve for draining, see Section V.
Range: yes or no
Default: no

• **NOTE:** The valve automatically closes when you exit the Setup Loop.

When the display indicates **StorE** press to save *all* changes or press to abort *all* changes. The display will return either the process fluid temperature or, if the unit was off when you entered the loop, a blank screen.

Diagnostic Loop

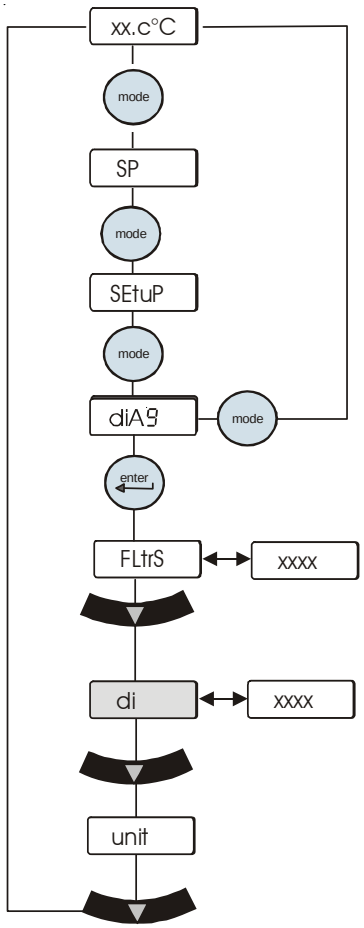
The Diagnostic Loop is used to view or reset the operating times of various unit components.

To enter the Diagnostic Loop ensure the controller display is either a blank screen (unit off) or displaying the process fluid temperature.

Press the mode key and the display will indicate **SP**, press mode again to display **SEtuP**, press mode again to display **diA9**.

Press enter to enter the loop or press mode to return to the process fluid temperature or blank display.

Use the key to sequence through the loop.



Shaded displays appear only on units equipped with that option.

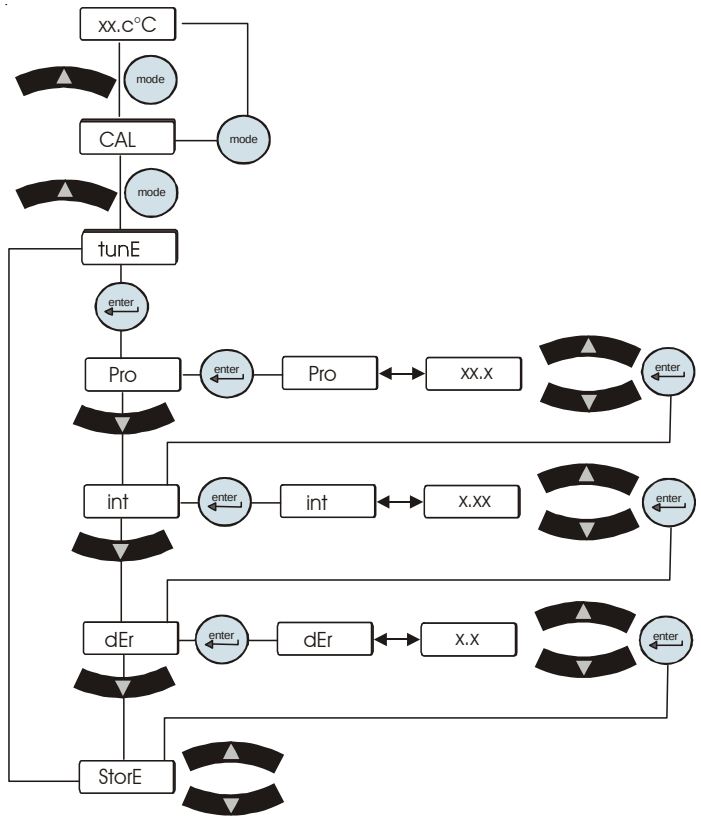
FLtrS - Indicates the total time the air and fluid filters have been in use, in hours. If desired, press and hold and then press enter to reset the value to 0, see Section VI.

di - Indicates the total time the di filter cartridge has been in use, in hours. If desired, press and hold and then press enter to reset the value to 0, see Section VI.

unit - Indicates the unit operating time, in hours. This value can not be reset.

Adjusting the Controller PID Values

The controller controls temperature using a Proportional-Integral-Derivative (PID) algorithm. Should your unit experience temperature control issues, adjusting the controller's PID values may correct the condition.



• **Pro** is the proportional value
Range: 0.0 to 99.9
Factory Preset: 10.0

• **int** is the integral value
Range: 0.00 to 9.99
Factory Preset: 0.50

• **der** is the derivative value
Range: 0.0 to 9.9
Factory Preset: 0.0

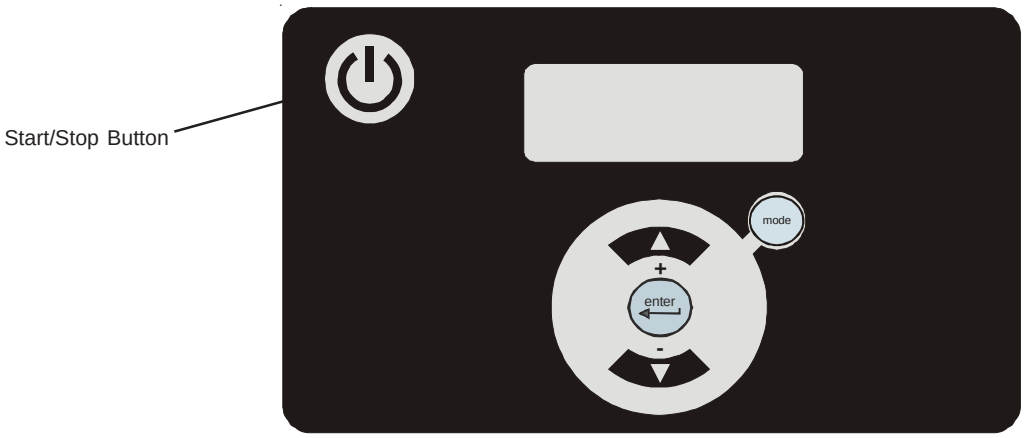
Shut Down

Press the key.

NOTE: To protect the unit's compressor, the unit will enter a 20 second shut down cycle before the refrigeration system and pump shut down. During this time the display will indicate OFF. The bars will scroll downward indicating the controller is in the shut down cycle.

When the display goes blank it is safe to place the circuit protector located on the rear of the unit to the off (**0**) position.

Using any other means to shut the unit down can reduce the life of the compressor.



Basic Controller

Always turn the unit off and disconnect it from its supply voltage before moving the unit.

The circuit protector located on the rear of the unit is not intended to be used as a disconnecting means.

Section VI Troubleshooting

Operational Error Codes

The controller can display Error Codes. If the unit shuts down the controller will continue to flash between the error code and **OFF**. Press **enter** to clear the display. Once the cause of the shut down is identified and corrected, you must press the controller's **enter** key *again* to clear the error code display.

Error Code	Reaction	Cause	Actions
di	Unit will continue to run.	Internal DI cartridge may need to be replaced.	•Check the Puralite sensor on the rear of the unit, if the light is red change the cartridge. See Section VI. •If the Puralite sensor is green, see Section V to revise DI cartridge run time.
FLtrS	Unit will continue to run.	Air and Fluid filters require preventative maintenance/replacement.	•Check air and fluid filters. If required, clean/change air and fluid filters, see Section VI. • If your filters do not need cleaning, you may increase the number of hours between preventative care reminders. There are three levels, see Section VI.
HiFLO	Unit reaction depends on HiFLo adjustable setting chosen in the Setup Loop, *Alr setting*. See section IV.	The process fluid flow rate has exceeded the adjustable setting's value.	• Verify your HiFLo setting, see Section IV, and adjust setting if necessary. •Check all application and plumbing shut off valves for correct position. • Adjust flow if unit is equipped with a flow control valve (option), see Section V. • If flow transducer was recently calibrated double check calibration, see Section VIII. •Contact Thermo Electron's Sales, Service and Customer Support.

Error Code	Reaction	Cause	Actions
Hi P1	Unit reaction depends on Hi P1 adjustable setting chosen in the Setup Loop, *Alr setting*. See Section IV.	The Pump's discharge pressure exceeded Setup Loop alarm value.	•Verify your Hi P1 setting, see Section IV. •Check application valves and ensure that they have not changed or been closed. **NOTE:** If routine shut-off of the process flow is required then an external pressure relief valve should be added, see Section V. • May occur as a result of changing the internal DI cartridge. Disconnecting the cartridge adds an additional 0.5 gpm to the main flow (for PD pumps). See Section V. • Check for debris in the application or external filters. • Double check fluid lines. Excessive bends, long tubing and diameter reductions can affect the pump's discharge pressure. **NOTE:** If diameter reductions must be made, they should be made at the inlet and outlet of your application, not at the chiller. •Contact Thermo Electron's Sales, Service and Customer Support.
Hi t	Unit reaction depends on Hi t adjustable setting chosen in the Setup Loop, *Alr setting*. See Section IV. **NOTE:** If the unit does shut down it can be restarted, but it will shut down again if the process fluid temperature goes above the customer adjustable setting within two minutes.	The Process fluid temperature exceeded Setup Loop alarm value. If operating at high altitude note that heat removal capacity decreases 1.2% per 1,000 feet above sea level. Also, the maximum temperature of the air entering the unit must be reduced by 1°C per 1,000 feet above sea level.	•Verify your Hi t setting, see Section IV. •Ensure the unit meets all environmental requirements, see Section III. •Clean air filter. Dirt and debris on filter can prevent the unit from functioning at full capacity, see Section VI. •Ensure that the heat load being applied to the chiller is not too high. Contact Thermo for assistance on calculating heat loads. •Bring cooler air in from another area or exhaust the hot air into another location using an auxiliary fan. •Ensure unit has adequate ventilation, see Section III. •Verify/adjust controller PID values, see Section VII. •If the internal process temperature sensor (RTD1) was recently calibrated, double check calibration to ensure that it was done properly, see Section VIII. •Contact Thermo Electron's Sales, Service and Customer Support.

Error Code	Reaction	Cause	Action
HPC	Unit will shut down.	High refrigeration pressure.	**Air-cooled units** •Clean air filter. Dirt and debris on filter can prevent the filter from functioning at full capacity - see Section VI. •Ensure that the ambient temperature is not exceeding the recommended range, see Section III. •Bring cooler air in from another area or exhaust the hot air into another location using an auxiliary fan. •Ensure unit has adequate ventilation, see Section III. •Contact Thermo Electron's Sales, Service and Customer Support. **Water-cooled units** •Ensure facility water is on and connected •Check facility water flow rate and pressure •Contact Thermo Electron's Sales, Service and Customer Support.
Lo P1	Unit reaction depends on Lo P1 adjustable setting chosen in the Setup Loop, *Alr setting*. See Section IV.	Pump's discharge pressure is below Setup Loop alarm value.	•Verify your LoP1 setting, see Section IV. •Ensure that chiller reservoir is not empty. •Unit requires >5 PSIG application pressure drop. If a bypass valve has been installed, some restriction may need to be added to the bypass line. •Contact Thermo Electron's Sales, Service and Customer Support.

Error Code	Reaction	Cause	Actions
Lo t	Unit reaction depends on Lo t adjustable setting chosen in the Setup Loop, *Alr setting*. See Section IV. **NOTE:** If the unit does shut down it can be restarted, but it will shut down again if the process fluid temperature goes below the customer adjustable setting within two minutes.	Process fluid temperature is below Setup Loop alarm value. Unit may not to be able to reach setpoint in low ambient temperatures.	•Verify your Lo t setting, see Section IV. •Ensure that the ambient temperature is not exceeding the recommended low-range, see Section III. If your application load is constant and/or the lower temperature can be temporarily tolerated, then continue operation. (The ThermoFlex will control setpoint when sufficient heat is added.) •Verify/adjust controller PID values, see Section VII. •Add insulation to external plumbing lines to reduce the heat-loss to the environment. •Install insulation to external plumbing lines to reduce heat loss. •For water-cooled units check facility water temperature. •Contact Thermo Electron's Sales, Service and Customer Support.
LoFLo	Unit reaction depends on LoFLo adjustable setting chosen in the Setup Loop, *Alr setting*. See Section IV.	The process fluid flow rate has gone below the adjustable setting's value.	•Verify your LoFLo setting, see Section IV. •Adjust flow if unit is equipped with a flow control valve (option), see Section V. •Check all valves in your application and plumbing lines to ensure that they have not changed or closed. **NOTE:** If routine shut-off of the process flow is required then disable the low flow alarm by setting the alarm to 0.5 gpm, see Section IV. •If flow transducer has recently been calibrated, double check calibration to ensure it was done properly, see Section VIII. •Contact Thermo Electron's Sales, Service and Customer Support.

Error Code	Reaction	Cause	Actions
LLF	Unit will shut down.	Reservoir fluid level too low for normal operation.	•Excessive evaporation. Ensure the unit is operating with the funnel and cap in place. •Check for leaks. •Check auto refill operation, see Section V. •Check the supply pressure on the auto refill supply line. With low pressure the auto refill time span setting may be set too low and the reservoir does not have time to fill. Check rEFiL settings and adjust if necessary, see Section IV. •Contact Thermo Electron's Sales, Service and Customer Support.
OFLO	Unit will shut down.	There is an overflow condition in the reservoir.	•Check for clogged reservoir filter. •Contact Thermo Electron's Sales, Service and Customer. Support.
rEFiL	Auto refill will shut off.	The auto refill did not reach the minimum operating level within the time chosen for the customer adjustable *Fill* setting, chosen in the Setup Loop, See Section IV.	•Check for leaks. •Check the supply pressure on the auto refill supply line. With low pressure the auto refill time span setting may be set too low and the reservoir does not have time to fill. Check rEFiL settings and adjust if necessary, see Section IV. •Contact Thermo Electron's Sales, Service and Customer Support.
		The auto refill successfully filled within the time frame chosen for the customer adjustable *fill* setting, but the unit tries to refill 5 times in 40 hours.	•Check rEFil settings and adjust if necessary, see Section IV. •Check for leaks. •Contact Thermo Electron's Sales, Service and Customer Support.

Error Code	Reaction	Cause	Actions
ER 1	Indc	RAM test fail Internal PCBA error	•Reinstall software •Replace control board
ER 2	Indc	Keypad failure Internal CBA error	•Reinstall software •Replace control board
ER 3	Indc	Checksum fail Internal PCBA error	•Reinstall software •Replace control board
ER 4	Indc	NVS_3_RESET Setup variables were reset	•Reinstall software •Replace control board
ER 5	Indc	NVS_2_3_RESET Maintenance counters and setup variables were reset	•Reinstall software •Replace control board
ER 6	Indc	NVS_1_2_3_RESET Calibration, maintenance counters and setup variables were reset	•Reinstall software •Replace control board
ER 7	Indc	SENSE_5V_Fault Calibration is out of expected range	•Calibrate the 5V sensor
ER 8	Indc	BAD_RTD1_CAL Calibrattion needs to be saved as a factory reset	•Recalibrate unit and save parameters
ER 9	Indc	BAD_RTD2_CAL Calibrattion needs to be saved as a factory reset	•Recalibrate unit and save parameters
ER10	Indc	BAD_RTD3_CAL Calibrattion needs to be saved as a factory reset	•Recalibrate unit and save parameters
ER11	Indc	BAD_PRESS1_CAL Calibrattion needs to be saved as a factory reset	•Recalibrate unit and save parameters
ER12	Indc	BAD_PRESS2_CAL Calibrattion needs to be saved as a factory reset	•Recalibrate unit and save parameters
Er 16	Unit continues to run	Bad temperature sensor calibration.	•Redo calibration

Error Code	Reaction	Cause	Actions
Er 22	Unit will shut down.	Reservoir fluid exceeded the factory preset value of +43°C. If operating at high altitude note that heat removal capacity decreases 1.2% per 1,000 feet above sea level. Also, the maximum temperature of the air entering the unit must be reduced by 1°C per 1,000 feet above sea level.	•Clean air filter. Dirt and debris on filter can prevent the unit from functioning at full capacity, see Section VI. •Ensure the unit meets all environmental requirements, see Section III. •Ensure that the heat load being applied to the chiller is not too high. Contact Thermo for assistance on calculating heat loads. •Bring cooler air in from another area or exhaust the hot air into another location using an auxiliary fan. •Ensure unit has adequate ventilation, see Section III. •Verify/adjust controller PID values, see Section VII. •If the internal process temperature sensor (RTD1) was recently calibrated, double check calibration to ensure that it was done properly, see Section VIII. •Contact Thermo Electron's Sales, Service and Customer Support.
Er 23	• Unit will shut down.	Refrigeration temperature sensor shorted.	•Contact Thermo Electron's Sales, Service and Customer Support.
Er 24	• Unit will shut down.	Refrigeration temperature sensor open.	•Contact Thermo Electron's Sales, Service and Customer Support.
Er 25	• Unit will shut down.	Internal temperature sensor shorted.	•Contact Thermo Electron's Sales, Service and Customer Support.
Er 26	• Unit will shut down.	Internal temperature sensor open.	•Contact Thermo Electron's Sales, Service and Customer Support.
Er 32	• Unit will shut down.	Refrigeration suction gas temperature exceeded 50°C.	•Contact Thermo Electron's Sales, Service and Customer Support.

Error Code	Reaction	Cause	Actions
Er 33	• Unit will shut down.	Reservoir fluid below the factory preset value of +3°C.	•Check ambient temperature. Unit may not to be able to reach setpoint at low ambient temperatures. If your load is constant, then turn your unit on. Unit will control setpoint when sufficient heat is added. •Verify/adjust controller PID values, see Section VII. •Add insulation to external plumbing lines to reduce the heat-loss to the environment. •Ensure that the ambient temperature is not exceeding the recommended range, see Section III. •Install insulation if necessary. For water-cooled units check facility water temperature. •Contact Thermo Electron's Sales, Service and Customer Support.
Er 35	• Unit will shut down.	Process pressure (P1) exceed factory preset limit of 105 psi.	•Check application valves and ensure that they have not changed or been closed. **NOTE:** If routine shut-off of the process flow is required then an external pressure regulator accessory should be added - contact Thermo. • May occur as a result of changing the internal DI cartridge. Disconnecting the cartridge adds an additional 0.5 GPM to the main flow (for PD pumps), see Section V. • Check for debris in the application or clogged external filters. • Double check fluid lines. Excessive bends, long tubing and diameter reductions can affect the pump's discharge pressure. **NOTE:** If diameter reductions must be made, they should be made at the inlet and outlet of your application, not the chiller. •Contact Thermo Electron's Sales, Service and Customer Support.
Er 36	• Unit will shut down.	Process pressure (P1) below factory preset limit of 3 psi.	•Ensure that the chiller reservoir is not empty. •Unit requires >5 PSIG application pressure drop. If a bypass valve has been installed, some restriction may need to be added to the bypass line. •Contact Thermo Electron's Sales, Service and Customer Support.

Error Code	Reaction	Cause	Actions
Er 41	• Unit will shut down.	Communication error between display and main control board.	•Cycle circuit protector on rear of unit off and on. •Contact Thermo Electron's Sales, Service and Customer Support.
Er 42	• Unit will shut down.	Internal communications error.	•Contact Thermo Electron's Sales, Service and Customer Support.
Er 58	•Unit will shut down.	Low flow fault. Flow dropped to 0 GPM for more than 15 seconds.	•Adjust flow if unit is equipped with a flow control valve (option), see Section V. •Check all valves in your application and plumbing lines to ensure that they have not changed or closed. **NOTE:** If regular shut-off of the process flow is required then disable the low flow alarm or by setting the alarm to 0.5 GPM, see Section IV. •If flow transducer has recently been calibrated, double check calibration to ensure it was done properly, see Section VIII. •Contact Thermo Electron's Sales, Service and Customer Support.
Er 59	•Unit will shut down.	Invalid level fault. Unit sensed both a high level and low level reservoir fluid level.	•Contact Thermo Electron's Sales, Service and Customer Support.

Checklist

Unit will not start

For first time use, please refer to the quick start instructions included with your unit or the copy in this manual. The manual's version follows the Table of Contents.

Make sure supply voltage is connected and matches the unit's nameplate rating ±10%.

Check the controller for error codes, see Error Codes in this section.

Ensure the circuit protector on the rear of the unit is in the on (**I**) position.

Unit shuts down

Ensure  button wasn't accidently pressed.

Ensure the circuit protector on the rear of the unit is in the on (**I**) position.

Check the controller for error codes, see Error Codes in this section.

Make sure supply voltage is connected and matches the unit's nameplate rating ±10%.

Restart the unit.

Unit will not circulate process fluid

Check the reservoir level. Fill, if necessary.

Unit requires >5 PSIG application pressure drop. If a bypass valve has been installed, some restriction may need to be added to the bypass line.

Check the application for restrictions in the cooling lines.

Ensure the reservoir bag filter is not clogged.

The pump motor overloaded. The internal overtemperature/overcurrent device will shut off the pump causing the flow to stop. This can be caused by low fluid, debris in system, operating unit in a high ambient temperature condition or excessively confined space. Allow time for the motor to cool down.

Make sure supply voltage matches the unit's nameplate rating ±10%.

Inadequate temperature control

Verify the setpoint.

Make sure the condenser/air filter is free of dust and debris.

Ensure your unit's installation complies with the site requirements listed in Section III.

Make sure supply voltage matches the unit's nameplate rating ±10%.

If the temperature continues to rise, make sure your application's heat load does not exceed the rated specifications.

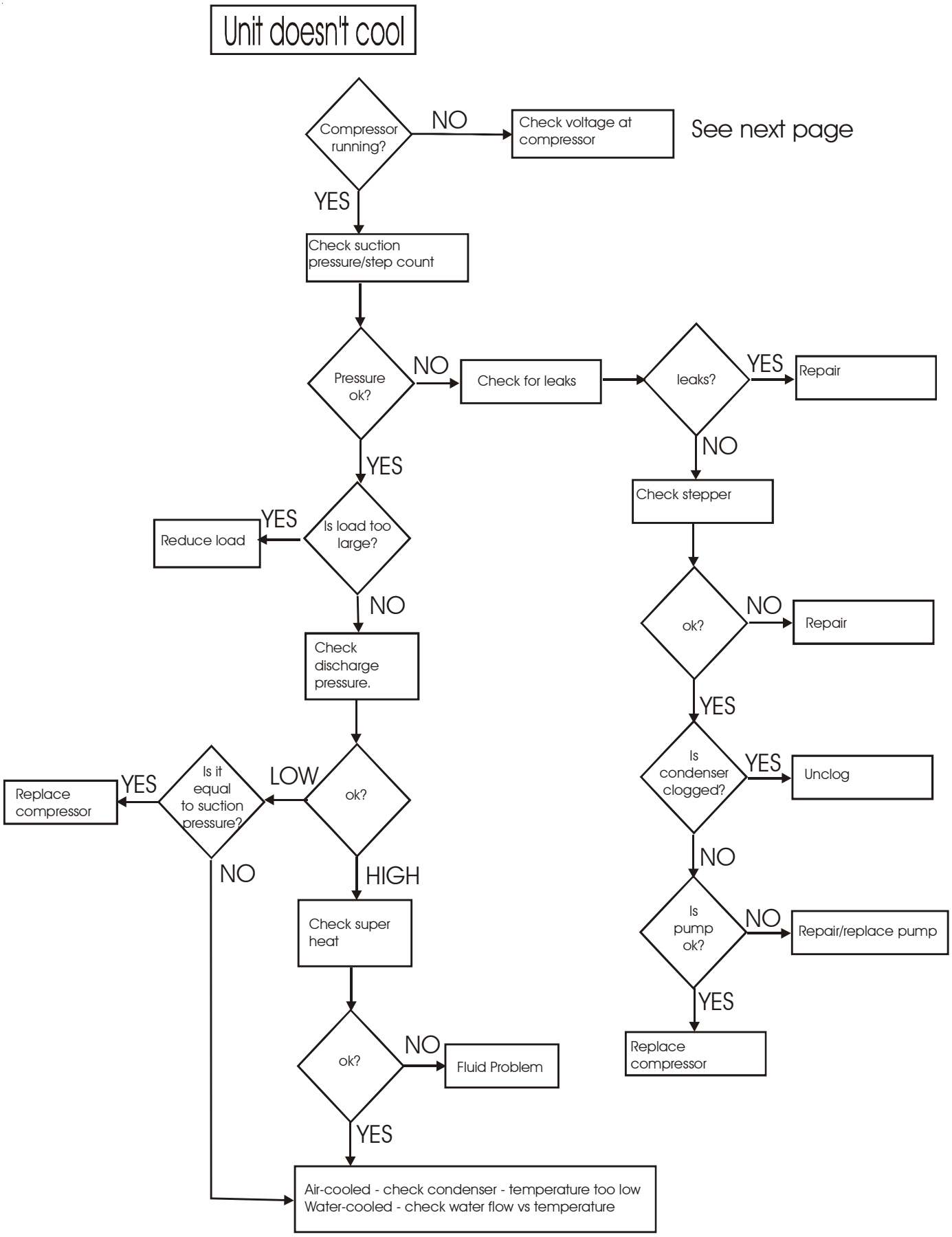
Check for high thermal gradients (i.e., the application load is being turned on and off or rapidly changing).

If operating at high altitude note that heat removal capacity decreases 1.2% per 1,000 feet above sea level. Also, the maximum temperature for the air entering the ThermoFlex must be reduced by 1°C per 1,000 feet above sea level.

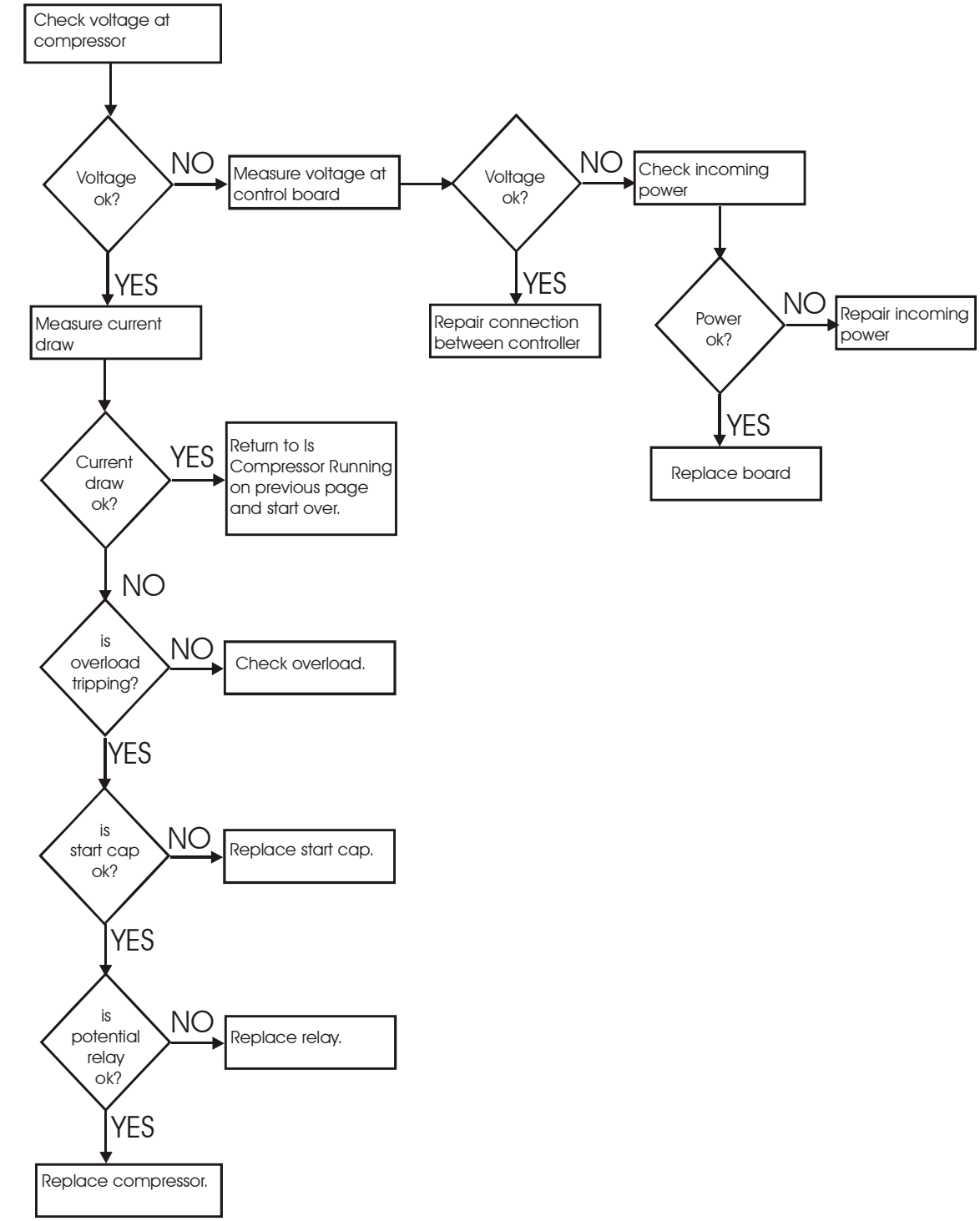
Verify/adjust controller PID values, see Section VII.

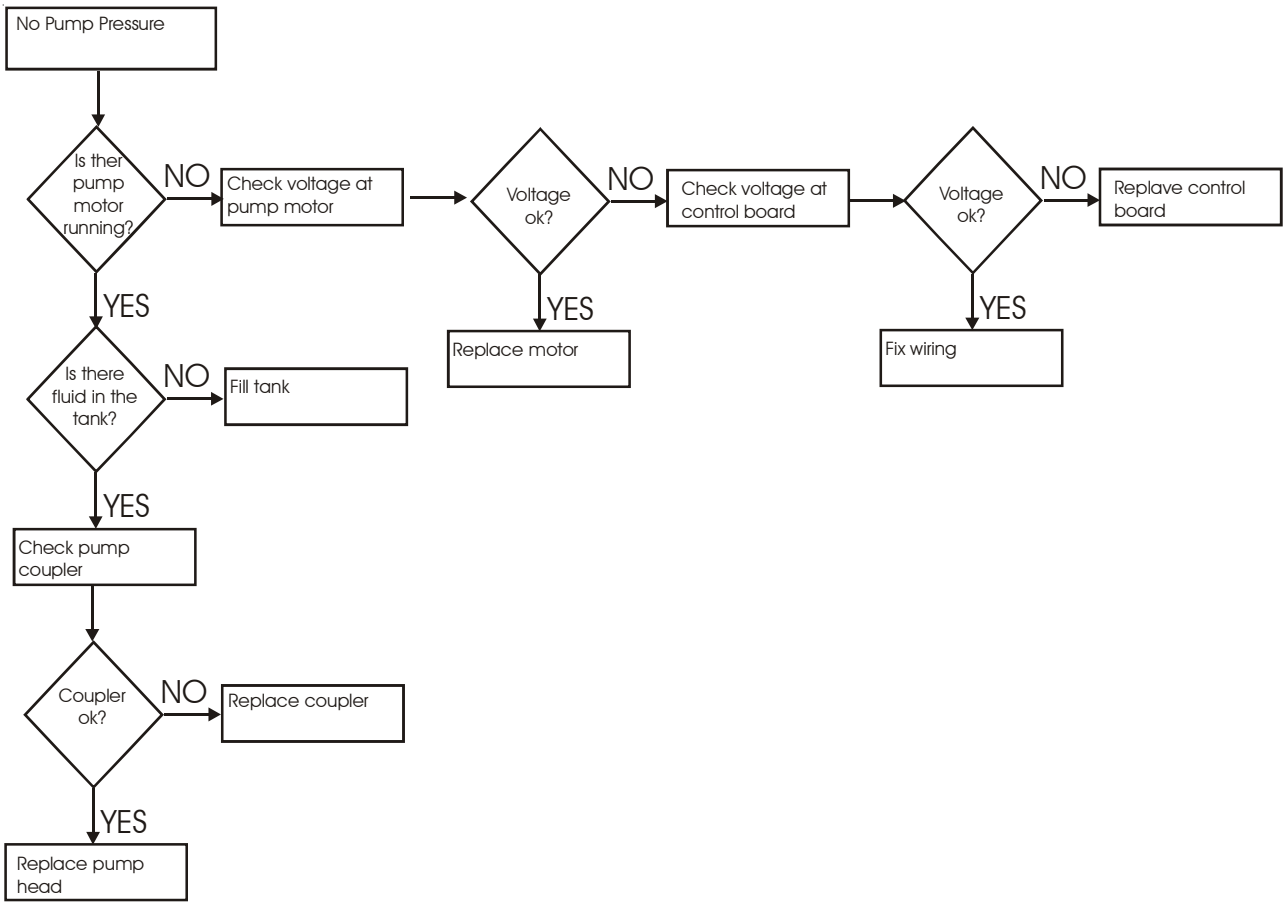
Ensure the unit was shut down properly, see Section IV. If not the compressor may be damaged.

Flowcharts

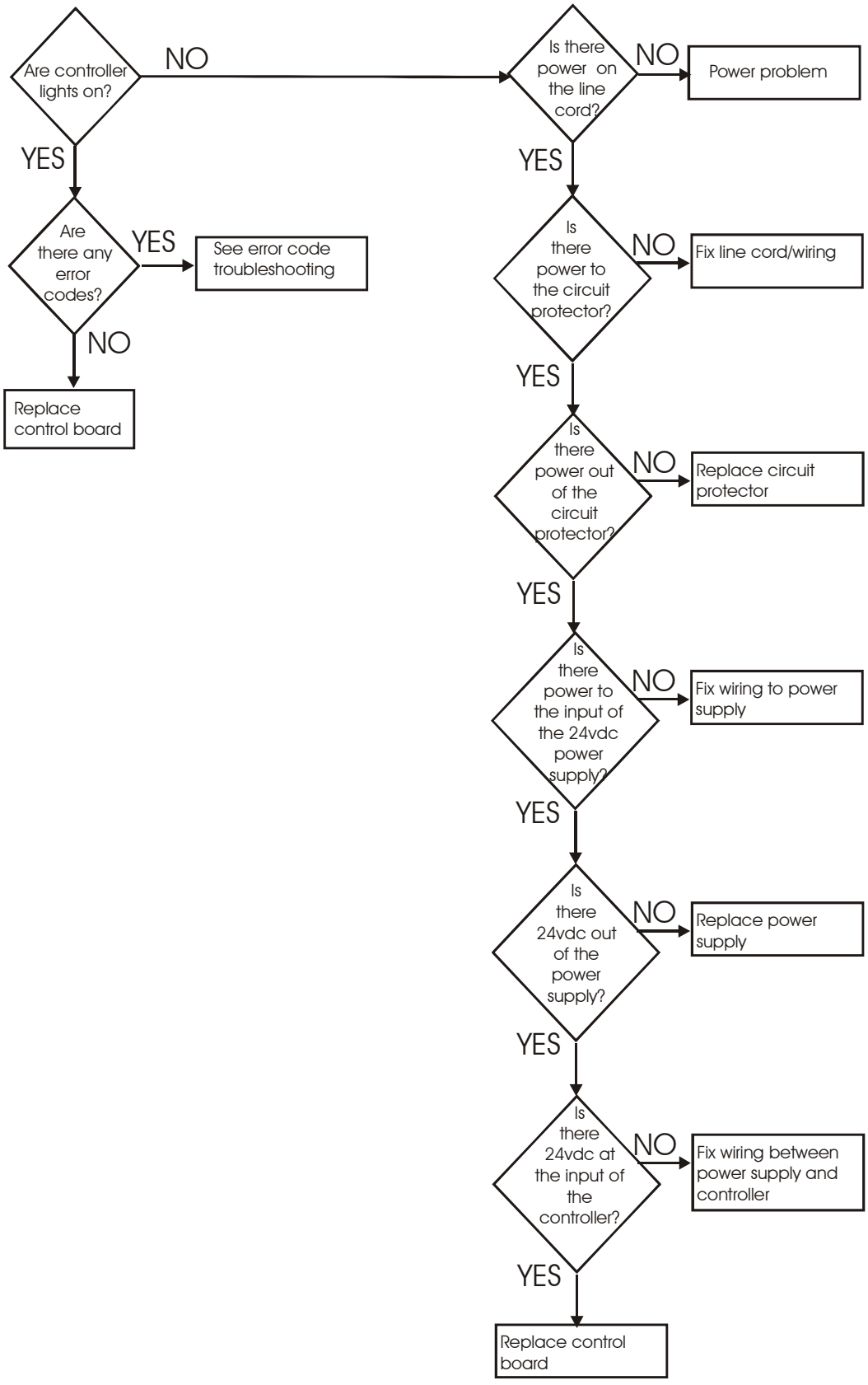

Unit doesn't cool
Compressor running?
NO
Check voltage at compressor
See next page
YES
Check suction pressure/step count
Pressure ok?
NO
Check for leaks
leaks?
YES
Repair
NO
YES
Check stepper
Is load too large?
YES
Reduce load
NO
ok?
NO
Repair
Check discharge pressure.
YES
Is condenser clogged?
YES
Unclog
NO
ok?
LOW
Is it equal to suction pressure?
YES
Replace compressor
NO
HIGH
Is pump ok?
NO
Repair/replace pump
YES
Check super heat
Replace compressor
ok?
NO
Fluid Problem
YES
Air-cooled - check condenser - temperature too low
Water-cooled - check water flow vs temperature

Unit doesn't cool




No Pump Pressure
Is ther pump motor running?
NO
Check voltage at pump motor
Voltage ok?
NO
Check voltage at control board
Voltage ok?
NO
Replave control board
YES
Replace motor
YES
Fix wiring
YES
Is there fluid in the tank?
NO
Fill tank
YES
Check pump coupler
Coupler ok?
NO
Replace coupler
YES
Replace pump head

Unit won't power on



Section VII Service Functions

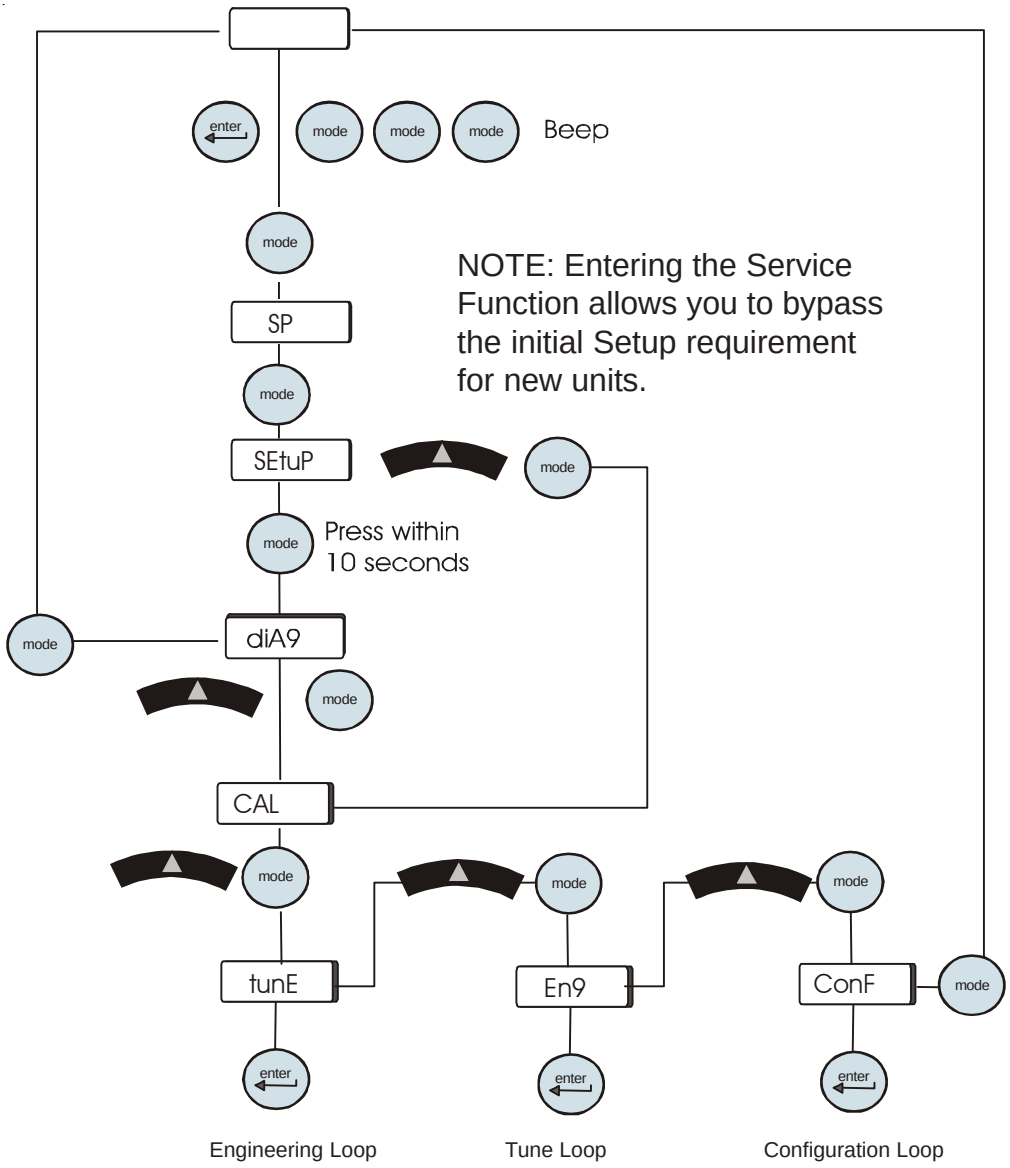
To enter the Service Function:

Press and hold the up arrow and then press mode - enter - mode.

The controller will beep, if not redo holding the up arrow and then press mode - enter - mode.

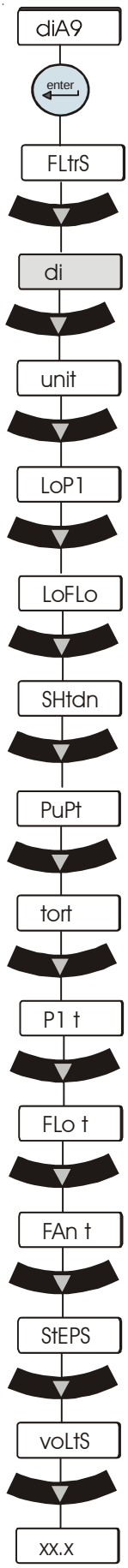
Press mode to display SP, press mode again to display Setup.

You have 10 seconds to press mode or the Service Function will time out.



NOTE: Entering the Service Function allows you to bypass the initial Setup requirement for new units.

Diagnostic Loop (dia9)



Ensure controller is in Service Function.

To reset any display to 0, press and hold the up arrow and then press enter.

FLtrS - indicates the total time the reservoir and condenser filters have been in use, in hours.

di - indicates the total time the di filter has been in use, in hours. (Optional)

unit - indicates the unit operating time, in hours. This display can't be cleared.

LoP1 - indicates number of low pressure faults.

LoFLo - indicates number of low flow faults.

SHtdn - indicates number of improper shutdowns i.e. faults, compressor turned off before stepper valve fully closed.

PuP t - indicates pump operating time, in hours.

tor t - indicates pump motor operating time, in hours.

P1 t - indicates supply pressure transducer time, in hours.

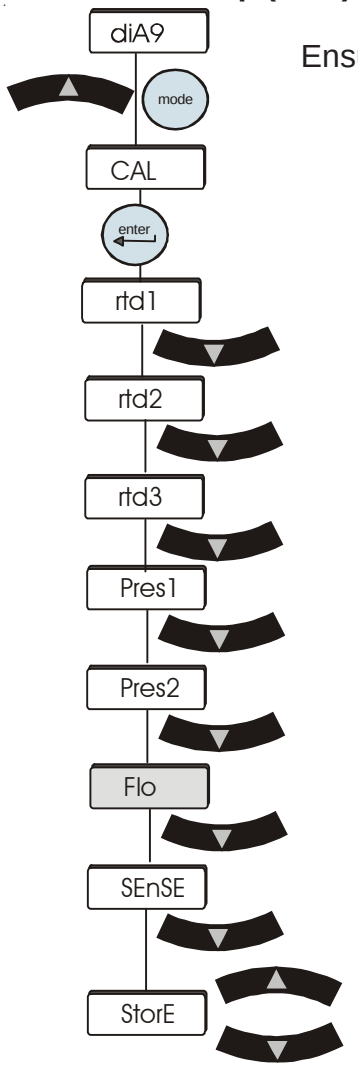
FLo t - indicates flow transducer operating time, in hours.

FAn t - indicats fan motor operating time, in hours.

StEPS - indicates the accumulated steps of the step valve x 1000.

voLts - indicates 5 volts on the circuit board. This display can't be cleared.

Calibration Loop (CAL)



Ensure controller is in Service Function.

rtd1 - internal sensor - defaults: r1H = +40°C r1L = +5°C

rtd2 - external sensor - defaults: r1H = +40°C r1L = +5°C

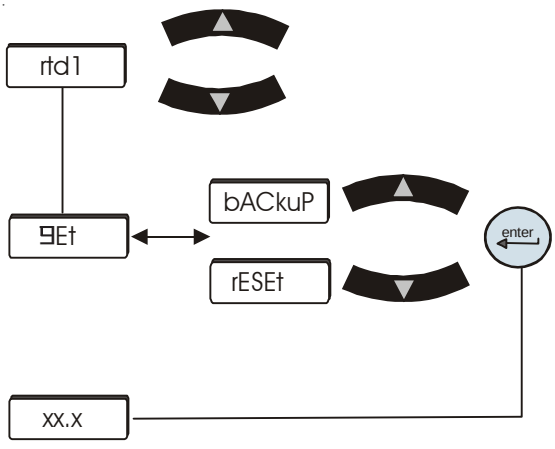
rtd3 - ambient sensor - defaults: r1H = +40°C r1L = +5°C

PrES1 - process fluid pressure - defaults: P1H = +4.50V P1L = +0.50V

PrES2 - refrigerant suction pressure - defaults: P2H = +4.50V P2L = +0.50V

FLo - flow transducer (Optional) - defaults: HiFLo = +2.00 LoFLO = +0.50

SEnSE - 5 volts on control board - defaults: +5.000V

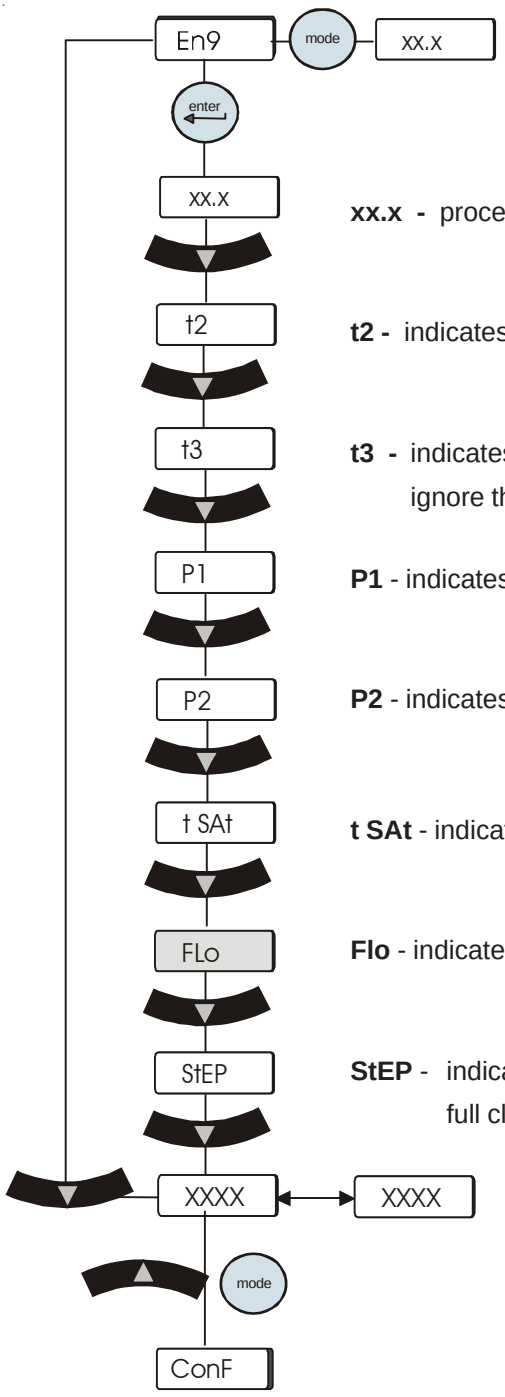


To reset a selected sensor to the factory values you have two options, reset and backup. Reset restores the board calibration, backup does the board and sensor calibration.

With the desired sensor displaying, press and hold the up key then press and hold the down key, keep both depressed for 10 seconds. The GEt will change to Put. Press the applicable arrow to get the desired option. Press the enter key to return to the process fluid temperature display.

Engineering Loop (En9)

Ensure controller is in Service Function.



xx.x - process fluid temperature in °C

t2 - indicates the refrigerant suction temperature in °C

t3 - indicates the ambient sensor temperature in °C
ignore this display if the unit is not equipped with an ambient sensor

P1 - indicates pump discharge pressure in psi

P2 - indicates refrigerant suction pressure in psi

t SAt - indicates temperature saturation value in °C

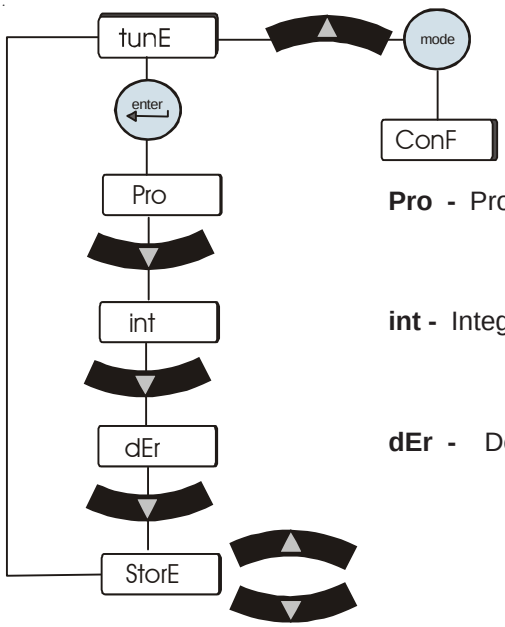
Flo - indicates flow rate in gpm (If flow transducer installed)

StEP - indicates the current step valve position
full closed = 0, full open depends on unit size

XXXX XXXX - refer to the decoder or the wiring diagram

Tune Loop (tunE)

Ensure controller is in Service Function.

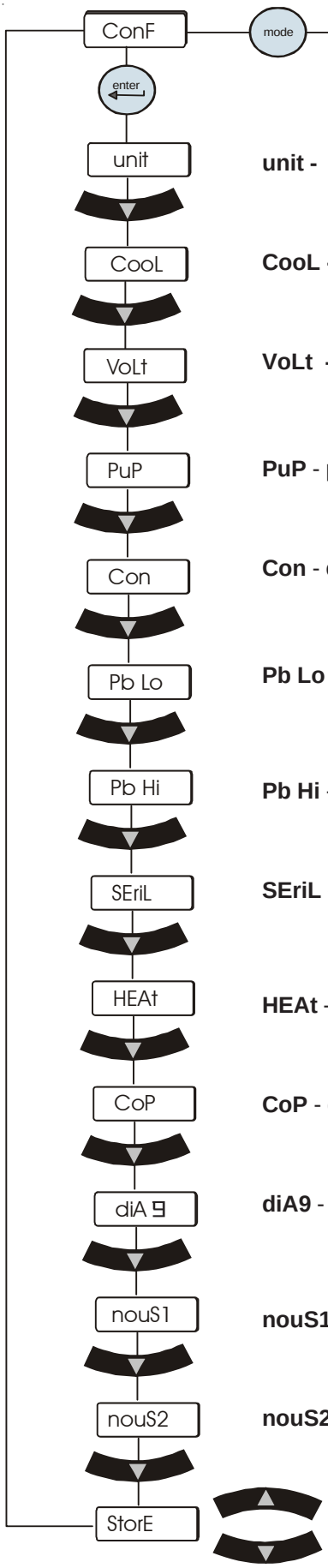


Pro - Proportional - Default 10.0 Range = 0.1 to 99.9

int - Integral - Default 0.50 Range = 0 to 9.99

dEr - Derivative - Default 0.0 Range = 0 to 5.00

Configuration Loop (ConF)



Ensure controller is in Service Function.

unit - unit type

Refer to End Item Decoding Document for configuration codes.

CooL - water or air cooled

VoLt - voltage

PuP - pump type

Con - controller

Pb Lo - plumbing options

Pb Hi - plumbing options

SEriL - communication options

HEAt - heater options

CoP - compliance options

diA9 - diagnostic options

nouS1 - unused

nouS2- unused

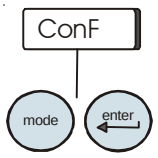
Master Reset

Before performing a Master Reset use the Configuration Loop and note the unit's configuration settings.

Ensure controller is in Service Function.

Enter Configuration Loop, see page 1.

Press and hold mode key and then press the enter key.



The unit will reset.

While resetting the display will indicate   as if the unit were powering up. The reset takes approximately 15 seconds.

After performing a Master Reset do the Setup, Tune and Configuration Loops in order to restore the values.

Then use the Calibration Loop to calibrate the unit.

End Item Numbert Decoding (Rev 4)

UNIT	COOLING	VOLTAGE	PUMP	CONTROLLER	PLUMBING	COMMUNICATION	HEATER	COMPLIANCE	DIAGNOSTICS	Unused	Unused	Unused	Unused
1-2	3	4-5	6-7	8	9-12	13	14	15	16	17	18	19	20

Unit Designator (2 digits)

10	C1
11	C2
12	C3
13	C4
14	C5
15	C6
16	C7
17	C8
18	C9
19	C10
20	HE1
21	HE2
22	HE3
23	HE4

Temp Range/Cooling Method (1digit)

1	A/C Std Temp
2	A/C Hi temp
3	W/C Std Temp
4	W/C Hi Temp
5	W/W Std Temp
6	W/W Hi Temp

Voltage (2 digits)

10	115/60/1, 100/50/1
11	100/60/1
12	208-230/60/1, 200/50/1
13	208-230/60/1 (C1, C2 US)
14	200/50/1 (C1, C2 Japn)
15	200/60/1
16	230/50/1
17	208-230/60/3
18	400/50/3
19	460/60/3
20	Global 200-230/50-60
21	Global 400-460/50-60

Pump Option (2 digits)	
10	PD1
11	PD2
12	Mag PD1
13	Mag PD2 (Not Avail)
14	SS PD1
15	SS PD2
16	SS Mag PD1
17	SS Mag PD2
18	P3 (10 gpm)
19	P4 (20 Gpm)
20	P5 (30 Gpm)
21	P6 (50 Gpm)
22	SS P3 (10 gpm)
23	SS P4 (20 Gpm)
24	SS P5 (30 Gpm)
25	SS P6 (50 Gpm)

Controller (1 digit)	
1	Basic
2	Deluxe
3	Basic EMO/LOTO
4	Deluxe EMO/LOTO
5	Basic EMO/LOTO/ GFCI
6	Deluxe EMO/LOTO/GFCI

Communication (1 digit)	
0	None
1	Analog I/O / Rem Sensor
2	RS 232/485
3	DeviceNet
4	Ethernet
5	Profibus
6	RS232/485 & Analog I/O Remote Sensor

Heater Option (1 digit)	
0	None
1	1kW Heater
2	2.5 kW Heater
3	5 kW Heater
4	10 kW Heater
5	20 kW Heater

Compliance (1 digit)	
0	None
1	Undefined
2	CSA/UL LAB
3	CSA/UL MED
4	SEMI S2 (F47)

Diagnostics (1 digit)	
0	None
1	Preventative Diagnostics

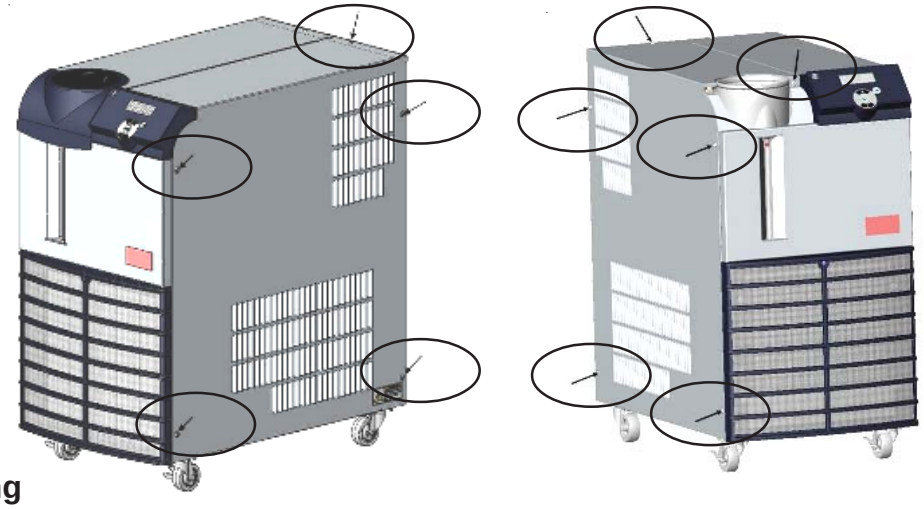
Plumbing Options (4 digits)

0	None	No options	
1	Auto Refill	Level Device & Solenoid	
2	Anti Drainback	Check valve & Solenoid	
4	DeI Internal Basic	Go/No Go Indicator	ONLY ONE CAN BE SELECTED
8	Dei External Basic	Go/No Go Indicator	
16	Dei Internal Control	Active Control	Deluxe Only
32	Flow Control Readout	Flow transducer & 3 way valve	ONLY ONE CAN BE SELECTED
64	Flow Pressure Control	Flow transducer & pressure relief valve	
128	Presssure Relief External	Pressure relief valve External	
256	Auto Flow/Press Control	Active flow or pressure control	Deluxe Only

Section VIII Advanced Service

Removing the Side Panels

Use a Philips head screwdriver to remove the eleven #6-32 x 3/8" screws indicated in the illustrations below. Slide the right panel back approximately one inch, then lift slightly from the rear to disengage the panel's two tabs from their slots. Then remove the left side.



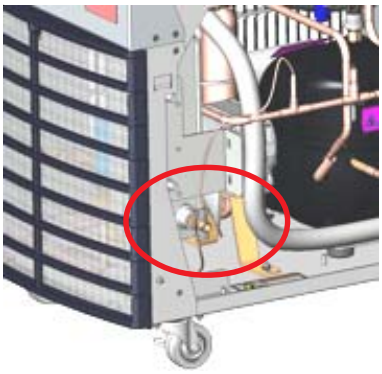
Draining

Position a suitable pan beneath the drain port at the rear of the unit. The drain pan must be shallow (under 3.5” in height) and have a volume of approximately 3 gallons. Remove ¼” Male NPT pipe plug from drain port. This will drain the return line, reservoir, plate exchanger, and the suction side of the pump.

To drain the discharge side of the pump disconnect the ½” Female NPT outlet connection (the brass fitting) on the rear of the unit. **NOTE:** Internally the unit does not contain a large quantity of fluid on the discharge side however care should be taken to contain what fluid does drain, a wet-vac can be employed to minimize the potential for spillage.

If the unit is equipped with the anti drainback option, enter the Setup Loop and then open the valve, see Section TBD. The fluid will drain out.

Reinstall ¼” Male NPT pipe plug using a sealant suitable for the materials prior to refilling unit.



Draining water-cooled units is accomplished by removing the right side panel. Installing a 7/16" ID tube on the drain petcock valve located on the lower end of the exchanger. Open the valve to allow fluid to drain into an external device.

A vacuum device is needed on the facility water inlet connection to thoroughly pull remaining fluid from the lines.

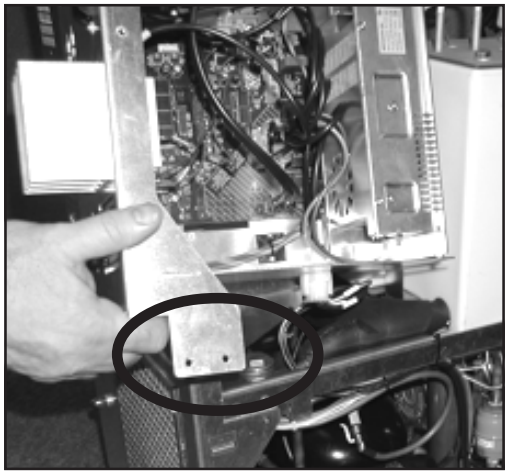
Control Board Replacement

Remove all power by unplugging the line cord and all other wires connected to unit.

Use proper ESD (Electro Static Discharge) procedures when handling the control board and display panel. Typically a grounded wrist strap is used to ground the individual so static discharge is released prior to and during handling.

Tools Required:
Small Philips Head Screwdriver
5/16" Socket

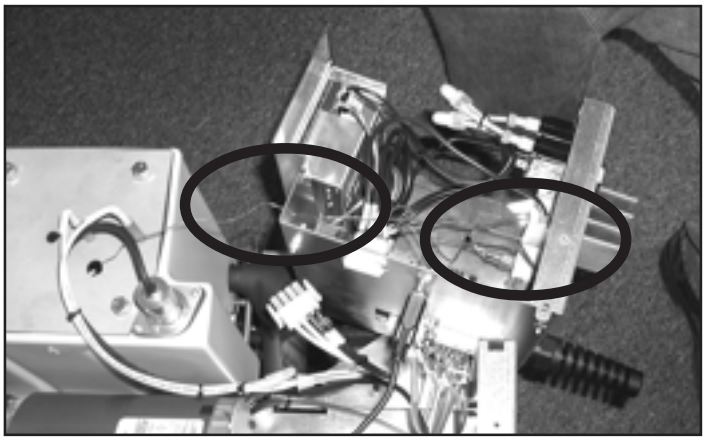
Procedure:
1. Remove the two screws securing the control box to the frame.



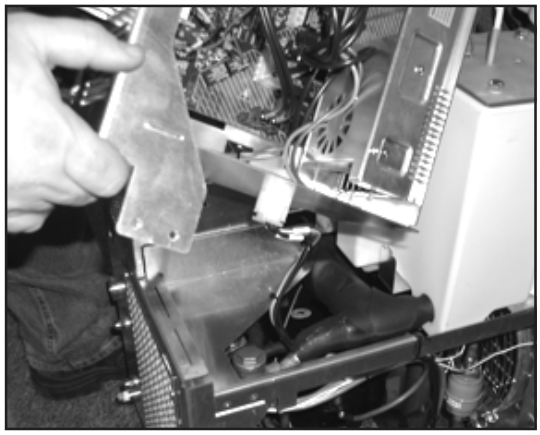
2. Remove all the electrical connections from the side of the control box.

If the unit is equipped with a HTC:
remove the two wires inside the control box that are attached to the HTC
undo the plastic cover on the back of the control box and remove the ??" nut
Remove the HTC sensor wire from the grommet on the rear of the control box

NOTE: When reinstalling the grommet ensure the cut is not facing the top of the unit or the sensor wire may not stay in the proper position when the unit is running.



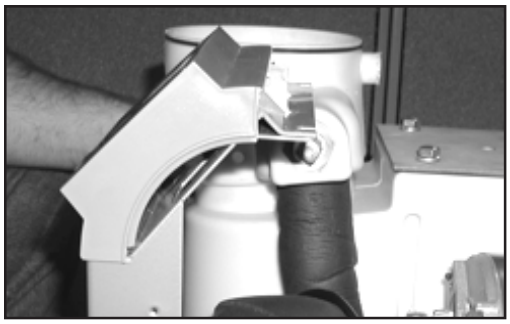
3. Undo the electrical connection from the bottom of the control box.



4. Remove the two screws securing the cover to the unit.

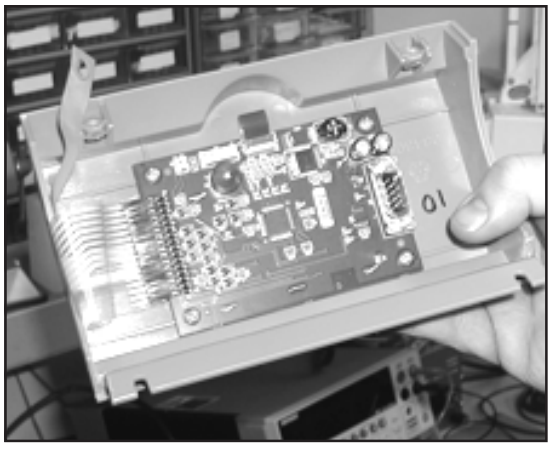
5. Undo the connection.

6. Remove the two screws securing the panel to the unit.



7. Remove the two remaining screws and the 5/16” nut

8. Undo the ribbon cable and the four screws securing the board to the panel. NOTE the orientation of the ribbon cable, ensure it does not get twisted when installing the replacement board.



9. When reinstalling the box ensure it mates to the bracket on the unit.

Pump

Remove all power by unplugging the line cord and all other wires connected to unit.

Tools Required:

1/4” nut driver
15/16” wrench
1” wrench

Proceure

1. Remove the clamps on either side of the motor.

2. Disconnect the electrical wiring including the ground wire

3.Use the 1/4” nut driver to remove the clamp securing the pump to the motor.

4. De-couple the pump from the motor and pull the pump up to access the fittings securing the pump to the inlet and outlet lines.

Use the 15/16” and 1” wrenches to undo the lines.

Top Assembly

Tools Required:

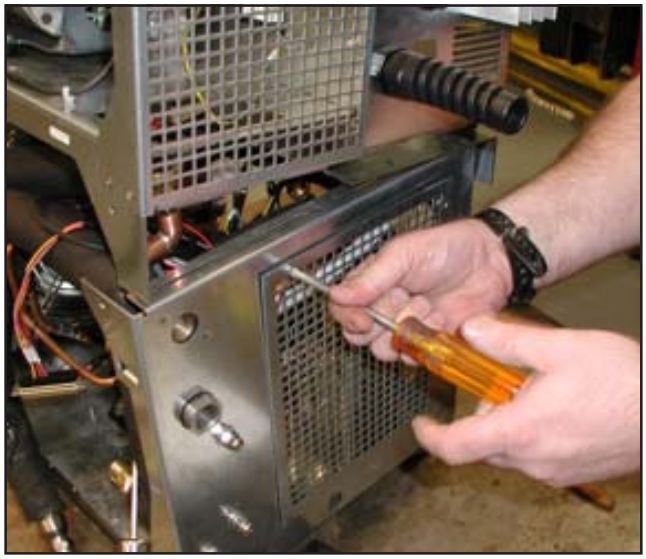
15/16” wrench
1 1/16” wrench
7/8” wrench
Phillips Head Screwdriver

Procedure:

1. Remove any insulation around the connection.

2. Use the 15/16” and 1 1/16” wrenches to disconnect the line.

3. Remove the grille to access the drain line connection.



4. Use the 7/8” wrench to disconnect the fittings.

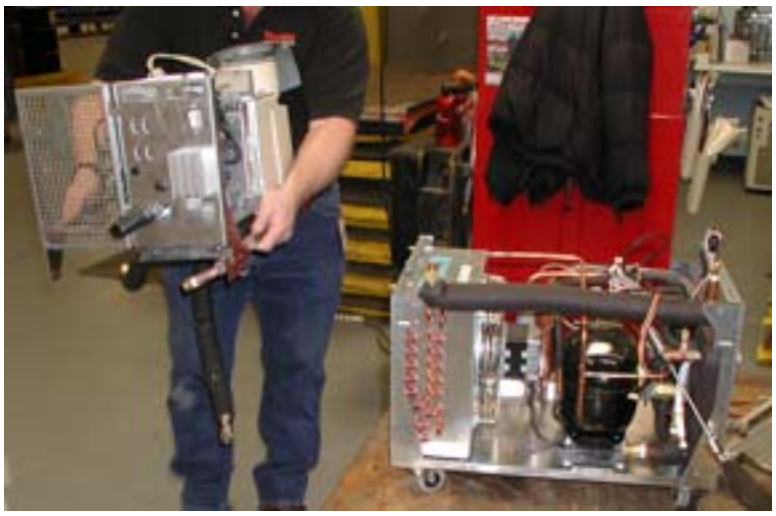
5. Disconnect all applicable connections to the control box.

6. If necessary, disconnect any optional features and feed them through the opening in the rear of the unit.

7. Remove the four screws, one on each corner, holding the top and bottom halves together.

8. Remove the applicable tywraps.

9. Lift off top assembly.



Pressure Transducers

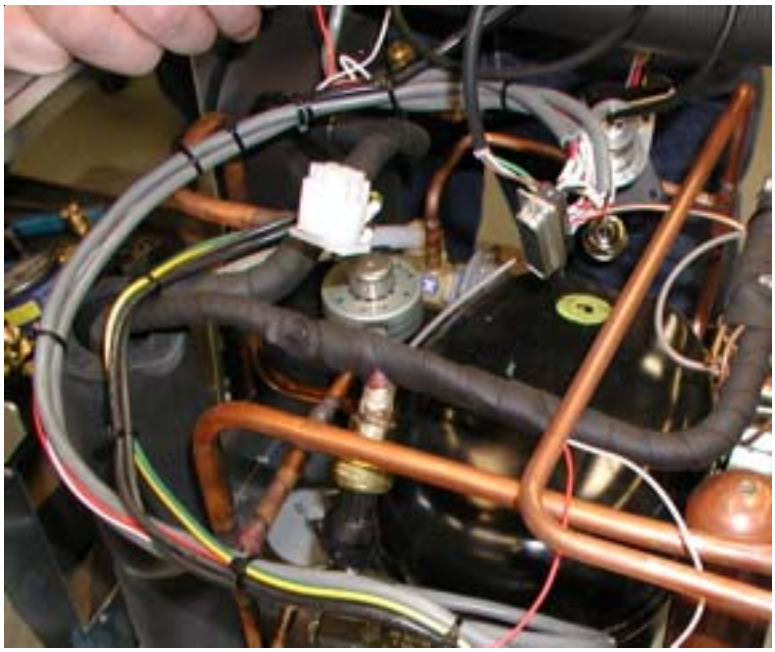
Tools Required:

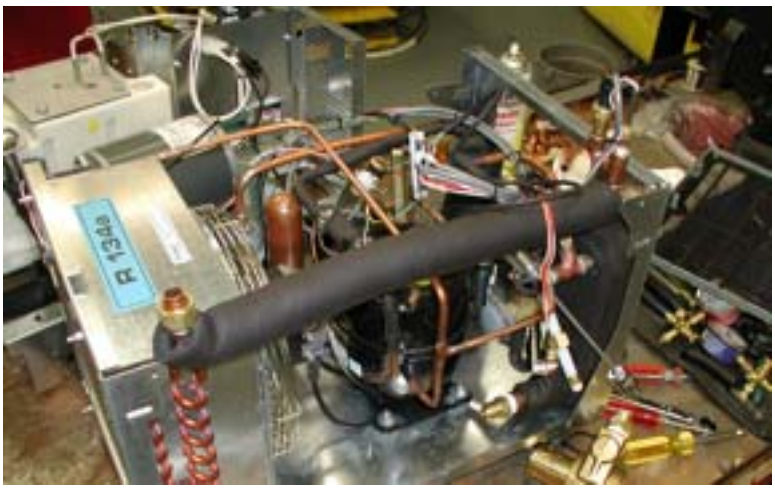
5/8" wrench
Tywrap cutters/Scissors

Procedure:
1. Unsnap the black plastic cap(s) on the transducer(s).
2. Use the 5/8" wrench to disconnect the transducer(s).
3. Unplug the wiring.

Temp Sensor (rtd1)

Tools Required:





Testing RTD Temperature Sensors

About Shielding
Some **Thermo** RTD sensors are shielded to prevent the controller circuitry from being affected by outside electro-magnetic fields. Shielded sensors have an additional bare, green, or green-yellow (ground) wire.

A unshielded sensor may be replaced by a shielded type, but a shielded type must never be replaced by an unshielded type.

Shielded sensors must be grounded using the ground wire provided. Do not ground the sensor shell - doing so will create a ground loop and negate the effect of the shielding. Both shielded and unshielded sensors are tested in a similar manner (below).

How it works
RTD sensors are resistors wound from platinum wire. They will measure 100 Ohms when at 0 °C. They exhibit a positive temperature coefficient: The resistance rises as temperature rises.

2-wire RTD sensors have two wires of the same color, or one red and one white.

3-wire RTD sensors have two wires of one color, and a third of another color.

4-wire RTD sensors have four wires: typically two are white and two are colored or striped.

Testing
Equipment required: A multimeter or ohmmeter. An analog meter may be used, provided it has a response of at least 20,000 Ohms per Volt.

Physically disconnect unit from line voltage.

Disconnect the RTD from the unit.

Set your multimeter to Ohms range, sufficient to read around 100 Ohms.

2-wire: Measure between the wires.
3-wire: Measure between two different color wires.
4-wire: Measure between either colored wire and either white wire.

The display should read a resistance relative to the temperature of the RTD, as shown:

°C	°F	Ohms
0	32	100.0
20	68	107.8
22	72	108.5
24	75	109.0
26	78	110.0
27	80	110.5

Warm RTD by hand and observe the resistance increase. This proves the RTD is responding.

4-wire only: Now measure between the two colored wires. Observe 0 or almost 0 resistance.

4-wire only: Now measure between the two white wires. Observe 0 or almost 0 resistance.

Finally test from any wire to the RTD shell. Observe OL (overload) or infinite resistance, indicating an open circuit.

In case of failure
Replacement RTDs are available from Thermo.

Thermo RTD sensors use the industry standard of 100 Ohms at 0°C, using the “European curve”, also known as alpha = 0.00385. You may be able to find one locally at an industrial supply house (W. W. Grainger or equivalent). Any RTD of equivalent length and diameter will generally work as a substitute.

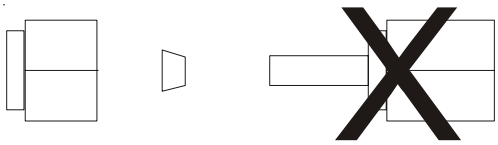
External Sensor specification:

Type:	2 wire Pt RTD
Curve:	Alpha = 0.00385
Resistance:	100 Ohms @ 0°C
Tolerence:	0.12% @ 0°C, Class B

Temperature Sensor Replacement

Remove all power by unplugging the line cord and all other wires connected to unit.

NOTE: Replacing the sensor requires a new brass compression fitting - part number 004322. Only the female portion and the ferrule are needed, discard the male portion.



1. Drain the unit

2. Remove the unit's top, front, and right side panels.

3. Remove the Swagelok® from the tip if the sensor using a ½" wrench.

4. Remove the red and white wires from the control board - note orientation.

5. Remove the sensor from the plumbing.

6. Install new compression fitting onto the new sensor. Ensure ferrule is aligned in the proper direction.

7. Install new sensor leaving approximately ¼" of it protruding from the plumbing.

8. Install the ½" Swagelok® - finger tight plus one turn.

9. Install wiring to the control board.

10. Fill the unit with fluid, turn it on and check for leaks.

11. Reinstall the panels.

Internal Process Fluid Temperature Sensor (rtd1) Calibration

To help prevent a service call, Thermo Electron's Sales, Service and Customer Support may recommend performing a temperature sensor calibration. Please use the following procedure.

This procedure requires a calibrated reference thermometer.
NOTE: Uninsulated applications may cause the internal temperature and an external reference temperature to be different and fluctuate. If inaccurate calibration is suspected, place the reference thermometer as close to the ThermoFlex process outlet as possible.

NOTE: If it is more convenient, the low-end calibration can be performed before doing the high-end.

Do not pick calibration points that are outside the safe operating limits of the fluid in your application. For example with water, 40°C and 5°C would be typical high and low calibration points.

Run the unit to a suitable high-end calibration point. Place a calibrated reference thermometer in the reservoir. Ensure the fluid temperature is stabilized.

To enter the Calibration Loop ensure the controller display is either blank or displaying the process fluid temperature, see the diagram on next page. Press and hold the  and then press the 

key again and the display will indicate **CAL**.

Press the 

key and the controller will display **rtd1**. Press 

again and the controller will display **r1 H** (high-end calibration). Press 

again and the controller will flash between **r1 H** and the temperature. Use  to adjust the temperature to match the reference thermometer. Press the 

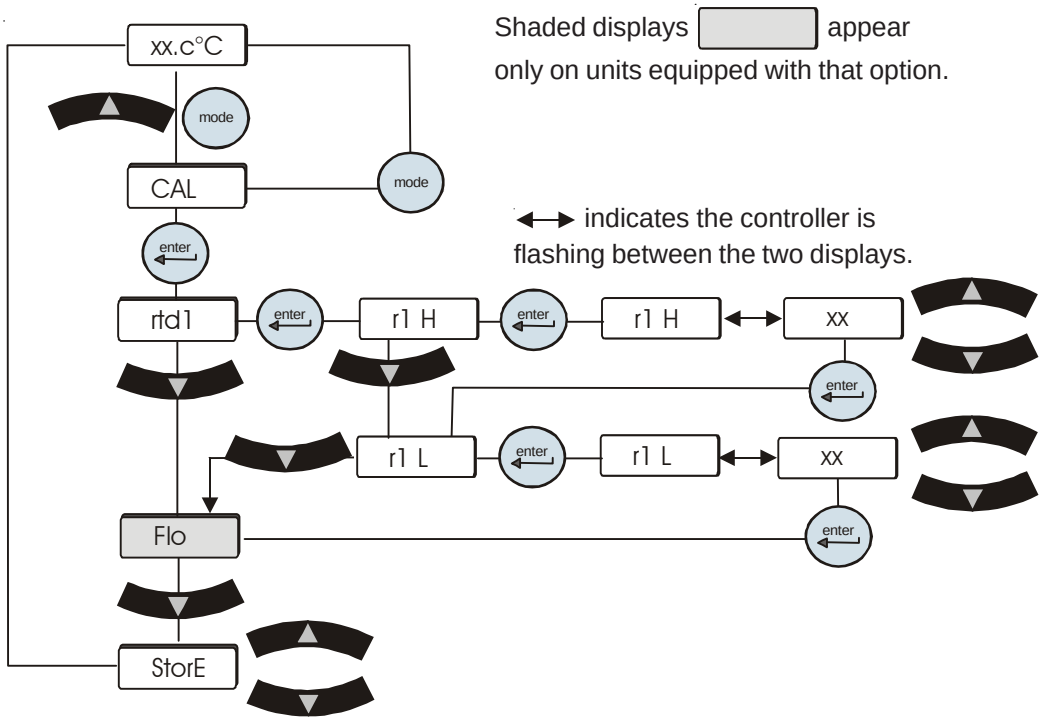
again to accept the value.

Press the  key until **StorE** is displayed, press  to accept the new value, press  to abort it.

Repeat for the low-end temperature. Run the unit to a suitable low-end calibration point. At the **r1 L (low-end calibration)** display use  to adjust the temperature to match a calibrated reference thermometer.

Press the  key until **StorE** is displayed, press  to accept the new value, press  key to abort it.

NOTE: After pressing the  button at the **StorE** prompt wait several seconds before proceeding to ensure that a bad calibration message (Er 16) does not appear. Premature use of the keypad after pressing  may cancel the bad calibration error message.



If you have any questions please contact Thermo Electron's Sales, Service and Customer Support.

Optional Process Fluid Flow Transducer (FLo) Calibration

To help prevent a service call, our Thermo Electron's Sales, Service and Customer Support may recommend performing a flow transducer calibration. Please use the following procedure.

This procedure requires a calibrated reference flowmeter and an external flow control valve.

Connect a calibrated reference flowmeter to the outlet line. Using an external flow control valve, increase the flow to a suitable high-end calibration point. Ensure the flow is stabilized.

To enter the Calibration Loop ensure the controller display is either blank or displaying the process fluid temperature, see the diagram on the next page.

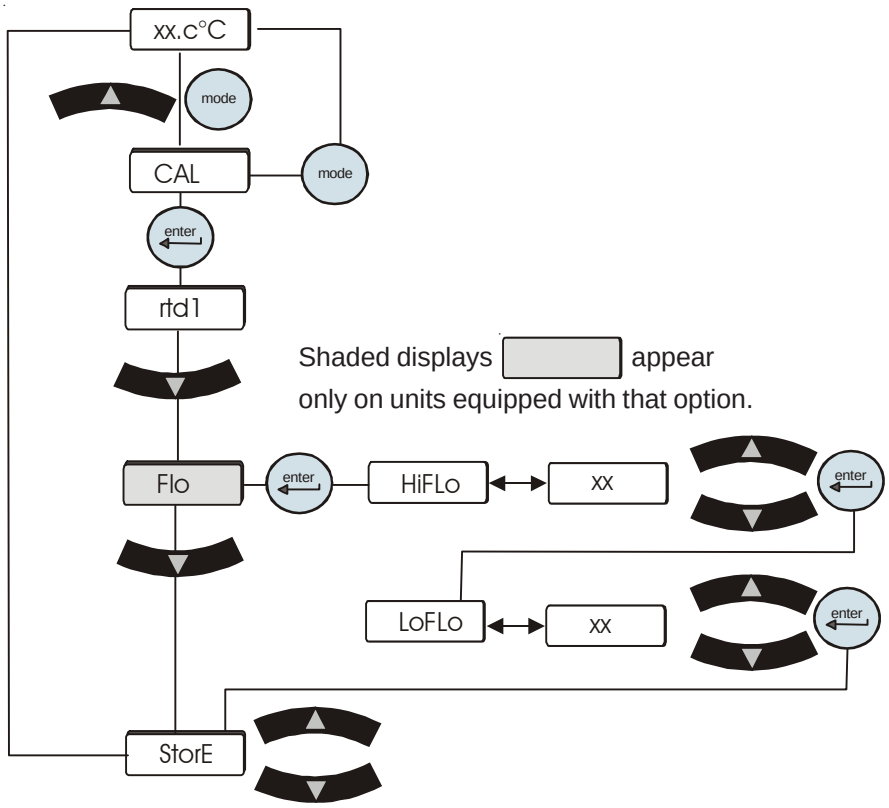
Press and hold the  and then press the  key again and the display will indicate **CAL**.

Press the  key and the controller will display **rtd1**. Press  until the controller displays **FLo**. Press  and the controller will flash between **HiFLo** and the flow rate. Use  to adjust the rate to match the reference flowmeter.

Decrease the flow to a suitable low-end calibration point.

Press the  key and the controller will flash between **LoFLo** and the flow rate. Use  to adjust the rate to match the reference flowmeter.

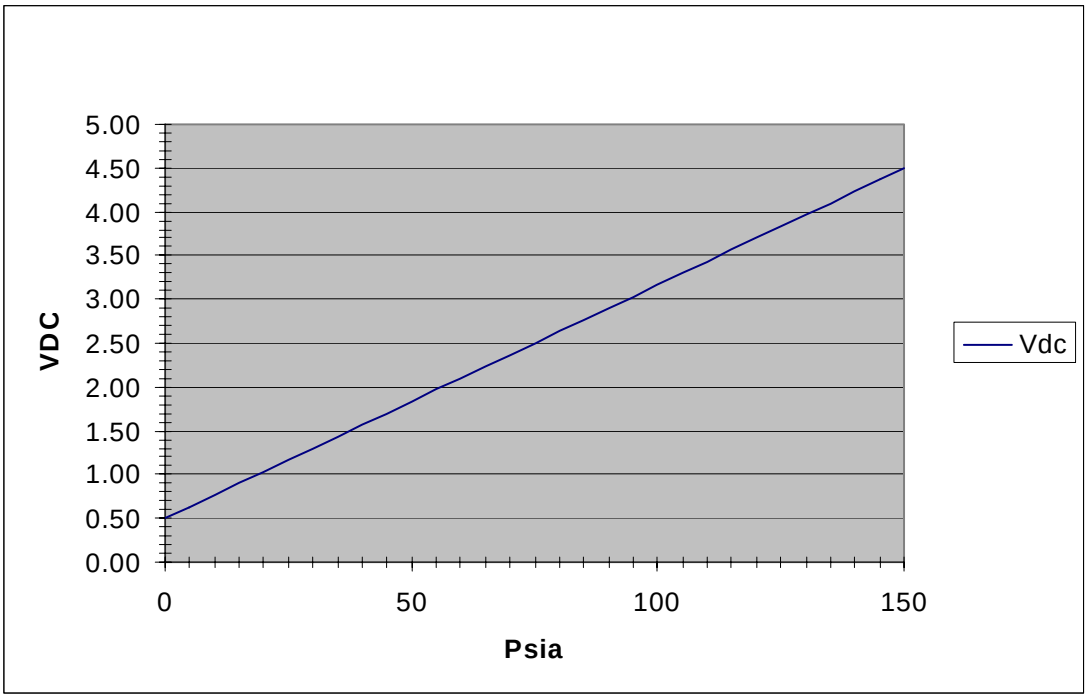
Press the  key and **StorE** is displayed, press  to accept both values, press  to abort them.



If you have any questions please contact Thermo Electron's Sales, Service and Customer Support.

Section IX Pressure Transducer Check

PD Pump Pressure Transducer (Psia vs VDC)



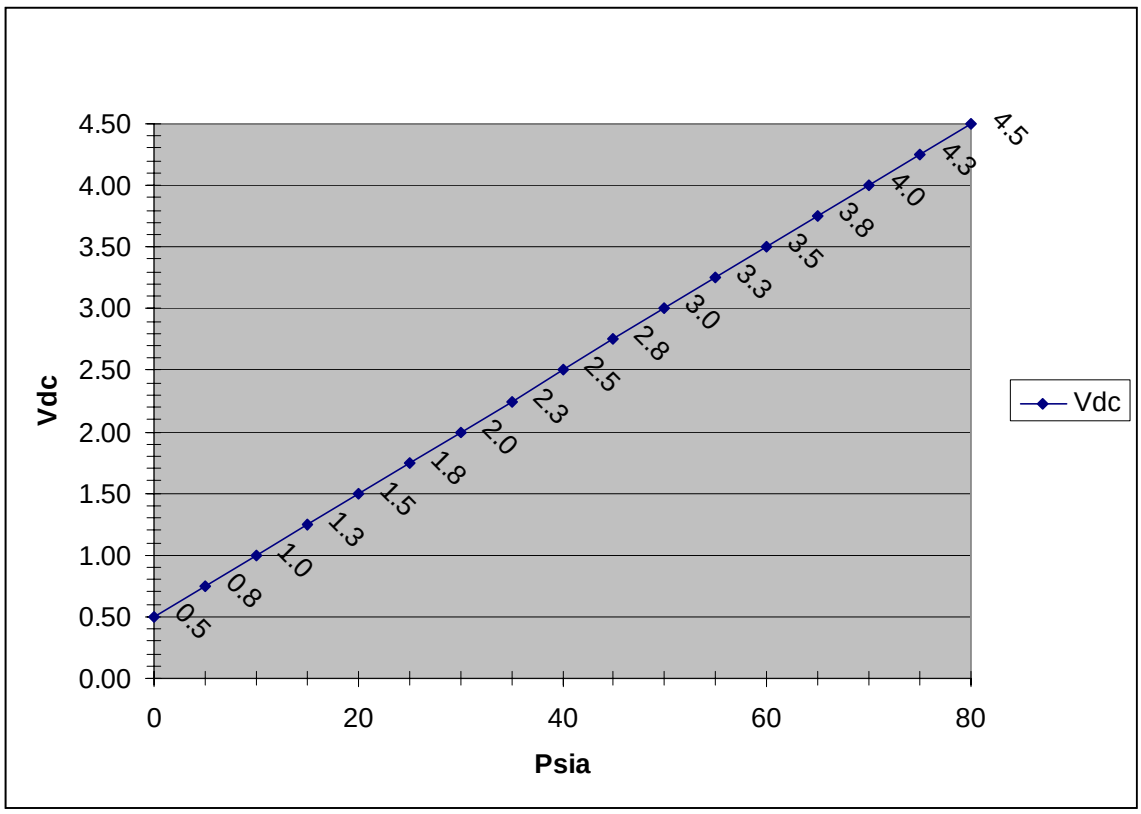
Psia	Vdc	Psia	Vdc	Psia	Vdc	Psia	Vdc	Psia	Vdc
0	0.50	35	1.43	70	2.35	105	3.28	140	4.22
5	0.63	40	1.56	75	2.49	110	3.42	145	4.35
10	0.77	45	1.69	80	2.62	115	3.55	150	4.50
15	0.90	50	1.83	85	2.75	120	3.68		
20	1.03	55	1.96	90	2.88	125	3.82		
25	1.17	60	2.09	95	3.02	130	3.95		
30	1.30	65	2.22	100	3.15	135	4.09		

To test the Transducer:
Use a voltmeter set to measure volts dc and measure across the ground wire and the V-out wire. Look at the chart above and find the voltage - it should correspond to the pressure next to it. If a pressure transducer is not working do the following.

Measure the 5vdc going to the xducer. If missing, check all connections and wiring. If it is all good replace the control board. If you have voltage out of the xducer all the way back to the controller also replace the controller. If you have input voltage to the xducer and no output voltage, replace the xducer.

Suction Pressure Transducer Data

There is also a transducer to measure the suction pressure use the same test as above except the psi vs. vdc is different. Use the following chart.



Psia	Vdc
0	0.50
5	0.75
10	1.00
15	1.25
20	1.50
25	1.75
30	2.00
35	2.25
40	2.50
45	2.75
50	3.00
55	3.25
60	3.50
65	3.75
70	4.00
75	4.25
80	4.50

Section X Refrigeration

R 134a Refrigerant Charging Data

900 Air Cooled

	US measure	metric measure
Amount	19 (±0.3) ounces	537 (±9) grams

900 Water Cooled

	US measure	metric measure
Amount	16 (±0.3) ounces	283 (±9) grams

1400 Air Cooled

	US measure	metric measure
Amount	19 (±0.3) ounces	537 (±9) grams

1400 Water Cooled

	US measure	metric measure
Amount	16 (±0.3) ounces	454 (±9) grams

Section XI C1- C3 Service Testing

Heat Load Capacity

A.verification of heat load capacity variation at factory floor ambient temperature at 20°C setpoint temperature:

Test Set-Up:

1.Configure C1 units for C2 operation (for 208/60 and 230/50 units).
NOTE: C2 115/60 units should **only** be configured as C2 units. To reconfigure a C1 unit go to the config loop and change the unit type to the C2 code. When you are done testing put the code back to a C1 unit.
2.Measure ambient at the condenser air inlet.
3.Install heater test loop onto the unit
4.Install all panels on unit (including front grill with air filter installed).

Test Procedure:

1.Fill circulating tank on the UUT (Unit Under Test) with water.
2.Connect UUT to the appropriate power source (115/60/1, 230/50/1 or 208/60/1 as applicable).
3.Depress “Start” button on the control keypad of the UUT to turn the unit on (make sure there are no leaks.)
4.Record ambient temperature at the UUT.
5.Adjust UUT set Point to 20°C.
6.Once at temperature +/- 0.1°C, apply ambient adjusted heat load per Table A.
7.UUT passes if the UUT stabilizes at noted set point and superheat minimum superheat is 7°C for STD units and 8°C for HT units. If suction pressure and temperature are oscillating, then observe superheat as a range where the lowest pressure and temperature and highest pressure and temperature are to be used to calculate superheat range, as applicable.

Record Test Data On service report:

- Ambient Temperature
- Applied Load W
- Supply water Temperature
- Supply Pressure Psig (Pump pressure).
- Suction Temperature
- Suction Pressure
- Unit current draw at full load
- Applied voltage (measured at unit line cord inlet)

Table A:

C2 - Load Values & Suction Pressure for Various Voltages & Ambient Temperatures at 20°C recirculating

	18	19	20	21	22	23	24	25	26	27	28	29	30	P-Max.
115V/60HZ	1645	1612	1570	1537	1503	1469	1435	1400	1365	1330	1295	1259	1223	50
230V/50HZ	1413	1379	1330	1311	1276	1241	1206	1170	1134	1098	1061	1024	987	45
208/60HZ	1645	1612	1570	1537	1503	1469	1435	1400	1365	1330	1295	1259	1223	43

Do not exceed PMAX value for these tests. Superheat must be $\geq$ 7°C for STD units and $\geq$ 8°C for HT units.

Section XII Printed Circuit Board Assembly (PCBA) Calibration

Overview

The “whole unit” calibration is broken up into two steps. This procedure covers step 1:

Step1) PCBA Calibration
The PCBA is calibrated with precision NIST traceable reference values. These values correspond acceptably to typical curves. They are used when the unit is reset to standard curves and is the only calibration in many instances.

Step2) PCBA + Sensor calibration
The PCBA+ Sensor calibration is an addition to the PCBA calibration to match the actual sensors attached at final integration for process flow and process temperature. This will be handled at final integration.

Procedure

Step 1, PCBA calibration must be done in any energized condition (must plug in 75W (Basic) 150W (Deluxe) 24VDC PWS to J2 pin 1 referenced to pin2 (Basic), J24 pin 1 referenced to pin2 (Deluxe). This calibration can be done in the unit, on a test stand, or on the bench.

NOTE: You don’t want to turn the keypad On/Off button “on” because you can enter the loops with this button off. This is an energized but not started condition.

1) T1-T3 (Basic) RTD1- RTD4 (Deluxe)

See appendix for variation of nomenclature and clarification note, PCBA pin out, reference connection method, firmware loop maps, and voltage reference information.

a) Enter Calibration Loop in “Super user mode” to calibrate all inputs listed.

b) Apply a 101.95Ω resistance reference across the RTD input pins T1. Enter the controller Calibration Loop (see attached loop map) and accept the low calibration point of 5°C.

c) Repeat low calibration for all temperature inputs T2-T3 (Basic) and T2-T4 (Deluxe).

d) Apply a 115.54Ω resistance reference across the RTD input pins T1. Enter the controller Calibration Loop and accept the high calibration point of 40°C.

e) Repeat high calibration for all temperature inputs T2-T3 (Basic) and T2-T4 (Deluxe).

f) Re-Enter Calibration Loop as “Super user mode” and save each sensor input individually as “rESEt” value.

2) P1- P2 (Basic)

Analog in 1, Analog in 2, Analog in 5, Analog in 6, Analog in 7, Analog in 8, LEV4 (Deluxe)

See appendix for variation of nomenclature and clarification note, PCBA pin out, reference connection method, firmware loop maps, and voltage reference information.

a) Enter calibration loop in “Super user mode” to calibrate all inputs listed.

b) Measure with a precision voltage meter the 5.0??V pressure transducer input pins “+5V sense” referenced to “common” adjust in the firmware Calibration Loop the voltage sense calibration parameter to match the volt meter reading. Accept the value when it is the same. Record the reading for later use in step 3.b.

c) Apply precision voltage reference to pressure transducer input pins “+V sig” referenced to “common”. Adjust voltage for 0.500V then accept it as the low calibration point in firmware Calibration Loop.

d) Repeat low calibration for P2 (Basic) P2, P5-P6 (Deluxe):

e) Re-adjust precision voltage reference on pressure transducer input pins “+V sig” referenced to “common”. Re-adjust voltage for 4.500V then accept it as the high calibration point in firmware Calibration Loop as the high calibration parameter.

f) Repeat high calibration for P2 (Basic) P2, P5-P6 (Deluxe):

g) Re-Enter Calibration Loop as “Super user mode” and save each sensor input individually as “rESEt” value.

3) Verification:

a)Connect a 107.790Ω resistor across T1-T3 (Basic) RTD1-RTD4 (Deluxe) one input at a time and observe display will read 20°C +/- 0.2°C in the Engineering Loop for each respective sensor reading.

b)Connect a 2.500v reference voltage across P1-P2 (Basic) Analog in 1, Analog in 2, Analog in 5, Analog in 6, Analog in 7, Analog in 8, LEV4 (Deluxe) (See appendix for variation of deluxe nomenclature and clarification note) one input at a time and observe display will read [((5.000V)/(“5 V sense” step 2.C))* ½] +/- 0.2% of the enabled pressure transducer full scale (See appendix for pressure transducer ratings). For “lev 4” it should be ½ full in (TBD) loop.

PCBA Numbers:
F300 (Basic PCBA) = Model#: MC038 = TE PART# 084797.1C
F301 (Deluxe PCBA) = Model#: MC037 = TE PART# 084736.2B

Pressure Transducer ratings:
P1= 150PSI(Basic)
P2= 80PSI (Basic)

P1 (Analog input 1)TBD (Deluxe)
P2 (Analog input 2)150PSI (Deluxe)
P3 (Analog input 3)not used (Deluxe)
P4 (Analog input 4)not used (Deluxe)
P5 (Analog input 5) 80 PSI (Deluxe)
P6 (Analog input 6) 500 PSI (Deluxe)
P7 (Analog input 7)150PSI (Deluxe)
P8 (Analog input 8)150PSI (Deluxe)

Connecting the Precision resistor reference

Connect the precision resistors for each input on the connector for high calibration and then change the resistors value for low calibration. This resistance reference should not be crimped directly on the connectors so 6" of #22 awg wire can be soldered to the resistor directly.
Wire# 001343 BLK and 001345 RED
Connector part # (084818 Basic (TBD) Deluxe)
Housing Part # (084841 Basic (TBD) Deluxe)

Connecting the Precision Voltage reference

Connect the precision voltage reference on the connector for each input. Change the value for high then change the value for low calibration. This voltage reference can not be crimped directly on the connectors so 6" of #22 awg wire can be connected to the voltage source leads.
Wire# 001343 BLK and 001345 RED
Connector part # (084818 Basic (TBD) Deluxe)
Housing Part # (084841 Basic (TBD) Deluxe)

Connecting the Precision Voltage meter

Connect the precision voltage meter on the connector for the 5V sense measurement. Adjust the display to match the meter. This voltage meter can not be crimped directly on the connectors so 6" of #22 awg wire can be connected to the voltage source leads.
Wire# 001343 BLK and 001345 RED
Connector part # (084818 Basic (TBD) Deluxe)
Housing Part # (084841 Basic (TBD) Deluxe)

Basic PCBA Pin out

T1 = J7 Pin 1(+) referenced to pin 2(-)
T2 = J7 Pin 3(+) referenced to pin 4(-)
T3 = J7 Pin 5(+) referenced to pin 6(-)
+5V Sense = J7 pin 7(+) referenced to pin 9(-)
P1 +V sig = J7 pin 8(+) referenced to pin 9(-)
P2 +V sig = J7 pin 11(+) referenced to pin 12(-)

Deluxe PCBA Pin out (TBD)

Clarification: For Deluxe units P1-P8 is specified on unit wiring diagram 6.4010 and analog input 1-8 is specified on PCBA schematic. These are the same inputs just labeled differently.

Resistance Reference

Source 1
Precision resistor Reference:
PRECISION RESISTOR CO., INC.
10601 75th Street North, Largo, FL 33777-1421 U.S.A.
Tel.: 727-541-5771 Fax: 727-546-9515
E-Mail: *prc@precisionresistor.com*
http://www.precisionresistor.com/hr103.htm

Part # 1 HR188N 101.950&! .01% 5PPM (4-6 week lead time $56 for 5C)
Part # 2 HR188N 115.540&! .01% 5PPM (4-6 week lead time $56 for 40C)
Part # 3HR188N 134.710&! .01% 5PPM (4-6 week lead time $56 for 90C when HT option used in deluxe)
Part # 4 HR188N 107.790&! .01% 5PPM (4-6 week lead time $56 for 20C)

Source 2 = http://www.rcd-comp.com/rcd/index.htm

(Accuracy of 40m &! is requirement)

Voltage Reference

Manufacturer#1 Fluke
Fluke model 725 Voltage calibration Tool or equivalent.

Alternate Manufacturer #2 Martel (Used on HX line)
Martel model # IVC222HPII

(Resolution 1mV, Accuracy +/- .02% +2 counts (3mV) is requirement)

Voltage Operation Procedure

(See manufacturer supplied operation manual and related documentation)

Voltage Meter

Manufacturer:
Fluke model 45, model 87,model 725 or equivalent.

(Resolution 1mV, Accuracy +/- .05% +/-2 counts is requirement)

Voltage Operation Procedure

(See manufacturer supplied operation manual and related documentation)

Ohm Meter (Optional)

Manufacturer:
Keithley 4 wire micro-ohmmeter (Model 580)
(Resolution 1m&!, Accuracy +/- 40m&! is requirement)

OHM Meter Operation Procedure

(See manufacturer supplied operation manual and related documentation

Section XIII Firmware Download

Procedure:

1. Boot PC station.

2. Plug in factory port connector (T1478) to the male connector inside the CBA.

3. Open Philips LPC 2000 Flash Utility from desk top.

4. Window Settings:

    Connected to port: COM1

    BAUD Rate: 38400

    DEVICE: LPC2292

    XTAL Freq. KHZ 10000

5. Connect unit to power source with circuit protector off (**0**).

6. Click on **BOX RERAD DEVICE ID**.

7. Place the circuit protector to on (**I**) position - CBA is powered - HMI display 888888.

8. Ready to read device **Click OK**.

9. See numbers in windows **Part ID** and **Boot Loader ID**.

10. Click on **Erase** window.

11. At the bottom of the window see "**Erased LPC2000 flash successfully**"

12. Press Browse for the latest 1A.hex file. Select file and click open. (This selects correct file for download.)

(Flash Programming File located at - F:\ALL\GROUPS|CONTROLS\PUBLIC\PRODUCTS\084992\1\A\1B.hex

13. Click on **Upload Flash**.

14. Downloading starts.

15. Wait for the **"File Uploaded successfully completed"** display.

This completes the firmware download.

Turn power off and disconnect Factory port connector on T1478.

Appendix A

Country Specific Receptacle Rating Requirements

1. Units shipped to the following locations require a **16 Amp current**:

Albania, Austria, Belgium, Belarus, Bulgaria, Croatia, Czech Republic, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Italy, Latvia, Lithuania, Luxembourg, Moldova, Netherlands, Norway, Poland, Portugal, Romania, Russia, Slovakia, Spain, Sweden, Ukraine, Serbia, Algeria, Angola, Benin, Burkina Faso, Burundi, Cameroon, Central African Republic, Chad, Congo, Egypt, Ethiopia, Gabon, Ivory Coast, Liberia, Mali, Mauritania, Morocco, Mozambique, Niger, Rwanda, Senegal, Somalia, Togo, Tunisia, DR Congo, Brazil, Chile, Ecuador, French Guiana, Paraguay, Peru, Uruguay, Afghanistan, Armenia, Azerbaijan, Cambodia, Georgia, Indonesia, Iran, Iraq, Kazakhstan, Kyrgyzstan, Lebanon, Saudi Arabia, Syria, Tajikistan, Turkey, Turkmenistan, Uzbekistan, Argentina, Libya, Andorra, Bolivia, Bosnia and Herzegovina, Cape Verde, Comoros, Djibouti, Eritrea, Guinea, Jordan, Madagascar, Monaco, Mongolia, North Korea, Saint Vincent and the Grenadines, San Marino, Sao Tome and Principe, Slovenia, South Korea, Thailand, Vanuatu, Vatican City, Vietnam, Denmark, Switzerland, Liechtenstein, Israel, South Africa, Namibia, Nepal.

2. Units shipped to the following locations require a **15 Amp current**:

Australia, Fiji Islands, New Zealand, Solomon Island, Tonga, China, Nauru, Papua New Guinea, Tuvalu.

3. Units shipped to the following locations require a **13 Amp current**:

Hong Kong, India, Ireland, United Arab Emirates, United Kingdom, Botswana, Gambia, Ghana, Kenya, Lesotho, Malawi, Mauritius, Nigeria, Sierra Leone, Sudan, Swaziland, Tanzania, Uganda, Zambia, Zimbabwe, Abu Dhabi, Bangladesh, Brunei, Cyprus, Kuwait, Malaysia, Myanmar, Pakistan, Qatar, Singapore, Sri Lanka, Yemen, Bahrain, Dominica, Gibraltar, Grenada, Kiribati, Maldives, Malta, Oman, Saint Lucia, Seychelles.