TCU Model 2080

Operation and Maintenance

BOM Version 851-110195-120

Revision B
August 2001

Revision A May 2000—First Printing (ECN released)

Revision B August 2001—Second Printing

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Part Number: 406-240155-120

Safety Preface

The safety guidelines for the equipment in this manual do not purport to address all the safety issues of the equipment. It is the responsibility of the user to establish appropriate safety, ergonomic, and health practices and determine the applicability of regulatory limitations prior to use. Potential safety hazards are identified in this manual through the use of words Danger, Warning, and Caution, the specific hazard type, and pictorial alert icons.

Hazard Levels

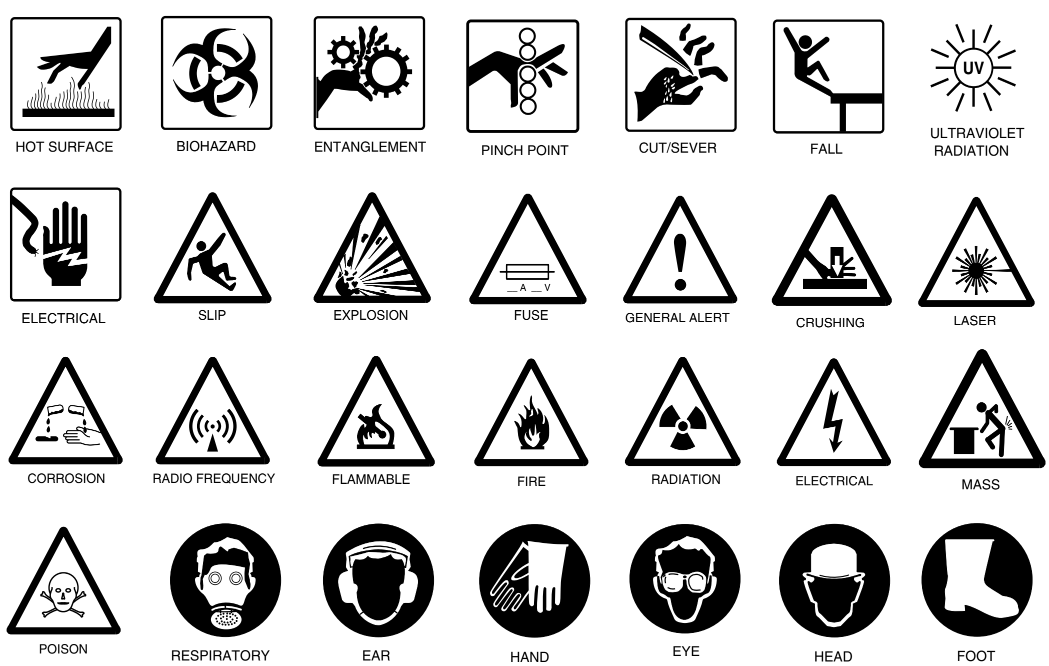
Danger: Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury. This is limited to the most extreme situations.

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

Caution: Indicates a potentially hazardous situation which, if not avoided, could result in minor or moderate injury. It may also alert users against unsafe practices.

Notice: Indicates a statement of company policy (that is, a safety policy or protection of property).

Pictorial Alert Icons



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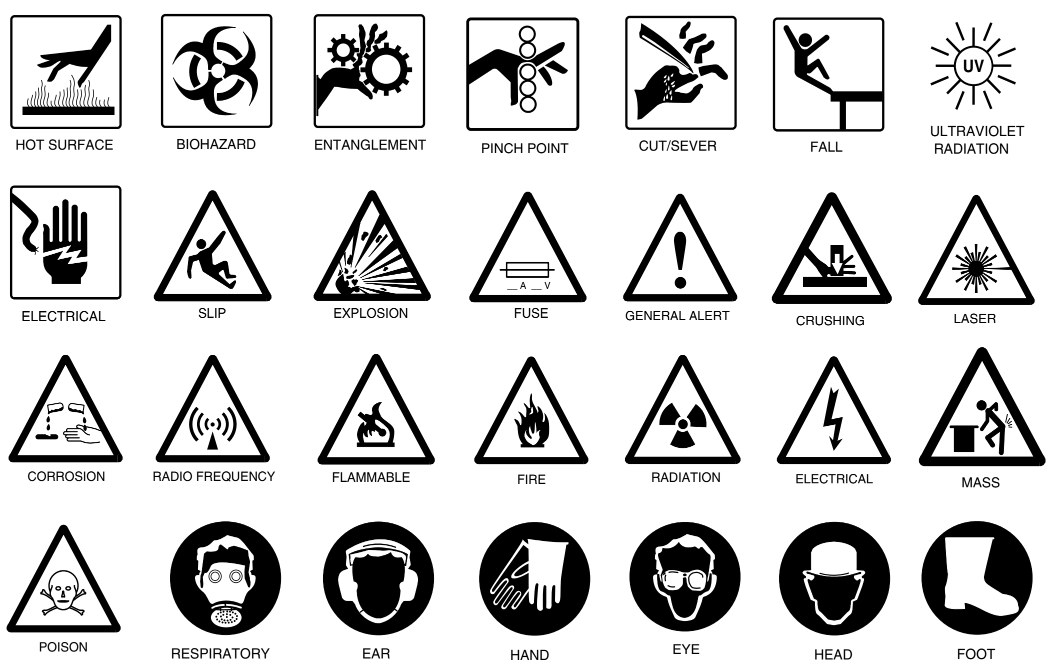

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Overview

Introduction

The dual channel temperature control unit (TCU Model 2080) is a compact, mobile, liquid heating/cooling system capable of operating over a wide temperature range. The TCU provides temperature control for both the upper and lower electrodes on Lam systems. It features a closed–loop design with no back pressure and features continuous deionization of the heating/cooling liquid (coolant). Reliable service for long periods is assured through the use of hermetically sealed refrigeration compressors and heat exchangers.

The TCU's upper and lower channels each contain three separate cooling circuits. The first is the primary or main circuit. This circuit runs continuously to remove heat from the coolant reservoir. It is also used to introduce heat into the coolant (in addition to the electrical heater) when required.

The secondary and tertiary circuits energize as the coolant temperature increases, extending the life of the polishing cartridges and preventing the loss of coolant.

Changes Since Last Revision

Revision B contains the following changes:

- Updates Appendix A, "Reference Documentation," to reflect revised drawings.
- Updates front and back title pages.
- Updates screen captures of the front and back control panels of the system.

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Safety

Training

All operating personnel must have the appropriate safety training pertaining to the hazards of the system.

Environmental Regulations

Environmental regulations and requirements vary by the geographic location or governmental jurisdiction in which the product is installed. Various local, regional, and national standards either exist, or are emerging, for the environmental performance of semiconductor process equipment.

Existing environmental requirements, as they pertain to process equipment, include the following categories: air emissions—hazardous air pollutants (HAPs), perflurocarbons (PFCs), volatile organic compounds (VOCs),—water effluent, and solid or liquid hazardous wastes. In addition, performance requirements developed by the semiconductor industry are emerging in the areas of water and energy use efficiency. Lam participates in these discussions and tracks all important developments, some of which will be included in future facility manuals as industry or company standards are developed.

Point-of-Use Abatement

Point-of-Use (POU) emission abatement systems are designed for treating air emissions from the outlet of a specific semiconductor process to remove compounds of interest before they enter the facility's main exhaust ductwork. This distinction separates POU systems from facility-level abatement systems that treat the collected exhausts of an entire facility, or large portion thereof. A typical POU system may serve from one to four similar process systems.

Several types of POU systems currently exist in the marketplace for specific classes of effluents such as HAPS (wet-scrub with chemical, wet-scrub without chemical, oxidation, and so forth), but specific equipment is typically neither provided by, nor recommended by, system suppliers as standard peripheral equipment. As development of such equipment continues to evolve, this may change. Currently Lam is engaged in several research and development efforts for such equipment.

The SEMATECH Transfer Document *Point-of-Use Control Systems for Semiconductor Process Emissions* provides guidance in the identification and selection of POU systems for particular process applications. In all cases where such equipment is used with Lam products, it is essential that the end-user investigate and comply with any environmental regulations which may be particular to the jurisdiction where the equipment is used.

Hazardous Waste

Various maintenance procedures generate waste products such as lint-free wipes soaked in isopropyl alcohol (IPA), distilled (DI) water, excess grease, and so forth. The amount of solid waste generation is roughly equivalent to the *disposable* solid waste generated during a preventive maintenance task in addition to the *discard* replacement materials from the preventive maintenance task.

Treat all waste as toxic. If disposal is required, please observe the proper Occupational and Safety Health Administration (OSHA)-approved and facility-approved disposal practices.

Secondary Containment

The TCU system has secondary containment to prevent hazardous material from accidently leaking into the environment. The secondary containment has sensors to detect leaks and notify the operator.

HAPS Regulations Management

At this printing Lam is underway with test methodologies concerning some HAPS emissions data for the TCU system.

Emergency Off

All Lam systems include an emergency off (EMO) system that enables an operator or service technician to quickly disconnect power to the unit. Large, red buttons are located around the system, readily accessible in an emergency. Pushing any one of these buttons shuts off main alternate current (AC) and radio frequency (RF) power and closes all gas valves.

Note After pushing an **EMO** button, power to the turbo pump or to the Envision™ interface may be provided for a limited time by a battery backup system or from another source.

Energized Electrical Work Types

The *Safety Guidelines for Semiconductor Manufacturing Equipment* (SEMI S2–93) defines five types of system electrical states. The five types are as follows:

Type 1 Equipment is fully de–energized (electrically cold).

Type 2 Equipment is energized. Live circuits are covered or insulated. Work is performed at a remote location to preclude accidental shock.

Type 3 Equipment is energized. Live circuits are exposed and accidental contact is possible. Potential exposures are less than 30 volts alternate current (VAC) route mean square (RMS), 42.2 VAC peak, 240 volt-amperes, and 20 joules.

Type 4 Equipment is energized. Live circuits are exposed and accidental contact is possible. Voltage potentials are greater than 30 VAC RMS, 42.2 VAC peak, 240 volt–amperes, and 20 joules, or RF is present.

Type 5 Equipment is energized and measurements and adjustment require physical entry into the equipment, or equipment configuration will not allow the use of clamp–on probes.

The applicable electrical work types are indicated in the safety information section at the beginning of each procedure.

Lockout/Tagout

Lam recommends that you carefully perform the following lockout/tagout procedures before servicing the unit. Only authorized technicians should perform these tasks.

Shutdown

▶ **To shutdown the system,**

1. Before servicing, inform all affected personnel that you will shut down the unit for servicing and that you will lock out all energy sources.
2. Shut down the unit using normal shutdown procedures.
3. Lockout and tagout as necessary.

   A lockout is a method of keeping equipment from being energized and endangering workers. Lockouts use the following methods:

   - A disconnect switch, circuit breaker, valve, or other energy-isolating mechanism is put in the safe or off position.
   - A device is placed over the energy-isolating mechanism to hold it in the safe position.

   For a tagout, place the energy-isolating mechanism in the safe position, and attach a written warning.

Ergonomics

Use proper lifting and handling when working on the system. Improper ergonomic handling may result in injury. Lam recommends using a sturdy stool or step ladder when performing all service and troubleshooting tasks on the TCU 2080. These tasks may require access to areas that are difficult to reach, especially for the shorter service technician.

Protective Gear

Wear protective, cleanroom–approved clothing, gloves, safety glasses and approved respiratory protection whenever appropriate.

Enclosure Interlocks

The TCU enclosure covers are equipped with interlocks that disconnect AC power to the system if activated. These interlocks are all in series in the 24 VAC interlock circuit.

TCU Description

The TCU possesses two independent heating/cooling loops. Each loop consists primarily of a coolant reservoir, circulating pump, heat transfer system, various flow and temperature safety interlocks, and controls to maintain coolant conditions. The operational coolant temperature range of the TCU extends from –20 to +80 degrees Celsius for the lower channel and –15 to +80 degrees Celsius for the upper channel. Both channels maintain a temperature stability of ±1 degree Celsius in an idle condition (no dynamic loads attached).

Three major modules are contained within the system: the control electronics module and two refrigeration modules. The control electronics module provides the circuitry required to operate the TCU and controls the safety interlocks. The refrigeration modules contain heater assemblies, water pumps, deionizing cartridges, and complete refrigeration systems. The lower refrigeration module can provide up to 1000 watts—3415 British thermal units per hour (BTU/hour)—of heat removal at an operating temperature of –20 degrees Celsius. The upper module is capable of providing 750 watts (2561 BTU/hour) of heat removal at an operating temperature of –15 degrees Celsius. The heating capacity for both channels is 1600 watts (5464 BTU/hour).

Refrigerant Characteristics

Contact the following company to obtain a Material Safety Data Sheet (MSDS) for information on refrigerant 404A:

National Refrigerants, Inc.
661 Kenyon Avenue
Rosenhayn, NJ 08352
Phone: 1-800-262-0012

Refrigerant Flow

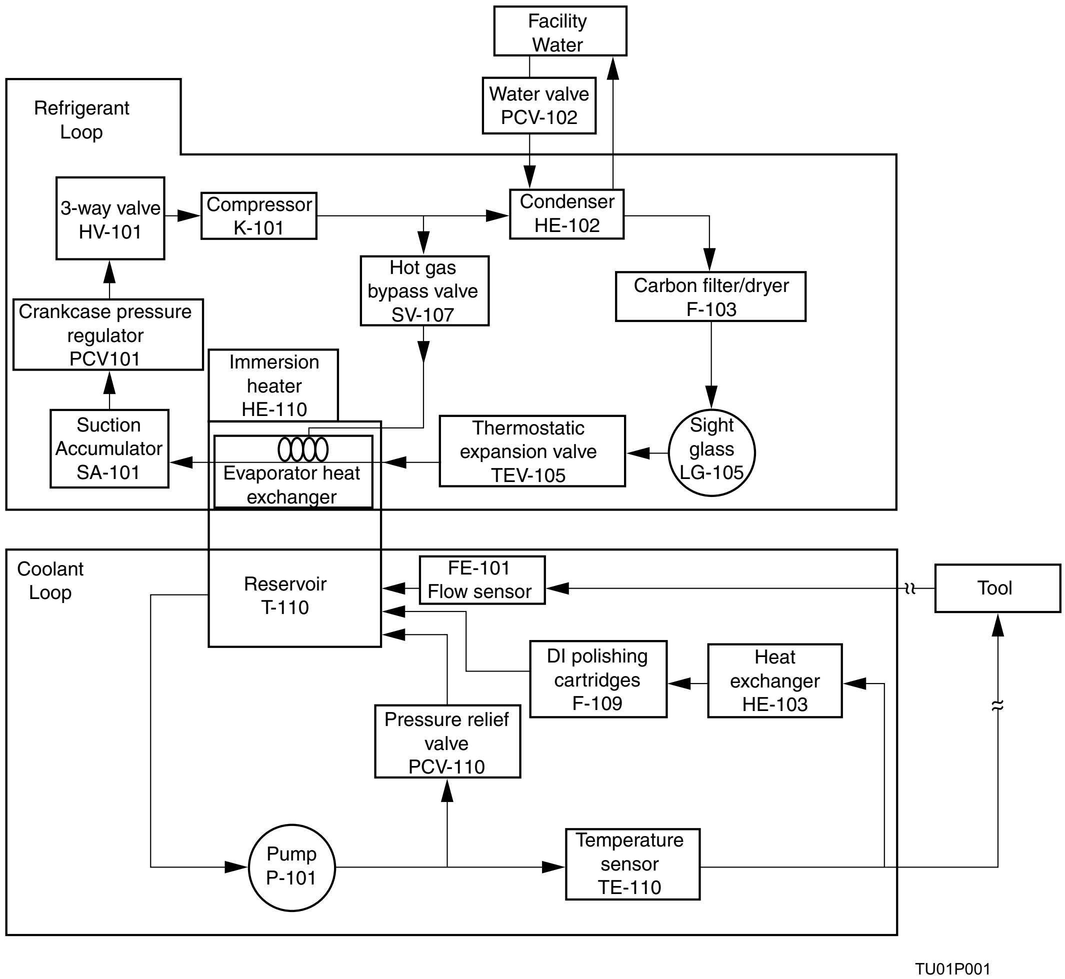
The TCU is a conventional evaporative refrigeration design that uses hydrofluorocarbons refrigerant R–404A. The refrigerant is cycled through the system and is repeatedly compressed, condensed, and evaporated.

Figure 1–1 is a functional block diagram that illustrates the primary cooling circuit for one of the two channels in the TCU (see Figure 1–2). The refrigerant exits the compressor (K–101), which operates continuously at a steady rate, as a high pressure, hot gas. This hot gas enters a condenser (HE–102) where the gaseous refrigerant is cooled and condensed to a liquid state. This cooler liquid exits the condenser and is filtered by an activated carbon filter (F–103), then passes through a sight glass (LG–105). The refrigerant is then metered through a thermostatic expansion (TX) valve (TEV–105) that controls the flow of refrigerant to the evaporator heat exchanger.

The refrigerant exits the TX valve and boils in the evaporator heat exchanger. As it boils off (evaporates) to a gaseous state, the refrigerant absorbs heat from the system's coolant. It then leaves the evaporator heat exchanger. The TX valve monitors the temperature and pressure of the refrigerant before entry to the suction accumulator (SA–101). The suction accumulator ensures that no liquid is sent to the compressor by diverting and storing any liquid until it can be vaporized.

The refrigerant, as a cool low pressure gas, roughly 30 pounds per square inch (psi), enters the compressor through a crankcase pressure regulator (PCV–101) and a three way service valve (HV–101). A solenoid–operated hot gas bypass valve (SV107) is located between the compressor (K–101) and the condenser (HE–102). This valve opens in the heating mode and closes while the channel is cooling. It effectively bypasses the condenser while allowing the compressor to continue to operate.

Figure 1–1. Functional Block Diagram of Primary Refrigeration System



Coolant Flow

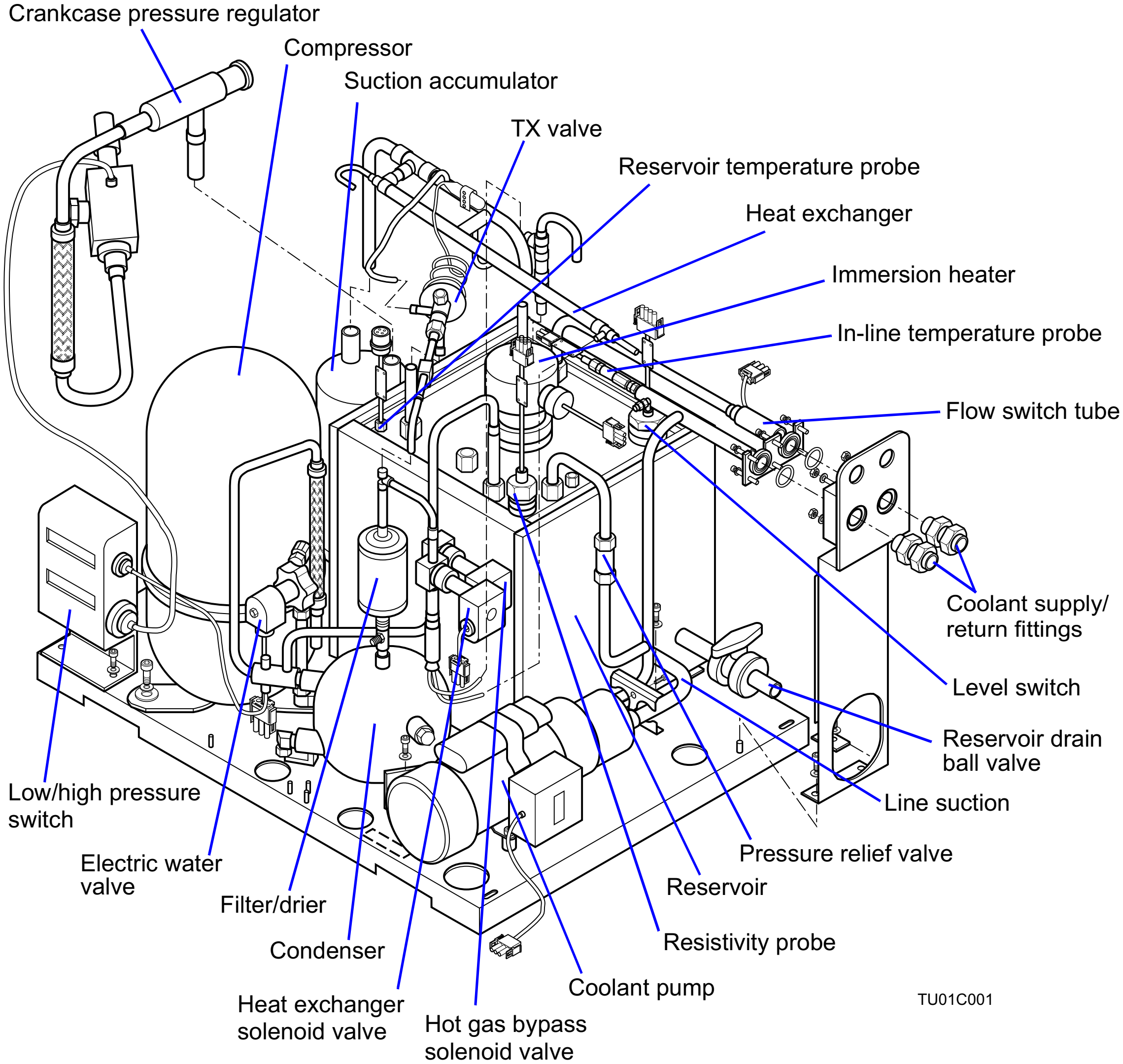
A 50/50 mixture (by volume) of deionized (DI) water and ethylene glycol is used as the coolant for the system. The coolant is drawn from a five gallon reservoir (T–110) into a positive displacement pump (P–101). If the coolant pressure exceeds 75 psi, the pressure relief valve (PCV–110) opens to divert coolant back to the reservoir.

Before the coolant exits the TCU, a temperature sensor (TE–110) measures the coolant temperature and sends the temperature data to the control board. This ensures that the actual coolant temperature is measured rather than the reservoir temperature.

The coolant pumped from the TCU to the system circulates through the electrode sealplates of the system reaction chamber and returns to the reservoir through a one gallon per minute (gpm) threshold flow switch (FE–110).

A small portion of the coolant is bypassed from the system and fed through a heat exchanger (HE–103) to DI polishing cartridges (F–109). The heat exchanger is cooled by the secondary refrigerant circuit and is activated when the reservoir temperature exceeds 30 degrees Celsius. Cooling the coolant extends the life of the deionizing cartridges.

Figure 1–2. Refrigeration Assembly-Right/Rear View



Specifications

Table 1–1. Coolant and Facility Water Flow

Item description	Flow gpm (LPM)	Pressure PSI	Temperature (° Celsius)
Upper channel coolant supply to system	4 (15.14) ± 0.5 (1.89)	60 ± 20	-15 to + 80
Lower channel coolant supply to system	4 (15.14) ± 0.5(1.89)	60 ± 20	-20 to + 80
Facility water supply requirements	6(22.72)±2 (7.56)	60 ± 20 (100 max)	+10 to + 25

Table 1–2. General Specifications

Description	Specification
Dimensions	Height: 55.25 in. (140.34 cm) Width: 23.75 in. (60.33 cm) Depth: 37.75 in. (95.89 cm)
Weight	616 lbs. (279.42 kg) w/reservoirs empty 690 lbs. (312.98 kg) w/ reservoirs full
Operating temperature range	—15 to + 80 degrees Celsius (upper channel) —20 to + 80 degrees Celsius (lower channel)
Temperature regulation	±1 degrees Celsius (±0.3 degrees Celsius typical) at rated static load
Setpoint resolution	±0.1 degrees Celsius
Power dissipation capability	Cooling: lower channel 1000 W at —20 degrees Celsius (3415 BTU/hr) upper channel 750 W at —15 degrees Celsius (2561 BTU/hr) Heating: upper/lower channel 1600 W(5464 BTU/hr)
Reservoir capacity	4.23 gallons (16 liters) per reservoir
Ambient operating temperature	+10 degrees Celsius to +40 degrees Celsius
Coolant composition	50/50 mixture by volume of DI water and ethylene glycol. This equates to a specific gravity of 1.065 ± 0.005 as measured with a hydrometer. Ethylene glycol should be laboratory grade or better.
Power requirements	3–phase 208/230VAC at 50–60 Hz, 30 A with10 kA I_{cu}

Table 1–2. General Specifications (continued)

Description	Specification
Fuses	28V EMO Circuit = (2) 1A, 250V SLO BLO Power Supply = (1) 0.75A, 250V SLO BLO
Sound pressure level	<75 dBA

Table 1–3. Coolant and Facility Water Interface Hardware Requirements

Item description	Fitting Size/Type	Line Size/Type
Upper channel supply	1/2–inch Swagelok or equivalent	1/2–inch OD Nylon Tubing
Upper channel return	1/2–inch Swagelok or equivalent	1/2–inch OD Nylon Tubing
Lower channel supply	1/2–inch Swagelok or equivalent	1/2–inch OD Nylon Tubing
Lower channel return	1/2–inch Swagelok or equivalent	1/2–inch OD Nylon Tubing
Facility water supply	5/8–inch Swagelok or equivalent	5/8–inch OD Nylon Tubing
Facility water return	5/8–inch Swagelok or equivalent	5/8–inch OD Nylon Tubing
Reservoir drain (one per channel)	1/2–inch FNPT	

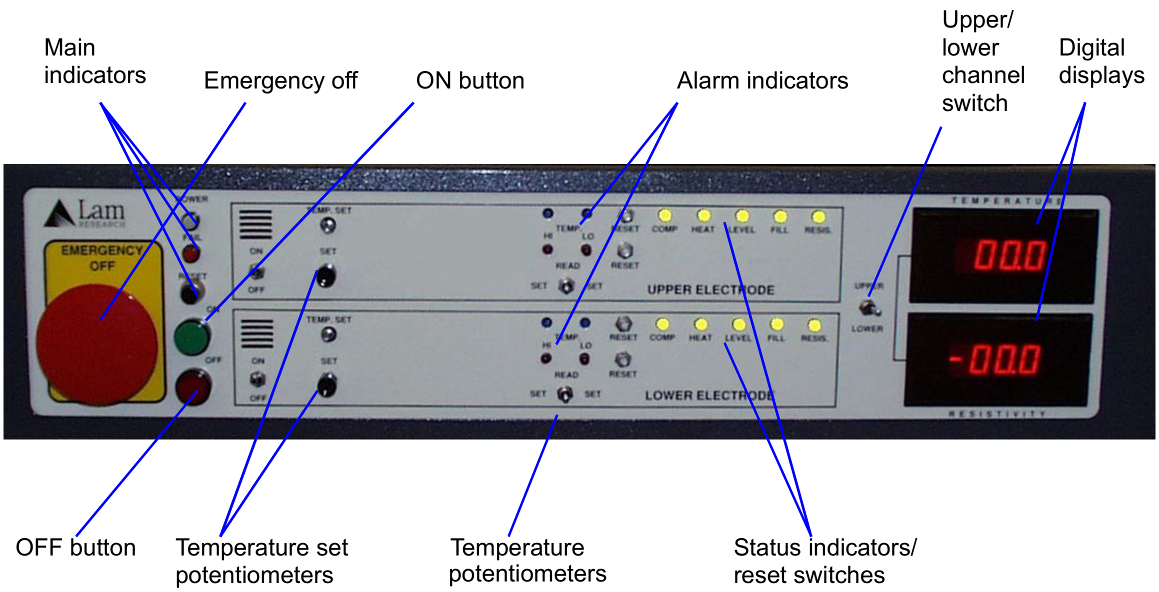
Caution

Mechanical Hazard: During normal TCU operation, the condenser water valve continuously cycles on and off. This cycling motion can cause the facility water lines to undulate or jump around. When routing the cooling water lines, prevent the lines from rubbing against other objects.

Front Control Panel

The front control panel (Figure 1–3) provides various controls, indicators, and displays. The controls turn the TCU on or off, as well as set parameters such as temperature setpoints and high and low temperature alarm limits. The indicators provide a convenient means of monitoring system status. The digital displays provide a continuous readout of coolant temperature and resistivity and accumulated operating hours.

Figure 1–3. Front Control Panel



Front Panel Controls

Main Controls

- **Emergency Off** (EMO) (red)—connected to the EMO circuitry of the system. Activation shuts down the TCU, system, RF generator, and all equipment included in the external EMO circuit.
- **Power On** (green)—turns the compressors and water pumps on.
- **Power Off** (black)—turns the compressors and water pumps off.
- **Upper/Lower switch**—activates the Temperature and Resistivity displays for the upper and lower channels.

Channel Control

There are two sets of channel controls, one set per channel.

- **Set** —selects between the temperature setpoint read mode and the temperature display mode for each channel. Temperature display mode is the default mode. It is active when the button is in its normal, unpressed position. When you press the **Set** button, the temperature setpoint appears on the temperature meter.

Local temperature set mode is enabled only when the TCU is in local control mode. When the TCU is in remote mode, the setpoint is specified as the *Electrode Parameter* on the etchers software on the **Recipe** page.

If the system is off, the TCU setpoint defaults to local setpoint.

- **Temperature Set** potentiometers—used in conjunction with the **TEMP. SET** buttons to set the temperature setpoint for each channel (enabled when the TCU is in local control mode only).
- **Local Temperature Hi/Lo Set** potentiometers—set the high and low setpoint alarm limits for each channel.
- **Temperature Alarm Hi Set/Read, Temp Alarm Lo Set/Read** two switches—used in conjunction with the TEMP. HI/LO potentiometers to set the high and low temperature setpoint alarm limits or display the current high or low temperature setpoint alarm limits.
- **Temperature Alarm Reset**—reset TEMP fault indicator only.

Front Panel Indicators and Displays

Main Indicators

- **AC On** (white)—illuminates when CB1 and CB6 are on and the main **RESET** button has been pressed.
- **Fail** (orange)—illuminates when the TCU has stopped running due to a system shutdown.
- **Intlk** (blue)—illuminates when all six panel interlocks are enabled and EMO's are not activated (operational condition).

Depressing the alarm reset switches clears all of the following indicators in their respective channel.

- Status Indicators

System Shutdown:

These faults send a signal to the system. See Table 1–4.

- **Compressor**—bicolor LED glows red indicating a system shutdown from high or low refrigerant pressures and glows green under normal operating conditions.
- **Flow**—bicolor LED glows red indicating a loss of coolant return flow from the system and system shutdown and glows green under normal operating conditions.
- **Heater**—bicolor LED glows red indicating overtemp failure and system shutdown and glows green under normal operating conditions.
- **Level**—bicolor LED glows red indicating the coolant level is below the safe limit for the TCU and indicates system shutdown and glows green under normal operating conditions.

Maintenance Required:

- **Fill**—bicolor LED glows red indicating the coolant level is low and that more coolant should be added and glows green under normal operating conditions.
- **Resistivity—**bicolor LED glows red indicating the resistivity of the coolant is not within proper operating limits and glows green under normal operating conditions.

Alarm Indicators

- **Temperature Alarm Hi/Lo**—illuminates to warn that a temperature high or low alarm limit has been exceeded.

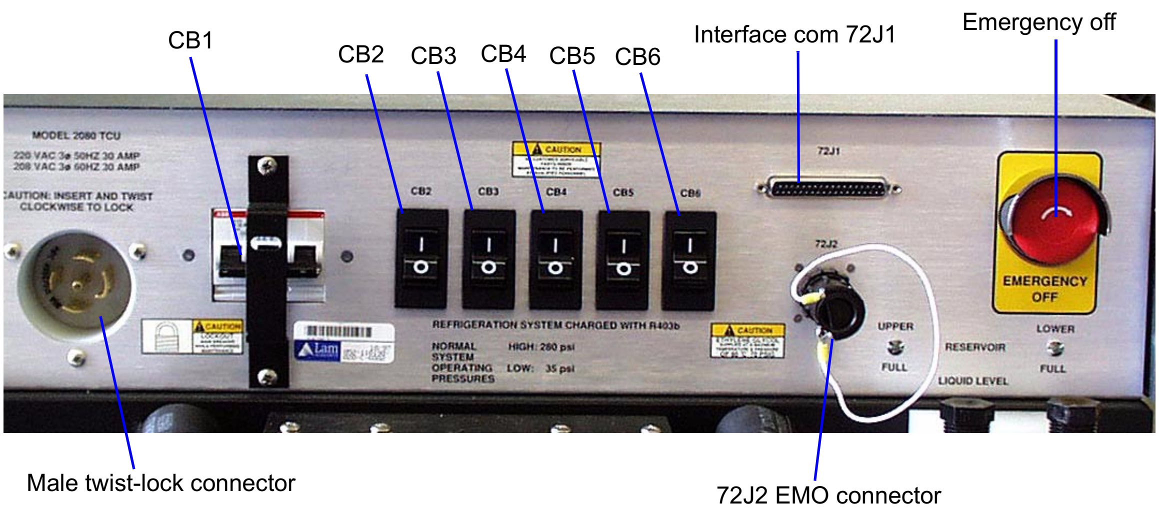
Panel Meters

- **Temperature**—displays the current operating temperature of the coolant.
- **Resistivity**—displays the absolute resistivity of the coolant.
- **Operational Hours**—displays the total number of hours that the TCU has been operating.

Rear Panel

The following is a listing of controls and connectors found on the rear panel of the TCU electronic enclosure (see Figure 1–4).

Figure 1–4. Rear Panel, Electronic Enclosure



Rear Panel Controls

- **CB1**—main circuit breaker with lockout bracket.
- **CB2**—circuit breaker for the lower pump.
- **CB3**—circuit breaker for the lower channel.
- **CB4**—circuit breaker for the upper pump.
- **CB5**—circuit breaker for the upper channel.
- **CB6**—circuit breaker for the electronics control.

Rear Panel Connectors

72J1—37–pin connector for remote data transfer between TCU and system. See Table 1–4 for pinout.

Table 1–4. Interface Connector 72J1

Function	Connector 72J1 pin number
Lower channel temp setpoint	24
Lower channel temp setpoint return	5
Lower channel temp sense	20
Lower channel temp sense return	1
Upper channel temp setpoint	25
Upper channel temp setpoint return	6
Upper channel temp sense	21
Upper channel temp sense return	2
TCU fail	26
TCU fail return	7
TCU warning	28
TCU warning return	9

72J2—9–pin connector for remote enable and EMO. See Table 1–5.

Table 1–5. EMO Connector 72J2

Function	Connector 72J2 pin number
Remote EMO contact (normally closed)	1
Remote EMO contact return (normally closed)	2
TCU local/remote select	3
TCU local/remote select return	4
Internal EMO contact (normally closed)	5
Internal EMO contact return (normally closed)	6
Not used	7
Not used	8
Not used	9

- **Male Twist–Lock connector**—accepts female AC power cable connector.
- **Emergency Off** (EMO) (red)—connected to the EMO circuitry of the system. Pushing the **EMO** button shuts down the system. Reset the **EMO** by twisting the button in the direction of the arrow.

EMO, Interlocks, and Safety Circuits

The TCU is equipped with safety features used to protect the operator from injury and to protect the equipment from damage.

Emergency Off

The front and rear panels of the electronic enclosure have an **EMO**. The **EMO**s are connected in series. When either **EMO** is pushed, contactor K1 opens, and 208 VAC is removed forward of the contactor. The interlock and subsystem safety circuits remain energized by 24 VAC. In addition, the remote EMO circuits open and affect the external equipment connected to J4.

The EMO circuit has two parallel loops. The first loop is powered by the remote equipment through connector 72J2 pins 1 and 2. The second is powered internally by the TCU, and is connected to external equipment through connector 72J2 pins 5 and 6 (see Figure 1–6).

If you plan to operate the TCU without an interface cable attached, then the TCU requires 72J2 pins 5 and 6 to be jumpered together. Use jumper assembly 853-017830-002.

Interlocks

The outer covers are interlocked stopping the operation of the TCU when one or more of the covers are removed. Pullout interlock switches are provided to override this safety feature when maintenance or testing is required.

The interlock switches are in series with the internal EMO loop. Activating one of the interlocks opens contactor K1, and 208 VAC is removed after the contactor. The interlock and subsystem safety circuits remain energized by 24 VAC. However, the remote EMO loop remains closed and external equipment connected to 72J2 pins 1 and 2 is not affected.

Subsystem Safety Circuits

Subsystems that are potentially hazardous to the operator are monitored by sensors that detect conditions out of normal range (see Figure 1–5 and Figure 1–6).

In the coolant loop the following is monitored:

- Coolant temperature in the reservoir
- Coolant level in the reservoir
- Coolant return flow to the TCU

In the refrigeration loop, the following is monitored:

- Compressor high side pressure
- Compressor low side pressure

Each channel in the TCU has an identical set of sensors, but any failure will shutdown the TCU.

If a failure occurs, contactor K2 opens and 208 VAC is removed from the compressors and pumps. The control electronics and the EMO/Interlock circuitry remain energized. Relay K1 on the relay board is deenergized, which in turn deenergizes relay K2. The failure lamp lights up on the front panel. The **ON** and **OFF** buttons and the control circuit turn off.

Figure 1–5. Schematic-Subsystem Safety Circuit

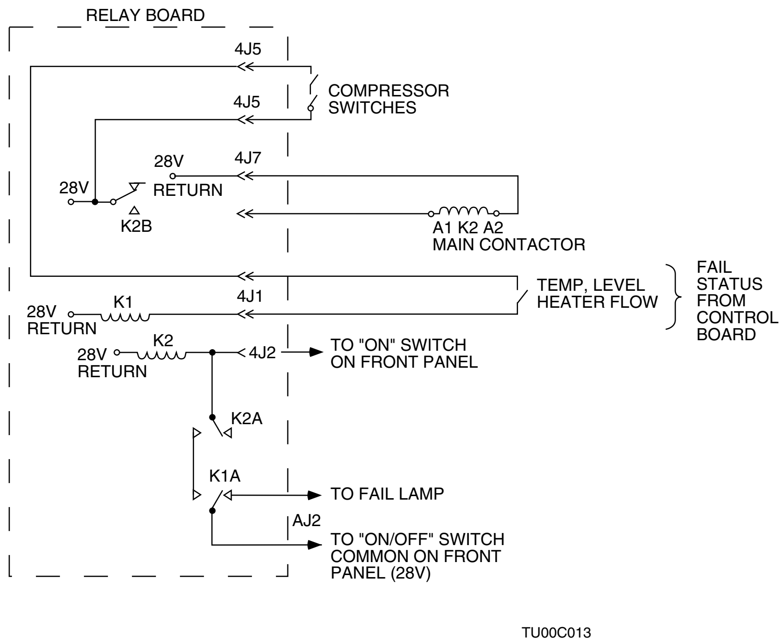
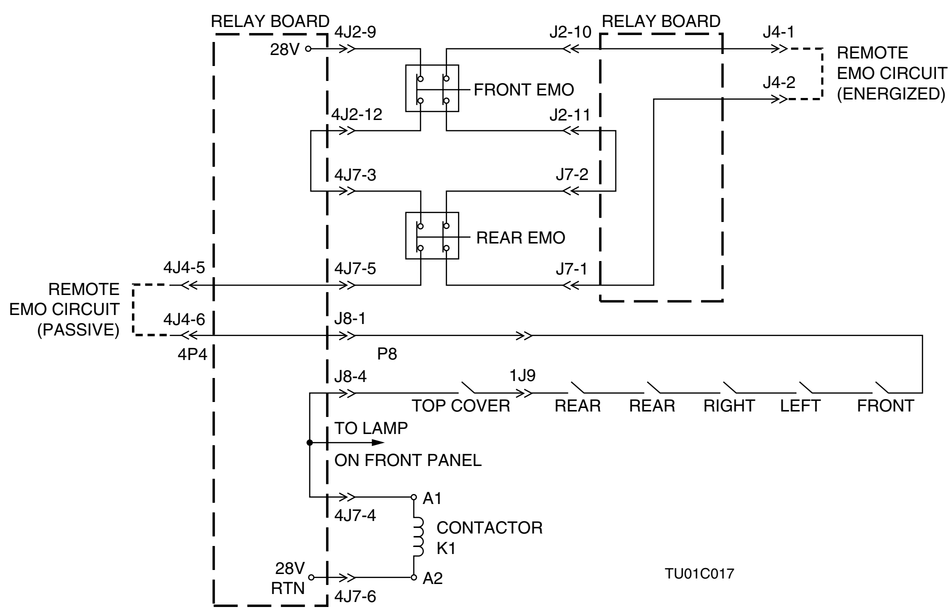


Figure 1–6. Schematic-TCU EMO/Interlock Circuit



2
Installing the TCU

Facility Requirements

The following guidelines are provided to assist in placing and installing the TCU.


POISON

Warning

Respiratory Hazard: In the event of a catastrophic failure of the refrigeration units, oxygen displacement can occur within the facility. This can lead to breathing problems and/or possible asphyxiation. Be sure that the TCU is in a well ventilated area.


HOT SURFACE

Caution

Equipment Hazard: Do not start the TCU until all of the facility requirements are satisfied and all of the preparation and installation procedures in this section have been performed.

Prepare for installing the TCU by providing the following:

- **Floor space.** The floor space required for the TCU is 60 inches high by 24 inches wide by 38 inches deep, with a minimum 24–inch clearance for the front and rear of the unit.
- **Facility water supply.** Water–cooled refrigeration systems require 6 ± 0.5 gallons per minute (gpm) of water for cooling. The water pressure should not exceed 100 pounds per square inch (psi). The temperature of the water should be between +10 and +25 degrees Celsius.


HOT SURFACE

Caution

Equipment Hazard: During normal TCU operation, the condenser water valve continuously cycles on and off. This cycling motion can cause the facility water lines to undulate, or jump around. When routing the cooling water lines, prevent the lines from rubbing against other objects.

- **Grounded electrical receptacle, with suitable over current protection.** 208/230 VAC at 50 to 60 hertz, 3–phase, 30 amperes with 10 kiloampere (kA) interrupting current capability (I_{cu}).
- **Deionized water and ethylene glycol.** Used for the coolant mixture. The contents should be 50 percent deionized (DI) water and 50 percent ethylene glycol (by volume) for both channels. The DI water should have a minimum resistivity of 10 megohm cumulative.

Note Used Ethylene Glycol may be considered a hazardous waste in your area. Contact your local environmental or other responsible agency for up–to–date information on proper disposal procedures.

Preparation

Safety

Type 1 task involved.

POISON

Warning

Electrical Hazard: Do not connect the TCU to the electrical service until you complete the following steps.

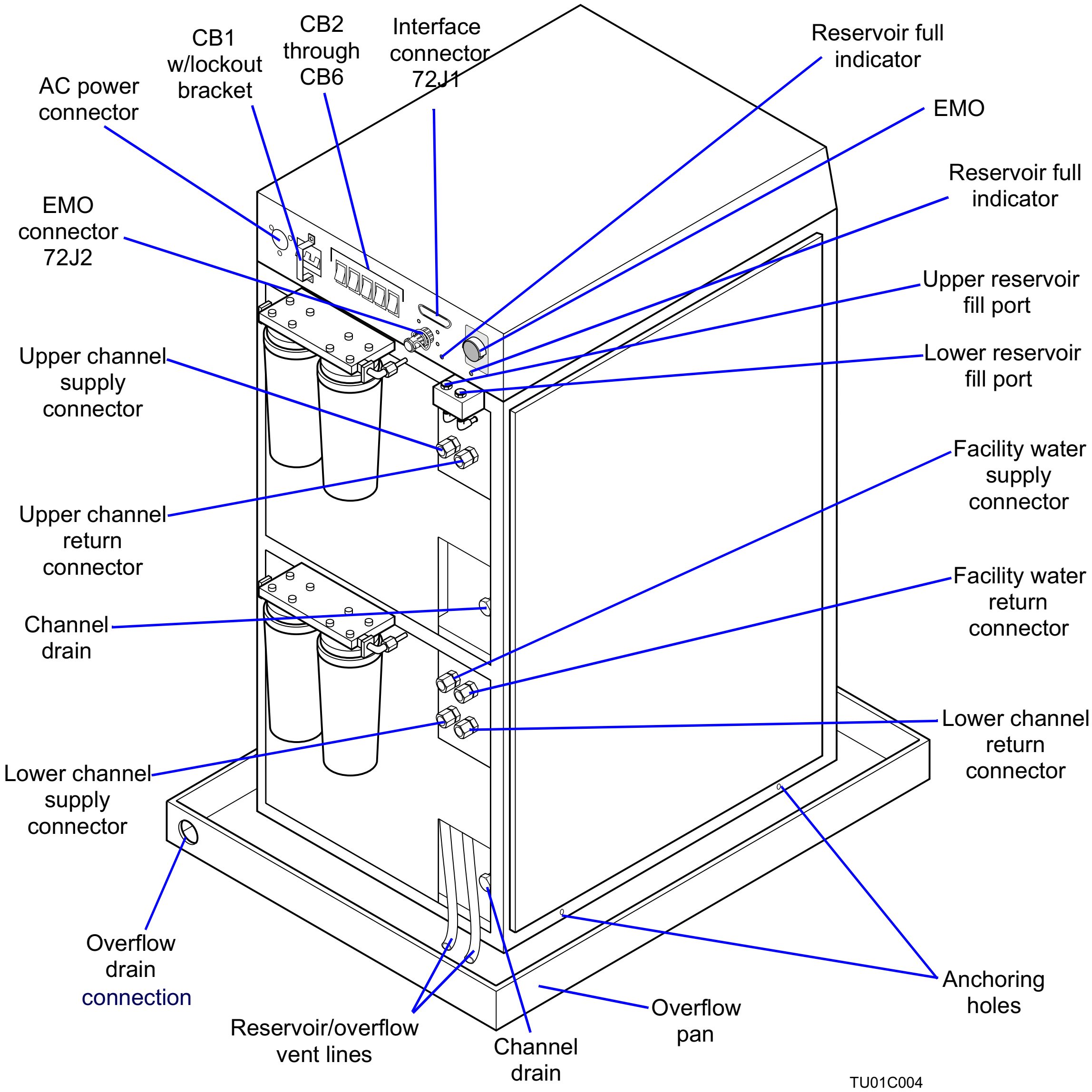
▶ **To prepare the system,**

1. Unpack the TCU and inspect it. Lam recommends that you remove the outer covers and check all interior assemblies for tightness, particularly the pumps. Remove the compressor shipping clamps. Complete the inspection of the assemblies. Install the covers.
2. Locate the unit as desired. Ensure that the front and rear clearance is 24 inches minimum, and that the TCU is within 50 feet of the system. Ensure that the total length of the return and supply lines between the system and the TCU does not exceed 100 feet.
3. Lock all wheel locks.

4 Prevent damage to the TCU, due to movement caused by earthquakes, by anchoring the system to the floor through the four holes provided on the lower left and right sides of the frame (see Figure 2–1). The customer is responsible for the following tie–down components:

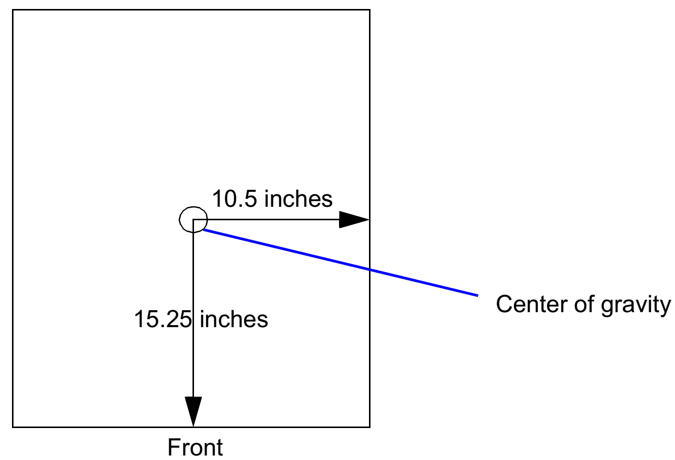
- **1/4 inch 20 x 2 inch (or M6x50) mounting bolts.** Use grade 4.6 or better.
- **1/4 inch 20 (or M6) fastening nuts.** Use grade 4 for grade 4.6 bolts, and grade 6 for all bolts grade 6.6 or better.
- **External floor mounts.** Floor mounts must accommodate a minimum of 837 inch foot pounds, ability to withstand a minimum of 150 foot pounds displacement force, and 3941 psi of shear stress.

Figure 2–1. Rear Panel Installation Connectors and Controls



Note The center of gravity (CG) for the TCU filled with the coolant is shown in Figure 2–2. The dimensions are measured from the outer edge of the TCU frame. The height of the CG is 24.5 inches from the ground.

Figure 2–2. Center of Gravity-Top View



Safety

Type 1 task involved.

Installing the TCU

▶ **To install the TCU,**

1. Prior to installing the TCU, disconnect the TCU power cord from the facility branch circuit connection. Do not operate the TCU without the system supply and return lines connected.

2. Lam recommends that you open the facility water return line valves before the supply valves to prevent shock to the system and its components. Be careful not to overtighten any valves.

3. Install the TCU to Lam standalone systems (see Figure 2–1 and Figure 2–3). Install the TCU to multi-chamber systems or OEM applications (see Figure 2–1 and Figure 2–4).

4. Attach the TCU coolant supply and return lines to the corresponding connectors.

5. Ensure proper flow rates by not reducing the line size from the TCU. Coolant connections are to have 1/2–inch Swagelok connectors with nylon ferrules.

6. Connect the facility water supply and return to the proper connectors on the rear panel of the TCU.
7. Connect the EMO cable from 72J2 on the rear panel of the TCU's electronic enclosure to the system. Connect the interface signal cable provided with the system to 72J1 on the rear panel of the TCU's electronic enclosure.
8. Plug the TCU power cord into the AC power connector on the rear panel of the electronic enclosure and connect it to a 50/60 hertz, 30 amperes, 208/230 VAC, 3–phase receptacle (facility branch circuit).
9. Ensure that the twistlock connectors are correctly aligned and fully inserted into the receptacle. Rotate the connector clockwise to lock it in position.

FIRE

Warning

Fire Hazard: Failure to properly seat the connector can result in arcing and possible fire hazard. Ensure that the connector is properly seated.

Figure 2–3. TCU Facility/Electrical Installation for Lam Standalone

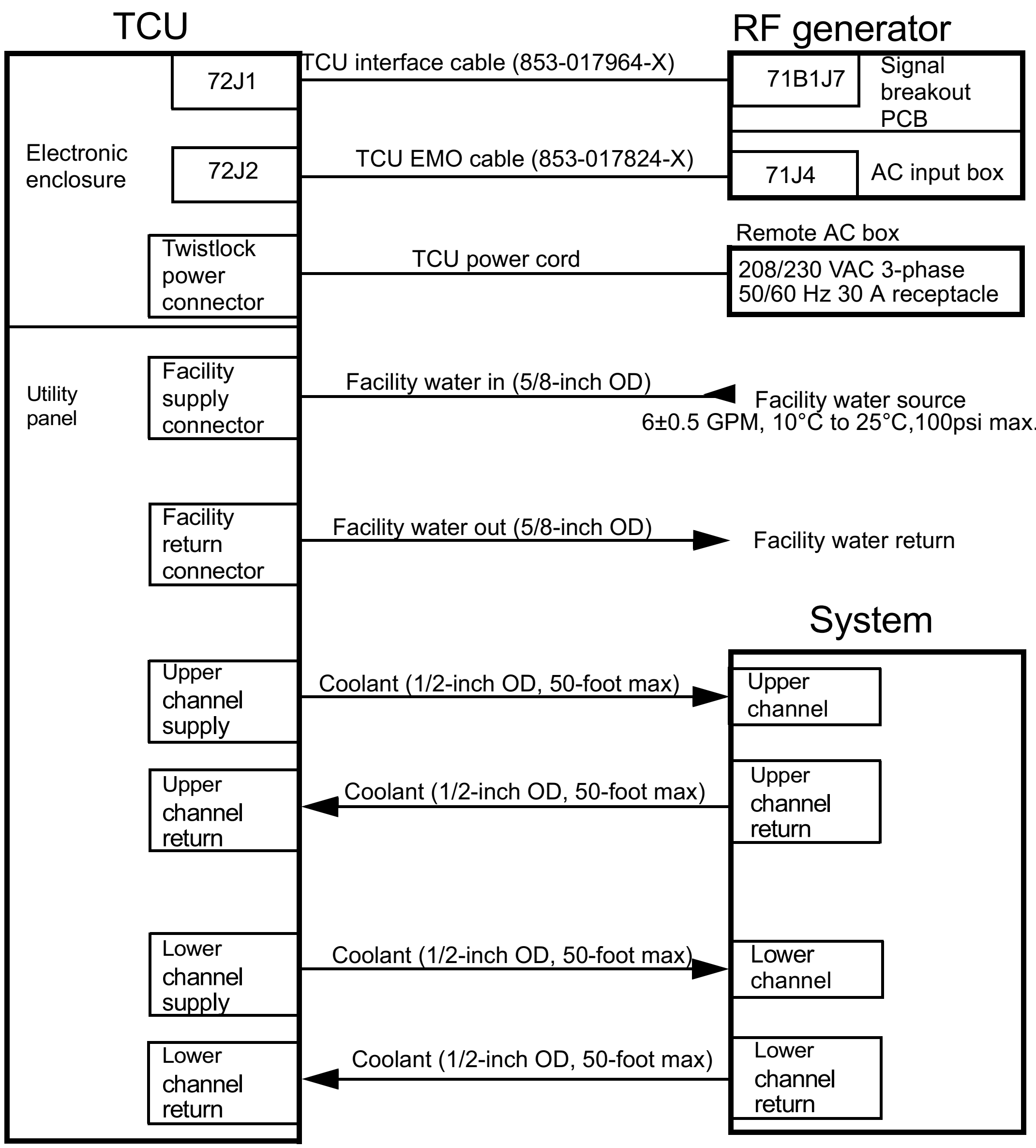
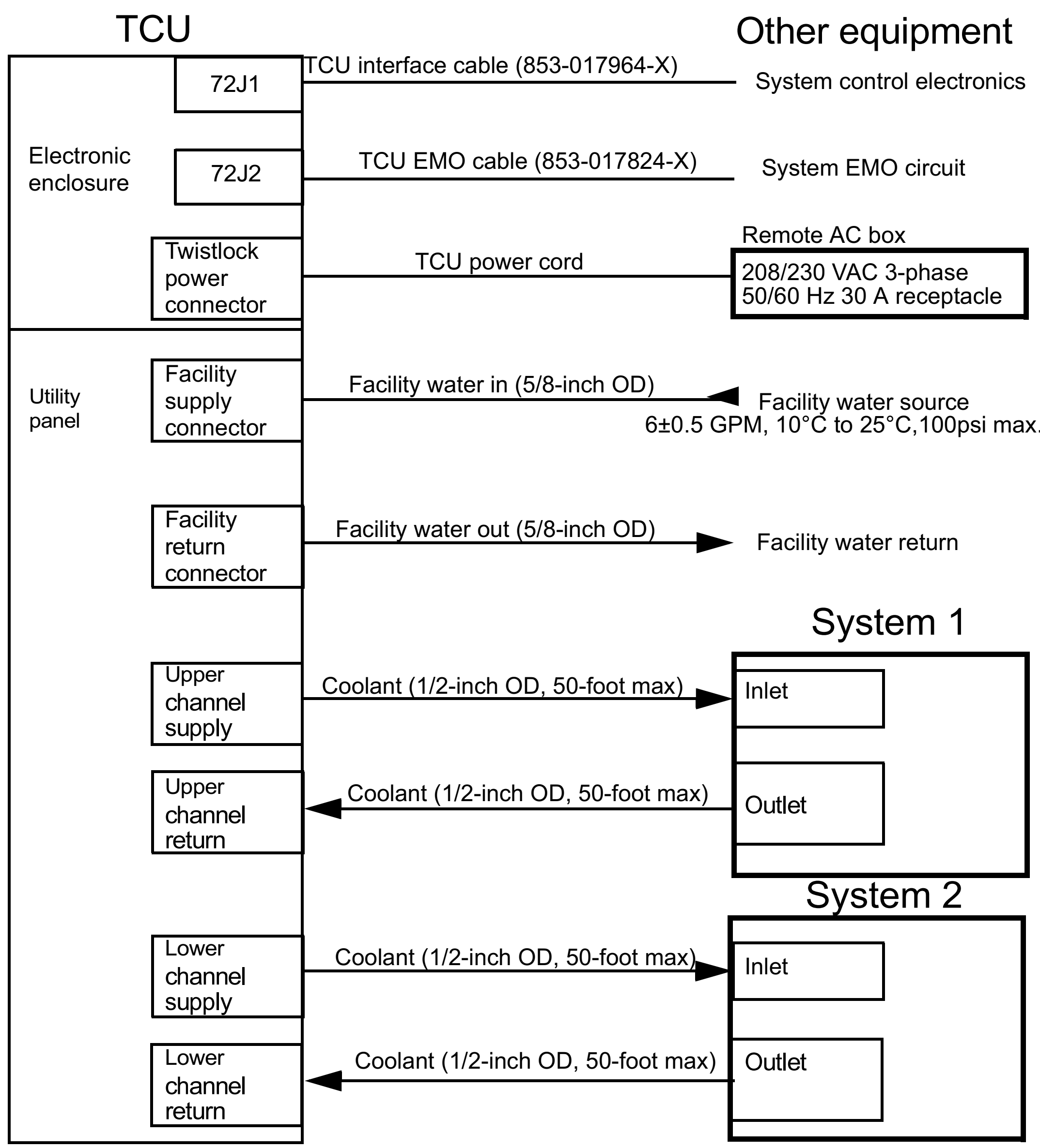


Figure 2–4. TCU Facility/Electrical Installation -Multi-chamber System/OEM



3
Start-Up

This chapter contains the start-up procedure for the TCU Model 2080.

Always follow your company's safety practices, in addition to the safety guidelines noted in the procedures. Make sure to use the proper equipment and observe all cautions and warnings.

Before proceeding, see the safety information in Chapter 1, "Overview."

3.1
Starting the TCU

The following procedure lists the steps required to perform the initial start–up for the TCU. You do not need any special equipment for this procedure. The only tool required is a small, standard screwdriver.

Safety

Type 2 task involved.

Preparation

See Figure 3.1–1 when performing the steps in this section.

▶ **To warm–up the TCU,**

1. Ensure that all protective covers are in place and secured.
2. Plug the TCU power cord into the AC power connector on the rear panel of the electronics enclosure. Connect it to a 30 amperes, 208/230 VAC, 3–phase receptacle. Ensure that the twistlock connectors are fully inserted into their receptacles. Rotate connectors clockwise to lock in position.


FIRE

Warning

Fire Hazard: Failure to properly seat the connector can result in arcing and possible fire hazard. Ensure that the connector is properly seated.

3. On the rear panel, turn on CB1 through CB6.
4. Allow the heater to run for approximately 120 minutes before proceeding. If the TCU has been exposed to temperatures below freezing, the oil in the compressor thickens. Allow the unit to warm up at room temperature for a minimum of 24 hours.

5 On the front control panel of the electronics enclosure (see Figure 3.1–1), press the **Temperature Alarm Reset** buttons for both channels. This clears both Hi and Low temperature alarms. Press any of the **System Shutdown** and **Maintenance Required** buttons to reset all six status indicator alarms. Flow indicators turn red again after approximately 5 to 10 seconds unless the TCU is turned on and the proper flow has been established.

Procedure

▶ **To start-up the TCU,**

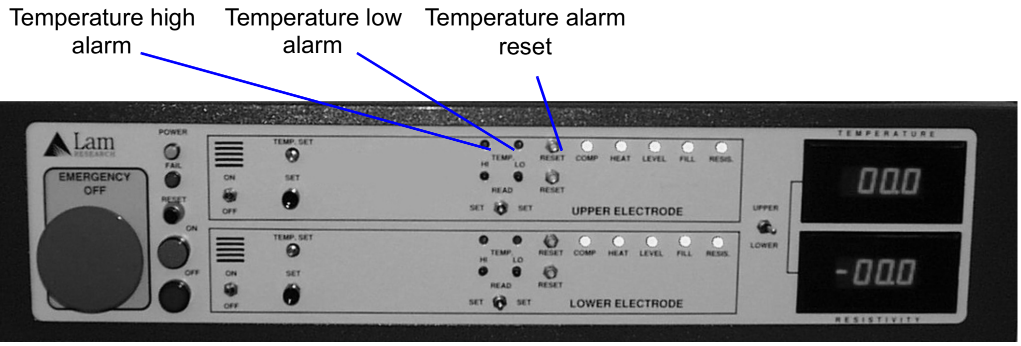
1. Foaming of the compressor oil may decrease the life or reliability of the compressor. Prevent foaming of the oil upon start–up of the unit by performing the following:
   - Apply power to the TCU.
   - Turn on CB1 and CB6. This energizes a heater for the compressor and removes dissolved refrigerant from the compressor oil.
2. Fill the coolant reservoirs. See Section 4.2, "Filling the Reservoir."
3. Locate the circuit breaker switches on the rear panel of the electronics enclosure of the TCU. Turn on CB2 through CB5.

Purging the TCU

▶ **To purge the TCU,**

1. If the resistivity indicator for either channel remains red, the resistivity of the coolant is below 1 megohms absolute. The TCU may need to operate for 24 hours before the resistivity of the coolant rises above 1 megohms absolute.

Figure 3.1–1. Status/Alarm Indicators and Reset Buttons



Note If one or more status indicators remain red after pressing the **Reset** button, you must correct the problems associated with those indicators before proceeding. The TCU does not operate when the Comp, Heat, Flow, or Level indicators are red. See Chapter 6, "Troubleshooting." When all problems have been corrected, proceed to step 2.

2 On the front control panel of the electronics enclosure, press the **Temperature Alarm Reset** buttons for each channel. Both sets of **Temperature Hi/Low** alarm indicators should turn from red to green. This step resets the temperature alarms.

Note If any alarm indicators remain lit, proceed to the next step to check the high and low temperature alarm limits for that channel.

3 Check the high and low temperature limits by performing the following:

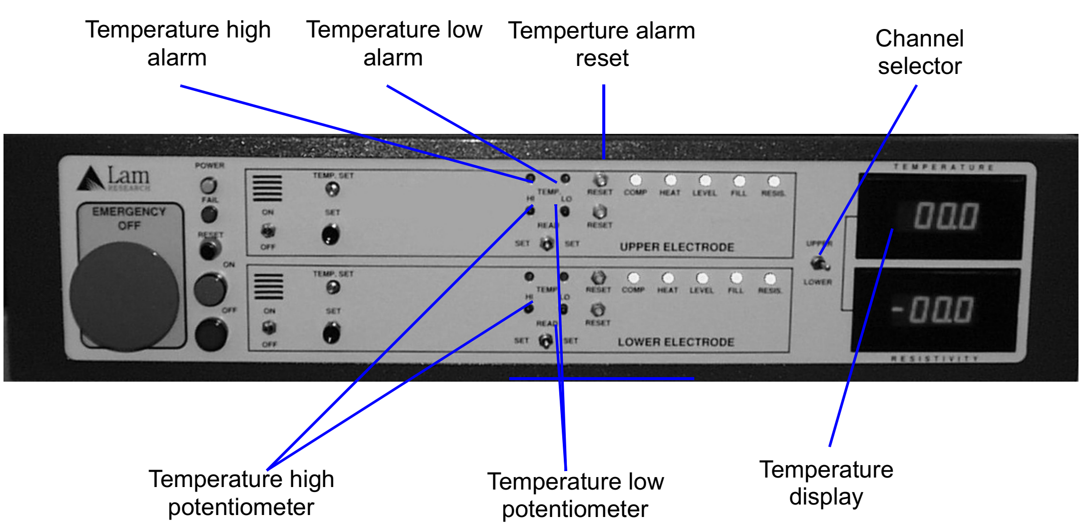
- On the front control panel (see Figure 3.1–2), push either the Upper or Lower channel selector for the desired channel.
- Push the **Temperature Alarm Set** button to check the high temperature alarm limit setpoint or push the **Temperature Alarm Low** button to check the low temperature alarm limit setpoint. The digital temperature display shows the current temperature alarm setpoint for the selected channel.

If the limits do not reflect the system operating temperatures, adjust the limits as required by following the procedure detailed in the next step.

4 Adjust the hi/low temperature limits, by performing the following:

- On the front control panel of the electronics enclosure (see Figure 3.1–2), push either the **Upper** or **Lower** button to select either the upper or lower channel.
- Push either the **Temperature Alarm Hi** or **Low Setpoint** button. The Temperature display shows the current high or low limit alarm setpoint for that channel.
- Using a small, standard screwdriver, adjust the temperature limit alarm setpoints by rotating the Temperature Hi potentiometer for the high limit or the Temperature Low potentiometer for the low limit. Decrease the setpoint by rotating the potentiometer counterclockwise. Increase the setpoint by rotating the potentiometer clockwise.
- Check the new setpoints by pressing the **Temperature Hi/ Low Reset Alarm** button for the desired channel. The status and alarm indicators should all turn off.

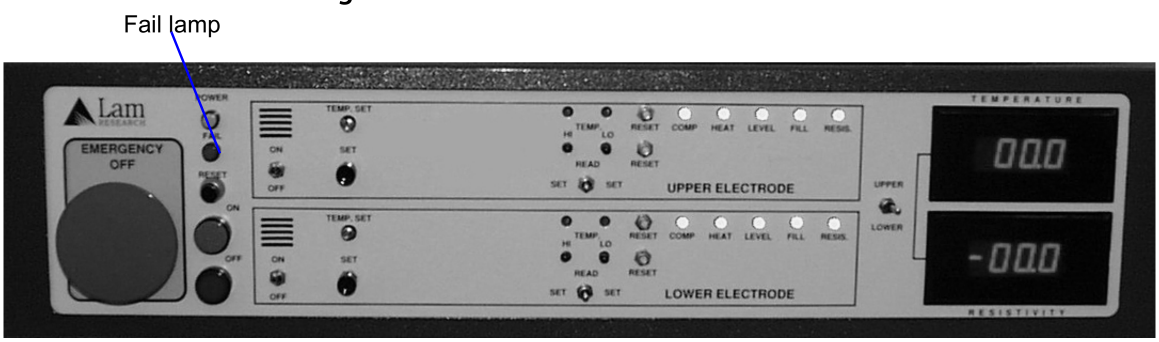
Figure 3.1–2. Hi/Low Temperature Controls and Meter



5 If all interlock and EMO conditions have been satisfied, the Fail lamp turns off and the blue Intlk lamp illuminates (see Figure 3.1–3).

Note Approximately 5–10 seconds after resetting the status indicators, the flow sensor reports a failure if the system flow has not been established.

Figure 3.1–3. Fail Indicator



4
Maintenance

The dual channel TCU is designed to provide reliable, long term operation with a minimum of service. The assemblies and components are easily accessible for both maintenance and repair.

Always be careful when you are performing any maintenance on the TCU. Be sure to observe the specific safety cautions and warnings when servicing this unit see Chapter 1, "Overview." See Appendix A, "Reference Documentation." for information on obtaining Material Safety Data Sheets.

Warning

Mechanical Hazard: The refrigeration units are hermetically sealed. No user serviceable parts are inside. Any maintenance on this equipment should be performed only by trained and licensed refrigeration personnel.

Warning

Physical Hazard: The coolant and refrigeration system components change temperature drastically in both the heating and cooling modes of operation. Use extreme caution when working on these units. Some refrigeration components can reach temperature up to 300 degrees Fahrenheit (149 degrees Celsius).

Troubleshooting Precautions

If you need to perform troubleshooting procedures when the power is on, be sure to observe the following warning:

Warning

Electrical Hazard: Voltages from circuitry within the TCU can cause severe injury or death. Contact with 208 VAC (3 ∅) and 28 VAC circuitry is possible in the rear half of the electronic enclosure. Avoid any physical contact or placement of tools within the rear half of the electronic enclosure. In addition, DC voltages ranging from 5 VDC to 15VDC are present. Only trained, qualified personnel should perform any maintenance on this unit.

4.1
Preventive Maintenance

Lam recommends that you adhere to the following maintenance schedules to ensure that the TCU continues to function as specified.

Monthly PM Schedule

▶ **To perform the monthly preventive maintenance,**

1. Check for leaks or condensation under, inside, and behind the TCU. Investigate and repair any abnormalities. See Chapter 6, "Troubleshooting."
2. Check the coolant specific gravity. For coolant composition and specific gravity, see Table 1–2 in Chapter 1, "Overview."
3. Analyze resistivity measurements from the last several weeks. Replace the polishing cartridges if the measurements are approaching default alarm setting (1 megohm absolute) or minimum process requirements. See Section 4.5, "Checking the Operation of the TCU."

Note Resistivity varies with temperature. High temperatures result in lower resistivity and conversely, low temperatures result in higher resistivity. Ensure that the TCU is at the same operating temperature each week when taking resistivity measurements. The TCU must also be running for at least 24 hours to ensure a proper resistivity reading.

4.2
Filling the Reservoir

Use this procedure to fill the TCU reservoir.

Safety

Type 2 task involved.

Caution

Physical Hazard: Be careful not to overfill the coolant reservoirs. Over filling causes the excess coolant to flow from the vent line located at the lower rear of the TCU (see Figure 4.2–2). Any over flow should be captured and disposed of in accordance with local, state and federal regulations. The reservoir tank capacity is 4.2 gallons (16 liters).

Equipment Required

- Sixteen liters coolant (50/50 mixture by volume, DI water/ethylene glycol)
- Safety goggles, uniform, apron, and rubber gloves
- Funnel
- Several cloths (for spillage)

Procedure

▶ **To fill the TCU reservoir,**

1. Locate the reservoir fill ports near the rear panel of the electronic enclosure (see Figure 4.2–2). Remove the fill plugs from the reservoir fill ports.
2. Using the funnel, fill one of the tanks with coolant consisting of a 50/50 mixture (by volume) of deionized water and ethylene

glycol. Note that since the tanks are not full, both FILL limit indicators on the rear electronics enclosure are not illuminated.

3 Continue to add the coolant, until the FILL indicator light on the rear of the TCU illuminates. Add 20 to 30 fluid ounces of coolant after the FILL LED illuminates. The coolant is now at the proper level.

4 Once the tank is full, press the status indicator **LEVEL** and **FILL Reset** buttons on the front panel (see Figure 4.2–1) for the reservoir tank being filled, either upper or lower. The LEVEL and FILL indicators reset from red to green.

5 Repeat steps 3 and 4 for the other tank and when topping off.

GENERAL ALERT

Warning

Equipment Hazard: The Lam specified 50/50 ethylene glycol/DI water mixture is required to properly lubricate the pump and to protect the coolant reservoir from freezing and cracking. Filling the reservoirs with anything other than the specified 50/50 coolant mixture will void the customer warranty.

Figure 4.2–1. Status Indicator Reset Buttons

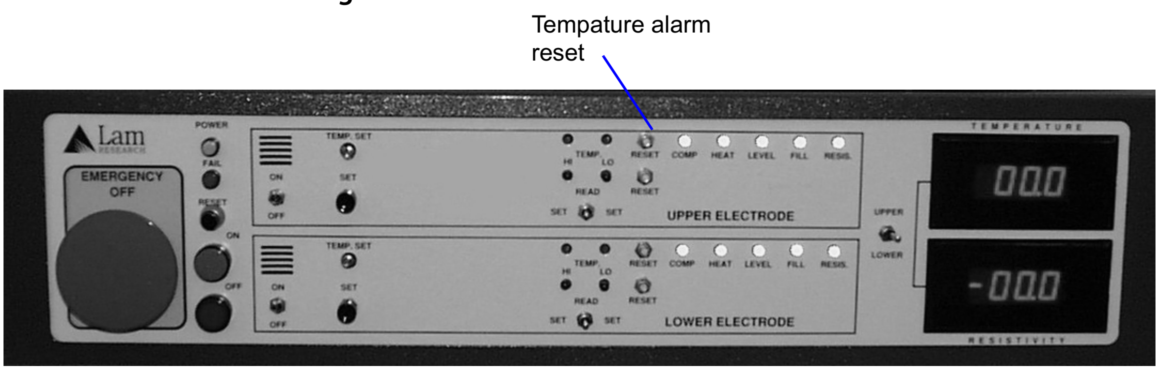
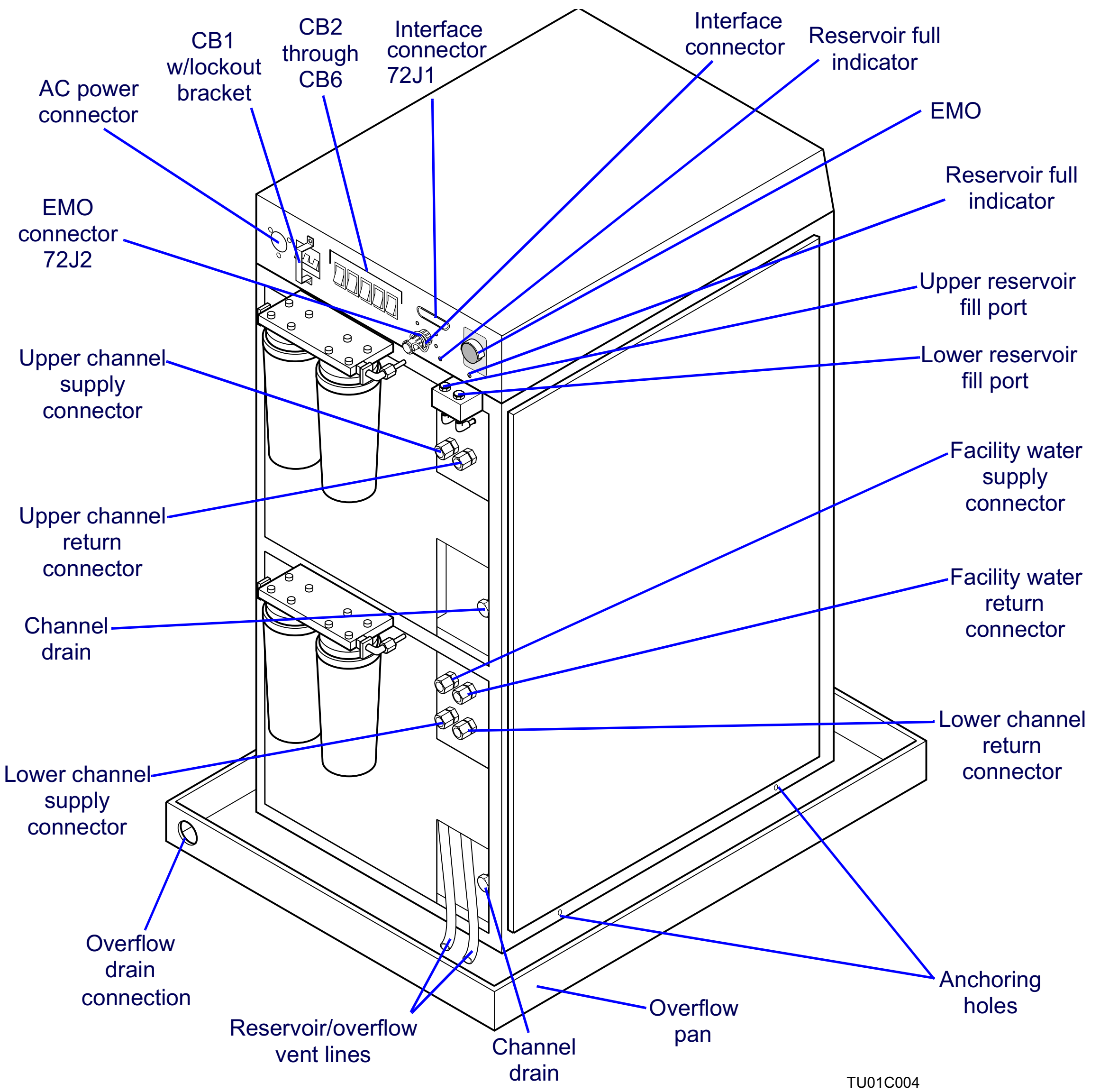


Figure 4.2–2. Circuit Breakers and Reservoir Fill Ports



4.3 *Replacing the Refrigerant*

In order to comply with current Environmental Protection Agency (EPA) regulations that restrict the use of R403B (69L) refrigerant in semiconductor applications, Lam has selected refrigerant R404A as a replacement.

The following procedure describes the method for replacing refrigerant R403B (69L) with refrigerant R404A. Replacement is not required unless the system needs more refrigerant. Replacement is limited to only the later 2080 TCU systems.

Reference Documentation

None

Equipment Required

- Refrigerant R404A
- Refrigerant pressure gauge set
- Vacuum pump
- Vacuum gauge
- 5/16-inch square refrigeration (or adjustable) wrench
- Refrigerant scale (accuracy: ±0.5 of an ounce)
- Approved refrigerant recovery unit

Safety

Type 2 task involved.

Caution

Equipment Hazard: The refrigeration units are hermetically sealed. No user-serviceable parts are inside. Only trained maintenance personnel should perform maintenance on this equipment.

Prior to opening this sealed system for either repair or parts replacement, recover all refrigerant in accordance with EPA standards (as required under section 608 of the Clean Air Act of 1990) or applicable local regulations.

The refrigeration units are sensitive to the amount of refrigerant charge. Charge only with the proper equipment. The refrigerant type and the amount of charge are indicated in the charging procedure. Do not attempt to adjust the charge. An overcharge or undercharge of as little as 2.0 ounces causes critically high refrigerant pressures or substantial loss of capacity.

Preparation

None

Procedure

► **To charge the refrigerant,**

1 Charge the system only with refrigerant R404A. Charge the upper channel with 1 pound, 4.0 ounces and the lower channel with 1 pound, 6.0 ounces. See Section 4.4, "Charging the Refrigerant."

2 Turn the TX valve five turns clockwise from the fully open position.

3 Set the high-pressure cutout switch to 400 psi.

4 Perform Section 4.5, "Checking the Operation of the TCU."

5 Locate the label for refrigerant type on each compressor (covered with black tape). The color of the label is half orange and half green. Cut and peel off the tape from the left side of the label to reveal the text “R404A.”

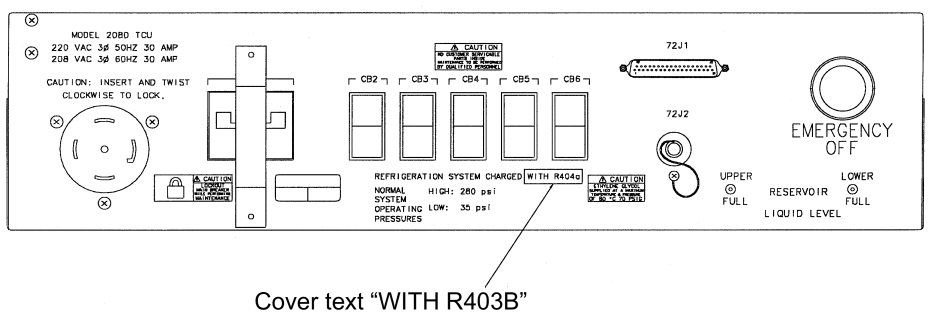
6 Remove the 69L label on each compressor and replace it with the new R404A label (785-111064-101 and 785-111064-102).

7 Install the new R404A label (785-111065-101) on the back of the TCU next to the serial number label.

8 Install the new label “WITH R404A” (785-111066-101) on the back of the electronic enclosure, cover the silk-screen text “WITH R403B” (see Figure 4.3–1).

Note Note, if the system has already been upgraded, do not perform steps 5 through 8.

Figure 4.3–1. Electronic Enclosure



4.4
Charging the Refrigerant

In compliance with the current EPA regulations that restrict the use of R403B (69L) refrigerant in semiconductor applications, Lam has selected refrigerant R404A as a replacement.

Prior to opening this sealed system for either repair or parts replacement, recover all refrigerant in accordance with EPA standards (as required under section 608 of the Clean Air Act of 1990) or applicable local regulations.

GENERAL ALERT

Caution

Mechanical Hazard: The refrigeration units are hermetically sealed. No user serviceable parts are inside. Any maintenance on this equipment should be performed only by trained and licensed refrigeration personnel.

The refrigeration units are sensitive to the amount of refrigerant with which they are charged. Charge only with the proper equipment. The factory charge for these systems is noted on the individual compressor label. Do not attempt to adjust the charge. An overcharge or undercharge of as little as 2.0 ounces causes critically high refrigerant pressures or substantial loss of capacity.

Safety

Type 2 task involved.

Equipment Required

- Refrigerant R404A
- Refrigerant pressure gauge set
- Vacuum pump
- Vacuum gauge

- 5/16 inch square refrigeration (or adjustable) wrench
- Refrigerant scale (accuracy: ±0.5 ounces)
- Approved refrigerant recovery unit

Procedure

Charging The Channels

▶ **To charge the channels,**

1. Completely power down the TCU.

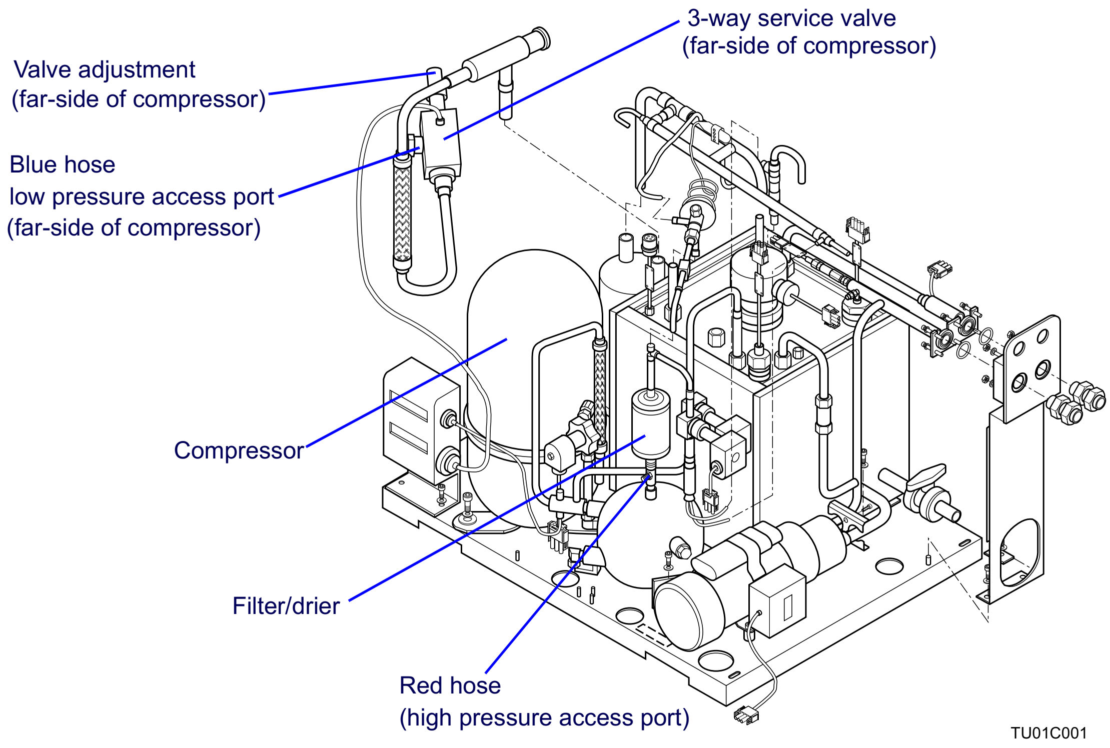
HOT SURFACE

Caution

Physical Hazard: Surface temperatures on the compressor and attached lines can become extremely hot and cause severe burns. Avoid contact with these surfaces. If components need servicing, allow sufficient time for the unit to cool down.

2. Remove the protective caps from the access port and 3–way service valve. Connect the red hose of the gauge set to the high–pressure side of the compressor and the blue hose to the low–pressure side (see Figure 4.4–1). Ensure that all refrigerant is recovered in accordance with applicable standards. Repair or replace faulty parts, then leak check the system. Connect a vacuum pump to the center port of the gauge set.
3. Open the 3–way service valve with the 5/16–inch wrench, turning the valve adjustment six turns in a clockwise direction (see Figure 4.4–1).
4. On the gauge set, open both the red and blue valves by turning the valve handles fully counterclockwise.

Figure 4.4–1. Gauge Set Connection Points-Refrigerant Charging



5 Evacuate the refrigerant loop by turning the vacuum pump on, and pumping the system down to 500 microns.

6 After pumping down the refrigerant loop, close both the red and blue valves on the gauge set by turning the valve handles fully clockwise.

7 Remove the vacuum pump line from the gauge set and connect the charging system in its place. Ensure that air is not trapped in the line by using previously purged lines with automatic shutoff valves. This ensures that no air enters the refrigeration system and that no refrigerant escapes into the atmosphere.

Note Charge with a measured liquid charge through the high–pressure side only.

8 Open the charging valve, then open the valve on the high–pressure side on the gauge set.

9 Open the refrigerant tank valve.

10 Charge the sytem with R404A. Charge the upper channel with 1 pound, 4 ounces and the lower channel with 1 pound, 6 ounces.

11 After charging is complete, close the refrigerant tank valve, then the gauge set valves.

12 Turn the 3–way service valve counterclockwise and fully seat the valve in the closed position. Replace the black plastic cap and remove the hose. Install the brass knurled cap on the access port.

13 Remove the hose from the high–pressure side port and install the brass knurled cap on the access port.

14 Power up the TCU.

4.5
Checking the Operation of the TCU

Perform an operational check after charging both channels on the TCU. This ensures that the charging procedure was successful and that the unit is meeting performance specifications.

Safety

Type 2 task involved.

Equipment Required

- Small, standard screwdriver

Preparation

None.

Procedure

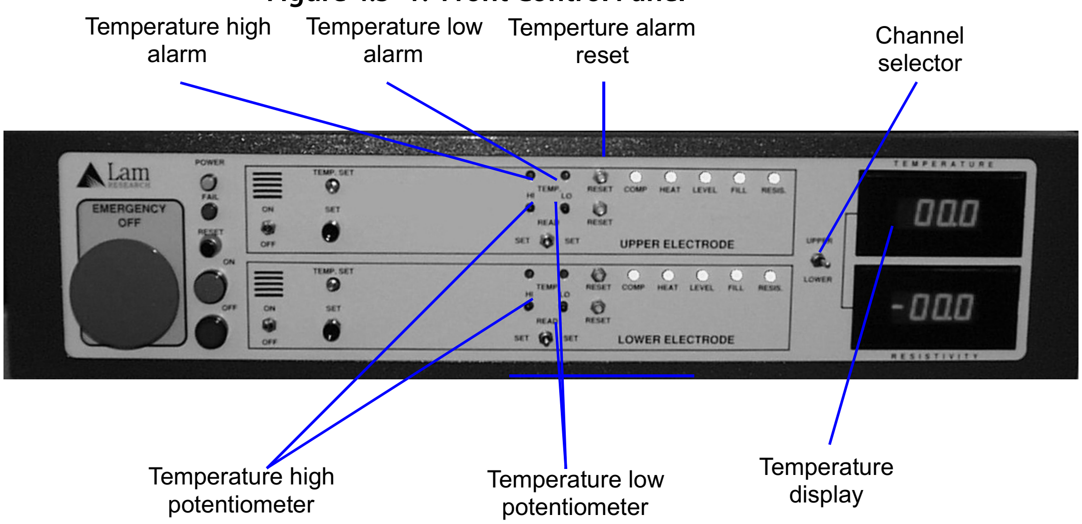
Note Ensure that the system is in local mode.

▶ **To perform the operational check,**

1. Operate the TCU at a setpoint of +20 degrees Celsius for 15 minutes.
2. Using the front control panel (see Figure 4.5–1), perform the following:
   - Select the upper channel by pushing the button marked **Upper**.
   - Depress and hold down the **Local Temp Set** button for the upper channel.

- Continue holding down the **Local Temp Set** button and use a small, standard screwdriver to turn the Local Temp Set potentiometer. Turn the potentiometer until the temperature display reads +80 degrees Celsius.
- Select the lower channel by pushing **Lower**.
- Press and hold down **Local Temp Set** for the lower channel.
- Continue holding down the **Local Temp Set** button and use a small, standard screwdriver to turn the Local Temp Set potentiometer. Turn potentiometer until the temperature display reads –20 degrees Celsius.

Figure 4.5–1. Front Control Panel



3 Allow both channels to operate at their respective setpoints see Table 1–2 in Chapter 1, "Overview."

4 Change the setpoints for each channel as follows:

- The upper channel setpoint = –15 degrees Celsius
- The lower channel setpoint = +80 degrees Celsius

Note Changing the setpoints for each channel takes approximately 45 minutes.

5 Allow both channels to operate at these setpoints for one hour.

6 If either channel does not cool down to its respective setpoint (−15 or −20 degrees Celsius), See Chapter 6, "Troubleshooting," "*TCU does not cool down*."

4.6
Replacing Coolant Polishing Filter Cartridges

Use this procedure to replace the TCU coolant polishing filter cartridges.

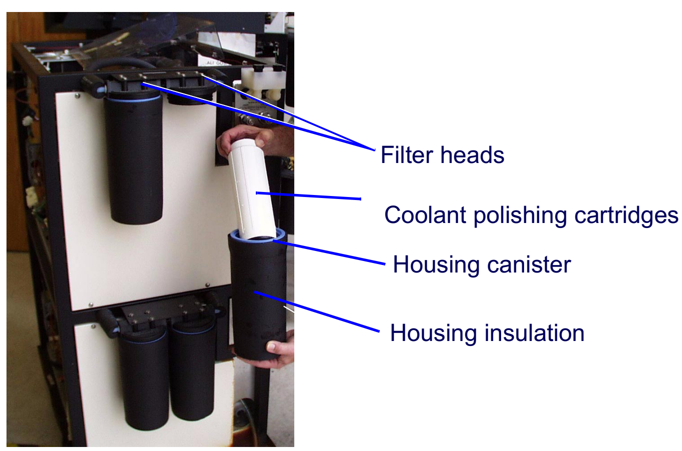
Safety

Type 2 task involved.

Equipment Required

- Strap wrench
- Four coolant polishing cartridges (775–091420–001)
- Safety goggles, uniform, apron, rubber gloves
- Cloths (for spillage)

Figure 4.6–1. Coolant Polishing Cartridges



Procedure

▶ **To replace the coolant polishing filter cartridges,**

1 On the front control panel, press the **Power Off** button to turn off the TCU (see Figure 4.6–2).

2 On the rear panel of the electronic enclosure, turn CB1, the main circuit breaker, off (see Figure 4.6–3).

Figure 4.6–2. Front Control Panel

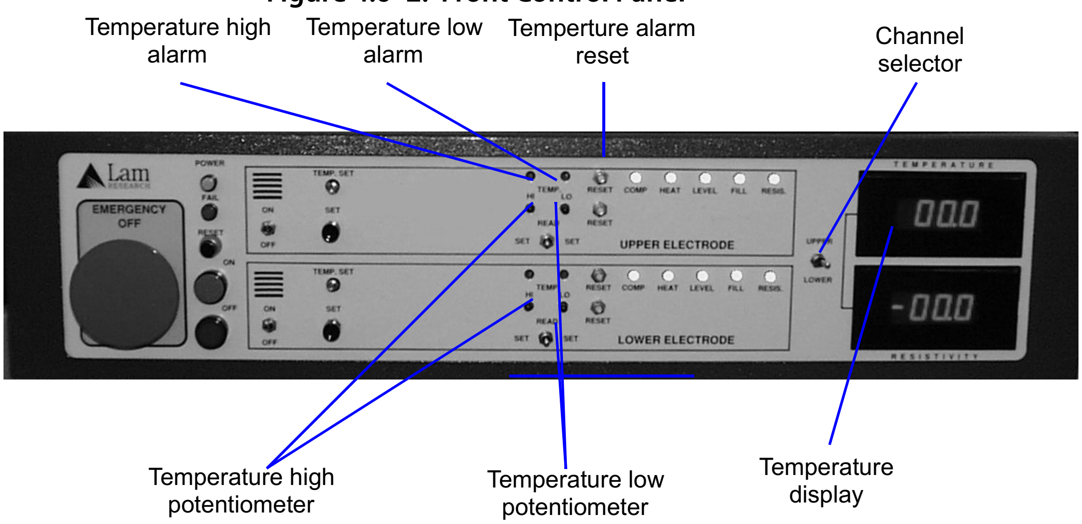
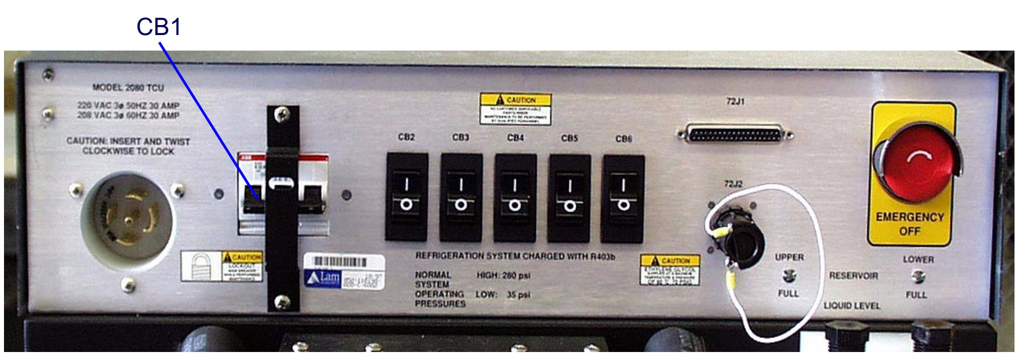


Figure 4.6–3. TCU Rear Panel



3 Locate the coolant polishing canisters, (two per channel, four total) mounted on the rear panel of the TCU (see Figure 4.6–1). Remove the housing insulation sleeves by sliding them off the canisters.

4 Using a strap wrench, loosen and remove the filter housing canisters.

Note When removing the polishing cartridges, coolant will spill and drip from the cartridges. It is recommended to use lint-free wipes to clean up any spilled coolant.

5 Remove the coolant polishing cartridges from the canisters and discard them.

6 Clean all film and sediment from the inside of the housing canisters, and rinse the canisters with DI water.

7 Clean the underside of the mounts.

8 Place a new polishing cartridge into each canister.

Note Before installing the canisters, ensure that the O–rings are seated correctly to prevent leaking and damaging the O–ring.

9 Install the housing canisters and tighten. Install the insulation sleeves.

10 On the rear panel of the TCU, turn CB1 on (see Figure 4.6–3).

11 On the front control panel of the TCU, press all **RESET** buttons (see Figure 4.6–2).

12 Refill the coolant reservoirs. See Chapter 4.2, "Filling the Reservoir."

13 On the front panel of the TCU, press **ON** to turn on the TCU.

14 Check for leakage from the coolant cartridges.

5
Calibration

This chapter contains procedures for calibrating the TCU Model 2080.

Always follow your company's safety practices, in addition to the safety guidelines noted in the procedures. Make sure to use the proper equipment and observe all cautions and warnings.

Before proceeding, see the safety information in Chapter 1, "Overview."

5.1
Calibrating the Temperature Probe

In order for the temperature probes to accurately track the reservoir liquid temperature for each channel, check the three potentiometers on the TCU control printed circuit board (PCB)(see Figure 5.1–1) to ensure that they are properly adjusted. The potentiometers are as follows:

- VR1 adjusts the scale factor for both upper and lower channel temperature probes. Temperature probes are preset to –2.7316 ± 0.0001 VDC.
- VR104 adjusts the upper channel remote temperature compensation See Section 5.2, "Adjusting the Remote Temperature Offset." The temperature compensation is preset to 0.000 ± 0.001 VDC.
- VR204 adjusts the lower channel remote temperature compensation. See Section 5.2, "Adjusting the Remote Temperature Offset." The temperature compensation is preset to 0.000± 0.001VDC.

Safety

Type 3 task involved.

ELECTRICAL

Warning

Electrical Hazard: Power is applied to the Control PCB when performing calibration procedures. Accidental contact with components operating at less than 30 VDC is possible. Avoid contact unless adjusting potentiometers.

Equipment Required

- Digital voltmeter
- Small, standard screwdriver

Materials

- Glyptal™

Procedure

▶ **To calibrate the temperature probe,**

1. Remove the electronics enclosure cover.
2. Remove the two hinge screws on the front panel, releasing the front panel. Pull the panel forward.
3. Pull out the interlock switches.
4. Power on the TCU. Allow five minutes for warm–up.
5. Connect the negative lead of the voltmeter to TPG3. Connect the positive lead to the test pins listed, and verify that the voltage readings are within the ranges shown.

TP9	4.85 to 5.15 VDC
TP11	14.25 to 15.75 VDC
TP13	–14.25 to –15.75 VDC

   These voltages are derived from the DC power supply. If any are out of specification, it is most likely a power supply problem.

6. Connect the positive lead of the voltmeter to the test pins listed, and verify the voltage readings are within the ranges shown.

TP5	–4.940 to –5.060 VDC
TP7	8.273 to 8.393 VDC
TP8	9.950 to 10.050 VDC

   These voltages are generated locally on the control PCB (see Figure 5.1–1). If any are out of specification, replace the control PCB.

7 Connect the positive lead of the voltmeter to the test pin listed, and verify that the voltage reading is within range.

TP6	−2.731 to −2.733 VDC

This voltage is precision set (using a 5.5 digit voltmeter) at the factory to −2.7316 ± 0.0001 VDC. If it is necessary to make adjustments in the field, adjust VR1 until TP6 reads −2.743 ± 0.000. The voltage controls the temperature accuracy of the upper and lower channels.

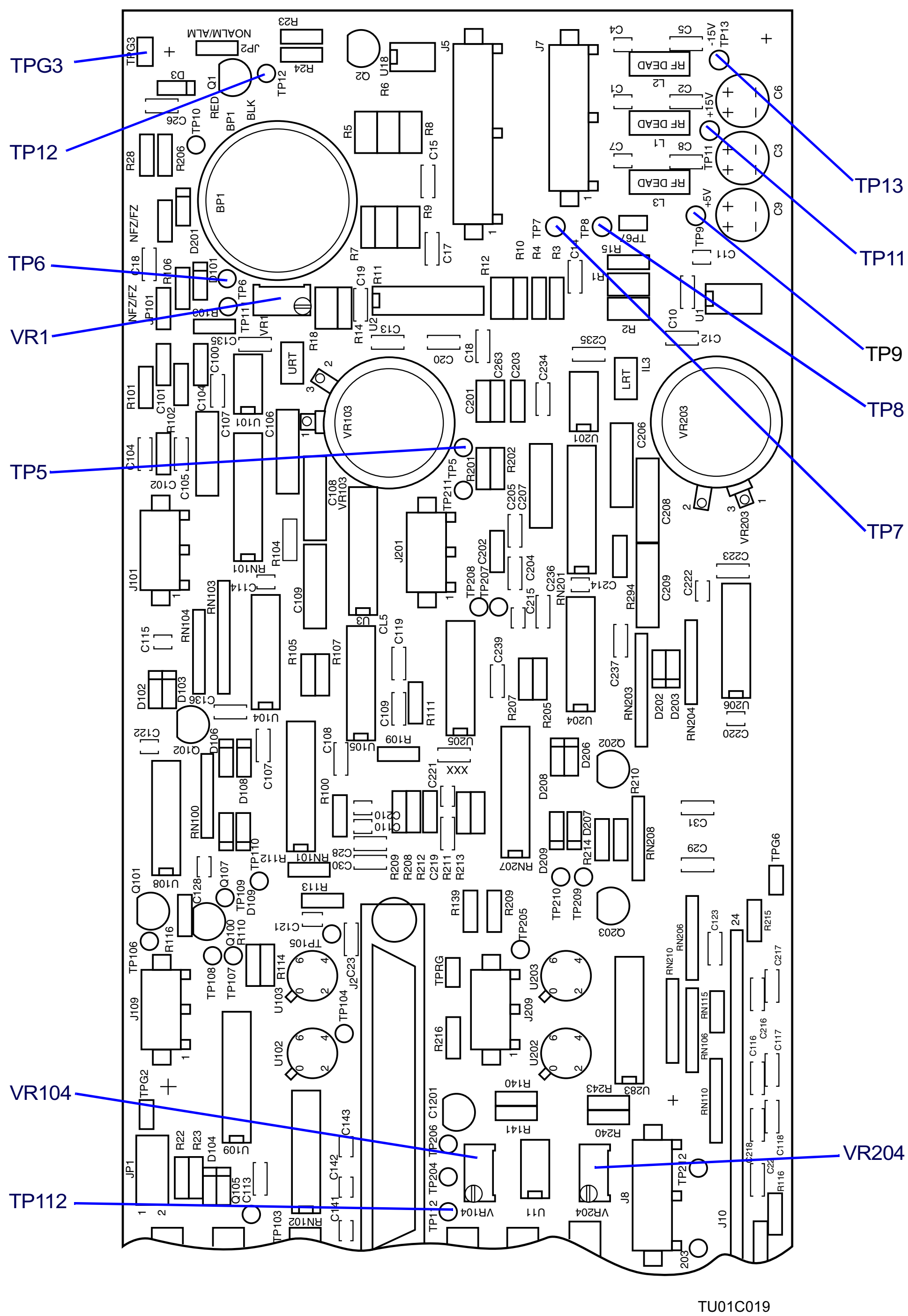
8 Connect the negative lead of the voltmeter to TPG2. Connect the positive lead to TP112, and adjust VR104 until TP112 is 0.000 ± 0.001 VDC.

9 Connect the positive lead of the voltmeter to TP212. Adjust VR204 until TP212 is 0.000 ± 0.001 VDC.

10 Apply a small amount of Glyptol to all of the potentiometers that were adjusted.

11 Remove all test leads. Secure the front panel using two hinge screws, and replace the electronics enclosure cover.

Figure 5.1–1. TCU Controller PCB



5.2 *Adjusting the Remote Temperature Offset*

Use this procedure to compensate for coolant temperature differences between the TCU and the main system due to losses in the coolant lines. These lines can run up to 50 feet in length.

Safety

Type 2 task involved.

Equipment Required

- Small, standard screwdriver

Materials

- Glyptal™

Procedure

▶ **To adjust the remote temperature offset,**

1. Determine the coolant temperature being received from the upper channel of the TCU by the main system. Observe this by selecting the appropriate screen display.
2. Turn the TCU on, then select the **upper channel**. Quickly adjust potentiometer **VR104** until the temperature that appears on the front panel of the TCU matches the temperature of the system.
3. Determine the coolant temperature being received from the lower channel of the TCU by the main system. Observe this by selecting the appropriate screen display at the system.

4. Turn the TCU on, and select the **lower channel**. Quickly adjust potentiometer **VR204** until the temperature that appears on the front panel of the TCU matches the temperature of the system.

5. Apply a small amount of Glyptol to all potentiometers that were adjusted.

5.3 Testing the Resistivity PCB

The following procedure is a manual test for checking the operation and function of the resistivity PCB and for calibrating the over–temperature probe. See Figure 5.3–1 for the locations of the potentiometers that you need to adjust.

Reference Documentation

Document number	Revision	Description
856-097477-001	A	KIT, 2080 RESISTIVITY UPGRADE
202-097479-001	A	PROC, RES UPGRADE, 2080 TCU
202-098854-001	A	PROC, RES SET POINT, 2080 TCU

Equipment Required

- Digital voltmeter
- Resistivity calibration tool, 685–110925–001
- Small, standard screwdriver

Materials

- Glyptal™

Safety

Type 3 task involved.

ELECTRICAL

Warning

Electrical Hazard: Power is applied to the control PCB during calibration. Accidental contact with components operating at less than 30 VDC is possible. Avoid contact with components unless adjusting potentiometers.

Procedure

The channels have been factory calibrated to trigger a low resistivity signal at 1 megohm centimeters. If adjustment is needed, use the following:

▶ **To test the resistivity PCB,**

1. Connect the resistivity calibration tool to header U_ J1 on resistivity board (see Figure 5.3–1).
2. Power on the TCU. Allow the TCU to warm up for five minutes.
3. Set the calibration tool to the position marked 0 megohm centimeters. Select the **upper channel** from the front panel. Adjust potentiometer AR8 until the resistivity display reads 0.0 megohm centimeters.
4. Set the calibration tool to the position marked 1 megohm centimeters. Adjust potentiometer AR22 until the resistivity display reads 1.0 megohm centimeters.
5. Connect the positive lead of the voltmeter to test pin ATP2 and the negative lead to left side of resistor AR5. Adjust potentiometer AR3 until the voltmeter reads 0.000 (±0.005) VDC. There is an audible clicking from the electro–mechanical relay at the threshold. This adjustment sets the resistivity level, sending a low resistivity error to the tool.
6. Set the calibration tool to the position marked 0 megohm centimeters. Adjust potentiometer AR8 until the resistivity display reads –0.4 megohm centimeters. This calibrates the

resistivity board to the family of Thornton resistivity/ conductivity meters (industry standard).

7 After completing the adjustment, the front panel display reads –0.4 megohm centimeters when the calibration tool is set at 0 megohm centimeters and 7.6 megohm centimeters when the calibration tool is set at 8 megohm centimeters.

8 Connect the calibration tool to header L_ J1 on the resistivity board.

9 Set the calibration tool to the position marked 0 megohm centimeters. Select the lower channel from the front panel. Adjust potentiometer BR8 until the resistivity display reads 0.0 megohm centimeters.

10 Set the calibration tool to the position marked 1 megohm centimeters. Adjust potentiometer BR22 until the resistivity display reads 1.0 megohm centimeters.

11 Connect the positive lead of the voltmeter to test pin BTP2 and the negative lead to the left side of resistor BR5. Adjust potentiometer BR3 until the voltmeter reads 0.000±0.005 VDC. There is an audible clicking from the electro–mechanical relay at the threshold. This adjustment sets the resistivity level, sending a low resistivity error to the tool.

12 Set the calibration tool to the position marked 0 megohm centimeters. Adjust potentiometer BR8 until the resistivity display reads –0.4 megohm centimeters. This calibrates the resistivity board to the family of Thornton resistivity/ conductivity meters (industry standard).

13 Connect the positive lead of the voltmeter to test pin ATP9 and the negative lead to test pin GND1. Measure and note the voltage on ATP9. The voltage varies greatly depending on the temperature of the coolant.

14 Connect the positive lead of the voltmeter to test pin ATP14. Adjust potentiometer AR26 until the voltage on ATP14 is exactly 10 times greater than that of ATP9.

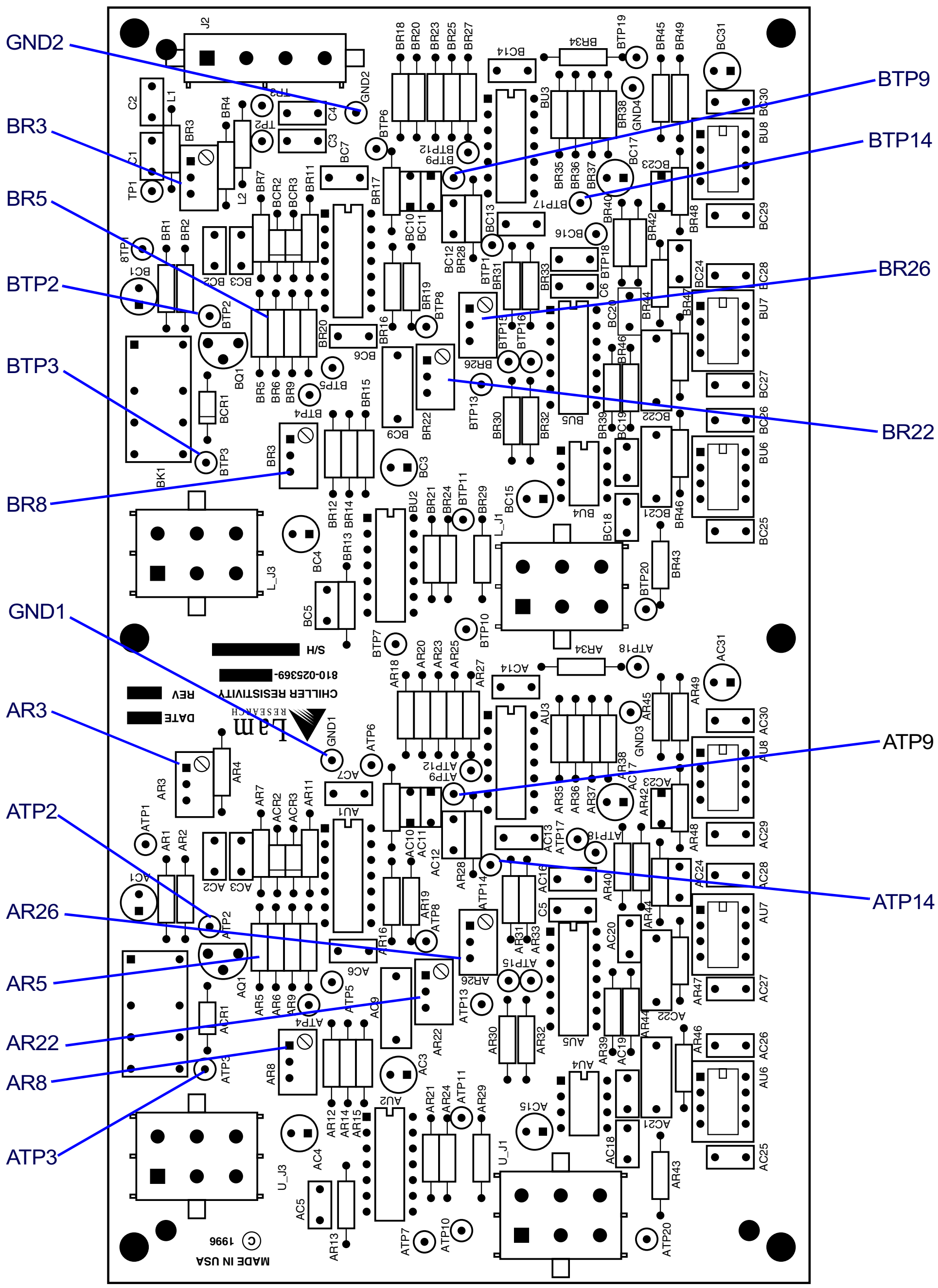
15 Connect the positive lead of the voltmeter to test pin BTP9 and the negative lead to test pin GND 2. Measure and note the voltage on BTP9.

16 Connect the positive lead of the voltmeter to test pin BTP14. Adjust potentiometer BR26 until the voltage on BTP14 is exactly 10 times greater than that of BTP14.

17 Apply a small amount of Glyptol to all potentiometers that were adjusted.

18 Remove all test leads.

Figure 5.3–1. TCU Resistivity PCB



TU01C018

5.4 *Resistivity Alarm Range Upgrade*

The 2080 TCU (851-110195-001 & -010) has a coolant low resistivity alarm which can only be set to actuate at 1 megohm centimeters. With the installation of the new Resistivity Upgrade Kit (856-097477-001), the range of the low resistivity alarm trigger will include settings of 1, 3, or 8 megohm centimeters. This kit also increases the range of resistivity displayed from [0 - 8 megohm centimeters] to [0 - 80 megohm centimeters].

The upgrade kit contains a new version PCB, new temperature probes, a calibration tool, and the procedure for performing the upgrade.

There is also a new calibration procedure (202-097479-001) for setting the low resistivity alarm trigger on the 2080 TCUs. This calibration procedure applies to all 851-110195-001 and -010 TCUs which have had the upgrade as well as all 851-110195-020 TCUs.

Reference Documentation

2080 TCU Resistivity Upgrade procedure 202-097479-001

Safety

Type 2 task involved.

Equipment Required

- Resistivity Upgrade Kit 856-097477-001

6
Troubleshooting

The 2080 TCU is a dual channel, wide range (–20 to +80 degrees Celsius) system. It incorporates a closed loop design with no back pressure, and features continuous deionization of the coolant (Ethylene glycol/deionized water). Coolant is pumped from the TCU to the system and is circulated through the seal plates of the reaction chamber to maintain the desired system temperature. The coolant flow is approximately four gallons minimum per minute, at a delivery pressure up to 75 psi.

When troubleshooting the TCU (unplugging connectors, adjusting potentiometers, shutting off valves, and so forth) and the problem is not resolved, it is imperative to return the TCU to its original state before making further adjustments. It is equally important to follow the steps in this guide in a sequential order. Failure to do so may complicate the problem and compromise personal safety.

Schematics

On the following pages two schematics are given to be used for reference when troubleshooting the TCU. The first is the top level interconnect diagram (see Figure 6–1). The second is the electronic enclosure schematic (see Figure 6–2 and Figure 6–3). These drawings also include reference designators and part numbers for related Lam assemblies and schematics.

ELECTRICAL

Warning

Physical Hazard: Voltages from circuitry within the electronic enclosure can cause severe injury or death. Contact with 208 VAC (3 Ø) and 28 VAC circuitry is possible in the rear half of the electronic enclosure. Avoid any physical contact or tools placed within the rear half of the AC box. In addition, DC voltages ranging from 5 to 15 are present. Only trained, qualified personnel should perform any maintenance in this unit.

Figure 6–1. Interconnect Diagram-210-110197-001

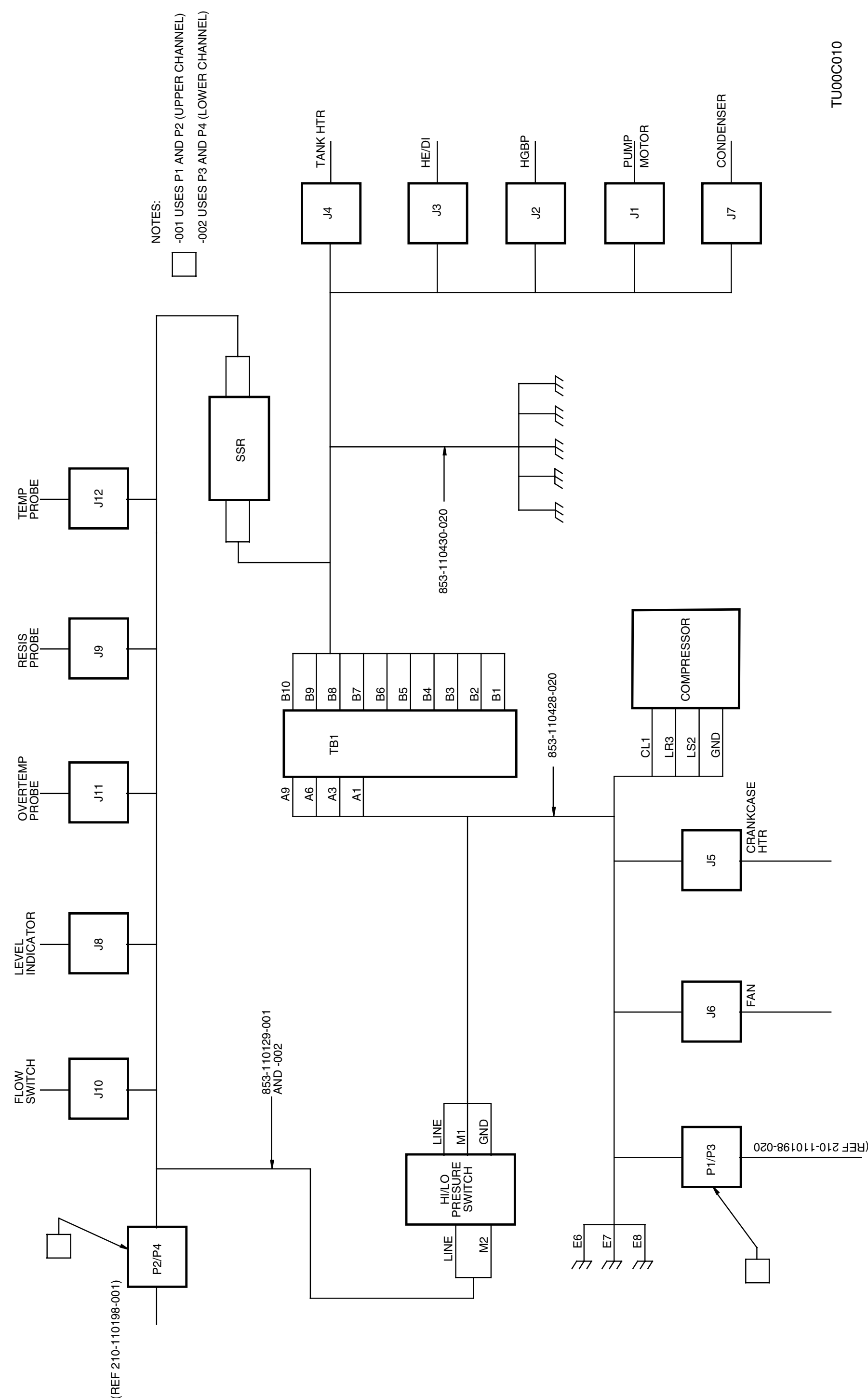


Figure 6–2. Electronic Enclosure Schematic-210-110198-001 Sheet 1

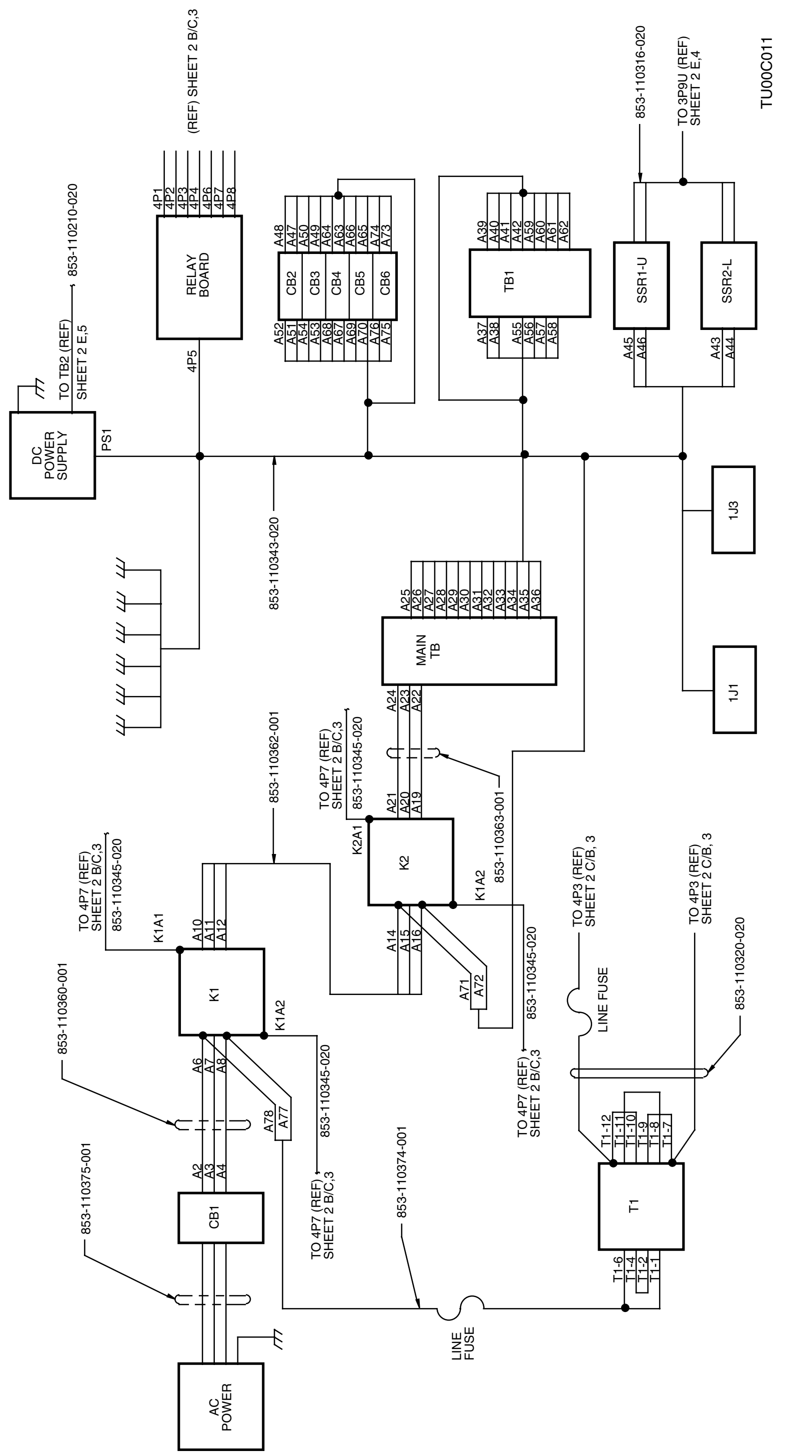
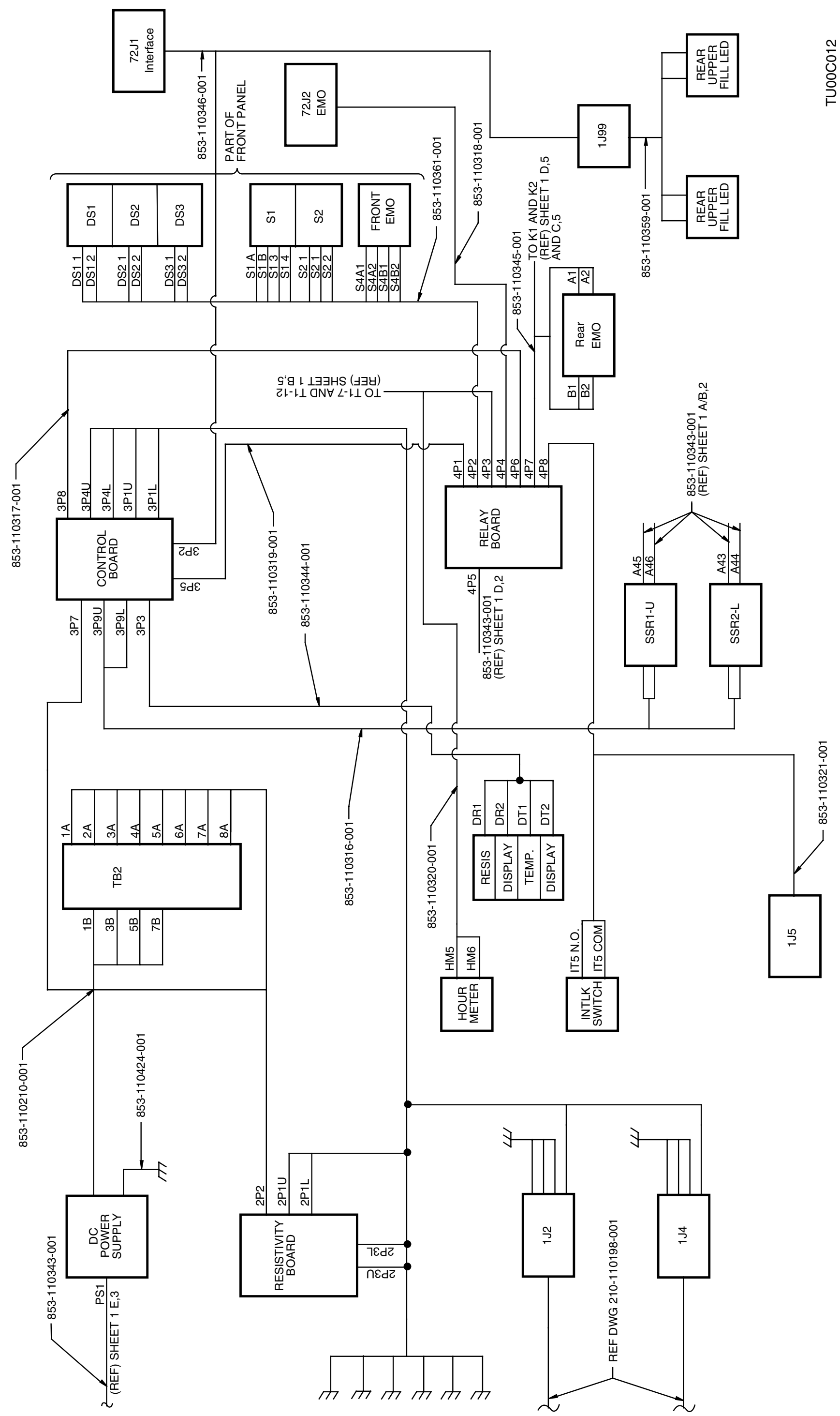


Figure 6–3. Electronic Enclosure Schematic-210-110198-001 Sheet 2



Basic Troubleshooting Using the Controller PCB

You can use certain connectors on the controller PCB for basic troubleshooting. These connectors have reference designators with a “U” or an “L” suffix. Since both channels on the TCU contain a great deal of identical circuitry, the suffix is used to distinguish between the upper and the lower channels. The following steps provide some basic troubleshooting techniques that you can perform using the controller PCB connectors.

▶ **To use the controller PCB for troubleshooting,**

1. If the red Comp, Flow, Level, Heat, or Resis indicators for the lower channel (front panel) do not clear, try swapping 3P4U with 3P4L. If the indicators on the upper channel fail to clear, the problem is not with the PCB, but with the wiring harness or the sensor.

Note Ensure that relocated plugs are properly seated on *all* pins of the connector. It is possible for a plug to be 1 or 2 pins out of alignment and still appear to be properly seated.

2. If the TCU needs to be placed in maximum cooling mode, set the local setpoint to –30 degrees Celsius.

GENERAL ALERT

Caution

Physical Hazard: The TCU, in maximum cooling mode, may reach temperatures to -25 degrees Celsius depending upon the installation and the distance from the system. Avoid direct contact with refrigeration lines and components.

3. Jumper 72J2 (pins 5 and 6) or turn tool off, placing TCU into local mode.

Basic Troubleshooting

The following troubleshooting guide is to better assist the technician in finding any anomaly within the system. It describes the circuitry involved, the possible cause of a particular problem, and the corrective action steps to alleviate the problem.

Status Indicators

Located on the front control panel of the TCU are two separate rows of status indicators, one row for the upper channel and one for the lower channel. Status indicators appear green when the system is operating normally and red when an alarm condition exists. A red illuminated LED on the control panel indicates the following:

Table 6–1. Status Indicators

Comp	The refrigerant pressure safety cut out has shut the TCU down.
Htr	The reservoir temperature has exceeded the safe limit and the TCU has shut down.
Flow	There is no flow returning from the electrode, the TCU has shut down. (Upper and lower indicators turn red when the TCU is shut down.)
Level	The coolant level in the reservoir is dangerously low, and the TCU has shut down.
Fill	The coolant level in the reservoir is low.
Resis	The resistivity of the tank mixture is low.

Warning

Equipment Hazard: The refrigeration units within the TCU are hermetically sealed and are not user serviceable. Only trained and licensed personnel should work on this equipment.

Table 6–2. Troubleshooting Guide

Problem	Corrective Action	Possible Causes	Circuit Description
AC and fail lights are the only lights illuminated. TCU will not start.	Unlock the EMO button. Reset the status indicators and restart the TCU.	EMO circuit activated.	The EMO circuit is a loop that travels through the TCU, the RF cart and the system. The TCU is also equipped with 6 safety interlocks (one on each of the covers). Removing any of these covers, while the TCU is running, shuts off the system.
	Be sure the six covers are in place and pushing in the safety interlocks.	Interlock switch activated.	
	Check fuses in enclosure.	Blown fuse.	
	Verify proper output voltage in enclosure.	Faulty transformer or power supply.	
	Verify the EMO circuit from the system, the TCU, and all remote equipment is continuous. Check the connector in the back of the TCU (72J2).	EMO signal cable is not a continuous circuit.	
COMP status indicator appears red. TCU has shutdown. Low pressure cut out.	Wait five minutes to allow the pressure switch to reset. Depress the COMP status indicator to clear the alarm. If the indicator appears green, a low pressure cut out is indicated. Restart the system. If the indicator does not clear, proceed to the “High Pressure Cut Out” section of Table 6–2. If a low pressure alarm occurs again, perform the following:	Low pressure cut out activated. Low pressure is automatically reset. High pressure cut out must be manually reset.	The low pressure cut out switch is activated when the suction pressure falls below the factory setting indicated on the label. After the TCU had been shut off and the refrigerant pressure has been equalized, the switch automatically resets and you can clear the alarm on the TCU panel.

Table 6–2. Troubleshooting Guide (continued)

Problem	Corrective Action	Possible Causes	Circuit Description
COMP status indicator is illuminated red. TCU shutdown. Low pressure cut out. (cont.)	Be sure the low pressure cut out switch is set as indicated on the label.	Low pressure cut out setting is too high.	The low pressure cut out and cut in pressures are factory adjusted. They can be accurately set only by the refrigerant pressure gauges monitoring the system.
	If operating at temperatures below 0 degrees Celsius, check the specific gravity of the coolant using a hydrometer. The reading should be approximately 1.065±0.005 at 20 degrees Celsius.	Incorrect coolant mixture.	The DI water and Ethylene Glycol mixture must be exactly 50/50 for proper TCU operation. This provides proper lubrication of the pump, and protects the system from unexpected freezing damage. If setpoints near or below freezing are being used and the mix contains too much water, ice begins to form on the evaporator coil in the reservoir. This causes the thermostatic expansion valve to restrict and the compressor to cut out from low pressure.
	With the channel in the cooling mode, check the sight glass for refrigerant flow. Check the baseplate, valves, and fittings for oil. If the sight glass is low or a leak is suspected, call a refrigeration service technician.	Low refrigerant charge.	In the cooling mode, a turbulent flow of liquid and vapor are visible in the sight glass. If there is little or no liquid, the unit is low on refrigerant. This may indicate a refrigerant leak. You can perform further leak checking with a halogen detector.

Table 6–2. Troubleshooting Guide (continued)

Problem	Corrective Action	Possible Causes	Circuit Description
COMP *status indicator appears red. TCU has shutdown. High pressure cut out.*	Check the facilities water flow to the TCU (4 to 8 GPM and < 25 degrees Celsius). Be sure the supply and return facility lines are connected at the TCU. Push in the reset switch firmly to overcome the spring pressure and clear COMP status indicator.	Insufficient supply or improperly connected water lines.	A high–pressure cut out may be caused by an improper facilities water supply. The high–pressure cut out switches are located on the right side of the TCU. They will cut out the compressor if the refrigerant pressure exceeds the safety setting. Holes in the side cover allow access to the reset bar.
	With the TCU in the cooling cycle, feel the condenser water valve and the outlet fitting from the condenser. They should be cold. If the outlet of the condenser is warm, it may indicate that the valve is not operating properly.	Defective condenser water valve.	The water valve is normally open, and remains open during the cooling cycle. It is energized (closed) only during the heat cycle. If it is not opening, the channel will cut out due to high pressure anytime it tries to cool.
	With the channel in the cooling mode, look in the sight glass, to verify proper refrigerant flow. If the sight glass fills with liquid refrigerant, it may indicate an overcharge. Call a refrigeration service technician.	Refrigerant in channel is overcharged.	A high–pressure cut out can occur due to a refrigerant overcharge. This may be likely if the TCU has recently been recharged. The label on the compressor contains the charge weight. A precision scale should be used when charging.
	Unplug J3, and remove the coil from the heat exchanger solenoid valve. Install it on the hot gas bypass valve using the J2 connector. If the valve opens, replace the coil. (Caution: Remove the coil from the valve only when it is unplugged. Energizing a solenoid coil when it is not snapped over a valve stem overheats the windings.)	Faulty solenoid coil.	A defective hot gas bypass valve may cause a high–pressure cut out when the unit cycles to the heat mode. When placed in the heat mode, this valve should open with an audible click. You can hear the gas rushing through the tubing into the evaporator. The sight glass will empty, and the tubing and valve get very hot from gas flow.

Table 6–2. Troubleshooting Guide (continued)

Problem	Corrective Action	Possible Causes	Circuit Description
COMP status indicator appears red. TCU has shutdown. High pressure cut out (continued)	With the channel in the heat mode, listen for the gas rushing through the hot gas bypass tubing. If there is no gas flowing through the tubing and the TCU cuts out instantly, the solenoid valve cannot open. Call a refrigeration service technician.	Hot gas bypass valve unable to open.	A defective hot gas bypass valve may cause a high pressure cut out when the TCU cycles to the heat mode. When placing the TCU in the heat mode, SV107 should turn on with an audible click, and you can hear the gas rushing through the tubing into the evaporator.
	Be sure the control PCB operates properly. Replace if faulty. To check orientation of the PCB see Section 5.1, "Calibrating the Temperature Probe."	Faulty control PCB.	
HTR status indicator is illuminated red. TCU has shutdown.	Verify the setpoint from the system.	Improper setpoint from the system. Overheat protection is activated.	There is a separate temperature probe located in the top of each reservoir. The probe sends the reservoir temperature signal to the resistivity PCB. If the tank exceeds 94 degrees Celsius, it will cause an overheat shutdown of the TCU.
	Verify the reservoir temperature. If the tank is overheating, see “TCU heats uncontrollably” section of Table 6–2.	Tank is overheated.	
	Verify tank temperature probe output. Bring the affected channel to 80 degrees Celsius. Use a DVM to measure voltage at test point ATP23 (upper) or BTP23 (lower) on resistivity PCB. If output is above 368 mV, replace the faulty probe.	Faulty tank temperature probe.	
	Check the wiring from the probe, through the connectors to the resistivity PCB.	Bad contact or faulty wiring from tank probe to PCB.	
	Be sure the resistivity and control PCBs are operating properly.	Faulty resistivity or control PCBs.	

Table 6–2. Troubleshooting Guide (continued)

Problem	Corrective Action	Possible Causes	Circuit Description
FLOW indicator appears red. Note: Both FLOW status indicators are normally red when the TCU is off or has shut down from other failures.	Clear the status indicators and start TCU. The first flow LED to turn red is the affected channel. Remove the return line from the back of this channel. While holding it in a proper container, start the TCU. If there is no flow, continue with the following. If the flow is acceptable proceed to step f.	No flow.	The 2080 TCU is equipped with a magnetically coupled gear pump. This pump requires an exact 50/50 mix for lubrication and proper operation. The pump circulates the mix past a bypass valve, over the temperature probe, to the system and back through a flow sensor into the tank. The flow sensors have a 10 second delay. This allows time to reset and start the machine. The flow sensor switches open when less than 1 gpm returns to the TCU. **Note:** When one channel fails from poor flow, the TCU shuts down and the FLOW indicators for both channels illuminate red.) For testing purposes, press and hold the ON button. When released, the TCU stops. **Note:** The TCU is wired in a way that causes one of the pumps to not operate correctly if one of the power phases is missing.
	a. Be sure lines to the tool were purged.	Air in the lines to and from the system.	
	b. Be sure the coolant lines are not blocked and valves on the system are open.	Coolant lines are blocked or valves are closed.	
	c. Verify CB2 and CB4 are in the On position and functioning.	CB2 or CB4 are defective or off.	
	d. Be sure there is 3–phase power to TCU.	TCU is receiving only two phases of power.	
	e. Be sure mixture ratio is 1.065 specific gravity.	Coolant mixture is off, causing the drive magnet to decouple.	
	f. Replace motor/pump.	Defective motor/pump.	
	g. After verifying good return flow, be sure the flow switch is functioning. Replace it if needed.	Faulty flow switch.	
	h. Check the wiring from P10 connector at the flow switch, through the harness, to the control board.	Defective connector or wiring.	
	i. Be sure the resistivity and the control PCBs are functioning.	Faulty resistivity or control PCB.	

Table 6–2. Troubleshooting Guide (continued)

Problem	Corrective Action	Possible Causes	Circuit Description
LEVEL status indicator is red.	a. Fill TCU coolant tank to proper level and restart. Check lines and fittings for leaks. (See Section 4.2, "Filling the Reservoir.")	Coolant level sensor is activated.	The level sensor indicates the level of the coolant in the tank. The normal operation of this sensor as the tank level drops is: a) the FILL status indicator turns red b) the LEVEL status indicator turns red c) the TCU shuts down.
	b.Verify the integrity of the wiring from the P8 connector, through the harness to the control board.	Defective connector or wiring.	P8 is the connector to the level sensor. The wiring goes through the resistivity PCB and onto the main PCB.
	c. Remove and inspect the level sensor. Replace if defective.	Defective level sensor.	If the tank is topped off and the red LEVEL warning will not clear, it may be a faulty level sensor.
	d. Verify the operation of the main PCB. Replace if defective.	Faulty control PCB.	
FILL status indicator appears red.	a. Add coolant to the tank, and verify that there are no leaks. Reset the status indicators.	Coolant is low.	See Section 4.2, "Filling the Reservoir." If the tank is topped off and the red FILL warning does not clear, it may be a faulty level sensor.
	b. Remove and inspect the level sensor. Replace if necessary.	Defective level sensor.	
	c. Check the main control PCB. Replace if necessary.	Faulty control PCB.	

Table 6–2. Troubleshooting Guide (continued)

Problem	Corrective Action	Possible Causes	Circuit Description
RESIS indicator appears red.	a. Run TCU to allow the coolant to regain proper resistivity. (This may take up to 12 hours.)	Coolant has not been scrubbed due to TCU standing idle.	The deionizing loop starts at the coolant line near the temperature probe. It enters a capillary tube at a swagelok fitting and the flows through a heat exchanger. It exits into a 1/4–inch tube and travels through both polishing cartridges and returns to the reservoir. The flow can be checked by removing a cartridge housing and starting the TCU. After a few seconds, the mixture should trickle out in a small stream.
	b. Verify proper flow through the deionizing loop. Be sure that the cartridges are not upside down.	Flow of the deionized loop is blocked.	
	c. Replace coolant and cartridges.	Bad coolant or cartridge: the coolant mixture maybe off, resistivity does not improve.	
	d. Check the resistivity and control PCBs. Replace if necessary.	Faulty resistivity or control PCB.	

Table 6–2. Troubleshooting Guide (continued)

Problem	Corrective Action	Possible Causes	Circuit Description
TCU will not heat properly.	a. Verify the setpoint from the system.	Improper setpoint.	
	b. Place the TCU channel into the cool mode. Look for a turbulent flow of refrigerant in the sight glass. If refrigerant is low or a leak is suspected contact a refrigeration service technician.	Low refrigerant.	When the channel is in the cooling mode, a rushing turbulent flow seen in the sight glass means the refrigerant is fully charged.
	c. Verify 208 VAC across the contacts at J4. If there is power, and the heater is not activated, replace the immersion heater.	Faulty immersion heater.	When the setpoint is above the tank temperature, the control board sends a 5 VDC signal to the solid state relay. This in turn sends 208 VAC to the channel which opens the hot gas bypass valve, activates the immersion heater, and closes the condenser water valve.
	d. Check the condenser water valve. Replace if necessary.	Condenser water valve will not close.	
	e. Check 3–phase power to TCU. With TCU on, verify power from J14 to compressor. If there is power to the compressor and the problem persists, contact a refrigeration service technician.	Compressor problem.	The compressor is a 3–phase hermetically sealed non–serviceable unit. It also has an internal thermal cut out that shuts it down if it gets too hot.

Table 6–2. Troubleshooting Guide (continued)

Problem	Corrective Action	Possible Causes	Circuit Description
TCU will not cool down.	a. Verify the proper setpoint from the system to the TCU.	Improper setpoint.	When the channel is in the cooling mode, a rushing turbulent flow seen in the sight glass means the refrigerant is fully charged. The hot gas bypass line is cool to the touch. The immersion heater is off, and the condenser water valve is open.
	b. Check the flow direction, the temperature, and the flow rate of the facilities water.	Insufficient cooling water.	
	c. Check the coolant mixture.	Improper coolant mixture.	
	d. Place the channel in the cooling mode. Look for a turbulent flow of refrigerant in the sight glass. If the refrigerant is low or a leak is suspected, contact a refrigerant service technician.	Low refrigerant level.	
	e. Check the bypass valve. If the solenoid valve is not energized or closed, and the hot gas line into the tank is hot, contact a refrigeration service technician.	Hot bypass valve unable to close.	
	f. Verify proper 3–phase power to TCU. With TCU on verify power from J14 to compressor. If there is power to the compressor and the problem persists, contact a refrigeration service technician.	Compressor problem.	

Table 6–2. Troubleshooting Guide (continued)

Problem	Corrective Action	Possible Causes	Circuit Description
TCU heats uncontrollably.	Verify proper setpoint from the system to the TCU.	Improper setpoint.	When the TCU (both channels) cycles to the heat mode, the main PCB sends a 5 VDC signal to the SSR (upper and lower). A 208 VAC is sent to the channel. The condenser water valve closes, the hot gas bypass valve opens, and the immersion heater activates. The piping from the hot gas bypass line to the tank becomes very hot and you can hear the gas entering the evaporator coil.
	Ensure that all power plugs in the enclosure are connected, and that the upper and lower connectors are not reversed.	Connectors improperly inserted.	
	Check temperature probe, see Section 5.1, "Calibrating the Temperature Probe."	Faulty temperature probe.	
	With the channel in the cooling mode, unplug the hot gas bypass valve. The valve should be cool to the touch. If it is warm, and gas is still passing though it contact a refrigeration service technician.	Hot gas bypass valve unable to close.	
	Check the control PCB. Replace if necessary.	Faulty control PCB.	

Table 6–2. Troubleshooting Guide (continued)

Problem	Corrective Action	Possible Causes	Circuit Description
TCU cools uncontrollably.	Verify the proper setpoint into TCU.	Improper setpoint from the system.	The setpoint voltage enters the TCU through the 37–pin connector as a DC voltage signal. 1 volt equals 10 degrees Celsius. (Example: 2.50 volts equals 25.0 degrees Celsius) If the 37–pin connector loses contact or if no DC signal is received, the TCU will cool to 0 degrees Celsius. The lower channel setpoint signal is pin 24 and the upper channel setpoint signal is pin 25. The signal travels to the PCB, and is compared to the TCU temperature probe. If the channel needs to warm, a 5 VDC signal is sent to the SSR. This activates the hot gas bypass valve, immersion heater, and water valve. If the channel needs to cool, no signal is sent. The AC power that activates the heater is sent from the SSR to the circuit breaker at the back of the enclosure, then it goes through the connectors and the terminal blocks to the components. Any interruption between the SSR and the channel will cause this problem.
	Verify setpoint on TCU front panel display. If the setpoint does not agree with the system, check setpoint voltage at the 72J1 connector.	No setpoint voltage into TCU.	
	Check solid state relay. Replace if necessary.	Faulty solid state relay.	
	Check CB3 (lower) and CB5 (upper). They control the AC power that activates the heating circuit.	Faulty 10 amp breaker.	
	Check the connectors. Look for backed out pins, arcing, loose contacts, and so forth.	AC voltage is not going through the connector to the channel.	
	Ensure that all power plugs in the enclosure are connected, and that the upper and lower connectors are not reversed.	Connectors improperly inserted.	
	Check temperature probe. Compare the channel display to the actual coolant temperature. Replace probe if necessary, see Section 5.1, "Calibrating the Temperature Probe."	Faulty temperature probe.	
	Check control PCB. Replace if necessary.	Faulty control PCB.	

Appendix A
Reference Documentation

Table A–1. Reference Drawings

Drawing number	Revision	Name
853-025245-202	A	Assembly, Temperature Probe, Insul Tank
853-025245-203	A	Assembly, Temperature Probe, Insul, Inln
810-025369-003	D	Assembly, PCB, Chiller, Resistivity
810-025370-004	C	Assembly, PCB Chiller Control
775-091420-001	1	Cartridge, DI Polishing
718-098540-001	A	Flow Switch Mod.
800-110195-120	A	Assembly, 2080 TCU CE97
851-110195-120	A	Assembly, Top 2080 TCU CE97
210-110198-020	F	Schematic, Electronic Box, 2080 CE97
800-110198-020	C	Assembly Electronic Box, 2080 CE97
853-110566-001	A	Assembly, Ind, Flt Sens, 2080 TCU
676-110636-003	B	Pump, Motor Fan Cooled, Motified Inlet Port
210-110747-001	E	Schematic, Refrigeration Unit Stainless 2080
800-110747-120	A	Assembly, Channel, Stainless, 2080, CE97
852-110747-120	A	Assembly, Channel, Stainless, Upper, 2080
852-110747-121	A	Assembly, Channel, Stainless, Lower, 2080
800-110748-120	A	Assembly, Refrigeration, Stainless, 2080
853-110748-XXX	E	Assembly, Refrigeration, Stainless, Upper, 2080
853-110748-121	B	Assembly, Refrigeration, Stainless, Lower, 2080
853-110877-001	C	Assembly, 2080, Resistivity Probe, K= .01
853-110997-003	A	Assembly, Valve, Solenoid, 2-Way, Normally Open

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