T-2500E
T-2500SE
Precision Temperature Forcing System
Maintenance Manual

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Note:
The information provided in this documentation covers both the T-2500E and T-25000SE precision temperature forcing systems. The naming convention used in this documentation is to refer to both systems as *T-2500E (SE)* when the information is applicable to either product. When the information is unique to a system, it is referred to by its actual product identifier which is *T-2500E* or *T-2500SE* respectively.

A table that displays the significant physical differences between the products is located on page 1 - 5 (See *System Configuration Variations*) of the *User's Manual*. The performance specifications for the systems are found on page 1 - 8.

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Wiring Diagrams

T-2500E (SE) Schematics

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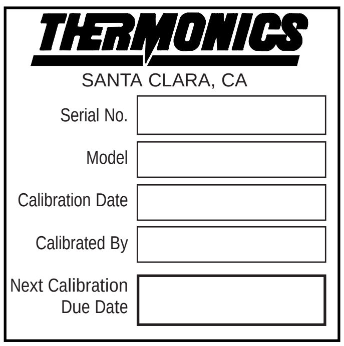
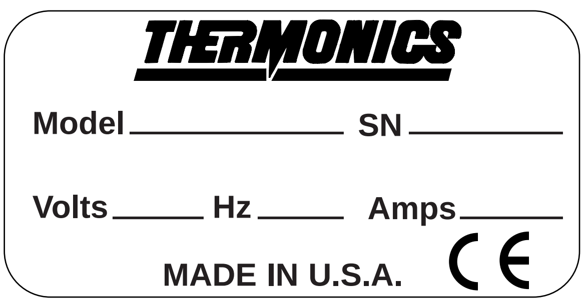
The following pages describe the significance of various labels found on precision temperature forcing systems produced by Thermonics.

This label is placed near the brake status lamp on the head handle of model T-2500. It reminds the operator that the rear brake is off when the lamp is illuminated so that arm rotation is performed with the brake off.

These labels are used to indicate which switches on the model T-2500 head handles are used to move the boom up/down or in/out.

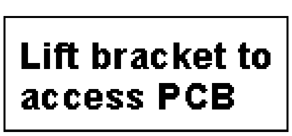


This label is used by a qualified service technician to provide information on system temperature calibration. The item can appear on any model system.

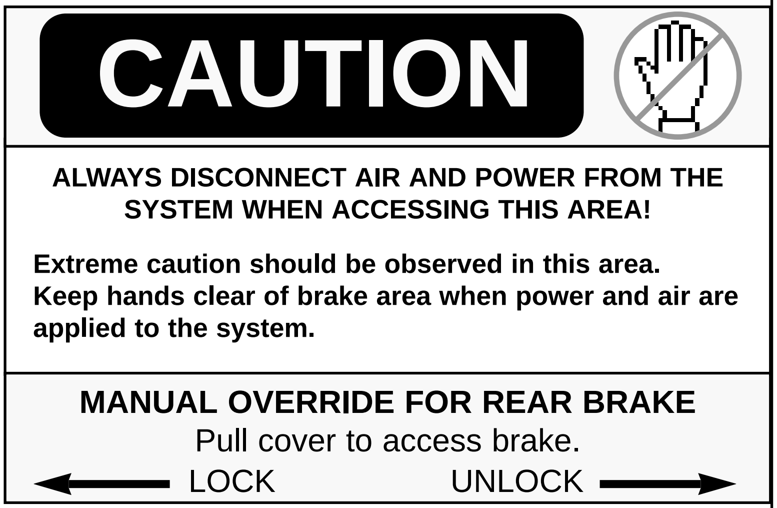


This label is placed on the rear panel of the system. It provides the model name of the system, its serial number and specific electrical parameters it is rated for. On models that have been CE certified the “CE” mark appears on the lower right-hand side of the label.

This label appears on the front of the Thermal Test Head of model T-2420. It serves as a reminder to the operator to not rest a hand on the head when it is in motion.



Used on the T-2500. This label is located on a bracket near the AC panel. It provides information to the service technician to enable access to the rear side of the panel.

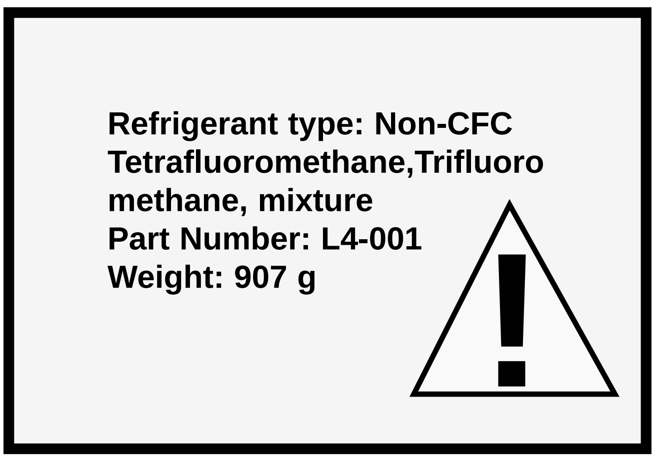


This label appears on the cover panel of the rear arm brake on model T-2500 and has three functions:

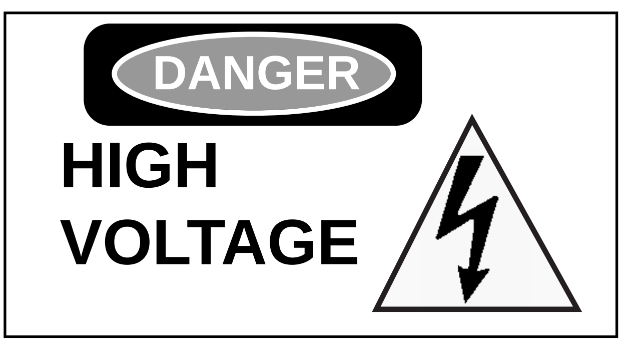
A.) It serves as a reminder to the service technician and others to remove air and power before accessing the brake area.

B.) It reminds the user that the brake assembly is a moving system so they should keep their hands away from the area.

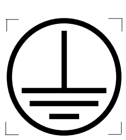
C.) It describes the locked and unlocked positions of the manual brake lever.



This label is located on the insulated enclosure of the refrigeration system. It describes the particular mixture of gases that the system uses.



This label is located on any areas of the system where the service technican may be exposed to high voltage.



This label describes the location of the main ground pin within the chassis of the system.

Introduction

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Introduction

1.1. General
The T-2500E (SE) is a very reliable temperature forcing system that provides superior performance in a wide range of applications. It is designed to withstand the environmental rigors of virtually any test or production environment. The materials and elements of the system have been assembled from technologies that have an historically proven track record, therefore, you can expect a long life of trouble-free performance from the T-2500E (SE).

There exists, however, a minimum amount of routine, preventive maintenance that must be applied, on a scheduled basis, to ensure continuous and reliable operation of the system and compliance with the warranty. There may also be the occasional need for trouble-shooting and repair/replacement of time-worn assemblies and components.

When the occasion arises for preventive, routine or corrective maintenance of the T-2500E (SE) PTFS, it must be performed by a qualified technician.

1.1.1. Scope of the manual
This manual provides information on preventive maintenance, trouble shooting, and corrective maintenance. Using this information, the service technician will be able to identify, locate, and repair malfunctions to the mechanical component or board level.

1.2. PTFS Description
Thermonics' model T-2500E (SE) Precision Temperature Forcing System (PTFS) provides the ability to heat or cool semiconductor components in their test socket with temperature controlled air. Components may be tested over the range of -85℃ to + 230℃.

The T-2500E (SE) consists of four functional units:

1.) Refrigerative Air Dryer (RAD),
2.) Refrigeration Unit (RU)
3.) Computer Control Unit (CCU), and
4.) Forced Air Output Assembly (FAOA).

1.2.1. Air Dryer
The regenerative air dryer uses a CDA input with a dew point of less than 10℃ at 80 PSI, and produces an output with a dew point less than -70℃. The air dryer consists of an inline input filter, four desiccant filters, and two desiccant tanks. Regenerative drying action is controlled by an electronic air switch and timing board.

1.2.2. Single-Stage Refrigeration
Extreme low temperatures are obtained by a single-stage refrigeration unit. The unit chills dry nitrogen or Compressed Dry Air (CDA) to a temperature less than -85℃. Primary components of the refrigeration unit are the compressor, condenser, fan as-

sembly, expansion tank, and heat exchanger. A pressure gauge is indirectly connected to the suction (low side) of the compressor. The gauge is the primary means of trouble-shooting the refrigeration unit.

1.2.3. Computer Control Unit

Air flow control, temperature control, I/O interfacing, touch screen input and all other fundamental operations of the system are controlled by the computer control unit. The unit consists of all components within the upper chassis. These primary components of the CCU are the power supply, mother board, thermocouple terminal board, temperature control board, memory I/O board, disk-drive control board, VGA board, and touch screen control board.

1.2.4. Motorized Arm and Thermal Fixture

Vertical motion of the boom is activated by a button on the right side of the thermal fixture. Vertical motion of the boom is accomplished by a linear actuator. The motorized boom allows quick and easy positioning of the thermal fixture onto varying load boards.

Horizontal motion of the boom arm is manual on model T-2500E and is motorized on model T-2500SE. A manual brake assembly restricts the in/out motion of the arm when the desired placement has been achieved.

1.2.5. Standard Thermal Fixture

The thermal fixture is mounted to the end of the movable arm on a ball joint. The joint allows the head to be placed in a variety of positions. The position is held in place by a clamp.

The thermal fixture is mounted to an air bearing that raises and lowers the fixture relative to the device under test (DUT). It can be activated by buttons on the sides of the fixture, by software selections, by a foot switch connected to the rear panel, or via remote communication commands.

To achieve quick air temperature transition times, the Standard Thermal Fixture utilizes an 1800 watt heater to control the air temperature. Several sizes of silicon boots are used to reduce the test chamber to the immediate area around the DUT.

1.2.6. System Configurations

The typical system configuration consists of a standard chiller and thermal test head (model T-2500E (SE)). Other installed system options are available and may modify the basic system and affect servicing of the unit.

Installed system options may include:

- Air Ionizer (T-ION)
- LN2 Injection (T-LN2/25)

The presence of these installed options is identifiable on the serial tag which is located on the rear panel just below the AC input. Additionally, the tag specifies the required input voltage and line frequency for systems that use a transformer to step the voltage up or down.

Identifier	Option
L	LN2 Injection
I	Air Ionizer

1.3. Repair/Service

Thermonics maintains a fully-equipped repair center in Santa Clara, CA, U.S.A., which provides warranty or non-warranty repairs and emergency spares support. For further information on repairs and spare parts availability, contact Thermonics' Customer Service department. Before returning the system, or parts of it, for repair; contact customer service for an RMA number. In some areas, third-party service is available.

1.4. User Repair

All repairs should be performed by qualified technical personnel. Thermonics will provide aid in the repair or replacement of all components, assemblies, or sub assemblies, as stated in the warranty.

1.5. Spare Parts

Replacement parts for all electrical, mechanical, and pneumatic components can be obtained directly from Thermonics Inc. Refer to the parts lists in the Illustrated Parts Breakdown for part numbers.

1.6. Technical Support

Technical questions should be directed to:

Thermonics Inc.
3350 Scott Blvd., Bldg., 32
Santa Clara, CA 95054-3118
Phone: (408) 496-6838
E-Mail: info@thermonics.com
URL: www.thermonics.com

1.7. Training

Formal technical training is conducted at the Thermonics' facility on a scheduled basis. Training of additional personnel or onsite training can be provided. The course covers the theory of operation and system maintenance. For further information, call Thermonics Customer Service.

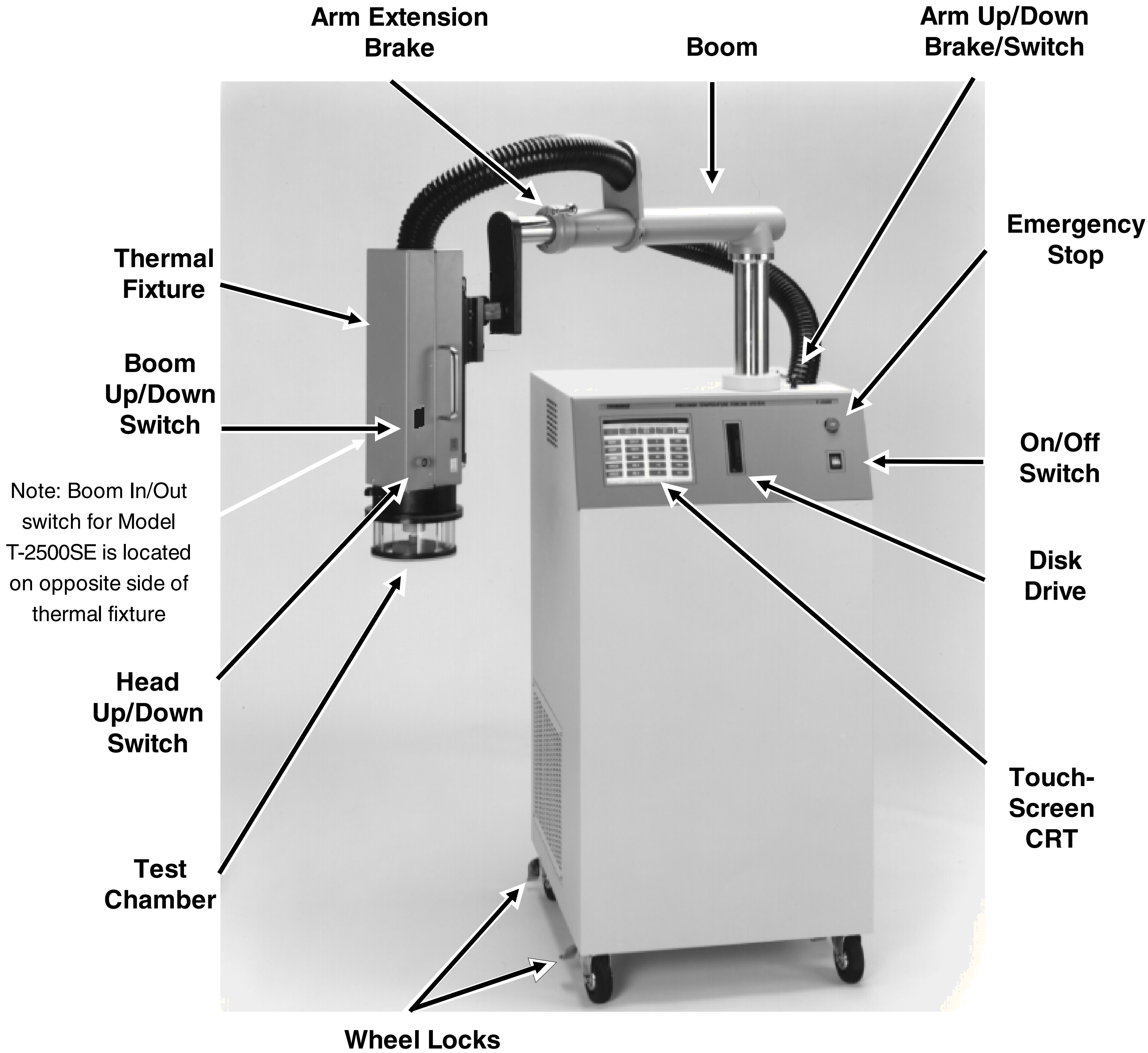

Fig. 1-1, The T-2500E (SE) PTFS

Safety

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Safety

2.1. Overview

Thermonics furnishes this information to enhance the safe use and servicing of this product. However, Thermonics **does not** assume any responsibility for the operator or service technicians' safety practices. The user or service technician is responsible for the implementation of safe and sane operating habits when using this equipment. All personnel who perform service on this product must understand the dangers of working on electrical and mechanical equipment and take precautions to protect themselves and others against possible bodily injury, damage to equipment or facilities.

2.1.1. Moving the System

When moving the system from one location to another, always use qualified moving personnel.

2.2. Electrical System

This system contains circuits that are capable of large currents at 230 volts ac or higher. Read this section before servicing the system.

- High voltages are used by some subsystems. Areas that contain high voltages are marked with warning labels that read: *WARNING High Voltage*. Use extreme caution when working on or near these areas.
- Never service or maintain any area of the system without first understanding the related circuits and voltages.
- Service panels should only be accessed by qualified technicians.
- Remove all jewelry such as rings or watches before performing any electrical troubleshooting.
- Remember the *One Hand in Pocket Rule* when working with high voltages.
- Never lean on frame or metal surfaces.
- Always work with a partner.
- When using probes or meters, make sure they are rated for the power that is being measured.
- Always disconnect the air line when servicing the pneumatic system.
- Wear safety glasses at all times.

WARNING!: 230 VAC is present is the chassis and rear enclosure with the machine power switch off.

2.3. Emergency Off Switch (EMO)

The emergency off switch is a large, round, red switch located on the upper-right-hand side of the front panel. Use the EMO (emergency machine off) switch to remove power from the system in an emergency. To secure the EMO function, press the switch.

NOTE: The EMO function trips the main circuit breaker. To reactivate the system, set the circuit breaker to the "ON" position.

WARNING!: When the EMO is engaged, 240VAC is present at main circuit breaker. The main circuit breaker must be switched off, locked out, and the power cord disconnected before servicing.

2.3.1. Electronic Enclosures

The system is designed to minimize the probability of electric shock during maintenance, repair, modification, calibration and adjustment. Energized circuits, components, or terminal strips are enclosed with covers that require a tool to remove. In addition, hazardous areas are clearly marked with tags that read: *DANGER HIGH VOLTAGE*.

Areas of the system that have active line voltages present when the system is switched off (using the main power switch, not the EMO) are: the main terminal strip, the On/Off switch, the EMO switch, transformers, line filters, and the circuit breaker. (Note: all items are located inside the chassis which has a screw-on cover.)

CAUTION: When the chassis or rear cover panels are removed, the system remains powered up.

2.4. Lock Out Tag Out

If service is required to the electrical system:

1.) Remove power to the system by shutting of the main circuit breaker.

2.) Disconnect the main power cord from the rear panel connector labeled AC INPUT.

3.) Attach a tag listing the individuals authorized to reconnect the main power cord.

2.5. Electrical Task Hazards

Classification of electrical task hazards as defined by SEMIS2-93:

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 electric shock.

Type 3: Equipment is energized. Live circuits are exposed and accidental contact is possible. Potential exposures are **less** than 30 volts RMS, 42 volts peak, 240 volt-amps, 20 Joules, or radio frequency (rf) is present.

Type 4: Equipment is energized. Live circuits are exposed and accidental contact is possible. Potential exposures are **greater** than 30 volts RMS, 42 volts peak, 240 volt-amps, 20 Joules, or radio frequency (rf) is present.

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

Listed below are all the electrical tasks that are classified as type 3 or higher:

Power Supply Checkout: The power supply checkout procedure is classified as a **Type 4** Electrical Task Hazard. Potential exposure to voltages greater than 30 volts RMS is possible. This procedure must be performed by a qualified technician.

NOTE: In almost all cases, the power supply voltages can be read on the diagnostics screen, eliminating any possible exposure to these voltages.

2.6. Moving Parts

Parts that move on the system are covered with cages or panels to prevent injury when the system is operating. Proper precautions should be observed when these subsystems are active and protective coverings have been removed. The following components of the system are capable of moving when the system is powered up:

- Thermal Fixture (up/down)
- Support Arm (up/down)
- System Fan (rotation)
- Compressor Fan (rotation)
- Air Flow Control Valves (rotation)

2.7. Damage to Equipment

- Never forcibly move the boom with the brakes/clamps engaged.
- Move the system using the push-bar and body of the system, do not move the system using the boom.
- Make sure that the input line voltage is correct; particularly so if a step-up or step-down transformer is installed.
- Always use clean, dry facility air.

2.8. Powering Up After Servicing

A qualified service technician must test and qualify the system for safety conformance, subsequent to service or repairs, prior to releasing it for normal use.

2.8.1. Prior to Applying Power

1.) Verify the input power. Make sure that it is 208 to 230VAC and correctly connected to the rear panel connector labeled AC INPUT.

NOTE: voltage may be 200 - 245VAC, when step-up or step-down transformers are installed.

2.) Verify that the facility air (CDA), used for pneumatic operation and temperature transference, is between 80 to 100 psi. A gage is located on the air input connector. Adjust if necessary. Clean, dry air must be used.

3.) Verify that all panel covers have been securely replaced.

2.8.2. After Applying Power

1.) Test the EMO (Emergency Machine Off) button. Power to the system should be removed, and the main circuit breaker activated, when the button is depressed. Restart the system by setting the main circuit breaker, located on the rear panel, to the ON position.

2.) Observe the operation of the system, the Start-up screens should appear with no warning messages or alerts active.

2.9. Installation

Observe the following safety precautions when installing the system:

- Personnel must receive proper training on safety procedures for the temperature-test environment. Do not operate the system without prior safety training. Appropriate safety equipment and medical treatment information must be available.

- All facility supply lines must be clearly labeled. All power cables and plumbing should be routed to prevent damage to the lines or individuals.

2.10.Heavy Loads

Two or more individuals must be used when removing any heavy items or subassemblies such as the chiller assembly.

Displays, Control and Interfaces

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Displays, Controls and Interfaces

3.1. General

This section of the manual provides information to familiarize the maintenance technician with the operation of the T-2500E (SE). Items covered include the front panel operator interface, the rear panel interface connectors, thermocouple interfaces, adjustment of purge and pneumatics, and the power-on and power-off procedures.

3.2. Front Panel Controls and Indicators

The front panel consists of three controls and indicators and one interface. The following information describes their function and actuation.

3.2.1. Power Switch

The power switch applies power to the system from the rear panel circuit breaker. The on position is indicated by illumination of the switch. After the system is switched on, the CRT displays configuration data and then auto-boots the operating software.

3.2.2. Emergency Stop Button

The emergency stop button immediately stops the system by tripping the circuit breaker via a special input.

3.2.3. The System Display Monitor

The T-2500E (SE) front panel displays pertinent system operation information via a custom software interface that displays on the CRT. The types of information displayed are: system operation status, error messages and alerts, and programmable configuration items. Interaction with the system occurs via a touch screen. The end user's touch is mapped to the system's software selections to provide the ability to enter data and access menu selections. Details on the functioning of the interface can be found in the chapter: *Physical and Functional Description*. An overview of the system software can be found in the <u>T-2500E (SE) Users Manual</u>.

3.2.4. Keyboard Access Port

A standard five-pin PC keyboard port can be found behind the removable front panel cover. This port can be used to connect a keyboard to the system to provide a means of interacting with the system at the operating system level. An example of a time when this might be necessary is if the BIOS data needs to be re-entered or changed.

3.3. The Rear Panel

The rear panel of the system contains all of the input connectors for system communications, power, and pneumatics. In addition it has two gages that are used to monitor the status of the pneumatics. A table of Thermonics part numbers for replacement of these items can be found in the *Appendix*.

3.3.1. Circuit Breaker

20 Ampere Circuit Breaker. Shunt trip with auxiliary switch.

3.3.2. AC Input

The ac input is a standard 220V, three pin, female connector. System power input specification is 208 to 230 VAC, 20 Ampere. (Unless otherwise specified on the serial tag. See Chpt. 1 page 1 - 2.)

3.3.3. Air Inlet

The air inlet is comprised of a 1/4" NPT connector and a male quick disconnect. Thermonics part number for this item is P2-181.

3.3.4. Air Pressure Gage

This gage displays the currently measured input air pressure. The air input specification is 80 to 110 PSIG. Flow rate of 18 SCFM. Dew point less than 10C at 80 PSIG. Air must be free of oil and particles.

3.3.5. Purge Air Pressure Gage

This gage displays the currently measured pressure of the purge air. This air is typically set to 20 PSIG.

3.3.6. Ports

The rear panel provides interfaces that enable the system to communicate with other machines and test equipment through cables. The tester I/O, RS-232C, and IEEE-488 connectors enable the system to communicate with, and be statused and controlled by external devices. A detailed overview of these items can be found in the T-2500E (SE) Users Manual, Chapter: *Remote Operation and Interfacing.*

The following connectors are found on the rear panel. A table providing information on the part numbers and mates for these connectors can be found in the *Appendix*:

- *Printer*: A female 25 pin connector. Provides the ability to connect to a printer. A list of supported printers appears in the appendix.
- *Tester I/O*: 24-pin female connector. Provides a standard handler interface.
- *RS-232C* I/0: 9-pin male connector. Standard RS-232C interface protocols are supported.
- *RTD*: 9-pin female connector. A resistive thermal device used for temperature sensing.
- *IEEE-488 BUS*: 24-pin female connector. Enables use of IEEE-488 and IEEE-488.2 interfaces.
- *Foot Control*: 15-pin female connector (also called head control). Enables foot operation of the thermal fixture up/down motion.

3.4. The Support Arm and Thermal Fixture

This assembly is comprised of the linear actuator, boom and thermal fixture.

3.4.1. Thermal Fixture

The thermal fixture has several items that are noteworthy: two head position controls, an arm up/down control and two thermocouple inputs jacks. These items are illustrated on the following pages.

3.4.1.1. Head Up/Down Buttons

The two small read buttons are used to raise and lower the thermal fixture. Both must be pressed simultaneously to affect this motion. This design helps to ensure the operator does not place fingers under the head or on the rear bearing when the thermal fixture changes position.

3.4.1.2. Boom Control Switch

The boom control switch is a spring action switch that activates the linear actuator. Pressing it in the upper position raises the entire arm assembly. Conversely, toggling it to the bottom position lowers the assembly.

3.4.1.3. Forearm Extension Control Switch

On model T-2500SE only. A spring action switch activates the forearm extension motor. The upper position extends the arm and the bottom position retracts the arm.

3.4.1.4. Thermocouple Access Ports

As a convenience, the two types of DUT sensors can be plugged into receptacles on the side of the thermal fixture. The blue receptacle is for the T-DUT thermocouple and the yellow if for the K-DUT thermocouple.

3.4.2. Arm

The arm has three mechanical adjustments that control its position.

3.4.2.1. Wrist Adjustment Brake

This brake restricts the position of the wrist near the thermal fixture. It allows the head to be rotated around a bearing into a variety of positions.

3.4.2.2. Arm Extension Brake

The arm extension brake restricts the motion/position of the forearm. The arm can be extended or contracted between 36 and 52 inches.

3.4.2.3. Vertical Motion Brake

The vertical motion brake prevents the upward or downward motion of the arm assembly. When the brake is in the off position it presses a switch near the arm base to inform the system that arm motion is possible. The up/down position of the arm assembly is between 32 and 49 inches.

3.5. The Flow Control Panel

The flow control panel is located inside the system behind the front panel cover. It contains three adjustments. The two smaller knobs are used to adjust the purge air flow rate and the thermal fixture air bearing up/down motion. The third, larger knob is used to regulate the main air flow. (See Fig. 3 - 7)

3.5.1. Purge Air Adjustment

This knob is located on the right-hand side of the panel. Purge air pressure is typically set to 20 PSI. An indicator is located on the rear panel.

3.5.2. Thermal Fixture Air Bearing Adjustment

Located on the left-hand side. This adjustment control the rate of up/down motion of the thermal fixture.

3.5.3. Air Flow Adjustment

This regulator steps down the air pressure to ensure that it is within a range that is easily regulated. It is typically set to 60 PSI at the factory and should not be adjusted in the field.

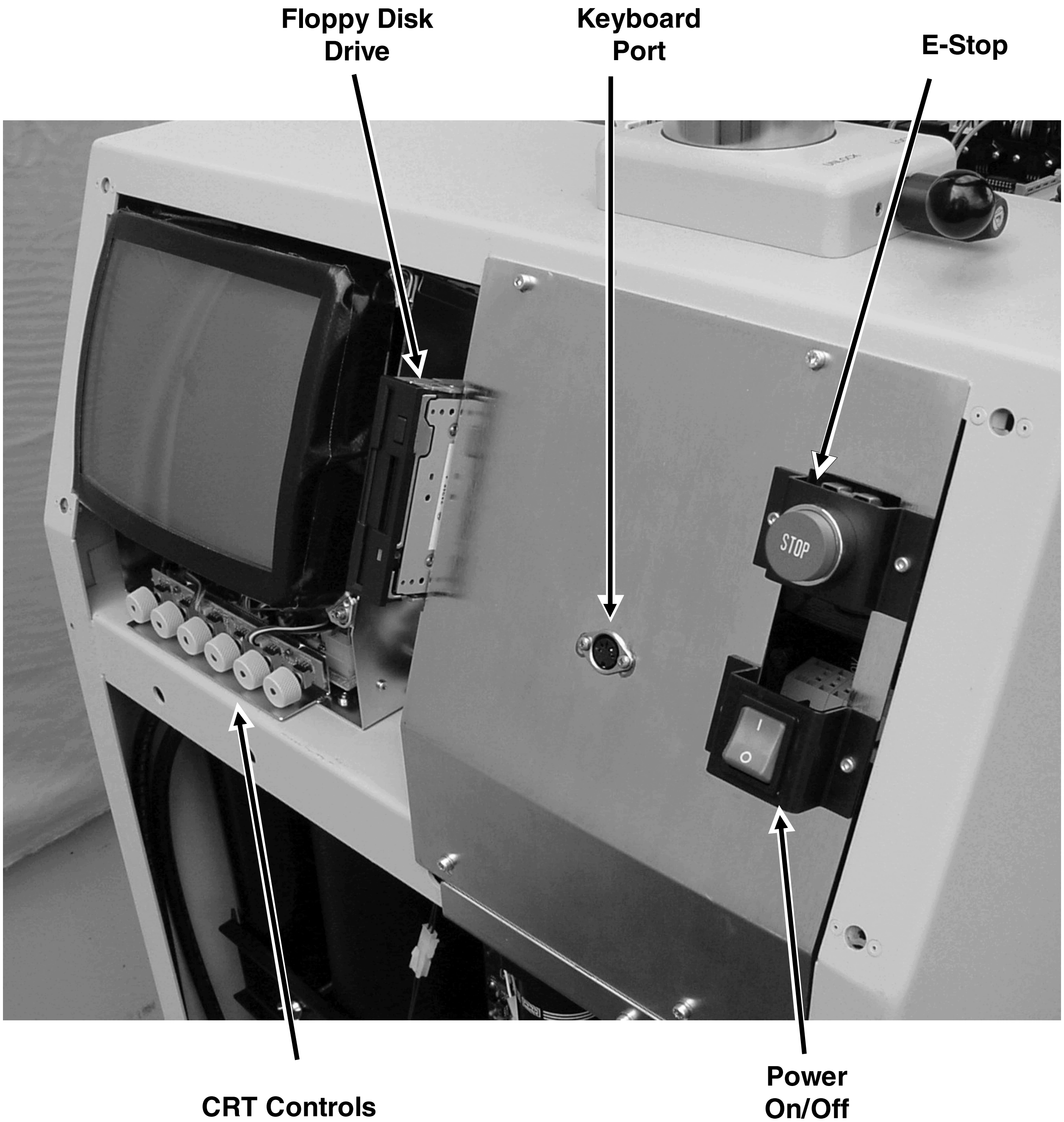


Fig. 3 - 1, Front Panel Controls

Fig. 3 - 2, Rear Panel Interfaces

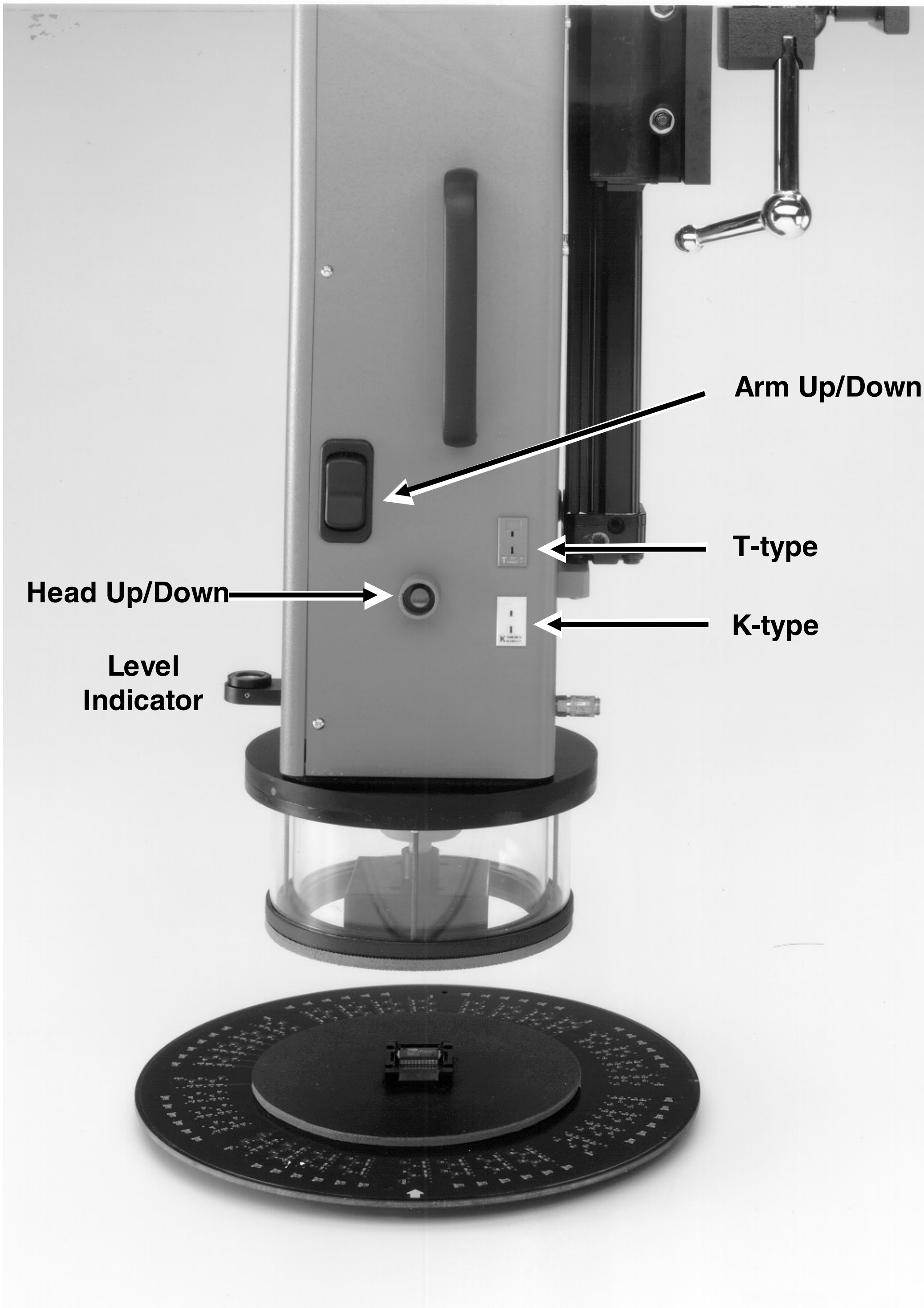


Fig. 3 - 3, DUT Sensor Thermocouple Sockets

Locked Position

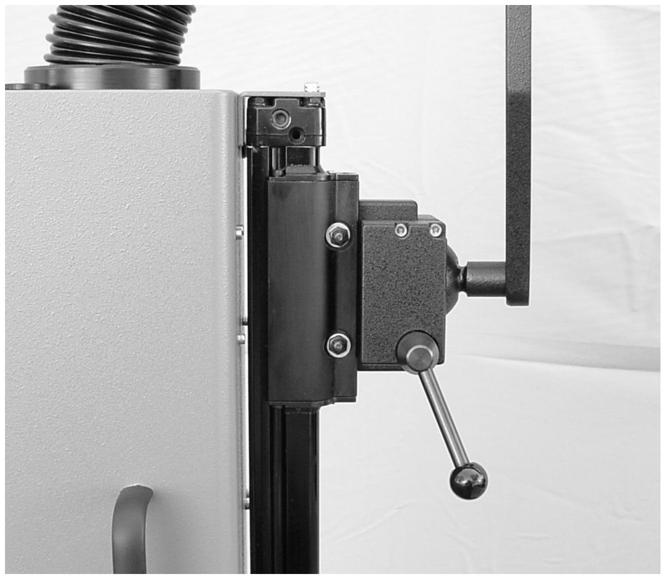
NOTE: Brake contains electical switch, boom will not activate in locked position.

Fig. 3 - 4, Vertical Motion Brake

Use clockwise rotation to engage brake. Counterclockwise to loosen brake.

Note: Horizontal positioning of arm on model T-2500E is manual. On model T-2500SE it is motorized.

Fig. 3 - 5, Forearm Extension Brake



Use counterclock-wise rotation of han-dle to engage head pivot clamp. Use clockwise rota-tion to loosen clamp.

Fig. 3 - 6, Wrist Brake

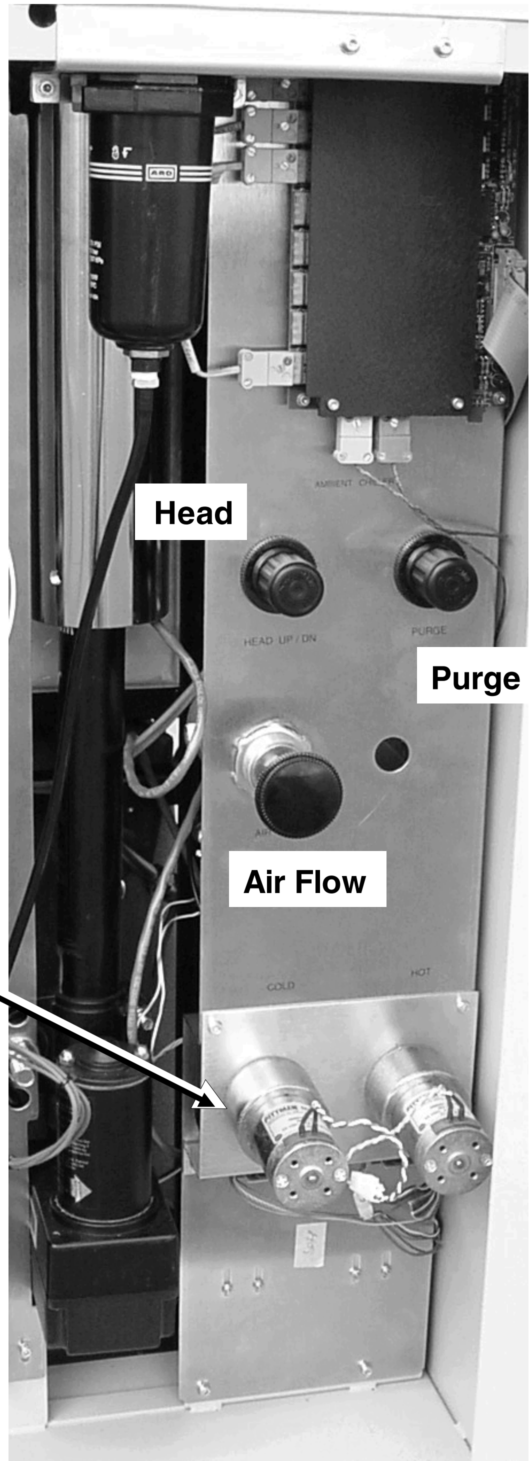


Fig. 3 - 7, Flow Control Panel

Note: Model T-2500SE has two servo valves (flow regulators); one for each air path (hot/cold).

Physical and Functional Description

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Physical and Functional Description

4.1. General

This chapter discusses various topics related to the functioning and design of the T-2500E (SE). Its purpose is to provide an overview of the scientific background and principles on which the system is based. Specifically, it provides a theoretical overview, in terms of both form and function, of the Computer Control Unit (CCU), the hot and cold flow paths, the Mechanical Refrigeration Unit (MRU), the Refrigerate Air Dryer (RAD), the Output Assembly, and some of the available options.

4.2. TYPICAL USES OF THE PTFS

The PTFS is most commonly used for directly testing semiconductor components at temperature extremes while they are on an auto-tester performance board. This permits measurement of all electrical parameters (ac or dynamic and dc) without adding the long test leads that are common for a conventional oven. Examples of additional applications of the PTFS are:

- Engineering evaluation or characterization of components.
- Incoming inspection.
- Production testing of small lots.
- Quality assurance testing and failure analysis.
- Testing printed circuit boards, wafers, or modules at temperature.

4.3. FUNCTIONAL OVERVIEW

The PTFS heats or cools the device to be tested with a stream of temperature controlled air. It is directed to the DUT by an insulated output hose connected to the built-in refrigeration system. Heat is provided by a heater located in the thermal test head. The test device is typically placed in a thermal fixture that keeps the device at the desired temperature by insulating it from the environment.

The air supplied to the system, from a regulated source of compressed air, is passed through an air dryer to remove moisture, oil and particles. The moisture removal process permits the air to be chilled to a lower temperature and also prevents the development of frost or moisture that could inhibit air flow. (An optional bypass fitting may be used if the air supplied to the system is dry air.) The air flows through a series of regulators and flow-metering devices that automatically control the flow. It then passes through the output hose to the thermal test head where heaters control its temperature.

Temperature-controlled purge air prevents frost and moisture from building up on the thermal fixtures and surrounding test components. Purge air is used in three locations: a.) on the circumference of the upper portion of the shroud. b.) On the inside of the junction of the shroud and thermal fixture. c.) Inside the thermal fixture itself. The purge air temperature can be specified in the operating parameters.

Various configurations of sensors permit the PTFS to monitor the temperature of the DUT. T or K-type thermocouples and RTD sensors may be used. The temperature control algorithm provides extremely accurate temperature control.

A touch screen CRT keeps the operator continuously informed of the system status via menus, messages, temperature information, and operating parameters that display on the CRT during use. Numeric values are entered into the system via a keypad graphic that appears on the monitor, and alphabetic characters are entered via a keyboard graphic.

4.4. USING AIR TO DETERMINE DEVICE TEMPERATURE(S)

The T-2500E (SE) PTFS forces a Device Under Test (DUT) to reach a specific temperature by subjecting it to a stream of temperature-controlled air. The compressed air is cooled below ambient by a refrigeration unit, and the air temperature is controlled or heated by in-line resistive-type air heaters.

The speed and accuracy of temperature-controlled compressed air make it superior to other methods such as slow moving ambient air or conduction of temperatures through hot or cold surfaces. Additionally, temperature controlled compressed air has several other characteristics that make it a superior medium for bringing devices to temperature, these are:

- It quickly submerges a device in a stream of air of a specific temperature.
- It accurately forces the device to the desired temperature.
- It can be used to for testing of devices or modules directly at the tester socket; soaking its leads and the socket in the stream of air.

4.5. TEMPERATURE CONTROL TECHNIQUES

The T-2500E (SE) senses the temperature of the Fixture air, the DUT, and the Purge air. All of which are monitored and controlled in an extremely accurate manner by the system (within ± 1°C). Accurate control is due to a new approach to temperature control via the Thermonics Proprietary Temperature Control Algorithm (TPTCA). (U.S. Patent No. 5,205,132)

4.5.1. Thermonics' Proprietary Temperature Control Algorithm

Temperature control of the T-2500E (SE) is accomplished via a dedicated sub-processor incorporated into an 80X86 CPU-based control system. An advanced proprietary control algorithm is incorporated into the firmware of a distributed processor (80186) that runs under Thermonics Proprietary Operating System (TPOS) It controls the temperature of the DUT precisely and accurately while permitting optimum transition to temperature stability.

4.5.2. Thermocouple Options

The temperature of the forced air delivered by the T-2500E (SE), and the temperature of the DUT, are measured using thermocouples. Thermocouples are temperature registering devices that are made up of dissimilar metals joined at each end. One junction is placed where the temperature is to be measured; such as in the air stream or at the DUT, and the other is kept at a reference temperature. A voltage (emf) is generated that is linearly proportional to difference in temperature of the junctions. The T-2500E (SE) system software then uses this information to determine the temperature for use in system control via the TPTCA.

The T-2500E (SE) is capable of using two types of thermocouples: type T and type K.

Type	Temp Range	EMF (mV)
T	-200 to 350°C	-5.602 to 17.816
K	-200 to 1250°C	-5.973 to 50.633

4.5.3. Thermocouple Signal Enhancement

The system contains sophisticated electronic circuitry designed to eliminate the noise generated by high-frequency environments. Experienced as unstable or drifting temperatures, noise can make control and accuracy of some systems difficult--particularly in DUT sense mode. When the thermocouple is grounded or connected to a conductive surface, such as device packaged in a metal enclosure, the noise problem can be a difficult one.

The T-2500E (SE) enhances the signal by isolating the common mode noise from the differential signal, and rejecting the noise via a charge capacitor switch. Low-pass filtering techniques are used to enhance the desired frequency response characteristics of the thermocouple signal with a low-noise precision operational amplifier. In addition, the differential thermocouple input is altered into single-ended output.

4.6. RELATIONSHIP OF THERMAL TIME CONSTANT OF A DEVICE TO SOAK TIME.

The thermal time constant of a device is a measure of the time it takes for a device to approach the temperature of its environment. When a device is placed in a thermal environment, such as the T-2500E (SE) Thermal Fixture, its temperature approaches the temperature of the environment (the temperature of the air in the thermal enclosure) following an exponential curve. See example of a 1000 ohm RTD below. (See Fig. 4 - 1.)

Many factors contribute to the amount of time that is required for a device to reach and stabilize at a given temperature - affecting the shape and character of the response curve. These factors include the material the device is made from, its size, the air temperature and flow rate, the properties of the thermal fixture, and the accuracy of the control technique. The two main attributes affected by these factors are the offset and transition time. The offset is the number of degrees of temperature overdrive required to quickly bring a device to temperature. The transition time is the amount of time required for the device to change tempera-

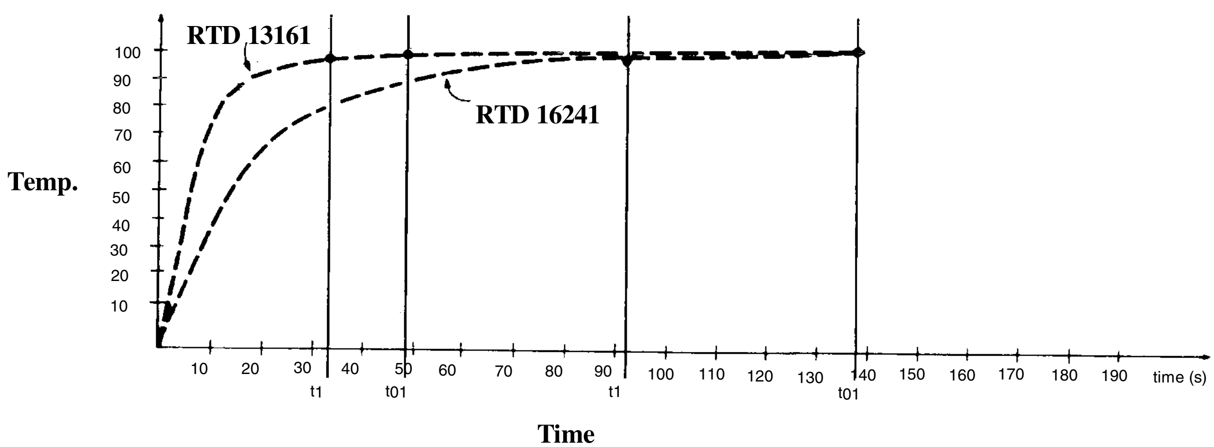

Fig. 4 - 1, Thermal Time Constant Example

ture. The T-2500E (SE) has several type/sizes of thermal boots available to help optimize the integration of the temperature controlled air and the DUT, which coupled with the control algorithm (TPTCA) greatly reduces the offset and transition time.

The average amount of time required by the device to become stable at temperature before testing can begin is the Soak Time. The Soak Time is typically determined and programmed into the system before testing begins to assure accuracy and repeatability of test results. The best way to determine the soak time is to directly measure the thermal response of the component. This can be implemented in several ways depending on the characteristics and requirements of the test item.
Examples:

- Replace the DUT with an RTD (temperature dependent resistor) that is packaged similarly to the device to be tested and measure the RTD's response.
- Measure the substrate diode characteristic of an integrated circuit.
- Measure the temperature inside the device by implanting a thermocouple in a hollow cavity sealed with RTV.

4.7. Hardware Design Concept

This section briefly describes each of the major functions of the Computer Control Unit (CCU). The Computer Control Unit, comprises the set of PC boards located within the chassis. It contains the following boards:

80*X*86 Mother board, Temperature Control board, Memory I/O board, Heater and Flow Control board, Super VGA board, Touch Screen Control Board, Floppy Driver board, Power Supply and Arm Controller board, and Terminal board.

4.8. Computer Control Unit

The system is built around a customized CPU (80*X*86). The CPU is the nerve center of the system that links together the internal and external components of the T-2500E (SE). Temperature control is managed by an embedded processor (80186). All other peripheral devices interface to the main CPU via standard serial or parallel interfacing techniques. A functional block diagram of the CCU is shown in figure 4 - 2.

4.8.1. Mother Board

The mainboard is a high-performance motherboard that uses an 80*X*86 microprocessor and features PCI and ISA bus support. The board is fully IBM PC/AT compatible.

The PCI (Peripheral Component Interconnect) local bus is a high performance 32-bit bus with multi-plexed address and data lines. It is used as an interconnect mechanism between the highly integrated perpheral components, peripheral add-in boards, and the process/memory system.

Perpheral boards provide the following functions:

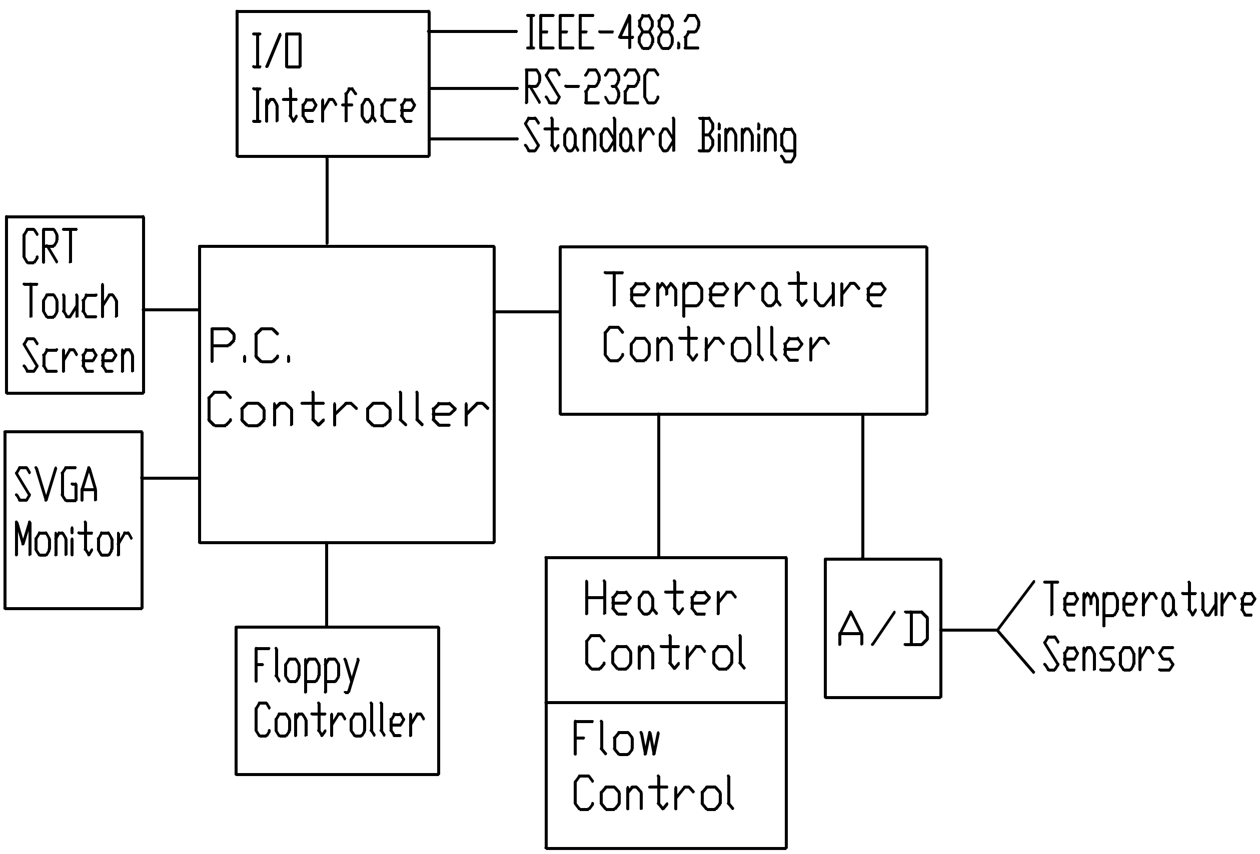

Fig. 4 - 2, T-2500E (SE) System Block Diagram

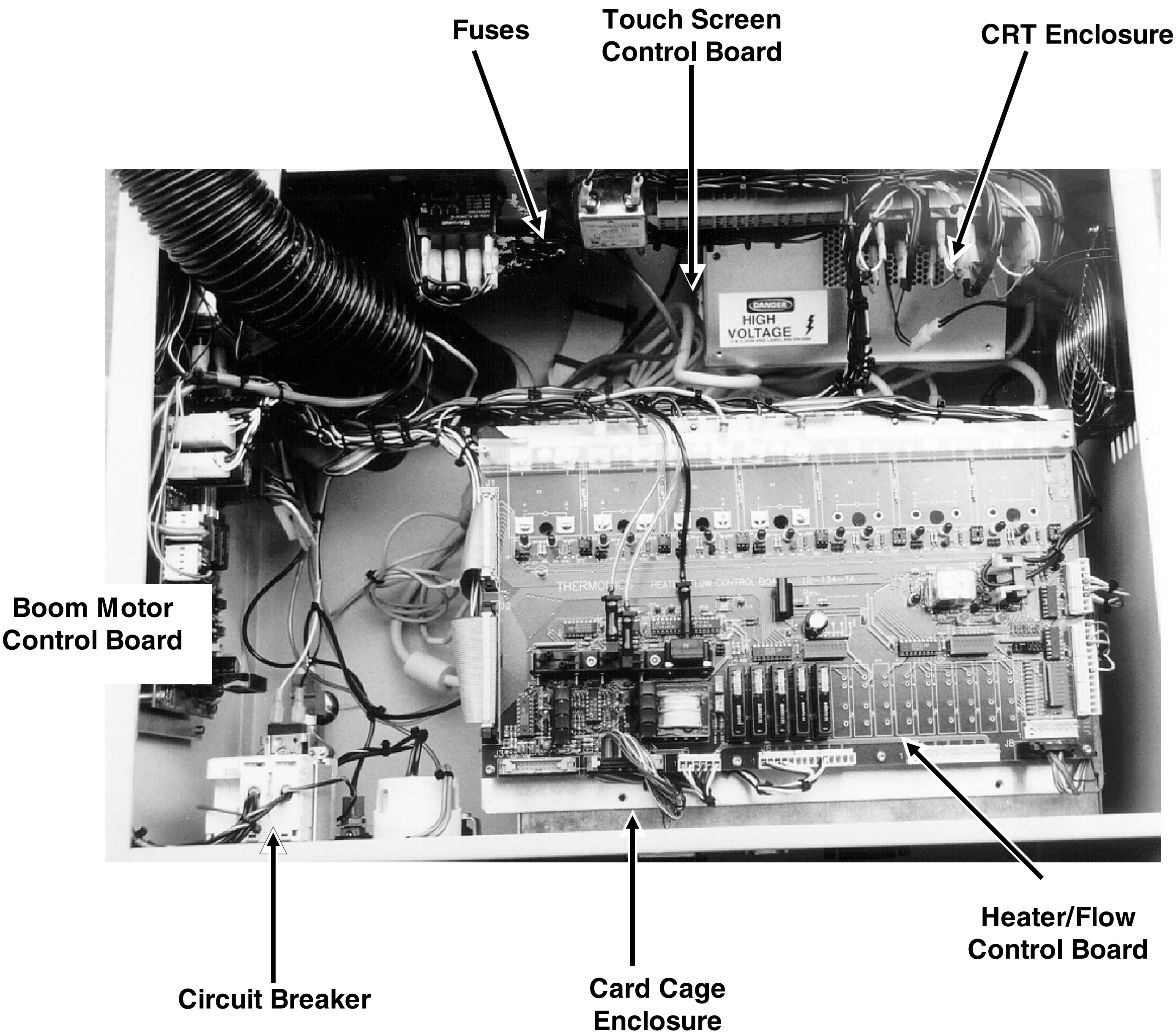

Fig. 4 - 3, Computer Control Unit (Chassis)

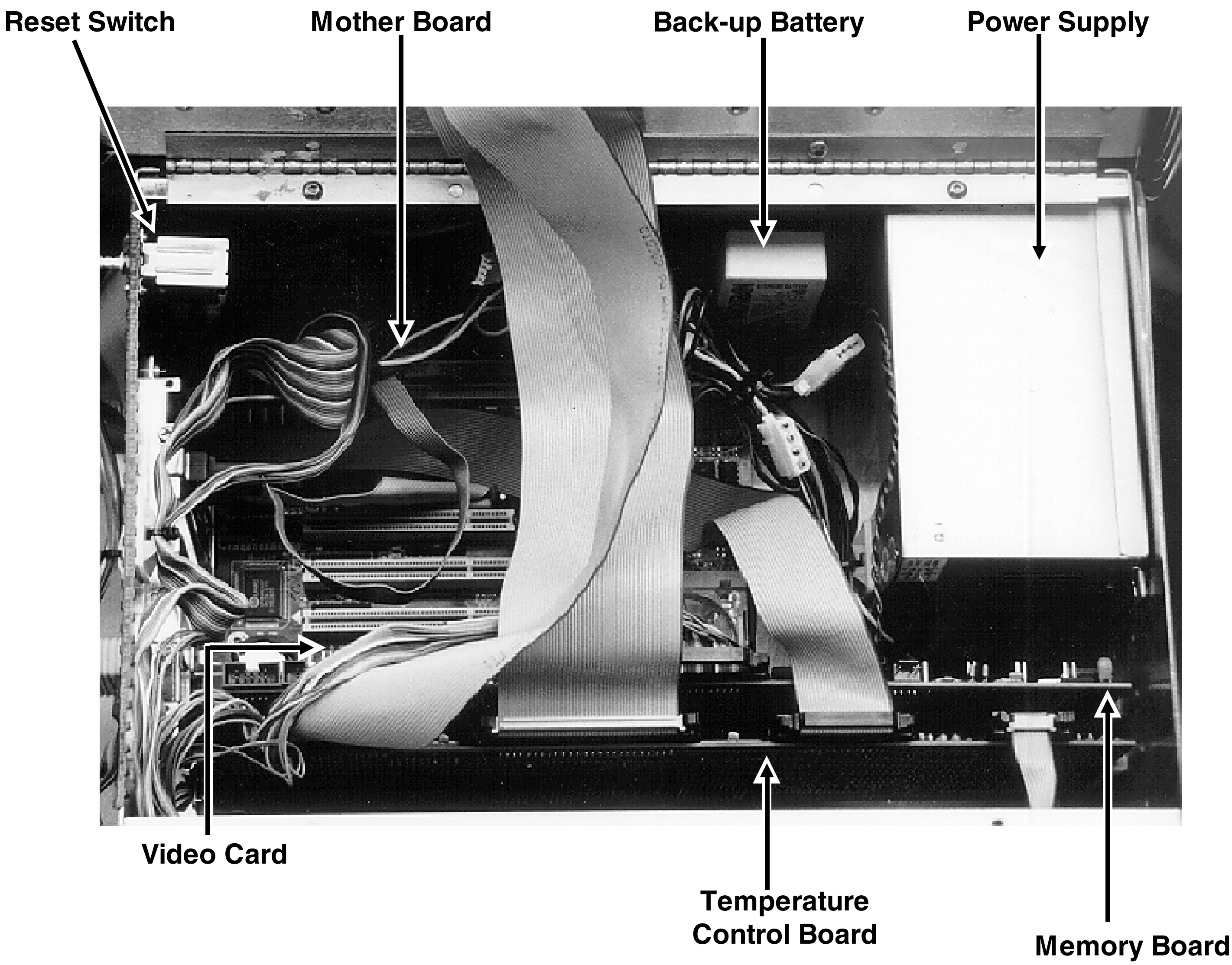

Fig. 4 - 4, Card Cage -- Inside View

BOARD	FUNCTIONS
Temperature Control Board	Analog to Digital conversion, Temperature Control. Communicates with Main CPU.
Memory I/O Board	IEEE-488.2, Tester Interface, Flash EPROM, Battery CMOS, Bulk Storage. Real-time operating system (TPOS).
Heater/Flow Control Board	5V dc input for 7 220 output solid state relays, 14 120 output relays. Opto-isolated relay sensors.
Super VGA Board	Uses 640 X 480 mode. 256-color capability.
Touch Screen Control Board	256 points/axis resolution, Input power: + 5V, 250-320 mA. RS-232C connector: DB9. Power connector: 5-pin right angle header.
Floppy Driver Board	RS-232C, Serial/Parallel Ports. Linked to Touch-screen board via RS-232C. Two Serial, one parallel. Floppy control.
Power Supply and Arm Controller Board	Controls speed and position of arm. Governs power supply. + 24V(Valves), 110 VAC (Solenoids), + 5V (ac Switches) , 36 V (Arm Motors).
Terminal Board	Thermocouple input (T & K), signal amplification, noise filtering, single-ended output.

4.9. Functional Overview

The following section describes what happens when the system is powered up.

4.9.1. Start-Up Events

The incoming air solenoid energizes allowing the pressurized source air to flow into the filter and desiccant air dryer tanks. The air dryer then begins to function. (See air dryer description section 4.11).

The system software then begins the automatic start-up sequence. The system performs a series of self-diagnostics. Any discrepancies in functioning will cause an error message to display on the screen. The refrigeration unit is purged of moisture for about five minutes. The compressor then operates for twenty minutes without any air flow in order for the heat exchanger to reach maximum cold temperature.

At this point, the air is flowing into the air dryer and venting out of the system through the muffler -- the system is in stand-by mode.

The system will remain in stand-by mode and won't become active until hot or cold air flow, or temperature cycling, is selected from the system software or a remote command is issued.

4.9.2. Air Flow Control Mechanism

Compressed air is connected to the rear panel of the PTFS. The air first passes through the main air valve (solenoid). The valve is initially closed and opens when the system is powered up. The air then enters an air dryer and filtration system. (See next section.) A pressure regulator maintains the air at an even pressure. After which it splits into separate paths for the test air and purge air. (See adjacent T-2500E (SE) Air Flow Block Diagram, Fig. 4 - 6.).)

Test air takes the following path:

- A solenoid opens or closes the test air path.
- A check valve ensures uni-directional air flow.
- A servo valve controls the flow rate.
- A venturi measures the air flow rate.
- A heat exchanger in the refrigeration system cools the air to a low temperature.
- A heater brings the cold air to the desired temperature.

An additional solenoid is used to provide a pathway of air that bypasses the solenoid, check valve etc. in order to implement COLD BOOST, which provides full-force unregulated air to the thermal fixture.

4.9.3. Purge Air Path

The second air flow channel is the Purge Air Path. A manual pressure reglulator and pressure gauge are used to set a precise flow rate. Purge air is used to prevent test equipment, that is used in conjunction with the Thermal Fixture, from overheating when using hot air or from freezing and icing up when cold air is forced. When using cold air, the purge air is typically heated to + 80°C. It blows onto the interface between the thermal fixture and the test equipment preventing the formation of ice. When using hot air, the purge air remains at ambient.

4.10. Mechanical Refrigeration Unit

The MRU is designed to cool a flow of dry compressed air entering at 80 psig at 25°C down to -60°C, as measured at the chiller exit. (It is designed to be operated continuously; however, if it is run for more than six days non-stop, the freon may become contaminated with oil particles from the compressor and thus become less efficient. Therefore, after using the system around-the-clock for six days, turn the system off for at least eight hours.)

The cooling process is a self-refrigerating four-step cascade system that uses a single-stage compressor. A mixture of non-flammable and safe refrigerants are compressed and circulated by the compressor in a five-step cycle. The cycle consists of:

1. Compressing the freon mixture.

2. Partially condensing the higher boiling fractions in the air-cooled condenser.

3. Withdrawing and throttling the con-

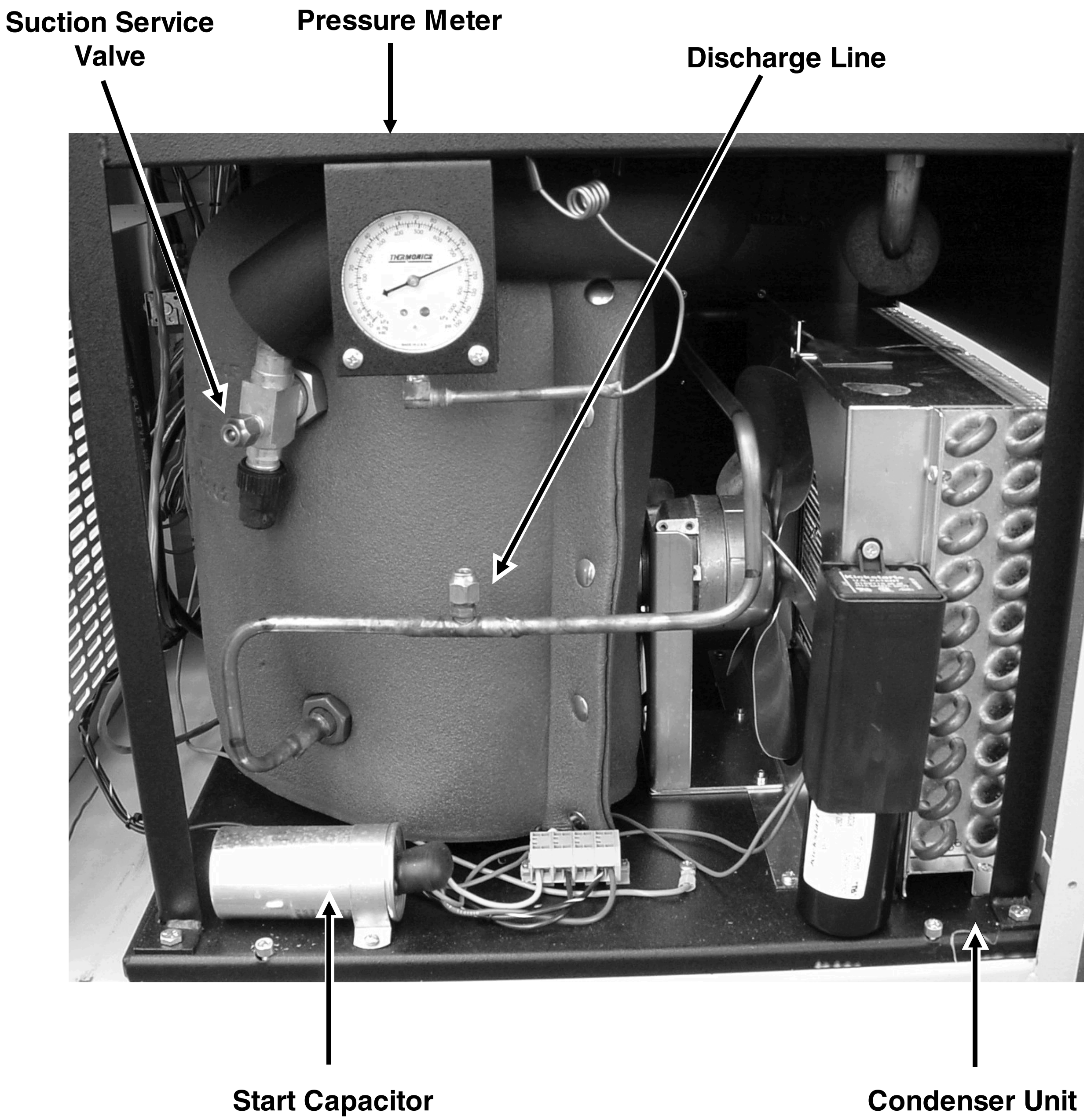

Fig. 4 - 5, T-2500E (SE) Refrigeration Unit

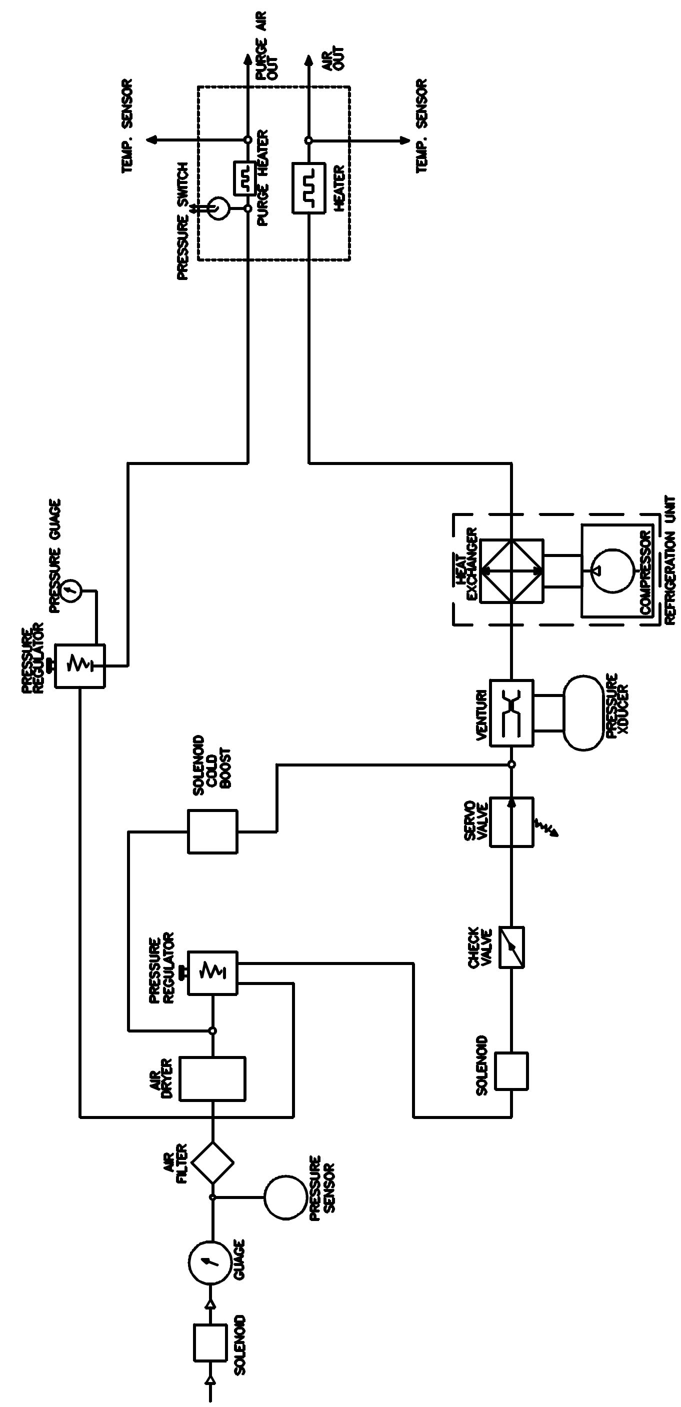

Fig. 4 - 6, T-2500E Air Flow Block Diagram

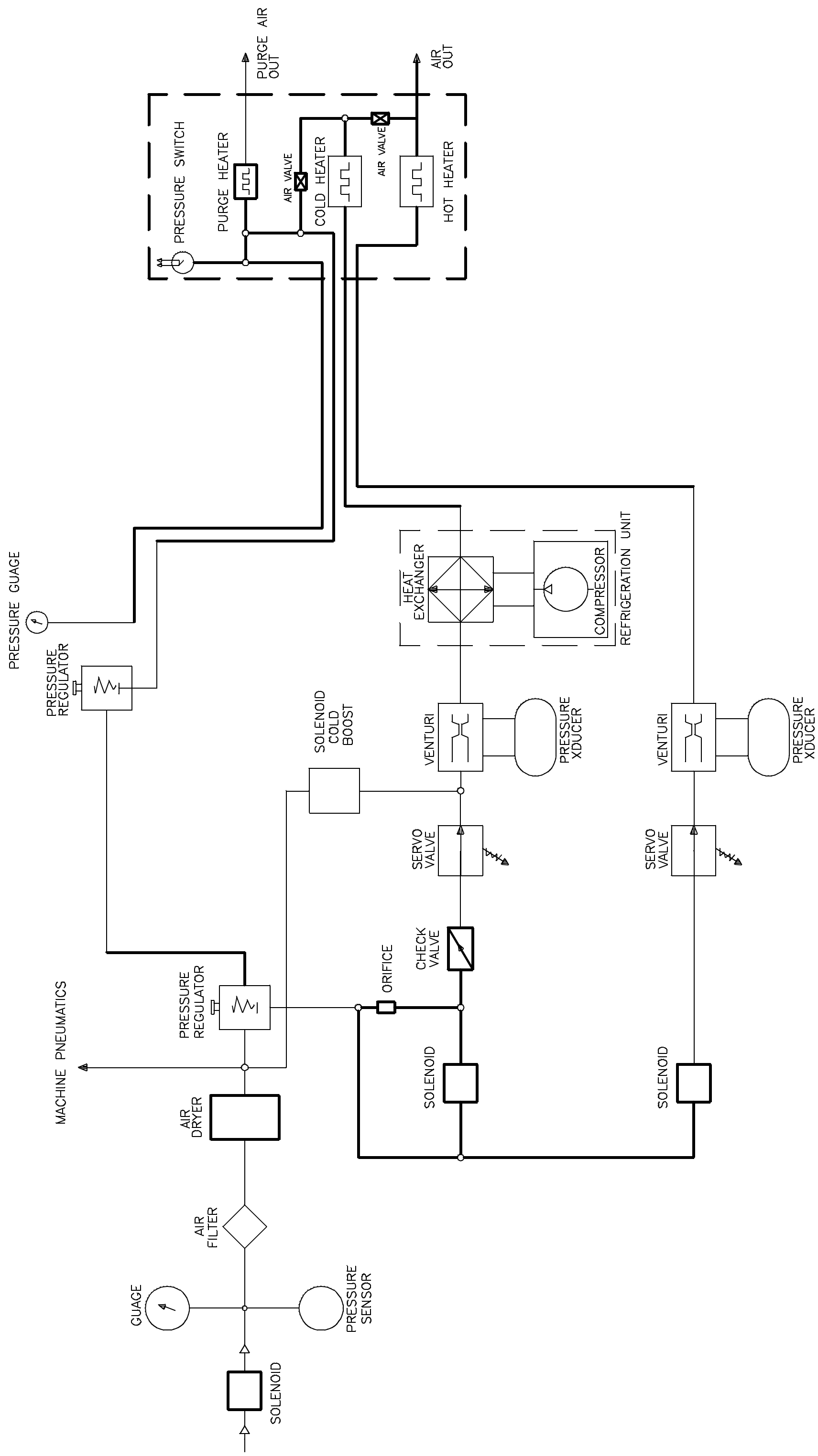

Fig. 4 - 7, T-2500SE Air Flow Block Diagram

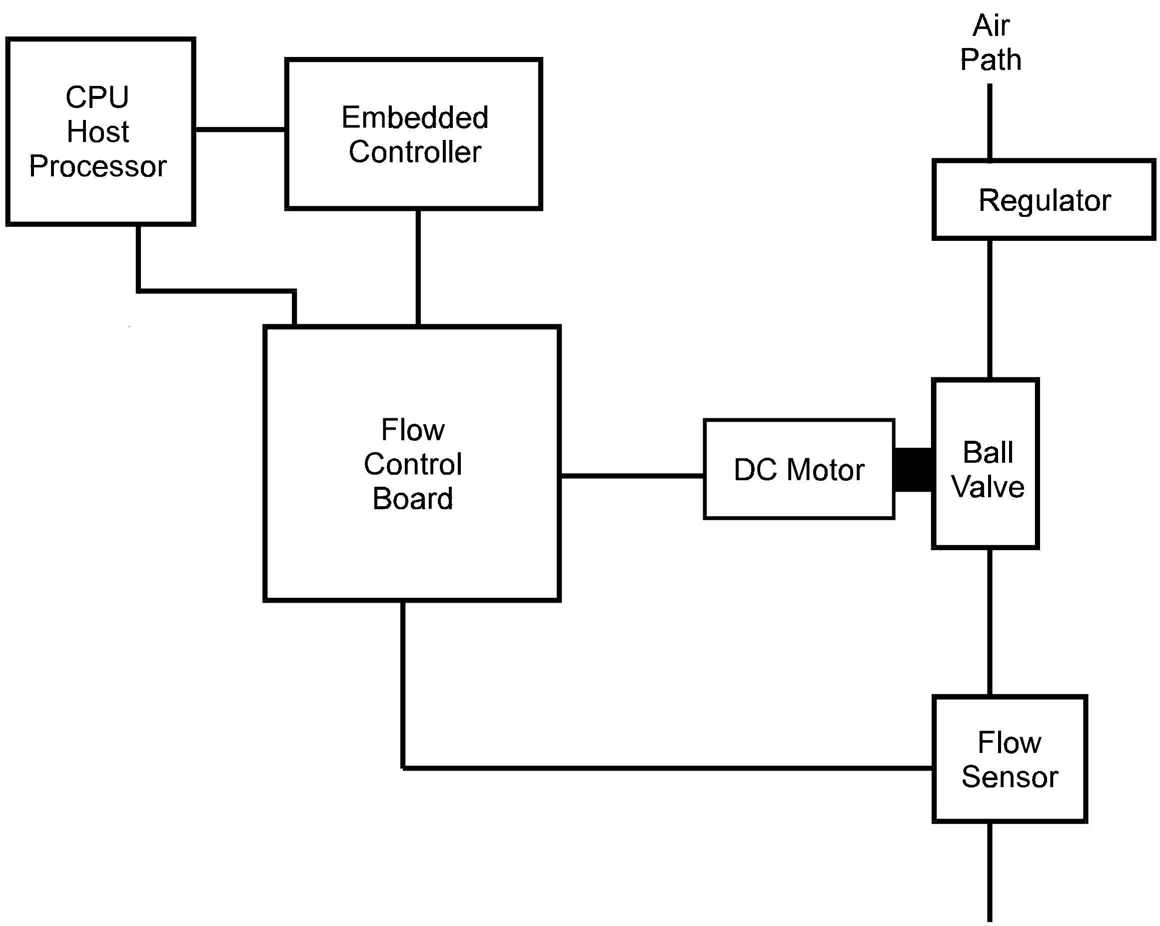

Fig. 4 - 8, T-2500E Air Flow Control Block Diagram

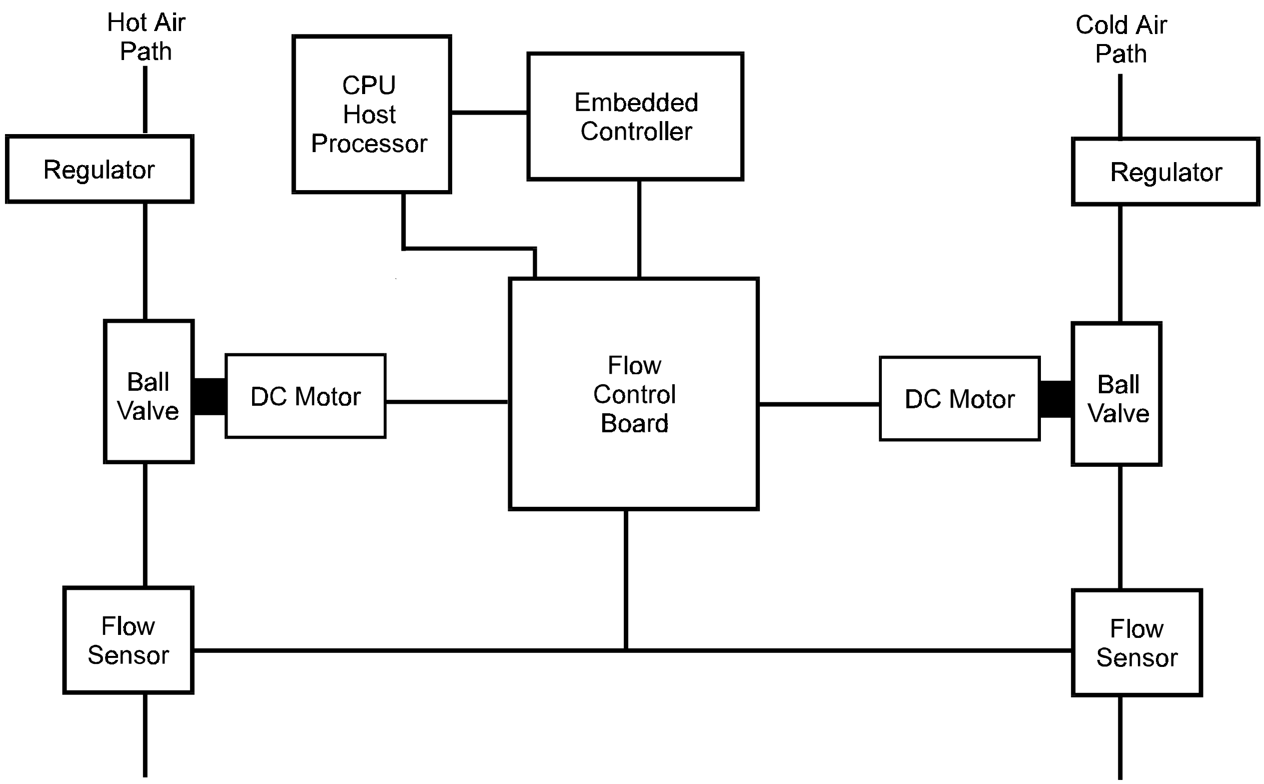

Fig. 4 - 9, T-2500SE Air Flow Control Block Diagram

densate to produce the cooling and condensing of the remaining vapors in the heat exchanger.

4. Throttling and evaporating the condensate in a coil to produce cooling to very low temperatures.

5. Returning of the refrigerant through the condenser to the compressor.

4.11. Regenerative Air Dryer

The T-2500E (SE) makes use of an air dryer and filtration system. The purpose of it is to remove excess moisture, oil, and particles from the input air and to lower the dew point of the air at 80 psi to -80°C.

Dew point, as you may recall, is the point at which air becomes saturated with water vapor and produces dew. The reason it is of concern, in the T-2500E (SE) PTFS, is that excess water can freeze in the air pathways and impair the functioning of the system.

The main components of the air dryer are: filters that purify the air, valves for directing air flow, and desiccant-filled tanks for drying the air. The end-product is air that is suitable for use in temperature-testing electronic components. The system operates by cleaning the source air (which must have a rating of 80 psi and a dew point of + 10°C or lower), passing the air through one of the two desiccant-filled tanks, and then out through the refrigeration path.

The first step in the air's transformation from source air into clean, dry air, is to pass through a water separation and coalescing filter (A). The filter; made up of a die-cast body, a metal bowl and other components; spins the air using centrifugal force to remove most of the water. The bowl contains the collected contaminants and also has a glass window that allows convenient visual inspection. The coalescing portion of the filter removes oil and dust particles. It uses coalescing elements to collect very small particles that eventually gather near the sump. The filter has a manual drain.

After the air is purified of particles and most of the water, it passes through a four-way solenoid-operated valve. (B). A timing circuit sends a signal to the valve at 90-second intervals. Upon reception of the signal, it adjusts the position of an inner shuttle using two opposed solenoids thereby alternating the flow of air between the desiccant-filled tanks (C).

The tanks are coaxial in design and contain desiccant. Because the desiccant has a high affinity for water, the air that emerges is very dry and thus has a very low dew point (-80°C). A spring-loaded diaphragm maintains the desiccant at proper density by applying continuous pressure.

While one tank is drying the air, the other tank is back-flushed with dry air; ensuring that a continuous source of dry desiccant is available. Most of the air passes out of the active tank, through the pilot-shuttle valve (D), and into the refrigeration path. However, a small portion of it flows through one of the air-flow restricting valves (E) and back-flushes the non-active tank. When the tanks switch, the three-way spring return valve (F) located near the muffler (G), momentarily engages maintaining pressure in the system during the switch.

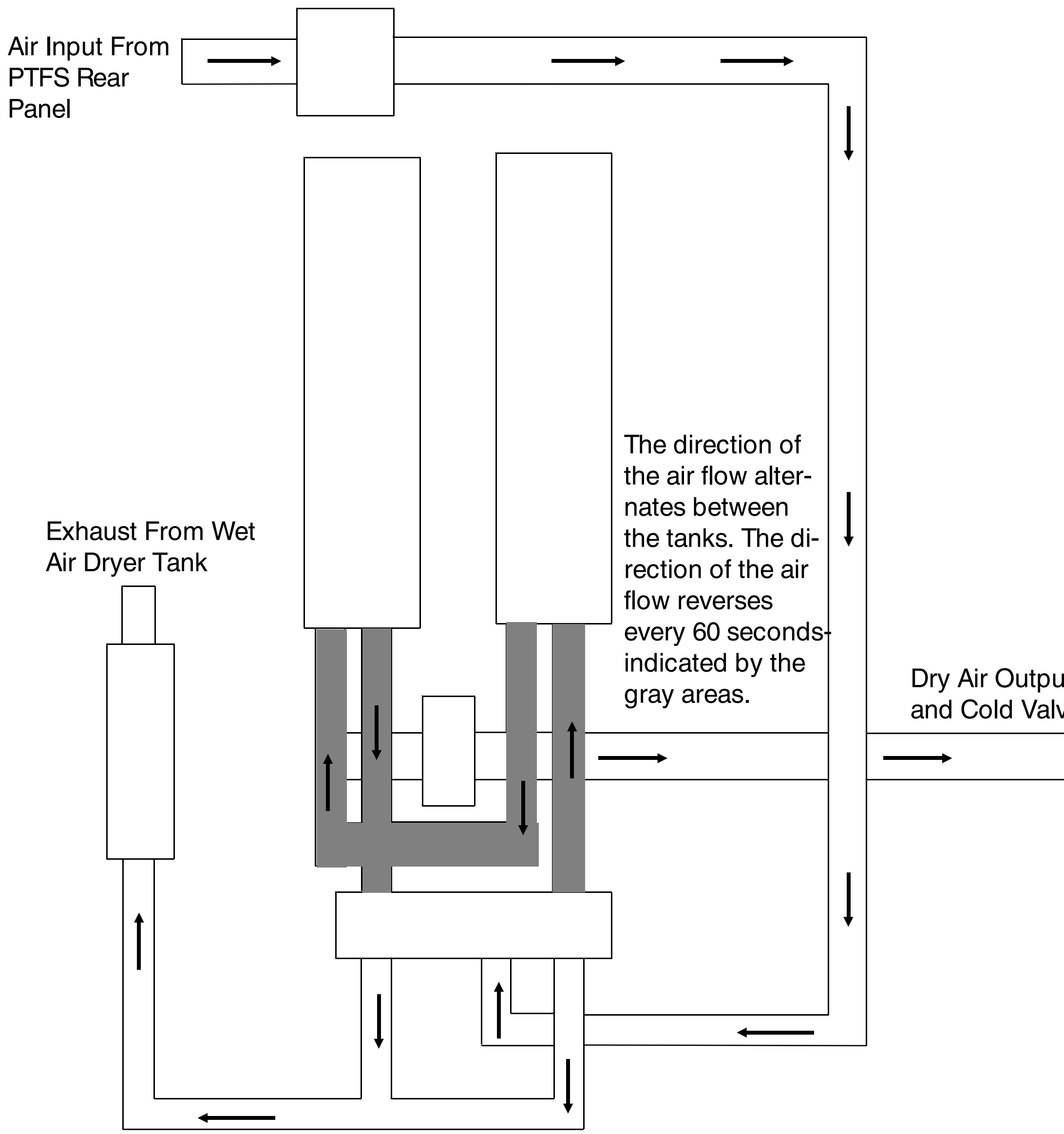

Fig. 4 - 10, T-2500E (SE) Air Dryer Flow Block Diagram

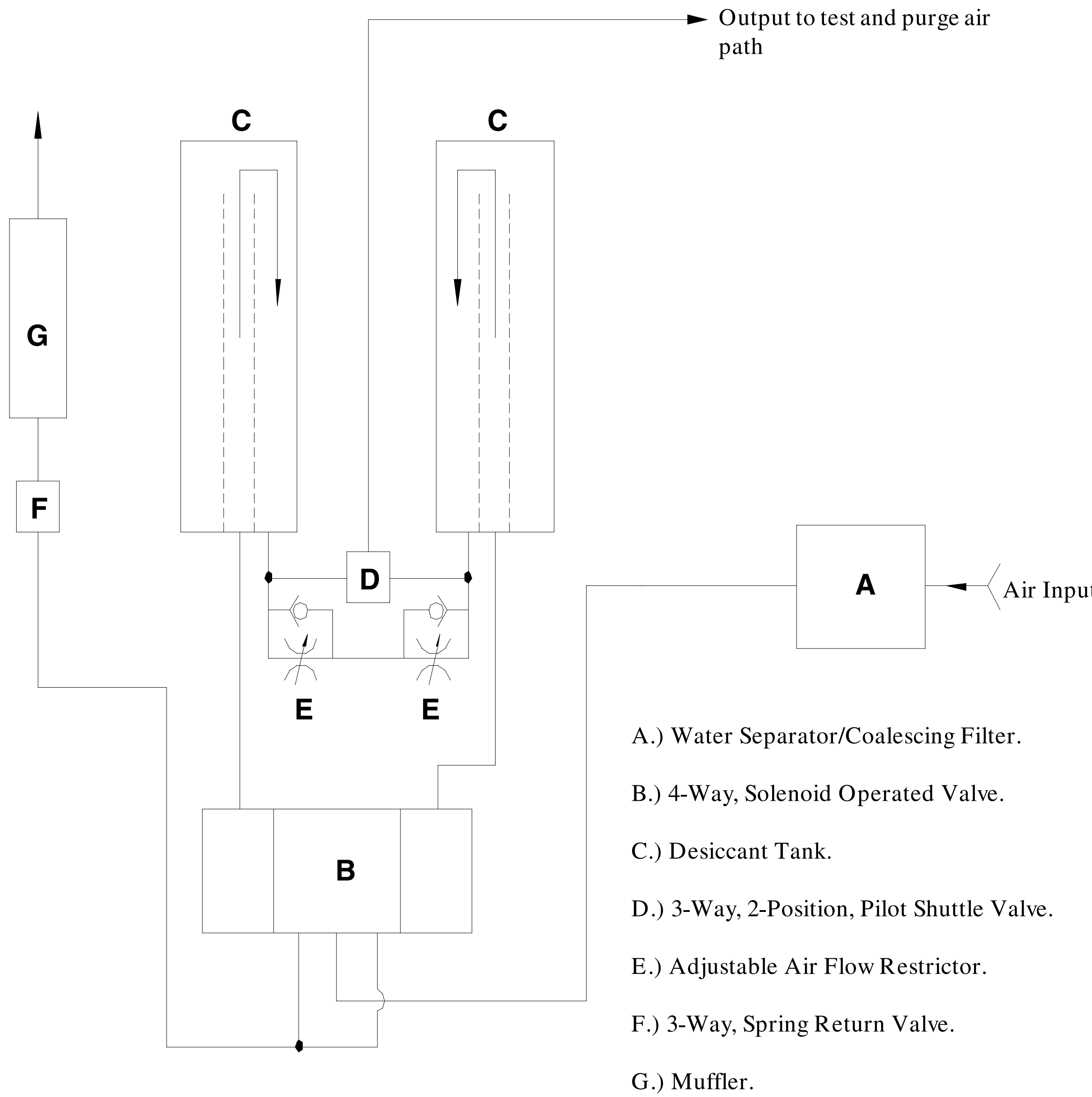

Fig. 4 - 11, T-2500E (SE) Air Dryer Block Diagram

NOTE: proper maintenance of the air dryer system will ensure long-lasting performance of the T-2500E (SE). Specifically, the unit requires annual or bi-annual replacement of the desiccant and routine maintenance of the filters. (See *Preventive Maintenance* Chapter.)

4.12.Support Arm and Thermal Head

Vertical movement of the support arm system is accomplished by a linear actuator. The linear actuator is activated by a toggle switch on the Thermal Head that engages a motor to raise or lower the arm using a screw-type mechanism. Horizontal motion of the arm is manual.

Both the horizontal and vertical motion of the arm is constrained by a braking system. The front brake controls the in/out motion of the arm, and uses a manual lever action to engage and disengage the brake. The rear brake constrains the vertical motion. This brake also makes use of a manual lever action. When the rear brake is not engaged, the lever presses against an indicator button to inform the system that motorized, vertical motion can be performed.

The Thermal Fixture is configured with an air heater and purge heater. A snap-disk thermostat attached to each heater case protects against over-temperature conditions. An air cylinder raises and lowers the thermal fixture.

4.13.Font Panel and Touch Screen

The front panel contains three major items: a power switch, an emergency stop, and a touch-screen CRT. The power switch turns the system on or off. The emergency stop quickly shuts off the power to all peripheral devices. The touch screen provides a physical interface between the end user and the software Graphical User Interface (GUI), which controls all aspects of the system--such as the operating parameters.

The touch screen is a thin film attached to a glass plate that covers the Cathode Ray Tube (CRT). The T-2500E (SE) control system (touch-screen control board) sends a small ac signal to the screen, from top to bottom and side to side. Changes to the signal correspond to the touch location. The position is translated into an electrical signal that the system can convert to a physical coordinate which is transmitted to the CPU via an RS-232C interface (COM 2). The touch locations map to specific areas of the GUI, enabling the end-user to interact with the system.

4.14.LN_2 Injection

LN_2, an optional feature of the T-2500E (SE), functions in the following manner: A solenoid controls the flow of LN_2 into the T-2500E (SE). It switches off when the measured DUT temperature is within 1°C of the set point, or when the solenoid is open for more than two minutes. The two-minute operating limit prevents liquid nitrogen from coming in contact with the DUT. Selecting cold operation from the touch screen, or sending the COLD command through either bus (IEEE-488.2 or RS-232C) resets the solenoid for an additional two minutes.

4.15.Static Control Option

Static charges, which are a significant matter of concern, are found in all phases of semiconductor manufacturing and test environments, including many of the environments into which the T-2500E (SE) is incorporated.

Often, static charges can result in unwanted problems such as particle contamination, ESD-generated device degradation, or latchup of electronic equipment--all adversely affecting production yields. Static can build up on both the conductive and non-conductive surfaces of the DUT, DUT load board, or the inside of the thermal fixture and lead to an ESD (Electro-static discharge) event either directly (conduction) or indirectly (induction).

Triboelectric charging is the primary cause of the static. It occurs whenever two surfaces are joined together and then separated. Any two materials can cause triboelectric charging including liquids, solids and gases. Temperature changes as well as humidity are also important contributing factors.

The T-2500E (SE) has an optional air ionization system that is available to control the build up of static charges within the thermal fixture to help prevent ESD events for any item that interfaces with the thermal fixture. The ionization system operates by intensifying a field around two bipolar pointed surfaces until the fields overcomes the dielectric strength of the air in the thermal fixture--creating an affect called corona discharge. As a result of the discharge, large quantities of positive and negative ions spill into the air stream greatly increasing the conductivity of the air. When the ions flow into the air, they are attracted to particles with an opposite charge, thus neutralizing any charged surfaces.

The T-2500E (SE) static controller is made up of a power supply, located within the body of the system, and two bipolar ionizer points (electrodes/emitters) located in the upper-bezel area of the thermal fixture. It operates on an input of 110 VAC, 50/60 hz and outputs 7.0 kv (10 Ma, max) at 70 ua DC (steady state, 0hz). The ionizer points are separated into two discrete chambers to prevent interference (arcing) between the positive and negative coronas. Additionally, two 1000M ohm resistors are incorporated into each chamber to provide a ground plane for the corona, altering the corona field lines. The resulting output air maintains a charge of $\pm$ 50 V, which is well within the range of safety for most applications.

Preventive Maintenance

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Preventive Maintenance

5.1. General

READ THE SAFETY CHAPTER BEFORE SERVICING THIS UNIT.

Maintenance of the T-2500E (SE) PTFS is an activity that can be categorized into two basic groups: Preventive and Corrective. Preventive maintenance activities are those procedures that are performed to keep the PTFS operating in a normal, usable condition. Corrective maintenance activities are procedures such as trouble-shooting, repair, and replacement of malfunctioning components and assemblies. There is a little overlap between the items that may be strictly considered preventive and those that are considered corrective—such as when an element of the system that doesn't normally require replacement is discovered damaged or defective during a routine periodic inspection. Hence, the activities and procedures listed here are for those items that are considered by Thermonics as appropriate for routine preventive maintenance. Other activities, such as replacement of defective PC boards, are considered corrective maintenance activities. The repair instructions for these item can be found in the Corrective Maintenance chapter.

For pragmatic reasons, such as staying within the bounds of the warranty issued with this product, it is prudent to follow the instructions in this section within the scheduled time periods.

NOTE: this section provides guidelines that can help an experienced individual, who is familiar with the correct operation of the system, keep it running properly. It does not eliminate or replace the need for common sense when maintaining or using the system.

Preventive maintenance consists of inspecting, cleaning, and/or replacing materials in key areas of the system. These areas are:

- the Refrigerative Air Dryer (RAD),
- the Refrigeration Unit (RU),
- the PTFS Computer Control Unit (CCU),
- and the Forced Air Output Assembly (FAOA).

When performed on a regular basis, preventive maintenance procedures can deter equipment from breaking down and ensure reliability and a long product life span. The schedules in this section are for normal operating conditions, and must be moderated by the severity of the environment to which the equipment is subjected. The general recommended interval for performing preventive maintenance is three months.

5.2. Cleaning Materials

The T-2500E (SE) is a very sturdy piece of equipment; however, it should be cleaned with the proper types of cleaning materials to prevent damage to its appearance or functioning. Mild household soap is the preferred cleaning solution. Methanol may also be used. Abrasive cleaners and chemicals such as acetone, benzene, and carbon tetrachloride should never be used.

5.3. Lubrication

No regular or periodic lubricating or oiling is required. The compressor and condenser fan motors are factory lubricated.

5.4. Periodic Inspections

To keep the system running properly, it is best to perform periodic inspections of all moving parts, gauges, lamps and LED's, for wear, play, fit, functioning and cleanliness. Examples of items to inspect are:

- Input Pressure Gauge
- Thermal Fixture motion (up/down)
- Boom motion (up/down)
- Boom motion (in/out)
- Arm rotation
- Fan filters
- Input air filters
- Refrigeration Unit Condenser
- Running and Balance Pressure of refrigerant

Perform inspection of the input pressure on a daily basis. Inspect all other listed items on a weekly basis.

5.5. Periodic Maintenance

The table on the following page (Table 3 - 1) displays the suggested preventive maintenance activities and the recommended time for each.

5.6. Maintenance Procedures

The procedures for each scheduled maintenance item follow. Maintenance to the air dryer system may require the replacement of a filter or desiccant. Typically, if the filter requires replacement, the desiccant also should be changed. To do so order replacement parts (See section 3.7.3).

5.6.1. Touch Screen Operator Interface

The touch-sensitive film is on the viewing (convex) side of a panel that sits over the CRT. The material it's made out of is as rugged as glass and requires the same care. Any glass cleaner may be used to clean the surface; however, you must avoid using any cleaning fluids that leave a conductive residue.

When cleaning the surface of the touch screen, do not spray the screen directly with the cleaning solution because a fluid buildup around the edges of the monitor may create a problem. It is best to dampen the cleaning cloth with the spray and then use it to wipe off the screen.

5.6.2. Exterior Panels

Remove loose dust and grime from the outside panels of the PTFS with a soft cloth or brush. A mild soap solution may be used on these surfaces.

5.6.3. Boom and Thermal Fixture

Periodically inspect the boom and thermal fixture for proper functioning. Make sure that the horizontal and vertical movement of the arm is smooth, and that the complete range of motion occurs. Also, make sure that the brakes are functioning properly.

ITEM	ACTIVITY	FREQUENCY
Water/Coalescing Filter	Clean or Replace	Biannual
Air Dryer Desiccant	Replace	Biannual
System Fan Filter	Replace	Annual
Refrigeration Unit Condenser	Clean	Monthly
Boom	Clean	Monthly
Thermal Fixture	Clean	Monthly
PTFS Body Panels	Clean	Monthly
Chassis Front Panel	Clean	Monthly
Gas Input Pressure	Inspect/Adjust	Daily
Refrigeration Balance Pressure	Inspect	Annual
BIOS Battery	Replace	5 Years
Air Temperature and Flow Rate*	Calibrate	Biannual (*See Chapter Six)

Table 5 - 1, Periodic Maintenance

Test the thermal fixture for up/down motion.

5.6.4. Forced Air Output Assembly

Inspect the thermal test head for accumulations of dirt or grease. Clean the guide areas of the air cylinder. Operate the ball joint to check for a loose or binding condition and restricted movement. Check for loose electrical and pneumatic connections.

Check the rubber O-ring (bumper) on the shroud and replace it if damaged or excessive frost or moisture builds up at the test site.

Thermonics' part numbers for shroud O-ring replacement:

SIZE	PART NUMBER
Small	3F-755-1A
Standard	3F-276-1D
Large	3F-377-1D

Table 5 - 2, O-Ring Part # s

5.7. Air Dryer

Inspect the input air filters for an accumulation of water and oil. Discharge any contamination found. If large amounts of contamination are found, clean and replace desiccant as described later in this section.

5.7.1. Desiccant Replacement

The need to replace the desiccant in the air dryer tanks can vary as a function of both the quality of the air source and the level of use of the PTFS. In many environments, the desiccant remains usable for a longer period of time than suggested here. If the PTFS is working well, and no drop in pressure or excessive frost or moisture is evidenced, you need not replace the desiccant. The recommended desiccant replacement interval is six months. A more frequent replacement interval indicates that the quality of the air source is not suitable and may contain too much moisture or oil.

Use the following procedure to replace the desiccant.

1.) Disconnect the power and air source from the PTFS rear panel.

2.) Perform the air dryer tank removal procedure. (See 3.7.2.)

3.) Remove the eight 8-32 cap head screws from the cylinder aperture covers and dispose of the old desiccant.

4.) Fill the cylinder with desiccant until it fills the tank. Leave about 1.5 - 2.0 inches of unfilled space at the top of the tank. With cover springs uncompressed, the cover should extend about .5 inches above the cylinder.

NOTE: It is very important to fill the tanks to the correct level; otherwise, the desiccant will be pulverized by the high pressure and pollute the system.

5.) Compress the cover springs and replace the tank aperture cover.

NOTE: The air tanks operate under extremely high pressure. Covers must be securely replaced.

5.7.2. Air Dryer Tank Removal Procedure

1.) Remove the clamp that holds the air-dryer tank in place. (See Fig. 3 - 2)

2.) Disconnect the tanks at the quick-disconnect fasteners and lift away from the mounting plate.

5.7.3. Air Dryer Preventive Maintenance Parts List

ITEM	PART NUMBER
Filter	P5-052
Desiccant	P5-015

Table 5 - 3, Air Dryer Part #s

5.7.4. Air Input Filters

There is one main air filter on the air dryer: the water separation and coalescing filter. The filter removes water, particles and oil from the source air.

To maintain maximum filtering efficiency and to avoid excessive pressure drops, the filter must be kept clean. A visible coating of dirt or condensate on the surface of the filter or a drop in pressure indicates that cleaning is necessary. The elements should be inspected and cleaned or replaced as required. The filters may need periodic attention about every three months.

Before cleaning the filter, remove the power

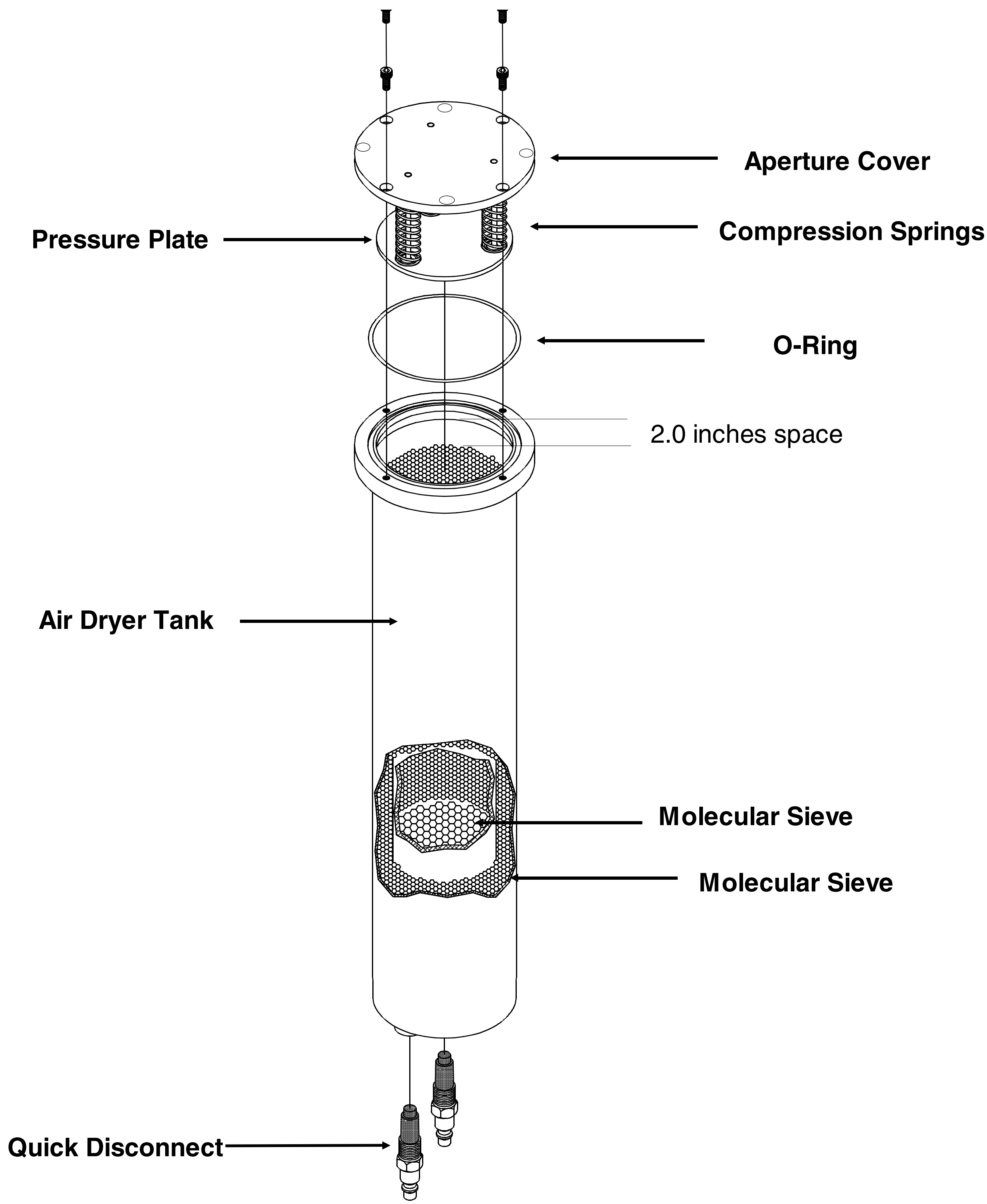

Fig. 5 - 1, Air Dryer Tank Cut-Away View

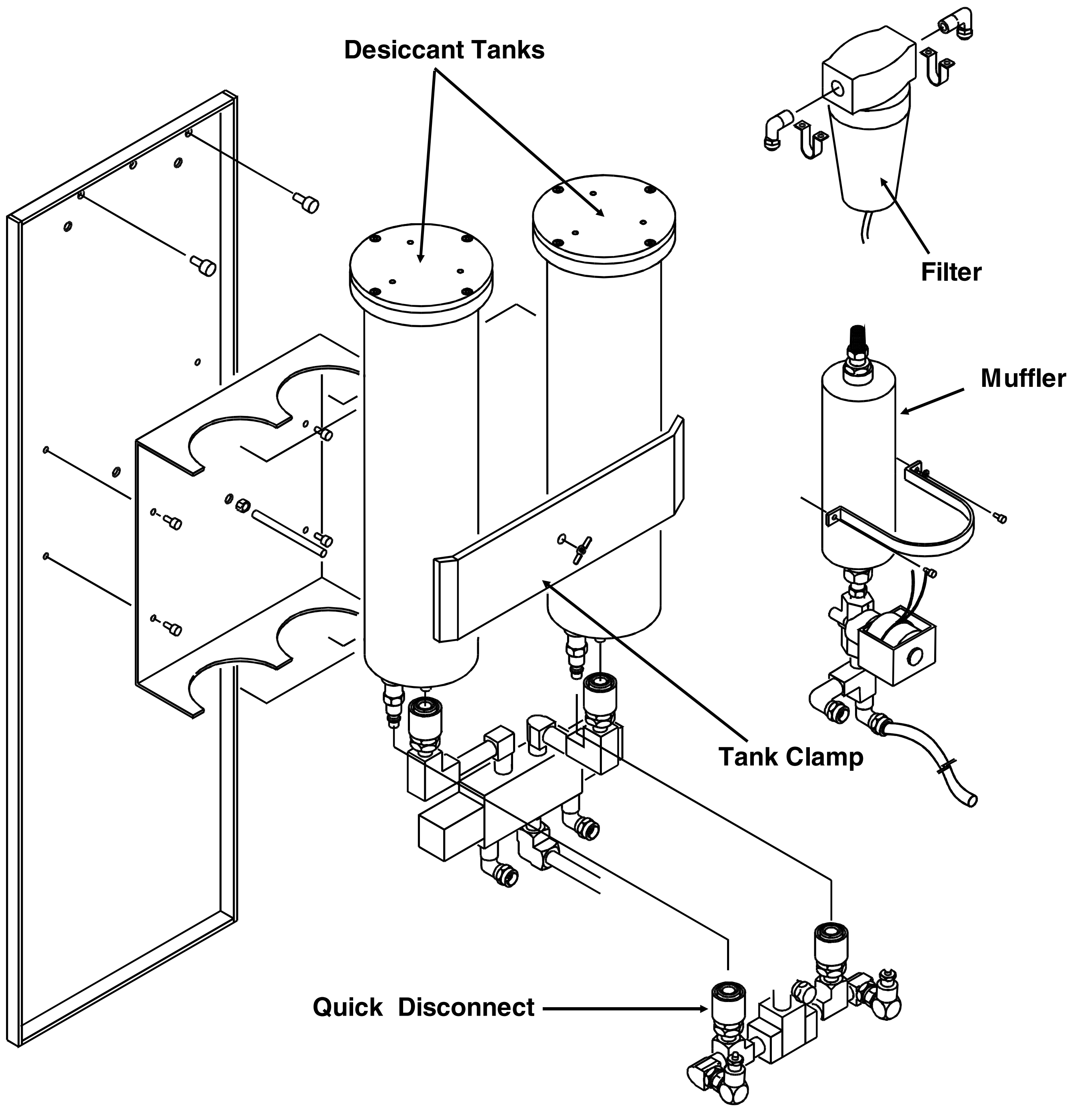

Fig. 5 - 2, Air Dryer Assembly

and air source from the PTFS. Then, use the instructions that follow.

5.7.4.1. Filter Cleaning Procedures

1.) Remove the metal bowl by twisting off in counter-clockwise direction. Clean the bowl assembly with household soap.

2.) Blow out the filter with an air hose, replace if necessary. When replacing the filter element, turn the bottom adapter counter-clockwise to remove the filter from the retaining rod.

    As much as possible, handle the replacement filter element by the ends to avoid contaminating it. Install it between the top and bottom adapters and hand tighten the adapter. Make sure to replace the rubber O-ring that goes between the top adapter and the filter cover.

3.) Flush the auto-drain.

4.) Reassemble the filter.

NOTE: Normally, the only required cleaning involves removal of the bowl and cleaning or replacing the filter. In severe contamination conditions, further cleaning of the auto-drain may be required.

1.) To disassemble the auto-drain mechanism, remove the nut on the exterior bottom of the filter cup, and pull it out of the cup.

2.) Remove the top portion of the auto-drain. Clean all parts with soapy water and reassemble.

5.7.4.2. Air Filter Cleaning Precautions

When replacing the filter bowl, tighten the bowl to a stop (approximately five turns).

5.8. Refrigeration Unit Condenser

An excessive build-up of foreign material on the refrigeration unit condenser inhibits the ability of the unit to effectively cool the air. Periodically inspect the condenser for dust, and remove any accumulated matter with compressed air.

To remove the dust use a vacuum with a soft brush to pull the material from the condenser.

5.9. Internal Control Unit

The internal control electronics of the PTFS are similar to those found in other sophisticated computer equipment, and are sensitive to corrosive gasses, dust, high humidity, and temperature extremes. Because dust is hard to avoid, you should inspect the internal PC boards periodically for a build up. Noticeable dust should be removed with a vacuum cleaner and a brush-tipped adapter. Check the aperture on the cooling fan to make sure it is not blocked.

NOTE: Make sure the unit is disconnected from the power source and take care to observe static precautions.

5.9.1. Battery Backup RAM

The lithium batteries, that supply power to the system's BIOS RAM, are good for about five years. Check the maintenance schedule portion of the software to see if the batteries require replacement. Allowing the batteries to run out will cause all the Computer Control Unit BIOS parameters to be voided, creating the need to re-enter them by hand.

5.9.2. Optional Air Ionizer

If an air ionizer is installed, check the system on a monthly basis for ion balance using a hand-held static field meter or a charge plate monitor. A complete check of the ionization system should be performed before making any type of adjustment or calibration to this system.

5.9.2.1. Ionizer Cleaning and Maintenance

Perform cleaning and maintenance of the air ionizer on a monthly basis as follows:

1.) Turn the power to the PTFS off.

2.) Inspect the electrodes in the thermal fixture for excessive wear or particle accumulation. With the air flow off, you may be able to hear a hissing sound if the electrodes are coated with dust or contamination.

3.) Clean the electrodes using a lint-free cleaning swab and denatured alcohol.

4.) Depending on the frequency of usage and the environmental conditions, the electrodes may require replacement about once a year.

5.) Clean the ionizer case using a lint-free cloth and a mild non-abrasive cleaner.

Calibrating the T-2500E (SE)

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Calibrating the T-2500E (SE)

6.1. INTRODUCTION

This chapter describes the procedures used to calibrate the T-2500E (SE) PTFS. The calibration methods covered are:

- Air-Flow Calibration
- Manual Calibration of the Air Temperature sensor, DUT sensor, or RTD.
- Millivolt Source Calibration of the Air Temperature and DUT Sensor

NOTE: the recommended interval for calibration is every six months.

The calibration process serves to adjust and standardize the air flow rate and temperature measurement systems of the T-2500E (SE). The sensors that you may calibrate are the air flow rate sensors, the fixture air temperature sensor, the DUT temperature sensors, and the RTD. DUT temperature sensors may be either T-type or K-type. Temperature calibrations can be stored separately and recalled for later use in specific testing situations.

The basic calibration procedure is to measure the actual temperature or air flow rate, compare it to a known standard and enter the new values from the standard. The external standard for air temperature calibration may be an external temperature meter or a millivolt source.

The system adjusts the control software to ensure accurate display and use of temperature or flow values.

The system software contains a series of screens that guide you throughthe calibration procedures. To access the calibration top-level menu, select CALIBRATION from the Main Menu screen.

Note: a detailed technical note on calibration is in the User's Manual Appendix.

6.2. AIR FLOW RATE CALIBRATION OVERVIEW

Periodic air flow rate calibration is essential to ensure proper functioning of the T-2500E (SE). Calibrate the air flow rate by connecting a flow rate meter, that measures the flow rate in SCFH, to the air output nozzle on the Thermal Fixture. Then, select the AIR FLOW RATE choice from the Calibration Menu and follow the on-screen instructions. (For T-2500SE, see note on pge 6-3.)

The system will force air at a high and low-flow rate in the flow pathway and ask you to enter the values measured by your external equipment for comparison. At the end of the process, you can choose to ACCEPT or ABORT the calibration. If you choose ACCEPT, the calibration values will be stored and used to quantify all future air flow rates. If you select ABORT, you will be returned to the opening screen to begin a new air flow rate calibration.

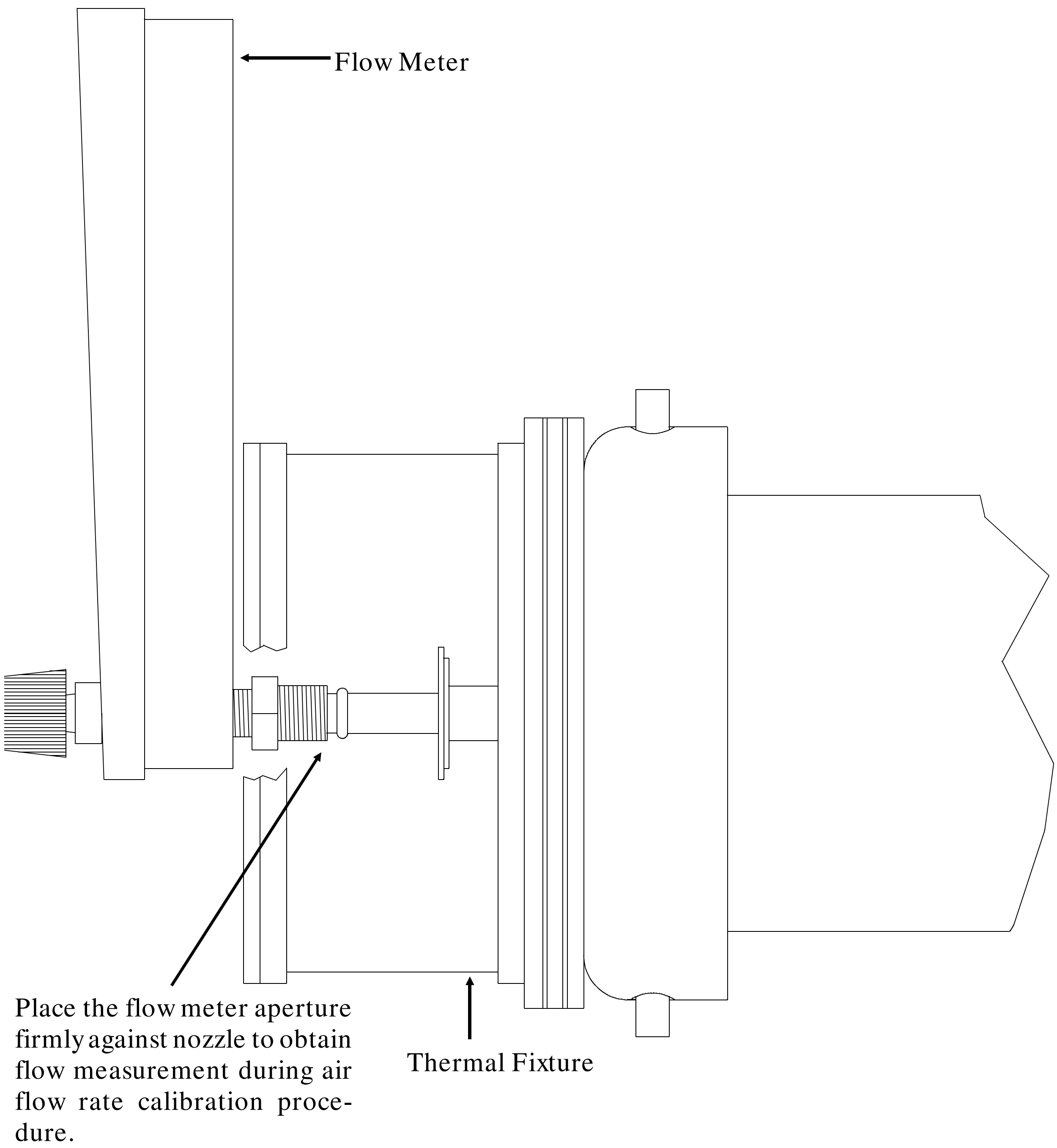


Fig. 6 - 1, Placement of Air Flow Meter

At any point in the process, you can halt the calibration procedure without making any permanent changes to the air flow rate measurement system by selecting ABORT from any screen on which this selection appears.

6.3. Air Flow Calibration Setup

The flow calibration procedure is as follows:

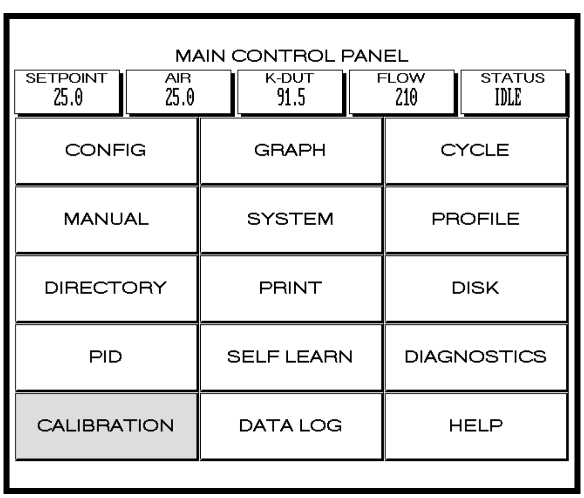
a. Start the system. Bypass the Automatic Power-Up feature. If the compressor has been running, use the defrost feature to make sure the refrigeration system is not cold.

b. Connect the flow meter in-line with the forced air output. (See opposite illustration.)

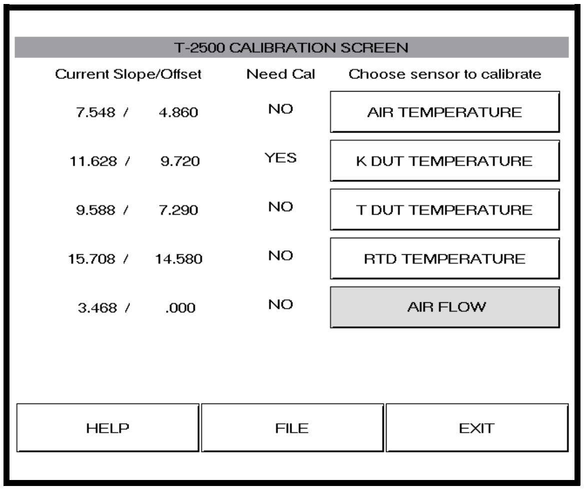
c. Select AIR FLOW from the Calibration Main menu, and proceed as below.

NOTE:. These instructions are for model T-2500E which has one air-flow pathway. For model T-2500SE, which has two pathways, this procedure must be performed twice. Once for the cold air path and once for the hot air path. Because of this design difference, the GUI for the air flow calibration on model T-2500SE is slightly different. It contains separate hot and cold air-flow path selections.

6.4. Air Flow Calibration Procedure

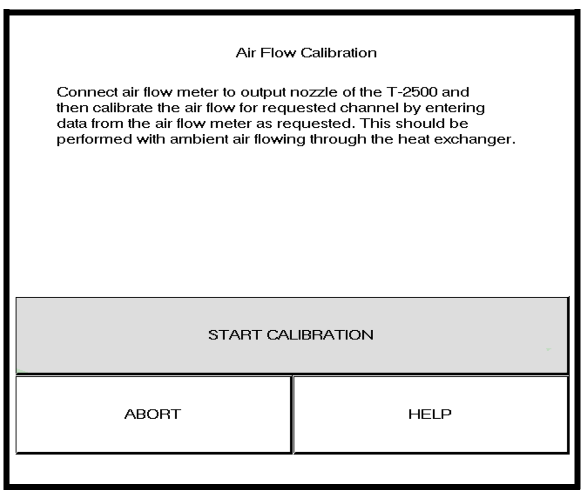


1. Select **CALIBRATION** from the Main Menu Screen.



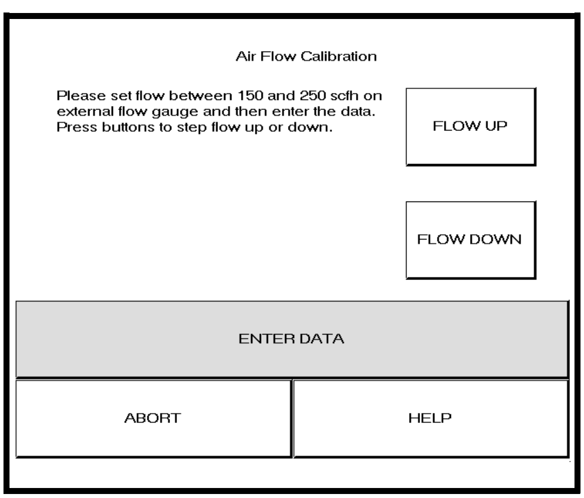
2. Chose **AIR FLOW**.

Note: On model T-2500SE, the selections are *Hot Air Flow* or *Cold Air Flow*. Select either one. Both pathways must be calibrated. The instructions are the same from this point forward for both systems.

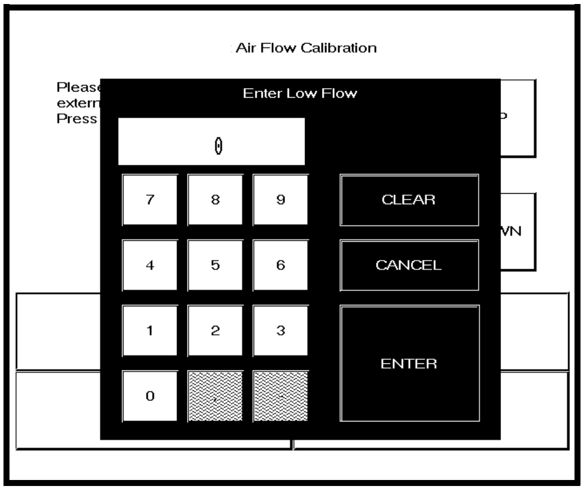


3. Connect the flow meter and choose **START CALIBRATION** to begin the calibration process. The low flow adjustment screen will appear.

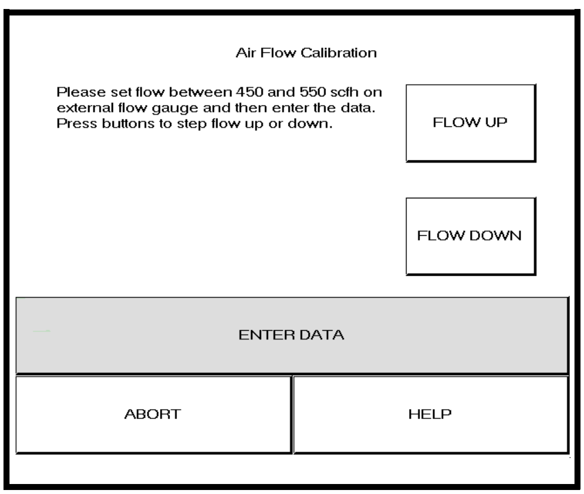
   Options:
   Select **HELP** to obtain the on-line help.
   Choose **ABORT** to exit without beginning an air flow calibration.



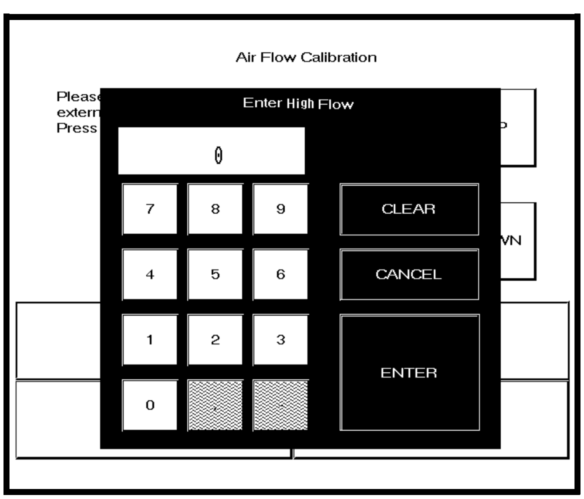
4. Use the **FLOW-UP** and **FLOW-DOWN** buttons to adjust the air flow between 200 and 300. Then, select **ENTER DATA**.



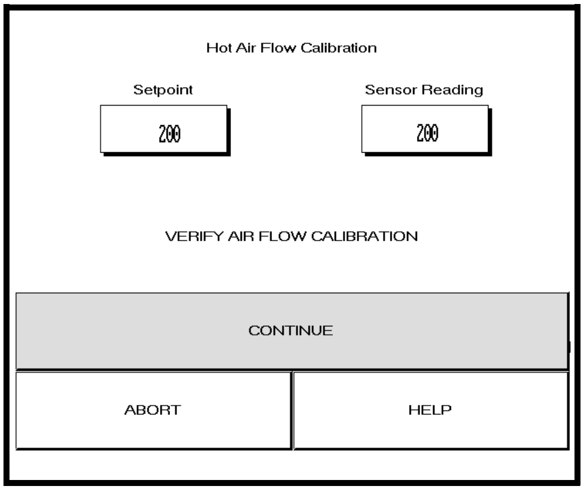
5. Enter the actual air flow registered on the external flowmeter into the numeric keypad and press **ENTER**. The high flow adjustment screen will appear.



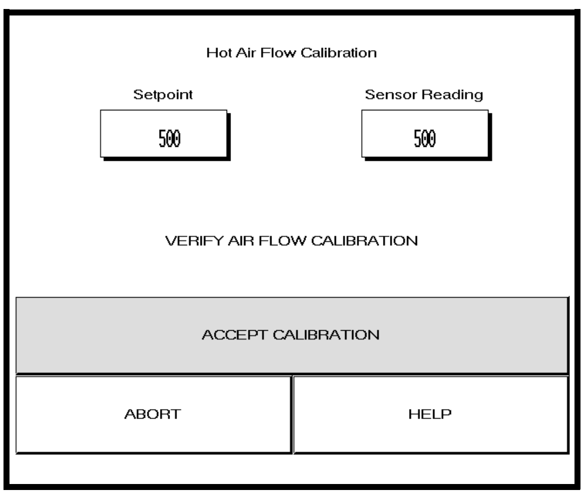
6. Use the **FLOW-UP** and **FLOW-DOWN** buttons to adjust the air flow between 450 and 550. Then, select **ENTER DATA**.



7. Enter the actual air flow registered on the external flowmeter into the numeric keypad and press **ENTER**. The low flow verification screen will appear.



8. Verify that the low-flow calibration set point and external meter are reasonably similar. Select **CONTINUE** to obtain the high-flow verification screen.



9. If the high flow set point and the external meter are in agreement select **ACCEPT CALIBRATION**.

Note: On model T-2500SE, you must calibrate both the hot and cold pathways separately. If you have not already done so, repeat this procedure for the remaining pathway.

6.5. THERMAL FIXTURE AIR TEMPERATURE SENSOR CALIBRATION OVERVIEW

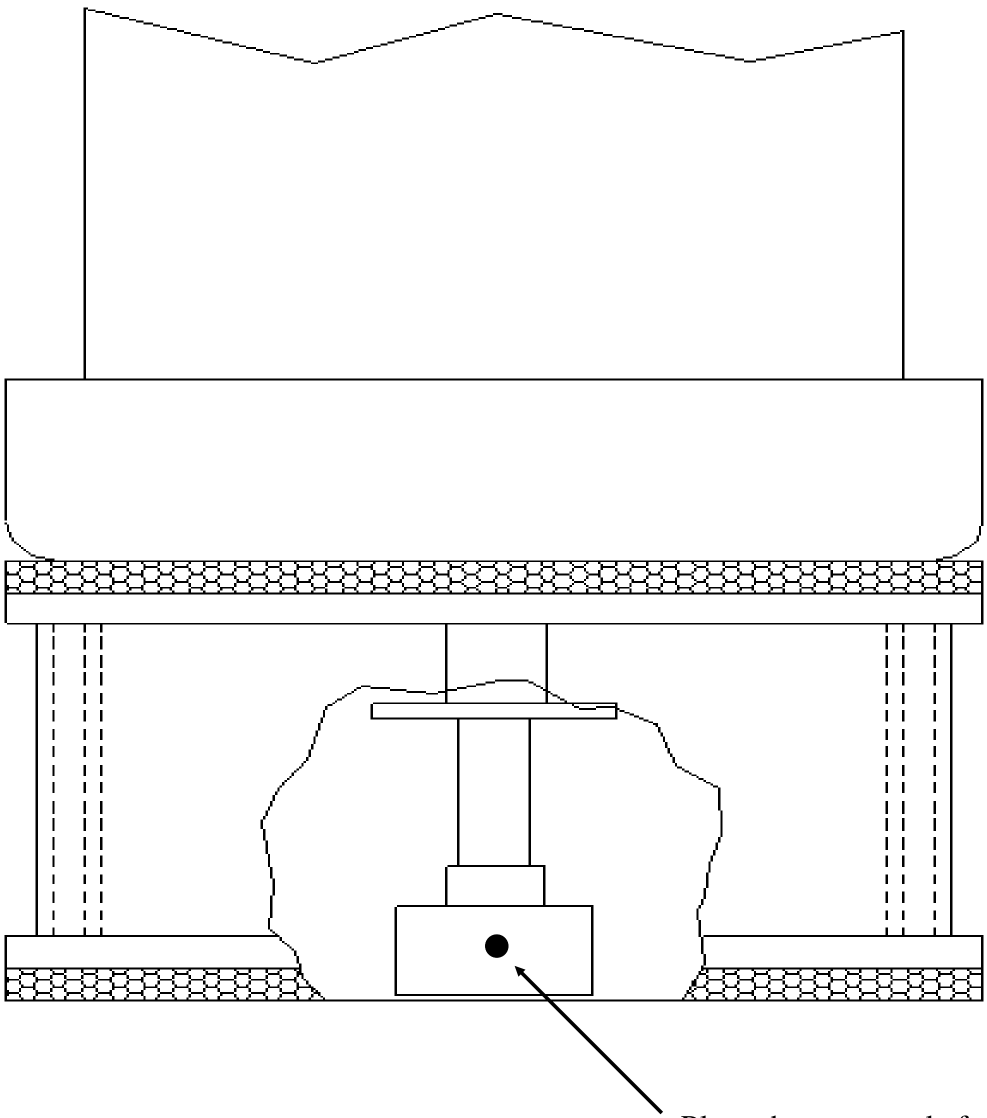
The air temperature calibration procedure adjusts the air temperature sensor that monitors the airstream exiting the nozzle in the Thermal Test Head. The temperature calibration process scales the temperature reading of the T-2500E (SE) such that it agrees with a secondary standard (temperature meter).

Calibration is facilitated by a series of screens that enable you to set the temperatures and flow rates used during the calibration. The system will begin forcing air to attain the calibration set points and then prompt you to enter the external readings. When finished calibrating, the system presents a window that displays the slope and offset values obtained for that calibration. Select ACCEPT CALIBRATION to enter the new calibration values into the system.

At any point in the air temperature calibration process, you can halt the procedure without making any permanent changes to the temperature measurement system by selecting ABORT from any screen on which the button appears. Additionally, you can view help text by selecting the HELP button.

6.5.1. Air Temperature Calibration Setup

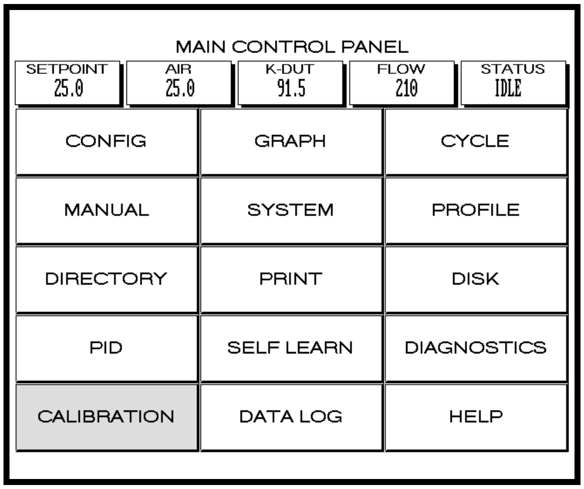
To perform the procedure, place an external temperature sensing device, such as an NBS-traceable thermocouple and temperature meter, in the air output nozzle of the Thermal Fixture. Then, select AIR TEMPERATURE from the T-2500E (SE) Calibration Menu and follow the on-screen instructions. (See illustration of following page for placement details.)



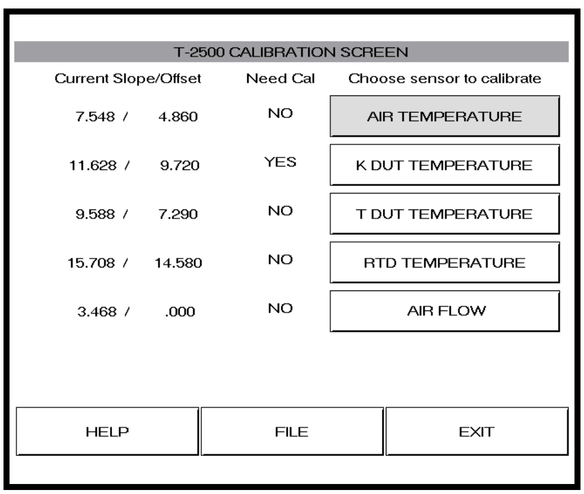
Place thermocouple from the secondary standard directly in the nozzle to obtain reading for air temperature calibration.

Fig. 6-2, Placement of Secondary Standard

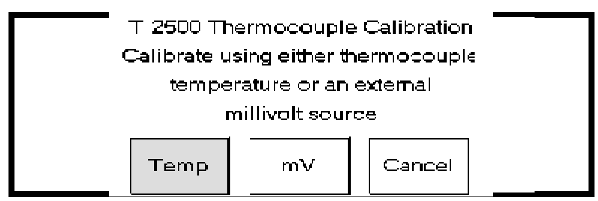
6.6. Thermal Fixture Cal. Procedure

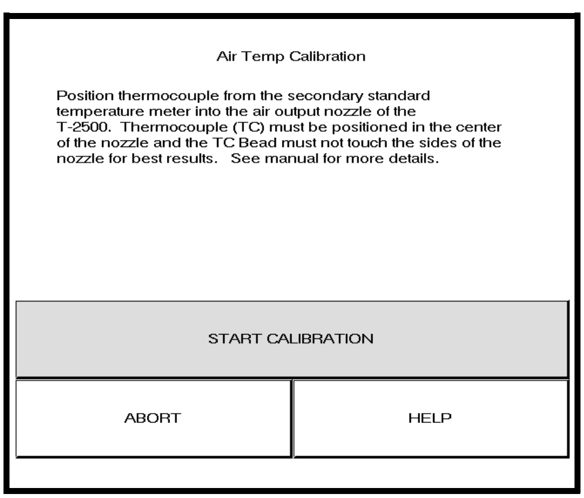


1. Select **CALIBRATION** from the Main Menu.



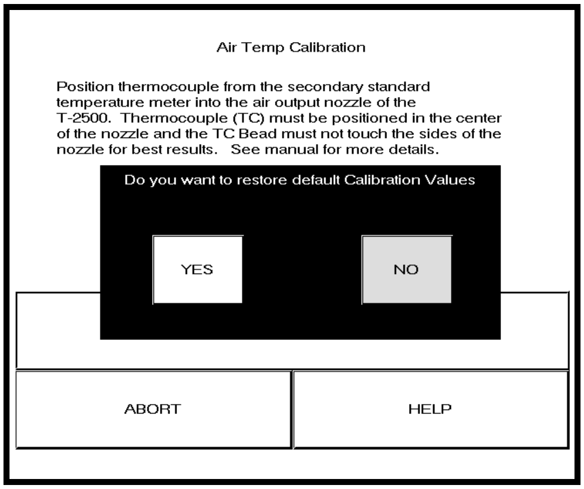
2. Select **AIR TEMPERATURE** from the T-2500E (SE) Calibration Screen. Then, select **TEMP** from the intermediate screen that appears. (See graphic below.)





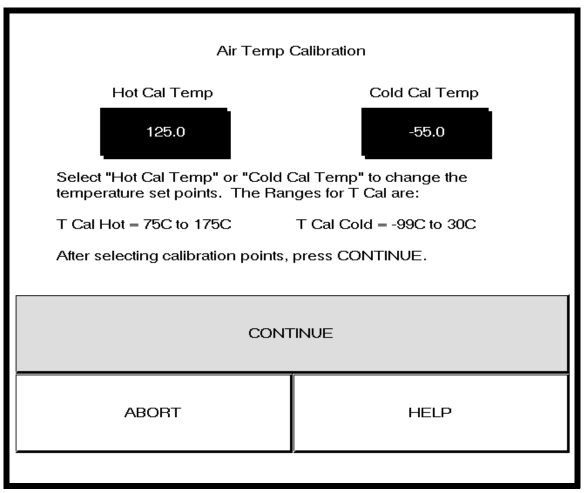
3. Position the thermocouple from the temperature meter in the air stream and select **START CALIBRATION**.

Thermal Fixture calibration cont.



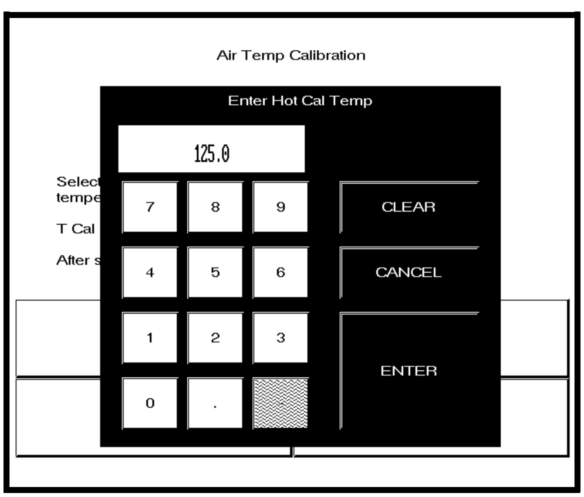
4. At this point you can restore the default calibration values if necessary. Otherwise, select **NO**.

NOTE: restoring default calibration values should only be done if the system is so far out of calibration that previous attempts have failed.



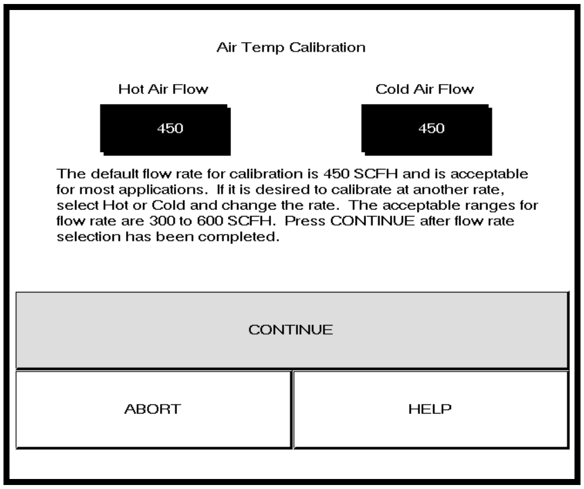
5. Touch the Hot and Cold cal. temp. fields to enter the calibration temperature set points via the Numeric Keypad. (see below)

   Then, select **CONTINUE**.



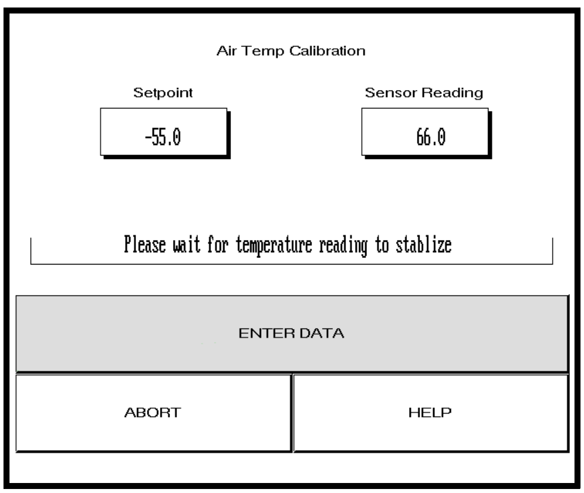
To use the numeric keypad, enter the desired numeric values, and select **ENTER**. The values will be placed in the original field touched.

Thermal Fixture calibration cont.



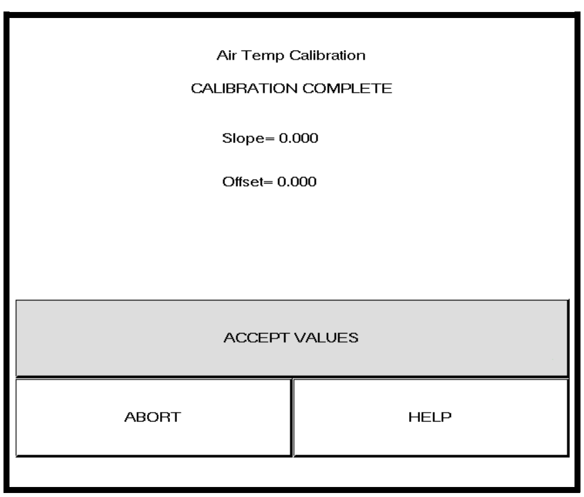
6. Enter the desired flow rate of air to be forced during the calibration procedure by touching the hot and cold flow rate fields and entering the data via the numeric keypad.

   Then, select **CONTINUE**.



7. The system will begin forcing air at the low temperature set point. When the system has stabilized (when temperature on external meter has stabilized), select **ENTER DATA** to input the temperature, measured by the secondary standard, into the system via the numeric keypad.

   NOTE: you will repeat this procedure for the high temperature setting.



8. After entering the readings from the external temperature registering device the final calibration screen appears. Select **ACCEPT VALUES** to enter the calibration into the system.

6.7. DUT AND RTD TEMPERATURE SENSOR CALIBRATION OVERVIEW

DUT or RTD calibration requires the use of an external temperature registering device, such as an NBS-traceable thermocouple and temperature meter, and requires the operator to enter readings from the meter at various times in the process. (Calibration accessories are available from Thermonics; call Thermonics' Customer Service.)

The DUT sense thermocouple (K or T) from the T-2500E (SE) must be positioned in the same place as the secondary standard thermocouple on the DUT. Also, temperature control should be verified before attempting DUT sense calibration or stability will not be achieved and a good calibration cannot be obtained.

6.7.1. DUT Calibration Setup:

Attach an external thermocouple to the underside of the DUT using thermal tape. Connect the thermocouple to your temperature meter. Select **K** or **T** DUT TEMPERATURE from the T-2500E (SE) Calibration menu, and follow the on-screen instructions.

6.7.2. RTD Calibration Setup:

Attach an external thermocouple to the underside of the RTD using thermal tape. Connect the RTD to the RTD connector located on the rear panel. Connect the thermocouple to your temperature meter. Select RTD Temperature from the T-2500E (SE) Calibration menu, and follow the on-screen instructions. The screens are similar to those used for DUT calibration.

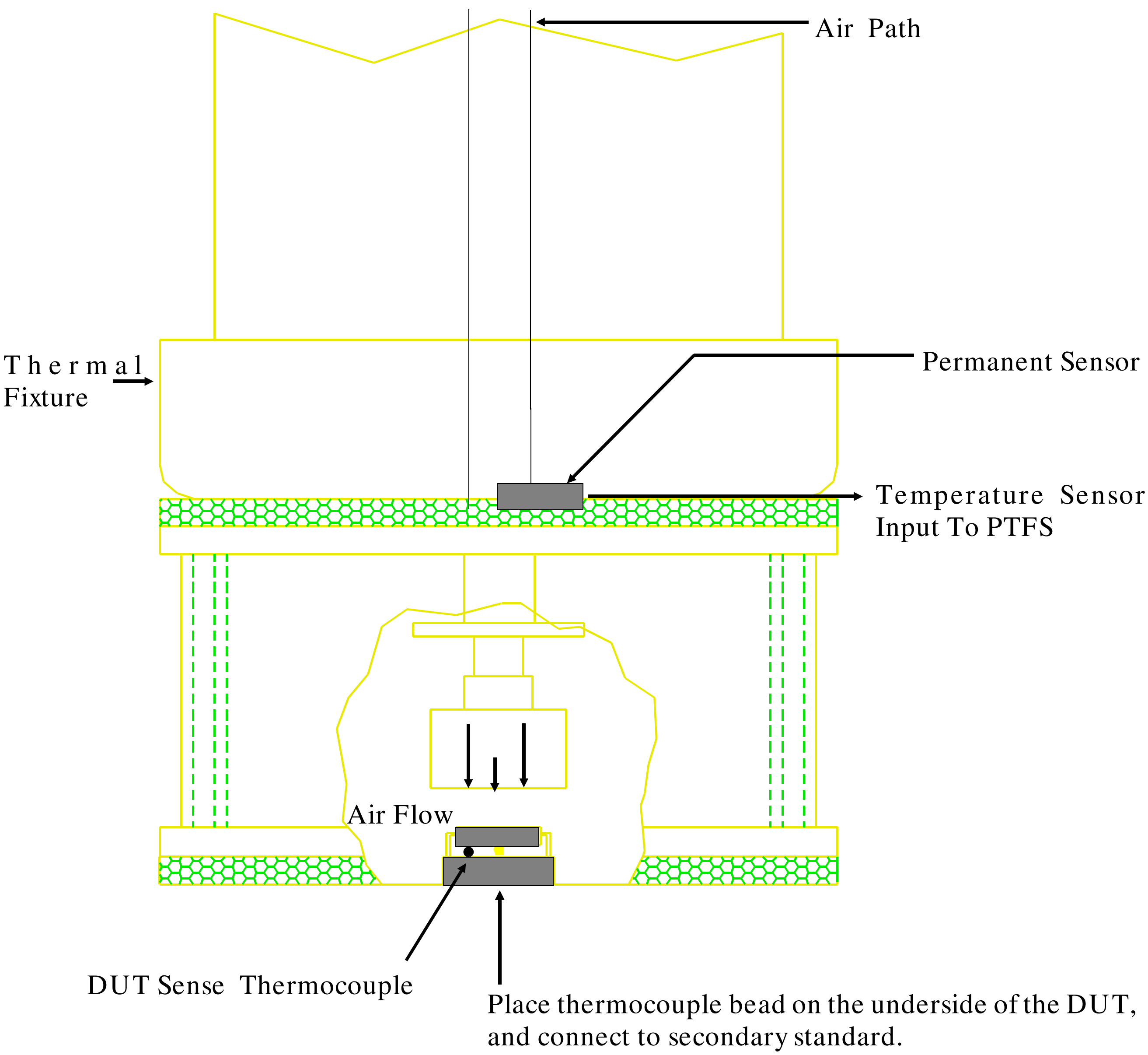
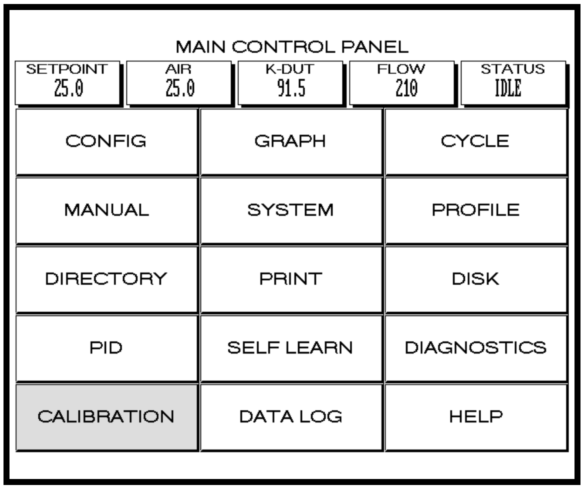
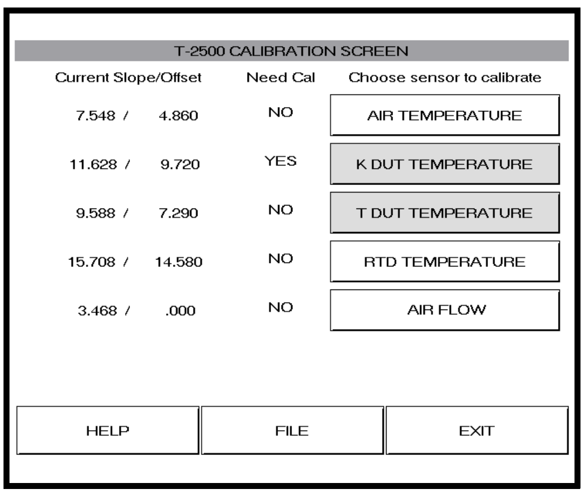


Fig 6 - 3, Placement of Secondary Standard for DUT CAL.

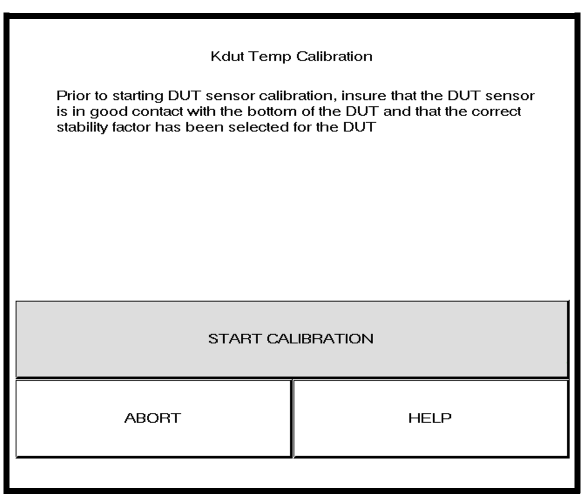
6.7.3. DUT Calibration Procedure



1. Select **CALIBRATION** from the Main Menu.

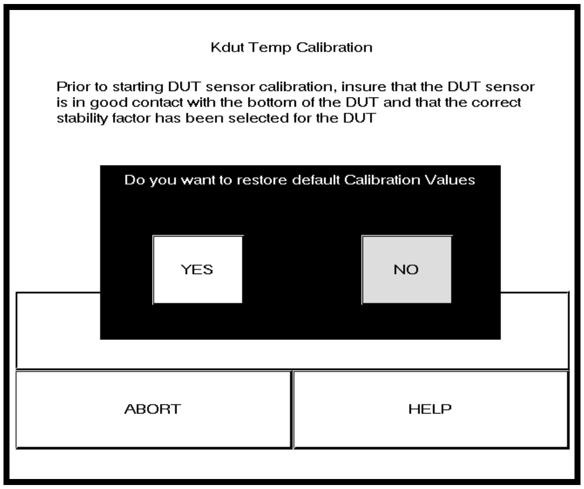


2. Select K or T **DUT TEMPERATURE** from the T-2500E (SE) Calibration Screen.



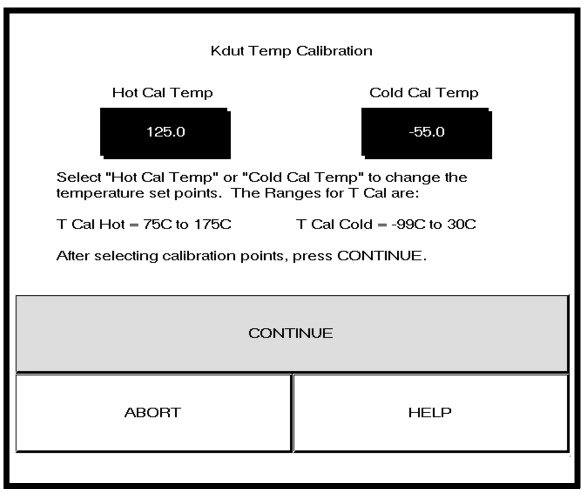
3. Place the thermocouple bead on the underside of the DUT, and select **START CALIBRATION**.

DUT Calibration Procedure Cont.



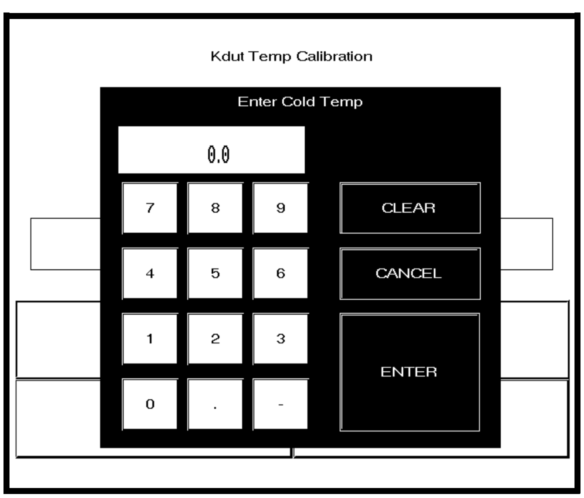
4. At this point you can restore the default calibration values if necessary. Otherwise, select **NO**.

NOTE: restoring default calibration values should only be done if the system is so far out of calibration that previous attempts have failed.



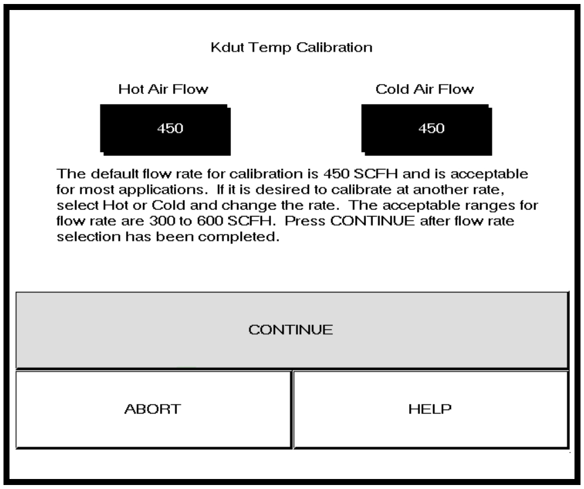
5. Touch the Hot and Cold cal. temp. fields to enter the temperatures via the Numeric Keypad. (see below)

   Then, select **CONTINUE**.



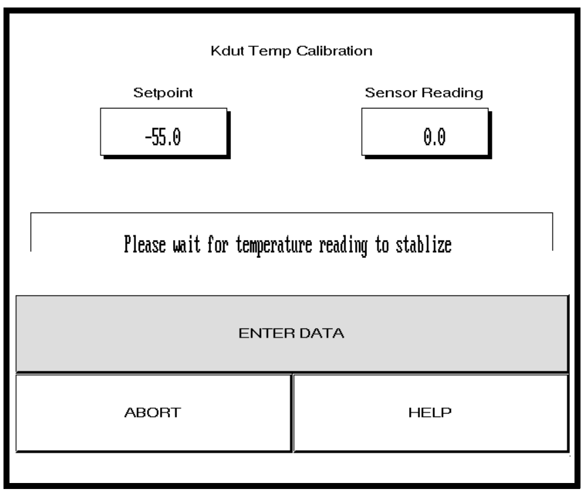
To use the numeric keypad, enter the desired numeric values, and select **ENTER**. The values will be placed in the original field touched.

DUT Calibration Procedure Cont.



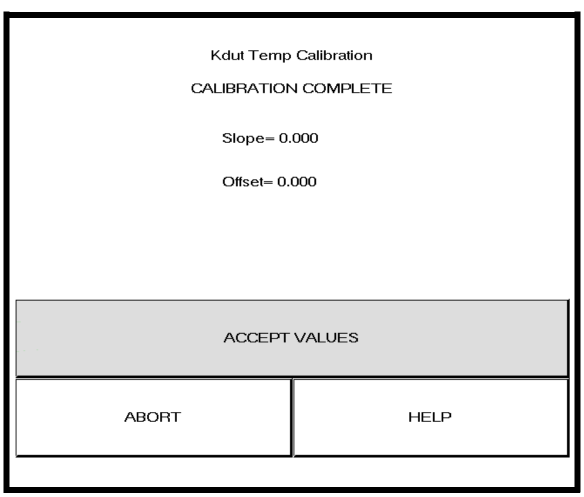
6. Enter the desired flow rate of air to be forced during the calibration procedure by touching the hot and cold flow rate fields and entering the data via the numeric keypad.

   Then, select **CONTINUE**.



7. The system will begin forcing air at the low temperature set point. When the system has stabilized (when temperature on external meter has stabilized), select **ENTER DATA** to input the temperature, measured by the secondary standard, into the system via the numeric keypad.

   NOTE: you will repeat this procedure for the high temperature setting.



8. After entering the readings from the external temperature registering device the final calibration screen appears. Select **ACCEPT VALUES** to enter the calibration into the system.

6.8. Calibration Using a Millivolt Source

An external millivolt source is capable of generating voltages equivalent to those a thermocouple exhibits at the calibration set points. It provides a very accurate voltage reference that the internal metering system uses to adjust the temperature scaling. The main advantage of using a millivolt source is that it is a fast way to calibrate the system.

A millivolt source can be used in place of an external temperature meter and thermocouple for air temperature and DUT temperature calibrations.

The millivolt source is plugged into the thermocouple receptacle in place of the external thermocouple. When the system requires input from the outside reference, the millivolt source is adjusted until the temperature meter displays the desired calibration set point; thus, indicating the source is providing the appropriate voltages to the system.

6.8.1. Millivolt Source Calibration Setup

When calibrating the air temperature sensor, the source is plugged into Junction J4 on the thermocouple termination board. When calibrating the DUT sensor, the source is plugged into the T or K-type thermocouple receptacles, located on the side of the thermal fixture. (See image on following page.)

6.9. Millivolt Source Calibration Procedure

The following procedure describes the steps to perform a millivolt calibration of the air temperature. The same basic steps are followed when performing a T or K-DUT calibration using a millivolt source. The main difference is that you place the source on the thermocouple receptacle located on the thermal fixture, and select T or K DUT TEMPERATURE from the calibration screen.

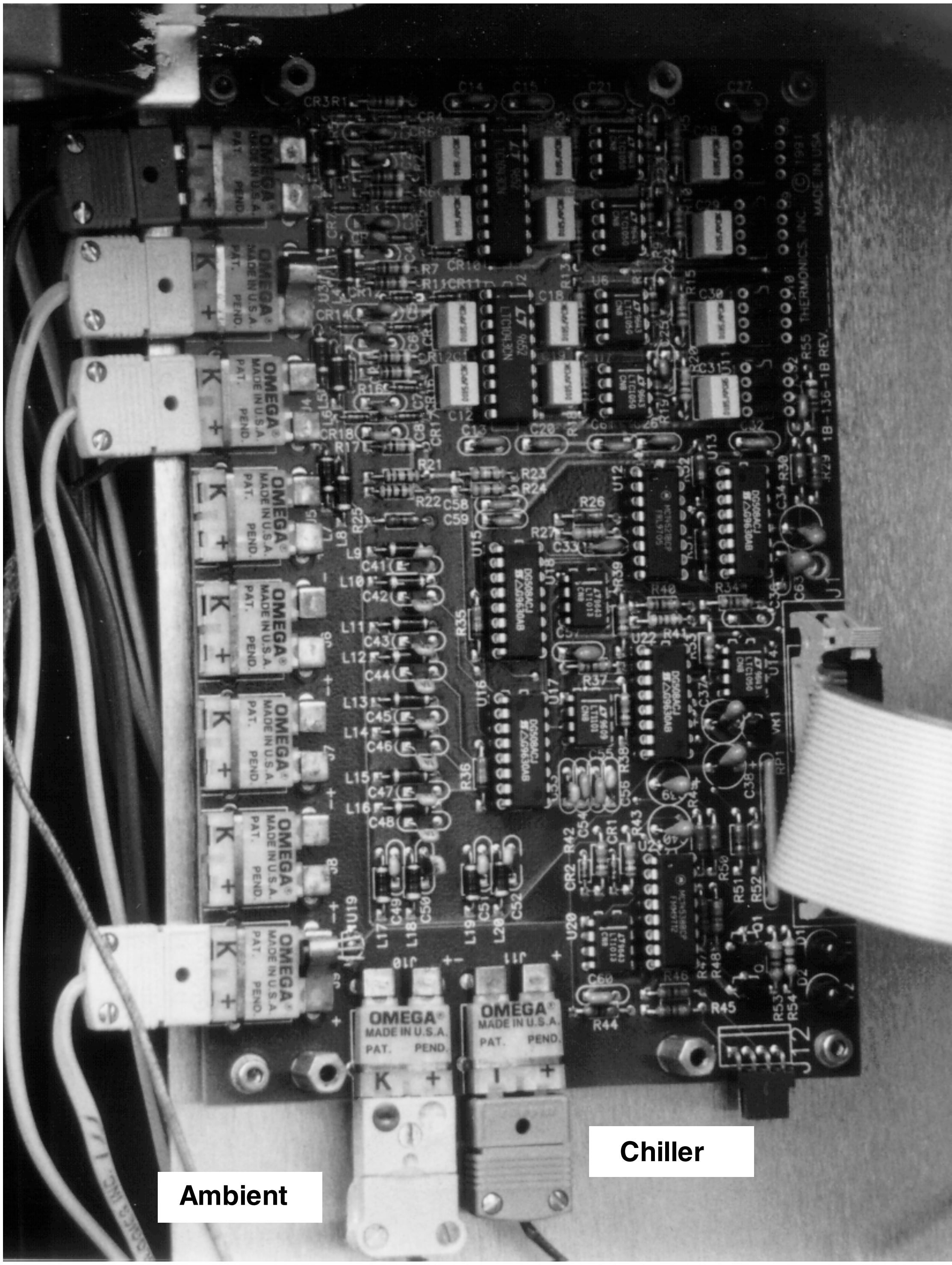
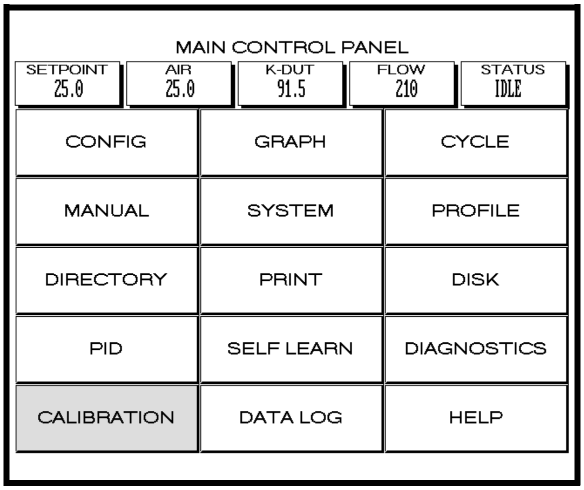
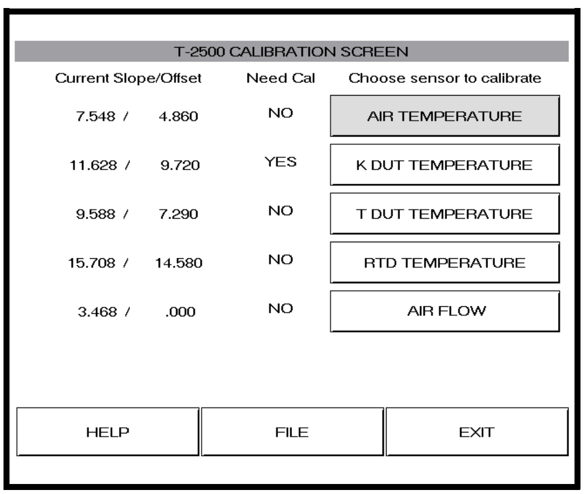


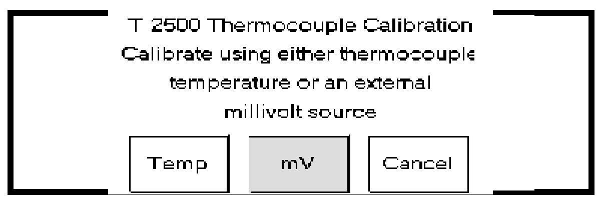
Fig. 6 - 4, Thermocouple Termination Board

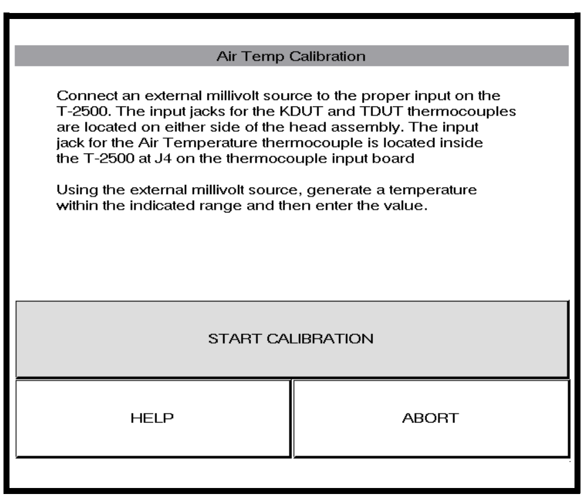


1. Select **CALIBRATION** from the Main Menu.



2. Select **AIR TEMPERATURE** from the T-2500E (SE) Calibration Screen. Then, select **Mv** from the intermediate screen that appears. (See graphic below.)

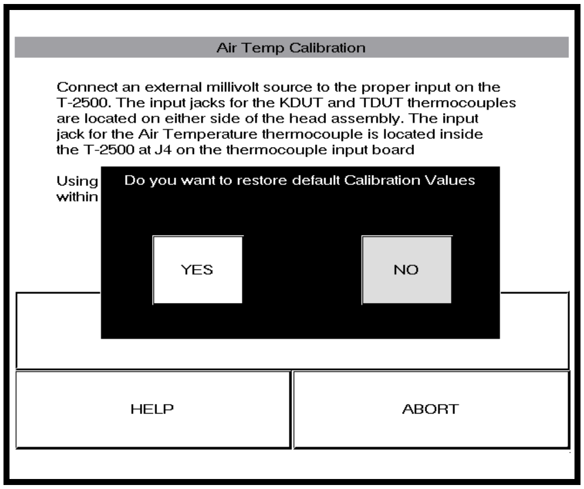




3. Connect the external millivolt source to junction J4 on the thermocouple input board and select **START CALIBRATION**.

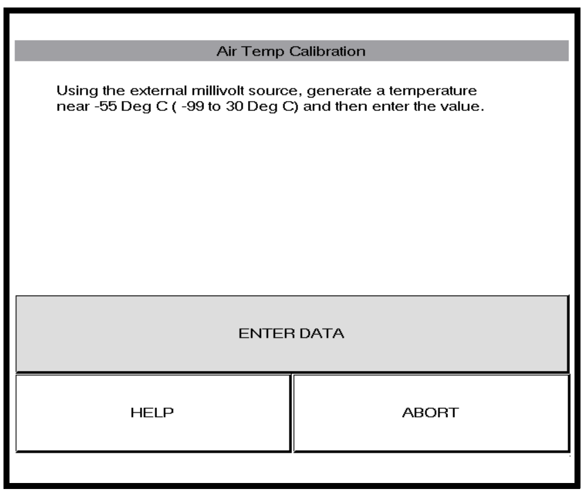
NOTE: you must remove the top cover of the chassis to gain access to this board.

Millivolt calibration cont.

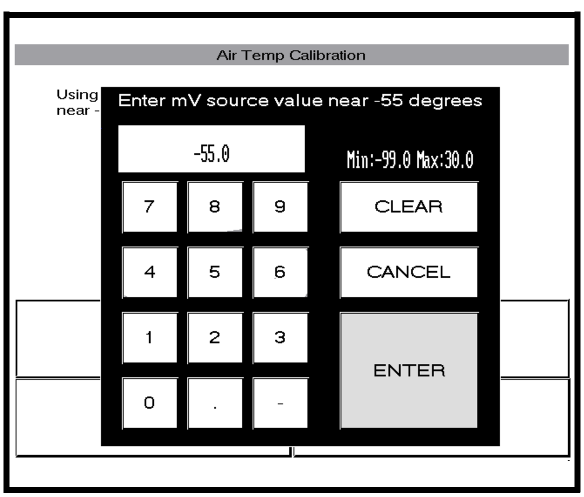


4. At this point you can restore the default calibration values if necessary. Otherwise, select **NO**.

NOTE: restoring default calibration values should only be done if the system is so far out of calibration that previous attempts have failed.

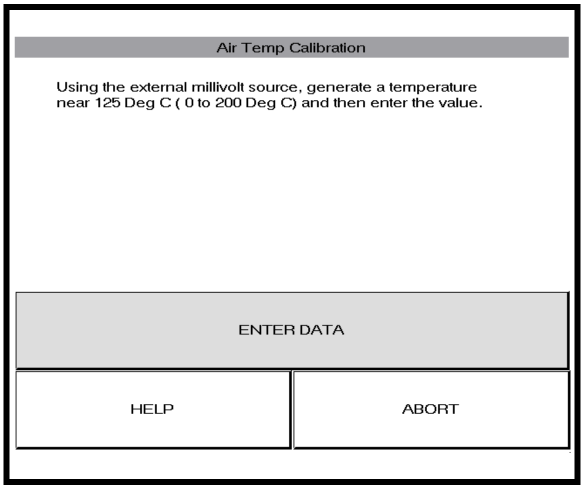


5. Using the external millivolt source, generate the cold temperature set point and then select **ENTER DATA**. The numeric keypad will appear.

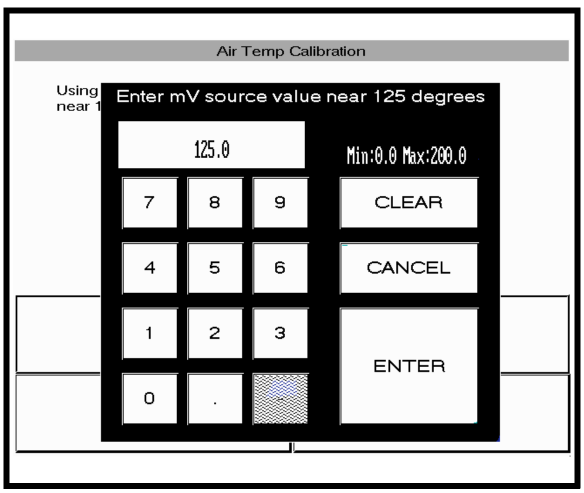


To use the numeric keypad, enter the desired numeric values, and select **ENTER**.

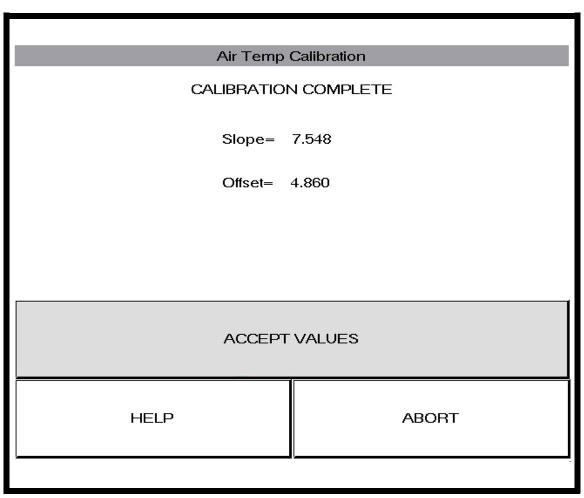
Millivolt calibration cont.



6. Using the external millivolt source, generate the hot temperature set point and then select **ENTER DATA**. The numeric keypad will appear.



To use the numeric keypad, enter the desired numeric values, and select **ENTER**.



6. The system calculates the slope and offset. To accept the calibration select **ACCEPT VALUES**.

6.10.Saving Calibration Setups

At the end of a particular calibration procedure, selecting **ACCEPT CALIBRATION** or **ACCEPT VALUES** permanently stores the new values into the system for that particular type of calibration DUT, RTD etc. Complete sets of calibration data are saved using the **FILE** selection, located on the top-level (first) calibration screen.

This feature enables you to save different sets of calibrations to use in various testing situations such as when testing at different set points or when using alternative thermal fixturing.

NOTE: The file named *DEFAULT* can be used at any time to restore the calibration data to its original format.

More information on the file processing menus can be found in the T-2500E (SE) User's Manual.

Refrigeration Recharge Procedures

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Refrigeration Recharge Procedures

7.1. General

When recharging the system, all refrigerant gasses must be recovered and properly disposed of. (As per EPA statute 608; Clean Air Act; July 1, 1992.) A freon recovery kit can be ordered from Thermonics' customer service department (phone: 408-496-6838). Thermonics will provide disposal of recovered gasses.

If the system has been open to atmosphere for any length of time, the system must be "blotted" with dry nitrogen before the new charge is used.

You will be performing the following five steps:

1.) Connect the service manifold.

2.) Recover refrigerant.

3.) Check for leaks.

4.) Evacuate the system.

5.) Recharge the system.

7.2. Equipment and Supplies Required

- One Thermonics' premixed refrigerant charge.
- Thermonics' freon recovery kit.
- Soap solution in spray bottle for leak checking.
- Cylinder of nitrogen gas and a pressure regulator (desirable, but not mandatory).
- Refrigeration service manifold with high and low pressure gauges.

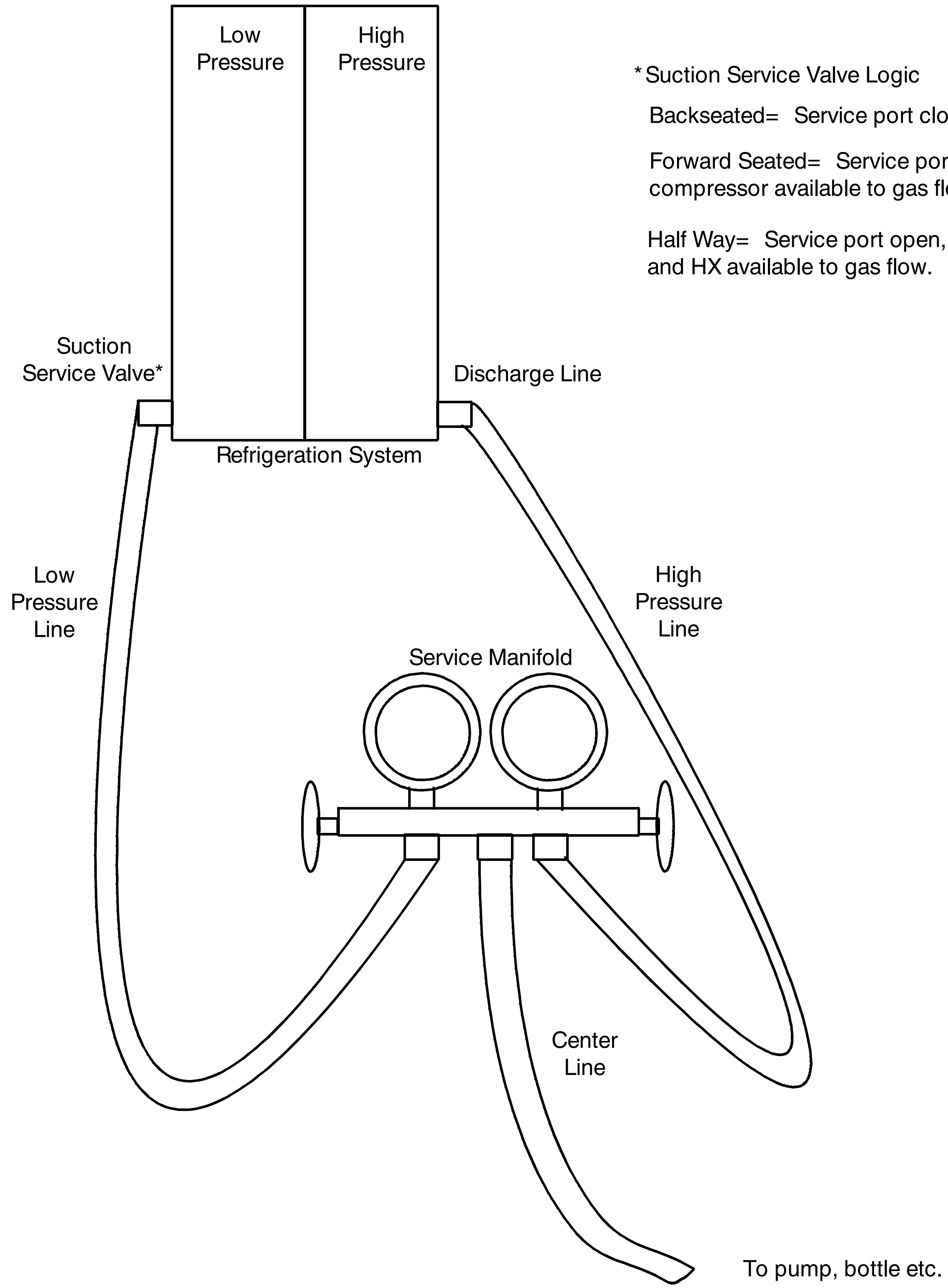
NOTE: The end of the discharge hose must have a push-pin for opening the Shrader access valve on the discharge line.

- Small vacuum pump suitable for system evacuation.
- Adjustable wrench and ratchet valve wrench.

7.3. Preliminary

A. **Read these instructions through before starting; make certain you fully understand all the procedures.**

B. Turn off the unit for at least 12 to 18 hours to allow it to warm up to room temperature. The heat exchanger section is well insulated and requires a long time to soak up heat from the surrounding ambient room temperature.



*Suction Service Valve Logic

Backseated= Service port closed.

Forward Seated= Service port open, compressor available to gas flow.

Half Way= Service port open, compressor and HX available to gas flow.

Fig. 7 - 1, Service Manifold Installation Diagram

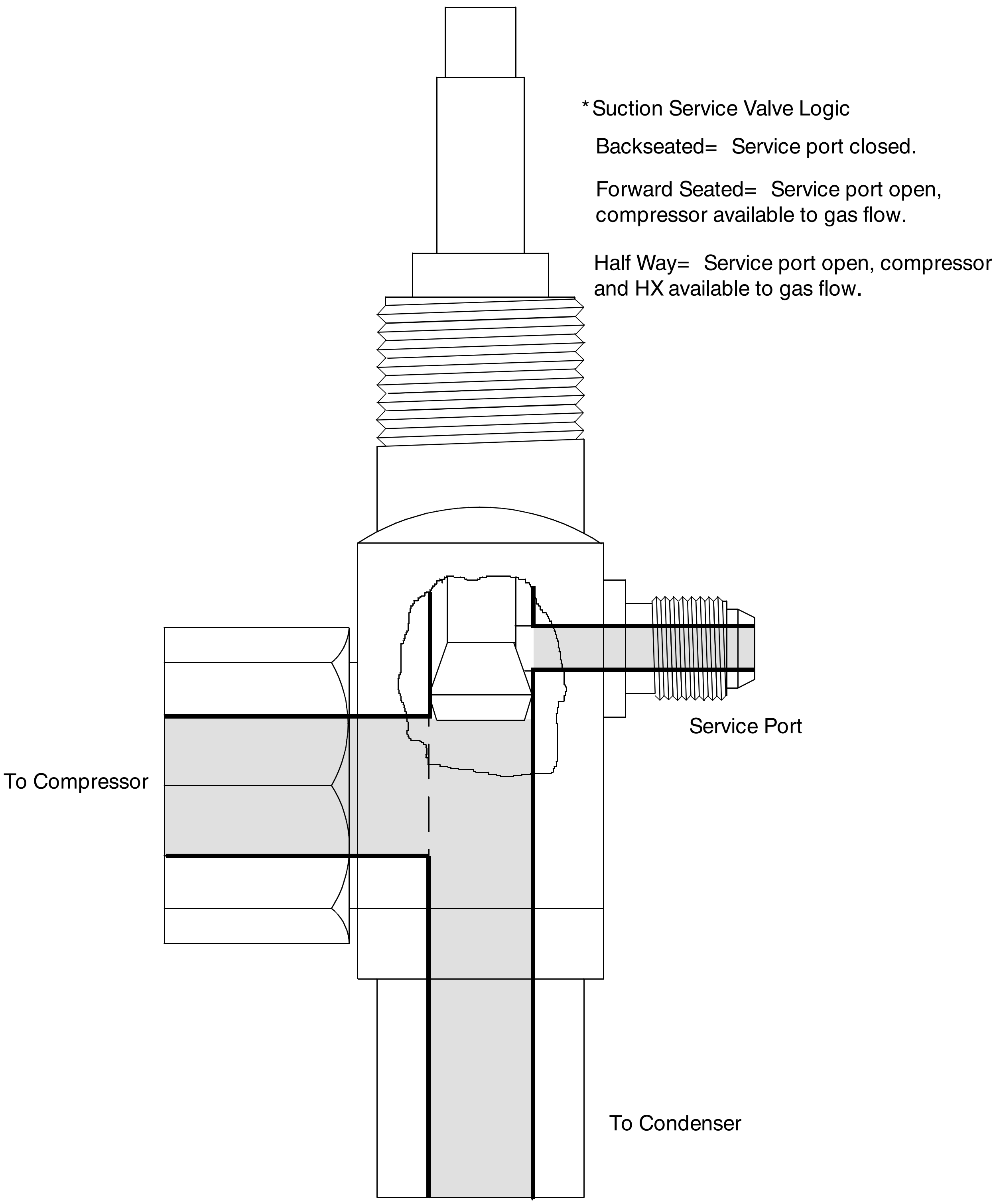


Fig. 7 - 2, Suction Service Valve Diagram

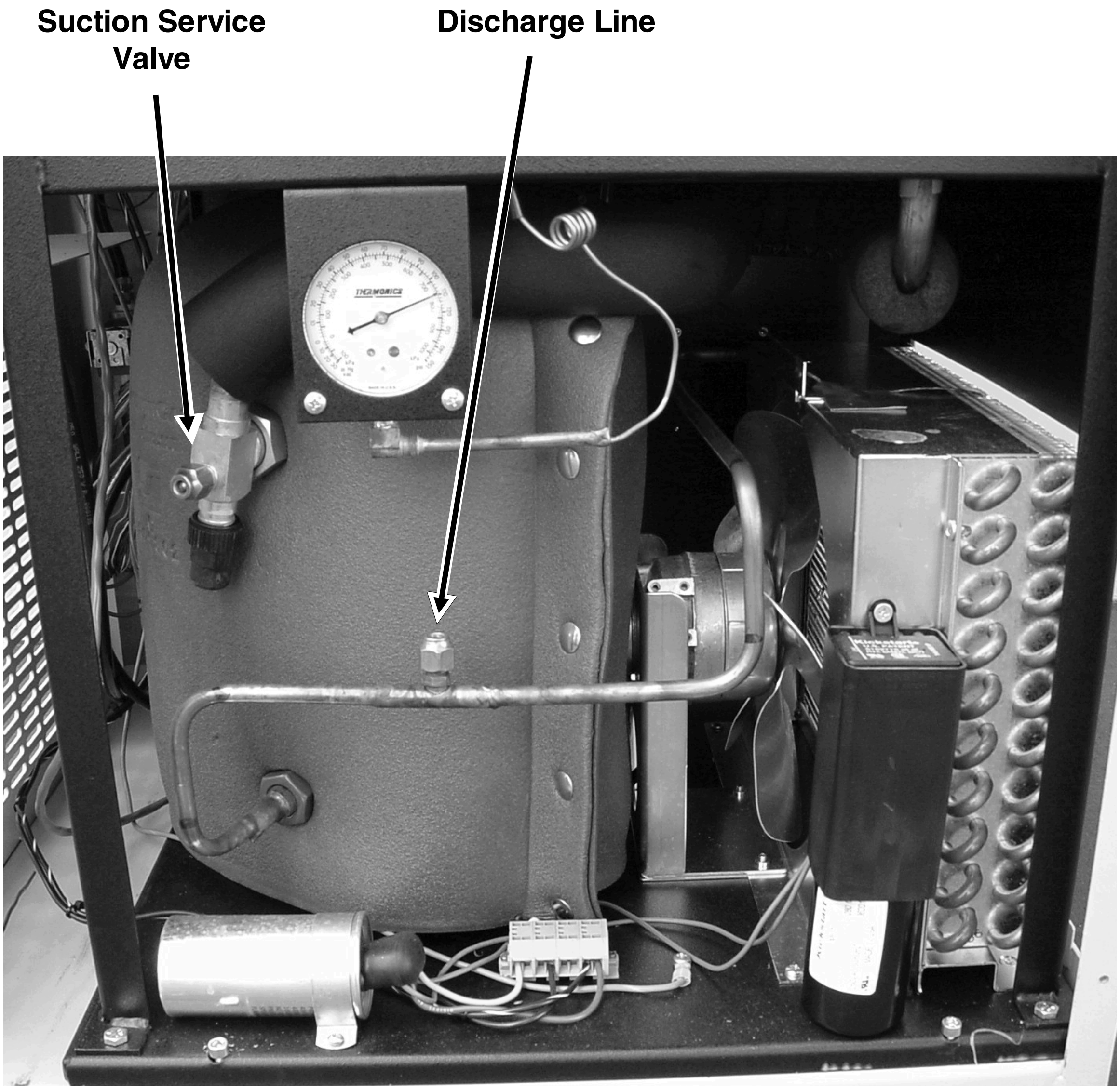


Fig. 7 - 3, Discharge Line Shrader Valve

C. Remove the front panel access cover over the compressor space and the rear panel cover.

7.4. Install Service Manifold

Locate the suction service valve and the discharge valve. The valves are located in the rear of the T-2500E (SE).

Remove the access port seal cap and valve stem cover from the suction service valve. Make sure that it is fully backseated. Remove the cover from the discharge line Shrader valve.

Close both valves on the service manifold. Connect the low-pressure hose to the suction service valve, and the high pressure hose to the discharge line.

Turn the compressor suction service valve four turns counter-clockwise, that is --away from the backseated position. All parts of the system are now open to the service manifold.

7.5. Recover Remaining Refrigerant

The following procedure describes how to remove freon from the refrigeration system so that it can be properly disposed of. The freon will be placed into three bottles that may returned to Thermonics for disposal.

Freon Disposal Kit:

- Three pre-prepared vacuum bottles
- Shipping Materials

1.) Connect the center line of the service manifold to one of the three vacuum bottles.

2.) Open the valve on the bottle.

3.) Open the high and low-pressure valves on the service manifold. Allow the pressure to equalize between the refrigeration system and the bottle. (The hissing will stop and the pressure gauge on the chiller stabilizes).

4.) Backward seat the service valve (clockwise) and close the bottle.

5.) Repeat the above procedures using the two remaining bottles. (The final pressure on system should be about 8 in. vacuum.)

6.) Return the bottles to Thermonics using the supplied shipping materials.

7.6. Leak Checking

Attach a nitrogen cylinder with regulator to the hose and increase system pressure to 100 psig. (**CAUTION**: do not over pressurize the system as this may cause a hazardous situation with the compressor) Leak check all fittings with soap solution. Make sure the system is completely leak-free before proceeding further. (If no leaks are found, and system continues to loose pressure the leak may be located inside the polyfoam enclosure. Return the system to Thermonics for repair.)

7.7. Preliminary Evacuation

Remove the nitrogen cylinder from the center manifold hose. Bleed nitrogen down to 5 psi.

7.8. "Blotting" Cycle

Connect the nitrogen gas cylinder to the center manifold hose, open the suction-side manifold valve and re-pressurize the system to a slightly positive pressure of 5-10 psig. Allow the system to stand for 10-15 minutes so the nitrogen gas can blot up or sweep out any moisture remaining in the system.

NOTE: This step may be skipped if the system has not been opened to atmosphere.

7.9. Final Evacuation

Connect the vacuum pump to the center manifold hose, turn the pump on, open both manifold valves and evacuate the system for 24 hours.

NOTE: If the refrigerant circuit:

(a.) has been open to the atmosphere,

(b.) has operated in a way which could draw in large amounts of moist air, or

(c.) shows evidence of compressor oil contamination, then you must perform a more thorough evacuation cycle. Please contact the Thermonics factory service department for details.

7.10. Recharge the System

A. Connect the cylinder of Thermonics' premix refrigerant charge to the manifold's center hose and open valve on bottle. To remove air from the hose, loosen the manifold end of this hose slightly for a brief second.

B. With both manifold valves still closed, turn the cylinder upside down so all of its liquid will flow into the system. Open the manifold discharge valve and allow the liquid and vapor mixture to flow into the discharge side of the evacuated system until the cylinder and the system pressures have equalized. This should occur within five minutes.

C. Prepare for using the compressor to pump out the refrigerant cylinder as follows:

1. Close the manifold discharge valve.

2. Open the manifold suction valve.

3. Fully forward seat (Turn CCW) the compressor's suction service valve.

D. Operate the compressor until the cylinder achieved the lowest possible vacuum, about 5-10 in Hg. vacuum, as shown by the manifold's suction gauge. This should take about 20 minutes. Close both the cylinder and suction-side manifold valves and turn the compressor off. Backseat fully, (CW) the compressor suction service valve. After allowing the compressor to cool, the unit balance pressure should be 130 to 140 psig. This pressure will drop after normal running of the gas chiller.

7.11. Check System Operation

Turn the unit on. Start-up pressures should be 25-35 psig suction and 250-310 psig discharge. When the unit reaches operating temperatures, pressures are about 10-25 psig suction, and 140-220 psig discharge--depending on the thermal load. Also, the suction line to the compressor should then be frosty or cold. If the start-up discharge pressure rises above 335 psig or the compressor has difficulty starting, check the fan for proper operation and the condenser for cleanliness.

7.12. Remove the Service Manifold

Turn the unit off. Fully back-seat the compressor suction service valve. Remove the hoses and tightly replace all the seal caps on the access fitting valves.

7.13. Final Check

Carefully, again, leak check all fittings, valve stems, and caps. The system is now ready for operation.

7.14. Recharge Container Safety Precautions

Each cylinder contains one complete refrigerant charge and is designed for one-time use only. The cylinders are disposable and must not be refilled. Make certain they are properly disposed of when empty--they should be rendered useless by puncturing. The tanks are absolutely not usable for compressed air tanks.

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Corrective Maintenance

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Corrective Maintenance

8.1. GENERAL

This section of the manual contains the diagnostic and repair procedures for common system failures that have occurred in the field. Its purpose is to aid in the diagnosis and repair of these problems to the board level. It does not, therefore, contain instructions on diagnosing and repairing any of the boards located within the chassis. It is the opinion of Thermonics that bad boards or components should be entirely replaced by the technician, and repairs to boards or components are done at your own risk.

This chapter is organized by symptom. The procedures for diagnosis and repair of various problems may be found in the section most associated with that symptom. Because there are often multiple causes and symptoms associated with a given problem, this section is best used as a check list to systematically eliminate potential causes during the diagnostic process. Once the probable cause is isolated the repair procedures may be followed sequentially until the system is again operational.

8.2. Diagnostics Menus

The operator interface contains three screens that provide a summary of the functional status of critical areas of the system. The information contained on these screens is a valuable resource that the service technician can use as an aid in trouble-shooting the T-2500E (SE). Access the first screen by selecting ***DIAGNOSTICS*** from the Main Menu.

The opening diagnostic screen, shown below, displays the values of several items monitored by the system. These include the: temperature control system, power supply voltages, reference voltages, compressor current, and inputs (voltages, air pressure, line frequency etc.). Additional screens display the status of RTDs and heaters. These can be accessed by selecting ***HEATERS*** or ***RTD*** from the screen buttons.

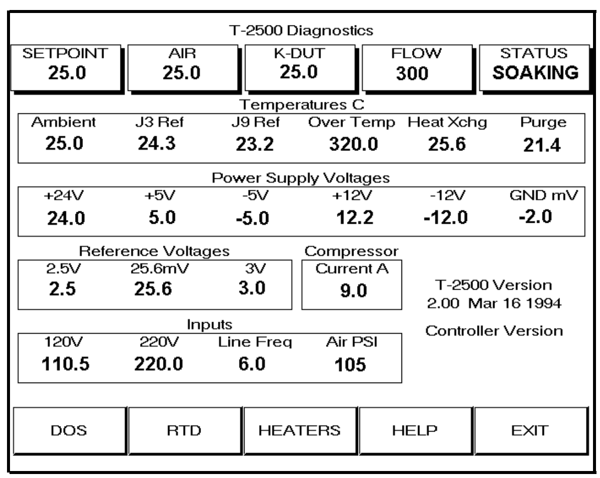


Fig. 8 - 1, Diagnostics Screen

Tables detailing the significance of the diagnostic screen values can be found on the following three pages.

8.2.1 Diagnostic Screen Display Messages

Diagnostic Item	Typical Reading	Explanation	Notes
Temperature Diagnostics:			
Ambient	25.0	The temperature of the environment used for thermocouple compensation.	System environmental requirements are: 15C to 28C.
J3 Ref	25.0	Cold junction compensation for high-speed (100-120/sec) thermocouple inputs. Used for DUT air temperature sensing.	
J9 Ref	25.0	Cold junction compensation for low-speed thermocouple inputs (1/sec). Used for ambient, purge, chiller, and heat exchanger.	
Over Temp	320.0	Hot limit setting for heater.	
Heat Xchng	25.0	The currently measured temperature of the heat exchanger in the refrigeration system.	Heat exchanger typical reading is -90C with compressor "on".
Purge	25.0	The currently measured air temperature from the purge heater.	
Power Supply Voltages:			
+24V	24.0	Heater, purge, and compressor relays. Solenoid valves. (Mechanical relays.)	All power supply voltages must be within 10%.
+5V	+5.0	Solid state relays on flow control board.	Allowable variance of 10%.
-5V	-5.0	Arm motor activation.	Motor uses 36V.
+12V	12.0	Temperature Control Board	Allowable variance of 10%.
-12V	-12.0	Temperature Control Board	Allowable variance of 10%.

Diagnostic Item	Typical Reading	Explanation	Notes
GND mV	0	Signifies ground fault.	
Reference Voltages:			
2.5V	2.5	High-precision, low-temperature coefficient reference voltage.	Allowable variance of 10%.
25.6mV	25.0	Linearization of low-speed A-D converter.	Allowable variance of 10%.
3.0V	3.0	Voltage reference for high-speed A-D converter.	Allowable variance of 10%.
Compressor:			
Current A	8.5	Current drawn by compressor in refrigeration system.	If current too high, problem may stem from: room too hot, condenser dirty, or too low input voltage. Allowable variance of 2A.
Inputs:			
120V	NA		
220V	220V	Input line voltage measured after step-up transformer.	Power must be within 208 to 230V.
Line Freq.	50/60	Frequency of input voltage.	System self adapting to input line frequency.
Air PSI	90	Input air pressure.	Specified range is 80-110 PSIG.
RTD Diagnostics:			
RTD Type	100/1000	The type of RTD installed: none, 100, or 1000 ohm.	
RTD Temp	Various	The current temperature reading obtained by the RTD.	

Diagnostic Item	Typical Reading	Explanation	Notes
100 Ohm REf	100.0	Displays one two readings from the reference resistors.	When 100 ohm RTD is in use, sys-tem uses 100 and 150 ohm reference resistors
1K Ohm Ref	1000.0	Displays one two readings from the reference resistors.	When 1000 ohm RTD is in use, system uses the 100 and 1000 ohm reference resistors.
Heater Diagnostics:			
Hot	On/Off	Not applicable to model T-2500E.	
Cold	On/Off	On/off status of the cold heater located in the ther-mal fixture.	
Purge	On/Off	On/Off status of purge air heater.	
Defrost	On/Off	On/off status of the refrigeration unit defrost system.	
Heater Relay	Open/ Closed	Safety relay for the main heater.	Mechanical relay. Trips if correspon-ding AC switch is shorted.
Purge/Defrost Relay	Open/ Closed	Safety relay for the purge air and refrigeration unit defrost heaters.	Mechanical relay. Trips if correspon-ding AC switch is shorted.
Fault Relay	Open/ Closed	Status of the fault relay.	Trips when a snap-disk thermostat on heater is open.
Purge Heater Pressure Switch	Open/ Closed	Status of safety switch for purge air pressure.	
Diverter Valve	Diverted/ Not Di-verted	Status of cold air diverter valve in thermal test head.	No divert on model T-2500E
Head Up/Down Valve	UP/ Down	Open/closed status of air valve for up/down posi-tion the thermal fixture.	

8.3. THE SYSTEM WON'T GO COLD

Typical problems that prevent proper cold operation of the system are:

- System out of calibration.
- Compressor cycling on and off.
- System frozen.
- Low Air Flow Rate.
- Low balance pressure in compressor.
- High running pressure in compressor.

If the T-2500E (SE) is not achieving cold temperatures, check the system for all obvious set-up errors such as improper power, compressed air input pressure, flow rate, and software set-up parameters such as temperature settings and DUT sensor selection. For example: if the cold temperature limit value or ramp enable feature, located in the *Configuration* menu, are set-up incorrectly it may prevent the system from reaching the programmed temperature. After ensuring the system is set up properly check the following in the order listed:

1.) Check the calibration with a secondary standard. See Cold Check-Out (8.3.1). and Calibration Check-Out (8.7.1.1.)

2.) Read the pressure gauge on the Refrigeration Unit to ensure that the pressure is stable and that the compressor is not cycling on and off. See Mechanical Refrigeration Check-out (8.3.2) and Compressor Cycles On and Off (8.8.)

3.) Make sure the Condenser is not blocked or dirty. See section 8.3.2.

4.) Check the flow rate it should be 450 to 500 scfh. If out of specification perform a flow calibration. See Chapter 6, section 6.2.

5.) Check the room temperature. It should be below 78 °F (26 °C).

8.3.1. Cold Check-Out

1.) Ensure calibration, measure temperature at external nozzle and compare to display value. If out of calibration, perform the manual calibration procedures in Chapter 6, section 6.5.

2.. Turn compressor off. Select ***COLD*** from the manual control screen and let system run until display reads at room temperature (approx. 25°C.)

3.) Power down the system.

4.) Make sure the amount of time air is forced and the compressor is run prior to operating the system is adequate. The automatic start-up sequence forces air for two minutes and runs the compressor for 20 minutes to start-up. Make sure the ***BYPASS COUNT*** feature is not being used before going cold.

5.) Place Thermocouple, from the temperture meter, in air stream at output of nozzle. See Chapter 6, Fig. 6-2.

6.) Let compressor run for 1 hr.

7.) Set cold temperature to -99°C and let system force air for ten minutes.

8.) Compare the maximum cold reading on the display to the value of an external temperature meter with TC located in nozzle. System should have a temperature reading below -70°C. If there is a discrepancy between the external reading and that displayed by the PTFS, perform the calibration routines located in Chapter 6.

If still not getting cold air, perform the Mechanical Refrigeration Check-Out Procedure below.

8.3.2. Mechanical Refrigeration Check-Out.

Use the following procedure to check-out the refrigeration system for proper functioning:

1.) Observe the AC input line. The system should not be connected to an extension cord.

2.) Observe unit location. Are there any other pieces of equipment blocking the vents on refrigeration system?

3.) Check the condenser for accumulated dust and lint. Contamination can easily prevent proper functioning of the condenser by preventing it from staying cool enough to condense the refrigerant.

4.) Check the room temperature. It should be below 78 °F (26 °C).

5.) Use a volt meter to monitor the input voltage. Power up the system and turn the compressor on. Measure the voltage both before and after the compressor engages and when the compressor is running. If the voltage is not within the proper specification of 208 to 230 VAC, a transformer will need to be installed. **NOTE**: the diagnostics screen should also provide you with this information.

6.) Check the Operating Pressure. With air flowing and compressor running, the gauge on the refrigeration system should read 30 ± 5 psi for all systems.

7.) With the system turned off for 24 hrs. the Balance Pressure should read 135 ± 5 psi.

8.) If either the Operating Pressure or Balance Pressure are out of spec., check the refrigeration unit for leaks. Brush all joints and fittings around the pressure gauge, compressor and condenser with a soapy water solution. Bubbles indicate a leak. Have leak soldered/brazed by a qualified professional.

NOTE: If no leaks can be found in the observable areas of the refrigeration unit, the leak may be in the Heat Exchanger, which is encased in foam. In this case, the unit must be repaired at the Thermonics Service Facility.

If the system is out of specification, and no leaks are present, Contact Thermonics.

If the refrigeration system checks out ok, you may have a frozen air tube. The main symptom of a frozen air line is low and/or non-existent flow through the system. To check for frozen tube follow procedure 8.4.

8.3.3. Refrigeration Recharge

In the event that the T-2420 requires recharging, follow the instructions in chapter six. The instructions are for recharging and do not apply to refrigeration systems that have been opened to the atmosphere. If the system has been opened to the atmosphere, refer to section *Recharging Opened Systems* 8.3.4., below.

8.3.4. Recharging Opened Systems

If the refrigeration system has been opened to the atmosphere, there is the possibility of contamination by moisture. Alternately pump and evacuate the system with 50 to 100 lbs. of dry nitrogen two times. Then perform recharge procedures in chapter 7.

8.4. NO AIR FLOW THROUGH SYSTEM

The air pathway comprises three main segments: a.) the main air pathway, b.) the “cold boost” path, and c.) the purge air path. (See illustration on following page.)

A series of pressure regulators, valves, and solenoids direct the air within the pathways. In standard operating mode, the air enters the system at the Main Air Solenoid, travels through the Main Pressure Regulator, through the Secondary Solenoid and to the Refrigeration Unit. When COLD BOOST is activated, most of the air bypasses the above systems and travels directly to the Refrigeration Unit. The purge air stems off the Main Pressure regulator and travels directly to the thermal test head.

Typically, a blocked flow condition is caused by a frozen refrigeration system. Additional causes of air flow restriction could be a bad air solenoid or some other component of the air path mentioned above. If there is no air flow, the first thing to do is make sure that you have supplied air to the rear panel. The input pressure should be 90 to 110 PSI. Then, follow the procedure below:

8.4.1. Airflow Diagnostic Procedure

1.) Turn the systems’ power off and then back on, using the main power switch located on the front panel.

2.) Allow the system to run through the start-up/purge cycle. This will require about twenty-two minutes.

3.) Check for airflow, if still absent, activate the defrost cycle: (See procedure 8.4.2, below).

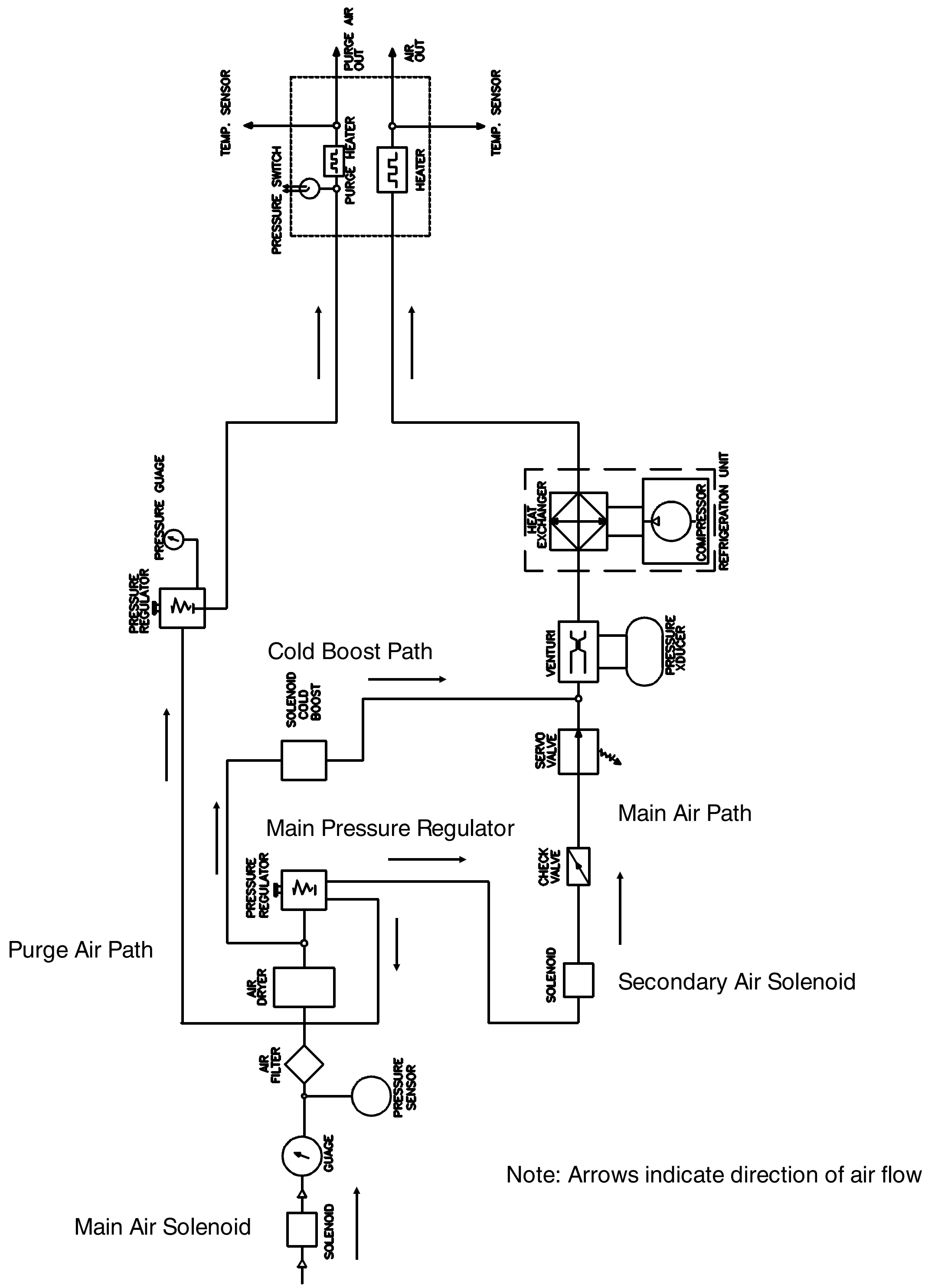


Fig. 8 - 2, T-2500E Airflow Path Diagram

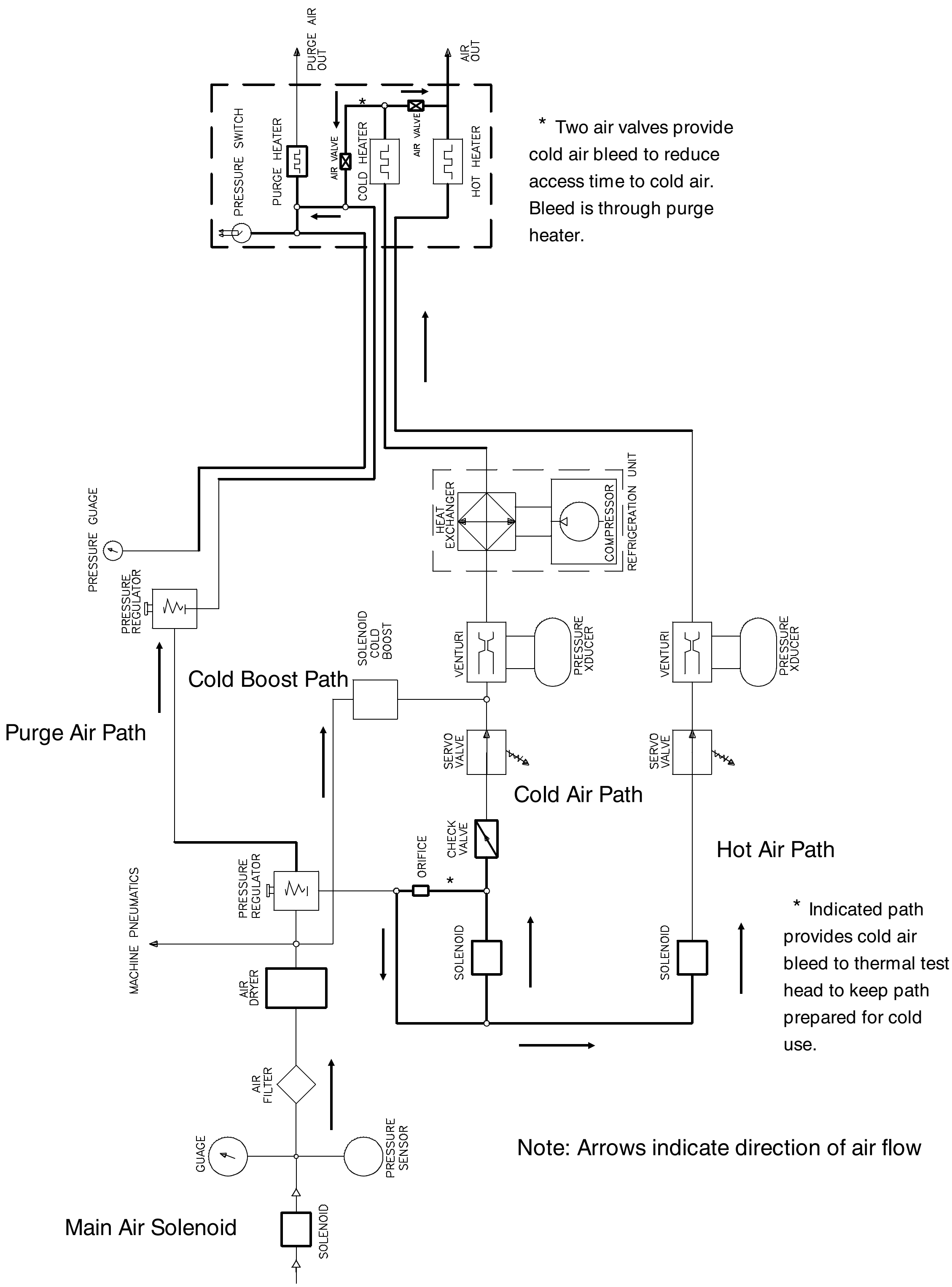


Fig. 8 - 3, T-2500SE Airflow Path Diagram

4.) After performing the defrost procedure, again check for air flow. If still no airflow, check out the airflow pathway, as follows:

a.) Check the air pressure gauge on the rear panel. It is located in sequence after the main air solenoid. If the gauge reads low, and you know proper air is supplied, then the main air solenoid is bad. (See solenoid check-out procedure.)

b.) When the main air solenoid is functioning, the air dryer continues to receive air. Air present at the dryer indicates the problem is further downstream. It could be with the Main Pressure Regulator or the Secondary Air Solenoid. To verify this, activate the ***COLD BOOST*** feature. The presence of full-force air at the thermal test head indicates the blockage lies between the air dryer and the heat exchanger - at the Main Pressure Regulator or the Secondary Air Solenoid.

c.) To determine if the airflow restriction is caused by the Main Pressure Regulator, check the purge air. Both the main and purge air pathways use this regulator. If it is bad, the purge air will be absent along with the main air. If purge air is present, the problem is with the secondary air solenoid. (See air solenoid check-out procedure.)

8.4.2. Defrosting a Frozen System

A frozen system is generally caused by one of three things: a.) a non-functional air dryer, b.) improper dew point of the source air, c.) improper system start-up.

Make sure that the automatic start-up procedure is not being bypassed by the operator. The system must be purged for two minutes and the compressor must be run for 20 minutes prior to using cold test temperatures. If the system is started properly, make sure that the source air meets the operating specifications (dew point less than 10C at 80 PSIG). Check the air dryer for wet or oily desiccant, and perform the desiccant replacement procedure to correct the situation if moisture or oil are found. (See *Preventive Maintenance*)

To defrost the system, proceed as follows:

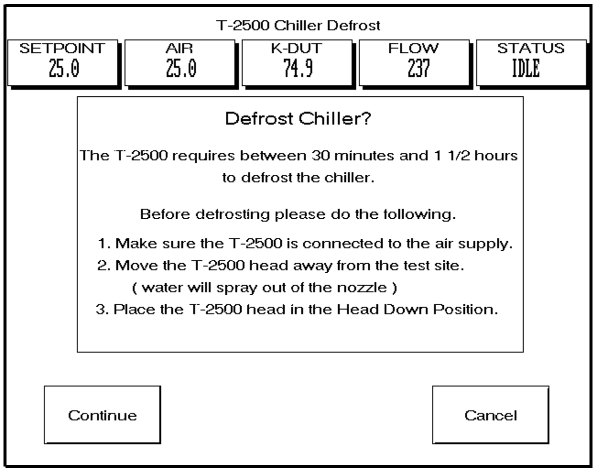
1.) Ensure the system is connected to an air supply.

2.) To prevent water from contaminating important electronics, move the thermal test head away from test fixtures. (Preferably over a container of some kind.)

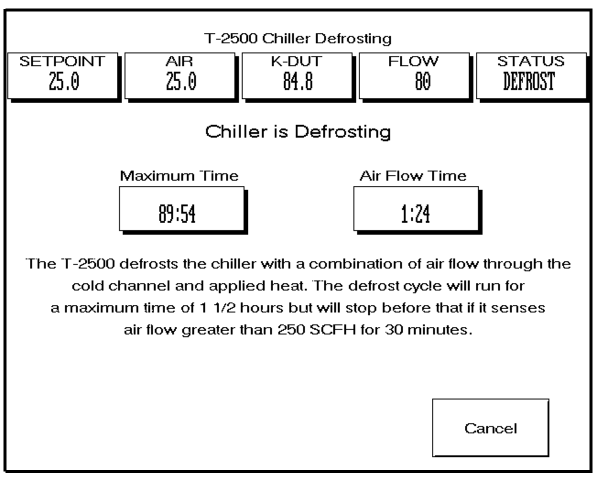
3.) Make sure the thermal test head is in the down position.

4.) Select ***SYSTEM*** from the T-2500 Main Menu Screen to enter the System Setup screen.

5.) Next, select ***DEFROST*** from the System Menu. The following screen appears. Follow the on-screen instructions and select ***CONTINUE***.



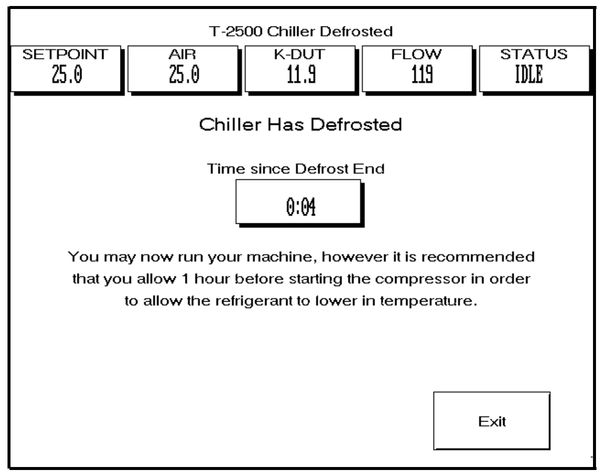
After selecting continue, this screen appears:



The system will force air and apply heat to the refrigeration system until it senses an air-flow rate higher than 250 SCFH for 30 minutes. The maximum amount of time the procedure will be in effect is 1 1/2 hours.

NOTE: Important - after the defrost procedures has been run, the internal temperature of the refrigeration unit is quite high. This tends to expand the refrigerative gasses and raise the gas pressure making the compressor work too hard or buck. Do not run the compressor for at least one hour to allow time for the refrigerant to obtain a lower temperature which allows the system to function normally.

When the defrost cycle is complete, the screen shown below appears indicating the amount of time elapsed since the defrost procedure has terminated.



8.4.3. Solenoid Check-out Procedure:

There are three* 2-way pilot-operated solenoid valves used in the main air pathway. These are:

a.) the Main Air Solenoid,

b.) the Secondary Air Solenoid,

c.) the Cold Boost Solenoid.

Check the operation of a solenoid as follows:

1.) *Faulty Control Circuit*: Check the electrical system by energizing the solenoid. A metallic click signifies the solenoid is operating. Absence of the click indicates loss of power supply.

Check for loose or blown out fuses, open-circuited or grounded coil, broken lead wires, terminals or splice conditions.

2.) *Burned Out Coil:* Check for open-circuited coil. Replace entire valve as necessary.

3.) *Low Voltage:* Check voltage across coil leads. Voltage must be at least 85% of operating specification which is 115V.

*NOTE: a fourth solenoid may be present if LN_2 injection option is installed.

8.4.4. Air Solenoid Replacement

An ineffective solenoid is easily repaired by replacing the coil assembly. New solenoids can be ordered from Thermonics. Part # P1-007.

It is best to leave the valve body in place and swap the coil assembly from the new solenoid with the old one. Replace as follows:

1.) Turn off the system.

2.) Remove the old coil assembly from the bad solenoid by loosening the two bracket screws and lifting it off. The coil assembly includes the: diaphragm, pilot seat, core assembly, core tube etc. When complete, only the valve body should remain. (See Fig. 8 - 4)

3.) Remove the new coil assembly from the replacement valve by again loosening the bracket screws. Reinstall it to the valve body and tighten in place. Take care not to allow the coil assembly to fall apart while installing. An illustrated parts breakdown is provided.

NOTE: Torque bracket screws to 20 inch-pounds (2.3 Newton meters). Tighten screws evenly to insure proper compression of the diaphragm assembly - because it also serves as a gasket.

8.5. THE SYSTEM WON'T GO HOT

The system may not be going hot for several reasons:

- Wrong sensor selected for DUT.
- Loose connection to Thermocouple Terminal Board.
- No flow.
- Bad Temperature Control Board.
- Bad heater relay or heater.

If the system is not going hot, more than likely the system software will indicate an error condition such as Hot *Heater Failure.*

Check out the flow, detailed procedures are in 8.4. To check the heaters, use the procedure outlined below. If one of the heaters is bad, replace as outlined below in the heater replacement instructions. If the heaters are operational, the problem may be the temperature control board.

8.5.1. Heater Check

Heaters are used to control test air and purge air temperatures. To check heaters:

1.) Check all wiring and connections to heaters.

2.) Check heater resistance.

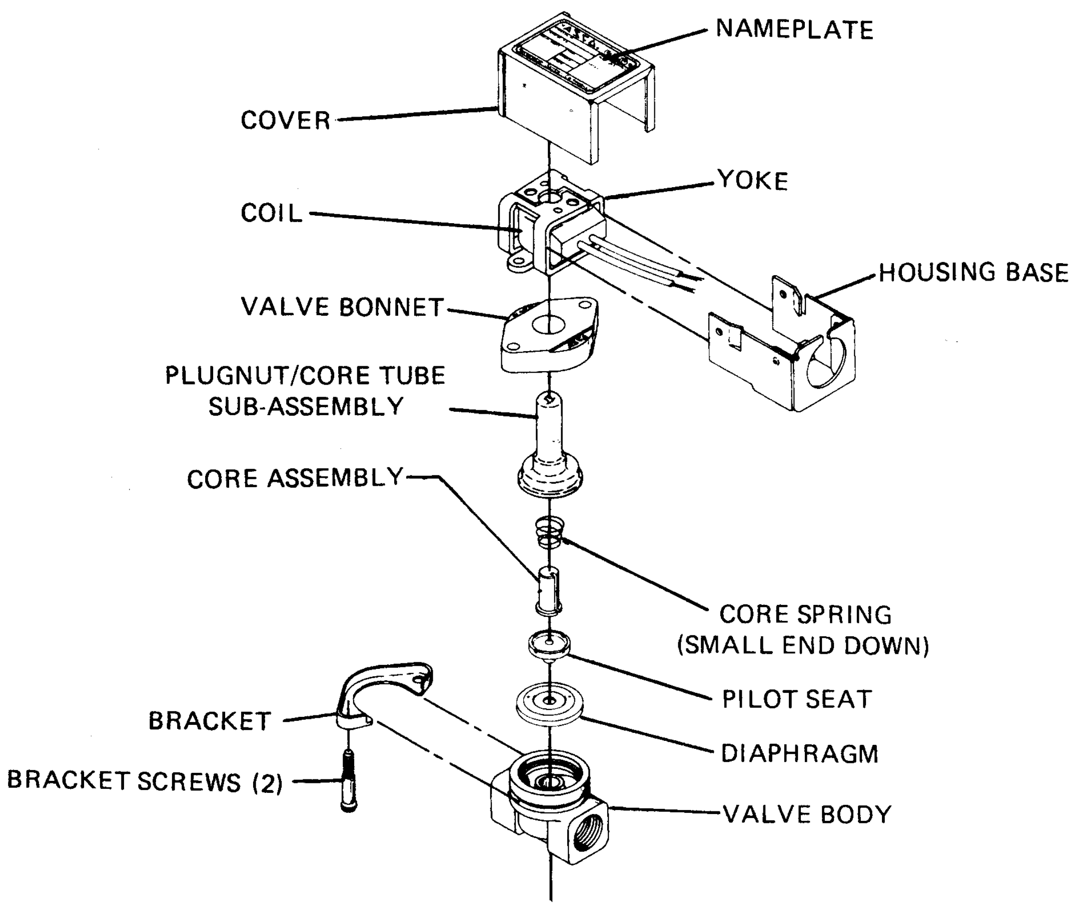


Fig. 8 - 4, Air Solenoid, Exploded View

Heater	Thermonics' Part #	Resistance
(E) Air	5F-036-1A	26Ω
(SE) Hot	5F-322-1A	30Ω
(SE) Cold	5F-328-1A	39Ω
Purge	K1-008	118Ω

If resistance does not match, replace heater.

8.5.1.1. Air Heater Replacement

These instructions are for replacing the air heaters located inside the thermal test head. There are separate instructions for each model as the designs differ. Detailed illustrations of the thermal test head assembly can be found in the *Illustrated Parts Breakdown* chapter (IPB).

8.5.1.2. T-2500E Hot/Cold Air Heater

The T-2500E has one heater for both the hot and cold air. A separate heater is used for the purge air. The heater is encased inside of an insulation tube. The replacement heater is pre-packed inside a similar insulation assembly. The heater integrates into the system via a flare fitting at the top and a threaded connector at the bottom.

Tools Required:
Allen wrench, small screwdriver, 5/8 open-end box wrench or adjustable open-end wrench, diagonal cutters.

1.) Make sure that the power and air are disconnected from the rear panel of the system. Lockout, tag out as necessary.

2.) Perform the inner test head access procedure (8.x.x).

3.) Remove the glass shroud from the bottom of the thermal test head. Remove the shroud by unscrewing the nozzle clamp, pulling the nozzle out and then pulling the shroud off. The shroud is held in place by two snap-on connectors.

4.) Disconnect the wires from the terminal block at the top of the heater assembly. Unscrew the terminal block from the heater enclosure.

5.) Remove the foam insulation that covers the flair fitting at the top of the heater assembly. Save this material for reassembly.

6.) Detach the ground wire from the base of the flare nut.

7.) Disconnect the heater bracket. It is attached to the rear of the thermal test head case with two screws (the slotted apertures).

8.) Disconnect the base plate assembly from the bottom of the thermal test head enclosure.

9.) Shift the base plate and heater assembly down, relative to the test head case, to access the flare nut at the top of the heater.

10.) Unscrew the flair fitting at the top of the heater.

11.) Turn the heater counter clockwise to remove it from the heater nozzle-coupling block.

12.) Replace heater and reassemble in reverse order as above.

8.5.1.3. T-2500SE Air Heaters

The model T-2500SE has separate heaters for cold, hot and purge air. The cold heater is packaged inside of a foam-filled insulation assembly. The hot and purge heaters reside in the back portion of the thermal test head, behind the cold heater assembly. The cold heater integrates to the system via a flair fitting at the top of the assembly. The bottom of the assembly connects to a push-on stem with O-rings that seal the connection.

8.5.1.4. Cold Heater

Tools Required:
Allen wrench, 5/8 open-end box wrench or adjustable open-end wrench, diagonal cutters.

1.) Make sure that the power and air are disconnected from the rear panel of the system. Lockout, tag out as necessary.

2) Perform the inner test head access procedure.(8.5.4)

3.) Loosen the brackets that hold the cold tube in place. Swing the brackets out of the way of the cold tube.

4.) Remove the foam insulation material that encases the flare fitting from around the top of the heater. Save this material for reinstallation.

5.) Detach any push on connectors from the heater power wires and snap disk. Remove any tie-wraps as appropriate.

6.) Disconnect the ground wire from the top of the heater case.

7.) Disconnect the lugs from the boom and arm control switches on the sides of the test head enclosure.

8.) Unscrew the flare fitting at the top of the heater.

9.) Pull the cold tube up and off the purge block assembly.

10.) Reinstall the new cold heater assembly and reassemble in reverse order as above.

8.5.1.5. T-2500SE Hot or Purge Heater

The cold heater must be removed to access the hot or purge heaters. Remove the cold heater as above in procedure.

Tools Required:
Allen wrench, 5/8 open-end box wrench or adjustable open-end wrench, diagonal cutters.

1.) Make sure that the power and air are disconnected from the rear panel of the system. Lockout, tag out as necessary.

2.) Perform the inner test head access procedure. (8.5.4)

3.) Remove the cold heater assembly.

4.) Loosen the brackets that hold the heater in place.

5.) Detach the push on connectors for the power and snap-disk thermostats.

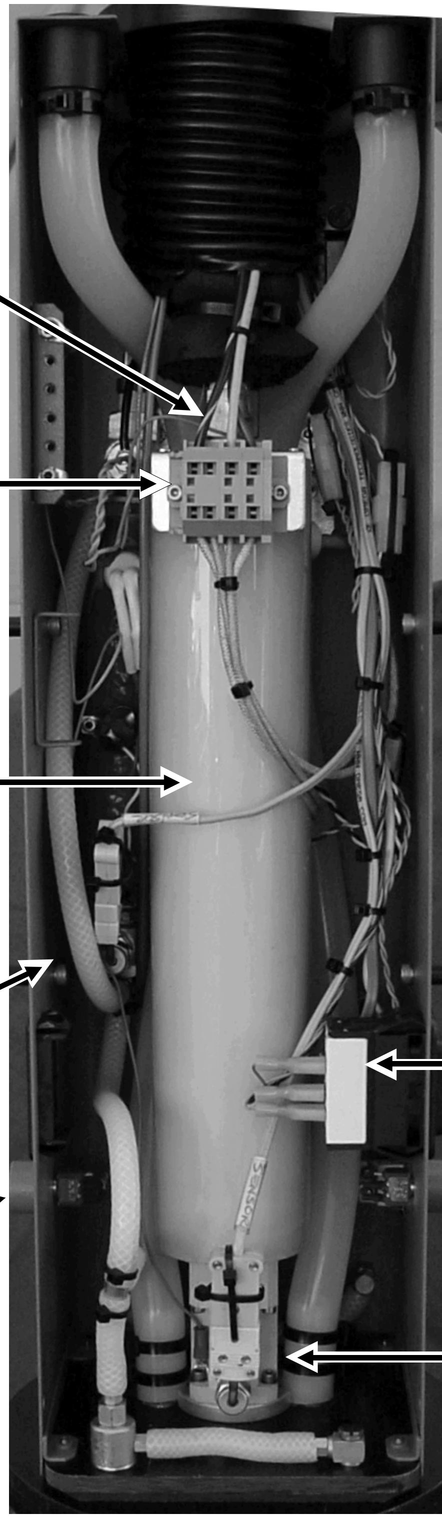


Fig. 8 - 5, T-2500E Thermal Fixture - Inside View

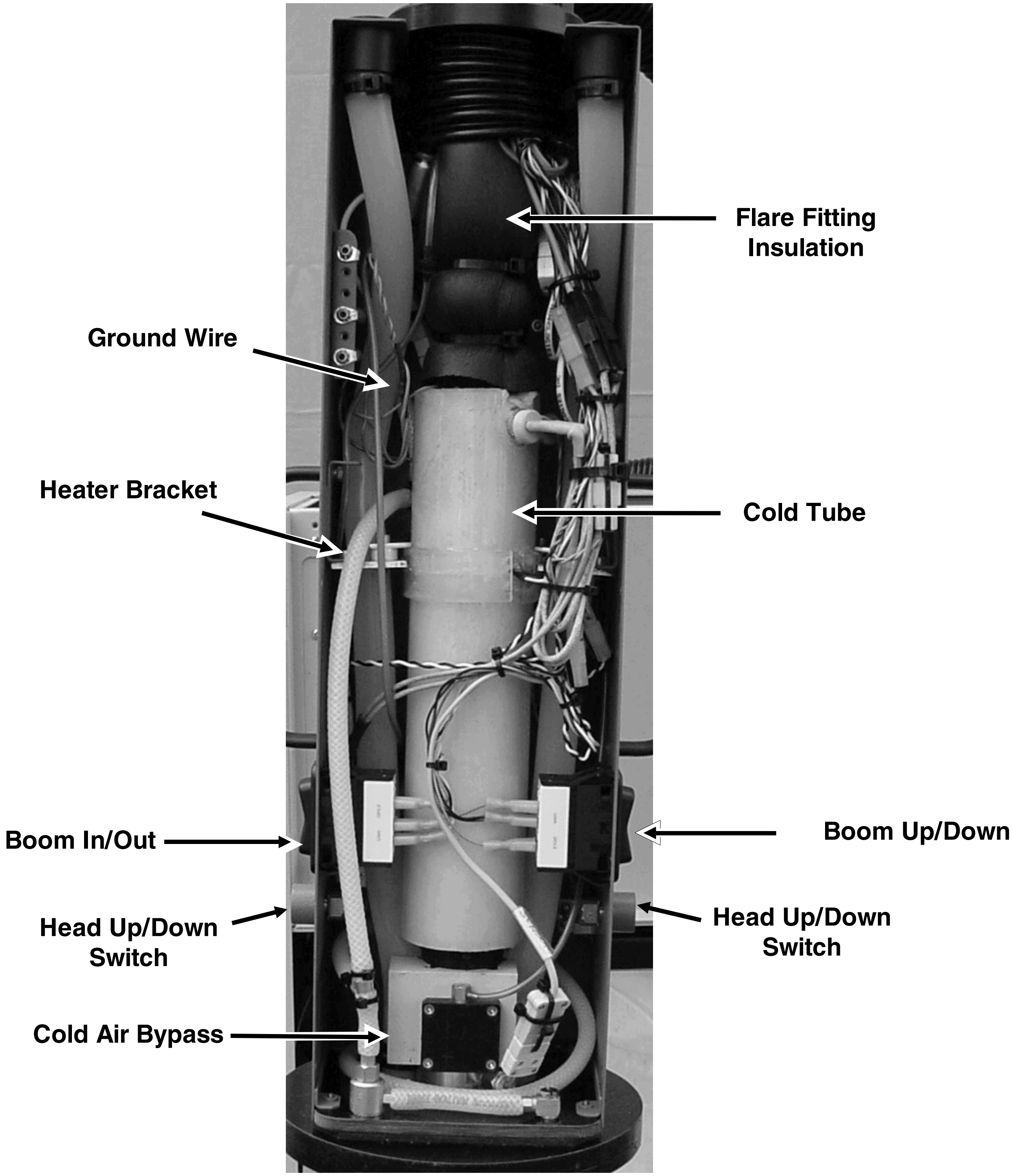


Fig. 8 - 6, T-2500SE Thermal Fixture - Inside View

6.) Disconnect the flare nut at the top of the heater. Pull the heater up and off the purge block assembly.

7.) Reinstall new heater in reverse order as above.

8.5.1.6. T-2500E Purge Heaters

Tools Required:
Allen wrench, small screwdriver, 5/8 open-end box wrench or adjustable open-end box wrench, diagonal cutters.

1.) Make sure that the power and air disconnected from the rear panel of the system. Lockout, tag out as necessary.

2.) Perform the inner test head access procedure.

3.) Remove the cold heater assembly as in procedure 8.5.2.4 , above.

4.) Detach the purge heater from the back of the test head. It is held in place with two M-3 screws.

5.) Disconnect the purge air line from the barb fitting at the bottom of the heater.

6.) Pivot the heater out of the case and unscrew it from the top fitting.

7.) Reinstall new purge heater and reassemble in reverse order as above.

8.5.2. AC Switch Check-Out

Relays supply power to the air, and purge heaters and to air input valve and cold bypass valve, depending on the system configuration. An AC switch may have a full or half shorted output causing full or one-half line voltage to be applied to the heater.

Generally, a failure message will appear on the CRT such as: "*Heater Disconnected or AC Switch Shorted*." In the case of the purge heater, the shorted relay may cause the snap disk thermostat to open due to very high temperature.

Opto isolators mounted on the Heater Control Board monitor the state of the AC switches. Two LEDs can be used to view the status of the switch. When the right LED is illuminated, the switch is not receiving power. During normal operation the lamp on the left side may flicker rapidly, indicating that the current to the heater is being controlled. If the lamp stays off, then the heater or relay is bad. A shorted relay will keep the optical isolator in an off condition. To check the relay, turn the power to the system off and read the resistance across it, as follows:

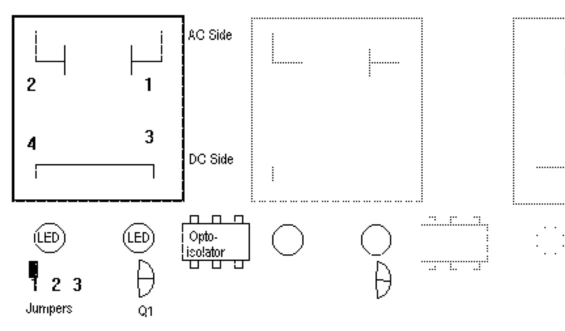


Fig. 8 - 7, AC Switch

1.) With power to the system off, check the AC switch in question with an ohm meter. The switch does not have to be removed from the board. Measure across pins 1 and 2 (AC side). The reading obtained should be approximately 5 M Ohm. Next, measure across pins 3 and 4 (DC side). The measurement should be about 3K Ohm. If these readings are not obtained, replace the AC switch.

8.5.3. Relay Replacement

It is not necessary to remove the heater/flow control board to replace the the relay.

1.) Remove the two screws that hold the relay to the to the card cage.

2.) Remove the the four screws that hold the relay to the heater control board.

3.) Slide out the the old relay and replace.

8.5.4. Inner Test Head Access Procedure

The inside of the thermal test head is very easily accessed.

Tools required: Hex wrench (2mm)

1.) Position arm so that thermal test head is easily accessed in a vertical orientation.

2.) Disconnect Power to PTFS.

3.) Remove the six M-3 button head screws that hold the cover in place.

4.) Pull the cover away from the system.

8.6. CRT IS NOT WORKING

The first thing to check if the front panel CRT is not functioning are the fuses and the circuit breaker. Then follow these steps:

1.) Check power cord to ensure system is receiving power.

2.) Check the fuses inside card cage and the circuit breaker at pins 3 & 4.

3.) Reset the CPU and I/O boards.

4.) Check power switch to see if power is transmitted in ON position. If no display, proceed as in next procedure.

8.6.1. Power Supply Check-Out

With the system on, and the front panel switch illuminated, do the following:

1.) Check the on/off switch for the power supply. It is located on the outside front of the chassis. Make sure it's on.

2.) Check that power is getting to the power supply. Pull the plug from the back of the power supply box, and measure the line voltage, which should be 220Vac. If no power is getting to the supply, trace back through the system until you find the problem area.

3.) Measure the output voltages of the supply. You are looking for + 5V, -5V, + 12V and -12V.

Connector	Pin #	Signal
System Board 1 PS8	1	Power Good
	2	+ 5Vdc
	3	+ 12Vdc
	4	-12Vdc
	5	GND
	6	GND
System Board 2 PS9	1	GND
	2	GND
	3	-5Vdc
	4	+ 5Vdc
	5	+ 5Vdc
	6	+ 5Vdc

Connector	Pin #	Signal
P210 1st Floppy	1	+ 12Vdc
	2	GND
	3	GND
	4	+ 5Vdc
PS11 2nd Floppy (not used)	1	+ 12Vdc
	2	GND
	3	GND
	4	+ 5Vdc
PS12 Fixed Disk (not used)	1	+ 12Vdc
	2	GND
	3	GND
	4	+ 5Vdc

8.7. SYSTEM IS NOT CONTROLLING AT SET POINT

If the system is not controlling at the temperature set point make sure that the thermocouple is connected to the proper receptacle on the thermal test head. Check the software for appropriate temperature selection mode. Check the calibration as described below in 8.7.1.1.

In general, follow these guidelines when temperature control difficulties arise:

1.) Check the fixture sensor. Make sure that it is properly connected and calibrated.

2.) Check the position of the DUT sensor. It must be under the device, contacting the surface of the DUT. Check the control-mode type selected in the Configuration Screens.

3.) For devices that are of smaller size, such as 40 pin DIP devices, use DUT control.

4.) Verify that air flow rate is correct.

8.7.1. System Out of Calibration

If the readings obtained in the procedure below indicate an out of calibration condition, recalibrate the system using instructions in Chapter 6.

8.7.1.1. Calibration Check-Out

Setup the Configuration Menu in the system software for the type of calibration you want to verify. Items to configure include the temperature control technique and the thermocouple type (Air, T-DUT, K-DUT or RTD). Next, set up a hot and a cold temperature in the manual control screen. Set the hot temperature to 125°C and the cold temperature to -55°C. Proceed as follows:

1.) Select ***HOT*** from the Manual Control screen.

2.) Wait about 5 minutes for the temper-ture to stabilize and measure the temperature at the thermal test head nozzle with an external temperature meter. The temperature should be 124 °C - 126 °C.

3. Select ***COLD*** from the Manual Control screen.

4. Wait ten minutes for the tempreture to stabilize. Measure the temperature at the thermal test head nozzle with an external temperature meter. The temperature should be -54 °C –56 °C.

8.8. COMPRESSOR CYCLES ON AND OFF

The compressor may cycle for the following reasons:

- Low or high AC power input.
- Room temperature too high, above 78 °F (26 °C).
- Flow too high, above 600 scfh continuously.
- Too much refrigerant pressure.
- Bad start and run capacitor.
- Bad thermal overload protector.

In most instances the problem will be found to stem from either the input line voltage or the high ambient room temperature.

8.9. THERMAL TEST HEAD ICES UP

The glass shroud, which provides the temperature environment for the DUT, is supplied with purge air to prevent ice from accumulating. If the thermal test head ices up, the purge heater may be bad, or the air may be blocked or escaping in its path to the thermal test head.

1. Check the purge heater.

2. Check the purge air pressure - should be 20 psi.

3. Pull head (See 8.5.7 *Inner Test Head Access Procedure*), and check for purge-air leaks. With system running cold, leaks will be obvious.

8.10. FAILURE MESSAGE DISPLAYS ON CRT

Error messages display on the front panel screen when the internal system diagnostics detect an error condition. Check the following if an error message is received:

1.) Turn off power

2.) Measure resistance to the air, and purge heaters.

3.) Measure the resistance of the solid state relays. Check for open and shorted conditions.

4.) Check wiring to the heaters.

8.10.1. Fail-safes

A special class of error messages that may appear on the CRT are fail-safe messages. Generally, these messages, such as "*Latched Open - SNAP DISK(S) MAY BE ACTIVATED.*" indicate that a heater case has become too hot. Check the following in response to this message.

- Check all heaters for resistance.
- All solid state AC relays for a shorted condition.

An alphabetical listing of all error messages can be found of the following pages.

8.11 T-2500E (SE) System Messages

#	Message	Significance
1.	*CALIBRATION PASSWORD, Calibration password protection has been turned off.*	Message indicating that the calibration screens are available.
2.	*CHANGE PASSWORD, Entries did not match. Password has not been changed, Try again.*	Did not re-enter the changed password correctly.
3.	*CHANGE PASSWORD, Password has been changed.*	A changed password is now in effect.
4.	*Choose Level of Password Protection: 1. No Protection. 2.Allow Operations Only.*	Operator instructions.
5.	*COMM DEBUG, Write trace buffer to (Floppy, Screen)*	Under IEEE-488, appears as an option when using START TRACE.
6.	*DEFROST ERROR, The T-2500E head must be in the down position.*	The test head is detected in the wrong position when defrost is selected.
7.	*DEFROST ERROR, The T-2500E must be connected to a source of air while defrosting.*	The system has detected a lack of air pressure during a defrost sequence.
8.	*DEFROST ERROR, The T-2500E must be connected to a source of air.*	An attempt has been made to initiate the defrost feature and no air pressure is detected.
9.	*DELETE RECORD, Are you sure?*	Operator alert when DELETE is selected.
10.	*Diag. Temperature Calibration, The new values are:*	Part of above.
11.	*DISK ERROR, Unable to compress.*	Memory is full, delete some files to enable compression to occur.

#	Message	Significance
12.	*DUPLICATE FILE NAME, THAT NAME IS ALREADY IN USE.*	Operator alert. Trying to save a record with a similar name.
13.	*Error in Reading Data from Temp Controller.*	Represents a communication problem with the temperature controller board.
14.	*EXIT TO DOS, Do you really want to exit to DOS?*	An operator alert that appears when Exit TO DOS has been selected.
15.	*FILE COPY ERROR*	The file is probably corrupted.
16.	*FILE COPY, Copy from diskette to memory. This will overwrite existing data.*	Operator alert indicating that current file stored in memory will be overwritten by new file.
17.	*FILE ERROR, Unable to open file (Name)*	File is corrupt.
18.	*Floppy Disk Format. Place disk in floppy drive. ALL DATA ON DISK WILL BE LOST.*	Operator alert that appears after selecting to format a disk.
19.	*FLOPPY DRIVE ERROR*	A communications problem with floppy drive.
20.	*FLOPPY ERROR: File not found.*	System cannot find file on diskette. Could be bad diskette.
21.	*FLOPPY ERROR: Not enough room on disk.*	The diskette is full.
22.	*FLOPPY ERROR: Unable to allocate transfer buffer.*	Hardware memory problem. Try a re-boot.
23.	*FLOPPY ERROR: Unable to write to disk.*	Diskette could be write protected or defective.
24.	*GENERAL PASSWORD, General password protection has been turned off.*	Indicates that password protection is no longer in effect.
25.	*HEATER DIAGNOSTICS: AC Switch Open.*	Appears on heater diagnostics screen when AC switch is open.

#	Message	Significance
26.	*HEATER DIAGNOSTICS: Closed*	Status message for heater relay, purge defrost relay, or purge heater pressure switch.
27.	*HEATER DIAGNOSTICS: Head Down*	Thermal test head status message that appears on heater diagnostic screen.
28.	*HEATER DIAGNOSTICS: Head Up*	Thermal test head status message that appears on heater diagnostic screen.
29.	*HEATER DIAGNOSTICS: Heater Disconnected or AC Switch Shorted.*	Appears on heater diagnostics screen when error is detected.
30.	*HEATER DIAGNOSTICS: Heater Off*	Heater Status Message on heater diagnostics screen.
31.	*HEATER DIAGNOSTICS: Heater On.*	Heater Status Message on heater diagnostics screen.
32.	*HEATER DIAGNOSTICS: Latched Open - SNAP DISK(S) MAY BE ACTIVATED.*	Fault relay status that appears on heater diagnostic screen. Could be due to heater that is too hot or bad snap disk.
33.	*HEATER DIAGNOSTICS: Open*	Status message for heater relay, purge defrost relay, or purge heater pressure switch.
34.	*Help File Error, Unable to allocate memory for help file buffer.*	Software/firmware problem. Reinstall software.
35.	*Help File Error, Unable to find help file.*	Software/firmware problem. Reinstall software.
36.	*INITIALIZATION ERROR, Checksum error in....Using Default Values.*	Call Thermonics.
37.	*INITIALIZATION ERROR, Unable to allocate memory to lode in....Using Default Values.*	Call Thermonics.
38.	*LOW AIR FLOW! Not enough air to run machine at 25C to keep ice from forming.*	Operator alert, air flow is too low.

#	Message	Significance
39.	*LOW AIR FLOW, There is not enough air flow to run the T-2500E.*	Low air flow has been detected during system initialization. Perhaps the air line is not connected to rear panel.
40.	*NOT ENOUGH MEMORY ON DISK, UNABLE TO CREATE FILE.*	The diskette is too full.
41.	*Overrange Error, Enter a Number between XX and XX*	Alert from calculator. An entered a value is out of range.
42.	*PASSWORD ERROR, Invalid Calibration Password.*	The password entered is not correct.
43.	*PASSWORD ERROR, Invalid Calibration Password.*	Selected text was not within specified parameters.
44.	*PASSWORD ERROR, Invalid General Password.*	Selected text was not within specified parameters.
45.	*PASSWORD ERROR, Invalid New Password.*	Selected text was not within specified parameters.
46.	*PASSWORD PROTECTED, Press Continue to Enter Password.*	Operator alert indicating that the selected section of the software is currently under password protection.
47.	*PRINTER ERROR, Printer Communications Error.*	System cannot communicate with the printer.
48.	*PRINTER ERROR, Printer has timed out.*	No response from printer.
49.	*PRINTER ERROR, Printer out of paper.*	Printer out of paper.
50.	*PRINTER ERROR, Unable to Locate Printer.*	System cannot detect a printer on the printer port.
51.	*RECALL ERROR, UNABLE TO RECALL DATA.*	This is most likely a hardware problem Indicates that logged data cannot be recalled.
52.	*Reset Cal Required Flag?*	A message that provides the option of turning off the Calibration Required statement for RTD.

#	Message	Significance
53.	*RESTART DATA LOG, Do you want to do this?*	An operator alert that appears during data logging.
54.	*Restore Default Cals? This will require that you recalibrate all diagnostic screen values.*	Appears when calibrating the sensors used for the diagnostic screen. This procedure is usually performed at factory. And not typically accessible in the field.
55.	*SAVE AS ERROR, UNABLE TO SAVE DATA.*	An operator alert signifying that the current data log file must be deleted before SAVE is used
56.	*Save Logged Data, This feature is not yet implemented. Delete entry then us SAVE AS.*	Operator alert regarding the functionality of SAVE when data logging.
57.	*SELF LEARN ERROR, DUT Temp control not selected. Select DUT control.*	Operator alert. Select DUT temp. control from the configuration screens.
58.	*SELF LEARN ERROR, Invalid Stability Factor. Restoring old value.*	The newly created value is out of range. The old value will be used.
59.	*SELF LEARN RESULTS, Use New Value?*	Operator alert. Allows operator to approve new values.
60.	*SELF LEARN, Restore default PID values before running self learn.*	A choice given the operator at beginning of self-learn sequence.
61.	*T-2500E Thermocouple Calibration. Calibrate using either thermocouple temperature or an external millivolt source*	A message that appears as part of the calibration sequence.
62.	*TEMPERATURE CONTROL, Restore Default PID Values?*	Selection available in PID section of software.
63.	*TEMPERATURE CONTROL, Unable to load default PID Values.*	Unable to load default PIDs as part of self learn procedure.

#	Message	Significance
64.	*Turn Compressor On?*	Part of the start up sequence messages. Option that appears if bypass purge has been selected.
65.	*Unable to delete data.*	A hardware problem has occurred, try a re-boot.
66.	*VERSION ERROR, Requires controller VX.X or newer to run.*	Wrong EPROM's have been installed on temperature controller board.
67.	*WARNING, HEATER ERROR!, Do Not Run Machine.*	System has detected a problem with the a heater. Could be due to AC switch, snap disk, or relay.
68.	*WARNING, Overwrite Existing File?*	Operator alert during data logging.
69.	*WARNING, VIRTUAL MEMORY ERROR!*	Hardware problem, try re-boot.

Wiring Diagrams

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T-2500E (SE) Schematics

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Illustrated Parts Breakdown

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Appendices

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SAFETY COMPLIANCE OF THERMONICS T-2500E (SE) PRECISION TEMPERATURE FORCING SYSTEMS AS REFLECTIVE OF THE SEMI S2/S8 SAFETY GUIDELINES FOR SEMICONDUCTOR MANUFACTURING EQUIPMENT

Purpose:

The purpose of this document is to demonstrate compliance with known and accepted safety standards in the design, construction and maintenance of the T-2500E (SE) Precision Temperature Forcing System. It provides an overview of the performance-based environmental, health and safety considerations of the T-2500E (SE) PTFS that are factored into its design and use and in the performance of maintenance tasks. It also identifies, and provides remedies for, any known concerns. It uses as its source for these issues the document titled: *SEMI S2-93 SAFETY GUIDELINES FOR SEMICONDUCTOR MANUFACTURING AND EQUIPMENT*, and other attendant or relevant documents referenced in the above.

Scope:

This document contains the following sections as deemed relevant per the above:

1.) Scope
2.) Safety Philosophy
3.) General Guidelines
4.) Audio Noise
5.) Electrical
6.) Environment
7.) Ergonomic and Human Factors

System Design Safety Philosophy:

Thermonics designs it equipment with safety of the operator and community as a primary design consideration. All known potential hazards are identified and engineered out of the system during the design and construction phase. And specific remedies are applied as new issues become known. Our equipment development programs include consideration of industry standards for electrical and fire codes; government regulatory requirements and general good practice.

General Guidelines:

The T-2500E (SE) is designed to comply with known safety standards as relevant to the document *SEMI S2-93 SAFETY GUIDELINES FOR SEMICONDUCTOR MANUFACTURING AND EQUIPMENT*. Thus, safety of the maintenance technician is a design element. However, the following considerations should always be observed when maintaining the system:

1.) The system should always be maintained by an individual who is fully competent to repair electrical and mechanical machinery. The technician should be aware of the hazards associated with high voltages and moving parts. And should be competent to work on the system in a safe manner. Determination of this status is, of course, the responsibility of the organization which owns or leases the equipment and not Thermonics.

2.) **All work performed on the system should be done with the power and air physically disconnected from the rear panel**. This provides compliance with *OSHA 29 CFR 1910.147 (iii) (A*), which eliminates the tagout requirement

Areas of safety concern have been identified as:

- AC power input: Make sure this is under exclusive control of the technician.
- CRT: Make sure that the CRT is properly discharged prior to work performed.
- Microprocessor power supply: Make sure system is unplugged.
- AC switches on the Heater/Flow control board: Safety precautions remedied by unplugging system.
- Moving fan blade on the compressor: Safety precautions remedied by unplugging system.

The system has been designed to minimize the probability of electric shock during maintenance, repair, modification, calibration, and adjustment. In all cases, exposed energized circuits, components and terminal strips are enclosed with covers that require a tool to remove. In addition, hazardous areas are clearly marked with tags that read: ***DANGER HIGH VOLTAGE***. Moving parts, such as fan blades, are surrounded with a shroud to protect against the accidental insertion of a finger.

Audio Noise:

The system has been designed to operate at the lowest practical dB(A) level. The system complies with *OSHA 29 CFR 1910.95*.

Electrical:

UL standards have been met in the design of the system circuit boards and system wiring.

The following built-in safety mechanisms prevent problems due to malfunctions. The safety mechanisms consist of a series of fuses, circuit breakers, thermocouple sensors, pressure switches and differential pressure sensors. They have the function of preventing the system from being operated during a malfunction, thus; enhancing operator safety and reducing the risk of fires. The five protected sub-systems are:

- AC Voltage Modules
- DC Voltage Modules
- Temperature Sensor Modules
- Air Flow Control Module
- Power Supply Module

AC Voltage Protection

CIRCUIT BREAKER, 20 amp, 250 VAC, 2 pole, shunt strip for emergency stop switch.

Protects: Entire system
200/220 VAC step-up transformer.
Compressor motor
Condenser fan motor
Air heaters
AC transformer

FUSE (2 ea.), 2 amp, 250 VAC, located on rear panel.

Protects: Computer power supply
200/100 VAC transformer fro air solenoid valves
All low current 200 VAC components

CIRCUIT BREAKER, located internally in compressor motor.

Protects: Compressor from overheating and overcurrent conditions.

CIRCUIT BREAKER, located internally in condenser fan motor.

Protects: Condenser fan motor from overheating.

DC Voltage Protection

FUSE, 10 amp, 250 VAC, located on Power Supply Board P/N 1B--141-1A

Protects: +36 VDC fro arm up/down motor

FUSE, 5 amp, 250 VAC, located on Power Supply Board P/N 1B-141-1A

Protects: +24 VDC for heater and compressor relay coils (primary) on heater/flow control board.

FUSE, 2 amp, 250 VAC, located on Power Supply Board P/N 1B-141-1A

Protects: +5 VDC for Power Supply Board logic and Heater/Flow Control Board logic.

POLYSWITCH FUSE: 5 amp, 100 VAC, located on Power Supply Board P/N 1B-141-1A

Protects: +36 VDC for arm in/out

Sensors

Any open thermostat latches a fail-safe circuit which removes power from all heaters through mechanical relays. Resetting is accomplished only by powering the T-2500E (SE) off and on again.

THERMOSTAT, 160 F, normally closed, located on the purge air heater.

Function: Senses case temperature of purge heater

Purpose: Protects purge heater from overheating if all other failsafes fail.

THERMOSTAT, 325 F, normally closed, located on hot air heater.

Function: Senses case temperature of hot air heater.

Purpose: Protects hot air heater from overheating if all other failsafes fail.

THERMOSTAT, 350 F, normally closed, located on cold air heater.

Function: Senses case temperature of cold air heater.

Purpose: Protects cold air heater from overheating if all other failsafes fail.

PRESSURE SWITCH, 6 PSI, normally closed, located in test head

Function: Senses input pressure of purge heater

Purpose: Inhibits voltage to purge heater if air pressure is below 6 PSI to prevent heater from overheating.

PRESSURE DIFFERENTIAL SENSOR (2 ea), 0 - 150 PSI, located on Heater/Flow Control Board P/N 1B-134-1A

Function: Measures pressure differential across flow venturi in hot and cold air circuits

Purpose: For calculation of flow-rate display. Signals software to disable heater if flow is below 100 SCFH.

FIXTURE THERMOCOUPLE SENSOR, K-type, located in test head air stream.

Function: Senses air stream temperature.

Purpose: For air temperature control. Signals software to limit air temperature to maximum 230C.

PURGE THERMOCOUPLE SENSOR, K-type, located in purge heater output.

Function: Senses purge heater air temperature

Purpose: To control purge temperature. Signals software to limit air temperature to maximum of 150 C.

Computer Power Supply

Input: 200 - 230 VAC, 4 amp
Output: +12, -12, +5, -5 VDC, 250 watt
Protection: Internal Fuse, 2 amp, 250 VAC

Environment

The primary environmental consideration occurs when the refrigeration system is being serviced. The refrigerants used in the system are of the “safe” variety, however they must be disposed of as per Clean Air Act, 1990, section 608. In compliance with this, Thermonics provides both the containers used to collect the refrigerants and provides disposal services. Detailed instructions for servicing the refrigeration system can be found in the T-2500E (SE) Precision Temperature Forcing System Maintenance Manual, Chapter seven.

Ergonomic and Human Factors (Semi S8)

Design considerations for the T-2500E (SE) include human factors and ergonomics. The interaction between the end-user and the PTFS (semiconductor test equipment) is designed to facilitate safe operation of the system. The division between hardware and software tasks is distributed to optimize the end-users' capabilities and performance while limiting operating hazards. The interfaces, both mechanical and software, have an intuitive look and feel that helps to minimize potential errors and mishaps by operating in an obvious and expected manner - that is, they conform to the end-users expectations.

The size of the system (height) and the motion of the boom, arm and thermal head are within the expected range for the body size, strength and range of motion characteristics of the typical end-user population. These factors play an important role in mitigating fatigue and injury during operation of the system.

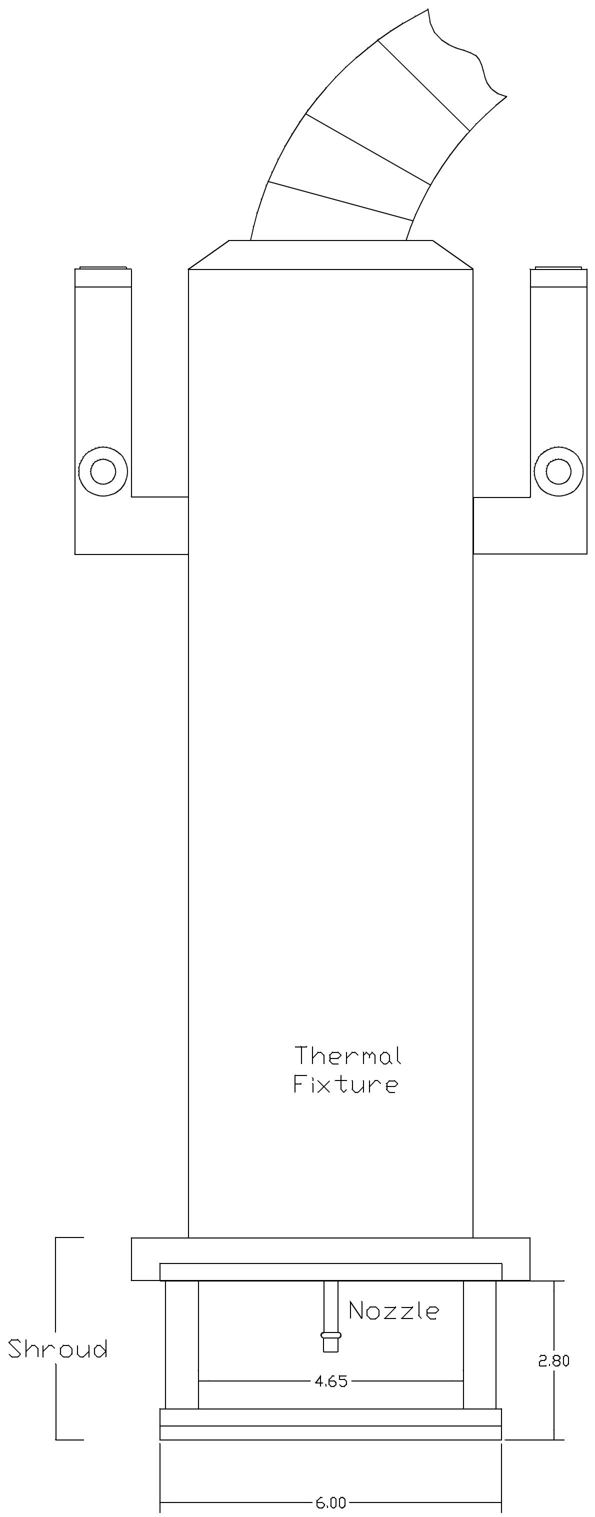
Specific features that conform to the standard include:

- Location and height of the front panel.

  The front panel is the main site of interaction by the end-user with the PTFS. It includes the graphical user interface (touch screen), removal disk media bay, and the EMO switch. The height of panel provides easy operation of the system by placing these items at a nominal height. The GUI provides an intuitive user interface that is easy to operate and performs in an expected manner. The EMO switch is obvious and easily accessed, as is the bay for the removable media.

- Location, height and range of motion of the boom and arm.

  The boom and arm include mechanical adjustments for positioning the thermal head over the test device. Brakes hold the arm in place to prevent any unexpected motion. Electronics are used to detect activation of the boom and forearm clamps to prevent motion when engaged. In addition, pinch-points have been reduced and eliminated as far as possible.



Standard Shroud

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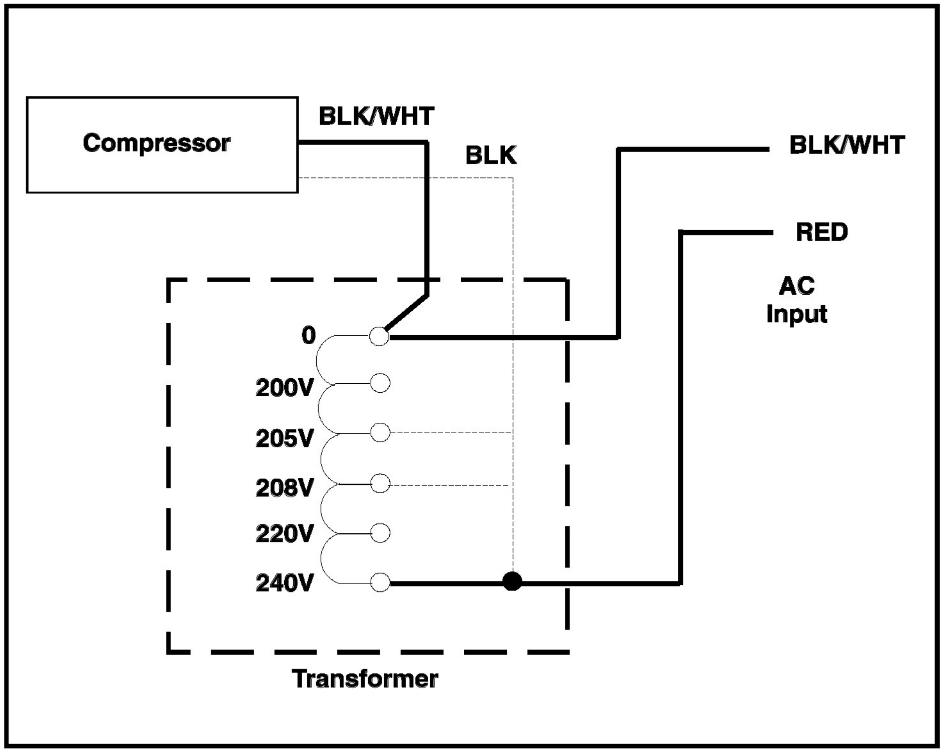
Transformer Configuration for 50 Hz Operation



50 Hz Operation

Trans Terminal Label \ Input Voltages	230	231 to 240	190 to 205
0V			
200V			
205V		X	
208V	X		
220V			
240V			X

Move black wire to indicated terminal for corresponding voltage

Note: For 50 Hz operation, the compressor requires 205V.
For 60 Hz operation, the compressor requires 220V.

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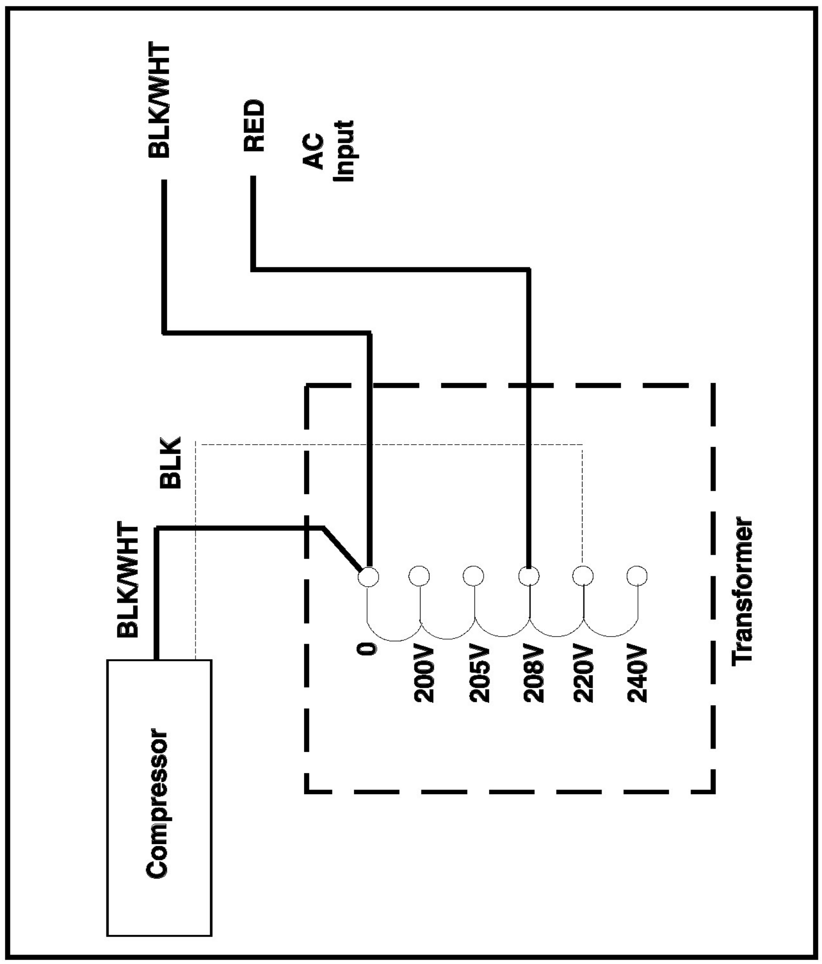
Transformer Configuration for 60Hz Operation



For 60Hz operation, the system is always wired, as above, for voltages between 200 and 230.