CONTROLLED ENVIRONMENT CHAMBER

Model 5532

Operating Manual

3/07

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1.0 Model 5532 CONTROLLED ENVIRONMENT CHAMBER

Many applications require a controlled environment for testing, fabricating and/or storage. The Model 5532 Microprocessor Controlled Environmental Chamber is a completely integrated system, fabricated from 0.375” clear and white acrylic that provides the user with excellent visibility of the controlled environment. It includes glove ports, equipment and sample access doors, circulating fans, lighting and accessory power outlets. The standard Chamber is capable of precisely controlling temperatures from 64-135°F (18-55°C) and humidity from 5-98% RH. (**NOTE:** The entire humidity range cannot be obtained at all temperatures due primarily to dew point considerations as shown in Figure 1.0-1.)

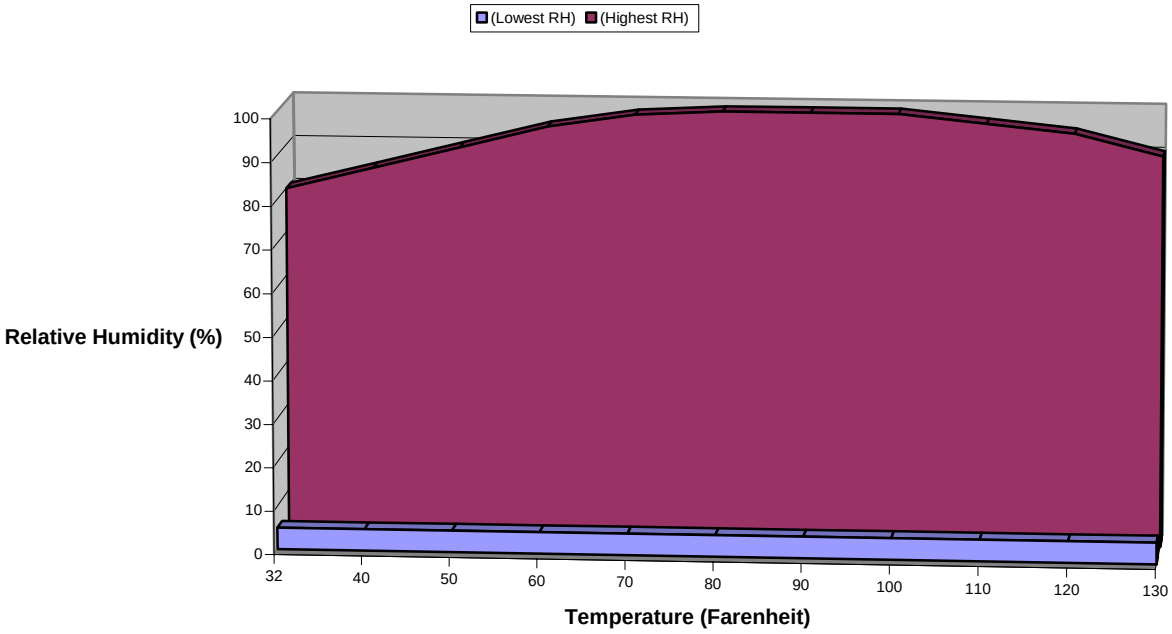


Figure 1.0-1: Model 5532 Dew point performance chart

The overall dimensions of the Model 5532 are 54”Wx25.5”Dx22”H (137x65x56cm). The usable interior working space measures 39”Wx20”Dx21”H (99x51x54cm).

1.1 Chambers Controllers & Operating Systems

The controllers, pumps and the humidifier operating system are housed in a separate compartment on the right side of the Chamber as shown in Figure 1.0-2.

Figure 1.0-2: Model 5532 Controlled Environment Chamber

The systems are totally accessible via the removable white, acrylic panel on the right side of the Chamber. Controllers and operating systems that are available with the Model 5532 are as follows:

1. Microprocessor Temperature Controller (multi ramp/soak, set point display; Std.)
2. Model 554 Temperature compensated RH and RTD Temperature Sensor (Std.)
3. Integrated 500 Watt Heater (Std.)
4. Choice of Cooling Systems: (5473-150W - Std.)
    a. Model 5473-(150W-400W) 510-1360 BTU Thermoelectric Cooling System
    b. Model 5463 Liquid CO_2 Cooling System
    c. Model 5566 Liquid Nitrogen Cooling System
    d. Model 5475 Variable Load Refrigerated Cooling System
5. Microprocessor Humidity Controller (multi ramp/soak, set point display, Std)
6. Model 5472 Ultrasonic Humidification System (Std)
7. Choice of Dehumidification Systems:
    a. Model 5471 Desiccant/Pump Dehumidification System - 2.5 lbs. of Desiccant (Std.)
    b. Model 5478 Self-Regenerating Dehumidification System (requires external air compressor or house air at 50-100 psi)
    c. Model 5465 Dry Gas Dehumidification System

8. CALCOMMS Computer Software/Interface Package. Allows remote monitoring, charting and reprogramming of the Microprocessor Controllers from a PC (Std).

1.1.1 Front Panel Description

The front panel of the Model 5532 Chamber is shown in Figure 1.0-3.

Figure 1.0-3: Model 5532 Chamber Front Panel

1.1.1.1 Microprocessor Controllers

The Model 5532 utilizes CAL 9500P microprocessor control modules to control the humidity and temperature in the chamber. The controllers may be operated as stand-alone units or as part of a computer-controlled system using the included CALCOMMS software package that can control, monitor and log up to 32 control modules 16 Chambers) simultaneously.

The 9500P module displays both the measured parameter and set point simultaneously, performs multiple ramp/soak cycles and includes a third set point for alarming. Point source LED's in both modules display the operating status of the control function. Front panel ON/OFF switches enable the respective operating systems to be placed in standby without disturbing controller settings.

Controllers can be programmed as either ON/OFF, or as proportional control where the process is constantly monitored and power to the operating system pulsed at a rate that maintains the parameter measured at the sensor, to within ±0.2 of the set point.

Refer to Sections 3.0 and 5.0 respectively for a full explanation of all functions and features.

1.1.1.2 Front Panel Switches

1. **'POWER' -** The Main Power Switch is the black rocker switch located directly below the Temperature Controller, to the left of the Fan Power Knob. This switch disconnects all power going to the Chamber Systems. "I" is "ON", "O" is "OFF".

2. **'FAN' -** The Variable Fan Speed Control Knob is located to the right of the Power Switch. This switch controls the speed of the circulation fans inside the cabinet workspace.

3. **'TEMP' –** Allows the user to manually disable the Temperature Control System. Pushing this switch to the "Off" ('0') position manually disconnects the low voltage control signal from either of the Temperature Control Relays independently. The Microprocessor will still show the Temperature in the display, the set point may still be adjusted, the internal LEDs will still illuminate and the AC Power will still be sent to the solid state Control Relays. The Relay "Output" will 'open' because the low voltage control signal will no longer be connected to the Relay, therefore, the corresponding Temperature system will not receive AC Power and will not operate.

4. **'RH' –** Allows the user to manually disable the Humidity Control System. Pushing this switch to the "Off" ('0') position manually disconnects the low voltage control signal from either of the Humidity Control Relays, independently. The Microprocessor will still show the Relative Humidity in the display, the set point may still be adjusted, the internal LEDs will still illuminate and the AC Power will still be sent to the solid state Control Relays. The Relay "Output" will 'open' because the low voltage control signal will no longer be connected to the Relay, therefore, the Humidity systems will not receive AC Power and will not operate.

5. **'LIGHT' -** The Light Switch is located to the right of the POWER Switches, left of the FAN Speed Knob. This switch controls the overhead light installed in the Chamber workspace.

1.1.1.3 Sensors & PC Boards

The Sensor Input and Control Relays are contained on a PC Board, located at the rear of the Front Panel.

1. Switches - The switches are mounted to the front panel, (refer to Figure 1.0-3).

2. **Relays -** The solid-state relays are removable and mounted in sockets secured with plastic cable ties on the PC Board.

3. **Sensor Input -** The Sensor Input is the 5-pin DIN jack located in the lower right corner of the PC Board. The ETS Model 554 RH Sensor consists of a Temperature Compensated Relative Humidity Sensor and a RTD Temperature Sensor and is plugged into this jack. The Sensor Head (Sensing Elements) must be in the 5532 Chamber environment. The sensor is held in place on the divider wall with a ¾" NPT plastic compression fitting.

   The input is configured at the factory to accept the signal from the ETS Model 554 Humidity/Temperature Sensor. The Model 554 signals are both 0-1VDC, corresponding 0-100% RH and 0-100 °C (32-212°F), respectively.

1.1.2 Side Interface Panel Description

All user connections to the Chamber are made through the Side Interface Panel shown in Figure 1.0-4. Power connections, Operating Systems connections and the Computer interface are all located on this panel. The Side Interface Panel is a modular layout that is modified to meet the specifications of the Operating Systems ordered with the Model 5532 Chamber. Tube fittings may be added/removed and power outlets may be added/removed. The following sections will describe the main features of the Side Interface Panel in the Standard Model 5532 Configuration. For other configurations, specific installation instructions will be included.

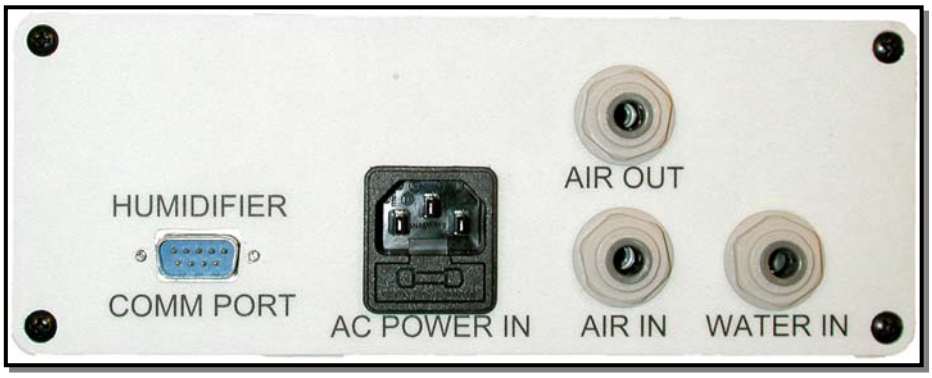


Figure 1.0-4 Model 5532 Side Interface Panel

1.1.2.1 AC Power (Mains)

Labeled **POWER**, this Universal IEC power connector is located on the bottom, left corner of the panel. **The Voltage supplied (Mains) must match the Chamber Voltage.** All Chambers are 115 VAC/60 Hz, unless otherwise specified.

1.1.2.2 COMM PORT (RS-485 & Analog Voltage Outputs)

The Comm Port is the 9-pin subminiature-D jack (sub-D) located directly above the AC Power Cord Input. This connector is used for both the analog sensor output signals and the RS-485 communications output from both the Temperature and Humidity Microprocessor Controllers. Comms access to either, or both, units is gained through this jack. **(Refer to Section 6.0, CALCOMMS Computer Interface.)**

1. **RS 485 Computer Interface**

   The RS 485 portion of the Comm Port is active with the standard Controllers fitted with the COMMS option (See Section 1.2.1 LEVL C). The COMMS option allows the microprocessor to communicate with a PC running the CALCOMMS software.

   RS-485 Wiring Connections

   Tx/Rx+ = Pin 7
   Tx/Rx- = Pin 2
   Ground = Pin 4

   If using the CALCOMM computer program, refer to Section 6.0 “CALCOMMS-Computer Interface” for set-up instructions.

2. **Analog Voltage Output**

   The Analog Voltage Output is always active. Temperatures of 0-100°C (32-212°F) correspond to an output of 0-1VDC. Relative Humidity of 0-100% RH also corresponds to an output of 0-1VDC. The analog output is a direct voltage reading from the sensors.

   This connector is configured as an Analog Voltage (0-1VDC) Output for monitoring the temperature and/or humidity performance using a chart recorder or any other analog input device. The minimum acceptable input impedance for the analog recording device is 20K ohms. Input impedance lower than 20K ohms will affect sensor accuracy of the entire system.

   Analog Voltage Output Wiring Connections

Temperature Positive (+)	Pin 9
RH Positive (+)	Pin 1
Common (Gnd) (-)	Pin 4

1.1.2.3 DEHUMIDIFY IN/OUT

The Model 5471 Desiccant/Pump Dehumidification System uses a pair of Quick Disconnect fittings. The Pump is inside the Chamber Control Cavity and the Desiccant Column is outside the Chamber. These two fittings (AIR IN & AIR OUT) connect the Column into the Dehumidify loop. **(Refer to Section 2.2.1 Dehumidification System)**

1.1.3 Operating Systems Compartment

The Operating Systems compartment, shown in Figures 1.0-5a, b & c, contains the control electronics, humidifier and dehumidifier pumps, ultrasonic humidifier, control electronics, fluorescent light ballast plus access to the sensor.

Figure 1.0-5a: Operating Systems compartment

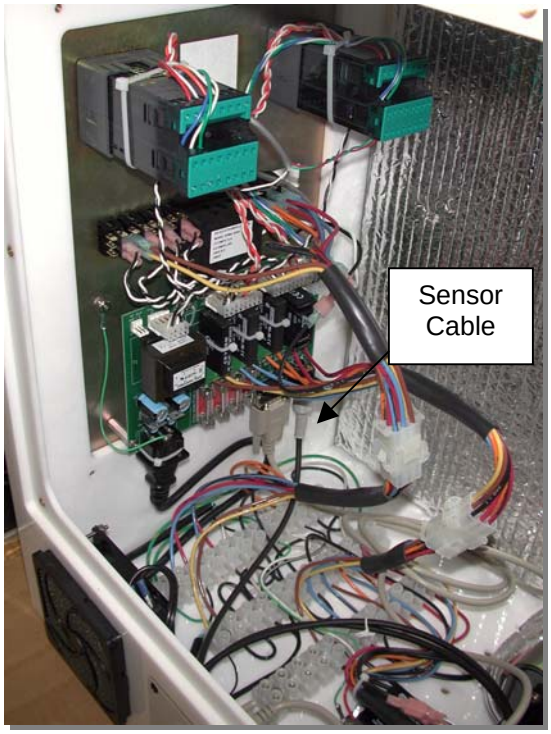


Figure 1.0-5b: Inside left side

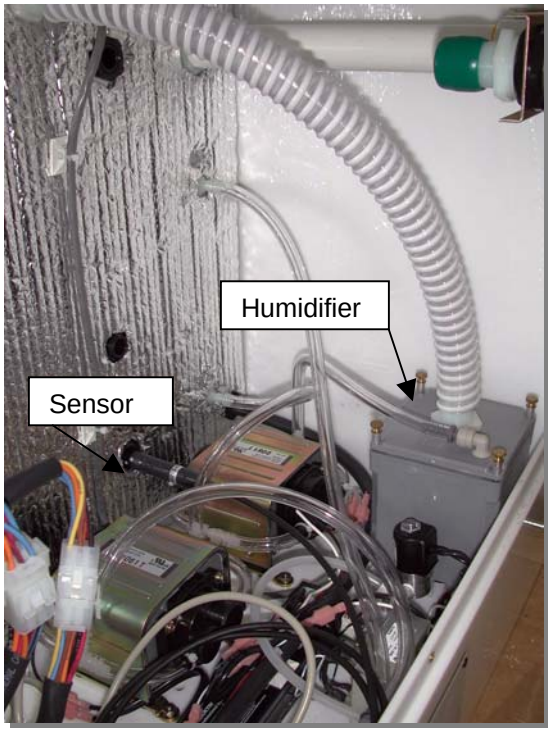


Figure 1.0-5c: Inside right side

1.2 Controlled Environment Description

The controlled environment section of the Chamber is 13 ft^3. (0.32 m^3) with a useable internal working space of 39”Wx20”Dx21”H (99x51x54 cm). Located on the rear wall is an aluminum panel that protrudes 4” inside and contains the heater, thermal safety switch, variable speed 110 cfm fans that are controlled by a speed control knob located on the front panel. Also included is an accessory north American GFI power outlet. Mounted to the top of the unit is a weather-tight 18-Watt fluorescent light (controlled by an ON/OFF switch located on the front panel.

The standard thermoelectric cooling system is mounted to the rear wall behind the aluminum panel when the chamber is equipped with either of those cooling systems.

The wall separating the controlled environment from the electronics compartment is 0.25” acrylic and contains the humidity and temperature sensor, dry air in/out ports plus the gas cooling fitting, if so equipped. The humidifier output is located on the upper middle portion of the wall.

The left hand side of the Chamber consists of a 12"W x 4"H (30.5x10cm) opening with a hinged access door secured by three (3) ½-turn latches. Towards the rear is a 1.25" (32mm) ID access hole for feeding cables and tubing to instrumentation placed inside. This hole should be sealed using the soft putty compound provided.

The front of the Chamber consists of a large door containing a pair of 8” (20cm) dia. ports to accept gloves or optional iris ports. The standard Model 5532 is equipped with accordion sleeves with removable #10 size latex rubber gloves (other sizes and types of gloves are available). Silicon rubber iris ports or a solid door are also available as options. The access opening is 32"W x 14"H (81x36cm) which enables large objects to be placed inside. To the right of the front door is the humidity and temperature control module. This module is easily removed for servicing by loosening the four (4) captive mounting screws.

1.3 General Specifications

Chamber:
Material:
3/8” (6mm) clear & white acrylic
Construction:
PS30 polished welded seams
Doors: 3/8” (9mm) clear acrylic, ½-turn latches
Seal:
¼” (6mm) Poron, non-setting gasket
Gloves: (when configured)
.018” (0.5mm) replaceable hands, natural rubber, accordion sleeves, 8” (20.3cm) ports
Operating Range:
Humidity: <10 to >98%
Temp: (Std) 64-135°F (18-55°C

Controllers:
Type: 2x CAL 9500, multiple ramp/soak cycles
1x CAL 9500, (opt.) 3rd parameter, linear input
Resolution: 0.1%/0.1°
Set Pt. Tracking: ±0.1
Rec. Out: 0-1vdc, 0-20ma, 4-20ma
Computer IF: MODBUS proto. Via RS485-
PC with W98 or higher, NT
Sensor:
Type: Temp compensated RH/Temp
RH: Capacitive film, 0 to 100%, non-condense
Temp: RTD, -40 to +140°F (-40 to 60°C)
Accuracy: ±1.5% RH @ 72°F (22°C)
±0.5°F (±0.3°C)

Fans: 2x110 cfm (6230 l/min), ON/VARY/OFF
Access Ports: (right side)
2x¼” (6mm) Quick disconnects
1x1” (25.4mm) Hose barb
1x1½” (31.4mm) cable pass through
(located on left side)
Lighting: 18W sealed fluorescent, ON/OFF Sw
Dimensions:
Overall: 54”Wx29”Dx22”H (137x65x56cm)
Working space (useable): 39”Wx20”Dx21”H
(99x51x54 cm)
Weight: 120 lbs (55 kg)

Operating Systems:
Dehumidify: Desiccant/Pump
2.5 lb (1.1kg) $CaSO_4$/1.2cfm
Humidify: Ultrasonic
Capacity: Tap water or 5 gal (19 l) ext. tank
Flow rate – 0.06 cfm (max)
Heat: Electric, 500W
Cool: 150W Thermoelectric (Std), 300W (Opt)
Power:
Voltage: 115/230VAC, 50/60Hz
Current: 8-10 Amps

1.4 Unpacking Chamber

The standard Model 5532 Controlled Environment Chamber is shipped in 2 separate cartons. The chamber is double boxed in double-wall custom cartons and the accessories, shown in Figure 1.0-6, are packed in a second double-walled carton.

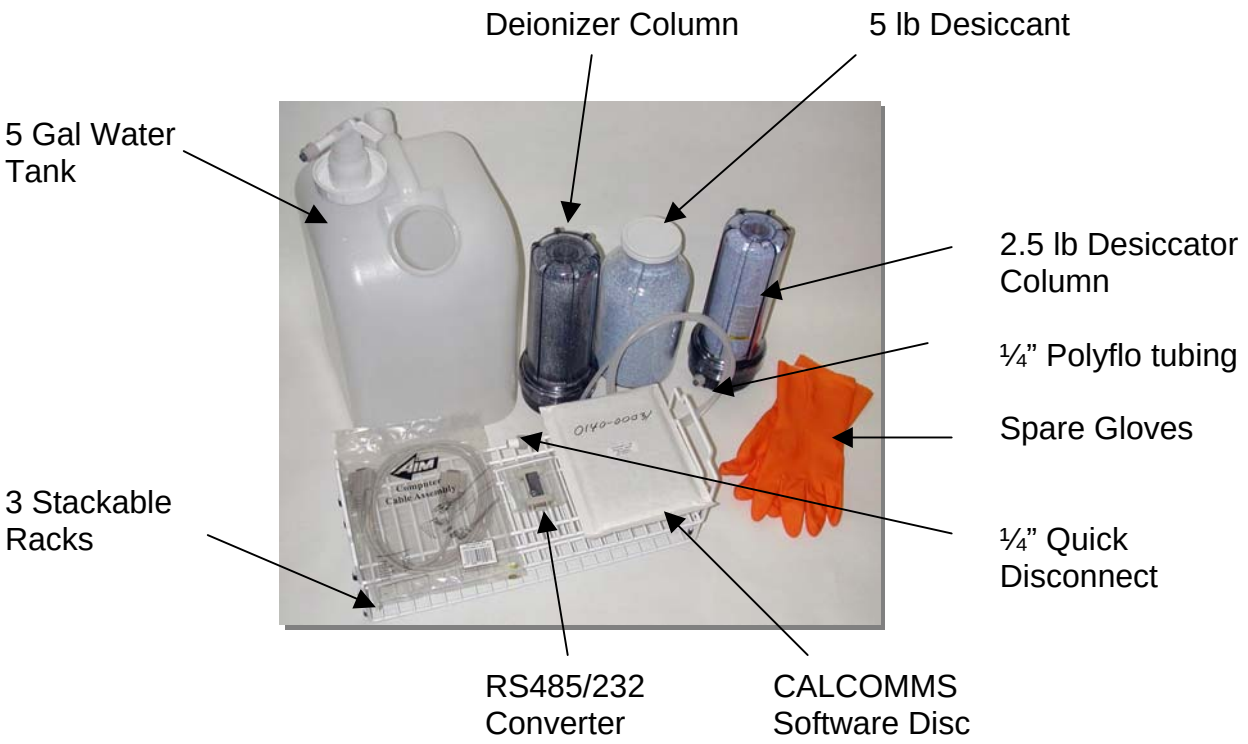


Figure 1.0-6 Accessory box contents

Upon receipt immediately inspect the cartons for any visible damage. If any shipping damage is noticed, unpack the chamber and inspect it for damage. Take pictures of any abnormalities observed. Save all cartons until it is certain that they will no longer be needed. If the Chamber has to be returned to ETS for any reason the original packaging must be used.

NOTE:

Report any damage immediately to the common carrier delivering the System and to ETS. All damage claims must originate from the recipient. Failure to report damage in a timely manner may result in the claim not being paid. ETS will not be responsible for damaged or lost components if not reported to ETS within 30 days of shipment.

Save all cartons and packing material until the Model 5532 System is installed and operating.

2.0 HUMIDITY OPERATING SYSTEMS

2.1 Humidification System

The Model 5532 Chamber includes an ETS Model 5472 Ultrasonic Humidification System. The Humidifier is located inside the Chamber Control Cavity as shown in Figure 1.0-5c. To access the Humidifier, remove the large white acrylic panel on the right hand side of the Chamber as shown in Figure 1.0-5a. The panel is held in place with eight (8) Phillips, #6-32 Truss Head screws.

Refer to the Set-up instructions below before using the Humidifier!!

The Ultrasonic Humidifier is an open loop system that produces a fine water mist through ultrasonic action. A small diaphragm air pump draws in ambient air and forces the fine mist from the humidifier into the chamber.

2.1.1 Ultrasonic Humidifier Accessories

The following are the humidification system accessories (Refer to Figure 1.0-6).

1. 5 Gallon Water Tank
   a. Tank includes a plastic faucet. When shipped, the faucet is attached to the white lid, protruding inside the tank.
   b. A ¼" OD Tubing Quick Connect Fitting is attached to the Faucet.
2. Water Deionizer Column
   a. #10 Clear Sump with black Lid and ¼" OD Tubing Connectors.
   b. The Column is filled with a mixed bed deionizing resin for water.
   c. The Column has Filter Pads on the input and output. The Filter Pads are held firmly in place by a cadmium plated steel spring.

2.1.2 Set-Up

The Model 5532 comes with green Caplugs covering the "mist output' and the 'chamber vent'. These Caplugs must be removed before set-up and operation.

The Model 5472 Humidifier may be operated using either a water tank or directly, without a tank, from a faucet using the included de-ionizer column. **Use distilled or de-ionized water ONLY!!**

A water de-ionizing column is included, suitable for up to 100 psig. (**NOTE:** The life of the de-ionizing column will be greatly increased by using a carbon black water filter, provided by the user, in line with the deionizer.)

When the de-ionizing resin is depleted, it will change from dark to light in color. When it is ¾ light, it must be replaced. Resin is available from specialty chemical

suppliers such as **Resintech Inc., Pt# MBD-30.** They can be reached at 1-865-768-9600. They are located at 160 Cooper Rd., Berlin, NJ 08091

2.1.2.1 Using the Water Tank

When using the water tank distilled or de-ionized water can be obtained from either a separate source or de-ionized water can be generated by the supplied de-ionizer column. Place the tank on the floor or other surface with the openings facing up.

1. If the de-ionizer is being used to supply the water, attach the water de-ionizing column to a water supply. The supply water should go to the side marked “IN”. The de-ionizer is fitted with a ¼” tube connected to a ¼” NPT quick disconnect fitting. ***The user must provide the appropriate fitting to adapt the de-ionizer ¼” NPT fitting to the supply water line***.

2. Unscrew the large white cap from the tank and remove the plastic faucet. Install the faucet onto the smaller tank fitting. Turn the faucet lever to closed (LEFT), the 9:00 o’clock position. With the faucet outlet facing downward screw the large cap onto the larger fill hole. Place the de-ionizer outlet tube into the smaller opening in the large white cap.

3. Turn on the water.

   The water flow rate through the purifier should not exceed *8oz. every 25-30 seconds*. Water will pass at up to 10 gallons per hour.

NOTE:

Do not increase the flow rate! The amount of water purification is in direct proportion to how long it takes the water to flow through the column.

Slow flow rate = highly purified water.
Fast flow rate = poorly purified water.

4. Fill the tank with the amount of water that can be used in 1-2 weeks of normal operation at the required operating conditions.

   Different operating conditions will consume different amounts of water. Leaving water in the tank longer than 1-2 weeks is not recommended. Always refresh the water supply to prevent the growth of bacteria and other things that will degrade water quality. **NEVER add anti-bacterial growth treatment to this water, it will damage the humidifier.**

5. Turn off the water source and remove the fill tube. **NOTE: The de-ionizer column should not be used to continuously fill the tank. There is no mechanism to automatically turn off the water supply when the tank is full.**

6. This is a gravity-feed system that requires the source tank to be above the humidifier. Also, air must be allowed to enter the 5-gallon tank or water will not flow. Remove the small white cap, if it had previously been reinstalled after the filling the tank, to allow air to enter. Place the water tank output at least 12" above the humidifier water input. Placing the water tank on top of the chamber is acceptable.

7. Make sure the faucet is closed, then push the ¼" OD. tubing into the quick connect fitting.

8. Attach the other end of the tubing to the fitting on the Chamber side panel labeled 'WATER IN'. Turn on the tank faucet (full right @ 3:00 o'clock position)

9. Turn on the 'RH INCREASE' switch.

   The Humidifier basin will begin to fill with water as soon as this switch is turned 'ON'.

2.1.2.2 Using the Tap Water System

1. Attach the water de-ionizing column to a faucet. The faucet should go to the fitting on the column lid labeled "IN". The de-ionizer is fitted with a ¼" tube connected to a ¼" NPT quick disconnect fitting. ***The user must provide the appropriate fitting to adapt the de-ionizer ¼" NPT fitting to the supply water line.***

2 Turn on the water. Establish the proper water flow rate before attaching to the humidifier. The water flow rate through the purifier should not exceed 8 oz. every 25-30 seconds. Water will pass at up to 10 gallons per hour.

NOTE:

Do not increase the flow rate! The amount of purification that can be performed on the water is in direct proportion to how long it takes the water to flow through the column.

Slow flow rate = highly purified water.
Fast flow rate = poorly purified water.

Attach the open end of the tubing to the 'WATER IN' fitting on the side of the ETS Model 5532 Chamber.

3. Turn on the water. Set the flow rate to the pre-determined amount. **DO NOT OPERATE THE HUMIDIFIER WITH THE WATER SUPPLY FAUCET 100% OPEN.** High flow rates will cause the humidifier to overfill and possibly damage the unit. The humidifier consumes very little water; a low flow rate will be sufficient to keep the unit full.

4. Turn on the 'RH INCREASE' switch. The Humidifier basin will begin to fill with water as soon as this switch is turned 'ON'.

2.1.3 Operation

Once the System has been properly set up, the user does not have to do anything else to operate the system. Operation will be under the control of the Model 5532 Microprocessor Humidity Controller. Refer to **Section 3.2 Microprocessor Humidity Controller Operation.**

1. Remove the green Caplug covering the Chamber Vent.

   The vent, inside the chamber, is the 1" (25mm) orifice on the right wall (the green plug is located here). The vent passes through to the outside right wall. The 1" (25mm) barb on the outside should remain open.

2. Set the Humidity Controller set point to a value above ambient humidity (Refer to **Section 3.2.1 Microprocessor Humidity Controller Operation**).

3. Turn on the "RH INCREASE" switch on the Model 5532 front control panel.

   This will not automatically turn on the Humidifier. Turning on the "RH INCREASE" switch only makes the humidifier *available* to the Microprocessor Controller.

   When the microprocessor tells the Humidifier to activate, the small green LED in the upper, left corner of the microprocessor will light. The Humidifier will begin producing a mist and the pump will force it into the chamber through the Humidity Input Barb.

4. The microprocessor will determine the amount of humidification needed to maintain the desired set point.

   If less than the full capacity of the Humidifier is needed, the controller will provide pulses of power to the unit to limit the output. The Humidifier will be turned on and off cyclically to obtain an average humidity output lower than the full capacity of the Humidifier.

NOTE:

To obtain a smooth, even humidity output the Cycle Time (CYC.t) should be set to 1.0 second. Longer cycle times will create longer "gaps" between humidification pulses. DO NOT SET THE CYCLE TIME LESS THAN 1.0 SECOND. Shorter pulses may damage the Model 5472.

2.1.3.1 Operating Precautions

The humidifier should operate reliably if the following precautions are observed:

1. **Always run the humidifier directly to the chamber.**

Never attempt to combine the humidifier output with another air or gas source.

2. **Always provide a vent on the chamber being humidified.**

3. **Clean the ultrasonic transducer frequently and thoroughly.**

Any dirt or particle build-up on the transducer will cause stress to the electronics. Once the electronics overheat and stop working, the humidifier must be replaced. With frequent cleaning, the electronics should operate reliably for many years.

4. **Use Distilled or Deionized water only.**

2.1.3.2 Maintenance & Cleaning

1. Always unplug the Chamber before cleaning the humidifier.
2. Empty the unit of all water. Siphon water out or soak up with a sponge.
3. Remove the humidifier top cover by removing the 4 brass thumbscrews
4. **Clean the surface of the transducer using distilled vinegar and a soft, clean cloth.**

NOTE:

If the transducer is not kept clean, it will fail. Using distilled or deionized water keeps the build-up to a minimum, but cleaning with distilled vinegar will always be necessary.

Do not use any tools with metal parts or sharp edges to clean the transducer. Scratching the transducer may cause fatal damage to the unit. Refer to Section 8.0 MAINTENANCE for transducer replacement.

5. To clean thick or heavy deposits, pour a small amount of vinegar into the humidifier until the transducer surface is completely covered. Let stand for 30-60 minutes. Wipe clean with a soft cloth. If further cleaning is needed, a soft, plastic bristle brush may be used to gently clean the transducer surface.

6. Never leave water in the humidifier or water tank when the humidifier is not in service.

   Always empty all water and thoroughly dry all parts of the humidifier when it is to be stored or taken out of service for any period longer than one week. Do not seal the water tank in storage. Leave the top off to allow the air to completely dry the tank. Any residual moisture will encourage bacterial growth.

   Never clean any parts of the humidifier with water above 120°F.

2.2 Dehumidification System

The Model 5532 Chamber includes a Desiccant-Pump Dehumidification System as standard. As an option, the ETS Model 5478 Self-Regenerating Dehumidification System is available. Operation of each system will be described below.

2.2.1 Desiccant/Pump Dehumidification System

The Dehumidification System is closed loop designed to reduce the relative humidity in the Model 5532 Chamber to less than 10%. When paired with the Microprocessor Humidity Controller, the humidity inside the chamber can be controlled, without disturbance, to within +/- 0.2% RH of the set point at the sensor.

2.2.1.1 Description

The Dehumidification System includes a small air pump (located inside the Chamber Control Cavity), 2.5 lbs. of indicating calcium sulfate ($CaSO_4$) desiccant in a clear plastic column (sits outside the chamber), and ¼" O.D. tubing to interface the drying column with the pump. The tubing connects to the chamber through the quick-connect fittings on the right side of the Chamber. The desiccant column may be placed on top of, or next to, the Chamber.

The air pump is already connected to the Model 5532 Microprocessor Humidity Controller. All the user needs to do is connect the Desiccant Column into the system using the provided ¼" OD Tubing.

The desiccant removes any moisture that is in the air. This dried air is then forced back into the chamber. The desiccant contains an indicator that turns the normally blue colored desiccant pink as it absorbs moisture. When the cylinder is mostly pink, the desiccant should be renewed or replaced.

2.2.1.2 Desiccator Unit Specifications

1. Average flow-rate from the unit is 1.2 cfm (34 lpm).
2. Air is dried to a dew point of -100°F.
3. Capacity for water vapor up to 100 grams.
4. Power – 115 VAC/60 Hz, 0.35
   230 VAC/50 Hz, 0.18 Amps
5. Desiccant Column is safe for working pressures up to 100 psig.
6. Contents: 2½ lbs. of #8 mesh $CaSO_4$ Indicating Desiccant.
7. All connections are made using ¼" OD tubing. Hose barb adapters may be provided for using ¼" ID tubing as an alternative.
8. Plastic cap is fitted with "O-Ring" gasket.
9. Desiccant coil spring is cadmium-plated steel.

The system delivers air dried to a dew point of -100°F. At room temperature, the system will lower the humidity in the Model 5532 Chamber from 50% RH to 12% RH in about 2 hours.

2.2.1.3 Desiccant Dehumidification System Set-Up

1. Place the desiccant column somewhere near the chamber. (Next to or on top of the chamber are good locations.)
2. Cut 2 pieces of the ¼" OD tubing long enough to connect the desiccant column to the 'Side Interface Panel' of the Chamber.
3. Connect one piece of the tubing between the fitting labeled "DEHUMIDIFY OUT", on the Side Interface Panel of the Chamber, and the fitting labeled "IN" on the desiccant column.

   To connect the tubing: Push the tube into the fitting orifice as far as possible. The tube will lock into place automatically. To release the tube, push in on the collar of the fitting and gently pull out the tube.
4. Connect the second piece of tubing between the fitting labeled "OUT" on the desiccant column and the fitting labeled "DEHUMIDIFY IN" on the Side Interface Panel of the Chamber.

5. The chamber vent, inside of the chamber, is the 1” (25mm) orifice on the right wall. The vent passes through to the outside right wall, the 1” (25mm) barb on the outside should remain open.

6. Set the Humidity Controller set point to a value below ambient humidity (Refer to Model 5532 Microprocessor Humidity Controller Operation).

7. Turn on the “RH DECREASE” switch on the Front Panel.

   This will not automatically turn on the Dehumidification System. Turning on the “RH DECREASE” switch only makes the Dehumidification System *available* to the Microprocessor Controller.

   When the microprocessor tells Dehumidification System to activate, the large red LED on the lower left side of the microprocessor will light. The internal air pump will begin moving. The pump will draw moist air out of the chamber and force it through the desiccant column. The dried air will then be returned to the chamber.

8. The microprocessor will determine the amount of drying needed to maintain the desired set point.

   If less than the full drying capacity of the Desiccant Dehumidification System is needed, the controller will provide pulses of power to the unit to limit the quantity of dried air coming into the chamber. The pump will be turned on and off cyclically to obtain an average input of dried air less than the full capacity of the Dehumidification System.

   To achieve a smooth, even dehumidification process the Humidity Microprocessor Cycle Time 2 (CYC.2) should be set to 1.0 second. Longer cycle times will create longer “gaps” between dried air pulses. **DO NOT SET THE CYCLE TIME LESS THAN 1.0 SECOND.** Shorter pulses may damage either or both the Dehumidification System and the Controller.

2.2.1.4 Renewing desiccant

The desiccant can be renewed approximately ten (10) times before having to be replaced. <u>The granules must be removed from the drying column.</u> Disconnect the IN/OUT tubing. Hold the unit with the base facing up. Unscrew the base from the clear plastic column and pour the desiccant into a metal tray. Spread evenly, 1-2 granules deep.

Heat the desiccant for approximately one (1) hour at about 400ºF (200ºC). It should be allowed to cool in an airtight container before refilling the acrylic drying column. The felt filters should also be pre-dried at 200ºF (100ºC) for about 30 minutes before assembly.

2.2.2 Self-Regenerating Dehumidification System (Optional)

The Model 5478 Self-Regenerating Dehumidification System is capable of drying the Model 5532 Chamber from 50% RH to 12% RH in less than 3 hours, at room temperature.

2.2.2.1 Description

The Model 5478 Self-Regenerating Dehumidification System requires 50-100 psi of air pressure at 2.6 cfm to operate. Since air must be provided continuously either a separate air compressor or house air should be used for long-term dehumidification applications to ensure, reliable long-term air.

The basic Self-Regenerating Dehumidification System consists of a dual column self-regenerating desiccant dryer utilizing molecular sieve desiccant, and a 3-way control valve. The dual column dryer operates continuously to assure a constant supply of dried air on demand. The 3-way control valve controls the flow of dried air into the chamber workspace.

The dryer and valve are mounted inside the control section of the chamber.

Compressed air is fed to the dual column dryer where it is forced through one of the desiccant columns. The desiccant removes the moisture and dries the air down to a dew point of -40 °F, minimum.

The dried air is then split in two directions: Most of the dried air is sent to the output. A small portion of the dried air is diverted from the main flow and directed into the second column to regenerate the desiccant in the second column. The flow into the second column is in the opposite direction from the flow in the first column. The dried air, under high pressure, forces out any moisture in the second column through the dryer vent (located internally).

Every 30 seconds, the process reverses and the second column will perform the air-drying while the first column is regenerating. The flip-flop process continues as long as the system is in use.

The dried air not used for regeneration is sent to the dryer output. The output of the dryer is attached to the 3-way control valve. When dry air is needed in the chamber, the valve is energized and opens to allow dry air to flow into the workspace. When the valve is not energized, the dry air is vented.

2.2.2.2 Unit Specifications

1. The average flow rate from the unit is 0.26 cfm (7.3 lpm).
2. The air will be dried to a minimum dew point of -40°F with a saturated input at 90°F.
3. Power – 115 VAC/60 Hz, 4.30Amps
   230 VAC/50 Hz, 2.15Amps
4. Dryer unit may be used with compressed air systems up to 120 psig.
5. Dual column dryer uses a molecular sieve desiccant.

2.2.2.3 Self-Regenerating Dehumidification System Set-Up

The standard self-regenerating dehumidification system is contained entirely within the chamber control section.
If house air is used, a quick disconnect air fitting will be installed on the Chamber rear panel.

2.2.2.4 Operation

To operate the self-regenerating system proceed as follows:

1. Open the Chamber Vent by removing the supplied 1” (25mm) green Caplug.
2. The Chamber Vent, inside of the chamber, is the 1” (25mm) orifice on the right wall (the green plug should be removed from the orifice). The vent passes through to the outside right wall, the 1” (25mm) barb on the outside should also remain open.

   The Model 5478 is a positive pressure system. Without adequate ventilation, the system will pressurize the chamber. Pressurizing the chamber is not recommended and may cause damage.
3. Set the Microprocessor Humidity Controller set point to a value below the ambient humidity.
4. Turn on the “RH DECREASE” switch on the front of the Model 5532.

   This will do two things:

   a. It will activate the dual column dryer. It will begin producing dry air as soon as the “RH DECREASE” switch is turned on. However, no dry air will be allowed into the chamber workspace until the 3-way control valve is energized.

   b. Turning on the “RH DECREASE” switch makes the 3-way control valve *available* to the Microprocessor Controller.

When the microprocessor tells the control valve to energize, the large red LED in the lower left corner of the Humidity Microprocessor will light. The valve will open and dried air will flow into the chamber workspace.

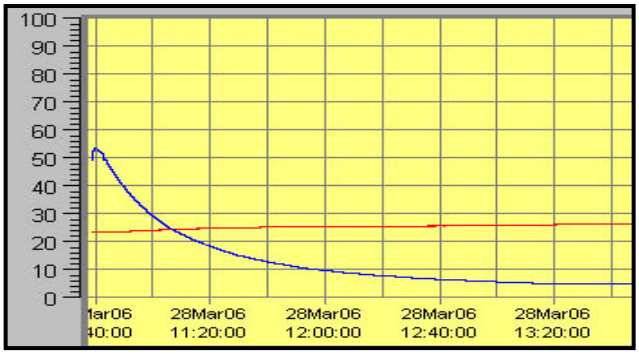
5. The microprocessor controller will determine the amount of drying needed to maintain the desired set point. If less than the full drying capacity of the Self-Regenerating Dehumidification System is needed, the controller will provide pulses of power to the Control Valve to limit the quantity of dried air coming into the chamber. The controller will open and close the Control Valve cyclically to obtain an average input of dried air less than the full capacity of the system.

   To achieve a smooth, even dehumidification process, the Humidity Microprocessor Cycle Time 2 (CYC.2) should be set to a low value. However, a short cycle time will prematurely wear out the control valve. As a compromise, CYC.2 should be set to 5.0 seconds. Shorter cycle times will afford better low humidity control at the desired set-point, but at the risk of accelerating valve wear.

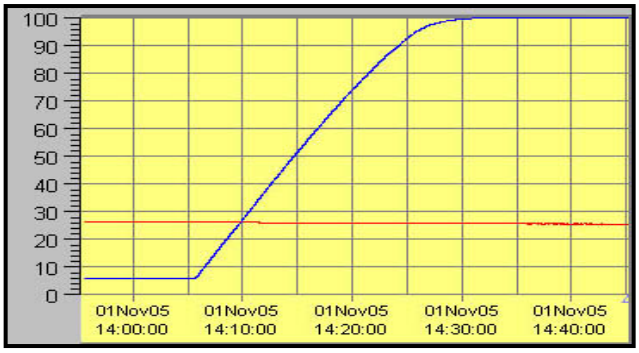
2.3 System Performance (Humidity)

Chamber performance pertains to the ability of the chamber to reach and then hold a given humidity level along with humidity gradients. It is not only a function of the chamber, but of the temperature, operating systems and controllers used. Figures 2.0-2a and 2b are charts showing the time typically required to decrease and increase humidity (Blue = RH, Red = T °C) plus humidity gradients using the standard CALCOMMS software package.

HUMIDITY



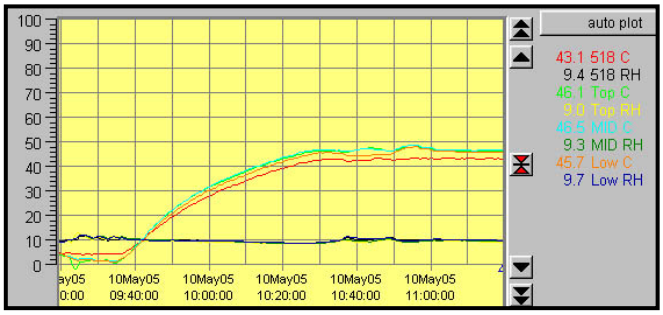
Rate of decrease



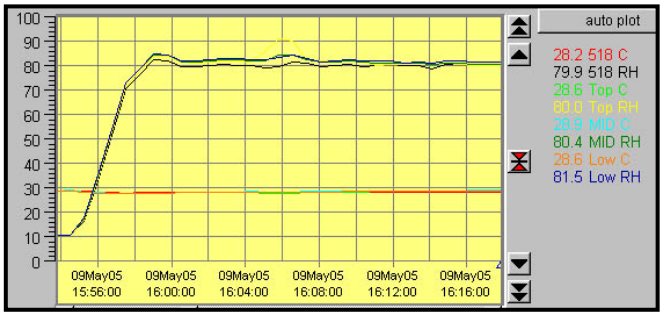
Rate of increase

Figure 2.02a: Rate of humidity decrease/increase

HUMIDITY GRADIENTS



Increase temperature, constant low RH



Increase RH, constant temperature

Figure 2.0-2: Typical Humidity/Temperature gradients

3.0 MICROPROCESSOR HUMIDITY CONTROLLER

3.1 Description

The Microprocessor Humidity Controller, in conjunction with the Model 554 temperature compensated RH Sensor, controls the relative humidity in the Model 5532 Chamber by supplying a proportionally controlled power output to the Humidification System and/or Dehumidification System.

The Controller provides low voltage (5 VDC, 15mA) control signals to the INCREASE and DECREASE solid-state relays, located on the 'PC Board'. When the low voltage signal is applied to the relay 'Input', the 'Output' of the relay 'closes' and allows AC Power to flow to the connected device.

When the 'RH Function' switches on the Front Panel are in the 'OFF' ('0') position, power is manually disconnected from the control relays and no humidification or dehumidification can take place until the switch is placed in the 'ON' ('I') position.

All devices in the Model 5532 are connected through terminals on the 'PC Board'.

3.1.1 Controller Specifications

Controller:
Sensor input (std linear): 0-1.0V
Accuracy: ±0.1%
Resolution: ±0.1 of digital readout
Calibration accuracy: ±0.25% (max input)
Sampling frequency: Input - 10 Hz, CJC - 2 sec
Display: High Brightness LED
  Reading: 0.4" (10mm) Green
  Set Point:0.35" (9mm)
  SP1: Flashing square Green
  SP2: Flashing round Red
  SP3 (Alarm): Flashing round Red
Controls:
  Control module: Function, Up/Down buttons
  Front Panel: INCR - ON/OFF, DECR - ON/OFF
Power (Input): 90-240VAC, 50/60 Hz
AC output control current: 1,000 VA max
  Std configuration: 4A
  Heater Control: 8A
  Solenoids: 2A (extra low turnoff leakage current)
Ramp/Soak: 126 segments/program, 31 programs max
Communications: MODBUS® protocol,
  Windows 95/98/2000/NT/XP, 200MHz/16MB RAM min (CALCOMMS only)
  Multiple unit link: RS-485
Software:
  Standard: CALCOMMS Applications Software
  Optional : CALgrafix Process Monitoring & Configuration Software
             CALopc Server Software

Sensor:
Temperature compensated
Humidity: Capacitive film
Range: 0-100% (10mV/%RH)
Range:0-100% (10mV/%RH)
Accuracy: ±2% RH @ 73°F (23°C)
Temperature: RTD
Range: -40 to +185°F (-40 to +85°C) (10mV/°C)
Accuracy: ±0.9°F (0.5°C)
Size: 0.625" dia.x 6.5" L (15mm x 165m)
Cable length: 6.5' (2m)
Housing: Polycarbonate, Black (Ral 7016)
Compliance: EN50081-2, EN50082-2

3.2 Controller Operation

3.2.1 Set-Point Adjust

1. Press and hold the "∗" button. The letters "rh" will appear, followed by the current set-point value. The set point value is displayed on the lower half of the microprocessor display.

2. To adjust the set point higher, press the "▲" button. To adjust the set point lower, press the "▼" button.

3. Release the "∗" button.

3.2.2 Humidification System

The Humidifier is built into the Model 5532 Chamber, located inside the Chamber Control Cavity. To access the Humidifier, remove the 'Side Access Panel'.

To operate the Humidification System:

1. Attach the ¼" OD Water Tube to the fitting labeled "WATER IN" on the Side Interface Panel. The water source may be either a water tank or a pressurized water line (up to 100psi.).

2. Adjust the RH set point to a value above the ambient RH conditions.

3. Turn on the "RH INCREASE" switch on the Model 5532 Front Panel.

   This will not automatically apply power to the Humidifier. Turning on the "RH INCREASE" switch only makes the Humidifier *available* to the Microprocessor Controller.

   When the microprocessor activates the Humidifier, the small green LED in the upper left corner of the RH Microprocessor display will illuminate. The Humidifier misting unit and air pump will activate and begin pushing a fine water mist into the chamber.

4. The Microprocessor will determine the amount of humidification needed to maintain the desired set point in the Chamber.

   If less than the full output capacity of the Humidifier is needed, the Controller will provide pulses of power to the unit to limit the output. The Humidifier will be turned on and off cyclically to obtain an average humidity output lower than the full capacity of the Humidifier, appropriate to maintain the desired set point in the enclosure.

   For best results, the Cycle Time (CyC.t) should be set as short as possible. The minimum cycle time for the Humidification System is 1.0 second.

3.2.3 Dehumidification System

The Dehumidification System air pump is located inside the Chamber Control Compartment. The desiccant column is attached externally through the fittings labeled “AIR IN” and “AIR OUT” on the SIDE INTERFACE PANEL.

To operate the Dehumidification System:

1. Read the operating instructions for the Dehumidification System being used.
2. Adjust the set point to a value below the ambient RH conditions.
3. Turn on the “RH DECREASE” switch on the front of the Model 5532 Control Panel.

   This will not automatically apply power to the dehumidification system. Turning on the “RH DECREASE” switch only makes the dehumidification system *available* to the Microprocessor Controller.

   When the microprocessor activates the outlet, the large red LED in the lower left corner of the RH Microprocessor Controller display will illuminate.

4. The controller will determine the amount of dehumidification needed to maintain the desired set point in the enclosure.

   If less than the full output capacity of the Dehumidification System is needed, the Controller will provide pulses of power to the unit to limit the output. The Dehumidification System will be turned on and off cyclically to obtain an average output lower than the full capacity of the Dehumidification System, appropriate to maintain the desired set point in the Chamber.

   For best results, the Cycle Time 2 (CyC.2) should be set as short as possible.

   Desiccant/Pump Dehumidification System minimum cycle time is 1.0 second.

   Self Regenerating Dehumidification System minimum cycle time is 5.0 seconds.

3.3 Programming the Microprocessor Controller

3.3.1 Accessing the Programming Menu

1. To access the Controller Program Menu, press the “▲” and “▼” buttons simultaneously for three (3) seconds. The controller will enter the Menu on Level 1 in the “tunE” function. (If using the CalComm Computer Program, refer to the “CALCOMM” section of the Manual).
2. To scroll to different parameters within a Level, press the “▲” button to scroll right and the “▼” button to scroll left.

3. To change a parameter or change Levels, press and hold the "∗" button. Press the "▲" or "▼" buttons to change the parameter.

4. All factory-programmed values listed here are optimized for use with the Dehumidification and Ultrasonic Humidification Systems. Other systems may require different settings.

   If the Model 5532 Chamber has different systems, the information programmed into the Controller will be different. Information on the specific program should be provided separately, if not, contact ETS.

5. To exit the menu press and hold "▲ ▼" for three seconds.

3.3.2 LEVL C (Level C)

Level C is only visible when the unit is fitted with the COMMS option (RS 485 computer interface card). Level C is responsible for the communication protocol for the unit when interfacing with a PC. The values in Level C must match the values on the computer screen to establish communication.

Addr – (2) Instrument Communication Address. This address may be changed to any number suitable to the user.

bAud – (9600) The baud rate should be set as high as possible.

dAtA – (18n1) *Do Not Change.* The data format should not change.

DbuG – (off) *Do Not Change.* Debugging is an advanced feature that will not be covered in this manual.

3.3.3 LEVL 1 (Level 1)

Level 1 is the programming level. The Proportional, Integral, and Derivative controls are adjusted here. The combination of PID values is virtually limitless. This allows the controller to be used in a wide variety of applications. However, this flexibility can also lead to confusion when programming the controller in the Model 5532's limited mode of operation.

To avoid confusion, this section will discuss which parameters may be adjusted, which parameters should not be adjusted.

All Parameters are programmed at the ETS Factory to match the Operating Systems shipped with the Chamber. The programmed values will control the Chamber within specifications. For better control, the user may adjust the values. The values listed here are for standard chambers only. Non-standard units may have different values than those listed here.
The following settings are approximations that will allow any user to achieve good RH control at any set point (approximately ±2.0 %, depending on the specific conditions). However, as the user becomes familiar with each parameter

and it's effect on RH control, the user will be able to program the unit to control within ever tightening tolerances. Control of ± 0.2% RH, or better, is achievable with this system.

tunE – (oFF) The Autotune function may be used to help determine the optimum operating conditions for a given set of operating systems and chamber volume. The Autotune operates using the Humidifier only. The Dehumidification System will be disabled during an auto tune. The 'Tune At Set point' (**At.SP)** option is recommended with the Model 5532 Chamber.

Occasionally, the message 'Tune Fail' will appear in the microprocessor display after the unit attempts an autotune. The user will need to clear the 'Tune Fail' message and attempt another autotune. To clear the message, turn the Model 5532 Main Power Switch 'Off' and then 'On' again. When power is re-applied, the message will no longer be displayed.

A "Tune Fail" may be caused by many variables. However, performing multiple 'Tune' attempts will generally result in a successful "Tune".

bAnd – (15.0) Proportional Band for Humidifier.

int.t – (1.0) Integral Time in minutes.

The integral time is responsible for calculating how much output should be coming from the Heating and Cooling Systems to maintain the desired conditions.

der.t – (2.0) Derivative Time in seconds.

The derivative time, in combination with the **dAC**, is responsible for keeping the environment moving toward the set-point, following a pre-determined curve (set by the **dAC** in combination with the **bAnd**). The curve is followed to help avoid set-point overshoots.

Shortening the derivative time will cause the controller to recover slowly from disturbances. Lengthening the derivative time may cause oscillations.

dAC – (1.0) *Recommended.* The **D**erivative **A**pproach **C**ontrol determines how quickly the unit will reach the set- point, without overshooting. The **dAC** creates a gently sloping, exponential curve that the system must follow when approaching the set-point. The smaller the number, the quicker the unit will allow the set-point to be reached. The **dAC** multiplied by the band determines where the beginning of the approach curve will be located. A larger **dAC** setting will cause the beginning of the **dAC** curve to be further away from the set point. The larger setting will control overshoots better, but will cause responses to disturbances to be slower.

CYC.t – (1.0) *Recommended.* Cycle time means how often the unit can potentially be turned on and then off in succession. The Humidifier may be safely

turned on and off once a second. **DO NOT DECREASE CYCLE TIME BELOW 1.0 SECOND when operating this system.**

The shorter the cycle time, the greater the degree of precision that may be achieved with the Controller.

If using any other humidification system, determine the minimum cycle time at which the unit can safely operate (consult the manufacturer's instructions for the unit).

oFSt – (0.0) *Do Not Change.* The Offset / Manual Reset control is only usable when the integral time (**int.t**) is turned off. Since the integral time is being used, the offset control may be ignored.

SP.LK – (oFF) Locks the set-point preventing unauthorized adjustment.

SP2 OPERATING PARAMETERS

The SP2 parameters can be configured in a variety of ways. In the Model 5532 Humidity Controller, the SP2 parameters are used to tailor the Dehumidification System output for best RH control.

SET.2 – (0.0) Setpoint 2 allows the user to create a setpoint offset for the Dehumidification System. It is generally not used for the Desiccant Dehumidification System.

bnd.2 – (30.0) *Recommended.* Band 2 should generally be equal to **bAnd**. The increase and decrease system will work within the same proportional band, helping to prevent overlap in the system's operation. (i.e., the dehumidification system will have a tendency to stay 'off' when only humidification is needed and vice versa). Doubling **bnd.2** helps prevent flip-flopping around the set point.

CyC.2 – (1.0) *Recommended.* Cycle time means how often the unit can potentially be turned on and then off in succession. The Dehumidifier may be safely turned on and off once a second. **DO NOT DECREASE THE CYCLE TIME BELOW 1.0 SECOND when operating this system.**

ETS Model 5478 Self-Regenerating Dehumidification System solenoid valve **CyC.2** may be set as low as 0.5 second, but short times will accelerate valve wear. The recommended Cycle Time is 5.0 seconds. To extend the life of the internal solenoid valve, the cycle time may be increased but control may suffer.

If using any other dehumidification system, determine the minimum cycle time at which the unit can safely operate (consult the manufacturer's instructions for the unit).

NOTE:

All functions in Level 2, 3, & 4 are "locked" and may not be altered unless "unlocked". See section 2.4.5 (Level 4).

3.3.4 LEVL 2 (Level 2)

Level 2 is the controller configuration level. The controller is capable of being configured in an unlimited number of ways. However, the parameters needed to control the Temperature Operating Systems, with the ETS Model 554 Humidity Sensor, are programmed and locked.

MANUAL CONTROL MODES

SP1.P – Read **SP1** output percentage power. (Read only).

hAnd – (off) SP1 Manual percentage power control.

For manual control, should a sensor fail, record typical **SP1.P** values before hand.

PL.1 – (100) Set **SP1** power limit percentage, 100 to 0% of the duty cycle.

Limits maximum SP1 (humidifier) output power during warm-up and in proportional band.

PL.2 – (100) Set SP2 power limit percentage, 100 to 0% of the duty cycle.

Limits maximum SP2 (dehumidifier) output power during warm-up and in proportional band.

SP2 OPERATING MODES

SP2.A – (Cool) Main SP2 operating mode.

Must remain in “Cool” mode to properly operate the Dehumidification System.

SP2.b – (nonE) Subsidary SP2 mode: latch/sequence. Non-linear dehumidify proportional band.

INPUT SELECTION AND RANGING

The following settings are used to calibrate the input of the unit for use with the ETS Model 554 RH Sensor.

diSP – (0.1) Select display resolution. With ‘Linear Input’ selected (**Lin)**, **deCP** in Level A supercedes this setting.

hi.SC – (100.0) Adjusts the maximum allowed value for the set point.

Lo.SC – (0.0) Adjusts the minimum allowed value for the set point.

inPt – (Lin) Selects Linear Input Voltage setting for the ETS Model 554 Humidity Sensor. (0-5 VDC max.)

unit – (rh) Selects process units. The process units can be changed independent of the calibration settings. In other words, changing the setting from

rh to any other units will not affect the calibration settings, it will only change the units displayed.

3.3.5 LEVL 3 (Level 3)

Level 3 is the output configuration level. There are also features for calibration adjustment and performance data reading.

OUTPUT CONFIGURATION

SP1.d – (SSd1) *Do not change.* Assigns humidification control to the appropriate output.

SP2.d – (SSd2) *Do not change.* Assigns dehumidification control to the appropriate output.

SAFETY SETTINGS

Burn – (uP.SC) *Do Not Change.* Sensor burnout/break protection. This safety setting is not applicable for RH control, it is meant as a high temperature / low temperature cutoff for heating applications to protect the surroundings from damage due to sensor failure.

rEv.d – (1r.2d) *Do Not Change.* Select output modes: Direct/Reverse. Select Reverse for Humidification and Direct for Dehumidification.

rEv.l – (1n.2n) *Do Not Change.* Selects Microprocessor LED display model. Normal mode is selected for each LED. In normal mode, the lower left (red) LED will light when the microprocessor calls for the Dehumidification System and the upper left (green) LED will light when the microprocessor calls for the Humidification System.

SPAn – (Calibration Setting) *SPAn* adjusts the range error over the 0-100% RH scale. ***DO NOT CHANGE!***
An increase of 1.0 will adjust a 99% RH reading to 100% RH without affecting lower RH readings.

ZEro – (Calibration Setting) *ZEro* Increases or decreases the Process Display reading linearly over the entire 0-100% RH scale. ***DO NOT CHANGE!***

An increase of 1.0 will raise all RH values 1.0%.

The SPAn and ZEro settings are used to calibrate the entire system. The Model 554 Humidity Sensor is calibrated separately. Reference points of 12.0% (ZEro) and 75.5% (SPAn) RH are recommended when calibrating the System. Humidity Sensor calibration should be performed at 23.0℃ (73.3℉) only and requires software.

PERFORMANCE DATA

ChEK – (oFF) Select control accuracy monitor.

rEAD – (Var) Read control accuracy monitor.
TECH – (Ct A) Read Autotune cycle data. Using the Autotune function is not recommended.

VEr – software version

rSEt – (none) *Do Not Change.* If the unit is reset, all programmed information will be lost. Each parameter must be re-entered manually.

3.3.6 LEVL 4 (Level 4)

Level 4 is a "hidden" level. This allows "locked" functions to be inaccessible to any unauthorized user. Access to Level 4 is gained through "VEr" in Level 3. Press and hold " ▲" and " ▼" for ten seconds.

Enter Level 4 at "LoCK", release " ▲" and " ▼" together.

LoCK – (LEV.2) Select from three lock options.

LEV.3 – Locks Level 3 and 4 only – Technical Functions.

LEV.2 – Locks Levels 2, 3 and 4 only – Configuration and Technical Functions.

ALL – Locks all functions (unrestricted LEVL, VEr, dAtA, SP.LK)
Note: Locked functions and options may be read.

ProG – (Auto) Program mode auto-exit switch. Auto-exit returns display to normal if 60 seconds of key inactivity, select **StAy** to disable.

no.AL – (oFF) Disable SP2 alarm annunciator -AL-. Select **on** to disable -AL-.

diS.S – (dir) *Do Not Change.* Display sensitivity.

DEr.S – (0.1) *Do Not Change.* Derivative sensitivity.

3.3.7 LEVL A (Level A)

Level A contains the Linear Input Scaling Settings and the SP3 Settings. The SP3 operating mode is not used in the ETS Model 5532.
LINEAR SCALING AND INPUT SETTINGS

An.hi – (100.0) Sets process display high scale value corresponding to the **hi.in** setting.

An.Lo – (0.0) Sets the process display low scale value corresponding to the **Lo.in** setting.
hi.in – (10.0) *Sensor Input Maximum (mV)*. The 9500P Controller uses a resistive divider of 100 to adjust the input voltage across the desired mV range. A 1VDC Maximum Sensor Output = 10.0mV **hi.in** setting.

Lo.in – (0.0) *Sensor Input Minimum (mV)*.

dECP – (000.0) Sets the resolution for the Linear Input Settings. When the 'Linear Input' option has been selected, this setting over-rides the scale resolution setting in **di.SP** in level 2.

SP3 SETTINGS

The Standard ETS Model 5532 does not use the SP3 Operating Mode.

SP3 MODES

SP3.A – (nonE) Main SP3 operating Mode.

SP3.b – (nonE) Subsidiary SP3 operating Mode.

SP3 ADJUSTMENTS

SEt.3 – (0) SP3 setpoint adjustment.
HYS.3 – (2.0) Set SP3 hysteresis (0.1 to 100% of **hi.SC**).

SP3 SAFETY SETTINGS

brn.3 – (uPSC) Sensor burn-out/break protection. Select Upscale or Downscale.
rEV.3 – (3d) Reverse SP3 output mode. Select direct or reverse operation.

4.0 TEMPERATURE OPERATING SYSTEMS

4.1 Heating System

The Model 5532 Chamber contains two (2), 250 Watt Electric Heaters (500 Watts total). The Heater is an integral part of the Chamber, located inside the chamber workspace. Since the Heater is already installed, there is no additional set-up required.

After turning “on” the “TEMP INCREASE” switch, the Microprocessor Temperature Controller governs the operation of the Heating System.

1. The Microprocessor will determine the amount of heat needed to maintain the desired set point. Power will be applied to the heater as a series of time proportioned pulses. **Refer to Section 2.2 – Microprocessor Temperature Controller Operation** for details.

2. The electric heating element and indicator light are located on white metal panel containing the Fans located on the inside, rear wall (the heater is hidden from view).

3. The Heater Indicator Light will illuminate to indicate when power is being applied to the Heater. (The Microprocessor LED’s will illuminate at the same time.)

A thermal safety switch (also on the panel) is connected in series with the heater. Power to the heater will be cut off if the temperature within the chamber exceeds 135°F (58°C) (The Acrylic Chamber will begin to melt at 150 °F)

4.2 Cooling Systems

The Model 5532 Chamber includes the *ETS Model 5473-150W, 510 BTU/hr Thermoelectric Cooling System* as standard. Other cooling options include:

ETS Model 5463	Liquid Carbon Dioxide Cooling System
ETS Model 5473-300	1020 BTU/hr Thermoelectric Cooling System
ETS Model 5466	Liquid Nitrogen Cooling System

The implementation and operation of each of these systems is described in detail below.

4.2.1 Thermoelectric Cooling Systems (Models 5473-(150W – 300W))

The Model 5473 Series of thermoelectric cooling systems utilize the Peltier effect to reduce the temperature of a large heat sink. One or more 110 cfm fans circulate the air within the workspace through the heat sink to continuously reduce the temperature. Very precise temperatures can be maintained with this system by the microprocessor temperature controller. The standard Model 5473-150 is capable of removing up to 510 BTU/hr (150 Watts/hr) from the Chamber.

The Model 5473-300 is capable of removing up to 1020 BTU/hr (300 Watts/hr) from the Chamber.

4.2.1.1 Thermoelectric Cooling Systems Set-Up

1. The Model 5473-150 & 300 Thermoelectric Cooling Systems operate in the same manner. The Model 5473 uses an external DC Power Supply (mounted on the Chamber's rear wall). While the type of power supply and location of the supply does not affect operation, it is noted for maintenance purposes.

2. The Thermoelectric System is an integral part of the Chamber, protruding through the rear wall. The cold side of the unit is located behind the aluminum panel.

3. The Thermoelectric Cooler is a solid-state heat pump. It is virtually maintenance free, with no filters to change. The only moving parts are the fans. As air inside the chamber is drawn through the interior heat sink by the internal thermoelectric fan (this fan is separate and different form the chamber circulation fans), heat is removed from the air and conducted through the thermoelectric modules to the exterior heat sink. The heat is removed from the exterior heat sink and dissipated into the atmosphere by a pair of external fans. **DO NOT BLOCK AIRFLOW TO THE REAR OF THE UNIT.** The hot air must be allowed to dissipate.

Increased hot side temperature = Decreased cooling effect.

4.2.1.2 Installation

The Model 5532 Chamber is shipped with the Thermo-Electric Cooler and Power Supply mounted on the rear wall. No installation is required

4.2.1.3 Operation

1. The Thermoelectric cooler operation is divided into two parts:

   a. The 115 VAC internal thermoelectric circulation fan.

   b. The Power Supply that provides power to the thermoelectric modules and the external fans.

2. Turn on the "TEMP DECREASE" switch on the front panel of the Chamber. This will allow the power supply to become *available to* the Temperature Microprocessor Controller (both the Model 5473-150 & Model 5473-300).

3. Adjust the Temperature Microprocessor Controller set point to a value below the ambient temperature (refer Controller Operation). When the

Microprocessor determines that cooling is needed, the external fans will begin moving, the internal heat sink will begin to cool and the external heat sink will begin to warm.

4. The controller is programmed to operate the Thermoelectric Module in on/off mode only. Therefore, **CYC.2** (*See Section 2.4.2 – SP2 Operating Parameters*) will be set to 'On/Off'. **Bnd.2** (*See Section 2.4.2 – SP2 Operating Parameters*) sets the range in which the TE Module will operate. It will usually be set to a value of 2.0 °C. If the actual temperature differs from the set point temperature by more than 2.0°C, then the microprocessor will turn on the TE Module to cool. Once turned on, the TE cooler will run at maximum output. The heaters will receive pulses of power to precisely regulate the temperature of the chamber.

5. The 115 VAC internal thermoelectric circulation fans are operated in tandem with the main circulation fans. The Fan Speed Control, located on the front panel, operates all of the internal circulation fans.

6. **Refer to Section 2.3**, Microprocessor Temperature Controller Programming.

4.2.1.4 Specifications and Performance

All cooling capacity figures are based on a room ambient temperature of 73 °F (23 °C).

All figures are expressed as a ΔT. ΔT expresses the difference in temperature from room ambient (73°F).

Example: 73 °F - 63 °F = ΔT of 10 °F

1. The Model 5473-150 Thermoelectric Cooler will remove up to 510 BTU/hr (150 Watts/hr) from the Model 5532 Chamber.
   In a *non-insulated* Model 5532 Chamber (standard chamber): ΔT = 10°F (5.5 °C).

   In a Model 5532 Chamber, using appropriate *insulation*, the ΔT may be increased an additional 10-15 °F (5.5-8.3°C), depending on the thickness and quality of the insulation.

2. The Model 5473-300 Thermoelectric Cooler will remove up to 1020 BTU/hr (300 Watts/hr) from the Model 5532 Chamber.

   In a *non-insulated* Model 5532 Chamber (standard chamber):

   ΔT = 18°F (10°C)

In a Model 5532 Chamber, using appropriate ***insulation***, the ΔT may be increased an additional 10-15 °F (5.5-8.3°C), depending on the thickness and quality of the insulation.

3. Contact ETS for details about insulating the Model 5532 Chamber.

4.2.2 Model 5463 Liquid CO_2 Cooling System (Optional)

The Liquid CO_2 Cooling System is an option for the Model 5532 Chamber. The Solenoid Control Valve is wired into the 'PC Board', which is controlled by the Microprocessor Temperature Controller. All the user needs to do is connect the Transfer Hose to the appropriate liquid CO_2 cylinder with dip tube. (**NOTE: CO_2 gas will not work**)

The Gas Cooling System enables the temperature within the Model 5532 Chamber to be reduced below freezing, 32°F (0°C).

1. The System utilizes Liquid CO_2* (Carbon Dioxide) as the cooling medium.

   CO_2 is user supplied. 50lb. CO_2 tanks are readily available from local bottled gas companies.

   ***Liquid CO_2* with a *Dip Tube* must be specified. The DIP Tube allows liquid to be siphoned from the bottom of the tank. CO_2 Gas (without DIP Tube) will not provide cooling with this system.**

2. The CO_2 is allowed to evaporate (expand from a liquid to a gas) within the chamber.

3. The phase change of the CO_2 produces a large cooling effect. (The temperature *directly in front of* the nozzle will be near -100 °F.)

4. The Temperature Controller will monitor the chamber temperature and proportionally control the Solenoid Valve to provide the appropriate amount of cooling to maintain the desired set point.

4.2.2.1 Cooling System Accessories

1. Liquid CO_2 Transfer Hose
2. 4' (122cm) long with Braided Stainless Steel Safety Shield.
3. Brass High Pressure Fitting for mating to Liquid CO_2 tank.
4. Brass Quick Disconnect (female) for mating to Valve Input.
5. Cooling Nozzle Cleaning Tool

4.2.2.2 Liquid CO_2 Tank Connections

1. Secure the CO_2 cylinder to a wall using an approved securing belt or clamp.

NOTE:

Failure to secure the cylinder to a wall or other suitable stationary object may result in serious injury to personnel should CO_2 cylinder fall over.

2. The CO_2 cylinder contains liquid carbon dioxide under extremely high pressure (800-1000 psi). Care must be exercised at all times when working with this cylinder. The manual valve on top of the cylinder should be closed (fully clockwise) when the cooling system is not in use.

3. Although CO_2 is non-toxic, it can cause asphyxiation if not used in areas with adequate ventilation. The Model 5532 Chamber is equipped with a Chamber Vent, 1" (25mm) White Hose Barb located in the middle of the Black Panel on the right side of the Chamber. The spent CO_2 gas will escape from the chamber vent and dissipate into the room atmosphere. To vent the gas outside of the room or building, connect an appropriate length of 1" (25mm) ID tubing to the Vent Hose Barb. The open end of the tubing should be exhausted outside the working environment.

5. Connect the Transfer Hose to the CO_2 Tank and Valve as shown in Figure 4.0-1.

Figure 4.0-1: CO_2 cylinder hook up

   a. Connect the Female Quick Disconnect fitting to the Male Quick Disconnect fitting installed in the Chamber. Pull back on the collar of the female fitting and place it onto the male fitting, release the collar. These fittings should mate to form a leak-free seal.

   b. Connect the other end of the transfer hose (Large Brass Fitting) to the CO_2 tank.

4.2.2.3 Operation

The user does not have to do anything else to operate the system. Total operation will be under the control of the Microprocessor Temperature Controller.

The Temperature Controller is a PID Microprocessor with a time proportioned AC voltage output. Refer to **Section 5.2**, **Microprocessor Temperature Controller Operation**, for a full description of operation.

The user should periodically monitor both the status of the CO_2 cylinder and the cooling performance of the system to check for an exhausted CO_2 tank.

4.2.2.4 Changing CO_2 Tank

Before disconnecting any fittings or attempting to change the tank, all of the CO_2 must be vented from the system. Venting the CO_2 will relieve any pressure in the system. **Failure to bleed the system may result in injury!**

To bleed the pressure from the line:

1. Turn “ON” the Cooling Valve. Turn on the “TEMP DECREASE” switch on the front panel of Temperature Controller and adjust the set point to the lowest possible setting. Wait for the Cool Valve to turn “ON”.

2. While the Cool Valve is open, turn off the manual valve on top of the CO_2 tank. This will shut off the CO_2 supply to the system.

   The CO_2 will bleed out of the Cooling Nozzle, into the chamber. When all the CO_2 is out of the system, the flow of gas from the Nozzle will stop.

3. Using a wrench, disconnect the Transfer Hose (loosen the large brass fitting) from the CO_2 tank.

4. Replace the empty tank with a fresh Liquid CO_2 tank. Then, using a wrench, reconnect the transfer hose.

5. Turn “OFF” the “TEMP DECREASE” switch on the Temperature Controller. This will close the Cool Valve.

6. After the system is turned “OFF”, open the manual valve on top of the CO_2 cylinder.

   The Transfer Hose and Cool Valve will now be pressurized. If any leaks occur, close the manual valve on top of the CO_2 cylinder. Then, tighten any fittings that are leaking. Open the manual valve and recheck for leaks.

4.2.2.5 Specifications and Performance

1. Cooling Capacity:

   The Model 5463 CO_2 Gas Cooling System, when used in the ETS Model 5532 Chamber with a full 50 lb. CO_2 tank, will provide cooling to below 32 °F (0 °C). The total CO_2 consumption rate for the system depends upon the temperature that is being maintained.

   The following chart shows the approximate consumption rate for the system at different temperatures, assuming a full 50lb. CO_2 tank and room ambient temperature of 72 °F (23 °C).

Temperature Set-point (°F)	Time (approx.) to empty CO_2 tank.
62 °F (16.7 °C)	6 hours
52 °F (11.1 °C)	3 hours
42 °F (5.6 °C)	2 hours
32 °F (0 °C)	1 hour

NOTE:

These consumption rates are for maintaining the shown temperatures. When lowering the temperature from room ambient to the set point temperature, the consumption rate will be higher. The consumption rate will be as shown once the set point temperature is reached.

2. To lower the CO_2 consumption rate and extend the operating time per tank, insulation should be added to the chamber. Adding insulation will reduce heat loss and aid in stabilizing the chamber temperature (especially at low temperatures).

4.2.2.6 Maintenance and Troubleshooting

The Liquid CO_2 Cooling System should provide years of trouble free service. Other than changing CO_2 tanks when depleted, very little servicing should be required.

Before performing any service, the pressurized CO_2 must be bled from the system. Refer to section 4.2.2.4.

1. Clearing a clogged Cooling Nozzle.

   Occasionally, the Cooling Nozzle, shown in Figure 4.0-2, may become clogged due to impurities in the CO_2, small pieces of dirt or small pieces of Teflon sealing tape breaking free and lodging in the nozzle.

Figure 4.0-2: Cooling nozzle orifice

Item #2, the Cooling Nozzle Cleaning Tool is provided to help clear such blockages. If the Nozzle is extremely clogged, it may be necessary to completely remove the Nozzle, clear the orifice, and reinstall it.

2. If the system is not producing a cooling effect after clearing the Nozzle, make sure the CO_2 tank is full and the manual valve is fully open.
3. If the Valve will not fully close when the system is turned “OFF”, a small piece of dirt, etc. may have lodged in the valve seal. The valve may be taken apart to inspect the seal.
4. Remove AC Power from the unit.
5. Remove the Solenoid from the Valve Stem.
6. Using a wrench, carefully unscrew the valve stem from the upper portion of the valve body.
7. The stem contains a plunger with a round, red seal on the top. Make sure the seal is clean and free of debris. Also check the valve internally for obstructions.
8. After cleaning, carefully replace the Valve Stem and Solenoid.
9. For help with any other problems, please contact ETS.

5.0 MICROPROCESSOR TEMPERATURE CONTROLLER

5.1 System Description

The Microprocessor Temperature Controller, in conjunction with the Model 554 RTD Temperature Sensor, is capable of controlling the temperature in the Model 5532 Chamber by supplying a proportionally controlled power output to the Heating and/or Cooling Systems.

The Controller provides low voltage (5 VDC, 15mA) control signals to the INCREASE and DECREASE solid-state relays, located on the 'PC Board'. When the low voltage signal is applied to the relay 'Input', the 'Output' of the relay 'closes' and allows AC Power to flow to the connected device.

When the 'TEMP Function' switches on the front panel are in the 'OFF' ('0') position, power is manually disconnected from the control relays and no heating or cooling can take place until the switch is placed in the 'ON' ('I') position.

All devices in the Model 5532 are connected through terminals on the 'PC Board'.

5.1.1 Controller Specifications

Refer to Section 3.1.1 Specifications (Humidity Controller)

5.2 Controller Operation

5.2.1 Set-Point Adjust

1. Press and hold the "∗" button. The letters "°C" or "°F" (depending on set-up) will appear followed by the current set-point value. The set point value is displayed on the lower half of the microprocessor display.

2. To adjust the set point higher, press the "▲" button. To adjust the set point lower, press the "▼" button.

3. Release the "∗" button.

5.2.2 Heating System

To operate the Model 5532 Heating System:

1. Adjust the Temperature set point to a value above ambient temperature.

2. Turn on the "TEMP INCREASE" switch on the Control Panel.

   This will not automatically apply power to the heaters. Turning on the "TEMP INCREASE" switch only makes the heaters *available* to the controller.

   When the microprocessor activates the heaters, the small green LED in the upper left corner of the Temperature Controller display will illuminate. The red

neon light on the aluminum rear panel will also illuminate to indicate that the heaters are receiving power.

3. The Microprocessor will determine the amount of heating needed to maintain the desired set point in the enclosure.

   If less than the full output capacity of the Heater is needed, the controller will provide pulses of power to the unit to limit the output. The heater will be turned on and off cyclically to obtain an average temperature output lower than the full capacity of the heater, appropriate to maintain the desired set point in the Chamber.

   For best results, the Cycle Time (CyC.t) should be set as short as possible. The minimum cycle time for the 500 Watt Heater in the Model 5532 Chamber is 1.0 second. Shorter cycle times may damage the Controller.

5.2.3 Cooling System

*Model 5473 Thermoelectric Cooling System may be disabled if it is not needed. In **LEVEL 2** of the Programming Menu, adjust **SP1.P** from **'Cool'** to **'nonE'.** This will manually disable only the cooling system. The Heating System will be unaffected.*

To operate the Model 5532 Cooling System:

1. Adjust the set point to a value below the ambient temperature.
2. Turn on the "TEMP DECREASE" switch on the front of the Control Panel.

   This will not automatically apply power to the cooling system. Turning on the "TEMP DECREASE" switch only makes the cooling system the *available* to Microprocessor Controller.

   When the microprocessor activates the cooling system, the large red LED in the lower left corner of the Temperature Controller display will illuminate.

3. The Microprocessor will determine the amount of cooling needed to maintain the desired set point in the enclosure.

   If less than the full output capacity of the Cooling System is needed, the controller will provide pulses of power to the unit to limit the output. The cooling system will be turned on and off cyclically to obtain an average output lower than the full capacity of the cooling system, appropriate to maintain the desired set point in the enclosure.

   The Cycle Time for the Thermoelectric Cooling Systems (Models 5473-150 & -300) and for the Refrigerated Cooling System (Model 5475) must be set to "ON/OFF". For best results, the Cycle Time 2 (CyC.2) for the Model 5463 Gas Cooling System should be set as short as

possible. To extend the life of these systems, they must be cycled as little as possible. Cooling System cycle time recommendations are as follows:

ETS Model 5473 minimum cycle time is 'On/Off'.
ETS Model 5463 minimum cycle time is 1.0 seconds.
ETS Model 5466 minimum cycle time is 'On/Off'.
ETS Model 5475 minimum cycle time is 'On/Off'.

5.3 Programming the Microprocessor Controller

5.3.1 Accessing the Programming Menu

1. To access the Controller Program Menu, press the "▲" and "▼" buttons simultaneously for three (3) seconds. The controller will enter the Menu on Level 1 in the "tunE" function. (If using the CalComm Computer Program, refer to the "CALCOMM" section of the Manual).

2. To scroll to different parameters within a Level, press the "▲" button to scroll right and the "▼" button to scroll left.

3. To change a parameter or change Levels, press and hold the "∗" button. Press the "▲" or "▼" buttons to change the parameter.

4. All factory-programmed values listed here are optimized for use with the ETS Model 5473 Thermo-Electric Cooling System and the ETS Model 5474L's 500-Watt Heating System. Other systems may require different settings.

   If the Model 5532 Chamber has different systems, the information programmed into the Controller will be different. Information on the specific program should be provided separately, if not, contact ETS.

5. To exit the menu press and hold "▲ ▼" for three seconds.

5.3.2 LEVL C (Level C)

Level C is only visible when the Controller is fitted with the COMMS option (RS 485 computer interface card). Level C is responsible for the communication protocol for the unit when interfacing with a PC. The values in Level C must match the values on the computer screen to establish communication.

Addr – (1) Instrument Communication Address. This address may be changed to any number suitable to the user.

bAud – (9600) The baud rate should be set as high as possible.

dAtA – (18n1) *Do Not Change.* The data format should not change.

DbuG – (off) *Do Not Change.* Debugging is an advanced feature that will not be covered in this manual.

5.3.3 LEVL 1 (Level 1)

Level 1 is the programming level. The Proportional, Integral, and Derivative controls are adjusted here. The combination of PID values is virtually limitless. This allows the controller to be used in a wide variety of applications. However, this flexibility can also lead to confusion when programming the controller in the Model 5532's limited mode of operation.

To avoid confusion, this section will discuss which parameters may be adjusted, which parameters should not be adjusted.

All Parameters are programmed at the ETS Factory to match the Operating Systems shipped with the Chamber. The programmed values will control the Chamber within specifications. For tighter control, the user may want to adjust the values. The values listed here are for standard chambers only. Non-standard units may have different values than those listed here.

The following settings are approximations that will allow any user to achieve good temperature control at any set point (approximately ±1.0°C, depending on the specific conditions). However, as the user becomes familiar with each parameter and it's effect on temperature control, the user will be able to program the unit to control within ever tightening tolerances. Control of ± 0.2 °C, or better, is achievable with this system.

tunE – (oFF) The Autotune function may be used to help determine the optimum operating conditions for a given set of operating systems and chamber volume. The Autotune operates using the Heater only. The Cooling System will be disabled during an auto tune. The "Tune At Set Point" (**At.SP)** option is recommended with the Model 5532 Chamber.

Occasionally, the message "Tune Fail" will appear in the microprocessor display after the unit attempts an autotune. The user will need to clear the 'Tune Fail' message and attempt another autotune. To clear the message, turn the Model 5532 Main Power Switch Off and then On again. When power is re-applied, the message will no longer be displayed.

bAnd – (2.0) Proportional Band for the Heaters.

int.t – (15) Integral Time in minutes.

The integral time is responsible for calculating how much output should be coming from the Heating and Cooling Systems to maintain the desired conditions.

der.t – (50) Derivative Time in seconds.

The derivative time, in combination with the **dAC**, is responsible for keeping the environment moving toward the set point, following a pre-determined curve (set by the **dAC** in combination with the **bAnd**). The curve is followed to help avoid set-point overshoots.

Shortening the derivative time will cause the controller to recover slowly from disturbances. Lengthening the derivative time may cause oscillations.

dAC – (1.0) *Recommended.* The **D**erivative **A**pproach **C**ontrol determines how quickly the unit will reach the set- point, without overshooting. The **dAC** creates a gently sloping, exponential curve that the system must follow when approaching the set-point. The smaller the number, the quicker the unit will allow the set-point to be reached. The **dAC** multiplied by the band determines where the beginning of the approach curve will be located. A larger **dAC** setting will cause the beginning of the **dAC** curve to be further away from the set point. The larger setting will control overshoots better, but will cause responses to disturbances to be slower.

CYC.t – (1.0) *Recommended.* Cycle time means how often the unit can potentially be turned on and then off in succession. The ETS 500 Watt heater may be safely turned on and off once a second. **DO NOT DECREASE CYCLE TIME BELOW 1.0 SECOND when operating this system.**

The shorter the cycle time, the greater the degree of precision that may be achieved with the controller.

If using any other heating system, determine the minimum cycle time at which the unit can safely operate (slightly shorter cycle times may be used for smaller heaters).

oFSt – (0.0) *Do Not Change.* The Offset / Manual Reset control is only usable when the integral time (**int.t**) is turned off. Since the integral time is being used, the offset control may be ignored.

SP.LK – (oFF) Locks the set-point preventing unauthorized adjustment.

SP2 OPERATING PARAMETERS

The SP2 parameters can be configured in a variety of ways. In the Model 5532 Temperature Controller, the SP2 parameters are used to tailor the Cooling System output for best temperature control.

The SP2 parameters are all shown in ℃.

SET.2 – (2.0) Set point 2 allows the user to create a setpoint offset for the Cooling System. It is generally not used for the Gas Cooling System. When a Thermoelectric Cooler or Refrigerated cooling system is used, this setting is increased to determine the point at which the Cooling System will activate. (These systems are operated in On/Off mode instead of within a proportional band.)

bnd.2 – (4.0) Band 2 should generally be equal to **bAnd**. The heating and cooling system will work within the same proportional band, helping to prevent overlap in the system's operation. (The cooling system will have a tendency to

stay off when only heating is needed and vice versa). For the Thermoelectric or System the proportional band is offset to keep the cooler on and allow the heaters to pulse to maintain the set point. (The Thermoelectric System is operated in On/Off mode instead of within a proportional band.)

CyC.2 – (on.off) *Recommended.* Cycle time means how often the unit can potentially be turned on and then off in succession. **5.0 SECONDS** is the recommended cycle time for the ETS Model 5463 cooling system to achieve good control and extended valve life. The ETS Model 5463 solenoid valve **CyC.2** may be set as low as 0.5 second, but short times will accelerate valve wear. **DO NOT DECREASE THE CyC.2 BELOW 0.5 SECOND when operating this system.** The cycle time may be increased above 3.0 seconds to extend valve life but control may suffer. If using any other cooling system determine the minimum cycle time at which the unit can safely operate (consult the manufacturer's instructions for the unit).

NOTE:

All functions in Level 2, 3, & 4 may be "locked" so that they may not be altered unless "unlocked". See section 4.4.5 (Level 4).

5.3.4 LEVL 2 (Level 2)

Level 2 is the controller configuration level. The controller is capable of being configured in an unlimited number of ways. However, the parameters needed to control the Temperature Operating Systems, with the ETS Model 554 Temperature Sensor, are programmed and locked.

MANUAL CONTROL MODES

SP1.P – Read **SP1** output percentage power. (Read only).

hAnd – (off) SP1 Manual percentage power control.

For manual control, should a sensor fail, record typical **SP1.P** values before hand.

PL.1 – (100) Set **SP1** power limit percentage, 100 to 0% of the duty cycle. Limits maximum **SP1** (heater) output power during warm-up and in proportional band.

PL.2 – (100) Set **SP2** power limit percentage, 100 to 0% of the duty cycle. Limits maximum **SP2** (cooling) output power during warm-up and in proportional band.

SP2 OPERATING MODES

SP2.A – (Cool) Main **SP2** operating mode.

Must remain in "Cool" mode properly to operate the cooling system.

SP2.b – (nonE) Subsidiary **SP2** mode: latch/sequence. Non-linear decrease proportional band.

INPUT SELECTION AND RANGING

°C to °F conversion - *A total of 3 settings must be modified to change scales. These include* ***An.hi****,* ***An.Lo*** *(See Level A), and* ***unit****. For these settings there will be two sets of values in parenthesis. The first one is the °C setting, the second is the °F setting.*

diSP – (0.1) Select display resolution. With 'Linear Input' selected (**Lin)**, **deCP** in Level A supercedes this setting.

hi.SC – (212.0) Adjusts the maximum allowed value for the set point.

Lo.SC – (0.0) Adjusts the minimum allowed value for the set point.

inPt – (Lin) Selects Linear Input Voltage setting for the ETS Model 554 Temperature Sensor. (0-5 VDC max.)

unit – (°C), (°F) Selects process units. The process units can be changed independent of the calibration settings. In other words, changing the setting from °C to °F or any other units will not affect the calibration settings, it will only change the units displayed.

5.3.5 LEVL 3 (Level 3)

Level 3 is the output configuration level. There are also features for calibration adjustment and performance data reading.

OUTPUT CONFIGURATION

SP1.d – (SSd1) *Do not change.* Assigns heating control to the appropriate output.

SP2.d – (SSd2) *Do not change.* Assigns cooling control to the appropriate output.

SAFETY SETTINGS

Burn – (uP.SC) *Do Not Change.* Sensor burnout/break protection. This safety setting will protect a system if the sensor quits working. All systems will be shut down if the temperature rises above the hi.SC setting.

rEv.d – (1r.2d) *Do Not Change.* Select output modes: Direct/Reverse. Select Reverse for Heating and Direct for Cooling.

rEv.l – (1n.2n) *Do Not Change.* Selects Microprocessor LED display mode. Normal mode is selected for each LED. In normal mode, the lower left (red) LED will light when the microprocessor calls for the Cooling System and the upper left (green) LED will light when the microprocessor calls for the Heating System.

SPAn – (*Calibration Setting*) SPAn adjusts the range error over the 0100°C (32-212°F) temperature scale. ***DO NOT CHANGE!***

An increase of 1.0 will adjust a 99.0°C (210.2°F) reading to 100°C (212.0°F) without affecting lower temperature readings.

ZEro – (*Calibration Setting*) *ZEro* Increases or decreases the Process Display reading linearly over the entire 0-100°C (32-212°F) scale. ***DO NOT CHANGE!***

An increase of 1.0°C (1.8°F), will raise all temperature values 1.0°C (1.8°F).

The SPAn and ZEro settings can be used to recalibrate the entire system in the field without recalibrating the Model 554 Temperature Sensor separately. ZEro should be adjusted to a low reference temperature, SPAn should be adjusted to a high reference temperature

PERFORMANCE DATA

ChEK – (oFF) Select control accuracy monitor.

rEAD – (Var) Read control accuracy monitor.

TECH – (Ct A) Read Autotune cycle data. Using the Autotune function is not recommended.

VEr – software version

rSEt – (none) *Do Not Change.* If the unit is reset, all programmed information will be lost. Each parameter must be re-entered manually.

5.3.6 LEVL 4 (Level 4)

Level 4 is a "hidden" level. This allows "locked" functions to be inaccessible to any unauthorized user. Access to Level 4 is gained through "VEr" in Level 3. Press and hold " ▲" and " ▼" for ten seconds.

Enter Level 4 at "LoCK", release " ▲" and " ▼" together.

LoCK – (LEV.2) Select from three lock options.

LEV.3 – Locks Level 3 and 4 only – Technical Functions.

LEV.2 – Locks Levels 2, 3 and 4 only – Configuration and Technical Functions.

ALL – Locks all functions (unrestricted LEVL, VEr, dAtA, SP.LK)

Note: Locked functions and options may be read.

ProG – (Auto) Program mode auto-exit switch. Auto-exit returns display to normal after 60 seconds of key inactivity, select **StAy** to disable.

no.AL – (oFF) Disable SP2 alarm annunciator -AL-. Select **on** to disable -AL-.

diS.S – (dir) *Do Not Change.* Display sensitivity.

DEr.S – (0.1) *Do Not Change.* Derivative sensitivity.

5.3.7 LEVL A (Level A)

Level A contains the Linear Input Scaling Settings and the SP3 Settings.

LINEAR SCALING AND INPUT SETTINGS

°C to °F conversion - *A total of 3 settings must be modified to change scales. These include* ***An.hi****,* ***An.Lo*** *, and* ***unit*** *(See Level 2). For these settings there will be two sets of values in parenthesis. The first one is the °C setting, the second is the °F setting.*

An.hi – (100.0°C) (212.0°F) Sets process display high scale value corresponding to the **hi.in** setting.

An.Lo – (0.0°C) (32°F) Sets the process display low scale value corresponding to the **Lo.in** setting.

hi.in – (10.0) *Sensor Input Maximum (mV)*. The 9500P Controller uses a resistive divider of 100 to adjust the input voltage across the desired mV range. A 1VDC Maximum Sensor Output = 10.0mV **hi.in** setting.

Lo.in – (0.0) *Sensor Input Minimum (mV)*.

dECP – (000.0) Sets the resolution for the Linear Input Settings. When the 'Linear Input' option has been selected, this setting over-rides the scale resolution setting in **di.SP** in level 2.

SP3 SETTINGS

The Standard ETS Model 5532 does not use the SP3 Operating Mode.

SP3 MODES

SP3.A – (nonE) Main SP3 operating Mode.

SP3.b – (nonE) Subsidiary SP3 operating Mode.

SP3 ADJUSTMENTS

SEt.3 – (0) SP3 setpoint adjustment.

HYS.3 – (2.0) Set SP3 hysteresis (0.1 to 100% of **hi.SC**).

SP3 SAFETY SETTINGS

brn.3 – (uPSC) Sensor burn-out/break protection. Select Upscale or Downscale.

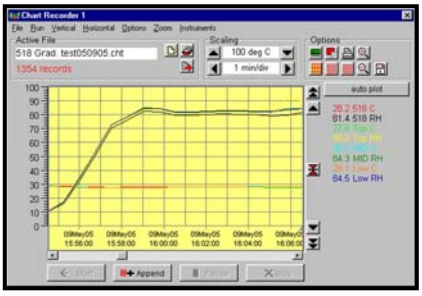
rEV.3 – (3d) Reverse SP3 output mode. Select direct or reverse operation.

6.0 CALCOMMS - COMPUTER INTERFACE

The standard CALCOMMS Applications Software provides enhanced display, charting and alarming. The Optional CALgrafix Process Monitoring & Configuration and CALopc Server (for interfacing with OPC compatible client software) software packages are also available. The software communicates with Windows 95/98/p2000/NT/XP using the MODBUS® protocol via a fully isolated RS-485 (multiple units) link for CALCOMMS. The graphic WINDOWS™ based software provides PC supervision of any combination up to 32 control modules with the capability of remote adjustment, instrument configuration, cloning, saving and retrieving instrument settings to files together with logging and charting as shown in Figure 6.0-1. Up to 12 controller readings can be shown live on the screen in real time.

Controller Configuration

Charting



Controller Activity

Figure 6.0-1: CALCOMMS display

To gain full benefit of CALCOMMS software, it is recommended that the PC be fitted with a Pentium processor (although a 486 will work) and is running WINDOWS 95, 98, 2000, XP or Windows NT programs. A minimum of 16 MB RAM is recommended to run the program (slightly less is acceptable), together with sufficient free hard disc space to meet logging requirements.

Because the controllers are “stand alone” they do not need PC supervision for their normal function, and will continue to control the process unaffected by failure of any part of the communications loop.

When used with the Model 5532 Chamber, the Temperature & Humidity Microprocessor COMM PORTS are wired together, in parallel. One RS-485 COMM PORT, common to both Controllers, is located on the ‘Side Interface Panel’ of the Model 5532 Chamber.

6.1 Set up and Installation

(Refer to pp. 2 & 3 in the CALCOMMS Manual)

6.1.1 RS485 COMM PORT

RS-485 is a half duplex serial communications link and is the standard most commonly used for industrial applications due to it’s high noise immunity and multi-drop capability. It enables a PC to communicate with up to 32 instruments

over distances of over 1200 meters, and requires the addition of an RS-485 interface card, or a separate RS-232/485 converter. A RS-485/USB converter is also available.

The RS-485 COMM PORT is a 9-pin subminiature-D female connector located on the ‘Side Interface Panel’.

6.1.2 RS-485/232 Converter

The RS-232/485 converter is not required if the computer is configured with an RS-485 interface card. The converter is a 9-pin/9-pin in-line style connector. The converter is gray and bears the label “RS-232 TO RS-485 / Model 485SDD9R”. If the computer has only a USB port contact ETS for the correct adapter.

6.1.3 Connections

1. Connect the supplied 9-pin male/female sub-D cable to the RS-485 COMM PORT on the ‘Side Interface Panel’.
2. Connect the other end of the cable to the RS-485 side of the RS-232/485 converter.
3. Connect the RS-232 side of the converter into the appropriate Comm Port on the PC.

6.1.4 Software Installation

Software installation instructions can be found on pp. 9-11 in the CALCOMMS Manual.

The CALCOMMS Manual is separate from the CAL 9500P Users Manual. It is the manual with the color cover.

6.2 Operation

After installing the computer program and making the appropriate wiring connections to a PC, turn to pg. 11 in the CALCOMMS Manual. This section is titled “GETTING STARTED”. Follow the directions to begin operating the program.

6.2.1 MODBUS Addresses

The **MODBUS** address is found in Level C.

The following addresses are preset at the factory:

TEMPERATURE controller address is set to **1.**

HUMIDITY controller address is set to **2.**

6.2.2 Open Communications

Instructions for opening communication are found on pg.13 of the CALCOMMS manual.

6.3 Logging and Charting

Instructions for operating the Logging and Charting functions of the CALCOMMS program begin on pg. 21 of the CALCOMMS Manual.

7.0 CALIBRATION

The only components of the Model 5532 Controlled Environment System that requires periodic calibration are the Microprocessor Controllers and Temperature/Humidity sensor. It is recommended that this section be returned to ETS for calibration. However, system calibration can be checked by the user.

Place the sensor of a known, calibrated temperature and humidity meter as close as possible to the System sensor. After the temperature and humidity within the chamber has stabilized, compare the readings. They should be within the combined tolerance of the two measuring devices.

To return equipment to ETS for calibration or repair it is first necessary to obtain a RMA number. **Call 215-887-2196.**

To remove the Control Panel and sensor, first gain access to the operating systems compartment by removing the 8 screws holding the right side panel in place. Unplug all connections to the front Control Panel. Loosen the 4 captive screws holding the Control Panel and remove. Remove the sensor by loosening the compression fitting inside the controlled environment section. Return both the Control Panel and sensor to ETS.

8.0 MAINTENANCE

The Model 5532 requires very little maintenance. If the procedures in the previous sections are followed the operating systems should operate trouble free. However, the ultrasonic transducer used in the humidifier will have to be replaced periodically. Follow the procedure described in Section 2.1.3.2 to gain access and refer to Figure 8.0-1.

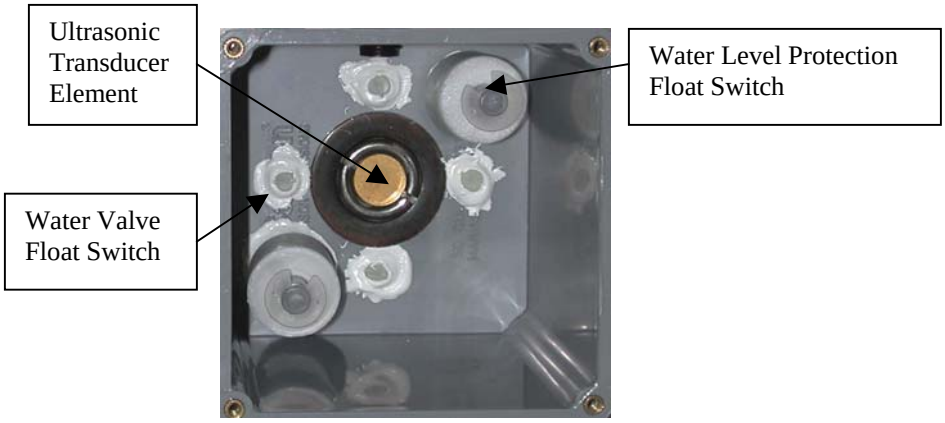


Figure 8.0-1: Transducer access

Replacement transducers are available from ETS and are Part # 0106-00030A for a package of 3 elements and #0106-00030B for a single element. Each kit comes with a special tool to remove the transducer. Unscrew the element using the tool and replace with the new element and seals as shown on the back of each package.

3/07

9.0 WARRANTY

Electro-Tech Systems, Inc. warrants its equipment, accessories and parts of its manufacture to be and remain free from defects in material and workmanship for a period of one (1) year from date of invoice and will, at the discretion of Seller, either replace or repair without charge, F.O.B. Glenside, similar equipment or a similar part to replace any equipment or part of its manufacture which, within the above stated time, is proved to have been defective at the time it was sold. All equipment claimed defective must be returned properly identified to the Seller (or presented to one of its agents for inspection). This warranty only applies to equipment operated in accordance with Seller's operating instructions.

Seller's warranty with respect to those parts of the equipment which are purchased from other manufacturers shall be subject only to that manufacturer's warranty.

The Seller's liability hereunder is expressly limited to repairing or replacing any parts of the equipment manufactured by the manufacturer and found to have been defective. The Seller shall not be liable for damage resulting or claimed to result from any cause whatsoever.

This warranty becomes null and void should the equipment, or any part thereof, be abused or modified by the customer of if used in any application other than that for which it was intended. This warranty to replace or repair is the only warranty, either expressed or implied or provided by law, and is in lieu of all other warranties and the Seller denies any other promise, guarantee, or warranty with respect to the equipment or accessories and, in particular, as to its or their suitability for the purposes of the buyer or its or their performance, either quantitatively or qualitatively or as to the products which it may produce and the buyer is expected to expressly waive rights to any warranty other than that stated herein.

ETS must be notified before any equipment is returned for repair. ETS will issue an RMA (Return Material Authorization) number for return of equipment.

Equipment should be shipped prepaid and insured in the original packaging. If the original packaging is not available, the equipment must be packed in a sufficiently large box (or boxes if applicable) of double wall construction with substantial packing around all sides. The RMA number, description of the problem along with the contact name and telephone number must be included in formal paperwork and enclosed with the instrument. Round trip freight and related charges are the owner’s responsibility.

WARNING

WOODEN CRATES MUST NOT BE USED. PACKAGING OF DELICATE INSTRUMENTS IN WOODEN CRATES SUBSTANTIALLY INCREASES THE CONTENT’S SUSCEPTIBILITY TO SHOCK DAMAGE. DO NOT PLACE INSTRUMENTS OR ACCESSORIES INSIDE OTHER INSTRUMENTS OR CHAMBERS. ELECTRO-TECH SYSTEMS, INC. WILL NOT ASSUME RESPONSIBILITY FOR ADDITIONAL COST OF REPAIR DUE TO DAMAGE INCURRED DURING SHIPMENT AS A RESULT OF POOR PACKAGING.