

# CONTROLLED ENVIRONMENT CHAMBER

**Model 5506-00 & 5506-11**  
With  
**Package A, B or C**



## Operating Manual

6/11



**electro-tech systems, inc.**

3101 Mt. Carmel Avenue, Glenside, PA 19038 • Tel: (215) 887-2196 • Fax: (215) 887-0131

[www.electrotechsystems.com](http://www.electrotechsystems.com)

# TABLE OF CONTENTS

	<u>Page</u>
<b>1.0 GENERAL</b>	<b>1</b>
1.1 Basic Chambers	1
1.2 Standard Packages	2
1.2.1 Pkg. A	3
1.2.2 Pkg. B	3
1.2.3 Pkg. C	4
1.2.4 Custom Configurations	5
1.3 Unpacking	5
<b>2.0 CHAMBER</b>	<b>7</b>
2.1 Description	7
2.2 Installation	8
<b>3.0 PACKAGE SYSTEMS</b>	<b>8</b>
3.1 Package A	9
3.2 Package B	9
3.3 Package C	9
<b>4.0 CONTROLLER</b>	<b>9</b>
4.1 Description	9
4.1.1 Model 554 Humidity/ Temperature Sensor	9
4.1.2 Control Unit	10
4.2 Installation	18
4.2.1 Initial Check Out	18
4.2.2 Set Up	19
4.3 Operation	20
4.3.1 Set Point Adjust	20
4.3.2 Increase	21
4.3.3 Decrease	21
4.4 Calibration	22
4.5 Maintenance	22
4.6 Specifications	24

<b>5.0</b>	<b>OPERATING SYSTEMS</b>	<b>25</b>
5.1	Model 5461 Dehumidification System	25
5.1.1	Description	25
5.1.2	Specifications	26
5.2	Model 5462 Humidification System	26
5.2.1	Description	26
5.2.2	Installation	27
5.2.3	Operation	30
5.2.4	Maintenance and Cleaning	30
5.3	Model 5474 Heating System	31
5.3.1	Description	32
5.3.2	Installation	32
5.3.3	Operation	33
5.3.4	Specifications	33
5.4	Model 5473-150 Thermoelectric Cooling System	34
5.4.1	Description	34
5.4.2	Installation	35
5.4.3	Operation	35
5.4.4	Performance	37
5.4.5	Specifications	37
5.5	Maintenance	37
<b>6.0</b>	<b>PROGRAMMING THE MICROPROCESSOR CONTROLLER</b>	<b>38</b>
6.1	Accessing the Programming Menu	38
6.2	Optimizing Controller Programming	38
6.3	Computer Software (Optional)	46
6.3.1	General	46
6.3.2	Set Up & Installation	47
6.3.3	COMM Port	48
6.3.4	RS232/485 Converter	48
6.3.5	Connections	48
6.3.6	Software Installation	49
6.3.7	Operation	49
6.3.8	Logging and Charting	49
6.3.9	Software Support	49
<b>7.0</b>	<b>Warranty</b>	<b>50</b>

# 1.0 GENERAL

Many applications, such as electronics, medical, pharmaceutical and research require a controlled environment for testing, assembly or storage. The Model 5506 is designed to meet these requirements. The Model 5506 is available in standard or custom configurations to meet specific customer requirements.

## 1.1 Basic Chambers

Model 5506-00: Enclosure only without glove ports

Model 5506-11: Enclosure only with 8" (203mm) glove ports (Figure 1.1-1)



Figure 1.1-1: Model 5506-11

### 1.1.1 Chamber Specifications

**Material:**

1/4" (6mm) clear acrylic front, top  
1/4" (6mm) white, rear, side, bottom  
3/8" (9mm) white left side

**Construction:**

6-panel, PS30 welded seams

**Door** (left side):

1/2" (12mm) clear acrylic with 1/2-turn latch

**Seal:** 1/4" (6mm) Poron, non-setting gasket

**Gloves** (when configured):

.018" (0.5mm), replaceable hands  
natural rubber, accordion sleeves,  
8" (203mm) ports

**Operating Range:**

Humidity: <10 – 100%

Temperature: 32 – 135 °F (0-55 °C)

**Fan:** 32 cfm (900 l/min)

(Specify 115 or 230VAC)

**Access Ports** (left side):

2x1/4" (6mm) hose barbs

1x1" (25.4mm) Hose barb

1x1/2" (12mm) compression fitting

1x1 1/2" (31.4mm) cable pass through

**Dimensions:** 24"Wx18"Dx15"H

(61x46x38cm)

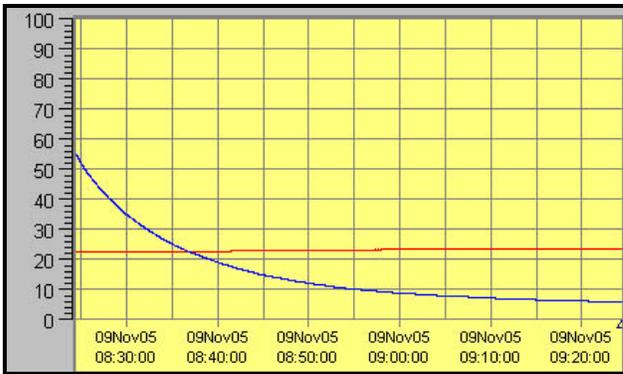
**Weight:** 41 lbs (19kg)

## 1.2 Standard Packages

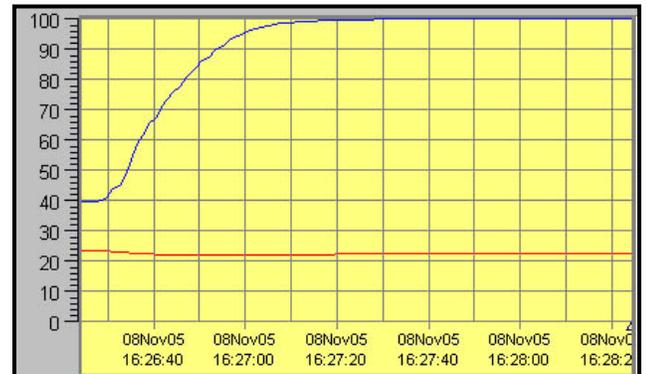
The following packages provide solutions to most dehumidification applications. Each package includes an ETS Series 5000 Microprocessor Controller plus respective operating systems to control humidity or humidity and temperature. Chambers can also be custom configured to meet special user requirements.

The ability of the chamber to reach and then hold a given humidity level along with humidity gradients is a function of the chamber (size, configuration etc.), temperature, operating systems and controllers used.

Figure 1.2-1 are charts showing the time typically required to decrease and increase humidity (Blue = RH, Red = T °C) plus humidity gradients using an ETS Model 5200-231-241 Controller with optional CALCOMMS software in conjunction with a Model 5461 Desiccant/Pump Dehumidification System and a Model 5462 Ultrasonic Humidification System (Package A).



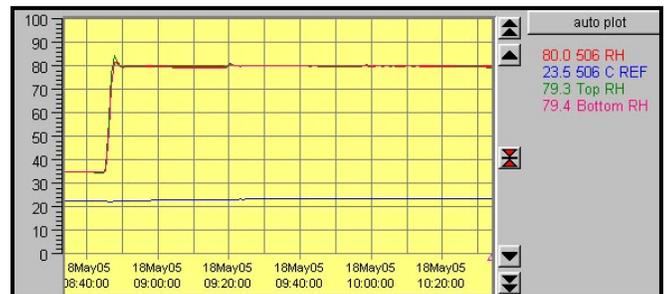
Rate of humidity decrease



Rate of humidity increase



Low humidity gradient, constant temp.



High humidity gradient, constant temp.

Figure 1.2-1: Humidity performance charts

### 1.2.1 Package A:

A full range humidity control system, shown in Figure 1.2-1, that utilizes the ETS Model 5200-240-030 Dual Controller with microprocessor humidity control and temperature display. A Model 5461 Dehumidification System plus a Model 5462 Ultrasonic Humidification System are used to maintain humidity within the chamber to better than  $\pm 1\%$  RH from  $<10\%$  to  $100\%$  RH at standard ambient conditions.

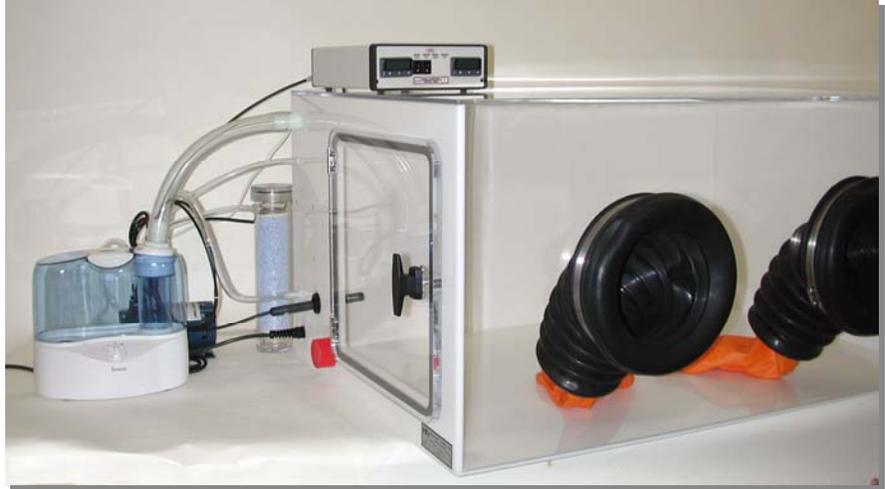


Figure 1.2-1: Package A Humidity Control System

### 1.2.2 Package B:

Utilizes the humidity operating systems included in Package A plus the ETS Model 5200-240-230 Dual Controller to control the Model 5474 Heating System, shown in Figure 1.2-2, to increase temperature up to  $130^{\circ}\text{F}$  ( $55^{\circ}\text{C}$ ).

#### **WARNING:**

**Chambers are fabricated from acrylic that is a hygroscopic material. When operated at high humidity and then low humidity is desired it will take longer and consume more desiccant to stabilize.**

**When operating the chamber at both high humidity and high temperature for prolonged periods of time the access door may warp. The door will return to its original shape when the chamber is allowed to dry out.**

**If the above conditions are to be run continuously, ETS can supply optional doors with additional latches to help maintain the door to gasket seal.**

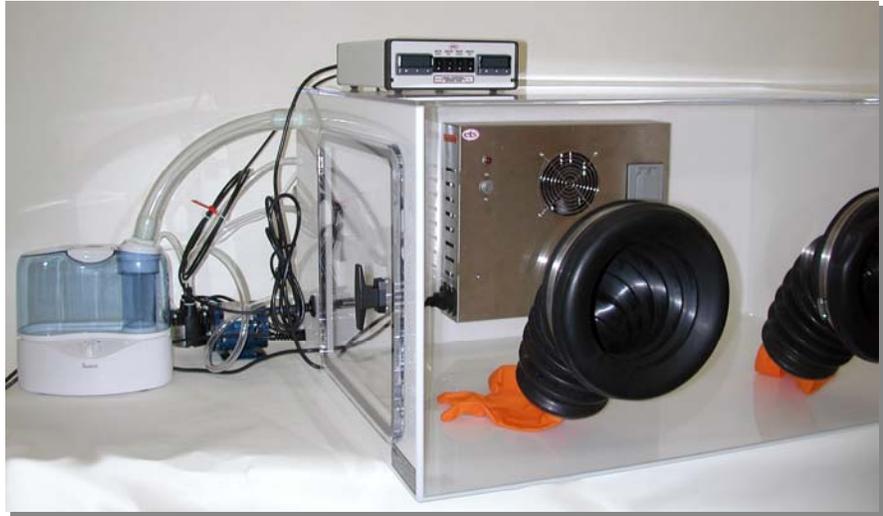


Figure 1.2-2: Package B Humidity and Heating Control System

### 1.2.3 Package C:

A complete humidity and temperature control system, similar to that shown in Figure 1.2-2, using the controller and operating systems of Package B plus the addition of the Model 5473-150 Thermoelectric Cooling System. The Model 5473-150 is mounted on the rear of the chamber behind the heater screen. The Chamber can operate over the temperature range of approximately 50°F (10°C) to 130°F (55°C). Figure 1.2-3 shows the thermoelectric system with the heater screen removed.

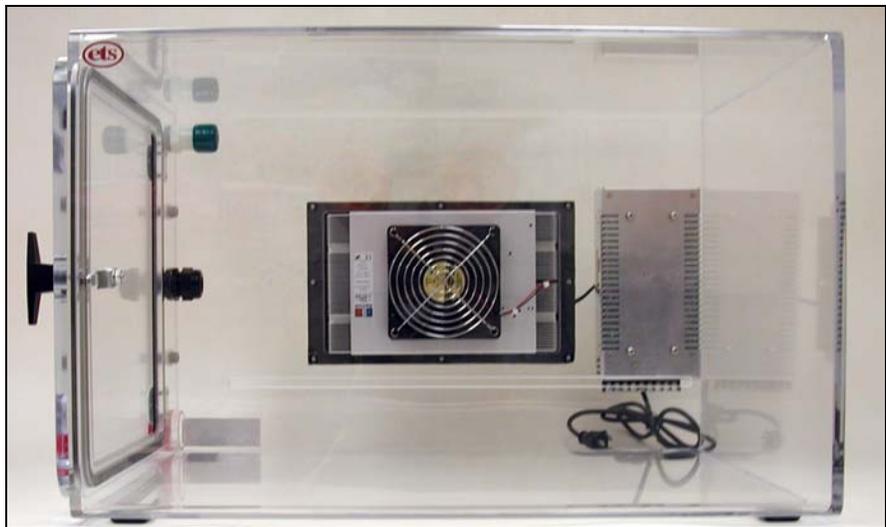


Figure 1.2-3: Package C Humidity/Temperature Control System

### 1.2.4 Custom Configurations

In addition to the standard packages, the Model 5506 can be configured with any combination of ETS controllers and operating systems to meet virtually any user requirement. Configurations include chamber customization, such as increased width, extensions, larger or multiple glove ports, iris ports, access doors, etc. Two examples are shown in Figure 1.2-4. Custom applications will be covered in the Appendix.

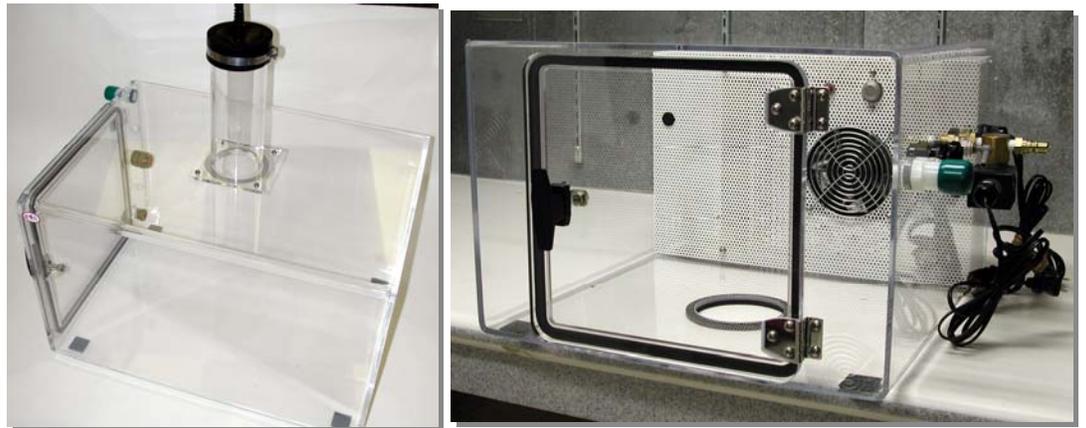


Figure 1.2-4: Customized chambers

### 1.3 Unpacking

Figure 1.3-1 shows the chamber in its shipping carton. Upon receipt immediately inspect the cartons for any visible damage. If any shipping damage is noticed, unpack the chamber and inspect it for damage.



Figure 1.3-1: Typical Chamber packaging

When handling the chamber **DO NOT** use any of the fittings or the door handle as a grip or for leverage. Lift the chamber by placing your hand all

the way into the glove port and grabbing hold of the chamber wall or gripping around the outside of the chamber. If an item is missing or broken please contact ETS immediately at 215-887-2196x226 and photograph the damage to both chamber and shipping carton. **Save all boxes and shipping material until the system is operational!**

**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.**

Chambers with standard Package A, B, or C have the respective operating instructions contained in this Operating Manual. Chambers with optional operating systems are provided with manuals applicable to the respective system(s). Each packaged system includes the following:

**Model 5506-00**

1. Chamber without glove ports with 12"x12" (30x30cm) door with gasket seal, and inlet/outlet ports for accessories.
2. Pliable sealer
3. Operating Manual

**Model 5506-11**

1. Chamber with glove ports, 8" (203mm) gloves, 12"x12" (30x30cm) door with gasket seal, inlet/outlet ports for accessories.
2. Pliable sealer
3. Operating Manual

**Model 5506-xx, Package A**

1. Chamber (see above).
2. Model 5461 Desiccant/Pump Dehumidification System includes pump (110 or 220 VAC), desiccator and 12' (3.6m) of clear plastic tubing.
3. Model 5462 Ultrasonic Humidifier includes 12" (30cm) 1" (25mm) ID plastic tubing (230/115VAC power converter when 230VAC system is ordered).
4. 4", (102mm) 110cfm fan.
5. Model 5200-240-030 Controller.
6. Model 554 Temperature Compensated Humidity Sensor.
7. 6' (1.8m) IEC Power Cord.
8. 5-lb (2.27kg) jar of Renewable Indicating Desiccant

### **Model 5506-xx, Package B**

1. Includes all accessories supplied with Package A.
2. Model 5200-240-230 Dual Microprocessor Controller.
3. Model 5474 Heating System with 32 cfm fan, thermal protection switch and 115VAC, GFIC duplex outlet (North American Std.) installed onto the chamber at the factory.
4. Three (3) additional IEC power cords.
5. 5-lb (2.27kg) jar of Renewable Indicating Desiccant

### **Model 5506-xx, Package C**

1. Includes all accessories supplied with Package B.
2. Heating and cooling systems installed onto the chamber at the factory.
3. Two (2) additional IEC power cords.
4. 5-lb (2.27kg) jar of Renewable Indicating Desiccant

## **2.0 CHAMBER**

### **2.1 Description**

The Model 5506 is a 9.0 cubic foot (0.26 cu. m), sealed chamber fabricated from 0.25" (6mm) and 0.375" (9.5mm) clear and white acrylic and measures 36"Wx24"Dx18"H (92x61x46 cm). Access to the chamber is through a 12" (30.5cm) square opening. A heavy-duty, 0.5" (13mm) clear acrylic door, secured by a single ½-turn latch, along with a compression resistant gasket ensures an airtight seal when the door is locked. A 1.5" (38mm) diameter pass-through is provided for passing cables and/or tubing through the chamber wall. A pliable reusable sealer seals the opening. The access door and all fittings are located on the left-hand side of the chamber as shown in Figure 2.0-1. Additional holes may be positioned elsewhere as an option.

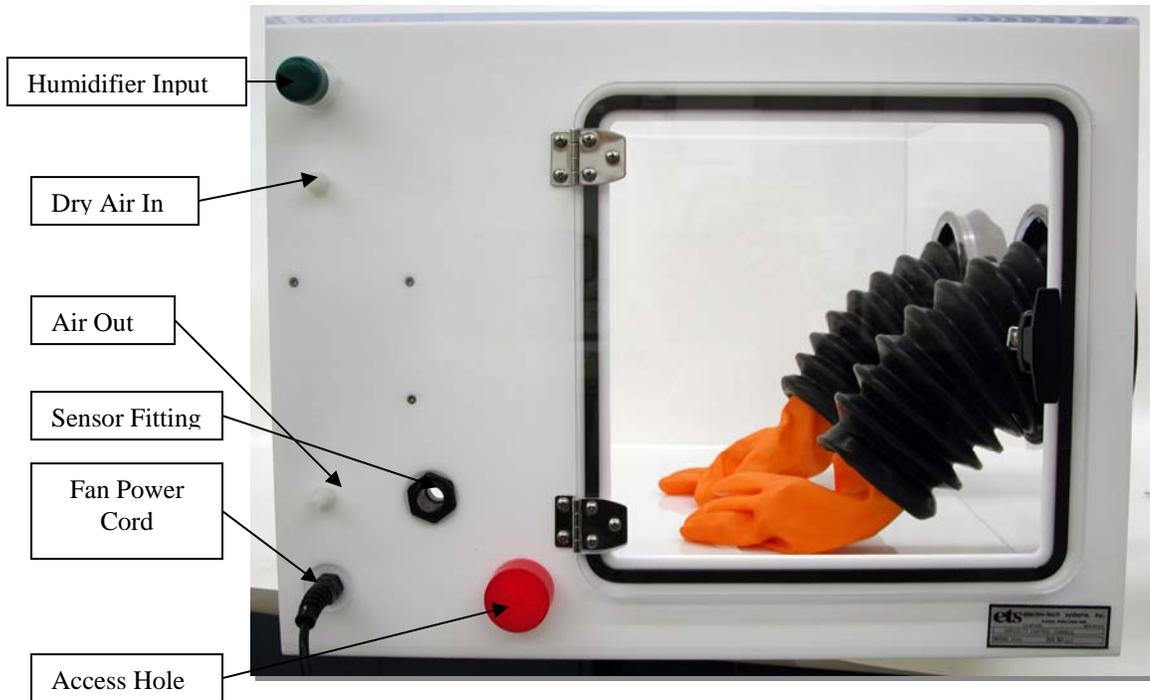


Figure 2.0-1: Chamber access door and fittings

The humidity level within the chamber is reduced using either dry gas (usually dry nitrogen or dry air) injected into the chamber or a desiccant/pump drying system. The desiccator contains a self-indicating, renewable drying agent (Anhydrous  $\text{CaSO}_4$ ) and is mounted externally to the chamber. A small pump draws air from the chamber and forces it through the desiccator back into the chamber. This circulating system is capable of producing humidity levels below 10% RH within the chamber (Actual lower humidity limit may be determined by the object placed in the chamber).

## 2.2 Installation

Place the chamber on an appropriate support surface such as a bench or desk. Open the latch by turning the handle counterclockwise until the cam turns away from the chamber wall and then open the access door. Place the object(s) to be stored or tested inside the chamber and feed any cables through the cable pass-through located at the rear of the left panel. Seal the opening using the supplied pliable sealer.

## 3.0 PACKAGE SYSTEMS

Model 5506 Chambers configured as Package A, B or F feature humidity or humidity and temperature control. These packages all utilize an ETS Series 5000 Microprocessor Controller to precisely control the respective humidity or temperature operating system to provide accurate measurement and control of

the chamber environment. The parameter can be controlled precisely at the sensor. However, the process being controlled, the level of circulation within the chamber plus the affect of other parameters also being controlled will determine the ultimate precision of the system.

Sections 4.0 and 5.0 describe the controllers and the individual operating systems respectively. Refer to the CONTROLLER plus the respective operating systems for the DESCRIPTION, INSTALLATION, OPERATION and MAINTENANCE for the package ordered. The following are the specific sections for each package:

### **3.1 Package A**

Series 5000 Microprocessor Controller	Section 4.0
Model 5461 Dehumidification System	Section 5.1
Model 5462 Ultrasonic Humidification System	Section 5.2

### **3.2 Package B**

Series 5000 Microprocessor Controller	Section 4.0
Model 5461 Dehumidification System	Section 5.1
Model 5462 Ultrasonic Humidification System	Section 5.2
Model 5474 Heating System	Section 5.3

### **3.3 Package C**

Series 5000 Microprocessor Controller	Section 4.0
Model 5461 Dehumidification System	Section 5.1
Model 5462 Ultrasonic Humidification System	Section 5.2
Model 5474 Heating System	Section 5.3
Model 5473 Thermoelectric Cooling System	Section 5.4

## **4.0 CONTROLLER**

### **4.1 Description**

The control system consists of two basic components: the sensor and the control unit.

#### **4.1.1 Model 554 Humidity/Temperature Sensor**

The Model 554 Temperature Compensated Humidity Sensor, shown in Figure 4.1-1, is capable of measuring over the entire 0-100% RH range with an accuracy better than  $\pm 2\%$  RH. This unit is the standard humidity sensor supplied with all Series 5100/5200 Controllers configured for humidity control. It contains both capacitive humidity and RTD temperature sensing elements. The electronics incorporated within the sensor housing utilize the

temperature information to compensate the humidity reading for changes in temperature. This improves accuracy when measuring relative humidity levels at temperatures significantly above or below ambient (72°F/23°C), which is the standard calibration point.



Figure 4.1-1: Model 554 Sensor

When the Model 5200 Dual Controller is configured for both humidity and temperature the separate RTD temperature signal output is used as the temperature sensor. Measurement accuracy is better than  $\pm 1.0^{\circ}\text{C}$  ( $1.8^{\circ}\text{F}$ ).

The sensor is housed in a black, flame retardant, polycarbonate housing. The complete assembly consists of a sensor/electronics section and a cable/connector section that measures .625" (16 mm) diameter x 5" (13 cm) long. It is designed to mount through the wall of a chamber using a 3/4" NPT or metric equivalent compression fitting. Other mounting configurations are available.

The standard sensor cable length is 6'6" (2m) with 16'3" (5m) as an option, terminated with a 5-Pin DIN connector that mates with the 5-Pin receptacle on the rear of the control unit. Other cable lengths or extensions up to approximately 300' (100m) can be provided to meet special requirements.

The operating range of the sensor is -40 to 185°F (-40 to 85°C). **The control module(s) is preset at the factory to display 0-100°C, unless otherwise specified. Refer to Section 4.3.4.2, pg. 29 for changing the scale from °C to °F.** Optional high temperature units are available up to 320°F (160°C).

#### 4.1.2 Control Unit

Figures 4.1-2 and 3 are the control units for the single mode (humidity control) Model 5100-240 and the dual mode (humidity and temperature control) Model 5200-240-230 respectively.

The 3300 control module(s) continuously display the measured parameter. A function button must be pressed to display the set point. It is also capable of performing a single ramp/soak cycle. Point source LEDs indicate the operating status of the control function.



Figure 4.1-2: Model 5100-240 Humidity Controller



Figure 4.1-3: Model 5200-240-230 Humidity/Temperature Controller

The control module continuously displays the measured parameter. A function button must be pressed to display the set point. It is also capable of performing a single ramp/soak cycle (increase or decrease, then hold the parameter).

The controllers operate as “stand alone” units. However, with the optional CALCOMMS software package they can be computer-controlled to control, monitor and log up to 32 control modules simultaneously.

The Controller includes North American AC power outlets on the rear panel to make AC power available to the operating system being controlled. For each control module there is one outlet that provides power to increase a parameter and

one to decrease a parameter. (For example: Humidify/Dehumidify, Heat/Cool.)

The Controller can be programmed as a simple ON/OFF system, but is usually programmed to provide proportional control. In this mode the controller constantly monitors the respective parameter and updates the operating system characteristics to match those of the function being controlled. Power to the operating systems will then be pulsed at a rate that, depending on the sensor and operating system, is capable of maintaining the parameter, at the sensor, to within  $\pm 0.2$  of the set point parameter.

#### 4.1.2.1 Front Panel

A CAL 3300 microprocessor control module provides the PID (Proportional, Integral, Derivative) control. Section 4.3.4 describes programming and adjustment procedures. Also, refer to the respective CAL manual(s) supplied along with this manual.

The Series 5000 Microprocessor Controllers are capable of controlling and/or alarming virtually any process by making available either constant or pulsed AC to the operating system. The major variable is in the programming of the control (Refer to Section 4.3.4 and the accompanying CAL manual for programming and adjustment information.)

The function control switches allow the user to manually disable the controlled outputs. This is very convenient if the user wants to shut off the operating system without having to disturb the control module settings.

**DECR** – Allows the user to manually disable the decrease control function of the system. For normal operation, the switch should be in the “On” (“I”) position. When the microprocessor activates the decrease function, the red LED on the control module display will light.

**INCR** – Allows the user to manually disable the increase function of the system. For normal operation, the switch should be in the “On” (“I”) position. When the microprocessor activates the increase function, the green LED on the display will light.

The main power switch for the Model 5100 Controller is located on the front panel. "I" is ON, "0" is OFF.

#### 4.1.2.2 Rear Panel

Refer to Figures 4.1-4 and 4.1-5 for the location of the rear panel connections for the Models 5100 and 5200 respectively.



Figure 4.1-4: Model 5100 Rear Panel



F

Figure 4.1-5: Model 5200 Rear Panel

**Power Entry Module** - The Power Entry Module is a standard IEC 3-pin receptacle located at the lower left side of the rear panel. It accepts standard International power cord sets.

**Power Switch** – Located above the Power Entry Module on the Model 5200 Controllers only. It controls power to the unit. "I" is "On", "O" is "Off".

**115 / 230 VAC Operation** – The Controller operates from 90 to 240 VAC, 50/60 Hz.

**NOTE:**

**All equipment being controlled by the Controller must match the line (mains) voltage.**

**Power Fuse** – This is a 5x20mm, 400ma, time delay fuse It protects the sensor, controller electronics and control module(s). The controlled AC outlets are individually fused. These fuses are installed on the main circuit board. Replace all fuses with those having equal rating.

**NOTE:**

**Disconnect AC power before attempting to change the Fuse.**

**AC Outlets** - There are 2 North American 3-prong AC outlets on the rear panel of the Model 5100 and 4 outlets on the Model 5200.

For 230VAC, the operating systems still use the North American power plugs.

Each AC outlet is fused separately with a fuse rated approximately 20% less than the rating of the specific solid-state relay. The fuses are ¼”, 3AG, 250 Volt, SloBlo. The specific fuse rating is a function of the operating system being controlled. For standard controllers, the following is a list of the relays and fuses installed.

**DECREASE** – Proportionally controlled output for controlling a parameter below the set point.

The AC power cord from this operating system is plugged into this outlet. A 3 amp, low leakage relay with 2 amp fuse is installed to accommodate any type solenoid valve. Many solenoid valves have very low turn off current. To address these type valves, a special low leakage solid-state relay is required to ensure proper operation of the valve.

For non-solenoid applications where higher current is required, a 5 amp relay is installed, but relays up to 10 amp capacity (8 amp fuse) can be used. The PCB is labeled “4A (5A Relay) & 8A (10A Relay)”. Refer to Figure 4.1-6 for fuse location.

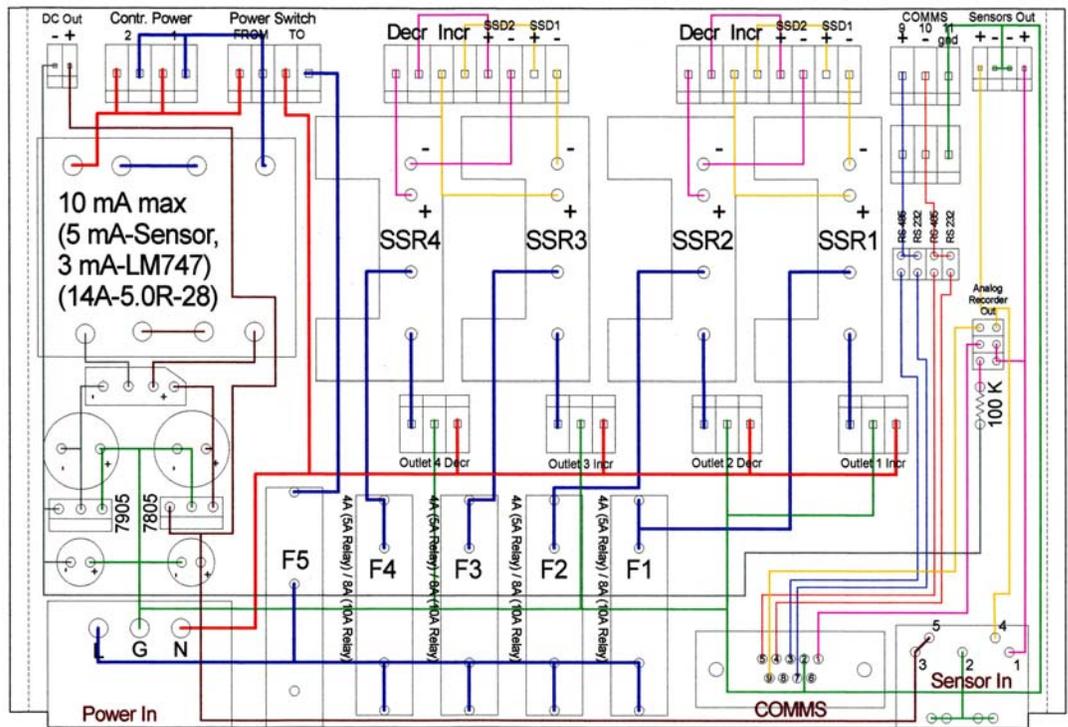


Figure 4.1-6: Fuse and relay locations

The microprocessor will determine the amount of control necessary to maintain the desired set point, specific to the parameter being controlled. Then, the unit will provide a proportional amount of power to the operating system through this outlet. The proportional control is delivered as a series of AC power pulses to the unit.

**INCREASE** – Similar to the DECREASE function except the proportionally controlled output controls a parameter above the set point. The AC power cord from this operating system is plugged into this outlet.

For this function, a 5 amp solid-state relay with 4 amp fuse is normally installed. When the unit is configured as a Temperature Controller, a 10 amp relay with 8 amp fuse is used. Contact ETS if a controller is to be reconfigured for temperature control.

**SENSOR Input** - The 5-pin DIN jack that is located in the lower right corner of the rear panel. Figure 4.1-7 is the wiring of the sensor input jack wiring.

The input goes through a buffer amplifier set at the factory to accept a 0-1 VDC input signal. For example, this corresponds to 0-100% RH and 32-212°F (0-100°C) when used with the ETS Model 554 Sensor.

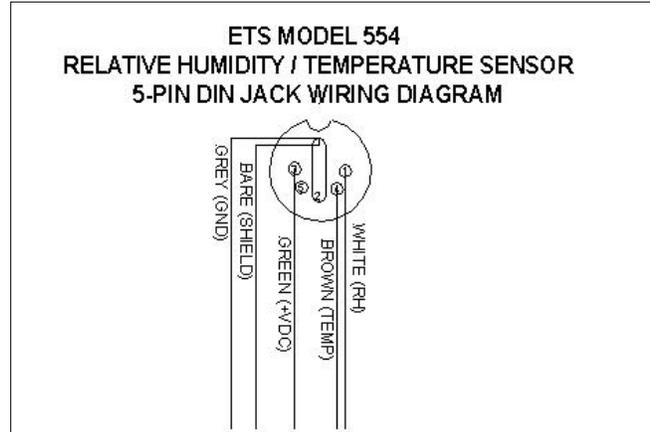


Figure 4.1-7 Sensor input connector wiring

**COMM PORT** – A 9-pin subminiature-D connector (sub-D) located to the left of the SENSOR input jack. It incorporates both the analog signal outputs from the Model 554 sensor and the RS-232 or RS-485 data link. The analog outputs are derived directly from the sensor input signals to the controller. Therefore, the analog output signal will be the same as the input signal. The COMM PORT provides the analog signal output when the COMMs option is **not** ordered. The following is the analog signal (0-1V) pin out for the COMM PORT connector:

- Pin 1 – Humidity
- Pin 9 – Temperature
- Pin 4 – Common

**NOTE:**

**The analog signal output is only available when the COMMS option is not installed. The device connected to the analog output must have an input resistance >10kOhms. If both signals are required, contact ETS.**

The COMM PORT computer link will only be active if the controller is fitted with the COMMS option (see Section 4.3.4 LEVEL C). The COMMS option allows

the microprocessor to communicate with a PC running the CALCOMMS or CALgrafix software. The COMMS option must be specified at the time of purchase. However, if this option is required at a future date, the unit can be returned to ETS for retrofit. Refer to the "Application Guide for Installation and Cabling of the Communications Option" when multiple units are to be linked together.

If using the CALCOMM or CALgrafix software refer to Section 4.4 for set-up instructions.

#### 4.1.2.3 Applications Software (Optional)

**Requires COMM boards for each control module. Contact ETS for retrofit if not initially ordered.**

All Series 5000 Controllers can operate with either the optional CALCOMMS Applications Software or CALgrafix, or CALOPC Process Monitoring & Configuration Software that allows up to 32 individual controllers to be controlled and monitored remotely. CALCOMMS requires a computer running Windows 95/98/2000/NT/XP with at least 200MHz and 16MB RAM. CALgrafix requires Windows 98/NT/ME/2000/XP with at least 450 MHz and 128MB RAM. CALOPC is used to interface the CAL control modules with an existing program.

The software offers the capability of remote adjustment, instrument configuration, cloning, saving and retrieving instrument settings to files together with logging and charting in real time. Communication with the computer uses the MODBUS<sup>®</sup> protocol via a fully isolated RS-232 (single unit only) or RS-485 (multiple units) link.

For more detailed applications refer to the respective manuals supplied with the software.

The control modules configured with the communications interface can be integrated with third party software or coded to the user's custom software. **The document entitled "CAL 3300/9300/9400/9500 Modbus RTU Communications Guide" is available from CAL Controls Ltd., USA at 847-680-7080.** This document

explains how to independently communicate with the control modules. **ETS does not directly provide support for customer software generation. This support is provided by CAL Controls.**

The controllers are “stand alone”; therefore, 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 the RS-485 interface board is ordered, an RS-232/485 converter and 6 ft. (2m) cable are supplied with the software package. If the computer has only a USB port, contact ETS for the appropriate adapter.

When just a single controller (Model 5100-xxx) is to be monitored and is ordered with the RS-232 interface board then just the 6 ft. (2m) cable is supplied with the software package.

**NOTE:**

**RS485/RS232 converters do not follow a standard pin out. Use of a converter other than the one supplied by ETS may not work.**

## **4.2 Installation**

Install the Control Unit and Sensor as follows:

### **4.2.1 Initial Check Out**

Plug the sensor cable into the SENSOR jack on the rear panel. Do not install the sensor at its final location yet.

Connect the communications cable, if used, into the COMM PORT and the other end to the computer or recorder. If using the RS-232/RS-485 converter, connect the converter to the computer serial port. If the computer has only a USB port, contact ETS for the appropriate converter.

Connect the line cord to the controller and plug it into the appropriate power (mains) outlet. The controller will operate directly from 90-240VAC.

Turn on the controller. It will have been preprogrammed at the factory for most typical applications. After a couple of seconds the display will measure the appropriate ambient parameter(s). For humidity gently breathe onto the sensor. A change in humidity

should be observed. For temperature, hold the sensor for several seconds in a closed hand. A change in temperature should be observed. After several seconds, the reading(s) should return to ambient

## 4.2.2 Set-Up

### 4.2.2.1 Sensor

The sensor mounts into the  $\frac{3}{4}$ " compression fitting located on the left-hand wall behind the door as shown in Figure 4.2-1. The sensor is a 2-piece unit consisting of the sensor/electronics and the cable/connector assembly. Loosen the retaining nut and insert the sensor into the fitting so the sensor section protrudes into the chamber. Tighten the retaining nut by hand. **Do not use any tools.**



Figure 4.2-1: Sensor installation

To remove and assemble the sensor/electronics section from the cable assembly refer to Figure 4.2-2 and proceed as follows:

1. Turn the locking ring (mounted on the cable/connector side and marked with 2 dots) counterclockwise until it stops.
2. PULL THE SENSOR STRAIGHT OUT. **DO NOT TWIST THE SENSOR.** THIS WILL BREAK THE CONNECTOR LOOSE FROM THE ELECTRONICS PC BOARD AND WILL VOID THE SENSOR WARRANTY.
3. To reinsert the sensor line up the 4 dots and plug it back in then twist the locking ring only clockwise until the assembly is locked in place.

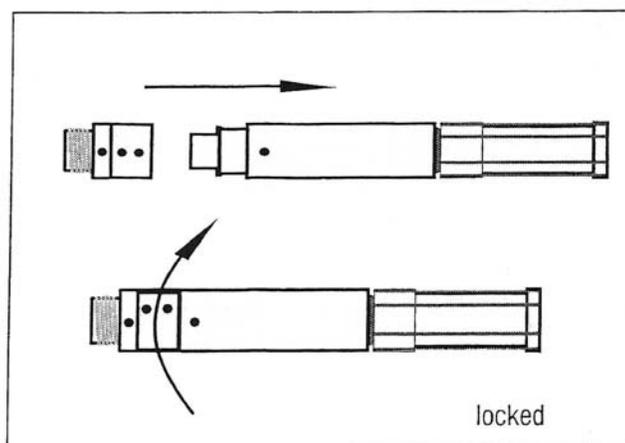


Figure 4.2-2: Model 554 Sensor Assembly

#### 4.2.2.2 Control Unit

The control unit may be placed on any surface near or on top of the test chamber.

Plug the sensor cable back into the SENSOR jack on the rear panel. Plug in the operating system power cord into the respective AC outlet on the rear panel. Dehumidification and cooling systems are plugged into the DECR outlet and humidification and heating systems are plugged into the INCR outlet.

### 4.3 Operation

The Controller is preprogrammed at the factory for most common applications for the parameter(s) being controlled. The following describes the basic operating procedures. Section 3.3.4 provides programming the user can perform to optimize the measurement and control of the respective parameter.

It is recommended that the instructions for the operating systems being used be read first. These can be found in Section 5.0.

#### 4.3.1 Set Point Adjust

Press and hold the “\*” button. The letters designating the type of sensor used such as “rh” for relative humidity will appear, followed by the current set point value. To adjust the set point higher, press the “▲” button. To adjust the set point lower, press the “▼” button. Release the “\*” button when finished.

### **4.3.2 Increase**

This mode controls an operating system that increases the desired humidity or temperature level. To operate in the Increase mode proceed as follows:

1. The operating system should be plugged into the “INCR” outlet.
2. Adjust the set point to a value above ambient conditions.
3. Turn on the “INCR” switch on the front panel. This will not automatically apply power to the “INCR” outlet. Turning on the “INCR” switch only makes the outlet available to the Controller.

When the microprocessor activates the outlet, the green LED on the display will light continuously or flash. The controlled device should then be activated.

4. The microprocessor will determine the amount of output from the operating system needed to maintain the desired set point.

If less than the full output capacity of the operating system is required, the controller will provide pulses of power to the unit to limit the output. The outlet (and operating system) will be turned on and off cyclically to obtain an average output lower than the full capacity of the operating system appropriate to maintain the desired set point.

For best results, the Cycle Time (CyC.t) should be set as short as possible. See the respective operating system specifications for minimum cycle time recommendations.

### **4.3.3 Decrease**

To operate the Controller in the decrease mode proceed as follows:

1. The operating system should be plugged into the “DECR” outlet.
2. Adjust the set point to a value below the ambient parameter level.
3. Turn on the “DECR” switch on the front panel.

This will not automatically apply power to the “DECR” outlet. Turning on the “DECR” switch only makes the outlet available to the Controller.

When the Microprocessor activates the outlet, the red LED on the display will flash or light continuously. The operating system should then be activated.

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

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

For best results, the Cycle Time 2 (CyC.2) should be set as short as possible. Refer to the respective operating system requirements for cycle time recommendations.

**NOTE:**

**For special applications and/or sensors contact ETS for technical support at 215-887-2196 x226.**

**For custom Controller programming refer to Section 6.0**

#### **4.4 Calibration**

As with all measuring instruments, the Series 5000 Controllers should be calibrated periodically. ETS recommends that this be performed once a year. ETS provides full calibration services for these instruments.

The Model 554 Temperature Compensated Humidity Sensor can only be calibrated at the factory. It requires calibrated environments plus appropriate computer software. If the user has the necessary precise controlled environment the software can be ordered from ETS. **This sensor cannot be calibrated manually.** Contact ETS at **215-887-2196 x220** to obtain the necessary RMA authorization or to order the calibration software.

#### **4.5 Maintenance**

The Series 5000 Controllers should operate reliably for many years without any maintenance, other than periodic calibration, if used with operating systems compatible with the AC output. The controllers contain very few user replaceable parts, however, those parts that can be replaced by the user are listed as follows:

1. Control Module – 3300
2. Sensor – Model 554
3. Solid State Relays – 3A (Valve), 5A (Pump) or 10A (Heater & TE)
4. Fuses: 5x20mm, 400 ma, 250V, Time Lag; ¼”, 3AG SloBlo - 2, 4 or 8 Amp

5. Power, Function ON/OFF Switches
6. AC Outlets

Except for the 400ma fuse all components are located internally. To gain access to the inside of the enclosure refer to Figure 4.5-1 and proceed as follows:

**WARNING:**

**Disconnect instrument from AC (Mains) power before servicing.**

1. Remove the front panel assembly by first removing the two (2) black screws that secure the front panel and bezel to the housing (a.).
2. After the front panel assembly is clear of the housing slide the top cover forward approximately 1" (2.5cm) (b).
3. Push the top cover sideways until it clears the groove in the die cast aluminum base.
4. Rotate the cover until the other side clears the groove (c).
5. Replace by spreading the cover and snapping it back into the grooves.



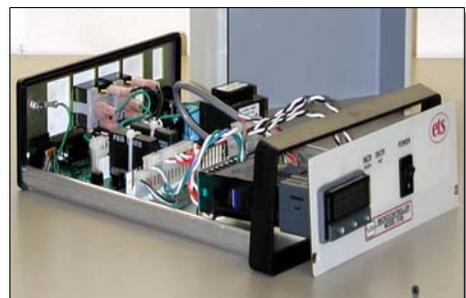
a.



b.



c.



d.

Figure 4.5-1: Accessing the enclosure

To remove the control module it is not necessary to remove either the housing or disconnect any wiring. Grasp the bezel firmly by the recess on

each side and pull forward. A screwdriver can be used as a lever if required.

To replace a fuse, use a small screwdriver to pry the fuse out of its holder. Be careful not to disturb the AC outlet wiring.

To replace a solid-state plug-in relay, first cut the tie wrap securing it in place. If the controller is not to be transported, the tie wrap need not be replaced.

All AC outlets and switches snap-in and out and are connected using spade lugs. Carefully snap out the defective item and replace. Make sure the new device is wired correctly.

## 4.6 Specifications

<p><b>Controller:</b> Meas. accuracy: <math>\pm 2\%RH/\pm 1.8^{\circ}F</math> (<math>1^{\circ}C</math>) Control accuracy:   Humidity: Better than <math>\pm 1\%RH</math>   Temp: Better than <math>\pm 1.8^{\circ}F</math> (<math>1^{\circ}C</math>) Display: High Brightness LED Reading: 0.4" (10mm) Green Set Point: Same as Reading   SP1: Flashing square Green   SP2: Flashing round Red   SP3 (Alarm): None Resolution: <math>\pm 0.1</math> of digital readout 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: 8A   Solenoids: 2A (extra low turnoff leakage current) Ramp/Soak: 1 cycle COMM PORT: 9-Pin Sub-D Analog Output: 0-1V directly from sensor Communications: MODBUS<sup>®</sup> protocol,   Windows 95/98/2000/NT/XP, 200MHz/16MB RAM min   Single unit link: RS-232   Multiple unit link: RS-485 Software:   Standard support: CALCOMMS Applications Software   Optional support: CALgrafix Process Monitoring &amp; Configuration Software     CALopc Server Software Dimensions: 7.25"Wx9.0"Dx2.5"H (185x229x64mm) Weight: 3 lb (1.4kg)</p>	<p><b>Sensor:</b> Temperature compensated Humidity: Capacitive film Range: 0-100% (10mV/%RH) Accuracy: <math>\pm 1.5\% RH @ 73^{\circ}F</math> (<math>23^{\circ}C</math>) Temperature: RTD Range: -40 to <math>+185^{\circ}F</math> (-40 to <math>+85^{\circ}C</math>) (10mV/<math>^{\circ}C</math>) Accuracy (sensor only): <math>\pm 0.9^{\circ}F</math> (<math>0.5^{\circ}C</math>) Size: 0.625" dia.x 6.5" L (16mm x 165m) Cable length: 6.5' (2m) Housing: Polycarbonate, Black (Ral 7016) Compliance: EN50081-2, EN50082-2</p>
---	--

## 5.0 OPERATING SYSTEMS

### 5.1 Model 5461 Dehumidification System

The Model 5461, shown in Figure 5.1-1 provides the dehumidification function for packages A, B and C (The fittings shown are already installed onto the chamber).



Figure 5.1-1: Model 5461 Dehumidification System

#### 5.1.1 Description

The Model 5461 Dehumidification System can reduce the relative humidity level in the Model 5506 Chamber to less than 10% RH. Calcium Sulfate, however, it is capable of reducing the humidity to <5%RH, but mechanical considerations of the chamber, load and operating system limit the specified lower limit to <10% RH.

This Dehumidification System utilizes a pump to draw air from the chamber and circulate it through a plastic cylinder that contains Calcium Sulfate. The desiccant absorbs any moisture that is in the air. This dried air is then forced back into the chamber. The Calcium Sulfate contains an indicator that turns the normally blue colored desiccant pink as it absorbs moisture. When the entire cylinder turns pink, the desiccant must either be renewed by removing it from the column and placing in an oven at 400°F (200°C) for approximately 1 hour or replaced.

The complete Model 5461 Dehumidification System consists of a desiccant column containing 1 lb (.45kg) of renewable, Calcium Sulfate (CaSO<sub>4</sub>) desiccant, a 0.6cfm pump, and 12' (4m) of 5/16"

(8mm) ID of flexible plastic tubing for connecting the pump, desiccator and chamber together.

**The desiccant can be renewed approximately ten (10) times before having to be replaced. The granules should be removed from the drying column and spread evenly, one granule deep on a tray. The desiccant should then be heated for approximately 1 hour at about 400°F (200° C). 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 200° F (100° C) for about 30 minutes before assembly.**

### 5.1.2 Specifications

<p><b>System Type:</b> Closed loop, Desiccant/Pump <b>Drying medium:</b> Renewable, #8 mesh Indicating CaSO<sub>4</sub> (DRIERITE)* <b>Capacity (Std):</b> 1 lb (.45kg) <b>Capacity (Optional):</b> 2.5 lb (1.2kg) <b>Column:</b> Molded acrylic plastic. <b>Dimensions:</b> 2 5/8" (67mm)O.D. x 11 3/8" (289mm). <b>Anodized aluminum cap:</b> Fitted with "O-Ring" gasket. <b>Safe working pressures:</b> 90 psig max. <b>Desiccant supports and coil spring:</b> cadmium plated steel. <b>DRIERITE (Calcium Sulfate):</b> Held firmly in place between felt filters. <b>Connections:</b> Plastic or rubber flexible tubing. (Hose clamps required when used under pressure.) <b>Water vapor capacity:</b> 50 grams max. <b>Flow rate:</b> 200 liters per hour or 0.1 scfm for maximum efficiency. <b>Air and gases drying:</b> -100° F (38°C) dew point max. <b>Outlet Dew Pt.:</b> -100°F (-73°C) @ 100°F (38°C) Sat. air in <b>Pump/Output flow rate:</b> Reciprocating, 0.21 SCFM <b>Capacity (free air):</b> 1200 cubic inch/minute <b>RPM:</b> 1550 <b>Power:</b> 115 VAC/60 Hz, 1.5 Amps 230 VAC/50 Hz, 0.75 Amps</p> <p><b>*Indicating DRIERITE is non-toxic and non-explosive.</b></p>
---

## 5.2 Model 5462 Humidification System

The Model 5462 provides the humidification function for Packages D, E and F.

### 5.2.1 Description

The Model 5462 Humidification System utilizes ultrasonic technology to create a fine mist at room temperature capable of producing full saturation (at room temperature) in enclosures up to 20 ft<sup>3</sup> (.57m<sup>3</sup>).

Applying power to the unit causes the submerged ultrasonic transducer to oscillate producing a fine mist. A small fan built into the humidifier forces the mist out of the humidifier, through a 1" plastic tube and into the enclosure. A 4" (102mm), 110 cfm fan is provided that runs continuously to circulate the moist air throughout the chamber.

The controller turns the humidifier on and off to maintain the humidity set point.



Figure 5.2-1: Model 5462 Ultrasonic Humidification System

### 5.2.2 Installation

The Model 5462 is an open loop system that displaces the dry air in the chamber. A vent is provided on the chamber to allow the dry air to escape. If this vent is sealed the humidifier will not work. If the dry air cannot escape, backpressure will develop and the moist air will not be blown in.

1. The Model 5506 Chamber is shipped with the ½" NPT x 1" (25mm) hose barb mounted inside the chamber to prevent shipping damage. Remove the barb and reinstall it facing the outside of the chamber as shown in Figure 5.2-2.



Figure 5.2-2: Humidifier installation

2. Place the humidifier a minimum of 12" (31mm) away from the chamber.
3. Slide the 1" (25mm) connecting tubing over each 1" (25mm) barb.

**NOTE:**

**Condensation will form inside the transfer tubing when the humidifier is in use. The condensation must be allowed to drain back into the humidifier. If there are any slack or dips in the tubing, water will accumulate and block the airflow.**

2. Place the fan inside the chamber. Run the power cord through the cable pass-through. If this is the only wire passing through, seal the hole with the pliable sealer provided at this time, otherwise wait until all cables have been installed.

Direct the airflow toward the humidity sensor. A strong air current will prevent condensation from forming on the sensor, which will produce false readings. The fan can run continuously for all chamber conditions.

6. Fill the water tank. **Use Distilled or Deionized water ONLY!!**

Remove the water tank from the humidifier unit and inspect it for small cracks or any other damage that may have occurred during shipping (A small crack will allow air to enter the tank, which can cause the water to overflow the basin and possibly damage the unit) After inspection, fill the tank  $\frac{3}{4}$  full with distilled or deionized water ONLY (user provided).

**NOTE:**

**Using tap water will damage the ultrasonic transducer and the associated electronics. Tap water will also cause a white dust to form on all surfaces (including the humidity sensor, which will also be damaged).**

7. Replace the tank on the humidifier unit.

The water will automatically drain from the tank into the basin and stop when the basin is full. If the tank is not put on properly, or the humidifier is not on a level surface, water may continue to flow after the basin is full. If this happens, remove the top immediately, check for problems and try again. If the problem persists, contact ETS.

8. Plug the humidifier into the AC outlet on the rear of the controller labeled HUMIDIFY. Turn on the humidifier POWER switch. Turn on the INCREASE switch on the controller. Set the humidity level set point above ambient.

The power indicator light on the humidifier will turn on immediately and the internal blower will begin moving. When the basin is full, the automatic water level switch will provide power to the ultrasonic transducer. When this happens, the unit will begin producing a fine mist. The controller will take over the injection of water mist into the chamber by pulsing the humidifier at a rate that will maintain the humidity level set point.

9. Set the mist intensity/fan speed knob to "I" or "II".

This control determines how fast the water is converted from a liquid to a mist. For most applications, set this control at "II" will produce a denser mist. Setting the knob to "I" will produce a finer mist. When operating at high temperatures or in large enclosures, set the knob at "II" for best results.

**NOTE:**

**The 230 VAC version of the Model 5462 must be operated with the provided 230 VAC to 115 VAC step-down transformer ONLY!!! Plug the transformer into the humidity controller output, then plug the humidifier into the 115 VAC side of the transformer. NEVER plug the humidifier directly into a 230 VAC outlet. The humidifier is meant for operation at 115 VAC only.**

**The circulating fan is supplied at the appropriate voltage of 115 VAC or 230 VAC.**

At this point the humidifier should be running properly, blowing a fine mist into the chamber.

### **5.2.3 Operation**

After following the above set-up procedure, the Model 5462 Ultrasonic Humidifier should be operating properly. The humidifier should perform well for a long time 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. Any backpressure in the humidifier system will cause the water mist to be forced into the electronics compartment which may damage the humidifier.

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

A chamber without a vent will cause backpressure, which could damage the humidifier. Also, if another pressurized source is being introduced into the chamber, the vent will allow both the humidifier and other source to operate properly. Without a dedicated vent, the other pressurized source will use the humidifier as a vent. This will cause the mist to back up into the electronics compartment.

#### **3. Never place the humidifier inside the chamber.**

The fans and electronics will become exposed to the wet air and will quickly fail. Always operate the humidifier outside the chamber and attach it with the supplied 1" tubing.

#### **4. Never immerse the humidifier for filling or cleaning.**

#### **5. 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 overheats and stops working the entire humidifier must be replaced. Frequent cleaning will allow the electronics to work normally for many years.

#### **6. Use distilled or deionized water only.**

### **5.2.4 Maintenance and Cleaning**

1. Always unplug the unit before cleaning.
2. Empty the unit of all water

3. **Clean the surface of the transducer using distilled vinegar** and a soft, clean cloth. This is very important. If the transducer is not kept clean, it will fail. Using distilled or deionized water keeps the build-up to a minimum, but cleaning cannot be ignored.

**NOTE:**

**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.**

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.

4. 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.

5. Never clean any parts of the humidifier with water above 120°F (50°C).

### 5.2.5 Specifications

<p><b>Type:</b> Open Loop, Single-Head Ultrasonic <b>Air source:</b> Fan, 1.0" (25mm) ID tube <b>Output:</b> &lt;0.5 cfm <b>Water:</b> Distilled or deionized <b>Capacity:</b> 0.5 Gal (1.9 l) <b>Max RH:</b> 100% @ 72°F (22°C) <b>Dimensions:</b> 11"Wx6"Dx9"H (28x15x23cm) <b>Weight:</b> 3 lbs (1.4kg)</p>
--

## 5.3 Model 5574 Heating System

The Model 5474 Heating System is installed on the Model 5506 Chamber at the time of purchase. There is no additional installation required except

plugging in the HEATER FAN and AUXILIARY power cords and running them through the cable pass-through.

### 5.3.1 Description

The Model 5474 Integrated Heating System, shown in Figure 5.3-1, is a 500 Watt heating system that consists of a stainless steel strip heating element, 135°F (57°C), thermal overload sensor, power on indicator plus a 110 cfm fan for use in small controlled environment chambers. In addition, a weather-tight AC accessory outlet box with a duplex North American outlet is provided. The Model 5474 houses the components in a stainless steel enclosure measuring 16"Wx13"Hx3.125"D (41x33x8 cm).

As an option, four replaceable filters with gasket seal can be added or retrofitted onto the sides of the chamber. The standard unit incorporates two IEC power connectors to accept standard IEC power cords.

In addition, the system can be customized to meet most user requirements by adding or removing accessories.



Figure 5.3-1: Model 5474 Integrated Heating System  
Shown with optional filters. Center power IEC conn. not incl.

### 5.3.2 Installation

The system is already installed using four #8-32 screws. The hole pattern is a 12"x12" (30.5 cm) square. The mounting hole diameters are .188" (5 mm).

The Model 5574 enclosure is mounted directly against the surface with aluminum-coated insulation between the unit and the rear wall of the chamber.

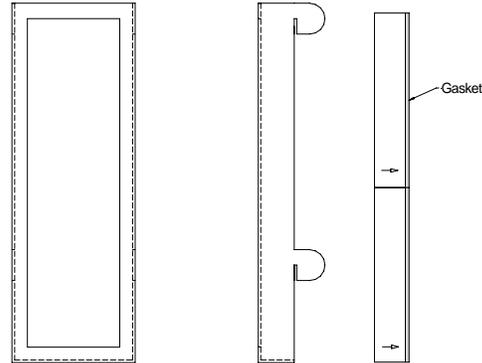
If equipped with the optional filters, a ¼" (6 mm) thick foam rubber gasket is installed around the outer edge of the unit. The insulation is then fitted inside the gasket. If the heating system is removed

tighten the mounting screws to compress the gasket (optional) approximately 50%, or whatever the insulation allows.

The system is configured at the factory for either 115 VAC/60 Hz or 230 VAC/50 Hz operation. However, the AC Accessory Outlet remains the standard North American type unless a custom variation is ordered. It is suggested that a power strip corresponding to the power plugs being used be fitted with a North American plug to use the installed AC outlet directly.

#### 5.3.3.1 Filters (Optional)

The Model 5474 is available with filtering over the intake ports located on both sides of the unit. Each side requires 2 filters that are held in place by stainless steel brackets as described in Figure 5.3-2.



Install HEPA Filter into Bracket, gasket facing toward mounting tabs.  
Install Bracket onto side(s) of screen. Insert the four (4) tabs into the four (4) slots on the side(s) of the screen. Push in firmly. Pull down firmly to lock bracket into place.

Figure 5.3-2: Filter installation

Replacement filters are available from ETS. Order Part #500-6613.

### 5.3.3 Operation

The Model 5474 Heating System operates in conjunction with the ETS Model 5200-240-230 Dual Microprocessor Controller. The Heater power cord plugs into the control outlet labeled INCREASE (second outlet from right) as shown in Figure 5.3-3. The Fan power cord plugs into an AC outlet with continuous power. The Accessory power cord plugs into an AC outlet that may or may not be switched.

**NOTE:**

The Model 5474 Heater requires constant air circulation for proper operation. If the fan is turned off and the heater is run at full power it may result in damage to the system.

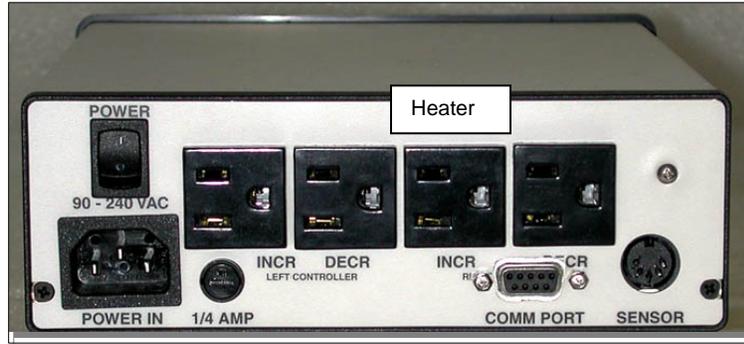


Figure 5.3-3: Heater power cord installation into Model 5200

### 5.3.4 Specifications

**Capacity:** 2x250 Watt Electric strip  
**Housing:** Stainless steel, 16"x13"x3.25" (41x33x8.3cm)  
**Fans:** 1x110 cfm  
**Thermal Protection:** 135°F (55°C)  
**Aux AC Outlet:** Duplex North American GFI

## 5.4 Model 5473-150 Thermoelectric Cooling System

### 5.4.1 Description

The Model 5473-150 is a solid-state, 150 Watt (510 BTU/hr) Thermoelectric Cooling System, shown in Figure 5.4.1. It is installed, (shown with the Model 5474 Heating System removed) onto the rear of the Model 5506 Chamber. It utilizes the Peltier effect to reduce the temperature of a large heat sink. The Model 5473 is used in conjunction with the Model 5474 Heating System to provide the heating necessary to maintain precise temperature control. The single 110 cfm fan of the Model 5473 circulates the air within the chamber through the heat sink to continuously reduce the temperature. The Microprocessor Controller pulses the heater while the thermoelectric unit runs continuously.

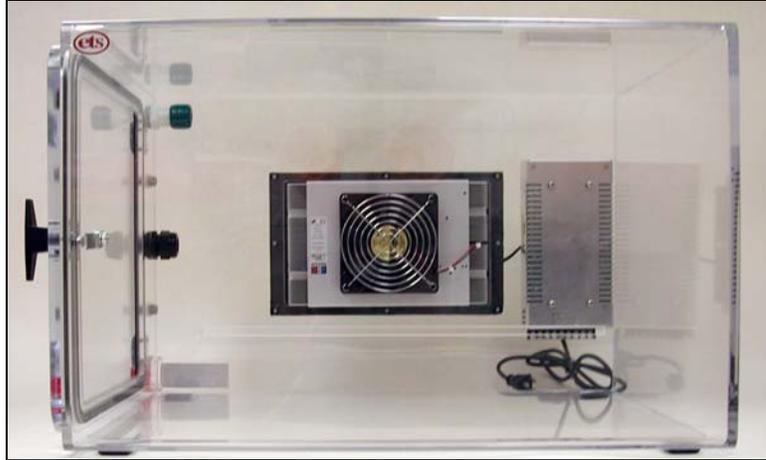


Figure 5.4-1 Model 5473-150 Thermoelectric Cooling System

#### 5.4.2 Installation.

The Thermoelectric System is an integral part of the chamber that protrudes through the rear wall. However, in custom applications, it may also be installed on the side.

The thermoelectric cooler is a solid-state heat pump that 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 Model 5474 Heating System fan 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 an external fan. **DO NOT BLOCK THE AIRFLOW TO THE REAR OF THE UNIT.** The hot air must be allowed to dissipate.

*Increased hot side temperature = Decreased cooling effect.*

Plug the power cord from the power module located on the rear wall next to the thermoelectric unit into the DECREASE outlet located on the far right side of the controller rear panel. The remaining operating systems are installed as described in Sections 5.2 and 5.3.

#### 5.4.3 Operation

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.

To operate, turn on the DECREASE switch (second switch from right on the front of the Controller). This will allow the Power Supply to become available to the Temperature Controller. Adjust the Temperature Controller set point (right side module) to a value below ambient temperature (refer to 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. The microprocessor should be operated in the on/off mode only. Therefore, **CYC.2** (Refer to Section 2.4.2 – SP2 Operating Parameters) will be set to 'On/Off'. **Bnd.2** – SP2 Operating Parameters) sets the range in which the TE module will operate. It will usually be set to a value of 3.6°F (2.0 °C) (Refer to Section 4.3.4.2, pg. 27). If the actual temperature differs from the set point temperature by more than 3.6°F (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. Refer to Section 6.3.4, Microprocessor Temperature Controller Programming.)

Turn on both the INCREASE and DECREASE switches located on the front panel (right two switches) of the temperature side of the Controller. This will do two things:

- a. It will activate the 24 VDC Power Supply. The outside 24V fans will begin moving, the internal heat sink will begin to cool and the external heat sink will begin to warm. All of this occurs regardless of the temperature set point. However, no cooling will take place in the chamber until the internal AC fan begins to move and draw in air through the cold side heat sink.
- b. Turning on the DECREASE switch makes the internal AC thermoelectric fan available to the Controller.

Set the temperature control module set point to a value below ambient temperature (Refer to **Controller Operation** in Section 4.3.1).

When the microprocessor tells the fan to activate, the red LED on the right-hand control module will light. Inside the chamber the internal fan will begin moving.

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

- a. If less than full cooling power is needed the controller will provide pulses of power to the fan.
- b. The pulses of power will speed up or slow down the fan, depending on the frequency and length of time of the pulses. The speed of the internal thermoelectric fan is directly proportional to the amount of cooling taking place inside the chamber.
- c. To achieve a smooth, even cooling process, the speed of the internal thermoelectric fan must remain constant. To keep the speed constant even when short pulses of power are being applied, the cycle time for the circulating fan (**CYC.2**) must be set very short, therefore, **CYC.2** should be set to 0.5 second.

#### 5.4.4 Performance

The Model 5473-150 Thermoelectric System will remove up to 510 BTU/hr (150 Watts) from the chamber. For the Model 5506 Chamber this translates to a  $\Delta T$  of approximately 20°F (11°C).

All cooling capacity figures are based on a room ambient temperature of 73 °F (23°C) and  $\Delta T$  expresses the difference in temperature from room ambient 73°F (23°C).

#### 5.4.5 Specifications

**Cooling capacity:** 150 Watts (510 BTU/hr)  
**Power Req.:** 4A @115/3.5A@230VAC  
**Weight:** 16.5 lb (7.5kg)

### 5.5 Maintenance

The Series 5400 Operating Systems should operate reliably for many years if maintained properly. Typical service includes gloves, desiccant, and hose replacement. Listed below are common replacement parts for the various operating systems along with the corresponding ETS part number.

ITEM	ETS Part #
1. 8" (203cm) Replaceable Hands – Size 10	0140-00027
2. Pliable Sealer	MORTITE™
3. Replacement Door Gasket (roll)	0141-06141
4. 5 lb Jar of Indicating Calcium Sulfate Desiccant	0122-00002
5. 1 lb Desiccant Column	0122-00001
6. 2.5 lb Desiccant column (Optional)	DH10-57101

7. Pump Repair Kit (Model 5561)	0104-00025
8. 18"Lx4"W (46x15cm) Stackable Sample Rack (optional accessory)	0023-00012
9. Replacement Humidifier	Model 5462
10. Heating Element (115VAC, 500W) (230VAC, 500W)	0103-00018 0103-00004
11. Thermoelectric Power Supply	0103-00024
12. High Pressure Hose for Model 5463 Gas Cooling	LL21-51801

## 6.0 Programming the Microprocessor Controller

For those applications where adjustments to the factory programming are required, the procedures described below should be followed.

Instructions for programming the control modules are contained in the respective manuals that are included along with this manual. The following are the most common programming functions that the user will normally have to perform to optimize system performance for humidity and temperature control.

### 6.1 Accessing the Programming Menu

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, see the “CALCOMM” section of the Manual).

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

To change a parameter or change Levels, press and hold the “\*” button. Press the “▲” or “▼” buttons to change the parameter.

The factory-programmed values are optimized for a chamber located in an area having normal ambient conditions and using the ETS Model 5461 Desiccant/Pump Dehumidification System and ETS Model 5462 Ultrasonic Humidification System, the Model 5474 500 Watt Heating System and the Model 5473-150 150 Watt Cooling System.

To exit the menu press and hold “▲ ▼” for three seconds.

### 6.2 Optimizing Controller Programming

**LEVEL 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 systems having a limited mode of operation.

To avoid confusion, this section will discuss which parameters **may** be adjusted, which parameters **should not** be adjusted and how to calculate a change in value to achieve good control.

The programmed values should control within specifications. For more specific control, the user may adjust the values.

The following calculations are approximations that will allow the user to achieve good control at any set point (approximately  $\pm 2\%$ , depending on the specific conditions). However, as the user becomes familiar with each parameter and its effect on system control, the user will be able to program the unit to control to within ever tightening tolerances. Control of  $\pm 0.2$ , or better, is achievable with this controller.

**tunE – (oFF) Do Not Change.** The tune and autotune functions should not be necessary. The CAL Manual dedicates a lot of time explaining the operation of this feature, but it is not useful in the limited mode of operation in which the controller is normally being used. **The best tuning will always be achieved manually.**

**bAnD – (10.0) bAnD** is used to optimize the on/off time of the operating system in relation to chamber size. In general, a larger band will allow the operating system to reach the desired set point faster, but at reduced set point accuracy. A smaller band will improve set point accuracy, but may not allow the operating system to approach the desired level. The user must choose or tune the band setting to achieve optimum control for the actual chamber size used. Setting the band at 1 and then performing a “tune at set point” is a good place to start to achieve basic control. Fine-tuning will be needed for the best control.

After the humidity (temperature) stabilizes near the desired set point, the band may be adjusted slightly up or down in 0.1 increments.

For the purpose of humidity (temperature) control, the band may be thought of as the parameter that controls the duration of the proportional power pulses (when the environment is stabilized around the set point). Increasing the band will increase the duration of the pulses, decreasing the band will decrease the duration of the pulses.

Optimum control is obtained when the controller generates short, even pulses constantly.

If the controller is to be set up for ON/OFF, control the band setting determines the hysteresis.

**Int.t Integral Time** - The Integral Time sets the rate that the controller checks to determine how much power is in each pulse that is applied to the operating system to maintain the desired conditions.

A smaller than necessary Integral Time will cause overshoot and oscillations. A larger than necessary Integral Time will slow down its ability to increase and also its response.

For Humidity:

**int.t – (0.5)**

For Temperature:

**int.t – (1.0)**

**der.t** - 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.

For Humidity:

**der.t – (2.0)**

For Temperature

**der.t – (10.0)**

**dAC** - 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.

For Humidity:

**dAC (1.0)**

For Temperature

**dAC (2.0)**

**CYC.t Cycle Time** - Cycle time means how often the unit can potentially be turned on and then off in succession. Check the respective operating system specifications to determine how often the system may be safely turned on and off. For example, turn-on time for pumps and solenoids and the current draw of electric heaters at turn-on limits the cycle time. **GENERALLY, CYCLE TIME SHOULD NOT BE DECREASED BELOW 1.0 SECOND. However, using the minimum allowable cycle time for the operating system used should provide optimum control.**

For Humidity:

**CYC.t – (1.0)**

For Temperature:

**CYC.t – (1.0)**

**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.

**PROGRAMMER SETTINGS** - The following settings are used for programming the single ramp-soak feature available with the 3300 control module. Complete instructions for programming this feature can be found in the CAL 3300 Users Manual.

**SPrr – (0.0)** - Sets the ramp rate.

**SPrn – (oFF)** Switches the ramp on or off, or holds at the last ramp value.

**SoAK – (--)** Sets the soak time.

**SP2 OPERATING PARAMETERS** - The **SP2** parameters can be configured in a variety of ways. In the Series 5100/5200 Controllers, the **SP2** parameters are used to tailor the DECREASE parameter (dehumidification/cooling) output for best control.

The recommended **SP2** parameters should be changed only if the dehumidification or cooling system (decrease) is being used (low RH or temp applications).

**SET.2** - Set point 2 allows the user to create a set point offset for certain DECREASE functions.

For Humidity

**SET.2 – (0.0)**

For Temperature:

**SET.2 – (0.0)** This setting allows the user to create a set point offset for the cooling system. For the thermoelectric cooling system this setting may be increased or decreased to determine the point at which the cooling system will activate. This system is operated in the ON/OFF mode instead of within the proportional band. Optimum cooling control is obtained by continuously operating the cooling system and controlling the heating system.

**bnd.2 – (10) - bnd.2** should equal **bANd.1** A **bnd 2** value less than **bANd.1** will prevent the decrease system from operating unless the environment is near the set point. This allows the increase system to perform most of the work. The opposite is also true. A **bANd.2** value larger than **bANd.1** will prevent the increase system from operating unless the environment is near the set point.

**CyC.2** - Cycle time means how often the unit can potentially be turned on and then off in succession.

Most solenoid, heating and small pump operating systems may be safely turned on and off once a second. Other operating systems will have different requirements. **IN GENERAL, DO NOT DECREASE THE CYCLE TIME BELOW 1.0 SECOND UNLESS THE PARTICULAR SYSTEM WILL BE ABLE TO OPERATE RELIABLY AT THE SHORTER CYCLE TIME.**

When controlling systems with solenoid valves, **CyC.2** may be set as low as 0.5 second, but short times will accelerate valve wear. On the other hand, to extend the life of the solenoid valve, the cycle time may be increased, but control may suffer.

For Humidity

**CyC.2 – (1.0)**

For Temperature

**CyC.2 – (3.0)**

**LEVEL 2 (Level 2)** - Level 2 is the controller configuration level. **DO NOT CHANGE ANY SETTINGS IN LEVEL 2.** The controller is capable of being configured in an unlimited number of ways. However, the parameters needed to operate the respective operating systems installed at the factory are programmed and locked.

## MANUAL CONTROL MODES

**SP1.P** – Read only. **SP1** Displays output percentage power of **SP1**.

**hAnd – (off) SP1** Manual percentage power control.

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

**PL.1 – (100)** Limits maximum **SP1** (INCREASE) output power during warm-up and in the proportional band. The percentage of power that is available to the **SP1** output. When set to 100 maximum power is available to the **SP1** output. When set to 0 the power to the **SP1** output is turned off. Any setting in between limits the **SP1** output to a percentage of the duty cycle.

**PL.2 – (100)** Limits maximum **SP2** (DECREASE) output power during warm-up and in the proportional band. (The percentage of power that is available to the **SP2** output.) When set to 100 maximum power is available to the **SP2** output. When set to 0 the power to the **SP2** output is turned off. Any setting in between limits the **SP2** output to a percentage of the duty cycle.

## SP2 OPERATING MODES

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

Must remain in “**COOL**” mode to properly operate the respective decrease operating system.

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

**°C to °F Conversion** To convert from °C to °F the following parameters need be changed:

In **Levl 2Units** – Change from °C to °F

**hi.SC** – set to **212**

**Lo.SC** – set to **32**

In **Levl 3**

**Zero** – set to **32**

**unit – (rh, °C, °F PSI, ph, SEt)** - 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. The insert on the controller overlay also indicates the parameter being measured.

**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 INCREASE control to the appropriate output.

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

## **SAFETY SETTINGS**

**Burn – (uP.SC) Do Not Change.** - Sensor burnout/break protection. This safety setting is meant to limit the output of the operating system to protect the process from damage due to sensor failure.

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

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

### **SPAn**

**(-60) Do Not Change** - This function calibrates the full scale of the Model 554 RH Sensor.

**ZErO – (0.0 for °C), (32 for °F)** - This function calibrates the zero of the Sensor.

## **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 then be re-entered manually.

## 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.

## LEVL C (Level C)

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) TEMP, (2) RH** 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.

## 6.3 Computer Software (Optional)

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<sup>®</sup> protocol via a fully isolated RS-485 (multiple units) link for CALCOMMS. The graphic WINDOWS<sup>™</sup> 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.

CALgraphix software is recommended when more comprehensive control, charting, ramp/soak programming, audible/visual alarming and networking are desired.



Controller Configuration

Charting

Controller Activity

Figure 6.0-1: CALCOMMS display

The following application notes apply to both CALCOMMS and Calgrafix software programs, but is specific to CALCOMMS.

### 6.3.1 General

CALCOMMS is a graphic Windows<sup>™</sup> based software package designed for PC supervision of CAL 3300 and 9500 Controllers. It offers the capability of remote adjustment, instrument configuration, cloning, saving and retrieving instrument settings to files together with logging and charting in real time. Communications uses the MODBUS<sup>®</sup> protocol via a fully isolated RS-485 link.

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 at least WINDOWS 95/98/2000/ME/NT/XP. A minimum of 16 MB RAM is recommended to run the program

(slightly less is acceptable), together with enough free hard disc space to meet logging requirements.

CALgrafix, on the other hand, requires a computer having a minimum of Pentium 450MHz with 128MB RAM and Windows 98/ME/NT/2000/XP.

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 multiple controllers, the COMM PORTs must be wired in parallel by the user as shown in Figure 6.3-1 to form the RS-485 link. All 5200 dual controllers with the interface option are already wired in parallel internally. One RS-485 computer input will handle up to 32 controllers on a single computer. Contact ETS for multiple computer license information.

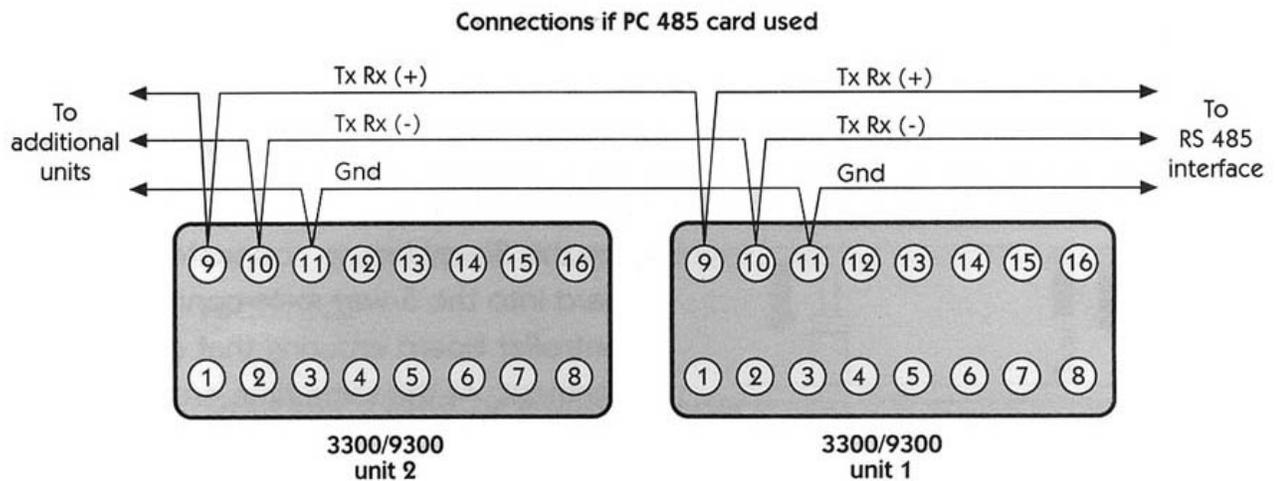


Figure 6.3-1: Multiple Controller RS-485 data link wiring

### 6.3.2 Set-up and Installation

For CALCOMMS, refer to pp. 2 & 3 in the CALCOMMS Manual.

For CALgraphics, refer to the Instructions CD supplied with the software.

For connecting multiple controllers (up to 32), refer to the Application Guide for Installation and Cabling of the Communications Option

### 6.3.3 COMM PORT

The COMM PORT has outputs for either RS-485 or RS-232 Interface. RS-485 is a half duplex serial communications link and is the standard most commonly used for industrial applications due to its high noise immunity and multi-drop capability. It enables a PC to communicate with up to 128 instruments over distances of over 1200 meters. It requires the addition of an RS-485 interface card or a separate RS-232/485 converter. If the computer has only a USB port contact ETS for the appropriate adapter.

The RS-232 link is used only when a **single control module** is to be monitored. The COMM PORT output pins are **3** (T<sub>x</sub>/R<sub>x</sub> [+]) and **2** (T<sub>x</sub>/R<sub>x</sub> [-]) with pin **4** connected to ground (shield).

The RS-485 link uses pin **7** (T<sub>x</sub>/R<sub>x</sub> [+]) and pin **2** (T<sub>x</sub>/R<sub>x</sub> [-]) with pin **4** connected to ground (shield). Refer to Figure 3.4-1.

### 6.3.4 RS-232/485 Converter

The RS-232/485 Converter will not be needed if the computer is outfitted with an RS-485 interface card or if a RS-232 interface card is installed. Contact ETS if a RS-485/USB adapter is required.

The converter is a 9-pin/9-pin in-line connector.

#### **NOTE:**

**Converters from different manufactures may have different pin out configurations. The Series 5000 Controllers are designed to work with those RS-485-RS-232 Converters having the pin-outs specified in Section 6.1.1. The specific converter supplied by ETS is the B&B Electronics Model 485SD9R.**

The other adapter (gender changer) included is a 9-pin/9-pin straight-through adapter.

### 6.3.5 Connections

Connect the supplied 9-pin male/female sub-D cable to the COMM PORT on the rear of the controller.

Connect the other end of the cable to the ▼RS-485▼ side of the RS-232/485 converter. For RS-232, connect this end directly to the computer.

Connect the ▲RS232▲ side of the converter into the appropriate COMM Port on the PC. Use the 9/9-pin adapter if necessary.

### **6.3.6 Software Installation**

Software installation instructions can be found on pp. 9-11 in the CALCOMMS Manual. The CALCOMMS Manual is separate from the CAL 3300 Users Manual.

### **6.3.7 Operation**

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

#### **6.3.7.1 MODBUS Addresses**

The MODBUS address is found in Level C. (See Section 5.4.1)

The Microprocessor Controller address is set to **2** at the factory.

#### **6.3.7.2 Open Communications**

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

### **6.3.8 Logging and Charting**

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

### **6.3.9 Software Support**

Full support for the CALCOMMS and CALgraphics software is available directly from CAL Controls, Inc. In the United States they may be reached at **847-680-7080**. In the UK and Europe they may be reached at + 44 (0) 1462-436161. Over the web they can be reached at [support@cal-controls.co.uk](mailto:support@cal-controls.co.uk).

## 7.0 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 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 or 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.**