MICROPROCESSOR CONTROLLER

Series 5100/5200

Operating Manual

7/12/06

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1.0 INTRODUCTION

Many applications require the accurate measurement and precise control of relative humidity, temperature or other engineering parameters in controlled environments. The Series 5100/5200 Controllers utilize microprocessor based technology to control these parameters. The controlled 115/230 VAC, solid-state outputs enable the controllers to operate individual operating systems to increase or decrease the required system parameters.

The controllers are designed to work in conjunction with operating systems such as ETS Desiccant/Pump and Dry Gas Dehumidification (Models 5461, 5463, 5471 & 5478), Ultrasonic Humidification (Models 5462 & 5472), Cooling (Models 5463, 5466, 5473 & 5475) and Heating (Model 5464 & 5474). However, they can also be used with any system that operates within the power output capabilities of the controllers. For applications that require higher power switching requirements, higher capacity or optional intermediate relays can be provided.

The controllers can control any desired parameter where the measuring sensor provides a linear voltage signal and the respective operating system operates from 115/230 VAC power. 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.

The controllers incorporate a removable front panel insert(s) that allows the specific parameter being controlled, such as %RH. °F or °C, %CO_2, PSI, etc. to be identified.

1.1 Identifying Controller Configuration

The expanded line of controllers now being offered by ETS allows for many different configurations to meet a variety of customer requirements. The configuration of a specific controller can be identified by the Model/Serial number printed on the label located on the bottom of the unit. An example is shown in Figure 1.The Model number printed on the front panel designates whether the Controller is a single unit (5100) or a dual unit (5200). Table 1 designates the specific function associated with each digit in the numbering system:

Figure 1 Controller identification label

BASE MODEL		LEFT CONTROLLER				RIGHT CONTROLLER		
		Controller Configuration	System Function	Computer Interface		Controller Configuration	System Function	Computer Interface
5☐**00**	**-**	☐	☐	☐	**-**	☐	☐	☐
1 - Single Unit 1 CAL controllers **2** - Dual Unit 2 CAL controllers		**0** –3300 Measure Only (No output relays & AC outlets) **1** – 3300 Standard Control w/o Operating system ON/ OFF switches **2** – 3300 Standard Control with Operating system ON/OFF switches **3** – 9500P Ramp Control w/o operating system ON/OFF switches **4** – 9500P Ramp Control with operating system ON/OFF switches	**1** – Universal (No parameter ID) **2** – CO_2 **3** – Temperature **4** – Humidity **5** – Pressure (Other – number as needed)	**0** – No computer Interface board **1** – RS485 interface board **2** – RS232 interface board		**0** – 3300 Measure Only (No output relays & AC outlets) **1** – 3300 Standard Control w/o Operating system ON/ OFF switches **2** – 3300 Standard Control with Operating system ON/OFF switches **3** – 9500P Ramp Control w/o operating system ON/OFF switches **4** – 9500P Ramp Control with operating system ON/OFF switches	**1** – Universal (No parameter ID) **2** – CO_2 **3** – Temperature **4** – Humidity **5** – Pressure (Other – number as needed)	**0** – No computer Interface board **1** – RS485 interface board **2** – RS232 interface board

Table 1 Controller Model Numbering System

2.0 SYSTEM DESCRIPTION

The control system consists of two basic components: The sensor and the control unit. The following are descriptions of the most common sensors used and control units with the most common operating configurations.

2.1 Sensors

2.1.1 Model 554 Humidity/Temperature Sensor

The Model 554 Temperature Compensated Humidity Sensor, shown in Figure 2, is capable of measuring over the entire 0-100% RH range with an accuracy better than $\pm2\%$ 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.
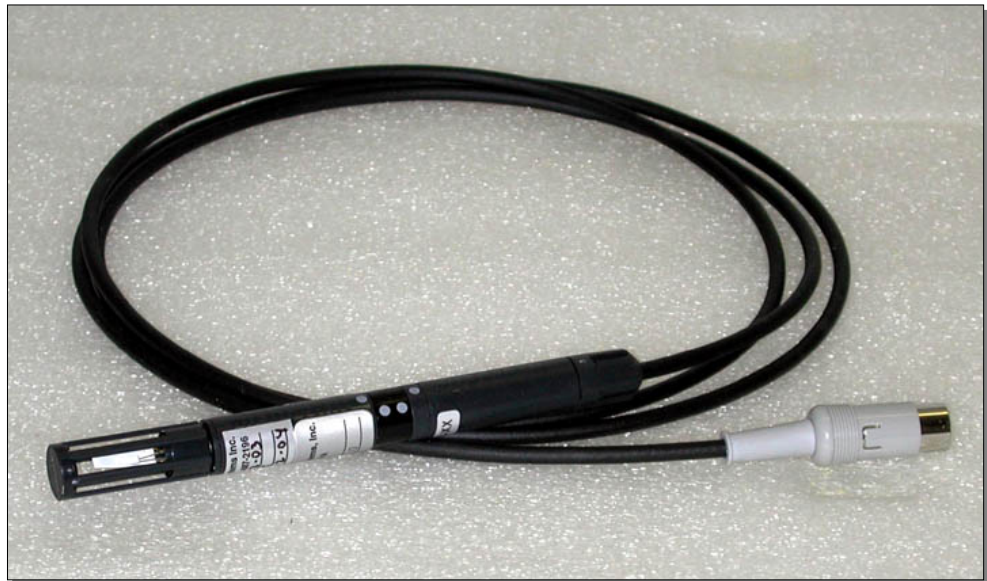
F
Figure 2 Model 554 Temperature Compensated Humidity Sensor

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 $\pm0.2°C$ (0.4°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" (2 m) with 16'3" (5 m) 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' (100 m) can be provided to meet special requirements.

The operating range of the sensor is –40 to 85°C (-40 to 185°F). **The control module(s) is preset at the factory to display 0-100°C, unless otherwise specified. Refer to Section 5.2.4 for changing the scale from °C to °F.** Optional high temperature units are available up to 160°C (320°F).

2.1.2 Model 555 Temperature Sensor

The Model 555 Temperature Sensor, shown in Figure 3, is an integrated circuit with a voltage output proportional to temperature (1mv/°C). This type of sensor provides fast response over the range 0 to 100°C (32° to 212°F) with a measurement accuracy of ±1°C (1.8°F).

Figure 3 Model 555 Temperature Sensor

The sensor assembly consists of a plug-in integrated circuit sensing element mounted in a .5" (12.7 mm) diameter Delrin housing with a plastic grid to protect the sensing element. The sensor housing is designed to be mounted to the wall of a chamber using either a ½" NPT compression fitting or a "C"-clip. Other mounting configurations are available as options.

The standard sensor cable length is 5' (1.5 m), terminated with a 5-pin DIN connector. Other cable lengths or extensions can be provided to meet special requirements.

2.1.3 Thermocouples

A wide variety of thermocouple sensors are available for virtually any temperature measurement application. ETS or the user can provide the correct sensor for the required temperature measurement application. A typical thermocouple sensor is shown in Figure 4. When using thermocouples the signal is connected directly into the thermocouple input of the control module. The buffer amplifier used with the 3300 is bypassed. When ordered with the controller all appropriate internal connections are made. However, if a thermocouple sensor is to be added at a later date it is recommended that the controller be returned to ETS for retrofit. Refer to pg. 11 of the 3300 or pg. 22 of the 9500P manual for the 9 types of thermocouples that can be used.
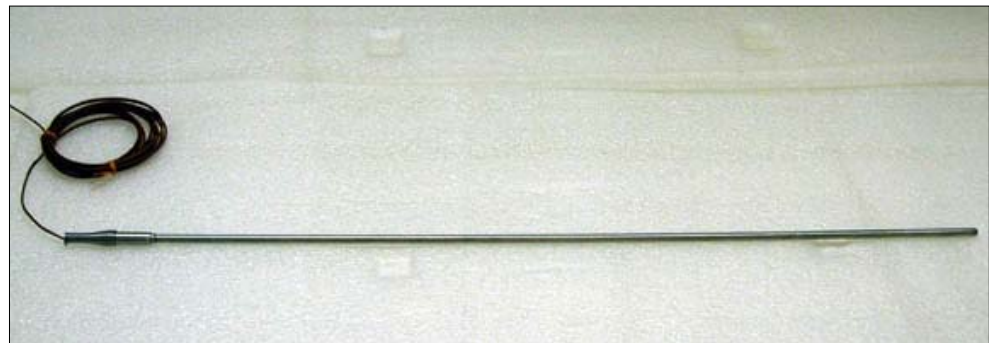

Figure 4 Typical Thermocouple Sensor

2.1.4 RTD Temperature Sensors

The controllers are capable of operating with RTD-2/Pt100 type sensors. These sensors, like the thermocouples, must be ordered with the controller or the controller should be returned to ETS for retrofit.

2.1.5 Other Sensors

The Series 5100/5200 Controllers can control virtually any engineering parameter that is measured by a sensor having a linear voltage output scalable to 0-50mv for the 3300 and 0-5V for the 9500 corresponding to the measurement range required. The controller will automatically control the respective operating system based on the control module settings. Different parameters will require different program settings.

Typical measurement parameters that can be controlled are CO_2, Pressure, Vacuum, O_2, N_2, ph, Air Velocity, RPM etc.

2.2 Control Unit

Typical control units are shown in Figure 5a for a basic Model 5100 with 3300 control module, Figure 5b for a 5100 with 9500P control module and Figure 6 for a Model 5200 with 3300 control modules. These units are capable of controlling any engineering process where the sensor has a linear voltage output. The control units can be configured with either 3300 or 9500P, or a combination, Programmable Processor Control module(s) and with or without controlled parameter ON/OFF switches.

The 3300 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. The 9500P module displays both the measured parameter (red display) and the user selected set point (green display) simultaneously plus it has the capability of performing multiple ramp/soak cycles as programmed by the user. It also has a third set point for alarming. Point source LED's in both modules indicate the operating status of the control function. The 3300 and 9500 control modules can be mixed in the 5200 Dual Controller, if required. For example: A Series 5200 Controller configured to provide ramp and soak capability for humidity and just maintain temperature would have both 9500P and 3300 control modules respectively.

The controllers can operate either as "stand alone" units or as part of a computer-controlled system with the optional software package. The software can control, monitor and log up to 32 control modules simultaneously.

Figure 5a Series 5100 Controller (Model 5100-140)

Figure 5b Series 5100 Controller (Model 5100-431)

Figure 6 Series 5200 Dual Controller (Model 5200-441-431)

The Controller includes 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 outlet that provides power 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 ± 0.2 of the set point parameter. Slow responding sensors such as those used to measure CO_2 may only be controlled to within ± 0.5.

Controllers configured with the 9500P control module can provide multiple ramp/soak profiles such as the example shown in Figure 7. Gradual or step changes can be set that can be separated by soak periods. The user has the option of configuring the controller for a small number of long programs or a larger number of shorter ones, up to the permitted maximum of 126 segments/program and a limit of 31 programs.
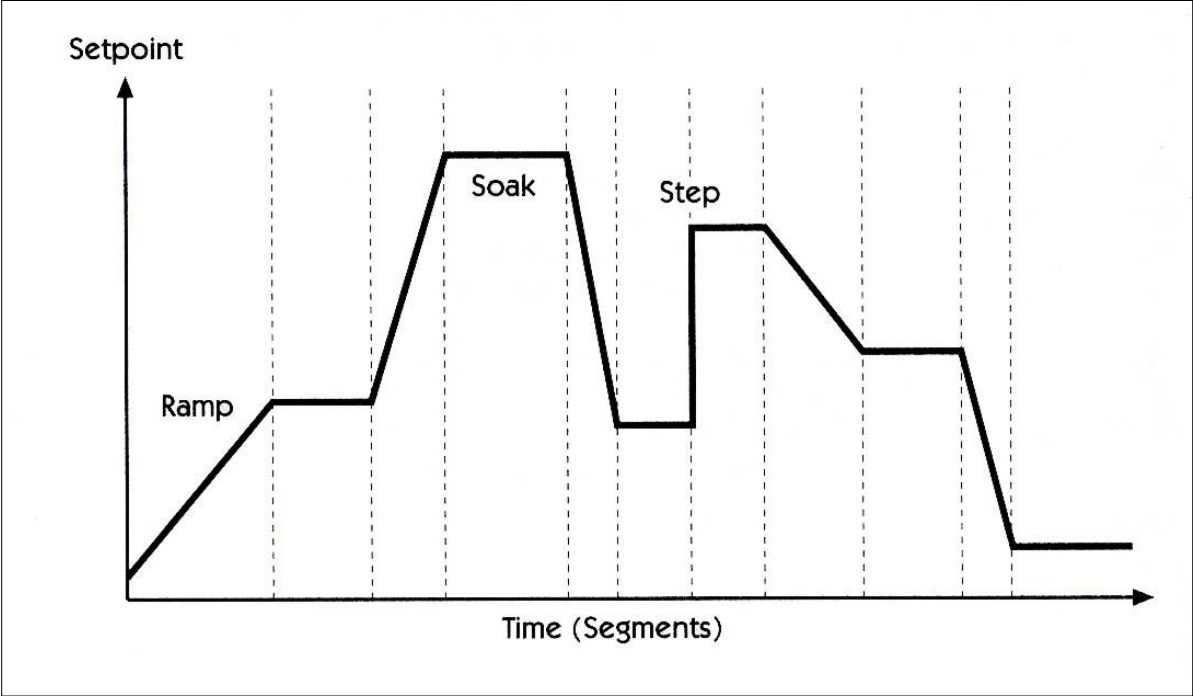

Figure 1.0-2: Example of a ramp/soak cycle

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2.3 Front Panel

2.3.1 Microprocessor Control Module(s)

The PID (Proportional, Integral, Derivative) control is provided by either CAL 3300 or CAL 9500P microprocessor control modules. Section 5.0 describes programming and adjustment procedures. Also refer to the respective CAL manual(s) supplied along with this manual.

2.3.2 Parameter Indicator

The Series 5100/5200 Microprocessor Controller is 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 5.0 and the accompanying CAL manual for programming and adjustment information.)

To identify the process being controlled, a replaceable identification label is inserted behind the clear window in the overlay. This label is normally installed when the controller is ordered, but may be changed by the user if the controller is to be used in a different application in the future.

2.3.3 Function Control ON/OFF Switches

The function control switches, if installed, 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.

1. **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.

2. **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.

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2.3.4 Power Switch

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

2.4 Rear Panel

Refer to Figures 8 and 9 for the location of the rear panel connections for the Models 5100 and 5200 respectively.
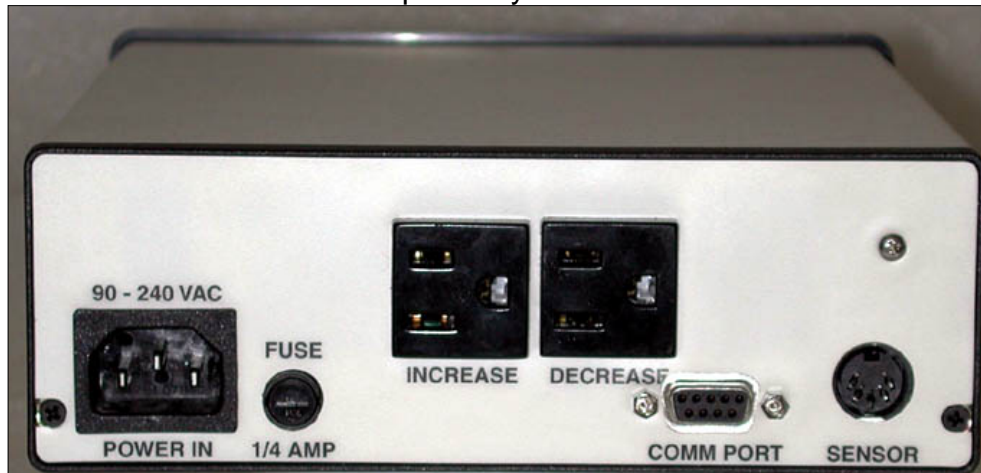

Figure 8 Model 5100 Rear Panel

Figure 9 Model 5200 Rear Panel

2.4.1 Input Power

1. **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.

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

3. **115 / 230 VAC Operation** – The Controller can operate from 90 VAC to 240 VAC, 50/60 Hz.

NOTE

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

4. **Power Fuse** – This is a ¼", 3AG, 250V SloBlo fuse (On earlier models this is 5x20mm, time delay, 400ma, 250V 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.

2.4.2 AC Outlets

There are 2 North American 3-prong AC outlets on the rear panel of the Series 5100 and 4 outlets on the Series 5200 when both control modules are configured for "control". If one of the modules is configured for "measure only" then the additional outlets are not installed.

For 230 VAC operating systems, either the power plugs can be changed or the system can be configured with IEC female power plug receptacles. **Be certain to properly label all modified power cords as 230 VAC.**

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.

1. **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.

For this function, a 3 amp, low leakage relay with 2 amp fuse is installed for generic controllers 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 10 for fuse location.
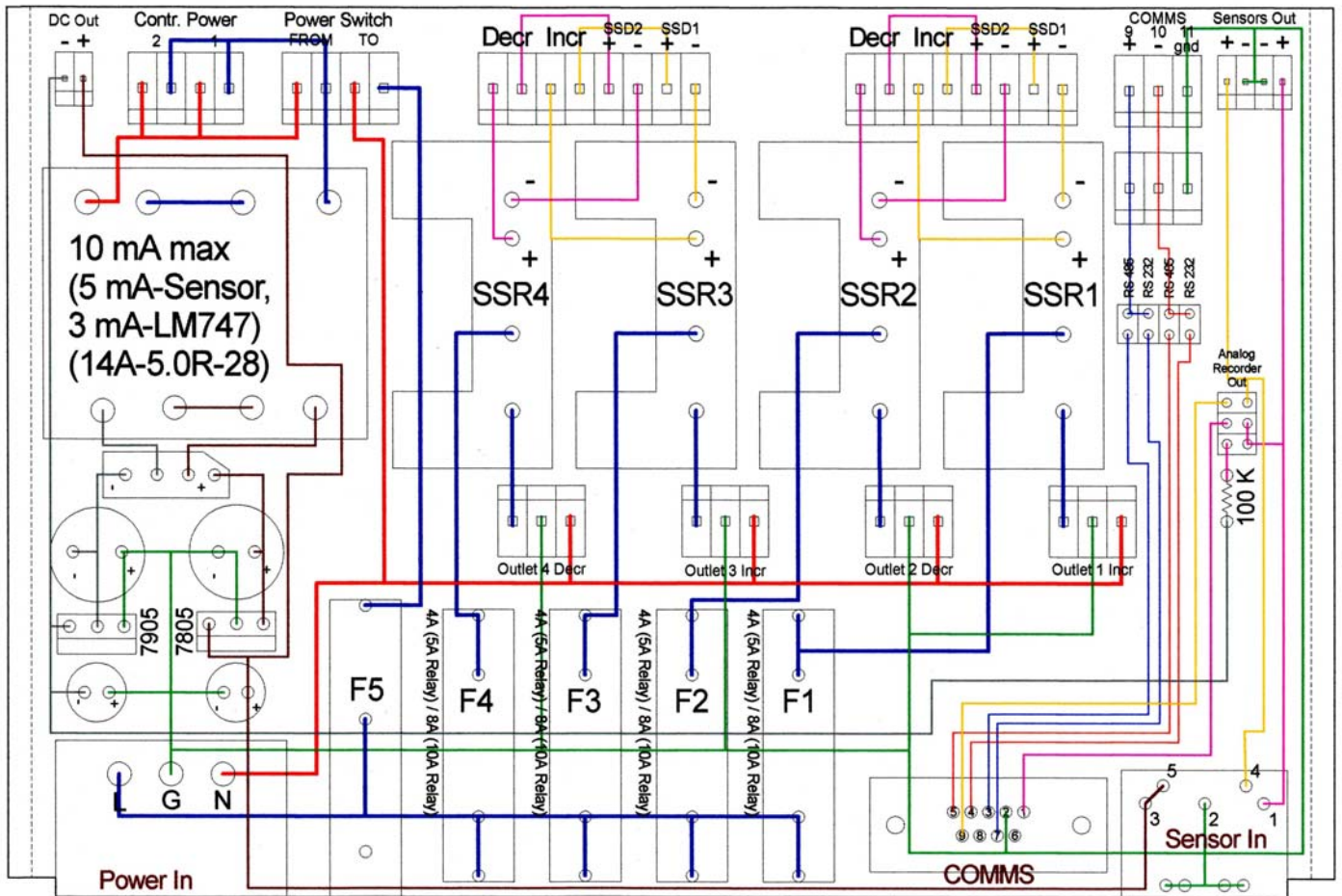
COMMS CONNECTIONS:

RS232:	T_x/R_x	(-) Pin2	(+) Pin3
RS485:		(-) Pin2	(+) Pin7
Analog Left Contr. (RH)(+) Pin1 / Right Contr. (T)(+) Pin9			
Common (Gnd/Shield for Analog & RS485)			Pin4
Common (Gnd/Shield for RS232)			Pin5

Figure 10 Main PCB component 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 power to the operating system through this outlet. The proportional control is delivered as a series of AC power pulses to the unit.

2. **INCREASE** – Proportionally controlled output for controlling 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.

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 power to the operating system through this outlet. The proportional control is delivered as a series of AC power pulses to the unit.

2.4.3 SENSOR Input

The Sensor Input is the 5-pin DIN jack located in the lower right corner of the rear panel.

The input goes through a buffer amplifier when the 3300 control module(s) are installed that is set at the factory to accept a 0-1 VDC input signal. For example, this would correspond to 0-100% RH when used with the ETS Model 554 RH Sensor and 0-100°C when used with the ETS Model 555 Temperature Sensor. When configured with the 9500P the sensor is connected directly the linear input of the control module. Contact ETS if a sensor with a linear output other than a 0-1 VDC output needs to be used. Figure 11 is the pin connections for the SENSOR input connector.
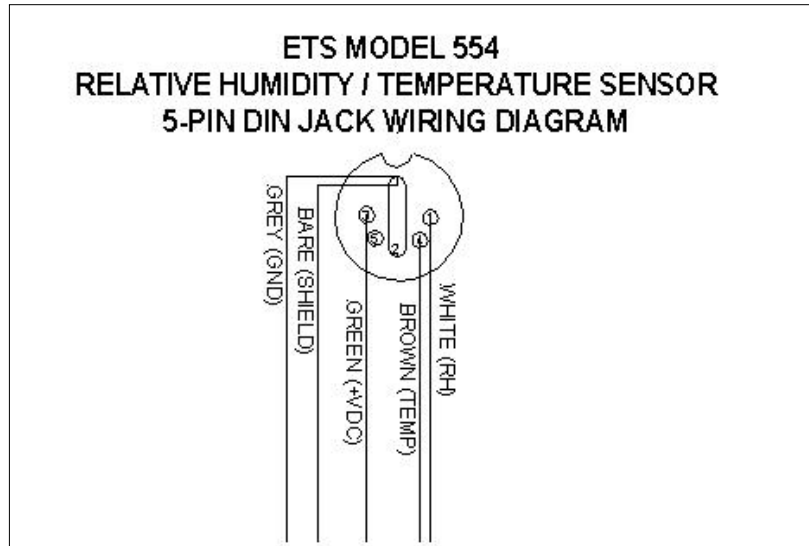
ETS MODEL 554
RELATIVE HUMIDITY / TEMPERATURE SENSOR
5-PIN DIN JACK WIRING DIAGRAM

GREY (GND)
BARE (SHIELD)
GREEN (+VDC)
BROWN (TEMP)
WHITE (RH)

Figure 11 Sensor input connector wiring

2.4.4 COMM PORT

The COMM PORT is the 9-pin subminiature-D jack (sub-D) located to the left of the SENSOR Input jack. It incorporates both the analog signal outputs from the Model 554 and 555 sensors and the RS-232 or RS-485 data link. Analog signals are only available from sensors having a voltage output. 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. There are no analog outputs for thermocouples. Figure 10 shows the pin out for the COMM PORT connector.

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 1.2.1 LEVL 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.

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If using the CALCOMM or CALgrafix software refer to Section 6.0 for set-up instructions.

2.5 Applications Software Option

The Series 5100/5200 Controllers can operate with the either optional CALCOMMS Applications Software or CALgrafix 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.

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 $^®$ 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" and 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.

The COMM PORT is a 9-pin subminiature D connector located on the rear panel. When the RS-485 interface board is ordered, a RS-232/485 converter and 6 ft. (2 m) cable are supplied with the software package.

When just a single controller is to be monitored and is ordered with the RS-232 interface board then just the 6 ft. 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.

The COMM PORT provides an analog signal output when the COMMs option is **not** ordered.

3.0   INSTALLATION

Unpack the Control Unit and Sensor and inspect for visible damage. If no damage is observed then proceed to check out the system as follows:

3.1   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-485/RS-232 converter, connect the converter to the computer serial port.

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 and/or temperature gently breathe onto the sensor. A change in humidity should be observed. 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. For other parameters perform an appropriate check prior to sensor installation.

3.2   Set-Up

3.2.1 Sensor

The sensors should be positioned in such a way that it measures the average gradient of the parameter being controlled within the enclosure. If precise control is required at a specific location then it is best to locate that sensor as close to that point as possible. The sensor should not be placed directly in the flow of the of the operating system output. Good air circulation is paramount for obtaining minimum humidity and temperature gradients within the enclosed controlled environment.

The Model 554 Temperature compensated humidity sensor requires a ¾" compression fitting with a 0.625" (16mm) pass-through hole for mounting through the wall of a chamber.

The Model 554 is a 2-piece unit consisting of the sensor/electronics and the cable/connector assembly. To remove and assemble the sensor/electronics section from the cable assembly refer to Figure 12 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 STAIGHT OUT. <u>DO NOT TWIST THE SENSOR.</u> 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 back in then twist the locking ring only clockwise until the assembly is locked in place.
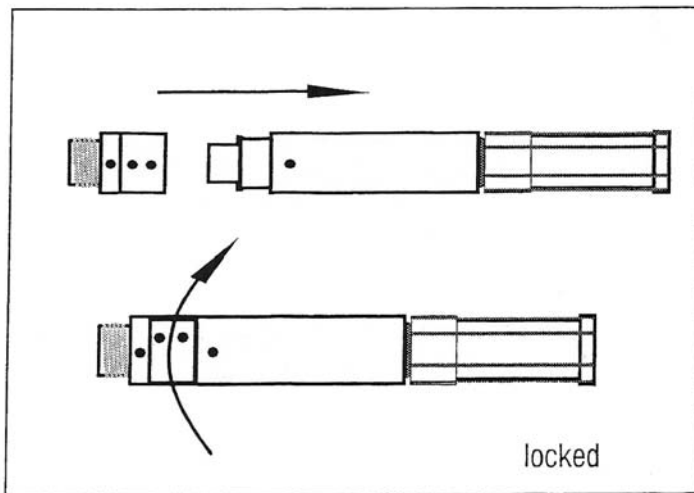
Figure 12: Model 554 Sensor Assembly

The Model 555 Temperature sensor is a single piece unit and requires a ½" NPT compression fitting with a 0.5462" (14mm) pass-through hole for through wall mounting.

These sensors can also be mounted using an adhesive or Velcro backed adjustable clamp.

After the sensors have been installed make sure they are tightly sealed around the opening to prevent air leakage.

ETS Series 500 Controlled Environment Chambers are already provided with appropriate fittings.

3.2.2 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. For other parameters plug the appropriate operating system into the respective AC outlet.

4.0 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 5.0 provides programming the user can perform to optimize the measurement and control of the respective parameter.

4.1 Set Point Adjust

1. 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.

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

3. Release the "∗" button.

4.2 Increase

This mode controls an operating system that increases the desired level such as temperature, humidity, gas, pressure etc. To operate in the Increase mode proceed as follows:

1. Read the respective operating system instructions.

2. The operating system should be plugged into the "INCR" outlet.

3. Adjust the set point to a value above ambient conditions.

4. If the controller is configured with the INCR/DECR function switches turn on the "INCR" switch on the front panel. If these

switches are not installed, power to the outlets are controlled solely by the microprocessor

This will not automatically apply power to the "INCR" outlet. Turning on the "INCR" switch only makes the outlet *available* to the Microprocessor 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.

5. 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   Decrease

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

1. Read the operating instructions for the operating system being used to decrease the respective parameter.

2. The operating system should be plugged into the "DECR" outlet.

3. Adjust the set point to a value below the ambient parameter level.

4. If configured with the INCR/DECR function switches turn on the "DECR" switch on the front panel.

6. This will not automatically apply power to the "DECR" outlet. Turning on the "DECR" switch only makes the outlet *available* to the Microprocessor Controller. If these switches are not installed, power to the outlets are controlled solely by the microprocessor

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

5. 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

5.0 PROGRAMMING THE MICROPROCESSOR CONTROLLER

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. For controllers configured by ETS to control other parameters an addendum sheet is included to assist the user in optimizing the controller for the specific application.

Programming the 3300 and 9500P control modules are similar. The FUNCTIONS MENU, LEVL's 1, 2,3, 4 and C are identical. The 9500P has additional LEVL's A (scaling) and P(ramp/soak programming). Where programming the 3300 differs from the 9500P both sets will be identified and included below.

5.1 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, see 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.	The factory-programmed values listed here are optimized for a nominal 10 cu.ft. acrylic enclosure having approximately 100 cfm air circulation located in an area having normal ambient conditions and using operating systems similar to the ETS Model 5471 Desiccant/Pump Dehumidification System and ETS Model 5472 Ultrasonic Humidification System, and the ETS Model 5463 Liquid CO_2 Cooling System and the ETS Model 5474 500 Watt Heating System. Other sensors and/or systems may require different settings.

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

5.2 Optimizing Controller Programming

5.2.1 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.

5.2.2 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 systems having a limited mode of operation.

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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 ±2%, depending on the specific conditions). However, as the user becomes familiar with each parameter and it's effect on system control, the user will be able to program the unit to control to within ever tightening tolerances. Control of ± 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 decent 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 determines 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.

To program the 9500P for multiple ramp/soak applications refer to pp. 11-18 of the 9500P Users Manual.

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 <u>only</u> 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.

> <u>For humidity</u>
> :
> **SET.2 – (0.0)**
>
> <u>For temperature:</u>
>
> **SET.2 – (0.0)** This setting allows the user to create a set point offset for the cooling system. For the gas Cooling System, the **bnd.2** should always be **0.0**, therefore, the **SET.2** should always be **0.0**. If a thermoelectric or refrigerated cooling system is used this setting may be increased or decreased to determine the point at which the cooling system will activate. These systems are operated in the ON/OFF mode instead of within the proportional band. Cooling control is best obtained by operating these cooling systems continuously 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)

5.2.3 LEVL 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 beforehand.

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) Subsidary **SP2** mode: latch/sequence. Non-linear decrease proportional band.

5.2.4 INPUT SELECTION AND RANGING *The following settings are used to calibrate the input for sensors having a linear voltage output equivalent to 0-100% of the measuring scale. The internal buffer amplifier converts the 0-1V signal to 0-50mV when configured with 3300 control modules. The 0-1V signal is converted directly in the 9500P.*

diSP – (0.1) Select display resolution.

hi.SC – (100.0) Sets sensor full scale.

Lo.SC – (0.0) Sets sensor minimum.

inPt – Selects a linear input voltage setting.

(Lin 1) - Selects sensor input voltage range, 0-50mV for 3300 control module

(Lin) Select linear input voltage range, 0-5V max for 9500P control module.

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

For 3300 control modules

In **Levl 2**

Units – Change from °C to °F

hi.SC – set to **212**

Lo.SC – set to **32**

In **Levl 3**

ZEro – set to **32**

For 9500P control modules

In **Levl 2**

Units – Change from °C to °F. Hi and Lo scales are automatically changed in the 9500P

In **Levl A**

An.hi Set to **212.0**

An.Lo Set to **32.0**

For both 3300 and 9500P control modules

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, and in the case where it is not available in the control module program, defines the parameter. For parameters other than those listed above select the **SEt** setting. The

only parameter indication will then be the label on the front panel.

5.2.5   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 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

For 3300

(-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.**

<u>For 9500P</u>

SPAn and Zero are calibration settings programmed at ETS. Do Not Change

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.

5.2.6   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.

6.0 COMPUTER SOFTWARE

Two computer software programs are available for the Series 5100/5200 Controllers, CALCOMMS and CALgrafix. CALCOMMS software is recommended for most applications when control, monitoring, charting and data logging are desired and the controllers are fitted with 3300 control modules.

CALgraphix software is recommended when more comprehensive control, charting, ramp/soak programming, audible/visual alarming and networking are desired. It is recommended when the above features are required and the controllers are configured with 9500P control modules.

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

6.1 General

CALCOMMS is a graphic Windows™ 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® 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 OK), 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 are wired in parallel by the user as shown in Figure 13 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.
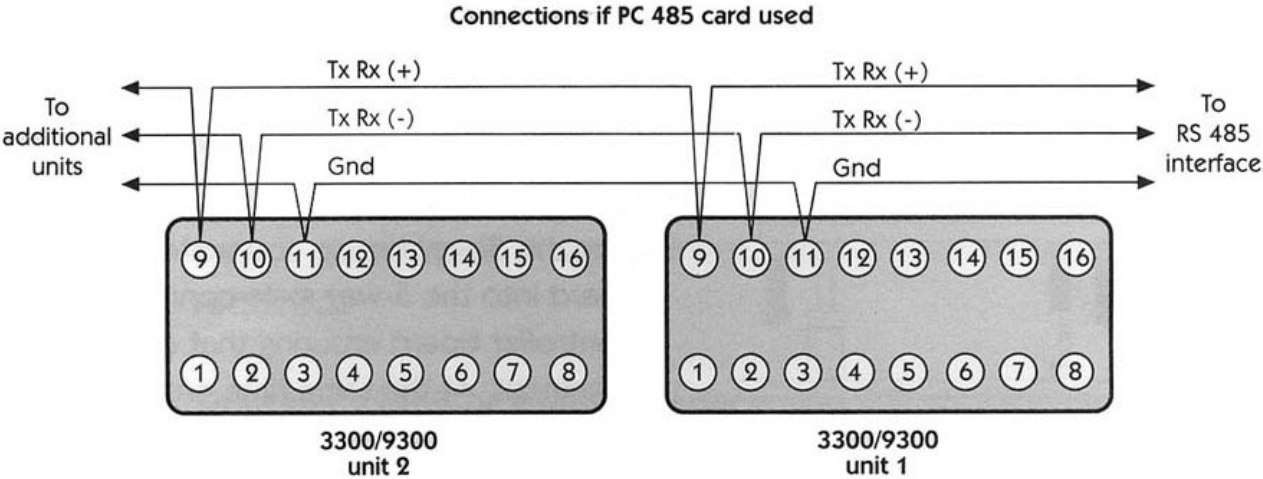

Figure 14 Multiple controllers RS-485 data link wiring

6.1.1 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

6.1.2 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 it's 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.

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

The RS-485 link uses pin **7** (T_x/R_x [+]) and pin **2** (T_x/R_x [-]) with pin **4** connected to ground (shield).

Refer to Figure 10.

6.1.2 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.

The converter is a 25-pin/9-pin in-line style connector.

<u>NOTE</u>
Converters from different manufactures may have different pin out configurations. The Series 5100/5200 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<u>&B Electronics Model 485SD9R.</u>

The other adapter included is a 25-pin/9-pin straight-through adapter.

6.1.3 Connections

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

2.   Connect the other end of the cable to the ▼RS485▼ side of the RS-232/485 converter. For RS-232, connect this end directly to the computer.

5   Connect the ▲RS232▲ side of the converter into the appropriate COMM Port on the PC. Use the 25/9-pin adapter if necessary.

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 3300 and 9500P Users Manuals. It is the manual with the color cover.

6.2   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.

6.2.1 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.

6.2.2 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.

6.4   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 <u>support@cal-controls.co.uk</u>**.**

7.0   CALIBRATION

As with all measuring instruments, the Series 5100/5200 Controllers should be calibrated periodically. Generally, this is usually performed at least once a year. ETS provides full calibration services for these instruments. Either NIST or Mil Std. Calibration can be performed and issued with the appropriate certificate of calibration.

The Model 554 Temperature Compensated Humidity Sensor can only be calibrated at the factory. It requires calibrated environments plus appropriate computer software. **This sensor cannot be calibrated manually.** Contact ETS to obtain the necessary RMA authorization.

The Model 555 Temperature sensor is an integrated circuit device with a voltage output of 1 mV/°C (1 mV/1.8°F). The sensor has a design accuracy of ±1°C. Readings outside this tolerance require replacement of the device. It is recommended that the user return the controller and sensor to ETS for recalibration certification.

Thermocouples are devices that cannot recalibrated. However, the control modules are designed to operate with thermocouples directly. The respective control module operating manual describes the procedure for calibrating a thermocouple measuring system.

8.0 MAINTENANCE

The Series 5100/5200 Controllers should operate reliably for many years without any maintenance, except for periodic calibration, if used with operating systems compatible with the AC output. The controllers contain very few user replaceable parts. Those parts that can be replaced by the user are as follows:

1.   Control Module – 3300
2.   Control Module – 9500P
3.   Solid State Relays – 3, 5 or 10 amp
4.   Fuses: ¼", 3AG SloBlo - 3/8, 2, 4 or 8 amp (5x20mm, 400 ma, 250V, Time Lag on earlier models)
5.   Power, Function ON/OFF Switches
6.   AC Outlets

Except for the 3/8 amp fuse all components are located internally. To gain access to the inside of the enclosure refer to Figure 14 and proceed as follows:

1.   Remove the front panel assembly by first removing the two (2) black screws that secure the front panel and bezel to the housing (14a.).
2.   After the front panel assembly is clear of the housing slide the top cover forward approximately 1" (2.5 cm) (14b).
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 14c.
5.   Replace by spreading the cover and snapping it back into the grooves.
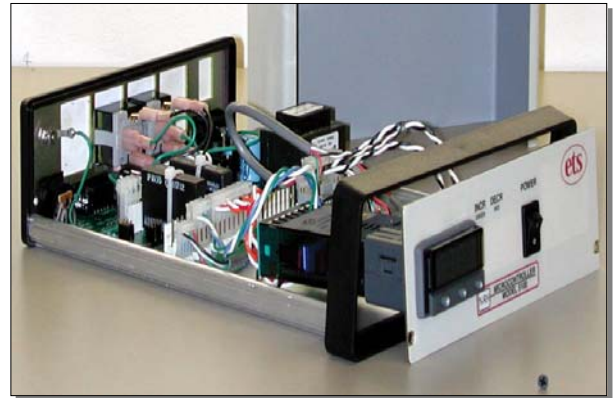
a.   b.

c.   d.

Figure 14 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 relay (they are plug-in) 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.

1/26/04

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
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.