



# EZT-560

*Environmental Chamber Controller  
User's Manual*



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## 1. Overview

This manual has been tailored to cover all of the specific features and options available on the EZT-560 environmental chamber controller. Note that all options and/or features may not be available for your particular chamber. It is highly recommended that you read this manual thoroughly and understand all aspects of the EZT-560's operation prior to operating your chamber.

### 1.1 Safety Information

Note, caution and warning symbols that appear throughout this manual are to draw your attention to important operational and safety information.

A **“NOTE”** marks a short message to alert you to an important detail.

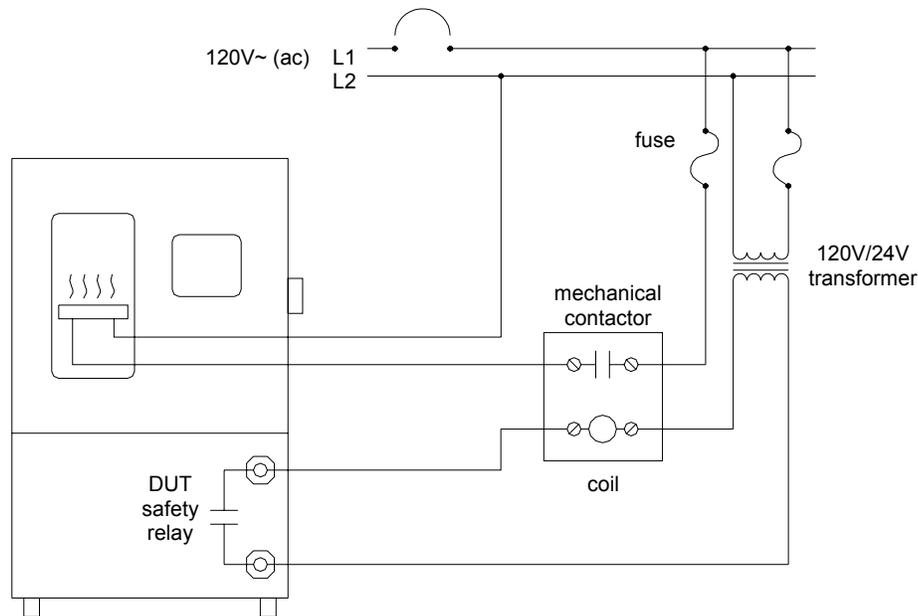
A **“CAUTION”** safety alert appears with information that is important for protecting your equipment and performance.

A **“WARNING”** safety alert appears with information that is important for protecting you, others and equipment from damage. Pay very close attention to all warnings that apply to your chamber.

#### **Device Under Test (DUT) Protection**

The environmental chamber is equipped with high heat limits and/or safety devices. These devices are installed to protect the chamber from exceeding design limits. These devices remove power from the chamber's heaters ONLY and DO NOT remove power from the device under test.

Provisions must be made by the end user to de-energize the tested device in the event of an over-temperature condition. For this reason, the chamber is equipped with a DUT safety relay that should be connected to the device's power supply control circuit at a minimum. This relay will open and de-energize the device under test to prevent a runaway thermal condition whenever the chamber is not operating. See wiring example below:



**Figure 1-1 DUT Safety Connections**

## **1.2 About the EZT-560**

The EZT-560 Environmental Controller is a DCS (Distributed Control System) which uses different hardware layers to perform the various functions needed to operate the chamber including user interface, system monitoring and protection, as well as process control. This type of platform allows for more flexibility in chamber design while providing a high level of reliability and control accuracy.

The heart of control is performed by individual Fuzzy PID controllers, one for each process. This allows for the utmost in performance by providing a separate processor for each loop. The process controllers utilize the latest technology with built-in adaptive tuning. This means that the process controllers continuously monitor the operation of the chamber and adjust their control parameters to achieve the most stable control possible without any user intervention. Adjusting PID parameters is a thing of the past.

The chamber's systems and components are monitored and controlled by the core CPU of the EZT to insure that limits are not exceeded and profiles are executed precisely. The chamber is protected from adverse operating conditions without the need for user intervention or knowledge on system operation.

The user interface provides local operator control and monitoring of the system. It can track all user actions with its built in security module as well as log process information and store it for later use. Together, the system components form a complete SCADA (supervisory control and data acquisition) system for total chamber management.

The graphic displays shown in this manual are representative of typical chambers. The screens may vary slightly based on options present on your chamber.

### 1.3 Touch Screen Interface

The EZT-560 display is divided into three main sections; the menu bar, main display area and detail window.

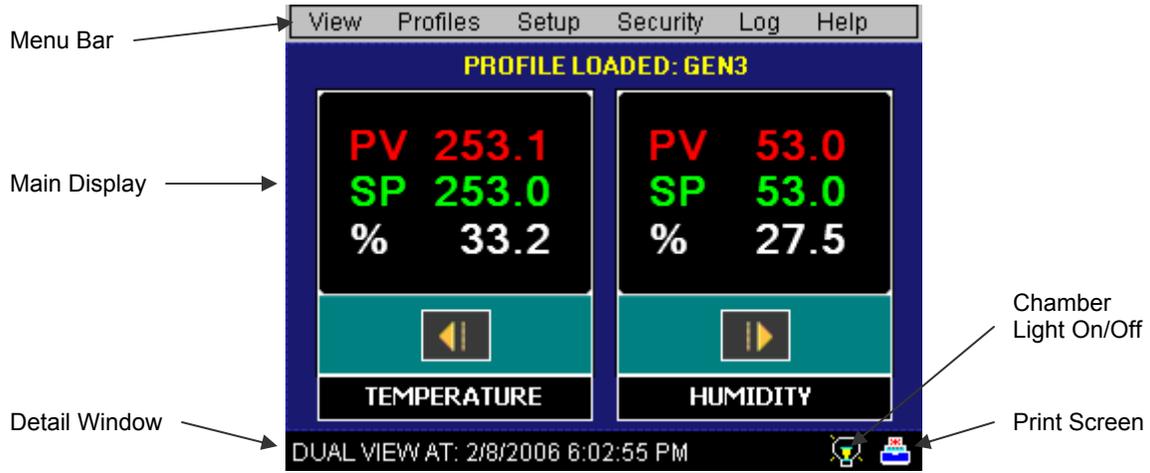


Figure 1-2 Touch Screen Interface

**Menu Bar:** Used to navigate through the available monitoring and control screens.

**Main Display Area:** Contains the active items for the menu item selected.

**Detail Window:** Provides display specific information.

Note that there are two special control icons located at the lower right corner of the screen in the detail window.

**Light Icon:** Turns the interior chamber lighting on and off.

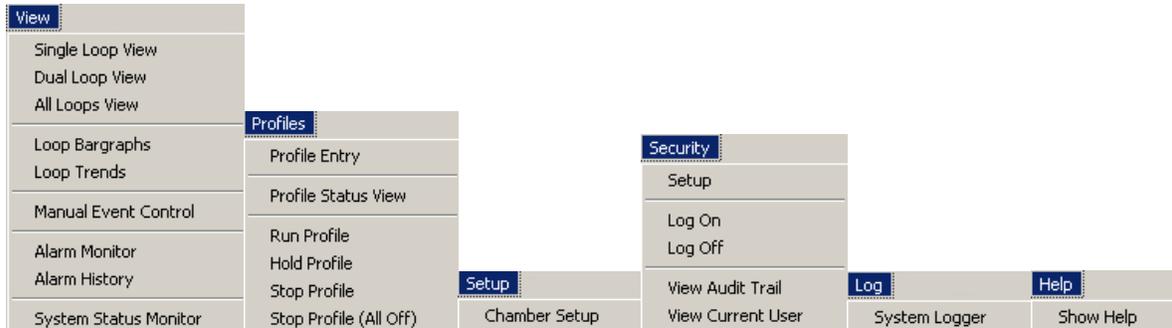
**Printer Icon:** Prints the currently displayed screen to an **HP 6540, 6940 or 6980** color printer connected to the controller's USB port (see Section 1.4 Print Features).

To select items on the display, simply touch the desired text or numerical entry item. Do not use any sharp or metal objects on the touch screen as they may damage the surface. For detailed information regarding the different screen elements and their use, see the following sections.

### 1.3.1 Menu Navigation

The EZT-560 display provides the user with an intuitive interface for navigating through the different menus and settings without having to go multiple levels deep in screens like other “button style” systems. The EZT-550 provides a “Windows” like feel with drop down menus and online help at all times. This section of the manual provides an overview of the menu items and structure.

#### Main Menu (default on power-up)



**Figure 1-3 Main Menu Navigation**

#### View Menu

The “View” menu provides navigation to all standard view screens. These include loop view, bargraph, trend, alarm monitor and alarm history operation screens.

#### Profiles Menu

The “Profile” menu provides access to the profile editing and monitor screens. From these screens a user can open, save, edit, delete and run profiles.

#### Setup Menu

The “Setup” menu provides access to system and controller setup options.

#### Security Menu

The “Security” menu provides access for user logon as well as audit trail viewing if the security system is enabled with users and the proper security rights.

#### Log Menu

The “Log” menu provides access to data log functions and the historical data viewer.

#### Help Menu

The help menu provides simple help regarding settings and use of screen parameters.

**Profile Menu**



**Figure 1-4 Profile Menu Navigation**

Views Menu

The “Views” menu provides navigation back to the main menu and the profile view screens. These include profile status, profile entry, soak limits, autostart and plot profile screens.

Edit Menu

The “Edit” menu provides all of the functions needed to open, create, edit and save profiles.

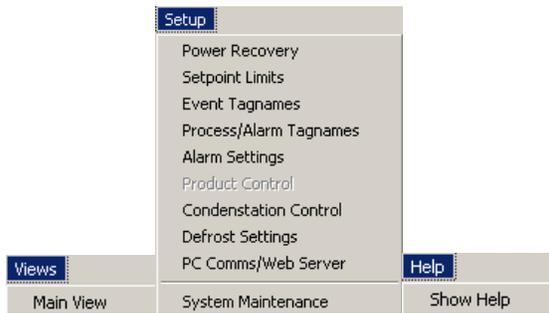
Log Menu

The “Run” menu contains the profile control selections such as run, hold and stop.

Help Menu

The help menu provides simple help regarding settings and use of screen parameters.

**Setup Menu**



**Figure 1-5 Setup Menu Navigation**

Views Menu

The “Views” menu provides navigation back to the main menu screen.

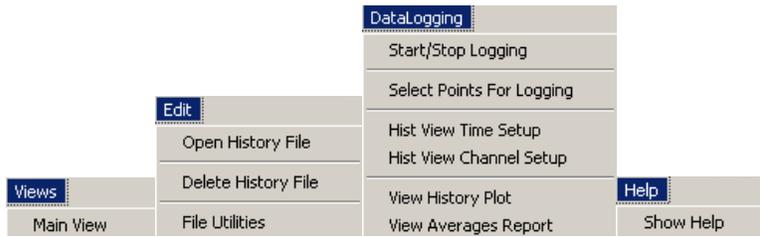
Setup Menu

The “Setup” menu provides access to the EZT-560’s setup screens and the link to the offline system maintenance area.

Help Menu

The help menu provides simple help regarding settings and use of screen parameters.

**Logging Menu**



**Figure 1-6 Logging Menu Navigation**

Views Menu

The “Views” menu provides navigation back to the main menu screen.

Edit Menu

The “Edit” menu provides access to the history files and the EZT-560 file utilities.

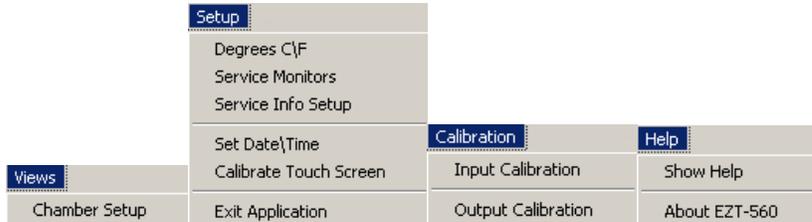
DataLogging Menu

The “Datalogging” menu provides access to the logging setup and historical file viewing utility.

Help Menu

The help menu provides simple help regarding settings and use of screen parameters.

**System Maintenance Menu**



**Figure 1-7 System Maintenance Menu Navigation**

Views Menu

The “Views” menu provides navigation back to the online setup screens.

Setup Menu

The “Setup” menu provides access to the service monitors and system settings.

Calibration Menu

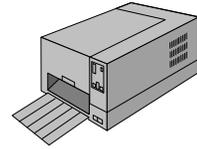
The “Calibration” menu provides access to the input monitor calibration offset and analog output calibration.

Help Menu

The help menu provides simple help regarding settings and use of screen parameters.

### 1.4 Print Features

The EZT-560 interface will print a variety of graphic, trend and textual reports. It can be connected to a standard “USB” inkjet printer (HP model 6540, 6940, 6980) via the standard USB host port provided on the chamber. No drivers are necessary, operation is “plug and play”. Note that the USB port can be used for “I-Stick” data backup and printing by “hot swapping” at any time during the EZT-560’s operation.



The EZT-560 will alert the user to any problems during the print operation. After a print error (printer not connected or bad cable), the EZT-560 will return to its normal operation after alerting the user. The EZT-560 interface might change colors during printing to prolong ink cartridge life (blue backgrounds require more ink than white backgrounds). The EZT-560 interface will be “locked” until the print function is complete and then return to normal operation.

**Important:** When using the HP 6940 or 6980 DeskJet printers, the printer’s USB cable must be plugged into the EZT-560 interface after the EZT-560 is powered up and in “normal” operating mode, and the printer is powered up and ready for printing (neither device should be in startup mode).

When the USB cable is connected to the USB port, the following dialog will appear on the EZT-560 display (each time the printer cable is plugged in).



**Figure 1-8 Print Driver Notification**

Press the “X” at the top right of the dialog box and the dialog will disappear. The printer is now ready for printing text or graphics from the EZT-560 interface. This dialog will not appear again unless the printer cable is disconnected and then re-inserted into the EZT-560 “USB” interface connection.

The print driver in the EZT-560 interface provides standard “USB” printing using “PCL 3” language support. Since printer models change so often, many manufacturers add features to new models of printers. To take advantage of these new features (Ethernet connectivity, etc.), each manufacturer supplies driver disks for different Windows “OS” versions. Since the EZT-560 is an embedded device (no hard disk or moving parts), installation of these drivers is not required. The dialog box appears due to the additional functionality the USB printer is transmitting to the EZT-560 interface. Pressing the “X” at the top of the dialog instructs the EZT-560 interface to ignore the advanced printer features and skip the installation of any print drivers that are not applicable to operation with the EZT-560.

## 2. Monitoring

The chamber view screens provide various means of verifying chamber operation and performance. The displays are accessed from the main menu under "View".



### 2.1 Loop Views

The loop screens provide different viewing options for the control and monitoring of chamber processes such as temperature, humidity, altitude, etc. The loop screens allow you to adjust the current set points (SP) and view the process variables (PV) and percentages of output (%) for each loop. The set points can be modified from these screens by touching the set point field. Upon selecting a set point, the pop-up numeric entry pad will appear from which the set point can be entered. However, if a profile is active, the set point fields are locked out from user adjustment. If the loop is monitor only, the set point and percentage of output will not be displayed since no control is associated with the input.

#### 2.1.1 Single Loop View

The single loop view display shows one control loop or monitor input at a time. The auto-tune feature is accessible from this screen.

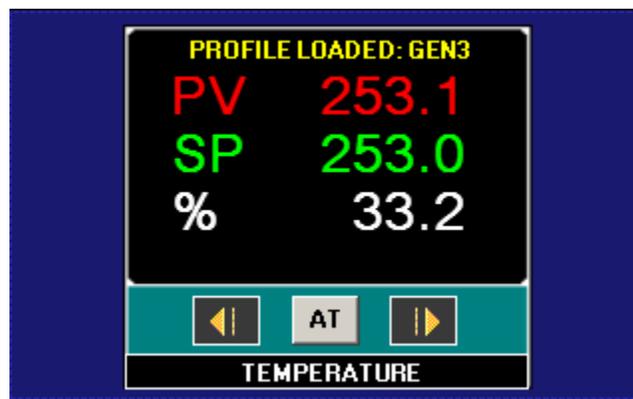


Figure 2-1 Single Loop View

**2.1.2 Dual Loop View**

The dual loop view display shows two control loops or monitor inputs at a time. It provides a large standard display for control of both temperature and humidity, common on most environmental test chambers.

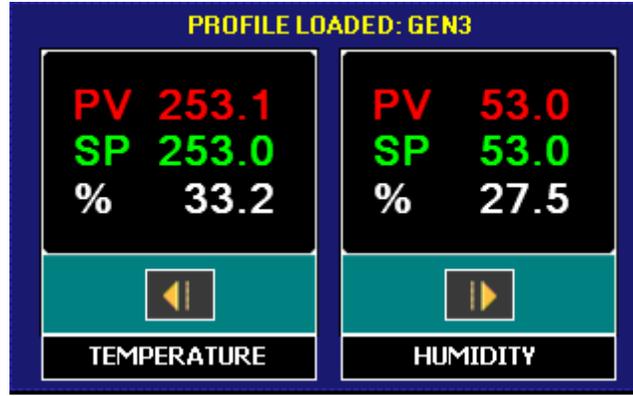


Figure 2-2 Dual Loop View

**2.1.3 All Loops View**

The all loops view display shows all available control and monitor inputs available on the chamber in a tabular format. From this view all setpoints, process variables and output percentages can be monitored at a glance.

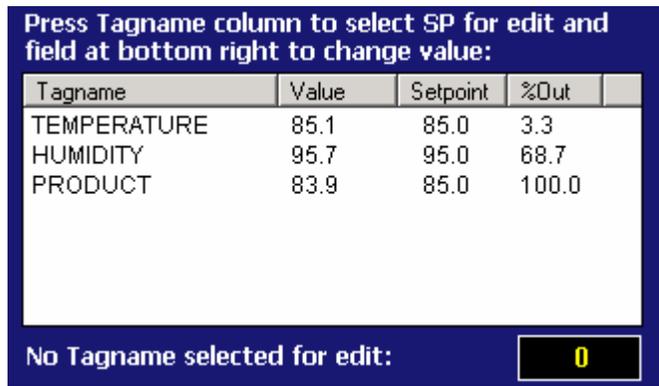


Figure 2-3 All Loops View

The set point entry field is located at the lower right of this screen. In order to modify a loop's set point, select the loop by touching its tagname field in the table. The loop's set point will then be available for edit. Touch the edit field in order to enter the new set point.

## 2.2 Graphing

There are two available graph formats for viewing each loop and monitor input of the EZT-560. These include a process bargraph display and a time trend display. Each loop and monitor input has its own bargraph and trend with individual display settings.

### 2.2.1 Loop Bargraphs

The bargraph display shows three individual bars representing the set point (SP), process variable (PV) and percentage of output (%). If the loop is a monitor loop, the set point and percentage of output will remain at the minimum range of the bargraph since no values are associated with these on a monitor input. The range of the set point and process value bargraphs can be changed by adjusting the "Lo" and "Hi" limits and pressing the "Set" button.

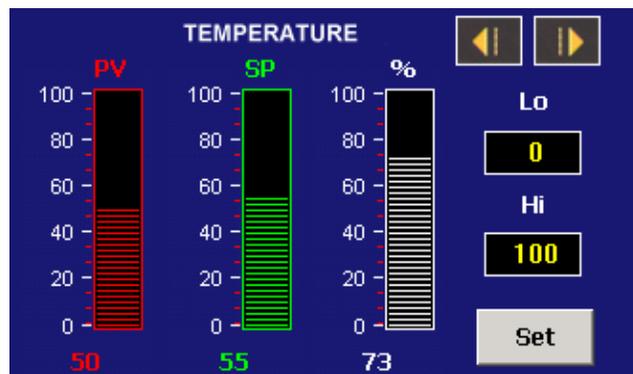


Figure 2-4 Loop Bargraph

### 2.2.2 Loop Trends

The loop trend can display the set point (SP), process variable (PV) and percentage of output (%) history over a period of time. The vertical axis determines the range of displayed data while the horizontal axis determines the history period. The maximum time period that can be shown in the trend is 4 hours.

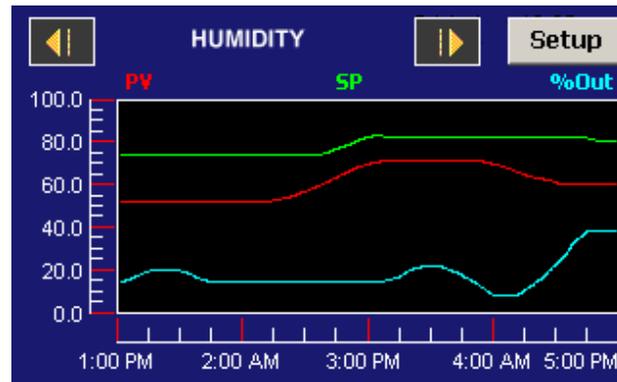


Figure 2-5 Loop Trend

The trends on the EZT-560 have a unique drag-n-zoom feature. By using your finger to select an area on the screen, the trend will zoom in on that area. To select a portion of the trend, touch and hold the screen with your finger. Drag your finger across the trend and a box will be drawn around the area. Removing your finger from the screen will cause the trend to redraw the trend with the selected area. To return to the normal view, touch the "x" or "y" axis and select zoom normal.

### ***Trend Setup***

To adjust the displayed variables, range and history period, touch the “Setup” button in the upper right corner of the trend display. The Trend Setup screen will appear with the available adjustment controls.



*Figure 2-6 Trend Setup*

### ***Trend Zero***

The zero value sets the minimum range of the vertical access for the trend variables.

### ***Trend Span***

The span value sets the maximum range of the vertical access for the trend variables.

### ***Time(Mins)***

The time interval is in minutes and adjusts the displayed time period for the trend. The allowable range is from 4 to 240 minutes (4 hours).

### ***Trend Points***

To adjust what items are shown on the trend, select/deselect the desired items by touching the check box next to the variable.

Press the “Done” or “Cancel” button to return to the trend screen. Any adjustments made when the “Cancel” button is pressed will be disregarded. Each time a trend setup is changed, the trend will fill with previous history and then operate in “real time” mode with the current settings.

### 2.3 Alarm Monitor

The alarm monitor screen displays any current and/or previously silenced alarms according to time and date of occurrence. On each new alarm occurrence, The EZT-560's screen background will turn red to notify the user of a new alarm. Once the alarm is silenced, the screen background will revert to the standard blue background; however, the alarm may still be present. The chamber will not restart until all alarms have been silenced and the alarm condition has cleared.

If the chamber does not restart upon silencing of the alarm, verify that all manual reset safeties have been reset and the alarms have been cleared by pressing the "Clear" button. This will remove all alarms from the list. If the alarm is still present, the alarm will not clear. See section 10, Diagnostics, for alarm codes and corrective actions.

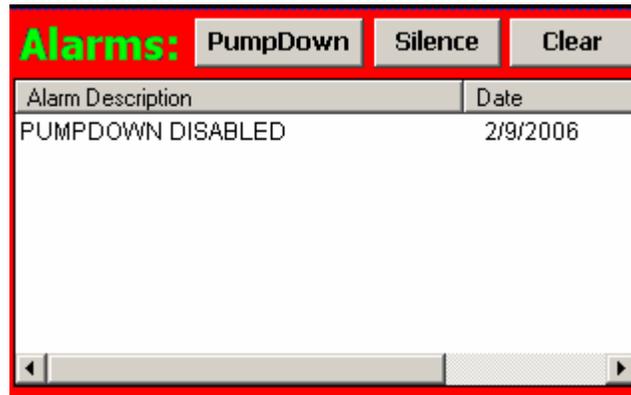


Figure 2-7 Alarm Monitor

#### Pumpdown

Chambers with large horsepower refrigeration systems have an automatic mode of operation called "pumpdown". The refrigeration system is in this mode whenever it is not running. In pumpdown mode, the system 1 compressor will automatically turn on and off at preset pressures in order to force the refrigerant into the high side of the system. This serves as a means to protect the compressor on start-up. If pumpdown was not used, refrigerant could migrate throughout the system and accumulate, typically in the coldest location like the compressor crankcase. On start-up, this refrigerant could enter the compressor as a liquid and cause permanent damage to the compressor. In addition, a crankcase heater is installed on the compressor and is energized when the compressor is not running. This heats the oil in the crankcase of the compressor and boils out any refrigerant, so that it can be pumped into the high side of the system.

If the chamber is equipped with the pumpdown mode of operation, the "Pumpdown" button will be provided on the Alarm Monitor screen. This provides a manual way to reset pumpdown mode. Pumpdown will be automatically disabled if main power is off for more than 30 minutes. This is due to the fact that without main power, the crankcase heater will be off and can not warm the compressor. Depending on the temperature of the compressor, this could allow refrigerant to accumulate in the compressor causing a potentially damaging start-up.

The "Pumpdown Disabled" alarm will notify the operator of this condition. The chamber will not operate when pumpdown is disabled. Pumpdown will automatically reset after the main power has been on for a period of 4 hours or it can be immediately reset by pressing the "Pumpdown" button.

### 2.4 Alarm History

The alarm history screen provides easy access to historical alarm data. To access an alarm file, press the "Open File" button on the upper right corner of the display. Select the desired alarm file from the list and press "Open". All alarms that occurred on that date will be displayed in the list box.

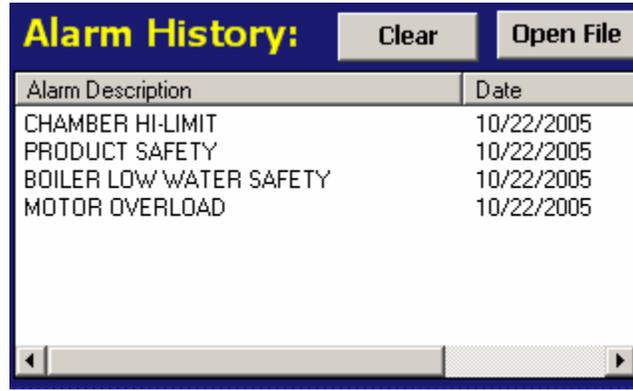
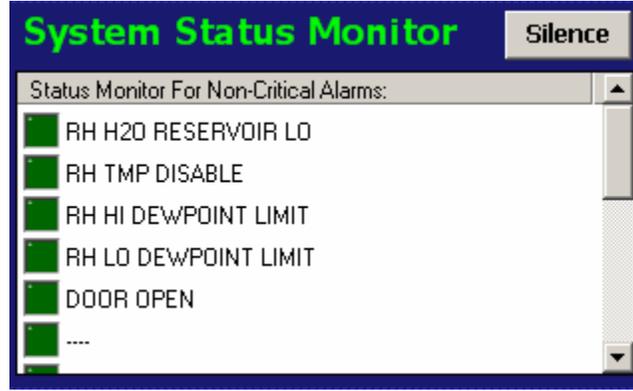


Figure 2-8 Alarm History

To clear the alarms from the list box, press the "Clear" button. Do this to refresh the display prior to opening another alarm file. All alarm files are stored by day using the day's date for the file name. Thus, a new file will be created every day in order to store any alarms for that day. If no alarms occurred on a given day, an alarm file will not be created for that day.

## 2.5 System Status Monitor

The system status monitor provides non-critical alarm information or alerts to indicate specific operational conditions or limits that have been reached in the chamber's operation.



*Figure 2-9 System Status Monitor*

Non-critical alarms and alerts that require operator attention will be indicated by an intermittent beeping of the chamber's audible alarm. This alert can be silenced through the use of the "Silence" button. See section 10, Diagnostics, for alarm codes and corrective actions.

### 3. Single Set Point Operation

The EZT-560 controller can function as either a static set point controller or as a profile controller. The EZT-560 is in static mode (single set point operation) when it is not running a profile. This section describes how to operate the chamber in this mode.

#### 3.1 Single Set Point Adjustment

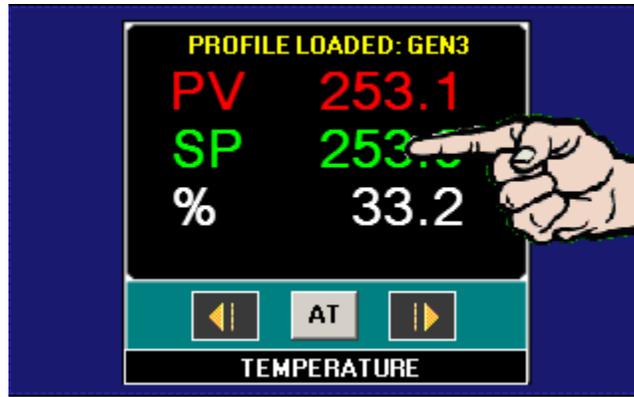


Figure 3-1 Single Set Point Adjustment

To adjust the set point:

- 1.1.1. Select one of the loop views from the main View menu.
2. Input the set point temperature.

Press the numeric display for the set point (SP) for temperature. The set point adjust keypad will pop up on the screen. Enter the desired set point value and press the “Done” button.

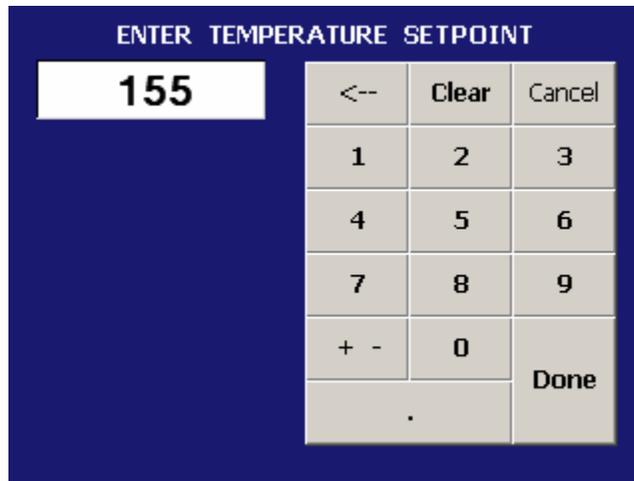


Figure 3-2 Numeric Entry

3. Turn the Chamber event on to start the chamber, see section 3.2 below.

### 3.2 Manual Event Control (Chamber On/Off)

Events are the “switches” used to turn the chamber, its related functions and optional systems on and off. These events can be manually turned on and off as well as programmed into profiles so that they can be turned on and off at set time intervals.



Figure 3-3 Manual Event Control

To turn the chamber and optional events on/off:

1. Select the “Manual Event Control” from the main View menu.
2. Select the events you wish to turn on by checking the check box next to each event in the list box. To turn off events, de-select the check box next to the event.
3. Press the Update button to set the new event status. Note that the events will not turn on or off until the update button is pressed.

#### 3.2.1 Standard Chamber Options

The first event is the “switch” that turns the chamber on and off. This will enable air circulators, pumps, heating/cooling systems and any other components associated with the operation of the chamber. This event is present on all chambers. Depending on the options provided with your chamber, additional events may also be present.

##### 3.2.1.1 Humidity

The humidity event turns the chamber’s humidity system components on and off. Note that when humidity is turned off, the relative humidity is still measured and displayed; however, no control takes place to obtain the target set point. The humidity system will not operate unless the chamber event is also turned on.

#### NOTES on humidity system operation

##### Temperature Extremes

When operating your environmental chamber at extreme air temperature set points, below freezing (0°C / 32°F) or above boiling (100°C / 212°F), the chamber is not capable of controlling humidity. This is due to the physical properties of air and its ability to hold moisture at standard atmospheric pressures when at these temperatures.

To prevent malfunction or damage to the chamber, the EZT-560 control system automatically disables the humidity system components when outside of the valid operating temperature range. The event will remain on; however, so once the air temperature within the chamber returns to valid operating temperatures, humidity control will resume at the target set point.

When humidity is disabled due to the chamber air temperature, the corresponding System Status Monitor indicator will illuminate to indicate that this condition is present.

#### Minimum Humidity Limitations

The standard humidity option provides a lower limit of humidity control relating to a 4.4°C (40°F) dewpoint. The dewpoint refers to the temperature at which the air contains the maximum amount of moisture it can hold. When a surface drops to that temperature or below, condensation will occur on that surface. The dewpoint varies logarithmically with temperature and relative humidity. This means that at higher temperatures, a much lower humidity level can be obtained because the air can hold more moisture the warmer it becomes.

For example, an air temperature of 85°C (185°F) and relative humidity of 12%, is the equivalent dewpoint of air at a temperature of 5°C (41°F) and 79%. Both of these values are at the minimum achievable dewpoint of the chamber, and thus the minimum achievable humidity at the related temperature. If you were to set the humidity set point at 0% for example, the humidity level would never reach 0 since the chamber is not capable of removing any more moisture from the air.

The EZT-560 is programmed to determine what the minimum achievable humidity point is at any given temperature and will control to that limit. Therefore, the system will not overwork itself trying to reach an unattainable point. This prolongs system life and reduces wear and tear on humidity system components. Thus, if you set a set point of 0%, you can be confident that the environment within the chamber will remain as dry as possible at any given temperature within the operating range.

When humidity is limited due to the fact that the minimum dewpoint has been achieved, the corresponding System Status Monitor indicator will illuminate to indicate that this condition is present. If your chamber is not obtaining the desired humidity level, check the status monitor to verify that you are not trying to operate the chamber at a point outside of the chamber's minimum dewpoint capability.

#### Maximum Humidity Limitations

Certain chambers have limitations on the maximum humidity level that they can operate at a given temperature in order to protect the chamber structure. This limit typically applies to modular chambers. These chambers are constructed of individual panels that lock together to form the chamber. The panels have an inner chamber liner and outer skin with a foam insulation sandwiched between them. They are primarily used for large walk-in/drive-in chambers. Due to the materials used in the construction of the modular panels, the humidity is limited to a maximum 70°C dewpoint which corresponds to a maximum of 95% at 70°C (158°F).

When humidity is limited due to the fact that the maximum dewpoint has been achieved, the corresponding System Status Monitor indicator will illuminate to indicate that this condition is present. If your chamber is not obtaining the desired humidity level, check the status monitor to verify that you are not trying to operate the chamber at a point outside of the chamber's maximum dewpoint capability.

### **3.2.1.2 Altitude**

The altitude event turns the chamber's altitude system components on and off. Altitude chambers are specifically built to withstand atmospheric pressures. They have heavy gauge liners with additional internal structure for reinforcement. They simulate altitude by utilizing a vacuum pump to draw air out of the chamber. The EZT-560 converts the resultant pressure within the chamber into feet, thus altitude can be entered directly in feet. The altitude system can operate independently of the chamber conditioning system.

#### **NOTES on altitude system operation**

##### Chamber Temperature Control Limitations

As altitude increases, the air density within the chamber decreases. The heating and cooling systems require a minimum amount of air flow in order to operate correctly and control the internal chamber air temperature. The altitude system will inhibit the operation of the heating and cooling systems when the altitude increases beyond the design limits. This limit is typically around 60Kft.

##### Humidity Control Limitations

On most altitude chambers with the humidity system option, operation of the humidity system is inhibited when the altitude system is enabled. The vacuum system used to control the internal chamber pressure, can not operate with the addition of moisture. Only altitude chambers with vacuum systems specifically designed to operate with the presence of moisture will allow humidity control with the altitude system enabled.

### **3.2.1.3 Auxiliary Cooling**

The auxiliary cooling system utilizes LN2 or CO2 as a boost cooling medium to assist the refrigeration system in lowering the chamber air temperature. It is an inexpensive method for fast cooling transitions without having to make the investment in a high horsepower refrigeration system that may rarely be used. It can also be used as the primary cooling source for ultra low temperature operation on chambers designed to operate at temperatures below -84°C (-120°F)

When this option is installed on the chamber, turn the "Aux Cooling" event on. When the boost is required during a pull down, the EZT-560 will turn on the boost cooling solenoids and inject LN2 or CO2, into the chamber to drop the temperature as required. Once the set point is achieved, the boost solenoids will close in order to conserve LN2 or CO2 since it is no longer required, and allow the refrigeration system to maintain the temperature.

If your chamber is designed for ultra low temperature operation, and the set point is below the minimum achievable temperature for the refrigeration system, the EZT-560 will disable the refrigeration system and use the boost cooling system for the primary cooling source. This automatically protects the refrigeration system from damage and optimizes system operation.

### **3.2.1.4 Dry Air Purge/Low RH Option**

The dry air purge event can provide two levels of operation.

**Level 1 -** The first level of this option is dry air purge only. The purge only option consists of an air dryer which dries a small volume of air and discharges the dry air within the chamber. This helps reduce condensation on surfaces within the chamber by drying the air. When this event is turned on with the purge only option, the air dryer will run continuously until the event is turned off. If the chamber is also equipped with the humidity option and the humidity system is enabled, the purge system will be disabled automatically by the EZT-560. The humidity system can not control the humidity level within the chamber if the purge system is continuously trying to dry out the chamber.

**Level 2 -** The second level of this option includes the frozen coil (low RH) option. This option allows the chamber to reach a  $-29^{\circ}\text{C}$  ( $-20^{\circ}\text{F}$ ) dewpoint. This relates to lower relative humidity capabilities. When the low RH option is installed and the humidity system is enabled, the dry air purge system is operated in conjunction with the frozen coil automatically by the EZT-560 controller based on the air temperature and humidity set points. When required to obtain low humidity levels, the frozen coil and dry air purge systems will start in order to achieve the target set point. When no longer required, they will automatically turn off.

This option also provides the benefit of being able to manually use the dry air purge system by turning the purge event on and off. However, in the case where the low RH option is installed, the humidity system must be disabled for the dry air purge to function manually.

### **3.2.1.5 Customer Event Option**

The EZT-560 controller has the ability to control up to 15 event output relays. These outputs can be manually turned on and off, and they can also be controlled programmatically through a running profile. They can be used to start and stop devices under test within the chamber, turn signal beacon lights on and off to indicate steps within the test cycle, etc. With this option, a pair of binding posts is provided on the chamber for external connection to each relay individually.

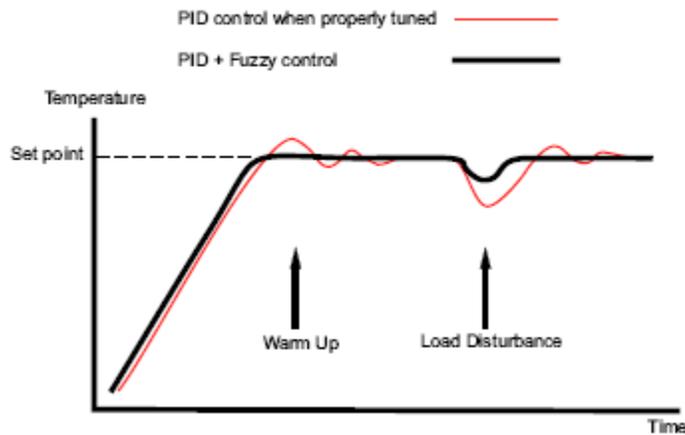
**CAUTION** The customer event output connections are rated for 24V AC/DC and are capable of switching up to 6A of current (resistive). To switch high power loads, the event relay must be used as the “switch” to turn a power contactor on and off to supply power to the load device.

### 3.3 One-Touch Tuning

All of the EZT-560 control loops feature the one-touch tune. No more tuning parameters to adjust or settings to change. The EZT-560 loop controls utilize fuzzy logic to continuously adapt to the process in order to maintain it as close as possible to the set point. The controls merely need base-line knowledge on the performance of the chamber and test load. To obtain this performance knowledge, the controller can be tuned using the one-touch tune.

All Cincinnati Sub-Zero chambers are factory tuned; however, the chambers are typically empty and under no load. Unless specific performance tests were performed at the factory for your particular needs, the base-line performance may not be accurate once your product is placed inside the chamber.

The one-touch tune makes it easy to tune the chamber to your product and performance needs. Just run the chamber at ambient conditions and press the "AT" button on the single loop display screen for the process to be tuned. The "AT" button will remain green for the duration of the tune to indicate it is working. Once complete, you are ready to test product.



**Figure 3-4 Tune Control Response**

As you change product configurations or other loads within the chamber, you can re-tune to the new configuration. All subsequent tests with that configuration will perform optimally. It is recommended that only one loop be tuned at a time so that they do not interfere with the tune of the other loop.

## 4. Profile Operation

A profile is a set of instructions programmed as a sequence of steps. The EZT-560 handles the profile steps automatically, in sequence. The EZT-560 can store hundreds and even thousands of profiles with up to 99 steps in each profile. This section covers the use and operation of the EZT-560 profiler. To access profile utilities, select "Profile Entry" from Profiles menu.



### 4.1 Profile Entry

Profiles are created and edited from the Profile Entry screen. The following instructions describe the steps involved for programming profiles.

1. To create a profile, go to the Profile Entry screen.
2. From the Edit menu, select “New Profile” and select “Yes” to create a new profile.
3. Enter the number of steps for the profile you want to create. Note that the number of steps can be changed at any time during the profile entry to shorten or lengthen the profile as required. Profiles can be from 1 to 99 steps in length.
4. For each step, enter the events, set points and time duration of the step.
5. Save the profile.



Figure 4-1 Profile Entry

#### Edit Menu Options

- New Profile:** Clears any existing profile entry data so that a new profile can be entered.
- Insert Step:** Inserts a step into the current profile at the current step number.
- Delete Step:** Deletes the current step.
- Copy Step:** Copies the current step data.
- Paste Step:** Pastes previously copied step data to current step.
- Select Profile:** Opens the file explorer window so that the user can select a profile from the profiles currently stored in memory.
- Save Profile:** Saves any changes made to the current profile under the existing name. If no name exists, the user must enter one in order to save the profile.
- Save As..:** Allows the user to save the current profile to a different file name. This is useful for making different versions of the same profile that only requires minimal changes.
- Delete Profile:** Allows the user to delete the current profile.

#### 4.1.1 Step Events

For each step of the profile, you must input which events are to be on during the step. To enter the step events, press the “Step Events” button. This opens the step event entry window. From this window, select the events that are to be on during the step. Once the selections are complete, return to the profile entry screen by pressing the “Back to Step Data” button.

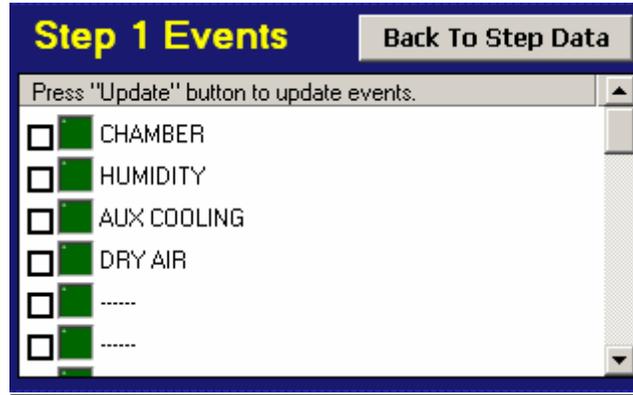


Figure 4-2 Profile Step Events

**NOTE:** This must be done for each step individually. Also, for the chamber to operate, the relevant chamber systems must be turned on via the event entry window. Even though a profile may be in operation, if the events are not set, the chamber will not run.

#### 4.1.2 GS Events

The GS Events are used to turn on the guaranteed soak option for one or more of the controlled loops. In order to enable a guaranteed soak in a step, you must select the loop(s) to be monitored by turning on the corresponding event. To enter the GS events, press the “GS Events” button. This opens the guaranteed soak event entry window. From this window, select the events that are to be on during the step. Once the selections are complete, return to the profile entry screen by pressing the “Back to Step Data” button.



Figure 4-3 Profile Guaranteed Soak Events

**NOTE:** It is not recommended to use guaranteed soak events for ramping steps. The ramp rate could be affected if the process variable deviates from the soak band because the profile will be placed in hold. When the profile is in hold, the step length will be extended and the set points will no longer ramp at the set rate. If the desire is to insure that the chamber is at temperature, for example, prior to beginning a soak, use the “wait for” feature. To set the guaranteed soak band for each loop of the profile, see section 4.2 Soak Limits.

### 4.1.3 Wait For

The wait for function is a powerful tool for pausing a profile until a particular process variable reaches a predefined state. This differs from the guaranteed soak function by being a single shot monitor. With the guaranteed soak, the process variable is monitored throughout the whole step. If the process exceeds the upper or lower deviation, the profile will hold until the process returns to within those limits. The wait for function when enabled, puts the profile in hold and “waits for” the process to achieve a particular value that you can set for the step. Once the process reaches this set point value, the profile will resume.

To enable a wait for in a step, press the “Wait For” button. This opens the wait for entry window. From this window, select the input to wait for and then enter the set point for the wait. Once the entries have been made, return to the profile entry screen by pressing the “Back to Step Data” button.

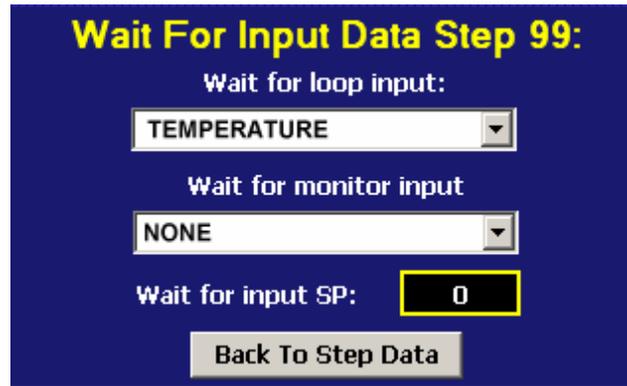


Figure 4-4 Profile Wait For Input

**NOTE:** The set point entry for a “wait for” is critical for the “wait for” to operate correctly. During the wait, the selected process input must cross the set point in order for the profile to resume operation. If the selected input does not cross the set point value, the profile will remain in hold on the step indefinitely.

### 4.1.4 Set Point/Step Time

To enter the set point(s) and time for a step, touch the set point/time display table at the bottom of the profile entry screen. This opens the set point and time entry window. From this window, enter in the time duration of the step in hours, minutes and seconds as well as the required set point(s) for the step. Once the entries have been made, return to the profile entry screen by pressing the “Done” button.

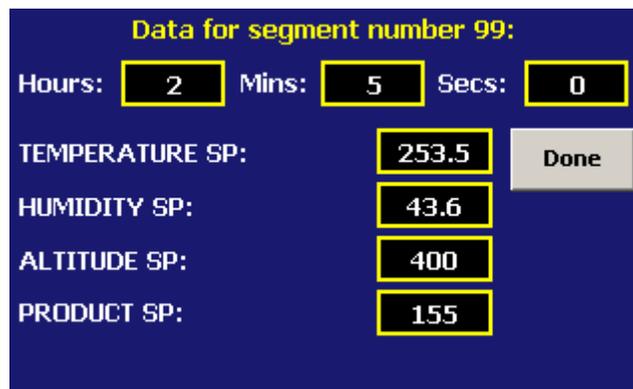


Figure 4-5 Profile Set Point Entry

### **Entering a Soak Step**

The set point entry for a step defines the target set point, i.e., the set point that will be achieved by the end of the step. Thus, if the set point of a step matches the previous step's set point, the chamber will soak, remain at that set point, for the entire step.

### **Entering a Ramp Step**

A ramp step is merely a step with a set point that is different from the previous step. The chamber will ramp from the previous set point, to the set point of the current step linearly over the current step's time. This generates a ramp to the current set point.

### **Determining Ramp Rate**

In order to enter a ramp rate, you must calculate the time it will take to go from the previous set point to the new target set point. For example, if you desire a ramp rate of 5 degrees per hour from the previous step's 20 degree set point to the new 85 degree set point, the step time will be the difference in temperature of 65 degrees divided by the rate of 5 degrees per hour. This equates to a time period of 13 hours. Thus, the new step will have a set point of 85 degrees with a step time of 13 hours.

**NOTE:** A step time of zero can be entered for a step to implement an immediate set point change. This will cause the chamber to ramp to a set point as quickly as possible. Used in conjunction with a wait for on the following step, maximum ramp rates can be achieved that are directly followed by a soak step at the same temperature.

### **4.1.5 Jump**

The jump allows the profile to "jump" between different steps within itself. This is useful for repeating the same ramp/soak combination during extended cycle testing of product. To enter a jump, enter the step number to jump to and the number of jumps to be made. A jump count of zero on a step indicates that no jump will be made regardless of what the jump step number is set to.

*Jump Step:* This defines the step number that the profile will jump to at the completion of the step.

*Jump Count:* This defines the number of jumps that will be made from the step. Once all jumps have been made, the profile will continue on to the next step in sequential order.

**NOTE:** The jump count defines how many jumps will be made. Thus, if you wish to perform 10 cycles within a profile, your jump count will be set to 9, 10 minus the 1 you performed prior to reaching the jump step.

## 4.2 Autostart

Autostart pauses a profile until the specified date or day, and time (of a 24-hour-clock). The autostart settings are stored with the profile. To enter the desired start date or day, select "Auto Start Profile" from the profile Views menu. Choose the desired autostart method, date or day, and enter the start time settings. Once the desired entries have been made, press the "Done" button to return to the profile entry screen.

**Auto Start Profile**

DOW (Sun-Sat = 0 through 6)

Month:  Day Of Week:

Day:  Hour:

Year:  Minute:

*Figure 4-6 Profile AutoStart*

*Autostart by Date:* When this mode is selected, the exact date and time must be entered. Enter the month, day, year and time of day in hours and minutes for when the profile is to start. The day of week entry is not used so its value is irrelevant.

*Autostart by Day:* When this mode is selected, only the day of week and time is required to be entered. The date settings are ignored so the values are irrelevant.

**NOTE:** The time is entered in 24 hour (military) time format. To convert time from AM/PM format into 24 hour format, add 12 to the hours in PM time. For example, 2pm will be a value of 14 for hours. A time of 5:30pm will be 17 hours, 30 minutes.

The autostart settings are stored with the profile; however, autostart can be used as a one time setting. Select a profile that you wish to autostart at a particular time, make the desired autostart selections and run the profile. The original profile settings will not be affected unless you save the profile.

### 4.3 Guaranteed Soak Limits

To access the guaranteed soak limits, select “Soak Limits” from the profile Views menu. The soak limits screen allows you to set the control tolerance for soak steps when in profile operation. When the process variables differ from the step set points by more than the soak limits, the profile will go into hold and the timer will stop until the process variables re-enter the soak bands. These limits apply to each step in the profile and only need to be set once.



Figure 4-7 Profile Guaranteed Soak Limits

To change the limits, touch the limit entry field. Enter the new soak band via the keypad. Note that setting a band limit too tight, could prevent the profile from operating correctly because the chamber may not be able to control to such a tight band setting. A typical band setting would be 1°C (1.8°F) for temperature, 3% for humidity and 1Kft for altitude. Once the desired bands have been set, press the “Done” button to return to the profile entry screen.

The soak limits are saved with the profile. When changing the soak band settings, be sure to save the profile in order to update the profile with the new settings. This insures that each time the profile is loaded and run, it will control to the proper band settings.

#### 4.4 Plot Profile

The currently loaded profile can be viewed by using the Plot Profile utility. This allows you to see if the profile you programmed matches the desired profile. To view the profile, select "Plot Profile" from the profile Views menu.

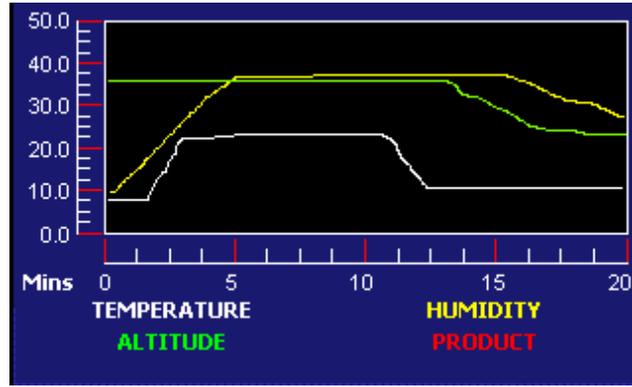


Figure 4-8 Profile Plot

The EZT-560 will automatically generate a graphical representation of your profile and display it on the screen. The Y-axis auto-scales to fit the set points within the profile. The X-axis auto-scales to the number of steps in the profile. Note that jump steps are not shown.

#### 4.5 Start/Stop Profile

To **start** a profile, it must first be loaded. The currently loaded profile is shown at the bottom of the profile entry screen. To start the profile, select “Run” from the Run menu.



You will then be prompted to enter the step number for the profile to start on (default is step 1).

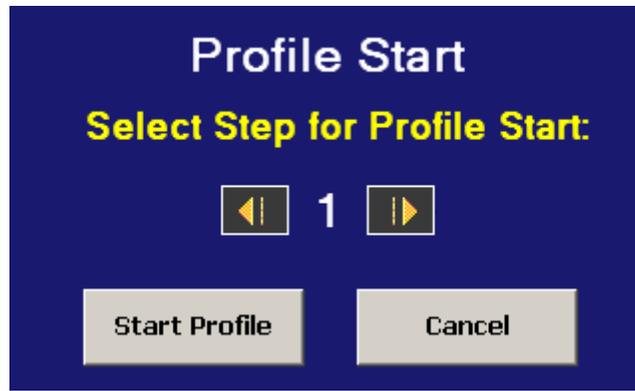


Figure 4-9 Profile Start

Use the scroll buttons to adjust the start step if required, and press the “Start Profile” button. The profile will then be transferred into the profiler memory and started once the transfer is complete. The “Profile Status” screen will automatically appear upon starting the profile so that the profile’s operation can be observed.

**NOTE:** If the profile was set up with the autostart feature enabled, the profile will enter autostart mode. Upon reaching the set date or day and time, the profile will begin running.

To **stop** a profile, there are two options. These selections are available from the “Run” menu.

**Stop Profile:** Stops the running profile, but leaves the set points and events at their current values when the profile stops. This allows you to stop a profile and continue its operation in manual mode without shutting down the chamber and causing a “hiccup” in control.

**Stop Profile (all off):** Stops the running profile and turns all events off. The set points will remain at their current values when the profile stops; however, all chamber system stop. This allows you to immediately stop a profile and all chamber operations.

#### **4.5.1 Hold/Resume a Profile**

At any time during the operation of a profile, the profile can be manually put into hold. This stops the profile timer; however, the chamber continues operation under the current step settings at the time the profile was put into hold. To put a profile into hold, select "Hold Profile" from the Run menu and select "Yes" to put the profile into hold.

To resume the profile at the point in which it was put into hold, select "Run Profile" from the Run menu and select "Yes" to continue the profile. Upon a power failure, you can also resume a profile's operation in this manner from the point that power was lost depending upon the power recovery action that is selected. See section 5.1 for more information regarding power recovery options.

#### **4.5.2 Advance Previous/Next Step**

The advance step function allows you to skip certain profile steps or repeat them by advancing to the desired step. To advance to a previous or next step in the profile, the profile must be first put into hold. Once the profile is in hold, the advance step menu items are enabled under the Run menu.

By selecting advance previous or advance next, the current step will be decremented or incremented by 1 each time. When the current step number is on the desired step, place the profile back into run and the profile will continue operation from the beginning of the selected step.

### 4.6 Profile Status View

The profile status view provides all information regarding the operation of the current profile. It can be accessed from the main Profiles menu as well as the profile Views menu.

Description	Value
PROFILE STATUS:	OFF
START DATE:	10/22/05 -10:15
ESTIMATE STOP DATE:	10/22/05 - 15:44
CURRENT STEP:	3
STEP TIME LEFT:	2:22:00
WAIT FOR INPUT:	NONE
WAIT SETPOINT:	NONE

**Current Profile Loaded:**

Figure 4-10 Profile Status View

1. *Profile Status:* Displays the current operating mode of the profile, i.e., autostart, run, hold, wait for, ramp, soak, guaranteed soak, etc.
2. *Start Date:* Displays the date and time at which the profile was started.
3. *Estimated Stop Date:* Displays the calculated stop date and time of the profile. Note that this may vary due to wait for and guaranteed soak steps set in the profile.
4. *Current Step:* Indicates the step number currently being executed.
5. *Step Time Left:* Displays the time remaining in the current step.
6. *Wait for Input:* Indicates the input being monitored if a wait for condition is present.
7. *Wait Setpoint:* Indicates the setpoint for the wait for condition if active.
8. *Target Setpoints:* Displays setpoints for each controlled process of the chamber, i.e, temperature, humidity, altitude, etc.
9. *Current Jump Step:* Dynamic field that is active only if step is a jump step. Displays the step number that profile will jump to at completion of the step.
10. *Current Jumps Remaining:* Dynamic field that is active only if step is a jump step. Displays the number of jumps remaining for the step.
11. *Last Jump from Step:* Dynamic field that is active only if a jump has been made. Displays the last step a jump was made from.
12. *Last Jump to Step:* Dynamic field that is active only if a jump has been made. Displays the last step a jump was made to.
13. *Total Jumps Made:* Dynamic field that is active only if a jump has been made. Displays the total count of all jumps made.



## 5. Chamber Setup

This section covers the use of extended controller features that enhance the functionality of your chamber. To gain access to the chamber setup options, select “Chamber Setup” from the Setup menu.



### 5.1 Power Recovery

The power recovery settings direct the EZT-560’s response to the interruption of electrical power. The EZT-560’s battery-powered real-time clock tracks the amount of time the power is out. When power is restored, the controller compares this amount of time to the Power-Out Time setting and takes whatever action is selected in the Recovery State.

First, determine how long the power can be interrupted without adversely affecting results. Set the Power-Out Time to this time. If power is returned in less time than this setting, the chamber will resume operation where it left off. Note that profile run time stops while the power is off. If power is returned after a time longer than this setting, the EZT-560 will take action based on the Recovery State parameter:

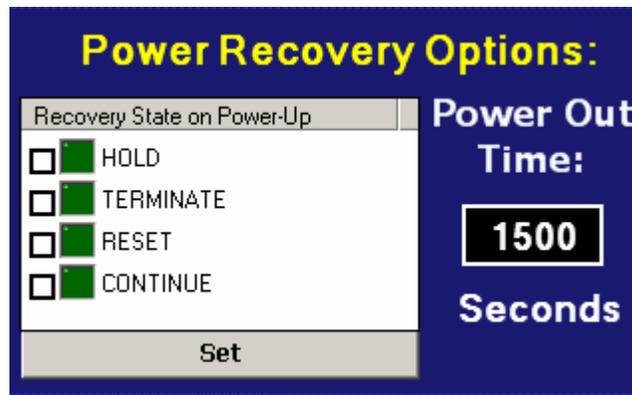
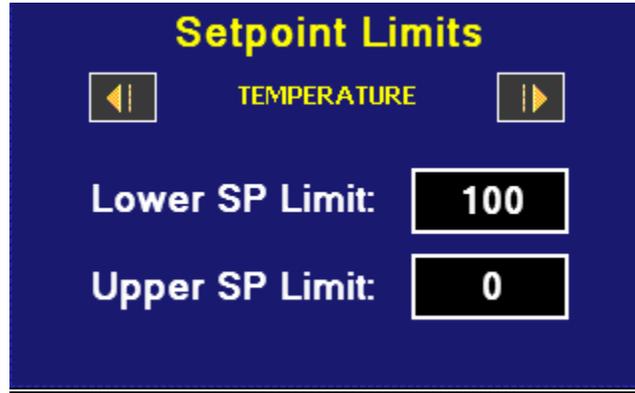


Figure 5-1 Power Recovery

- Hold**                      Select hold to have the chamber return to operation at the same point it was prior to the power outage. If a profile was running, the profile will still be active; however, it will remain in hold until manually set to continue.
  
- Terminate**                Select terminate to have the chamber default to the off state on power-up. If a profile was active prior to the power outage, the profile will also be stopped.
  
- Reset**                      Select reset to automatically restart the profile that was running at power failure. Use this option if it is critical for a profile to run from start to finish without interruption.
  
- Continue**                 Select continue to have the chamber pick-up where it left off on loss of power. If a profile was running prior to the power outage, it will resume where it left off and continue through the rest of the profile.

## 5.2 Set Point Limits

The set point limits screen allows the user to adjust the minimum and maximum operating set points allowed for the control loops. These limits can be used to prevent operators from entering a value that exceeds the survivability limits of a product being tested.

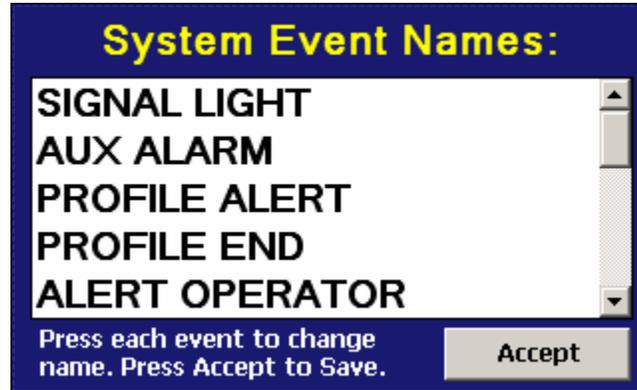


*Figure 5-2 Set Point Limits*

**WARNING** The set point limits are factory set for the maximum safe operating range of the chamber. These limits are locked out from user adjustment by default at the factory. User adjustment of these limits, which exceed those limits set by the factory, may result in damage to system components and will void the chamber warranty.

### **5.3 Event Tagnames**

The names of the optional customer events can be changed to describe what function you have chosen for them to perform. To alter event names, select "Event Tagnames" from the Setup menu.

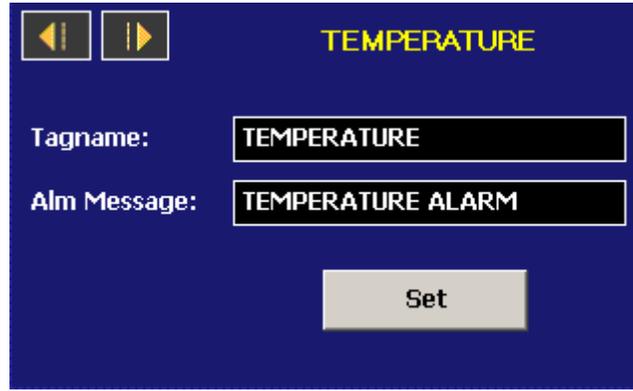


*Figure 5-3 Event Tagnames*

To change the name of the event, select the event by touching its current tag name. The pop-up keypad will appear allowing you to enter a new description. Once complete, select "Done" and the new name will appear in the event tag name list box. Once all changes have been made, press the "Accept" button to save the changes to memory.

### 5.4 Process/Alarm Tagnames

The names of the optional monitor inputs and alarms can be changed to describe what function you have chosen for them to perform and what they are monitoring. To alter tagnames, select "Process/Alarm Tagnames" from the Setup menu.



*Figure 5-4 Process/Alarm Tagnames*

To change the name of the event, select the event by touching its current tag name. The pop-up keypad will appear allowing you to enter a new description. Once complete, select "Done" and the new name will appear in the event tag name list box. Once the change has been made, press the "Set" button to save the changes to memory.

## 5.5 Alarm Settings

The EZT-560 provides user configurable alarms for each input. The alarms are activated when the process value or temperature leaves a defined range. A user can configure how and when an alarm is triggered, what action it takes and whether it turns off automatically when the alarm condition is over.

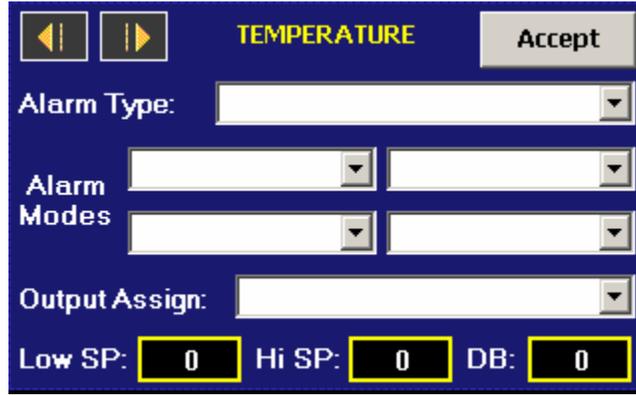


Figure 5-5 Alarm Settings

### Alarm Types

**Process:** A process alarm uses one or two absolute set points to define an alarm condition. A process alarm can be set for high only, low only or both high and low.

**NOTE:** The alarm settings for the product loop are fixed as a process alarm for both high and low alarm. The alarm set points should be set by the user to protect the product under test from damage in the event of a thermal runaway condition.

**Deviation:** A deviation alarm uses one or two set points that are defined relative to the control set point. High and low alarm set points are calculated by adding and/or subtracting offset values from the control set point. If the set point changes, the window defined by the alarm set points automatically changes with it. A deviation alarm can be set for high only, low only or both high and low.

**NOTE:** The deviation alarm type is not available for the optional monitor inputs. The monitor inputs are not associated to a control set point.

### Alarm Modes

**Self Clear/Latching:** A latched alarm will remain active after the alarm condition has passed. It can only be deactivated by the user. An alarm that is not latched (self-clearing) will deactivate automatically when the alarm condition has passed.

**Close/Open on Alarm:** An open on alarm condition means that the event output assigned to the alarm will be energized in a non-alarm condition, i.e., fail-safe. A close on alarm settings means that the output is normally open and will close in an alarm condition.

**Audible On/Off:** When the audible alarm is on, an alarm condition will trigger the audible horn on the chamber and it will sound until silenced by the user. If the audible alarm is off, there will be no audible signal when an alarm condition is present.

**Shutdown/Continue:** An alarm set to continue will not affect the operation of the chamber when in alarm condition. If the alarm is set for the shutdown mode of operation, the chamber will turn off all systems in an alarm condition

### **Output Assignment**

If the customer event option is supplied on the chamber, the alarm can be assigned to one of the events. Utilizing the “close on alarm” or “open on alarm” mode settings, the event output will turn on and off with the alarm it is assigned to.

**NOTE:** When setting an event output as an alarm, the output can still function as an event. Thus, the output will be on if the event output is on or if the alarm state and mode tells it to be on. More than one alarm can also be tied to the same output. This allows one output to function as a remote indicator for any configured alarm condition.

### **Alarm Set Points**

*High Set Point (Hi SP):* The alarm high set point defines the process value or temperature that will trigger a high side alarm. It must be higher than the alarm low set point.

*Low Set Point (Lo SP):* The alarm low set point defines the temperature that will trigger a low side alarm. It must be lower than the alarm high set point.

**Hysteresis (DB):** An alarm state is triggered when the process value reaches the alarm high or alarm low set point. Alarm hysteresis defines how far the process must return into the normal operating range before the alarm can be cleared.

It creates a zone inside each alarm set point. This zone is defined by adding the hysteresis value to the alarm low set point or subtracting the hysteresis value from the alarm high set point.

## 5.6 Product Control

If the chamber is equipped with the product control option, this screen will be accessible from the Chamber Setup menu.



Figure 5-6 Product Control

Product control is a control strategy in which one control loop provides the set point for another loop. It allows the process or part temperature to be reached quickly while minimizing overshoot. Product control can be used to optimize the performance of chambers containing product with long thermal lag times.

If only single-loop control is used, i.e., air temperature, the air will reach its designated set point and the chamber will hold at this temperature. However, the part in the chamber may take hours or even days to reach the temperature you desire due to its thermal mass. As the part temperature approaches the set point, the difference between the part temperature and the air temperature decreases. This difference in temperature is what forces the heat to move between the part and the air. The lower this difference, the slower the heat moves. The composition of the material, whether it is a natural insulator or conductor, also affects this rate of heat transfer.

The product control feature can be used to speed up this process and insure that your part reaches the set temperature. It does this by monitoring the part temperature through the product control loop, and based on the set point for product temperature, generates a set point for the air temperature control loop. This set point is then automatically fed into the air temperature control loop. This allows the air to exceed the desired product temperature and increase the temperature difference between the part and the air. This accelerates the transfer of heat between the air and product under test.

There are two modes of operation for the product control feature, deviation and process. These modes define how the air temperature set point is calculated.

**Deviation:** This mode uses the lower and upper set points to generate a set point that is defined relative to the product set point. The upper and lower range of the air temperature set point is calculated by adding and/or subtracting these values as offsets from the product set point. As the product set point changes, the window defined by the upper and lower points automatically changes with it.

**Process:** This mode uses the lower and upper set points as the upper and lower range of the air temperature set point. The output of the product control loop is linearized between these two values in order to provide the set point for the air temperature loop.

The deviation mode has the benefit of limiting the maximum and minimum temperature that the air can achieve relative to the desired product set point. This allows the system to be fine tuned to the minimum amount of overshoot required to obtain the desired product temperature.

The process mode has the benefit of maximum change rates by allowing the air temperature to go to absolute limits. This allows the product to achieve set point temperature as quickly as possible, but does so at the cost of stability. If the part has a large thermal lag, the air temperature control may oscillate uncontrollably once the product reaches set point because of the large overshoot. In most cases, deviation control is the recommended choice.

### 5.7 Condensation Control

The optional condensation control feature is for situations in which condensation is undesirable or detrimental to the product being tested. When enabled, the rate of rise in temperature is limited in order to allow the humidity control system to strip moisture from the chamber in order to keep the dewpoint of the air below the product temperature. If the dewpoint of the air were to exceed the product temperature, moisture could form on the product's surface.

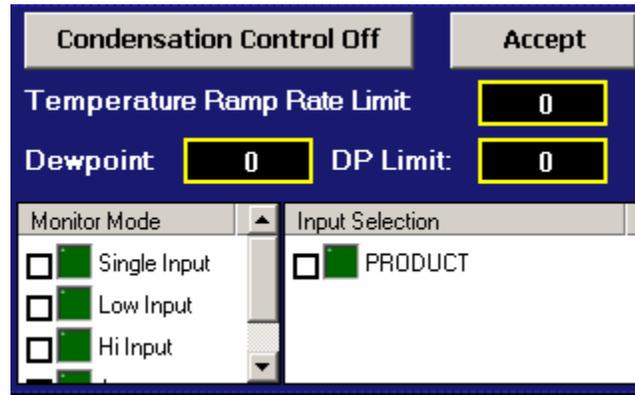


Figure 5-7 Condensation Control

There are many factors that can affect the performance of the chamber including product placement, mass of product and air distribution throughout the chamber. The required ramp rate limit will be affected by these factors. It may take a little trial-and-error to determine what setting is best for your testing needs.

**Ramp Rate Limit:** Adjustable ramp rate limit. Valid range is from zero to 5.0°C (9.0°F). Note that a limit setting of zero will have no limiting affect on rate of rise.

**Dewpoint:** Read only parameter which displays current dewpoint of the air within the chamber.

**DP Limit:** Read only parameter which displays the maximum dewpoint that can be maintained without causing condensation on product.

**Monitor Mode:** Defines the method of part temperature monitoring.

*Single Input:* Uses single input, i.e., single sensor located on part.

*Low Input:* Uses input with the lowest part temperature.

*Hi Input:* Uses input with highest part temperature.

*Avg:* Uses average of all selected part temperature inputs.

**Input Selection:** Used to select which inputs will be used for monitoring part temperature. Note that the standard system has only one selection, the product control loop input. If the EZT-560 is equipped with the input monitor option, the additional inputs will be listed for selection.

### 5.8 Defrost Settings

These settings will be available on special systems equipped with the hot-gas defrost option. This option is provided on systems that operate at ultra-low temperatures for extended periods of time to periodically warm the refrigeration coils and remove the normal ice build-up.

Moisture in the air is naturally attracted to the cold surface of the refrigeration coils in the chamber. This moisture freezes to the surface of the coil over time and can eventually cover the entire surface. This will render the coil useless and block all airflow in the chamber. In chambers that run through high and low temperature cycles, the moisture does not accumulate to a detrimental level, but in chambers that run at low temperatures for days or weeks at a time, this can be a problem.

Hot-gas defrost is a means of warming the refrigeration coils to melt the ice, while minimizing the rise in air temperature within the chamber. When defrost is enabled, the air circulators shut down and the hot gas solenoid opens. The hot gas flows through the refrigeration coil and melts the ice. Once the coil reaches a preset temperature limit, typically 10°C (50°F), defrost terminates. The refrigeration system then prechills the coil prior to turning on the air circulators. This further prevents the warming of the chamber's contents.

Defrost can be set to run automatically or under manual control through the use of an event. When auto mode is selected, the EZT-560 will monitor the conditions of operation and automatically start defrost based on the parameters the user has entered.

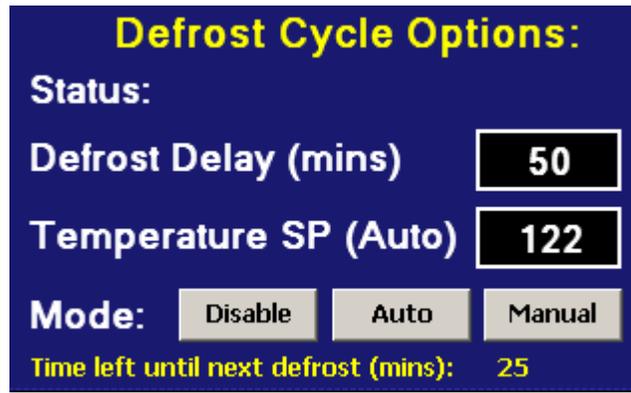


Figure 5-8 Defrost Settings

**Defrost Delay:** Time in minutes between defrosts when auto mode is enabled. This is based on Individual operating conditions. It may take some analysis to determine how long your chamber can run before defrost is required.

**Temperature SP:** Temperature below which defrost is enabled when in auto mode. After the defrost delay, defrost will be activated. If at any time the chamber temperature rises above the set point temperature, the delay timer will be reset and the countdown will begin anew the next time the chamber temperature drops below the set point.



## **6. Security**

The EZT-560 provides an enhanced array of security features. The security model provides an administrator with the tools to add up to 30 users to the system. Each user must have a unique ID, full name and password. Three levels of users are provided to include operator, supervisor and administrator levels. Specific access rights can be assigned to each user level as well as password aging for each user. Re-authentication is provided (if enabled) for any parameters that will change a control parameter which could upset the process (i.e. setpoint, tuning, etc...). Re-authentication requires that the logged in user must log in again before the process value will actually be changed. This feature is provided for extra security. The following example will make re-authentication clearer:

*A supervisor logs on the system. The supervisor then steps away from the system to take a phone call but does not log out before leaving. If another user tries to change the control setpoint on any loop the system will require another login (by an authorized user for that level) before the control setpoint is actually changed. This provides an extra level of protection to make the system more "tamper proof".*

**NOTE:** Default UserID is "FACTORY".  
Default Password is "CONTROL"

## 6.1 Security Setup

All security parameters are accessed via the Security menu.



### 6.1.1 Add User

The “Add User” tab provides the ability to add up to 30 users to the system. Select the type of user from the drop down list (Operator, Supervisor or Administrator). Press each field to add the user ID, full name and password (no spaces allowed). If the passwords do not match or the user ID is already used, the EZT-560 will alert the user and not accept the entry.

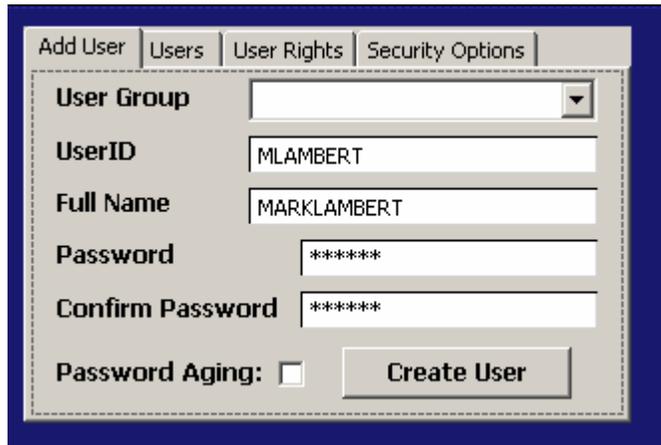


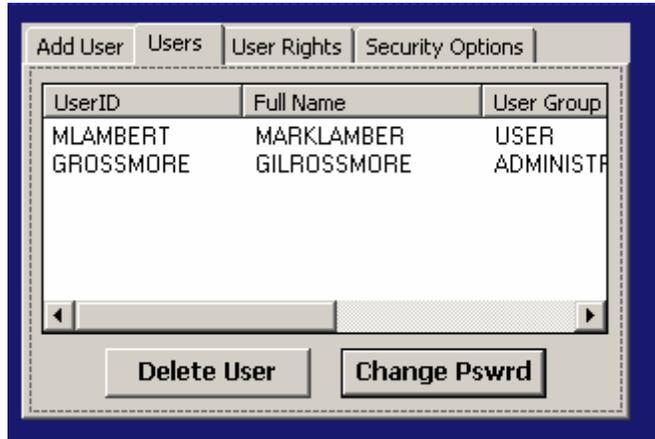
Figure 6-1 Security (Add User)

Click on the password aging checkbox if you wish to enable password aging for this user. If password aging is enabled and the password has expired, a new password must be entered for the user by the system administrator before that user can log into the system again.

**NOTE:** The system administrator can not use the “Password Aging” option. This will lock the administrator out of the system, thereby preventing the system administrator from managing passwords for the system users. The EZT-560 will prevent administrators from using this option.

### 6.1.2 User List

The “Users” tab provides the administrator the ability to view information on each user entered into the system. Password information is not available. The user can be deleted from this tab and the password for each user can also be changed from this area.



*Figure 6-2 Security Users List*

### 6.1.2.1 Delete User

The administrator can delete a user by selecting the user from the list. To select a user, touch the UserID in the list box and press the "Delete User" button.

### 6.1.2.2 Change User Password

The administrator can also change the password of a user in the system. This may have to be done if password aging is set up for the user or for other security reasons. To change a password, select the user by touching the UserID in the list box and press the "Change Pswrd" button. Enter the new password and confirm the password. Press the "Accept" button to change the password.

### 6.1.3 User Rights

The "User Rights" tab provides the administrator the ability to assign rights to each user level (Operator, Supervisor and Administrator). Select the user type from the drop down box and then enable or disable specific program functions (rights) by selecting the checkbox next to the function. If the checkbox is selected, the user right will be enabled for the user level currently being edited. The "Select All" and "Clear All" buttons will select or clear all rights in the "user rights" list view. You must press the "Accept" button for each user level to save the selections for that user type, before selecting another user type from the drop down list, or entries made will not be saved.

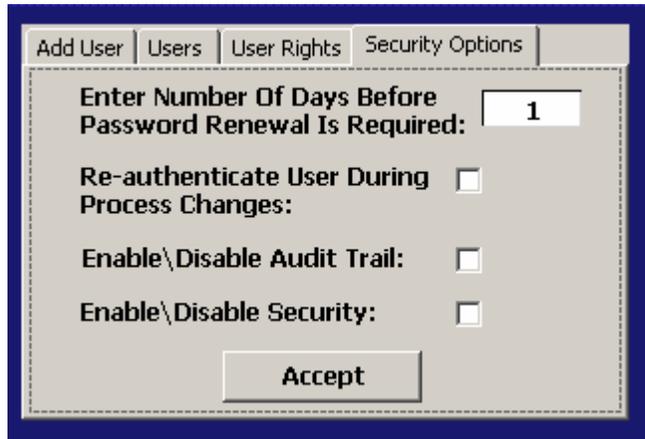


*Figure 6-3 Security User Rights*

**NOTE:** You must have at least one user with administrator access and the “Access Security” right option enabled in order to turn on security. There is no “back door” to the system. If the password is lost or forgotten, you must contact Cincinnati Sub-Zero’s Service Department to order a new compact flash card.

**6.1.4 Security Options**

The “Security Options” tab provides the administrator the ability to set the global security options.



*Figure 6-4 Security Options*

**Enter Number Of Days Before Password Renewal Is Required**

This is a global setting for all users. Password aging starts from the day the user is entered into the system.

**Re-authenticate User During Process Changes**

This feature requires that the logged in user must log in again before the process value (at the controller) will actually be changed.

**Enable\Disable Audit Trail**

This is a global setting that turns the audit trail on or off. When the audit trail is turned on, all operator actions are written to a daily log.

**Enable\Disable Security**

This is the global setting that turns the EZT-560 security system on or off.

## **6.2 User Log On/Off**

When security is enabled, a user must log on to the system in order to gain access to privileged items. To log on to the system, select "Log On" from the Security menu. Enter the user "UserID" and "Password" on the login screen and press "Done" when finished. If the entries made are valid, the user will be logged onto the system. In order for a user to log off the system, select "Log Off" from the Security menu.

## **6.3 View Audit Trail**

The "View Audit Trail" selection from the Security menu allows the user to view all audit trail files stored in memory. This selection opens the audit trail viewer. Press the "Open Audit Trail" button to open the explorer window. Select the desired audit trail file and press the "Open" button. The audit trail files are stored by date. One file will be created for each day. If no activity occurred during a given day, no file will be available.

## **6.4 Current User**

The "Current User" selection merely provides a means of identifying the current user logged into the system. If none of the users configured in the system are logged on, the current user will be displayed as "CSZ System".

## 7. Logging

The EZT-560 logging features are accessed via the “Log” menu item. The system data logging provides the ability to select individual points for logging, view datalog files and start/stop logging operations. The logging ability of the EZT-560 provides an easy-to-use, convenient method to obtain electronic data without the need for additional equipment.



### 7.1 Start/Stop Logging

The main system data logging screen is used to start or stop the logger and also to add a file prefix to the file name. File names are automatically generated using m\_d\_y\_h\_m\_s format (file prefix is entered before the date/time stamp if the user enters one).

The main logging screen will display the current data file name if system logging is enabled as well as the currently loaded file name (on the bottom status bar), if a historical file is loaded. To start the log, press the “Logging On” button (controller variables must be assigned first by selecting the “Select Points For Logging” menu item). Any time logging is enabled, the “Logging On” button will be green.

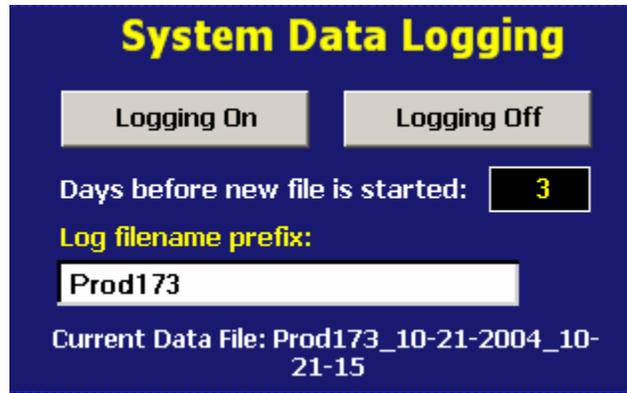
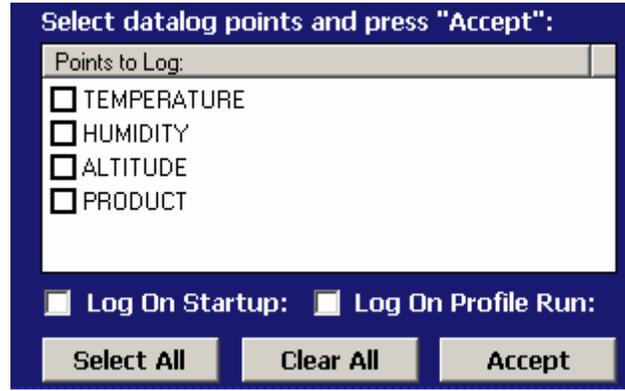


Figure 7-1 Start/Stop Datalogging

The logging rate is adjusted on this screen by changing the value for the “Days before new file is started” parameter. Files can be 1 to 31 days long (before system starts a new file) with datalog rate dependent on file selection length. The data log rate (in minutes) is the number of days selected for file length. If 5 days is selected for file length, the datalogger will save to disk every 5 minutes.

## 7.2 Logging Setup

The "Select Points for Logging" screen allows the user to select any point(s) from the system for data logging. The "Select All" and "Clear All" buttons provide a quick way to select or deselect all points in the system.



*Figure 7-2 Logging Setup*

Use the checkbox to enable/disable a point for logging. When selections are completed, press the "Accept" key to write the point selection to memory. This is important so that the EZT-560 saves the settings for power-up operation. New settings will not take effect until the "Accept" button is pressed.

**Log On Startup:** The log on startup option automatically turns logging on whenever the chamber is powered on.

**Log On Profile Run:** The log on profile run option is a convenient method for gathering information that pertains only to the operation of a profile. When selected, the EZT-560 will turn the logger on at the beginning of a profile and off once the profile is completed.

### 7.3 History Files

Historical files are stored on the internal compact flash memory of the EZT-560. All files can be opened and viewed on a trend graph.

#### 7.3.1 Open/Delete History Files

The data logging “Edit” menu provides three options for handling stored historical files.

**Open History File:** Opens a history file for review.

**Delete History File:** Allows the user to delete the currently loaded history file.

**File Utilities:** Allows the user to copy files to an I-Stick from internal storage as well as delete files. See section 7.4 for more information.

**NOTE:** The “Delete History File” function does not affect the currently running data file, only the current history file loaded for review.

#### 7.3.2 View History Plot

In order to view a historical data file, it must first be opened by selecting “Open History File” from the data logging Edit menu. Once the file has been opened, the user has the ability to adjust the time period to plot from the file as well as what points are to be plotted.



To plot the file, select “View History Plot” from the Datalogging menu. The EZT-560 will open up a trend graph and plot the selected channels. When you are done viewing the file, press the “Done” button to return to the main datalogging menu.

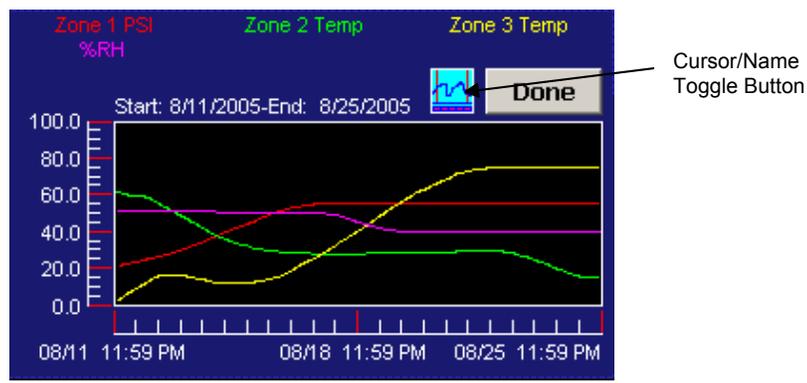
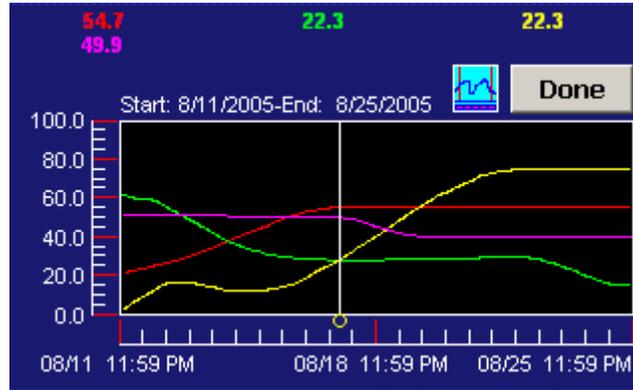


Figure 7-3 History Plot

The plotted channels will be shown across the top of the graph in their associated colors. The history plot provides the drag-n-zoom feature like the loop trends. To zoom in to a particular section, touch the screen and drag your finger across the screen to make a window around the particular area of interest. Once you remove your finger from the screen, the plot will zoom in to that particular section. To return to the full plot, touch either the x or y axis and select “Zoom Normal”.

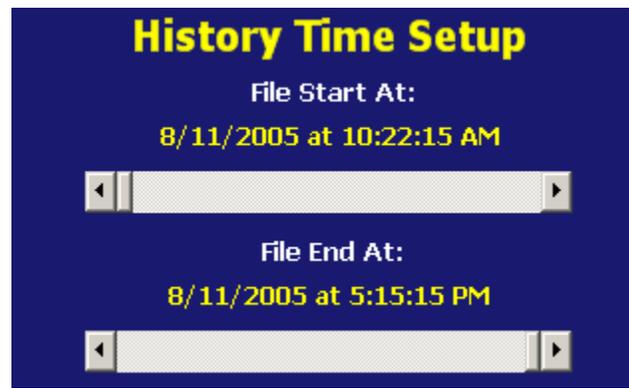
The Cursor button enables a cursor that can be scrolled across the plot in order to display the value of each variable at that particular time. When the cursor is enabled, the name for each variable will become the actual value at the current cursor position. As the cursor is scrolled across the plot, the value will change accordingly. Pressing the Cursor button again will turn off the cursor and restore the variable names.



*Figure 7-4 History Plot Cursor*

### 7.3.2.1 History Plot Time Setup

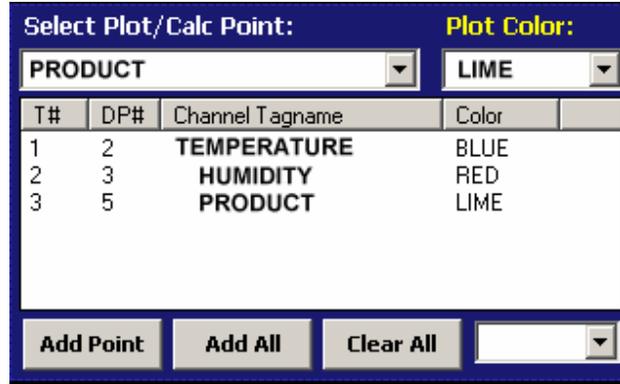
Select "Hist View Time Setup" from the Datalogging menu. The history time setup allows the user to select any time frame (zoom in/out) to view historical data. A historical data file must be loaded (using the Edit\Open History File menu item) before data can be plotted. The History Plot Setup screen displays the start and end time for the currently loaded file in hours and minutes. Use the sliders to adjust the time span for historical viewing if desired.



*Figure 7-5 History Plot Time Setup*

### 7.3.2.2 History Plot Channel Setup

Select "Hist View Channel Setup" from the Datalogging menu. The history plot channel setup allows the user to plot up to 8 channels of data simultaneously. Any point from the data file can be selected along with the color for each channel to be plotted.



T#	DP#	Channel Tagname	Color
1	2	TEMPERATURE	BLUE
2	3	HUMIDITY	RED
3	5	PRODUCT	LIME

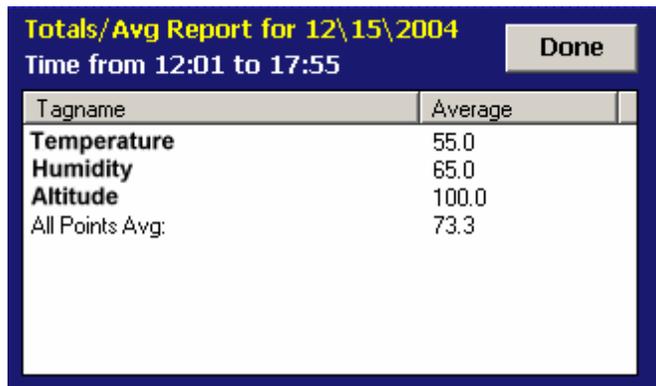
Figure 7-6 History Plot Channel Setup

Use the drop down boxes to select a channel for the plot and then the color for the channel. Press the "Add Point" button to add the point to the current list of historical plot channels. The "Clear All" button will clear the list of all points so a new group can be added for plotting. The "Add All" button will automatically fill the list with the first 8 channels, if available, and assign individual colors to each channel.

### 7.3.3 View Averages Report

The "View Averages Report" provides a text report that displays the average value over time for each channel selected in the "History Plot Channel Setup" screen. Averages are calculated for the period of time selected in the "History Plot Time Setup" screen. The report supplies the average value for each channel over time as well as the combined average for all channels selected. This is a useful tool with the monitor option because it can be used for analyzing gradients within the chamber or within the product under test.

To view the averages report, select "View Averages Report" from the Datalogging menu.



Tagname	Average
Temperature	55.0
Humidity	65.0
Altitude	100.0
All Points Avg:	73.3

Figure 7-7 Averages Report

### 7.4 File Utilities

The “File Utilities” screen allows the user to copy or erase files from the internal compact flash card. Complete file directories for all EZT-560 file types can be copied to the USB “I-Stick” or erased from the internal compact flash card. Complete status for file functions as well as progress bar status is displayed for the operator during copy/erase operations.

A quick note regarding file storage. The files (log files, alarm history and audit files) need some maintenance every now and then. After a period of time, storage devices fill up and files require backup or file deletion when no longer needed. The “File Utilities” section of the EZT-560 provides all the functionality required for maintaining the internal compact flash card. The internal compact flash card should not be removed from the EZT-560 interface. Any change to compact flash directory structure (moving or deleting files with a PC) will cause the EZT-560 interface to stop operating and a new compact flash card will need to be ordered. Never move or delete the directories unless using the internal EZT-560 file utilities.

**To copy files to the USB I-Stick:**

Check the checkbox next to “Copy To I-Stick”. Press the specific button that represents the file type to copy (Profile, etc.). All files from directory will be copied with progress status displayed to user.

**To erase files from internal compact flash:**

Check the checkbox next to “Delete From Internal Storage”. Press the specific button that represents the file type to erase (Profile, etc.). All files from directory will be erased with progress status displayed to user.

**To copy files to I-Stick and then erase files from internal compact flash:**

Check “Delete From Internal Storage” and “Copy To I-Stick” checkboxes. Press the specific button that represents the file type to copy/erase (Profile, etc.). All files from directory will be copied and then erased with progress status displayed to user.

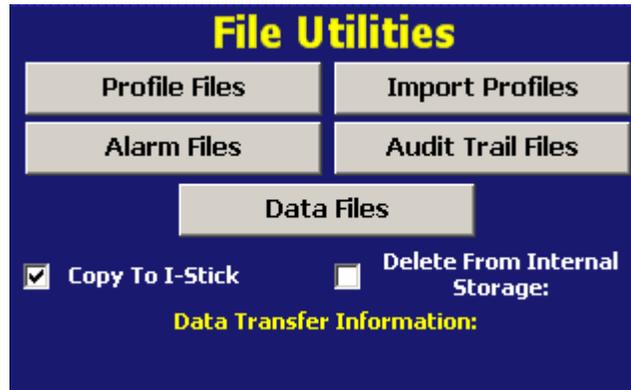


Figure 7-8 File Utilities

**NOTE:** Use only Cincinnati Sub-Zero “I-Stick” USB memory cards for copy file utilities. CSZ has tested and validated the “I-Stick” for proper operation and performance. CSZ does not guarantee or support the use of any other USB memory device.

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When files are being copied to the I-Stick storage device, a directory for each file type will be created to store the copied files. The directory structure is as follows:

Profile files directory: Profiles\_mm\_dd\_yyyy-hh\_mm\_ss  
Alarm files directory: AlarmFiles\_mm\_dd\_yyyy-hh\_mm\_ss  
Audit files directory: AuditFiles\_mm\_dd\_yyyy-hh\_mm\_ss  
Log files directory: DataFiles\_mm\_dd\_yyyy-hh\_mm\_ss

The reason for using the date and time as part of the directory name is to make sure the user can track the date and time of the file transfer. If a user transfers a file type more than once in a single day the files will be grouped logically by time.

The data files can be opened directly with Microsoft Excel or any program that opens a comma separated file format. You can copy or empty the "DataFiles" directory by simply plugging in the USB "I-Stick" in a PC's USB host port. This device then becomes like any removable disk attached to the computer and can be manipulated as once while plugged into the PC. The I-Stick requires no drivers when using WindowsXP operating system. The CSZ Data Viewer program is a free Windows accessory program that allows users to view, plot and print data files and is available from CSZ.

**NOTE:** Alarm and Audit files are also written in a ".csv" format and can be opened directly with excel after the "I-Stick" is inserted into the PC (after files are copied from internal compact flash to "I-Stick" memory device). No additional software is required to view alarm or audit files.

Once files are deleted from EZT-560 storage devices, they are gone and can not be retrieved. Once again, do not edit, move or delete any other files from the internal compact flash card unless using the EZT-560 "File Utilities". The EZT-560 will not operate properly if you do so.

*"WindowsXP" and "Excel" are trademarks of the Microsoft Corporation.*

## 8. System Maintenance

System maintenance options are available from the Chamber Setup menu. To access system maintenance, select System Maintenance from the chamber setup menu.

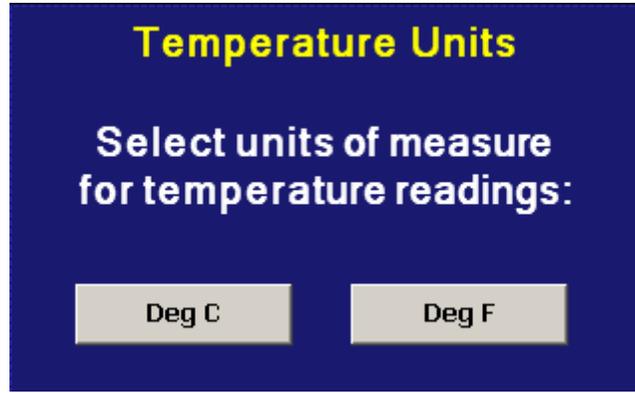


**NOTE:** Prior to entering system maintenance, all automatic chamber operations must be stopped. This includes data logging and profile operation.

Upon selecting system maintenance, an alert will tell the user that the chamber will be taken off line. The user can select "No" to return to the chamber setup menu without shutting down any current operations. If the user selects "Yes", all operating systems of the chamber will stop.

### **8.1 Degrees C/F Selection**

The EZT-560 can display temperatures in either degrees C or F. To change the units, select "Degrees C/F" from the Setup menu.



*Figure 8-1 Degrees C/F Selection*

Press the appropriate button to select the desired units. A message box will appear to acknowledge the units change. Press OK to close make the switch. The button for the selected unit will be illuminated green once selected.

**CAUTION** When changing display units, profile set points will not be converted between units. Separate profiles are required for each temperature range. Equipment damage may result if profiles of alternate units are used.

## 8.2 Service Monitors

The service monitors provide service interval alerts and life total service numbers for chamber components and systems. The service intervals are set by CSZ at the optimum period for system performance and reliability. When a component exceeds its service interval, a notification alarm can be generated. This will alert notify the operator that service should be performed at the next available down period.

Description	Interval	Actual
AIR CIRCULATORS	1000	155
SYS 1 COMPRESSOR	2250	133
SYS2 COMPRESSOR	2250	155
HEATERS	2000	455
HUMIDITY SYSTEM	2000	122
NOT USED	0	0

Press Tagname to clear counter:

Figure 8-2 Service Monitors

When a service interval is exceeded, an alert can be set to illuminate the corresponding indicator on the System Status Monitor screen. An audible alert can also be turned on to get the operator's attention. In order to clear the service alert, the elapsed service counter must be cleared.

To clear the service interval count, you must select the count that has been exceeded by touching its description on the Service Monitor screen. A pop-up window will ask if the count is to be cleared for the item you selected. Select "Yes" to clear the count. Note that the Service Monitor screen must be showing the "Elapsed" count.

The service monitor screen can be set to display the elapsed service interval or the life total for the component based on the selection made in the Service Info Setup screen. The alert method can also be disabled if this feature is not desired.

### 8.2.1 Service Monitor Setup

The service monitor display options as well as alert action can be adjusted from the Service Info Setup screen.

**Service Info Setup**

ELAPSED SERVICE OR TOTALS

ELAPSED SERVICE

TOTALS

ENABLE/DISABLE SERVICE ALARMS

SERVICE ALERT OFF

SERVICE ALERTS ON

ALERTS W/AUDIBLE ALARM

Accept

Figure 8-3 Service Monitor Setup

**Elapsed Service or Totals:** Selects which count is to be displayed on the Service Monitor screen.

**Enable/Disable Service Alarm:** Selects the method of service notification or disables alerts completely.

Service alerts are disabled by default. To make changes, place a check in the appropriate check box and press the "Accept" button. For information regarding the service monitors and what they mean, see section 10, Diagnostics.

### 8.3 Set Date/Time

The date and time can be adjusted by selecting Set Date/Time from the maintenance setup menu. The current date and time will be displayed in the field entry windows.



Figure 8-4 Set Date/Time

To make adjustments, touch the desired field entry box. The pop-up keypad will appear allowing a new value to be entered. Once all corrections are made, press the "Set Time" button. A message window will appear to acknowledge that the new date and time have been accepted. Press OK to close the message window.

**NOTE:** The time is set in 24 hour (military time). The day of week must be set correctly in order for the profile autostart by day to function correctly.

### 8.4 Touch Screen Calibration

After extended use and many hours of operation, it may be necessary to recalibrate the touch screen of the EZT-560. A typical sign that the screen may be out of adjustment, is inaccurate responses when attempting to press buttons, check boxes or adjust fields on the display. The calibration utility is provided in order to readjust the screen when this happens.

**NOTE:** Even after calibration, some fields may require finesse to operate. Check boxes require precise presses even when the screen is in full calibration. Most response issues result from “fat-fingering” the display. Use the tip of your finger or a stylus if necessary to operate the unit.

To access the screen calibration utility, select “Calibrate Touch” from the Setup menu. Push the “Calibrate Touch” button.



Figure 8-5 Touch Screen Calibration

From the “System Settings” window, touch the “Calibrate” button to start the calibration utility.

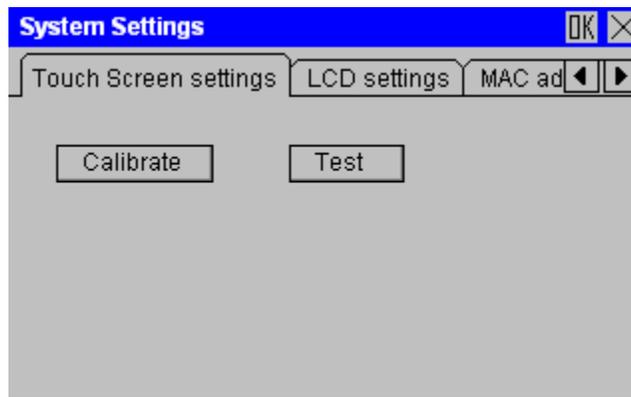
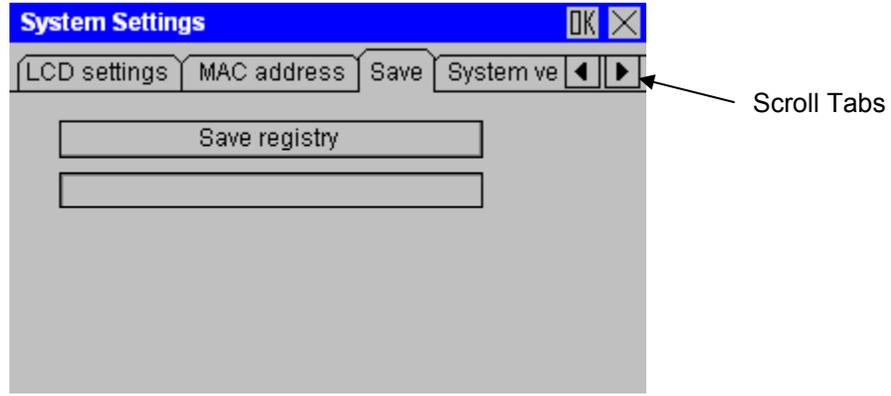


Figure 8-6 Touch Screen Settings

Crosshairs will appear on the screen. At each crosshair position, touch the screen and hold position until the crosshairs move to the next calibration point. Repeat this for each position in order to set the calibration. The calibration requires five points, the center and four corners. Once complete, the calibration utility will exit and return to the System settings window.

Use the scroll arrow button in the Systems settings window to scroll to the right until you see the "Save" tab. Touch the Save tab and press the "Save Registry" button. This will store the calibration parameters in memory. If the settings are not saved, the changes will be lost when power is cycled to the unit. Press the "OK" button on the upper right corner of the System settings window to close the window and return to System Maintenance.

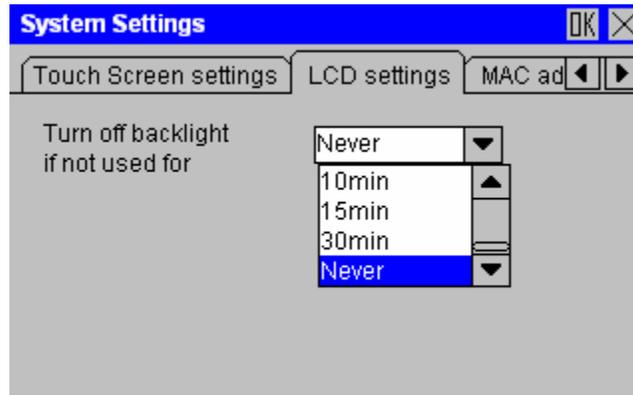


**Figure 8-7 Save Registry**

#### 8.4.1 LCD Settings

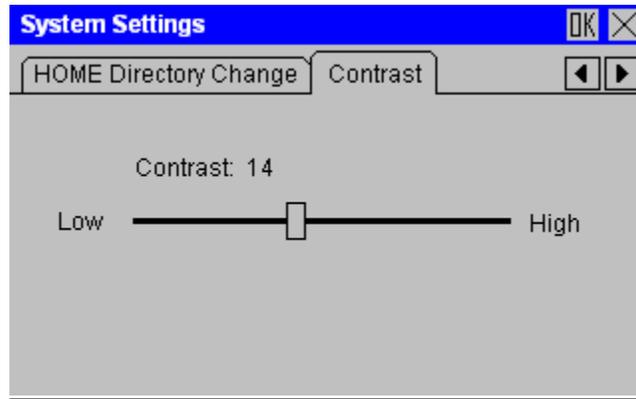
The "System Settings" window also provides access to the contrast and backlight adjustment of the EZT-560 touch screen. To access these settings, perform the procedure above to access system settings; however, do not perform the calibrate touch procedure.

The backlight is set to never turn off by default. To adjust the backlight, select the "LCD Settings" tab from the system settings window. Using the drop down menu and select the time period for which the backlight should turn off after no activity.



**Figure 8-8 LCD Settings**

Proceed to the "Save Registry" tab to save any changes in order for them to be the default at the next power-up. If the screen appears too bright or too dim based on your ambient lighting, you can adjust the screen brightness by selecting the "Contrast" tab from the System Settings window.



**Figure 8-9 Contrast**

Use the slider to adjust the screen contrast to achieve the best picture for your viewing. Remember to save any changes in order for them to be the default at the next power-up.

## 8.5 Calibration

The calibration menu provides access to the analog input and output ranges for calibration. Note that the "Input Calibration" will only be available if the monitor input option is provided on the chamber. The "Analog Output" calibration will only be available if analog outputs have been provided for retransmit of signals to external devices such as a chart recorder.

### 8.5.1 Input Calibration

There are two methods for calibrating inputs to the EZT-560. The control inputs, i.e., temperature, humidity, product, etc., must be done on through the individual 9300 PID control(s) located on the electrical panel. The monitor input calibration, is done through the EZT-560 touch screen interface.

#### 8.5.1.1 Calibrating Control Inputs

See Chapter 4, "Calibration", of the Future Design, FDC-9300 Self-Tune Fuzzy / PID Process / Temperature Controller User's Manual provided with your chamber for procedures and instructions on calibrating the control inputs.

**CAUTION** Do not alter any other parameters or settings within the 9300 controls. Any changes made to CSZ factory settings may cause unpredictable operation of the chamber which can result in damage to equipment and will void the chamber warranty.

#### 8.5.1.2 Calibrating Monitor Inputs

The monitor option provides up to 8 separate type "T" thermocouple inputs for monitoring temperatures throughout the chamber. The calibration range is fixed within the EZT-560 Eagle hardware; however, the user can input an offset in order to adjust for sensor tolerances and lead affects.

Through the use of a simple ice bath, all sensors can be corrected within a matter of minutes without having to disconnect leads or have expensive calibration equipment. With the chamber at ambient temperature, place a bucket of ice filled with water in the chamber. Place all monitor input thermocouples into the ice bath. Allow the probes to soak for a minimum of 30 minutes BEFORE entering an offset.

Select "Input Calibration" from the System Maintenance menu. Enter the number of the input in the "Input Num" field. The current reading from the input will be shown in the "Cur PV" field.

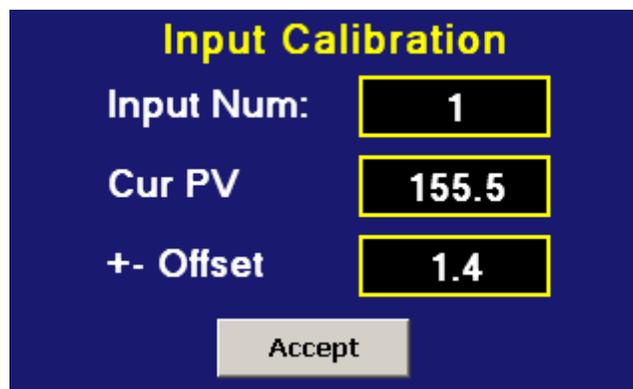


Figure 8-10 Monitor Input Calibration

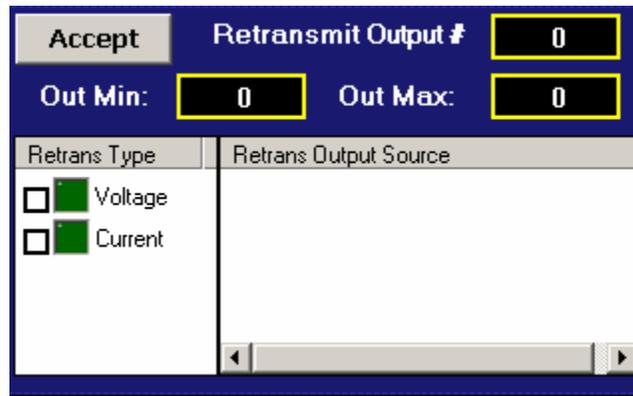
The reading should be 0°C (32°F), i.e., the ice bath temperature. To “zero” the input, enter the offset value in the “+/- Offset” field and verify the reading. Be sure to press the “Accept” button to save the new offset value before proceeding onto other inputs or exiting calibration or the offset value will be lost. The total error for the monitor inputs is  $\pm 3.5^{\circ}\text{C}$  ( $6.3^{\circ}\text{F}$ ). The input types are fixed and cannot be changed. If replacing sensors, be sure to replace with the same type.

**8.5.2 Output Calibration**

The EZT-560 can have up to 4 analog outputs which can be used to retransmit setpoints, process variables or percentages of output from the installed control loops. These outputs are optional and not included on all chambers.

**CAUTION** Some outputs may be provided for specific control functions depending upon the design of your chamber. Do not alter these output settings unless you are sure that they are used for monitoring purposes only. If you have any questions regarding the use of the output, contact Cincinnati Sub-Zero’s customer service department for assistance.

The analog outputs can be configured to retransmit signals either in a 0-10V range or a 4-20mA range. The minimum and maximum values of the output can be set to correspond to a specific value of the retransmitted source. The output will retransmit this source linearly from the minimum to maximum range. To configure an output, select “Output Calibration” from the System Maintenance menu.



*Figure 8-11 Output Calibration*

To configure an output, first select the output number by entering the value in the “Retransmit Output #” field. Upon entering the value, the outputs current configuration will be loaded and indicated by the LED’s next to the selected type and source. The minimum and maximum values will be shown in the “Out Min” and “Out Max” fields.

To make changes to the output’s configuration, place a check in the box next to the desired type and source for the output. Enter the new minimum and maximum values for which the output is to retransmit. Once all modifications have been made, press the “Accept” button to save the changes. If you do not press the “Accept” button, all changes will be lost if you leave the screen or enter a new analog output number.

**NOTE:** If you change the analog output type, i.e., change from voltage to current or vice versa, power must be cycled to the EZT-560 controller in order for the output to switch modes.

<b>Output Specifications</b>	Voltage Output	Current Output
Output Range	0-10Vdc	4-20mA
Load Impedance	2K ohm minimum	300 ohm maximum
Applicable Load	resistive	
Total Error	<u>+1%</u> of full scale	

## **9. Communications**

This section is targeted towards new users interested in using data communications with CSZ EZT-560 controllers. The purpose of this section is to enable users to:

1. Understand the basics of data communications via standard definitions, interfaces and protocols.
2. Set up and use a simple network of one or more EZT-560 controller(s).

In this section, numbers in the format 0x00 represent values in hexadecimal. Numbers in the format 0 represent values in decimal and finally, numbers in the format 00000000 represent values in binary unless otherwise stated.

### **9.1 Definition of Terms**

#### ***Machine-to-Machine Communication***

In order for machines to communicate with each other, they need a code called a character format or character set. They need rules called protocol to govern their conversation and prevent confusion and errors. Computers need a connecting interface over which to communicate. They may use one pair of wires to send information in one direction and another pair to send in the opposite direction (full duplex). Or they may use one pair to send in both directions (half duplex).

#### ***Character Format***

The code or character format for the EZT-560 data communication is shared by virtually everyone in the electronics industry. This code defines a computer stream of 1's and 0's, that are created by varying a voltage signal in a regular manner. This code is the American Standard Code for Information Interchange, called ASCII.

#### ***Bits and Bytes***

The word bit is simply the contraction of the words binary digit. A bit is the basic unit in ASCII. It is either a "1" or a "0". A byte is a string of eight bits that a computer treats as a single character. ASCII can use a single byte to represent each letter of the alphabet, each digit and each punctuation mark we use.

#### ***ASCII***

The ASCII code defines 128 separate characters, one for each letter, digit and punctuation mark. ASCII also includes control characters similar to those we find on computer keys, such as backspace, shift and return. It also has nine communications control characters for identification, enquiry (inquiry), start of text, end of text, end of transmission, acknowledge, negative acknowledge and escape. The ASCII code is sometimes written in a base 16 number system that is called hexadecimal or "hex" for short. The numbers 0 through 9 represents the first ten digits of this system, and the letters A through F represents the final six digits. The 128 ASCII character codes with the decimal, binary and hexadecimal equivalents are listed in the table below.

#### ***ASCII Control Codes***

ASCII Control Codes are used to give instructions to the remote device and result in specific actions, such as a line feed instruction on a printer. ASCII Control Codes, the first 33 ASCII characters (non printable), are important for the operation of communicating equipment. They give instruction to remote devices that result in specific actions such as a line feed on a printer. Holding down the keyboard control key while pressing the appropriate keyboard key will send these values.

### ASCII Chart

Char	Code	Decimal	Binary	Hex	Char	Code	Decimal	Binary	Hex
NUL	Ctrl @	0	00000000	00	@	Shift 2	64	01000000	40
SOH	Ctrl A	1	00000001	01	A	Shift A	65	01000001	41
STX	Ctrl B	2	00000010	02	B	Shift B	66	01000010	42
ETX	Ctrl C	3	00000011	03	C	Shift C	67	01000011	43
EOT	Ctrl D	4	00000100	04	D	Shift D	68	01000100	44
ENQ	Ctrl E	5	00000101	05	E	Shift E	69	01000101	45
ACK	Ctrl F	6	00000110	06	F	Shift F	70	01000110	46
BEL	Ctrl G	7	00000111	07	G	Shift G	71	01000111	47
BS	Ctrl H	8	00001000	08	H	Shift H	72	01001000	48
TAB	Ctrl I	9	00001001	09	I	Shift I	73	01001001	49
LF	Ctrl J	10	00001010	0A	J	Shift J	74	01001010	4A
VT	Ctrl K	11	00001011	0B	K	Shift K	75	01001011	4B
FF	Ctrl L	12	00001100	0C	L	Shift L	76	01001100	4C
CR	Ctrl M	13	00001101	0D	M	Shift M	77	01001101	4D
SO	Ctrl N	14	00001110	0E	N	Shift N	78	01001110	4E
SI	Ctrl O	15	00001111	0F	O	Shift O	79	01001111	4F
DLE	Ctrl P	16	00010000	10	P	Shift P	80	01010000	50
DC1	Ctrl Q	17	00010001	11	Q	Shift Q	81	01010001	51
DC2	Ctrl R	18	00010010	12	R	Shift R	82	01010010	52
DC3	Ctrl S	19	00010011	13	S	Shift S	83	01010011	53
DC4	Ctrl T	20	00010100	14	T	Shift T	84	01010100	54
NAK	Ctrl U	21	00010101	15	U	Shift U	85	01010101	55
SYN	Ctrl V	22	00010110	16	V	Shift V	86	01010110	56
ETB	Ctrl W	23	00010111	17	W	Shift W	87	01010111	57
CAN	Ctrl X	24	00011000	18	X	Shift X	88	01011000	58
EM	Ctrl Y	25	00011001	19	Y	Shift Y	89	01011001	59
SUB	Ctrl Z	26	00011010	1A	Z	Shift Z	90	01011010	5A
ESC	Ctrl [	27	00011011	1B	[	[	91	01011011	5B
FS	Ctrl \	28	00011100	1C	\	\	92	01011100	5C
GS	Ctrl ]	29	00011101	1D	]	]	93	01011101	5D
RS	Ctrl ^	30	00011110	1E	^	Shift 6	94	01011110	5E
US	Ctrl _	31	00011111	1F	_	Shift -	95	01011111	5F
SP	SPACE	32	00100000	20	`	`	96	01100000	60
!	Shift 1	33	00100001	21	a	A	97	01100001	61
"	Shift 2	34	00100010	22	b	B	98	01100010	62
#	Shift 3	35	00100011	23	c	C	99	01100011	63
\$	Shift 4	36	00100100	24	d	D	100	01100100	64
%	Shift 5	37	00100101	25	e	E	101	01100101	65
&	Shift 7	38	00100110	26	f	F	102	01100110	66
'	'	39	00100111	27	g	G	103	01100111	67
(	Shift 9	40	00101000	28	h	H	104	01101000	68
)	Shift 0	41	00101001	29	i	I	105	01101001	69
*	Shift 8	42	00101010	2A	j	J	106	01101010	6A
+	Shift =	43	00101011	2B	k	K	107	01101011	6B
,	,	44	00101100	2C	l	L	108	01101100	6C
-	-	45	00101101	2D	m	M	109	01101101	6D
.	.	46	00101110	2E	n	N	110	01101110	6E
/	/	47	00101111	2F	o	O	111	01101111	6F
0	0	48	00110000	30	p	P	112	01110000	70
1	1	49	00110001	31	q	Q	113	01110001	71
2	2	50	00110010	32	r	R	114	01110010	72
3	3	51	00110011	33	s	S	115	01110011	73
4	4	52	00110100	34	t	T	116	01110100	74
5	5	53	00110101	35	u	U	117	01110101	75
6	6	54	00110110	36	v	V	118	01110110	76
7	7	55	00110111	37	w	W	119	01110111	77
8	8	56	00111000	38	x	X	120	01111000	78
9	9	57	00111001	39	y	Y	121	01111001	79
:	Shift ;	58	00111010	3A	z	Z	122	01111010	7A
;	;	59	00111011	3B	{	Shift [	123	01111011	7B
<	Shift ,	60	00111100	3C		Shift \	124	01111100	7C
=	=	61	00111101	3D	}	Shift ]	125	01111101	7D
>	Shift .	62	00111110	3E	~	Shift `	126	01111110	7E
?	Shift /	63	00111111	3F	DEL	Delete	127	01111111	7F

## **9.2 Serial Communication**

The primary interface CSZ has chosen for the EZT-560 employs serial communication, which is the exchange of data in a one-bit-at-a-time, sequential manner on a single data line or channel. Serial contrasts with parallel communication, which sends several bits of information simultaneously over multiple lines or channels. Not only is serial data communication simpler than parallel, it is also less costly.

### **Baud Rate**

The baud unit is named after Jean Maurice Emile Baudot, who was an officer in the French Telegraph Service. He is credited with devising the first uniform-length 5-bit code for characters of the alphabet in the late 19th century. What baud really refers to is modulation rate or the number of times per second that a line changes state. This is not always the same as bits per second (BPS). However, if you connect two serial devices together using direct cables then baud and BPS are in fact the same. Thus, if you are running at 9600 BPS, then the line is also changing states 9600 times per second.

Typical baud rates for computers are 300, 600, 1200, 2400, 4800, 9600 and 19200 baud. As the baud rate increases, so does the transmission rate of data. Thus you get more information in a shorter period of time. However, the faster the transmission rate, the more susceptible it is to error due to the quality of the cable and sources of electrical "noise" in the environment. In order to balance throughput with reliability, CSZ has chosen to use 9600 baud as the data rate for the EZT-560. *Thus a device used to communicate with the EZT-560 must have its serial port set for 9600 baud in order to for data communications to work properly.*

### **Start and Stop Bits**

The start bit informs the receiving device that a character is coming, and a stop bit tells it that a character is complete. The start bit is always a 0. The stop bit is always a 1. The human speech equivalent of these bits could be a clearing of the throat to get someone's attention (start bit); and a pause at the end of a phrase (stop bit). Both help the listener understand the message.

A stop bit has a value of 1 - or a mark state - and it can be detected correctly even if the previous data bit also had a value of 1. This is accomplished by the stop bit's duration. Stop bits can be 1, 1.5, or 2 bit periods in length. CSZ has chosen to use the default - and most common - length of 1 period for the EZT-560. *A device used to communicate with the EZT-560 must also have its serial port set to use a stop bit of 1 in order for data communications to work properly.*

### **Parity Bit**

Besides the synchronization provided by the use of start and stop bits, an additional bit called a parity bit may optionally be transmitted along with the data. A parity bit affords a small amount of error checking, to help detect data corruption that might occur during transmission. You can choose either even parity, odd parity, mark parity, space parity or none at all. When even or odd parity is being used, the number of marks (logical 1 bits) in each data byte are counted, and a single bit is transmitted following the data bits to indicate whether the number of 1 bits just sent is even or odd.

For example, when even parity is chosen, the parity bit is transmitted with a value of 0 if the number of preceding marks is an even number. For the binary value of 0110 0011 the parity bit would be 0. If even parity were in effect and the binary number 1101 0110 were sent, then the parity bit would be 1. Odd parity is just the opposite, and the parity bit is 0 when the number of mark bits in the preceding word is an odd number. Mark parity means that the parity bit is always set to the mark signal condition and likewise space parity always sends the parity bit in the space signal condition. Since these two parity options serve no useful purpose whatsoever, they are almost never used. CSZ has chosen to use even parity with the EZT-560. *A device used to communicate with the EZT-560 must also have its serial port set to use even parity in order for data communications to work properly.*

### **9.2.1 Interface Standards**

An interface is a means for electronic systems to interact. It's a specific kind of electrical wiring configuration. CSZ has selected to use two of the most common serial interfaces used today. This provides both a simple 1 to 1 connection to a PC or PLC using readily available cabling as well as a multi-drop connection where more than one EZT-560 can be placed on the line.

#### ***EIA-232 (Full Duplex)***

An EIA-232 (formerly RS-232C) interface uses three wires: a single transmit wire; a single receive wire; and a common line. Only two devices can use an EIA-232 interface. A -3 to -24 volt signal indicates a 1 and a +3 to +24 volt signal indicates a 0. The EIA-232 signal is referenced to the common line rather than to a separate wire, as in EIA-485. Thus, an EIA-232 cable is limited to 50 feet, due to noise susceptibility.

#### ***EIA-485 (Half Duplex)***

An EIA-485 interface uses two wires: a T+/R+, a T-/R- line. A -5-volt signal is interpreted as a 1, a +5-volt signal as a 0. As many as 32 remote devices can be connected to a master on a multi-drop network up to 4,000 feet long.

#### ***Wiring***

Most PCs and some PLCs have a standard EIA-232 port (usually referred to as RS-232). In these instances, you must use an interface converter to connect to EIA-485. These interface standards are required to have a multi-drop system (more than one controller on the bus). See the list below for some vendors who sell these converters. Should your PC or PLC have the appropriate interface, just connect using the wiring shown in the Getting Started section.

For EIA-485, the terminal marked "A" usually connects to the T-/R- while the "B" terminal connects to the T+/R+ of the EZT-560 controller. The standards do not specify the wire size and type. Use of AWG 24 twisted pair provides excellent results. If shielded cable is used, terminate the shield at one end only. Always follow the manufacturer's instructions supplied with the interface converter. See Biasing of Buses next.

#### ***Biasing of Buses***

The EIA-485 standard requires the bus to be biased for reliable communication. This means to provide termination resistors across the T+/R+ and T-/R- wires. One resistor is placed at the PC or PLC where it connects to the EIA-485 bus. The second resistor is placed at the last controller on the network. Do not place resistors at each controller. The impedance of the wires used for the bus determines the resistor value. For twisted pair, the value is typically 120 ohms. In addition, it may be necessary to have a pull-up and pull-down resistor between the power supply and ground of the interface adapter.

Check the documentation that came with your interface adapter. Biasing the bus reduces reflection of signals sent down the bus. These reflections are sometimes referred to as a standing wave. This condition is most notable when communicating at high baud rates.

### 9.2.1.1 Interface Converters

The purpose of an interface converter is to allow two different buses to be connected together. Interface converters are required when connecting an EIA-232 port to an EIA-485 bus. The EIA-485 bus is a half duplex bus. This means that it can only send or receive data at any given time. Some interface converters on the market provide the ability to have full duplex with the EIA-485 bus. This is accomplished by using two receivers and transmitters tied in tandem. This type of converter will not work with the EZT-560 controller. Be sure that the model you purchase is designed for half duplex.

Another consideration when selecting an interface converter is how the converter handles switching between transmit and receive. Typically it is accomplished via a handshake line from the PC or PLC. When data flows into the converter from the PC, a handshake line is placed high. When data flows out of the converter to the PC, the handshake line is placed low. In this way, the handshake line controls the direction of information. Another method of achieving this is to use a built-in timer. The converter switches to transmit when a character is sent to it from the PC. After a period of time when the PC has not transmitted, the converter switches to a receive mode.

It is important that you understand how your converter accomplishes this task. You are required to wire this feature or make settings on the converter to enable this function. The PC will not talk to the controller correctly with out properly setting this. Your converter may also require settings through dip switches, to set up communications parameters like baud rate, data bits, start bits, stop bits and handshaking. The converter may also require a separate power supply. Some converters get their power from the handshake lines of the PC. If you rely on this method, you will need to wire these additional lines. In addition, your software must set these lines high. A more reliable method is to use the external power supply. This is especially necessary when using a laptop computer. See the documentation that comes with your converter for more detail.

Not all converters are equal in performance. If your chamber operates in a harsh, electrically noisy environment, this can cause less robust converters to work intermittently or not at all. CSZ has only tested the converters listed below; however, CSZ makes no claims as to the performance or compatibility of these converters with your PC or PLC device. These converters are equipped with automatic send data control circuits, driver control in the converter hardware, so you don't have to work with software at all. The circuit monitors data flow and enables the driver during transmission and automatically disables it when no data is being sent. There is no need to rework software or install new drivers.

B&B Electronics  
707 Dayton Road  
PO Box 1040  
Ottawa, IL 61350  
Phone 815-433-5100  
<http://www.bb-elec.com>

Part # **485OI9TB** for EIA-232 to EIA-85

Part # **485PS2** (external power supply – required if handshake lines unavailable for power)

RESmith  
4311 Smith Drive  
Hamilton, OH 45011  
Phone 513-874-4796  
<http://www.RS485.com>

Part # **ASC24T-B9FPS** for EIA-232 to EIA-485 (provided with adapter cables and power supply)

### 9.2.2 Protocol

Protocol describes how to initiate an exchange. It also prevents two machines from attempting to send data at the same time. There are a number of different data communications protocols, just as there are different human cultural protocols that vary according to the situation.

The protocol portion of EZT-560 communications is very important, because it provides a quality of communication that others often don't have. Protocol-driven communications are more accurate, because they are less prone to both operator and noise errors. Protocol maintains system integrity by requiring a response to each message. It's like registered mail — you know that your letter has been received because the post office sends you a signed receipt.

In EZT-560 data communications, a dialog will continue successfully as long as the messages are in the correct form and responses are returned to the protocol leader. If the operator enters an incorrect message, or interference comes on to the data line, there will be no response. In that case the master must retransmit the message or go to a recovery procedure. If an operator continues to enter an incorrect message or interference continues on the data line, the system will halt until the problem is resolved. CSZ has selected Modbus RTU as the protocol of choice. Modbus RTU enables a PC or PLC to read and write directly to registers containing the EZT-560's parameters. With it you could read all 180 of the controller's parameters with three read commands.

#### **Modbus Remote Terminal Unit (RTU)**

Gould Modicon, now called AEG Schneider, created this protocol for process control systems called "Modbus". It has the advantage over other protocols of being extremely reliable in exchanging information. This protocol works on the principle of packet exchanges. The packet contains the address of the controller to receive the information, a command field that says what is to be done with the information and several fields of data. Reading from these registers retrieves all information in the controller. The last item sent in the packet is a field to ensure the data is received intact. This is called a cyclic redundancy check-sum. See the example below for information on how to generate this value. All information exchanged is in hex numbers. The EZT-560 only supports the binary version of Modbus, referenced as RTU. The ASCII version is less efficient and is not supported.

The CRC (Cyclical Redundancy Checksum) is calculated by the following steps:

1. Load a 16-bit register (called CRC register) with 0xFFFF
2. Exclusive OR the first 8-bit byte of the command message with the low order byte of the 16-bit CRC register, putting the result in the CRC register.
3. Shift the CRC register one bit to the right with MSB zero filling. Extract and examine the LSB.
4. If the LSB of the CRC register is zero, repeat step 3, else Exclusive OR the CRC register with the polynomial value 0xA001.
5. Repeat steps 3 and 4 until eight shifts have been performed. When this is done, a complete 8-bit byte will have been processed.
6. Repeat steps 2 through 5 for the next 8-bit byte of the command message. Continue doing this until all bytes of the command message have been processed. The final contents of the CRC register is the CRC value.

**When transmitting the CRC value in the message, the upper and lower bytes of the CRC value must be swapped, i.e. the lower order byte will be transmitted first.**

**Cyclical Redundancy Checksum (CRC) Algorithm**

```
unsigned int calc_crc(unsigned char *start_of_packet, unsigned char *end_of_packet)
{
    unsigned int crc;
    unsigned char bit_count;
    unsigned char *char_ptr;

    /* Start at the beginning of the packet */
    char_ptr = start_of_packet;
    /* Initialize CRC */
    crc = 0xFFFF;
    /* Loop through the entire packet */
    do{
        /* Exclusive-OR the byte with the CRC */
        crc ^= (unsigned int)*char_ptr;
        /* Loop through all 8 data bits */
        bit_count = 0;
        do{
            /* If the LSB is 1, shift the CRC and XOR the polynomial mask with the CRC */
            if(crc & 0x0001){
                crc >>= 1;
                crc ^= 0xA001;
            }
            /* If the LSB is 0, shift the CRC only */
            else{
                crc >>= 1;
            }
        } while(bit_count++ < 7);
    } while(char_ptr++ < end_of_packet);
    return(crc);
}
```

### **9.2.3 Write your own Modbus Application**

Listed below are a few of the more common software packages that claim to support the Modbus protocol. CSZ does not recommend any one software package nor supports the implementation of any software package not sold by CSZ. This list is provided as informational only. CSZ makes no claims as to the performance or compatibility of any software package with your particular PC or PLC hardware. Contact the software manufacturer for more information in applying their software.

LabView by National Instruments  
6504 Bridge Point Parkway  
Austin, TX 78730-5039  
Phone 512-794-0100  
<http://www.natinst.com>

OI-2000 by Software Horizons, Inc.  
10 Tower Office Park  
Suite 200  
Woburn, MA 01801-2120  
Phone 617-933-3747  
<http://www.shorizons.com>

SpecView by SpecView, LLC  
41 Canyon Green Court  
San Ramon, CA 94583  
Phone 510-275-0600  
<http://www.specview.com>

Wonderware 2000 by Wonderware  
Corp.  
100 Technology Drive  
Irvine, CA 92718  
Phone 714-727-3200  
<http://www.wonderware.com>

If you already have a software application that uses Modbus, you can simply skip to EZT-560 parameter table in the Getting Started section for the information your program will need. The rest of this section provides information for writing a software application that uses Modbus.

1. You need to code messages in eight-bit bytes, with event parity, one stop bit (8, even, 1).
2. Negative parameter values must be written in twos' complement format. Parameters are stored in two-byte registers accessed with read and write commands to a relative address.
3. Messages are sent in packets that are delimited by a pause at least as long as the time it takes to send 30 bits. To determine this time in seconds, divide 30 by the baud rate. In the case of EZT-560 communications at 9600 baud, this calculates to a minimum period of 3ms.
4. Values containing decimal points such as process values and setpoints, have the decimal point assumed, i.e., the data exchange can only be performed using whole numbers. Thus, the value must be offset by a factor of 10 in order to exchange the data correctly. For example, a setpoint of 42.4 degrees must be sent as a value of 424 in order for the EZT-560 to set correctly. Likewise, a process value read from the EZT-560 with a value of 967 is actually 96.7 degrees. Consult the parameter table for the proper format of each value.
5. When monitoring a process, try to keep the number of read and write commands to a minimum of 500ms between exchanges to a single controller. Continuously reading data at a faster rate consumes an excess amount of the controller's processor time and does not provide any additional benefits in process monitoring.

#### ***Handling Communication Errors***

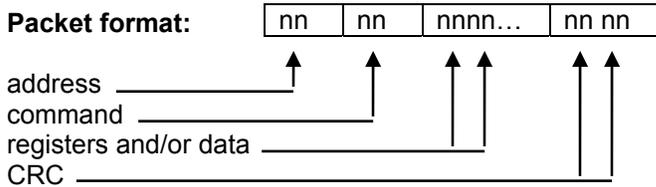
Reading or writing from/to a register that does not exist or is currently disabled will typically respond with an erroneous value or result in a time-out response, i.e., the EZT will not respond with a return message. Messages with the wrong format, timing or CRC are also ignored. A response will not be given to them. Only messages with the proper format, timing and CRC will be acknowledged. It is the user's responsibility to handle the error appropriately within their own software and determine whether to resend the message or halt for operator intervention.

#### ***User Responsibility***

Refrain from altering prompts that do not appear on the EZT-560's front panel or are not included on the specific model. Care must also be taken that the process can not cause damage to property or injury to personnel if the wrong commands are sent due to operator error or equipment malfunction. Be sure to use limit devices on any equipment placed inside the chamber that can generate heat to prevent system runaway.

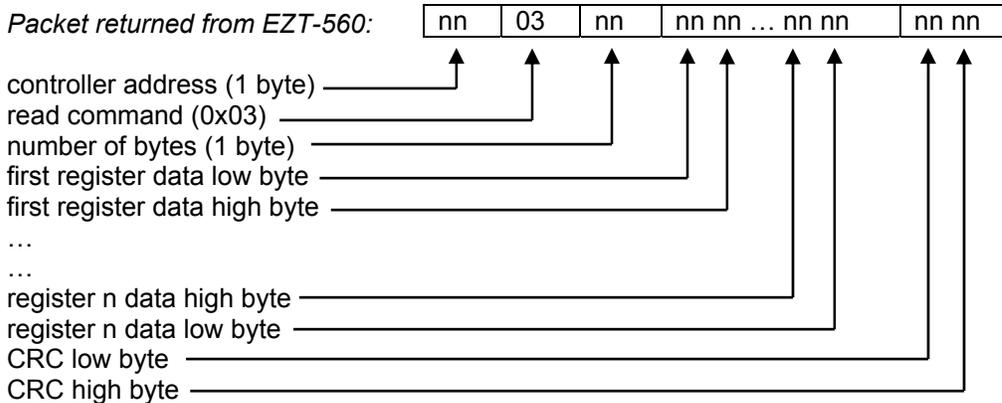
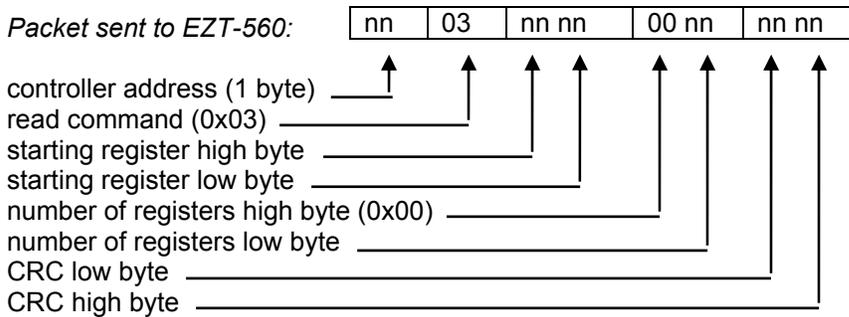
**9.2.4 Packet Syntax**

Each message packet begins with a one-byte controller address, from 0x01 to 0xF7. The second byte in the message packet identifies the message command: read (0x03); write (0x10); or loop back (0x08). The next n bytes of the message packet contain register addresses and/or data. The last two bytes in the message packet contain a two-byte Cyclical Redundancy Checksum (CRC) for error detection.



**Read Register(s) Command (0x03)**

This command returns from 1 to 60 registers.



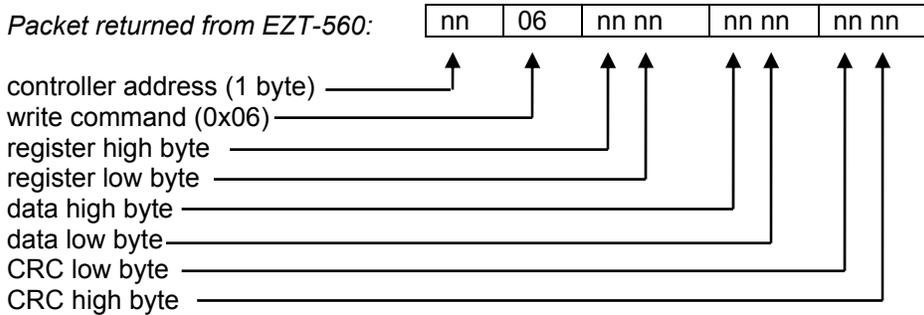
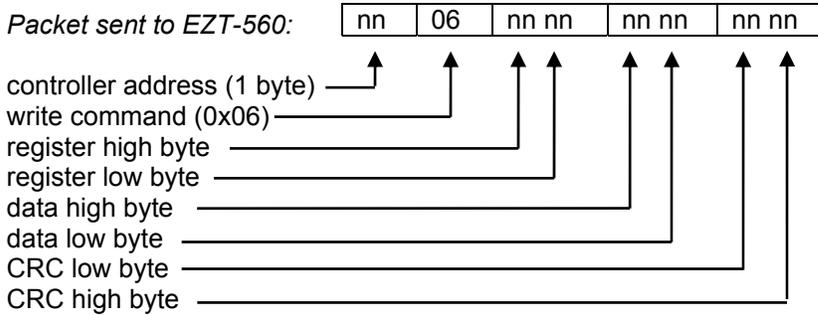
**Example:** Read register 61 (chamber temperature) of controller at address 1.  
 Sent: 01 03 00 3D 00 01 15 C6  
 Received: 01 03 02 00 EC B9 C9  
 Message: 236 (0x00EC) – temperature is 23.6 degrees

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**Example:** Read registers 60 and 61 (chamber setpoint and temperature) of controller at address 1.  
 Sent: 01 03 00 3C 00 02 04 07  
 Received: 01 03 04 01 90 01 48 FA 44  
 Message: 400 (0x0190) and 328 (0x0148) – setpoint is 40.0 and temperature is 32.8 degrees

### Write Register Command (0x06)

This command writes a value to a single register.

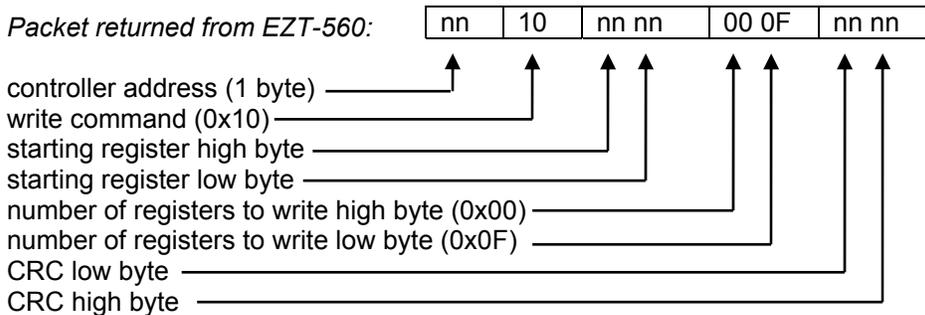
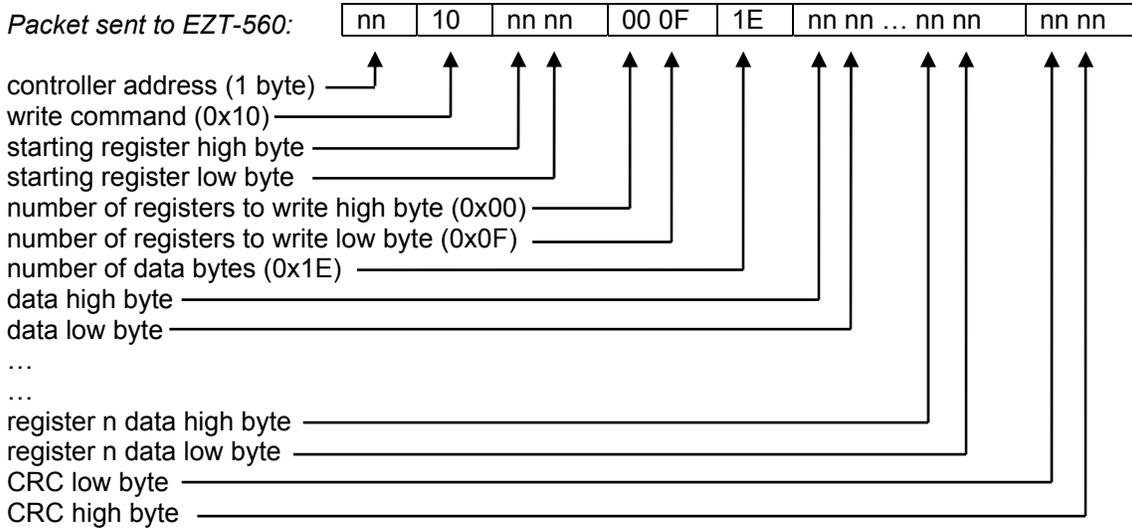


**Example:** Write register 60 (temperature set point) of controller at address one to 20 degrees.  
 Sent: 01 06 00 3C 00 C8 48 50  
 Received: 01 06 00 3C 00 C8 48 50

**Write Registers Command (0x10)**

**NOTE:** This command is for use with profile download only. It is used to transmit profile data one step at a time to the EZT-560. See Section 9.4.2 for the profile parameters and their use.

If this command is used to write to registers other than the correct profile step registers, the EZT-560 will respond with the acknowledge that the message was received; however, the command will not be executed.



### **9.3 GPIB (IEEE-488) Communication**

The GPIB communication option is provided through the use of ICS's Model 4899 GPIB-to-Modbus Controller. The 4899 is an IEEE 488.2 compatible GPIB device that can control single or multiple Modbus slave devices. It accepts simple GPIB bus commands that are used to create Modbus RTU packets that are transmitted serially to the Modbus slave device(s). The data transmission can be to a single Modbus device over an EIA-232 link or to multiple Modbus devices over an EIA-485 network.

The Controller's SCPI parser accepts IEEE-488.2 common commands, SCPI commands and Modbus commands. The IEEE-488.2 and SCPI commands are used to setup the Controller's Status Reporting Structure or to configure its GPIB and serial interfaces. Any commands that end in a '?' are a query and the Controller responds by outputting the requested data on the GPIB bus the next time it is addressed as a talker.

The 4899 includes a list of commands for controlling Modbus devices. These commands specify the Modbus slave device address, a read or write operation, a register number and data or the number of registers to be read. When the Controller receives a read (R) or write (W) command, it converts the GPIB characters into HEX bytes, assembles the packet, and transmits it to the Modbus device. This simplifies communications with the EZT-560 by automatically handling the Modbus protocol.

By utilizing the two read and write commands, it is possible to access all of the EZT-560's parameters. See the parameter list in the Getting Connected section of this manual for the list of registers and their associated values. For a complete description and detailed explanation of the 4899 and all of its associated commands, see section 3, Operation, of the 4899 manual provided with your chamber.

**9.3.1 Command Structure**

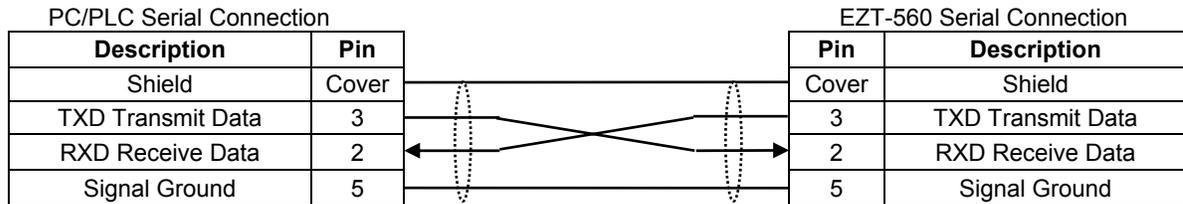
There are five base commands that are required to configure and operate the GPIB controller in order to communicate with the EZT-560 controller. These commands are listed in the table below. All commands are generated using standard ASCII text characters.

Command	Use
SYST:COMM:GPIB:ADDR <i>addr</i>	<p>GPIB Address Command</p> <p>Sets the GPIB controller's device address for subsequent commands. Value for <i>addr</i> is 1 to 30. This is the address you will use to communicate with the EZT over the GPIB bus.</p>
*SAV 0	<p>Save Configuration Command</p> <p>Saves current 4899 configuration in nonvolatile memory so that on next power-up, settings such as the GPIB address will remain in tact.</p>
R[?] <i>reg, num</i>	<p>Read Register Command</p> <p>Reads one or multiple EZT-560 registers. User specifies starting register <i>reg</i> and number of registers to be read <i>num</i>. The [?] is an optional symbol so programs like ICS's GPIBKybd program can recognize the command as a query and automatically read the response. Values for <i>reg</i> are 0 to 32767. Values for <i>num</i> are 1 to 60. Responses are returned as 16-bit decimal values separated by commas.</p> <p>R? 61,1 reads EZT-560 loop 1 process value. Example response is 527 for 52.7 degrees.</p> <p>R? 60,3 reads three successive registers for loop 1 SP, PV and %Out. Example response is 550,527,10000 for SP of 55.0, PV of 52.7 and %Out of 100.00.</p>
WB <i>reg, num, w(0).w(n)</i>	<p>Write Block Command</p> <p>Writes one or multiple 16-bit words, <i>w(i)</i> to one or multiple registers. Starting register, <i>reg</i>. Number, <i>num</i> specifies how many words are to be written. Values for <i>reg</i> are 0 to 32767. Values for <i>num</i> are 1 to 60. Values for <i>w</i> are 0 to 65535.</p> <p>WB 60, 1, 550 writes a set point of 55.0 to loop 1.</p>
E?	<p>Read Error Command.</p> <p>Reads and clears the Modbus Error Register and bit 6 in the Event Status Register. Returns an error code whose value is 0 to 255.</p> <p>Error values are:  0 No errors present  1 Exception Code 1  2 Exception Code 2  3 Exception Code 3  100 CRC Error  101 Timeout Error indicates no characters received  2nn Partial or corrupted message, nn is number of received bytes.</p>

### 9.4 Getting Connected

#### EAI-232 Connections

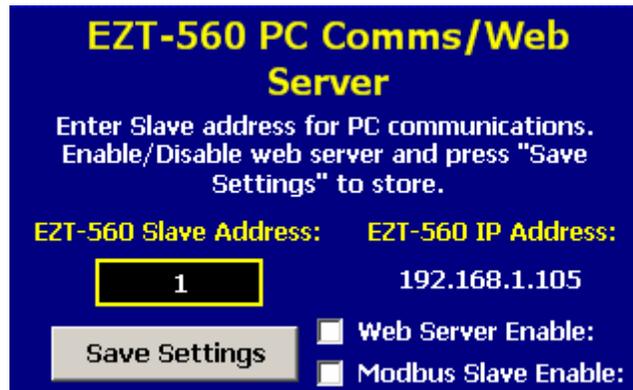
To connect the EZT-560 to a PC or PLC's serial port, a null-modem cable is required. This type of cable is designed to allow two devices to communicate with each other via their serial ports. This cable differs from that of a standard cable in the fact that transmit and receive wires are reversed. If one is not available, a cable can be fashioned rather easily. Use a high quality shielded cable and connect the leads as shown below:



Connect the cable between the EZT-560's serial port and the desired serial port on the PC or PLC. The serial port settings of the EZT-560 are fixed other than the controller address. The PC or PLC's serial port must be set to match the EZT-560's port settings.

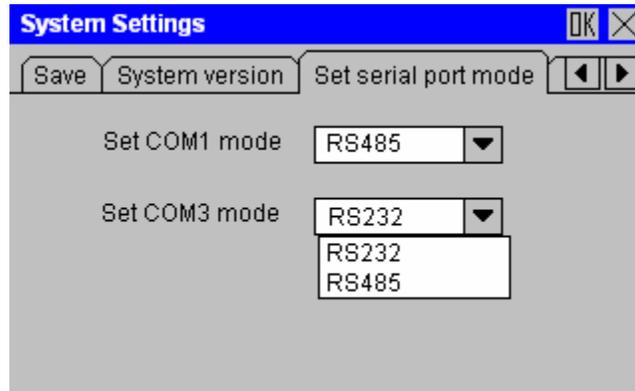
#### EIA-485 Connections

The EZT-560's serial communications is configured for EIA-232 by default. The Modbus slave can only communicate via one mode or the other (232 or 485) at a given time. In order to use the EIA-485 connection, you must change the serial communications mode. To do this, you must first disable the Modbus slave on the "PC Comms/Web Server" screen under the chamber setup menu.



To disable the slave, uncheck the check box next to "Modbus Slave Enable" and press the "Save Settings" button. This will turn off the serial server. Next, enter system maintenance and select "Calibrate Touch Screen" from the system maintenance setup menu. Press the "Calibrate Touch" button to enter the CECP utility.

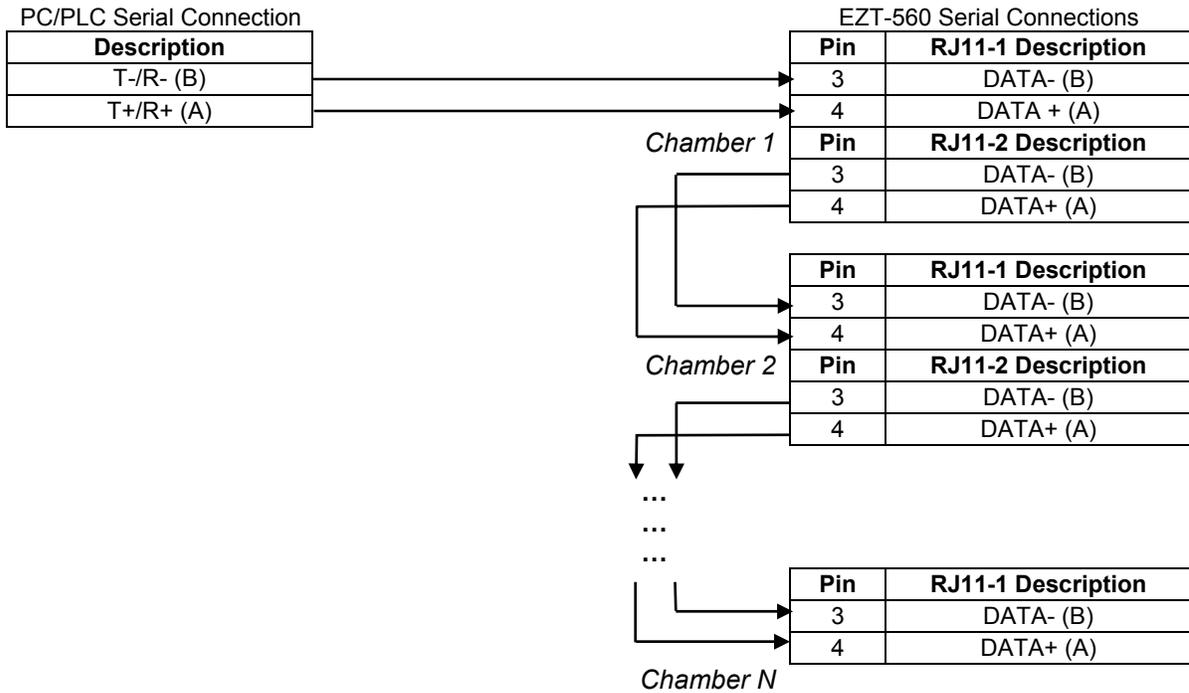
Select the "Set serial port mode" tab. Set the COM3 mode to "RS485". **DO NOT** change the COM1 mode or the EZT-560 will fail to start. COM1 mode must be RS485.



*Figure 9-1 Serial Port Mode*

Once the change is made, select the "Save" tab and save the change to the registry. The serial port mode change will not be retained unless you do this. Press the "OK" button at the top right of the window to close the CECF utility. Press the "Return to Setup" button on the calibrate touch screen and navigate back to the "PC Comms/Web Server" screen in the chamber setup menu. Place a check in the modbus slave enable check box and press the "Save Settings" button. This will turn the slave back on. The EZT-560 is now set to use EIA-485 for serial communications.

The EZT-560's communication interface supplies two RJ-11 connectors for convenient daisy-chaining of multiple chambers to a single PC or PLC's serial port. The connection requires only two wires, pins 3 and 4 of the RJ11 connection. The PC or PLC's serial port must be equipped for RS-485 half duplex communications or an interface converter must be used.



**Required PC/PLC Serial Port Settings**

Baud Rate: 9600  
 Data Bits: 8  
 Stop Bits: 1  
 Parity: Even

The EZT-560 is configured with a default address of 1. The address can be changed by selecting a new value via the PC communications Setup menu. Using the following parameter list, format the proper commands using the afore mentioned Modbus protocol packet structure.

***GPIB (IEEE-488) Connections (optional)***

If your chamber is equipped with the optional IEEE communications port, connect the chamber to your PC's IEEE port using a high quality shielded cable. Up to 15 devices can be connected on a single IEEE bus.

The IEEE interface is configured with a default address of 4. The address can be changed by using the proper command string (see section 9.3). Note that the PC communications address set in the EZT-560 should always be 1. This is the default address that the IEEE interface will use when communicating on its serial interface to the EZT-560 controller.

**9.4.1 EZT-560 Control Parameters**

The EZT-560 is capable of utilizing up to five control loops and eight monitor inputs. The following parameter table lists the associated values for all of the loops, inputs and their associated alarms by the loop or monitor input number. While the monitor inputs will be easy to decipher, since they are shipped from the factory with the relative number in their tag name, the loops are not. The loop names are defined by the chamber process they control, i.e., temperature, humidity, etc., since the number of control loops required and their function can vary between different chamber models.

For all chamber models, loop 1 will always be the temperature loop. As each loop is scrolled through, from left to right on the EZT interface, the loop number will increment by one for each loop view until all loops are viewed and the interface wraps back around to loop 1. The chart below provides a loop number to controlled parameter reference for use in selecting the desired parameter from the parameter list.

LOOP	TEMPERATURE/HUMIDITY MODELS		ALTITUDE MODELS		VTS/TSB MODELS	DTS MODELS
1	TEMPERATURE	TEMPERATURE	TEMPERATURE	TEMPERATURE	HOT CHAMBER (BATH)	LEFT CHAMBER
2	PRODUCT	HUMIDITY	ALTITUDE	HUMIDITY	COLD CHAMBER (BATH)	CENTER CHAMBER
3	-	PRODUCT	PRODUCT	ALTITUDE	PRODUCT	RIGHT CHAMBER
4	-	-	-	PRODUCT		DUT LEFT BASKET
5	-	-	-	-		DUT RIGHT BASKET

The chamber events also vary based on the model of chamber and options present. In order to turn the chamber and associated options on and off, it is necessary to set the proper event. The chart below provides the chamber event number and its associated function based on the chamber model. The chamber events are listed in order from top to bottom on the EZT's event screen. The EZT can use a combination of up to nine chamber events.

EVENT	STANDARD MODELS (TMP/RH/ALTITUDE)	VTS/TSB MODELS	DTS MODELS
1	CHAMBER	HOT CHAMBER / BATH ON	LEFT CHAMBER
2	HUMIDITY	COLD CHAMBER (VTS ONLY)	CENTER CHAMBER
3	AUX COOL	AUX COOL	AUX COOL
4	PURGE	PURGE	PURGE
5	ALTITUDE	XFR HOT	XFR LEFT
6	-	XFR COLD	XFR RIGHT
7	-	XFR UNLOAD (TSB ONLY)	RIGHT CHAMBER
8	RC BLOWER	-	-
9	INITIATE DEFROST	INITIATE DEFROST (VTS ONLY)	INITIATE DEFROST (CENTER ONLY)

**User Responsibility**

Adhere to the following table of registers and their allowable data ranges. Do not attempt to write to any other register number than those listed below. Do not write to registers that are for options your unit does not have. Failure to do so can result in erratic control and or damage to equipment.

**NOTE:** Register numbers listed are relative values. To convert to absolute values, add 40001.

Register #	Description	Use
0 r	(0x0000) EZT-560 Mode	0 Offline (maintenance mode) 1 Online  When the EZT-560 is in maintenance mode, the system no longer updates parameter values and the chamber is inoperative.
1 r	(0x0001) Clock (YY/MM)	0-99 Year (high byte) 1-12 Month (low byte)  Parameter contains both current year and month of system clock. The value will be an integer value based on the combined bytes of both the year and month. In order to obtain the individual values, split the word into its two component bytes. Example:  0x0601 read from EZT high byte 0x06 converted to decimal 6 (2006) low byte 0x01 converted to decimal 1 (January)
2 r	(0x0002) Clock (DAY/DOW)	1-31 Day of Month (high byte) 0-6 Day of Week (low byte) 0 Sunday 1 Monday 2 Tuesday 3 Wednesday 4 Thursday 5 Friday 6 Saturday  Parameter contains both day of month and day of week of system clock. The value will be an integer value based on the combined bytes of both the day of month and week. In order to obtain the individual values, split the word into its two component bytes. Example:  0x1701 read from EZT high byte 0x17 converted to decimal 23 (23 <sup>rd</sup> day of month) low byte 0x01 converted to decimal 1 (Monday)
3 r	(0x0003) Clock (HH/MM)	0-23 Hours (high byte) – 24hr format (military time) 0-59 Minutes (low byte)  Parameter contains both hours and minutes of system clock. The value will be an integer value based on the combined bytes of both the hours and minutes. In order to obtain the individual values, split the word into its two component bytes. Example:  0x1131 read from EZT high byte 0x11 converted to decimal 17 (5pm) low byte 0x31 converted to decimal 49 (minutes)
4 r	(0x0004) Clock (seconds)	0-59

Register #	Description	Use
5 r/w (0x0005)	Restart Mode	0 Continue 1 Hold 2 Terminate 4 Reset
6 r/w (0x0006)	Recovery Time	0-32767 seconds
7 r/w (0x0007)	Defrost Operating Mode*	0 Defrost Disabled 1 Defrost in Manual 2 Defrost in Auto
8 r/w (0x0008)	Auto Defrost Temperature Setpoint*	-32768-32767 (-3276.8-3276.7)  Note that value must be converted from/to whole number, i.e., divide/multiply by ten to convert the decimal number from the value read or to the proper value for a write.
9 R/w (0x0009)	Auto Defrost Delay*	0-32767 minutes
10 r (0x000A)	Defrost Status*	0 Not in Defrost 1 In Defrost 2 Prechill
11 r (0x000B)	Time Remaining until next Defrost*	0-32767 minutes
12 r/w (0x000C)	Product Control Mode*	0 Product Control Off 1 Product Control in Deviation Mode 2 Product Control in Process Mode
13 r/w (0x000D)	Product Control Upper Setpoint*	-32768-32767 (-3276.8-3276.7)  Note that value must be converted from/to whole number, i.e., divide/multiply by ten to convert the decimal number from the value read or to the proper value for a write.
14 r/w (0x000E)	Product Control Lower Setpoint*	
15 r/w (0x000F)	Condensation Control Mode*	0 Condensation Control Off 1 Condensation Control On
16 r/w (0x0010)	Condensation Control Monitor Mode*	1 Single Input 2 Lowest Input 4 Highest Input 8 Average
17 r/w (0x0011)	Condensation Control Input Selection*	Bit1 Product Bit2 PV1 (monitor) Bit3 PV2 (monitor) Bit4 PV3 (monitor) Bit5 PV4 (monitor) Bit6 PV5 (monitor) Bit7 PV6 (monitor) Bit8 PV7 (monitor) Bit9 PV8 (monitor)  This parameter is bit oriented, i.e., enabling the different bits of the word enables (1) or disables (0) the use of the input for condensation control. Note that monitor inputs may not be available on your system. Example:  Select product, PV1, PV5, PV6 and PV7 inputs: 000000011100011 (227 decimal converts to 0x00E3)

Register #	Description	Use
18 r/w (0x0012)	Temperature Ramp Rate Limit*	0-50 Temperature (0.0 to 5.0C) 0-90 Temperature (0.0 to 9.0F)  Note that value must be converted from/to whole number, i.e., divide/multiply by ten to convert the decimal number from the value read or to the proper value for a write.
19 r (0x0013)	Dewpoint Limit*	-32768-32767 (-3276.8-3276.7)  Note that value must be converted from whole number, i.e., divide by ten to convert the decimal number from the value read.
20 r (0x0014)	Actual Dewpoint*	
21 w (0x0015)	Chamber Light Control	1 Turn on/off chamber interior light.  Parameter automatically resets to 0 once set.
22 r/w (0x0016)	Chamber Events	Bit1 Chamber Event 1 Bit2 Chamber Event 2 Bit3 Chamber Event 3 Bit4 Chamber Event 4 Bit5 Chamber Event 5 Bit6 Chamber Event 6 Bit7 Chamber Event 7 Bit8 Chamber Event 8 Bit9 Chamber Event 9 Bit10 ---- Bit11 ---- Bit12 ---- Bit13 ---- Bit14 ---- Bit15 ----  This parameter is bit oriented, i.e., enabling the different bits of the word enables (1) or disables (0) the event. Note that not all events may be present on your chamber or additional events may be present depending upon options. Consult your chamber manual. Example:  Turn on Chamber: 0000000000000001 (1 decimal converts to 0x0001)  With chamber on, turn on dry air purge : 000000000001001 (9 decimal converts to 0x0009)
23 r/w (0x0017)	Customer Events*	Bit1 Customer Event 1 Bit2 Customer Event 2 Bit3 Customer Event 3 Bit4 Customer Event 4 Bit5 Customer Event 5 Bit6 Customer Event 6 Bit7 Customer Event 7 Bit8 Customer Event 8 Bit9 Customer Event 9 Bit10 Customer Event 10 Bit11 Customer Event 11 Bit12 Customer Event 12 Bit13 Customer Event 13 Bit14 Customer Event 14 Bit15 Customer Event 15  This parameter is bit oriented, i.e., enabling the different bits of the word enables (1) or disables (0) the events. These are available only with customer event output option. Example:  Turn on Customer events 7, 10 14 and 15: 0110001001000000 (25152 decimal converts to 0x6240)

Register #	Description	Use
24 (0x0018) r/w	Profile Status	<p><u>Control Values</u></p> <p>0 Off 1 Terminate (all off) 2 Hold 4 Run/Resume</p> <p><u>Monitor Values</u></p> <p>8 Autostart 16 Wait 32 Ramp 64 Soak 128 Guaranteed Soak</p> <p>The control values allow the currently loaded profile to be started, stopped or placed into hold. The monitor values provide status on the current operating profile's condition.</p> <p>Should the profile be placed into hold, it will remain in hold and the parameter value will remain at 2 until the profile is resumed or terminated.</p>
25 (0x0019) w	Profile Advance Step	<p>1 Advance Previous Step 2 Advance Next Step</p> <p>When profile is in hold, the parameter is enabled and allows the user to manually repeat or advance steps in a profile. The parameter automatically resets to 0 once set to indicate advance has taken place.</p>
26 (0x001A) r	Profile Name (chars 1 & 2)	<p>These parameters store the operating profile's name up to 10 characters in length. (uses ASCII character set) Characters are stored in sequence from low byte to high byte. Example:</p> <p>0x4554 0x5453 0x3120 0x3332 0x0000 read from EZT E T T S 1 3 2 converted to ASCII</p> <p>Swap each character pair and combine to form: TEST 123</p>
27 (0x001B) r	Profile Name (chars 3 & 4)	
28 (0x001C) r	Profile Name (chars 5 & 6)	
29 (0x001D) r	Profile Name (chars 7 & 8)	
30 (0x001E) r	Profile Name (chars 9 & 10)	
31 (0x001F) r	Profile Start Date (YY/MM)	<p>0-99 Year (high byte) 1-12 Month (low byte)</p> <p>Parameter contains both current year and month of profile start date. The value will be an integer value based on the combined bytes of both the year and month. In order to obtain the individual values, split the word into its two component bytes. Example:</p> <p>0x0601 read from EZT high byte 0x06 converted to decimal 6 (2006) low byte 0x01 converted to decimal 1 (January)</p>
32 (0x0020) r	Profile Start Date (DAY/DOW)	<p>1-31 Day of Month (high byte) 0-6 Day of Week (low byte)</p> <p>0 Sunday 1 Monday 2 Tuesday 3 Wednesday 4 Thursday 5 Friday 6 Saturday</p> <p>Parameter contains both day of month and day of week of profile start date. The value will be an integer value based on the combined bytes of both the days. In order to obtain the individual values, split the word into its two component bytes.</p>

Register #	Description	Use
		<p>Example:</p> <p>0x1701 read from EZT                      high byte 0x17 converted to decimal 23 (23<sup>rd</sup> day of month)                      low byte 0x01 converted to decimal 1 (Monday)</p>
33 r	(0x0021) Profile Start Time (HH/MM)	<p>0-23 Hours (high byte) – 24hr format (military time)                      0-59 Minutes (low byte)</p> <p>Parameter contains both hours and minutes of profile start time. The value read from the EZT-560 will be an integer value based on the combined bytes of both the hours and minutes. In order to obtain the individual values, split the word into its two component bytes. Example:</p> <p>0x1131 read from EZT                      high byte 0x11 converted to decimal 17 (5pm)                      low byte 0x31 converted to decimal 49 (minutes)</p>
34 r/w	(0x0022) Profile Estimate Stop Date (YY/MM)	See Profile Start Date (YY/MM)
35 r	(0x0023) Profile Estimate Stop Date (DAY/DOW)	See Profile Start Date (DAY/DOW)
36 r	(0x0024) Profile Estimate Stop Time (HH/MM)	See Profile Start Time (HH/MM)
37 r/w	(0x0025) Profile Start Step	1-99
38 r	(0x0026) Profile Current Step	1-99
39 r	(0x0027) Profile Last Step	1-99
40 r	(0x0028) Profile Time Left in Step (HHH)	0-999
41 r	(0x0029) Profile Time Left in Step (MM/SS)	<p>0-59 Minutes (high byte)                      0-59 Seconds (low byte)</p> <p>Parameter contains both minutes and seconds of remaining step time. The value read from the EZT-560 will be an integer value based on the combined bytes of both the minutes and seconds. In order to obtain the individual values, split the word into its two component bytes. Example:</p> <p>0x1131 read from EZT                      high byte 0x11 converted to decimal 17 (minutes)                      low byte 0x31 converted to decimal 49 (seconds)</p>
42 r	(0x002A) Profile Wait for Input	<p>0 Not Waiting                      1 Loop 1 Input                      2 Loop 2 Input                      4 Loop 3 Input                      8 Loop 4 input                      16 Loop 5 Input                      32 PV1 Monitor Input                      64 PV2 Monitor Input                      128 PV3 Monitor Input                      256 PV4 Monitor Input                      512 PV5 Monitor Input                      1024 PV6 Monitor Input                      2048 PV7 Monitor Input                      4096 PV8 Monitor Input</p>
43 r	(0x002B) Profile Wait for Setpoint	<p>-32768-32767 (-3276.8-3276.7)</p> <p>Note that value must be converted from whole number, i.e., divide by ten to convert the decimal number from the value read.</p>

Register #	Description	Use
44 r (0x002C)	Profile Current Jump Step	1-99
45 r (0x002D)	Profile Current Jumps Remaining	0-999
46 r (0x002E)	Profile Loop 1 Target Setpoint	-32768-32767 (-3276.8-3276.7)
47 r (0x002F)	Profile Loop 2 Target Setpoint*	Note that value must be converted from whole number, i.e., divide by ten to convert the decimal number from the value read.
48 r (0x0030)	Profile Loop 3 Target Setpoint*	
49 r (0x0031)	Profile Loop 4 Target Setpoint*	
50 r (0x0032)	Profile Loop 5 Target Setpoint*	
51 r (0x0033)	Profile Last Jump from Step	
52 r (0x0034)	Profile Last Jump to Step	1-99
53 r (0x0035)	Profile Total Jumps Made	0-32767
54 w (0x0036)	Alarm Acknowledge	1 Alarm Silence 2 Pumpdown Reset  The parameter automatically resets to 0.
55 r (0x0037)	EZT Alarm Status	Bit1 Loop 1 Sensor Break Bit2 Loop 2 Sensor Break Bit3 Loop 3 Sensor Break Bit4 Loop 4 Sensor Break Bit5 Loop 5 Sensor Break Bit6 PV1 Monitor Sensor Break Bit7 PV2 Monitor Sensor Break Bit8 PV3 Monitor Sensor Break Bit9 PV4 Monitor Sensor Break Bit10 PV5 Monitor Sensor Break Bit11 PV6 Monitor Sensor Break Bit12 PV7 Monitor Sensor Break Bit13 PV8 Monitor Sensor Break Bit14 not used Bit15 EZT internal communications failure  This parameter is bit oriented, i.e., more than one alarm can be present at a time. The value must be converted to binary and the status of each bit checked to see if the alarm is on (1) or the alarm is off (0). Example:  0x0120 read from EZT converted to binary 0000000100100000  Bit6 and Bit9 on (PV1 and PV4 Sensor Break)
56 r (0x0038)	Input Alarm Status	Bit1 Loop 1 Alarm Bit2 Loop 2 Alarm Bit3 Loop 3 Alarm Bit4 Loop 4 Alarm Bit5 Loop 5 Alarm Bit6 PV1 Monitor Alarm Bit7 PV2 Monitor Alarm Bit8 PV3 Monitor Alarm Bit9 PV4 Monitor Alarm Bit10 PV5 Monitor Alarm Bit11 PV6 Monitor Alarm Bit12 PV7 Monitor Alarm Bit13 PV8 Monitor Alarm

Register #	Description	Use
		<p>This parameter is bit oriented, i.e., more than one alarm can be present at a time. The value must be converted to binary and the status of each bit checked to see if the alarm is on (1) or the alarm is off (0). Example:</p> <p>0x0002 read from EZT converted to binary 0000000000000010</p> <p>Bit2 on (Loop 2 Alarm)</p>
57 r	(0x0039) Chamber Alarm Status	<p>Bit1 Chamber High Limit                      Bit2 Product Safety                      Bit3 Boiler Over-Temperature                      Bit4 Boiler Low Water                      Bit5 Dehumidifier System Fault                      Bit6 Motor Overload                      Bit7 Fluid System Temperature                      Bit8 Fluid System Pressure                      Bit9 Fluid System Low Flow                      Bit10 not used                      Bit11 not used                      Bit12 not used                      Bit13 Emergency Stop                      Bit14 Combustible Monitor                      Bit15 Transfer Error</p> <p>This parameter is bit oriented, i.e., more than one alarm can be present at a time. The value must be converted to binary and the status of each bit checked to see if the alarm is on (1) or the alarm is off (0). Example:</p> <p>0x1000 read from EZT converted to binary 0001000000000000</p> <p>Bit13 on (Emergency Stop)</p>
58 r	(0x003A) Refrigeration Alarm Status	<p>Bit1 System 1 Hi/Lo Pressure                      Bit2 System 1 Hi/Lo Pressure                      Bit3 System 1 Discharge Temperature                      Bit4 System 1 Protection Module                      Bit5 Pumpdown Disabled                      Bit6 not used                      Bit7 not used                      Bit8 not used                      Bit9 System 2 Hi/Lo Pressure                      Bit10 System 2 Hi/Lo Pressure                      Bit11 System 2 Discharge Temperature                      Bit12 System 2 Protection Module</p> <p>This parameter is bit oriented, i.e., more than one alarm can be present at a time. The value must be converted to binary and the status of each bit checked to see if the alarm is on (1) or the alarm is off (0). Example:</p> <p>0x10 read from EZT converted to binary 0000000000010000</p> <p>Bit5 on (Pumpdown Disabled)</p>

Register #	Description	Use
59 r	(0x003B) System Status Monitor	Bit1 Humidity Water Reservoir Low Bit2 Humidity Disabled (temperature out-of-range) Bit3 Humidity High Dewpoint Limit Bit4 Humidity Dewpoint Limit Bit5 Door Open Bit6 not used Bit7 not used Bit8 not used Bit9 Service Air Circulators Bit10 Service Heating/Cooling System Bit11 Service Humidity System Bit12 Service Purge System Bit13 Service Altitude System Bit14 Service Transfer Mechanism  This parameter is bit oriented. The value must be converted to binary and the status of each bit checked to verify status.
60 r/w	(0x003C) Loop 1 Setpoint	-32768-32767 (-3276.8-3276.7)
61 r	(0x003D) Loop 1 Process value	Note that value must be converted from/to whole number, i.e., divide/multiply by ten to convert the decimal number from the value read or to the proper value for a write.
62 r	(0x003E) Loop 1 Percentage of Output	-10000-10000 (-100.00-100.00)  Note that value must be converted from whole number, i.e., divide by 100 to convert the decimal number from the value read.
63 r/w	(0x003F) Loop 1 Autotune Status	0 Autotune Off 1 Initiate Autotune 2 Autotune Active 4 Terminate Autotune
64 r/w	(0x0040) Loop 1 Upper Setpoint Limit	-32768-32767 (-3276.8-3276.7)
65 r/w	(0x0041) Loop 1 Lower Setpoint Limit	Note that value must be converted from/to whole number, i.e., divide/multiply by ten to convert the decimal number from the value read or to the proper value for a write.
66 r/w	(0x0042) Loop 1 Alarm Type Selection	0 Alarm Off 3 Process High Alarm Selected 5 Process Low Alarm Selected 7 Process Both Selected 24 Deviation High Alarm Selected 40 Deviation Low Alarm Selected 56 Deviation Both Selected
67 r/w	(0x0043) Loop 1 Alarm Mode	Bit1 Off – alarm self clears Bit1 On – alarm latches Bit2 Off – close on alarm (action of assigned alarm output) Bit2 On – open on alarm (action of assigned alarm output)  Bit5 Off – audible alarm off Bit5 On – audible alarm on Bit6 Off – chamber continues on alarm Bit6 On – chamber shuts down on alarm  Parameter is bit oriented, only those bits listed perform control action. State of other bits do not affect operation.

Register #	Description	Use
68 (0x0044) r/w	Loop 1 Alarm Output Assignment	0 No Output Selected 1 Customer Event 1 Output 2 Customer Event 2 Output 4 Customer Event 3 Output 8 Customer Event 4 Output 16 Customer Event 5 Output 32 Customer Event 6 Output 64 Customer Event 7 Output 128 Customer Event 8 Output 256 Customer Event 9 Output 512 Customer Event 10 Output 1024 Customer Event 11 Output 2048 Customer Event 12 Output 4096 Customer Event 13 Output 8192 Customer Event 14 Output 16384 Customer Event 15 Output
69 (0x0045) r/w	Loop 1 High Alarm Setpoint	-32768-32767 (-3276.8-3276.7)
70 (0x0046) r/w	Loop 1 Low Alarm Setpoint	Note that value must be converted from/to whole number, i.e., divide/multiply by ten to convert the decimal number from the value read or to the proper value for a write.
71 (0x0047) r/w	Loop 1 Alarm Hysteresis	0-32767 (0-3276.7)  Note that value must be converted from/to whole number, i.e., divide/multiply by ten to convert the decimal number from the value read or to the proper value for a write.
72 (0x0048) r/w	Loop 2 Setpoint*	-32768-32767 (-3276.8-3276.7)
73 (0x0049) r	Loop 2 Process value*	Note that value must be converted from/to whole number, i.e., divide/multiply by ten to convert the decimal number from the value read or to the proper value for a write.
74 (0x004A) r	Loop 2 Percentage of Output*	-10000-10000 (-100.00-100.00)  Note that value must be converted from whole number, i.e., divide by 100 to convert the decimal number from the value read.
75 (0x004B) r/w	Loop 2 Autotune Status*	0 Autotune Off 1 Initiate Autotune 2 Autotune Active 4 Terminate Autotune
76 (0x004C) r/w	Loop 2 Upper Setpoint Limit*	-32768-32767 (-3276.8-3276.7)
77 (0x004D) r/w	Loop 2 Lower Setpoint Limit*	Note that value must be converted from/to whole number, i.e., divide/multiply by ten to convert the decimal number from the value read or to the proper value for a write.
78 (0x004E) r/w	Loop 2 Alarm Type Selection*	0 Alarm Off 3 Process High Alarm Selected 5 Process Low Alarm Selected 7 Process Both Selected 24 Deviation High Alarm Selected 40 Deviation Low Alarm Selected 56 Deviation Both Selected

Register #	Description	Use
79 r/w (0x004F)	Loop 2 Alarm Mode*	Bit1 Off – alarm self clears Bit1 On – alarm latches Bit2 Off – close on alarm (action of assigned alarm output) Bit2 On – open on alarm (action of assigned alarm output)  Bit5 Off – audible alarm off Bit5 On – audible alarm on Bit6 Off – chamber continues on alarm Bit6 On – chamber shuts down on alarm  Parameter is bit oriented, only those bits listed perform control action. State of other bits do not affect operation.
80 r/w (0x0050)	Loop 2 Alarm Output Assignment*	0 No Output Selected 1 Customer Event 1 Output 2 Customer Event 2 Output 4 Customer Event 3 Output 8 Customer Event 4 Output 16 Customer Event 5 Output 32 Customer Event 6 Output 64 Customer Event 7 Output 128 Customer Event 8 Output 256 Customer Event 9 Output 512 Customer Event 10 Output 1024 Customer Event 11 Output 2048 Customer Event 12 Output 4096 Customer Event 13 Output 8192 Customer Event 14 Output 16384 Customer Event 15 Output
81 r/w (0x0051)	Loop 2 High Alarm Setpoint*	-32768-32767 (-3276.8-3276.7)
82 r/w (0x0052)	Loop 2 Low Alarm Setpoint*	Note that value must be converted from/to whole number, i.e., divide/multiply by ten to convert the decimal number from the value read or to the proper value for a write.
83 r/w (0x0053)	Loop 2 Alarm Hysteresis*	0-32767 (0-3276.7)  Note that value must be converted from/to whole number, i.e., divide/multiply by ten to convert the decimal number from the value read or to the proper value for a write.
84 r/w (0x0054)	Loop 3 Setpoint*	-32768-32767 (-3276.8-3276.7)
85 r (0x0055)	Loop 3 Process value*	Note that value must be converted from/to whole number, i.e., divide/multiply by ten to convert the decimal number from the value read or to the proper value for a write.
86 r (0x0056)	Loop 3 Percentage of Output*	-10000-10000 (-100.00-100.00)  Note that value must be converted from whole number, i.e., divide by 100 to convert the decimal number from the value read.
87 r/w (0x0057)	Loop 3 Autotune Status*	0 Autotune Off 1 Initiate Autotune 2 Autotune Active 4 Terminate Autotune
88 r/w (0x0058)	Loop 3 Upper Setpoint Limit*	-32768-32767 (-3276.8-3276.7)
89 r/w (0x0059)	Loop 3 Lower Setpoint Limit*	Note that value must be converted from/to whole number, i.e., divide/multiply by ten to convert the decimal number from the value read or to the proper value for a write.

Register #	Description	Use
90 r/w (0x005A)	Loop 3 Alarm Type Selection*	0 Alarm Off 3 Process High Alarm Selected 5 Process Low Alarm Selected 7 Process Both Selected 24 Deviation High Alarm Selected 40 Deviation Low Alarm Selected 56 Deviation Both Selected
91 r/w (0x005B)	Loop 3 Alarm Mode*	Bit1 Off – alarm self clears Bit1 On – alarm latches Bit2 Off – close on alarm (action of assigned alarm output) Bit2 On – open on alarm (action of assigned alarm output)  Bit5 Off – audible alarm off Bit5 On – audible alarm on Bit6 Off – chamber continues on alarm Bit6 On – chamber shuts down on alarm  Parameter is bit oriented, only those bits listed perform control action. State of other bits do not affect operation.
92 r/w (0x005C)	Loop 3 Alarm Output Assignment*	0 No Output Selected 1 Customer Event 1 Output 2 Customer Event 2 Output 4 Customer Event 3 Output 8 Customer Event 4 Output 16 Customer Event 5 Output 32 Customer Event 6 Output 64 Customer Event 7 Output 128 Customer Event 8 Output 256 Customer Event 9 Output 512 Customer Event 10 Output 1024 Customer Event 11 Output 2048 Customer Event 12 Output 4096 Customer Event 13 Output 8192 Customer Event 14 Output 16384 Customer Event 15 Output
93 r/w (0x005D)	Loop 3 High Alarm Setpoint*	-32768-32767 (-3276.8-3276.7)
94 r/w (0x005E)	Loop 3 Low Alarm Setpoint*	Note that value must be converted from/to whole number, i.e., divide/multiply by ten to convert the decimal number from the value read or to the proper value for a write.
95 r/w (0x005F)	Loop 3 Alarm Hysteresis*	0-32767 (0-3276.7)  Note that value must be converted from/to whole number, i.e., divide/multiply by ten to convert the decimal number from the value read or to the proper value for a write.
96 r/w (0x0060)	Loop 4 Setpoint*	-32768-32767 (-3276.8-3276.7)
97 r (0x0061)	Loop 4 Process value*	Note that value must be converted from/to whole number, i.e., divide/multiply by ten to convert the decimal number from the value read or to the proper value for a write.
98 r (0x0062)	Loop 4 Percentage of Output*	-10000-10000 (-100.00-100.00)  Note that value must be converted from whole number, i.e., divide by 100 to convert the decimal number from the value read.
99 r/w (0x0063)	Loop 4 Autotune Status*	0 Autotune Off 1 Initiate Autotune 2 Autotune Active 4 Terminate Autotune

Register #	Description	Use
100 (0x0064) r/w	Loop 4 Upper Setpoint Limit*	-32768-32767 (-3276.8-3276.7)
101 (0x0065) r/w	Loop 4 Lower Setpoint Limit*	Note that value must be converted from/to whole number, i.e., divide/multiply by ten to convert the decimal number from the value read or to the proper value for a write.
102 (0x0066) r/w	Loop 4 Alarm Type Selection*	0 Alarm Off 3 Process High Alarm Selected 5 Process Low Alarm Selected 7 Process Both Selected 24 Deviation High Alarm Selected 40 Deviation Low Alarm Selected 56 Deviation Both Selected
103 (0x0067) r/w	Loop 4 Alarm Mode*	Bit1 Off – alarm self clears Bit1 On – alarm latches Bit2 Off – close on alarm (action of assigned alarm output) Bit2 On – open on alarm (action of assigned alarm output)  Bit5 Off – audible alarm off Bit5 On – audible alarm on Bit6 Off – chamber continues on alarm Bit6 On – chamber shuts down on alarm  Parameter is bit oriented, only those bits listed perform control action. State of other bits do not affect operation.
104 (0x0068) r/w	Loop 4 Alarm Output Assignment*	0 No Output Selected 1 Customer Event 1 Output 2 Customer Event 2 Output 4 Customer Event 3 Output 8 Customer Event 4 Output 16 Customer Event 5 Output 32 Customer Event 6 Output 64 Customer Event 7 Output 128 Customer Event 8 Output 256 Customer Event 9 Output 512 Customer Event 10 Output 1024 Customer Event 11 Output 2048 Customer Event 12 Output 4096 Customer Event 13 Output 8192 Customer Event 14 Output 16384 Customer Event 15 Output
105 (0x0069) r/w	Loop 4 High Alarm Setpoint*	-32768-32767 (-3276.8-3276.7)
106 (0x006A) r/w	Loop 4 Low Alarm Setpoint*	Note that value must be converted from/to whole number, i.e., divide/multiply by ten to convert the decimal number from the value read or to the proper value for a write.
107 (0x006B) r/w	Loop 4 Alarm Hysteresis*	0-32767 (0-3276.7)  Note that value must be converted from/to whole number, i.e., divide/multiply by ten to convert the decimal number from the value read or to the proper value for a write.
108 (0x006C) r/w	Loop 5 Setpoint*	-32768-32767 (-3276.8-3276.7)
109 (0x006D) r	Loop 5 Process value*	Note that value must be converted from/to whole number, i.e., divide/multiply by ten to convert the decimal number from the value read or to the proper value for a write.
110 (0x006E) r	Loop 5 Percentage of Output*	-10000-10000 (-100.00-100.00)

Register #	Description	Use
		Note that value must be converted from/to whole number, i.e., divide/multiply by ten to convert the decimal number from the value read or to the proper value for a write.
111 r/w (0x006F)	Loop 5 Autotune Status*	0 Autotune Off 1 Initiate Autotune 2 Autotune Active 4 Terminate Autotune
112 r/w (0x0070)	Loop 5 Upper Setpoint Limit*	-32768-32767 (-3276.8-3276.7)
113 r/w (0x0071)	Loop 5 Lower Setpoint Limit*	Note that value must be converted from/to whole number, i.e., divide/multiply by ten to convert the decimal number from the value read or to the proper value for a write.
114 r/w (0x0072)	Loop 5 Alarm Type Selection*	0 Alarm Off 3 Process High Alarm Selected 5 Process Low Alarm Selected 7 Process Both Selected 24 Deviation High Alarm Selected 40 Deviation Low Alarm Selected 56 Deviation Both Selected
115 r/w (0x0073)	Loop 5 Alarm Mode*	Bit1 Off – alarm self clears Bit1 On – alarm latches Bit2 Off – close on alarm (action of assigned alarm output) Bit2 On – open on alarm (action of assigned alarm output)  Bit5 Off – audible alarm off Bit5 On – audible alarm on Bit6 Off – chamber continues on alarm Bit6 On – chamber shuts down on alarm  Parameter is bit oriented, only those bits listed perform control action. State of other bits do not affect operation.
116 r/w (0x0074)	Loop 5 Alarm Output Assignment*	0 No Output Selected 1 Customer Event 1 Output 2 Customer Event 2 Output 4 Customer Event 3 Output 8 Customer Event 4 Output 16 Customer Event 5 Output 32 Customer Event 6 Output 64 Customer Event 7 Output 128 Customer Event 8 Output 256 Customer Event 9 Output 512 Customer Event 10 Output 1024 Customer Event 11 Output 2048 Customer Event 12 Output 4096 Customer Event 13 Output 8192 Customer Event 14 Output 16384 Customer Event 15 Output
117 r/w (0x0075)	Loop 5 High Alarm Setpoint*	-32768-32767 (-3276.8-3276.7)
118 r/w (0x0076)	Loop 5 Low Alarm Setpoint*	Note that value must be converted from/to whole number, i.e., divide/multiply by ten to convert the decimal number from the value read or to the proper value for a write.
119 r/w (0x0077)	Loop 5 Alarm Hysteresis*	0-32767 (0-3276.7)  Note that value must be converted from/to whole number, i.e., divide/multiply by ten to convert the decimal number from the value read or to the proper value for a write.

Register #	Description	Use
120 (0x0078) r	PV1 Monitor Process value*	-32768-32767 (-3276.8-3276.7)  Note that value must be converted from whole number, i.e., divide by ten to convert the decimal number from the value read.
121 (0x0079) r/w	PV1 Monitor Alarm Type Selection*	0 Alarm Off 3 Process High Alarm Selected 5 Process Low Alarm Selected 7 Process Both Selected
122 (0x007A) r/w	PV1 Monitor Alarm Mode*	Bit1 Off – alarm self clears Bit1 On – alarm latches Bit2 Off – close on alarm (action of assigned alarm output) Bit2 On – open on alarm (action of assigned alarm output)  Bit5 Off – audible alarm off Bit5 On – audible alarm on Bit6 Off – chamber continues on alarm Bit6 On – chamber shuts down on alarm  Parameter is bit oriented, only those bits listed perform control action. State of other bits do not affect operation.
123 (0x007B) r/w	PV1 Monitor Alarm Output Assignment*	0 No Output Selected 1 Customer Event 1 Output 2 Customer Event 2 Output 4 Customer Event 3 Output 8 Customer Event 4 Output 16 Customer Event 5 Output 32 Customer Event 6 Output 64 Customer Event 7 Output 128 Customer Event 8 Output 256 Customer Event 9 Output 512 Customer Event 10 Output 1024 Customer Event 11 Output 2048 Customer Event 12 Output 4096 Customer Event 13 Output 8192 Customer Event 14 Output 16384 Customer Event 15 Output
124 (0x007C) r/w	PV1 Monitor High Alarm Setpoint*	-32768-32767 (-3276.8-3276.7)  Note that value must be converted from/to whole number, i.e., divide/multiply by ten to convert the decimal number from the value read or to the proper value for a write.
125 (0x007D) r/w	PV1 Monitor Low Alarm Setpoint*	
126 (0x007E) r/w	PV1 Monitor Alarm Hysteresis*	0-32767 (0-3276.7)  Note that value must be converted from/to whole number, i.e., divide/multiply by ten to convert the decimal number from the value read or to the proper value for a write.
127 (0x007F) r	PV2 Monitor Process value*	-32768-32767 (-3276.8-3276.7)  Note that value must be converted from whole number, i.e., divide by ten to convert the decimal number from the value read.
128 (0x0080) r/w	PV2 Monitor Alarm Type Selection*	0 Alarm Off 3 Process High Alarm Selected 5 Process Low Alarm Selected 7 Process Both Selected

Register #	Description	Use
129 (0x0081) r/w	PV2 Monitor Alarm Mode*	Bit1 Off – alarm self clears Bit1 On – alarm latches Bit2 Off – close on alarm (action of assigned alarm output) Bit2 On – open on alarm (action of assigned alarm output)  Bit5 Off – audible alarm off Bit5 On – audible alarm on Bit6 Off – chamber continues on alarm Bit6 On – chamber shuts down on alarm  Parameter is bit oriented, only those bits listed perform control action. State of other bits do not affect operation.
130 (0x0082) r/w	PV2 Monitor Alarm Output Assignment*	0 No Output Selected 1 Customer Event 1 Output 2 Customer Event 2 Output 4 Customer Event 3 Output 8 Customer Event 4 Output 16 Customer Event 5 Output 32 Customer Event 6 Output 64 Customer Event 7 Output 128 Customer Event 8 Output 256 Customer Event 9 Output 512 Customer Event 10 Output 1024 Customer Event 11 Output 2048 Customer Event 12 Output 4096 Customer Event 13 Output 8192 Customer Event 14 Output 16384 Customer Event 15 Output
131 (0x0083) r/w	PV2 Monitor High Alarm Setpoint*	-32768-32767 (-3276.8-3276.7)
132 (0x0084) r/w	PV2 Monitor Low Alarm Setpoint*	Note that value must be converted from/to whole number, i.e., divide/multiply by ten to convert the decimal number from the value read or to the proper value for a write.
133 (0x0085) r/w	PV2 Monitor Alarm Hysteresis*	0-32767 (0-3276.7)  Note that value must be converted from/to whole number, i.e., divide/multiply by ten to convert the decimal number from the value read or to the proper value for a write.
134 (0x0086) r	PV3 Monitor Process value*	-32768-32767 (-3276.8-3276.7)  Note that value must be converted from whole number, i.e., divide by ten to convert the decimal number from the value read.
135 (0x0087) r/w	PV3 Monitor Alarm Type Selection*	0 Alarm Off 3 Process High Alarm Selected 5 Process Low Alarm Selected 7 Process Both Selected
136 (0x0088) r/w	PV3 Monitor Alarm Mode*	Bit1 Off – alarm self clears Bit1 On – alarm latches Bit2 Off – close on alarm (action of assigned alarm output) Bit2 On – open on alarm (action of assigned alarm output)  Bit5 Off – audible alarm off Bit5 On – audible alarm on Bit6 Off – chamber continues on alarm Bit6 On – chamber shuts down on alarm  Parameter is bit oriented, only those bits listed perform control action. State of other bits do not affect operation.

Register #	Description	Use
137 (0x0089) r/w	PV3 Monitor Alarm Output Assignment*	0 No Output Selected 1 Customer Event 1 Output 2 Customer Event 2 Output 4 Customer Event 3 Output 8 Customer Event 4 Output 16 Customer Event 5 Output 32 Customer Event 6 Output 64 Customer Event 7 Output 128 Customer Event 8 Output 256 Customer Event 9 Output 512 Customer Event 10 Output 1024 Customer Event 11 Output 2048 Customer Event 12 Output 4096 Customer Event 13 Output 8192 Customer Event 14 Output 16384 Customer Event 15 Output
138 (0x008A) r/w	PV3 Monitor High Alarm Setpoint*	-32768-32767 (-3276.8-3276.7)
139 (0x008B) r/w	PV3 Monitor Low Alarm Setpoint*	Note that value must be converted from/to whole number, i.e., divide/multiply by ten to convert the decimal number from the value read or to the proper value for a write.
140 (0x008C) r/w	PV3 Monitor Alarm Hysteresis*	0-32767 (0-3276.7)  Note that value must be converted from/to whole number, i.e., divide/multiply by ten to convert the decimal number from the value read or to the proper value for a write.
141 (0x008D) r	PV4 Monitor Process value*	-32768-32767 (-3276.8-3276.7)  Note that value must be converted from whole number, i.e., divide by ten to convert the decimal number from the value read.
142 (0x008E) r/w	PV4 Monitor Alarm Type Selection*	0 Alarm Off 3 Process High Alarm Selected 5 Process Low Alarm Selected 7 Process Both Selected
143 (0x008F) r/w	PV4 Monitor Alarm Mode*	Bit1 Off – alarm self clears Bit1 On – alarm latches Bit2 Off – close on alarm (action of assigned alarm output) Bit2 On – open on alarm (action of assigned alarm output)  Bit5 Off – audible alarm off Bit5 On – audible alarm on Bit6 Off – chamber continues on alarm Bit6 On – chamber shuts down on alarm  Parameter is bit oriented, only those bits listed perform control action. State of other bits do not affect operation.
144 (0x0090) r/w	PV4 Monitor Alarm Output Assignment*	0 No Output Selected 1 Customer Event 1 Output 2 Customer Event 2 Output 4 Customer Event 3 Output 8 Customer Event 4 Output 16 Customer Event 5 Output 32 Customer Event 6 Output 64 Customer Event 7 Output 128 Customer Event 8 Output 256 Customer Event 9 Output 512 Customer Event 10 Output 1024 Customer Event 11 Output 2048 Customer Event 12 Output

Register #	Description	Use
		4096 Customer Event 13 Output 8192 Customer Event 14 Output 16384 Customer Event 15 Output
145 r/w	(0x0091) PV4 Monitor High Alarm Setpoint*	-32768-32767 (-3276.8-3276.7)
146 r/w	(0x0092) PV4 Monitor Low Alarm Setpoint*	Note that value must be converted from/to whole number, i.e., divide/multiply by ten to convert the decimal number from the value read or to the proper value for a write.
147 r/w	(0x0093) PV4 Monitor Alarm Hysteresis*	0-32767 (0-3276.7)  Note that value must be converted from/to whole number, i.e., divide/multiply by ten to convert the decimal number from the value read or to the proper value for a write.
148 r	(0x0094) PV5 Monitor Process value*	-32768-32767 (-3276.8-3276.7)  Note that value must be converted from whole number, i.e., divide by ten to convert the decimal number from the value read.
149 r/w	(0x0095) PV5 Monitor Alarm Type Selection*	0 Alarm Off 3 Process High Alarm Selected 5 Process Low Alarm Selected 7 Process Both Selected
150 r/w	(0x0096) PV5 Monitor Alarm Mode*	Bit1 Off – alarm self clears Bit1 On – alarm latches Bit2 Off – close on alarm (action of assigned alarm output) Bit2 On – open on alarm (action of assigned alarm output)  Bit5 Off – audible alarm off Bit5 On – audible alarm on Bit6 Off – chamber continues on alarm Bit6 On – chamber shuts down on alarm  Parameter is bit oriented, only those bits listed perform control action. State of other bits do not affect operation.
151 r/w	(0x0097) PV5 Monitor Alarm Output Assignment*	0 No Output Selected 1 Customer Event 1 Output 2 Customer Event 2 Output 4 Customer Event 3 Output 8 Customer Event 4 Output 16 Customer Event 5 Output 32 Customer Event 6 Output 64 Customer Event 7 Output 128 Customer Event 8 Output 256 Customer Event 9 Output 512 Customer Event 10 Output 1024 Customer Event 11 Output 2048 Customer Event 12 Output 4096 Customer Event 13 Output 8192 Customer Event 14 Output 16384 Customer Event 15 Output
152 r/w	(0x0098) PV5 Monitor High Alarm Setpoint*	-32768-32767 (-3276.8-3276.7)
153 r/w	(0x0099) PV5 Monitor Low Alarm Setpoint*	Note that value must be converted from/to whole number, i.e., divide/multiply by ten to convert the decimal number from the value read or to the proper value for a write.
154 r/w	(0x009A) PV5 Monitor Alarm Hysteresis*	0-32767 (0-3276.7)

Register #	Description	Use
		Note that value must be converted from/to whole number, i.e., divide/multiply by ten to convert the decimal number from the value read or to the proper value for a write.
155 (0x009B) r	PV6 Monitor Process value*	-32768-32767 (-3276.8-3276.7)  Note that value must be converted from whole number, i.e., divide by ten to convert the decimal number from the value read.
156 (0x009C) r/w	PV6 Monitor Alarm Type Selection*	0 Alarm Off 3 Process High Alarm Selected 5 Process Low Alarm Selected 7 Process Both Selected
157 (0x009D) r/w	PV6 Monitor Alarm Mode*	Bit1 Off – alarm self clears Bit1 On – alarm latches Bit2 Off – close on alarm (action of assigned alarm output) Bit2 On – open on alarm (action of assigned alarm output)  Bit5 Off – audible alarm off Bit5 On – audible alarm on Bit6 Off – chamber continues on alarm Bit6 On – chamber shuts down on alarm  Parameter is bit oriented, only those bits listed perform control action. State of other bits do not affect operation.
158 (0x009E) r/w	PV6 Monitor Alarm Output Assignment*	0 No Output Selected 1 Customer Event 1 Output 2 Customer Event 2 Output 4 Customer Event 3 Output 8 Customer Event 4 Output 16 Customer Event 5 Output 32 Customer Event 6 Output 64 Customer Event 7 Output 128 Customer Event 8 Output 256 Customer Event 9 Output 512 Customer Event 10 Output 1024 Customer Event 11 Output 2048 Customer Event 12 Output 4096 Customer Event 13 Output 8192 Customer Event 14 Output 16384 Customer Event 15 Output
159 (0x009F) r/w	PV6 Monitor High Alarm Setpoint*	-32768-32767 (-3276.8-3276.7)  Note that value must be converted from/to whole number, i.e., divide/multiply by ten to convert the decimal number from the value read or to the proper value for a write.
160 (0x00A0) r/w	PV6 Monitor Low Alarm Setpoint*	
161 (0x00A1) r/w	PV6 Monitor Alarm Hysteresis*	0-32767 (0-3276.7)  Note that value must be converted from/to whole number, i.e., divide/multiply by ten to convert the decimal number from the value read or to the proper value for a write.
162 (0x00A2) r	PV7 Monitor Process value*	-32768-32767 (-3276.8-3276.7)  Note that value must be converted from whole number, i.e., divide by ten to convert the decimal number from the value read.

Register #	Description	Use
163 r/w (0x00A3)	PV7 Monitor Alarm Type Selection*	0 Alarm Off 3 Process High Alarm Selected 5 Process Low Alarm Selected 7 Process Both Selected
164 r/w (0x00A4)	PV7 Monitor Alarm Mode*	Bit1 Off – alarm self clears Bit1 On – alarm latches Bit2 Off – close on alarm (action of assigned alarm output) Bit2 On – open on alarm (action of assigned alarm output)  Bit5 Off – audible alarm off Bit5 On – audible alarm on Bit6 Off – chamber continues on alarm Bit6 On – chamber shuts down on alarm  Parameter is bit oriented, only those bits listed perform control action. State of other bits do not affect operation.
165 r/w (0x00A5)	PV7 Monitor Alarm Output Assignment*	0 No Output Selected 1 Customer Event 1 Output 2 Customer Event 2 Output 4 Customer Event 3 Output 8 Customer Event 4 Output 16 Customer Event 5 Output 32 Customer Event 6 Output 64 Customer Event 7 Output 128 Customer Event 8 Output 256 Customer Event 9 Output 512 Customer Event 10 Output 1024 Customer Event 11 Output 2048 Customer Event 12 Output 4096 Customer Event 13 Output 8192 Customer Event 14 Output 16384 Customer Event 15 Output
166 r/w (0x00A6)	PV7 Monitor High Alarm Setpoint*	-32768-32767 (-3276.8-3276.7)
167 r/w (0x00A7)	PV7 Monitor Low Alarm Setpoint*	Note that value must be converted from/to whole number, i.e., divide/multiply by ten to convert the decimal number from the value read or to the proper value for a write.
168 r/w (0x00A8)	PV7 Monitor Alarm Hysteresis*	0-32767 (0-3276.7)  Note that value must be converted from/to whole number, i.e., divide/multiply by ten to convert the decimal number from the value read or to the proper value for a write.
169 r (0x00A9)	PV8 Monitor Process value*	-32768-32767 (-3276.8-3276.7)  Note that value must be converted from whole number, i.e., divide by ten to convert the decimal number from the value read.
170 r/w (0x00AA)	PV8 Monitor Alarm Type Selection*	0 Alarm Off 3 Process High Alarm Selected 5 Process Low Alarm Selected 7 Process Both Selected
171 r/w (0x00AB)	PV8 Monitor Alarm Mode*	Bit1 Off – alarm self clears Bit1 On – alarm latches Bit2 Off – close on alarm (action of assigned alarm output) Bit2 On – open on alarm (action of assigned alarm output)

Register #	Description	Use
		Bit5 Off – audible alarm off Bit5 On – audible alarm on Bit6 Off – chamber continues on alarm Bit6 On – chamber shuts down on alarm  Parameter is bit oriented, only those bits listed perform control action. State of other bits do not affect operation.
172 (0x00AC) r/w	PV8 Monitor Alarm Output Assignment*	0 No Output Selected 1 Customer Event 1 Output 2 Customer Event 2 Output 4 Customer Event 3 Output 8 Customer Event 4 Output 16 Customer Event 5 Output 32 Customer Event 6 Output 64 Customer Event 7 Output 128 Customer Event 8 Output 256 Customer Event 9 Output 512 Customer Event 10 Output 1024 Customer Event 11 Output 2048 Customer Event 12 Output 4096 Customer Event 13 Output 8192 Customer Event 14 Output 16384 Customer Event 15 Output
173 (0x00AD) r/w	PV8 Monitor High Alarm Setpoint*	-32768-32767 (-3276.8-3276.7)
174 (0x00AE) r/w	PV8 Monitor Low Alarm Setpoint*	Note that value must be converted from/to whole number, i.e., divide/multiply by ten to convert the decimal number from the value read or to the proper value for a write.
175 (0x00AF) r/w	PV8 Monitor Alarm Hysteresis*	0-32767 (0-3276.7)  Note that value must be converted from/to whole number, i.e., divide/multiply by ten to convert the decimal number from the value read or to the proper value for a write.
176 (0x00B0)	Special Use	Special Use
177 (0x00B1)	Special Use	Special Use
178 (0x00B2)	Special Use	Special Use
179 (0x00B3)	Special Use	Special Use
180 (0x00B4)	EZT-560 Offline/Downloading Profile	0 EZT-560 Online 1 EZT-560 Offline/Profile Download  When the EZT-560 is offline, refrain from writing to any control registers. In offline mode, there are no updates made to any control registers.  After a profile transfer to the EZT-560 from a PC, the EZT-560 will go into profile download. Do not write to any registers until profile download is complete. Once profile download complete, normal operation may commence.

\* Indicates parameters associated with options not available on all chambers.

**9.4.2 EZT-560 Profile Parameters**

Profiles must be downloaded one step at a time with a 1 second pause between steps. Each step consists of 15 registers including the first 15 which contain the format and special function registers. See the provided example code for assistance in creating the proper download sequence.

You must use the write multiple registers command (0x10) to transmit the profile to the EZT-560. See Section 9.2.4, Packet Syntax, for the command format.

**CAUTION** It is the user's responsibility to make sure that the format and data ranges for each step is followed correctly. Failure to do so can result in erratic control and or damage to equipment.

The following table contains the profile format and special function registers. These values must be downloaded as the first "step" of the profile or the download will not execute correctly.

**NOTE:** Register numbers listed are relative values. To convert to absolute values, add 40001.

Register #	Description	Use
200 (0x00C8) w	AutoStart On/Off	0 AutoStart Off 1 AutoStart by Date 2 AutoStart by Day
201 (0x00C9) w	AutoStart Time (YY/MM)	0-99 Year (high byte) 1-12 Month (low byte)  Parameter contains both year and month for the profile to start when AutoStart by Date selected. The value will be an integer value based on the combined bytes of both the year and month. In order to set the value, combine the two component bytes into the word. Example:  <u>Start Date of January 2006</u> decimal 6 (2006) converted to high byte 0x06 decimal 1 (January) converted to low byte 0x01 set value of 0x0601 to EZT
202 (0x00CA) w	AutoStart Time (DAY/DOW)	1-31 Day of Month (high byte) 0-6 Day of Week (low byte) 0 Sunday 1 Monday 2 Tuesday 3 Wednesday 4 Thursday 5 Friday 6 Saturday  Parameter contains both day and day of week for the profile to start when AutoStart is enabled. The value will be an integer value based on the combined bytes of both the day and day of week. In order to set the value, combine the two component bytes into the word. Example:  <u>Start day of 23<sup>rd</sup> and day of week is Monday</u> decimal 23 converted to 0x17 (high byte) decimal 1 (Monday) converted to 0x01 (low byte) set value of 0x1701 to EZT

Register #	Description	Use
203 (0x00CB) w	AutoStart Time (HH/MM)	0-24 Hours (high byte) – 24hr format (military time) 0-59 Minutes (low byte)  Parameter contains both hour and minutes for the profile to start when AutoStart is enabled. The value will be an integer value based on the combined bytes of both the hour and minutes. In order to set the value, combine the two component bytes into the word. Example:  <u>Start time of 5:49 pm</u> decimal 17 (5pm) converted to 0x11 (high byte) decimal 49 converted to 0x31 (low byte) set value of 0x1131 to EZT
204 (0x00CC) w	Profile Name Characters 1 and 2	These parameters store the operating profile's name up to 10 characters in length. (uses ASCII character set) Characters are stored in sequence from low byte to high byte. Example:  <u>Profile name is "TEST 123"</u> TE converted becomes 0x4554 ST converted becomes 0x5453 _1 converted becomes 0x3120 23 converted becomes 0x3332 __ converted becomes 0x8224  The "_" indicates a space in the above example. It is recommended that all empty characters be filled with a space rather than a null character.
205 (0x00CD) w	Profile Name Characters 3 and 4	
206 (0x00CE) w	Profile Name Characters 5 and 6	
207 (0x00CF) w	Profile Name Characters 7 and 8	
208 (0x00D0) w	Profile Name Characters 9 and 10	
209 (0x00D1) w	Total Number of Steps in Profile	1-99
210 (0x00D2) w	Guaranteed Soak Band Loop 1	-3276.8-3276.7 (-32768-32767)  Note that value must be converted to whole number, i.e., multiply by ten to convert the decimal number to the proper value for a write.
211 (0x00D3) w	Guaranteed Soak Band Loop 2	
212 (0x00D4) w	Guaranteed Soak Band Loop 3	
213 (0x00D5) w	Guaranteed Soak Band Loop 4	
214 (0x00D6) w	Guaranteed Soak Band Loop 5	

The following table contains the profile step data registers. Download only the number of steps set in register 209 during the download process.

**NOTE:** Register numbers listed are relative values. To convert to absolute values, add 40001.

Register #	Description	Use
215 w (0x00D7)	Step 1 Time (hours)	0-999
216 w (0x00D8)	Step 1 Time (MM/SS)	0-59 Minutes (high byte) 0-59 Seconds (low byte)  Parameter contains both minutes and seconds for the profile step duration. The value will be an integer value based on the combined bytes of both the minutes and seconds. In order to set the value, combine the two component bytes into the word. Example:  <u>Step time duration of 30 seconds</u> decimal 0 (minutes) converted to 0x00 (high byte) decimal 30 converted to 0x1E (low byte) set value of 0x001E to EZT
217 w (0x00D9)	Step 1 Chamber Events	Bit1 Chamber Event 1 Bit2 Chamber Event 2 Bit3 Chamber Event 3 Bit4 Chamber Event 4 Bit5 Chamber Event 5 Bit6 Chamber Event 6 Bit7 Chamber Event 7 Bit8 Chamber Event 8 Bit9 Chamber Event 9 Bit10 ---- Bit11 ---- Bit12 ---- Bit13 ---- Bit14 ---- Bit15 ----  This parameter is bit oriented, i.e., enabling the different bits of the word enables (1) or disables (0) the event.
218 w (0x00DA)	Step 1 Customer Events	Bit1 Customer Event 1 Bit2 Customer Event 2 Bit3 Customer Event 3 Bit4 Customer Event 4 Bit5 Customer Event 5 Bit6 Customer Event 6 Bit7 Customer Event 7 Bit8 Customer Event 8 Bit9 Customer Event 9 Bit10 Customer Event 10 Bit11 Customer Event 11 Bit12 Customer Event 12 Bit13 Customer Event 13 Bit14 Customer Event 14 Bit15 Customer Event 15  This parameter is bit oriented, i.e., enabling the different bits of the word enables (1) or disables (0) the events.
219 w (0x00DB)	Step 1 Guaranteed Soak Events	Bit1 Guaranteed Soak Loop 1 Bit2 Guaranteed Soak Loop 2 Bit3 Guaranteed Soak Loop 3 Bit4 Guaranteed Soak Loop 4 Bit5 Guaranteed Soak Loop 5  This parameter is bit oriented, i.e., enabling the different bits of the word enables (1) or disables (0) the events.

Register #	Description	Use
220 w (0x00DC)	Step 1 Wait for Loop Input	0 No Input Selected 1 Loop 1 Input Selected 2 Loop 2 Input Selected 4 Loop 3 Input Selected 8 Loop 4 Input Selected 16 Loop 5 Input Selected  Note that only wait for loop or wait for monitor input can be selected. DO NOT enable both at the same time.
221 w (0x00DD)	Step 1 Wait for Monitor Input	0 No Input Selected 1 Monitor Input 1 Selected 2 Monitor Input 2 Selected 4 Monitor Input 3 Selected 8 Monitor Input 4 Selected 16 Monitor Input 5 Selected 32 Monitor Input 6 Selected 64 Monitor Input 7 Selected 128 Monitor Input 8 Selected  Note that only wait for loop or wait for monitor input can be selected. DO NOT enable both at the same time.
222 w (0x00DE)	Step 1 Wait for Setpoint	-3276.8-3276.7 (-32768-32767)  Note that value must be converted to whole number, i.e., multiply by ten to convert the decimal number to the proper value for a write.
223 w (0x00DF)	Step 1 Jump Step	1-99
224 w (0x00E0)	Step 1 Jump Count	0-999  Jump count of 0 disables jump.
225 w (0x00E1)	Step 1 Loop 1 Set Point	-3276.8-3276.7 (-32768-32767)  Note that value must be converted to whole number, i.e., multiply by ten to convert the decimal number to the proper value for a write.  DO NOT exceed safe operating limits of chamber. Set points must be within chamber operational limits.
226 w (0x00E2)	Step 1 Loop 2 Set Point	
227 w (0x00E3)	Step 1 Loop 3 Set Point	
228 w (0x00E4)	Step 1 Loop 4 Set Point	
229 w (0x00E5)	Step 1 Loop 5 Set Point	
230 thru 244 w (0x00E6) (0x00F4)	Step 2 data registers	See step 1  (all steps maintain same format)
245 thru 259 w (0x00F5) (0x0103)	Step 3 data registers	
260 thru 274 w (0x0104) (0x0112)	Step 4 data registers	
.	.	
.	.	
.	.	
1685 thru 1699 w (0x0695) (0x06A3)	Step 99 data registers	

**Profile Download Algorithm**

The download profile procedure as well as the timer procedure is provided in visual basic below. These are sample procedures and CSZ does not take responsibility for end user actions. The user must be very careful regarding ranges and user interaction during profile download.

Private Sub downloadProfile()

'This sub will initiate the profile download and start the timer for profile download. Timer should be set at 1 second intervals  
'to make sure timeout from EZT controller does not occur.

-----  
'Variables used in procedure. User can select static, form, global variables or class type based on preference.  
G\_vary(x,x) is array for each EZT in system. First element is EZT number, second element is EZT register. EZT register  
are a total of 180 registers per EZT.

f\_curProfileName is form var that holds currently loaded profile.

f\_profRegsToWrite is form var that holds the current profile array point being written when timer ticks are active.

f\_writeNum is form var that holds the current segment being written when timer ticks are active.  
-----

'User error checking for sub should go here

'Check to see if profile is running before downloading profile (see EZT register list for profile status register)

'if EZT is offline mode or downloading a profile do not start profile download from PC and alert user

If G\_vary(f\_EztNum, 180) = 1 Then

    MsgBox "Local EZT-560 is in the offline mode or running/downloading a profile!" & vbCrLf & \_

        "Writes from the PC can not be initiated at this time.", \_

        vbInformation

    Exit Sub

End If

'Before download, make sure to save the profile name to disk as well as to array registers within profile list.

'EZT manual outlines profile register list. Profile name is 5 registers (10 chars total) and must be converted from

'text to integer values (2 chars per register)

If f\_curProfileName = "" Then

    MsgBoxOver "You must load or save a Profile before download to processor!", vbInformation, "Download Profile", Me.hWnd

    Exit Sub

End If

'following should disable graphic user interface for profile download while profile is being downloaded. User dependent code but

'user should not press download button again during download of profile from PC to EZT controller.

f\_profRegsToWrite = 0 'set var to zero each time profile download is initiated.

f\_writeNum = 0 'set var to zero each time profile download is initiated.

f\_regAdd = 201 'registers for profile data start at register 200 in HMI. Modbus master dependent based on zero based addressing.

End Sub

```

Private Sub downloadTimer_Timer()
'timer code that is initiated by downloadProfile procedure. Timer should be set at a minimum of 1 second intervals.
'write profile data array to PLC
-----
'variables used in procedure. User can select static, form, global variables or class type based on preference.
Dim x As Integer, writeValue As Integer 'write values to EZT must be integer values.
profileData(x,x) is array that holds profile data for currently active profile that is being edited (14,99) elements zero based.
'refer to downloadProfile procedure for form or global variables used.
-----
'Error checking should go here

f_profWrite = True 'profile write in progress flag form var. Not required - user dependent to block other actions during download
If f_writeNum < (totalNumSegs) Then 'totalNumSegs should be var or reference to total number of segs created for profile.

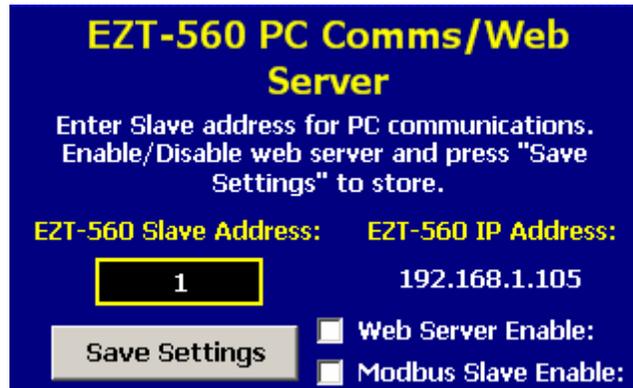
'for all element in profile array (15 elements total per segment. zero based)
For x = 0 To 14 '14 total elements in profile
  If f_profRegsToWrite = 0 Then 'first element that hold data global to complete profile
    Select Case x
      Case 0 To 9 'autostart and profile name requires no scaling in element 0
        writeValue = CInt(profileData(x, f_profRegsToWrite))
      Case 10 To 14 'gs soak band requires scale by 10
        'values are for SP's so scale by 10 for PLC
        writeValue = CInt(profileData(x, f_profRegsToWrite) * 10)
    End Select
  Else 'elements 1 to 99 of profarray which holds data for each segment
    Select Case x
      Case 0 To 6
        'hours, mins,/secs, chamber events, cust events, gs events
        'wait or loop input, wait for monitor input.
        'first 6 elements require no scale by 10
        writeValue = CInt(profileData(x, f_profRegsToWrite))
      Case 7 'wait for input setpoint. value for SP so scale by 10
        writeValue = CInt(profileData(x, f_profRegsToWrite) * 10)
      Case 8, 9 'jump step and jump count are integers, dont scale by 10
        writeValue = CInt(profileData(x, f_profRegsToWrite))
      Case 10 To 14 'setpoint values for loop1 - 5. scale by 10
        writeValue = CInt(profileData(x, f_profRegsToWrite) * 10)
    End Select
  End If
  ModProf.WordVal(x) = writeValue 'modbus master array. code line is modbus server dependent for multi-writes.
Next
ModProf.Address = f_regAdd 'start register for profile download. code is modbus server dependent
ModProf.Size = 15 'size of array. code is modbus server dependent
ModProf.Trigger 'trigger comms write. command is modbus master dependent
'increment writes for end of loop when total writes equal
'total number of segments in profile.
f_writeNum = f_writeNum + 1
f_profRegsToWrite = f_profRegsToWrite + 1 'increment registers within profile for write
f_regAdd = f_regAdd + 15 'increment to next 15 profile registers
Else
'profile writes are complete. Segments written = total number of segments created for profile.
downloadTimerer2.Enabled = False 'stop download timer
'hide progress bar and download messages. Unlock screen if user locked to block other actions here.
f_profWrite = False 'profile write completed reset flag if used.
End If
End Sub

```

### 9.5 Ethernet (Web Server) Connectivity

The EZT-560 allows a user to remote monitor chamber operations anywhere via a PC's standard web browser. To connect the EZT-560 to a network, just connect the EZT's Ethernet port to your network using a standard CAT5 cable connection. The EZT will be automatically assigned an IP address via the network's DHCP server.

You must use the assigned IP address to access the EZT-560. To obtain the correct IP address, go to the PC Comms/Web Server selection under the chamber setup menu. Write down the IP address, you will need to enter this in your web browser.



**NOTE:** Contact your IT department prior to connecting the EZT-560 to your network. Company policy may prohibit the use of web servers for security reasons. Cincinnati Sub-Zero is not responsible for the use of, nor makes any claims as to the security of the web server interface over your network. The use of the EZT-560 web server is the responsibility of the end user.

To access and view the EZT-560's status web page, enter the following link in your PC's browser address window: <http://IPaddress/ezt.html> (from example address, <http://192.168.1.105/ezt.html>).

The example below is typical of the EZT-560 web page appearance. The web page updates automatically every 30 seconds and provides information on each individual loop, profile status, alarm status and event status.



## 10. Diagnostics

This section provides technical help for diagnosing problem conditions with your chamber. The information provided here covers typical options and accessories. If you are unable to diagnose a problem through the use of this guide, contact Cincinnati Sub-Zero's Service Department.

### 10.1 Alarm Codes and Troubleshooting

**WARNING** Some of the procedures may require access to live circuitry. Dangerous accidental contact with line voltage is possible. Only qualified service personnel should be allowed to perform these procedures. Potentially lethal voltages are present inside the unit.

Alarm Description	Corrective Action
"Input" ALARM	Indicates user configurable alarm is on for "input" listed.
BOILER OVERTEMP	Boiler exceeded operating temperature. Check water supply and water level. Verify low water float operation. Reset high temperature safety on boiler.
BOILER LOW WATER	Boiler water level low. Check water supply. Check low float operation. Check operation of fill level float and water supply solenoids. Check and replace filters if necessary.
CHAMBER HI LIMIT	Chamber high limit safety tripped. Limit must be manually reset or power cycled to chamber to reset. Verify proper air flow in chamber. Do not set temperature set point above chamber design limits.
COMBUSTIBLE MONITOR	Optional air monitor detected hazardous condition. Vent area with fresh air. Possible asphyxiation or explosion hazard exists. Keep personnel clear. Keeps sources of ignition away from chamber.
DEHUMID SYSTEM FAULT	Optional dehumidifier system fault. Check manufacturer's manual provided with the chamber for troubleshooting and diagnostic information.
EMERGENCY STOP	Investigate cause of stop. Verify conditions are safe. Reset emergency stop.
FLUID SYS TEMP	Fluid system high temperature safety tripped. Verify fluid level and flow. Do not set temperature set point above fluid system design limits.
FLUID SYS HI PSI	Fluid system exceeded operating pressure limits. Check for restrictions in fluid system. Verify all isolation valves are open. Reset high pressure safety.
FLUID SYS LOW FLOW	Fluid flow safety tripped. Verify fluid level. Check for restrictions in system. Check pump operation and service if necessary.
GATEWAY COMMS FAILURE	Check communication wiring between gateway communication module and 9300 loop controls. Verify proper addresses on 9300 controllers. Verify power to 9300 controllers and optional EAGLE input monitor if equipped. Verify 9300 address.

<b>Alarm Description</b>	<b>Corrective Action</b>
MOTOR OVERLOAD	Motor overload tripped or motor drive fault. Requires manual reset of motor overload. Check drive and motor fusing. Check motor for overload condition, i.e., bearing wear binding shaft, etc. Replace fuse, repair/replace motor or drive.
PRODUCT SAFETY	Optional product safety limit tripped. Manually reset limit to clear alarm. Check limit set points and verify properly set for product testing.
PUMPDOWN DISABLED	Chamber power off for more than 30 minutes. Will automatically reset in 4 hours. Can be manually reset via alarm monitor screen. Unit will not run with pumpdown disabled.
"Input" SENSOR BREAK	Check sensor wiring for indicated "input". Verify lead connections. If sensor requires power, i.e., humidity, altitude, etc., verify power to sensor. Replace sensor.
SYS# HILO PSI	Refrigeration system # (# = system number) high or low pressure safety tripped. High pressure safety requires manual reset. Check condenser for blockage, clean if necessary. Low pressure will automatically reset. Check static pressure for possible leaks.  Service and further diagnostics require authorized, certified refrigeration service personnel.
SYS# LOW OIL PSI	Refrigeration system # (# = system number) oil pressure safety tripped. Check compressor oil level. Requires manual reset.  Service and further diagnostics require authorized, certified refrigeration service personnel.
SYS# HI DISCHARGE TMP	Refrigeration system # (# = system number) discharge safety tripped. Check liquid injection solenoid. Automatically resets.  Service and further diagnostics require authorized, certified refrigeration service personnel.
SYS# COMP MONITOR	Refrigeration system # (# = system number) compressor protection module tripped. Check fusing and contactor for proper operation. Automatically resets after approximately 30-45 minutes.  Service and further diagnostics require authorized, certified refrigeration service personnel.
TRANSFER ERROR	Transfer fault. Check for mechanical obstructions in basket transfer mechanism. Verify proper sensor locations and operation for basket positions.

**NOTE:** An audible signal will sound for all system alarms. User can disable audible signal for input alarms if desired. All view screen backgrounds will turn red on alarm.

<b>System Status Description</b>	<b>Corrective Action</b>
RH H2O RESERVOIR LO	Optional Humidity water reservoir low. Add more water.  (an audible alert is associated with this indicator)
RH TMP DISABLE	Temperature outside allowable humidity operational limits. Turn off humidity system or set temperature set point within proper operating range.  (no audible alert is associated with this indicator)
RH HI DEWPOINT LIMIT	EZT-560 is limiting the maximum humidity level based on the maximum allowable dewpoint that the chamber can operate safely without causing potential damage to the structure of the chamber. Set temperature and humidity set points to within allowable chamber range.  (no audible alert is associated with this indicator)
RH LO DEWPOINT LIMIT	EZT-560 is limiting the minimum humidity level based on the minimum allowable dewpoint that the chamber can operate safely without causing potential damage to the refrigeration system. Set temperature and humidity set points to within allowable chamber range.  (no audible alert is associated with this indicator)
SERVICE FANS	Service alert, if enabled, indicating that the prime air movers of the chamber require regular maintenance. Perform service and clear elapsed service count for corresponding components.
SERVICE COND SYS	Service alert, if enabled, indicating that the heating and/or cooling system components require regular maintenance. Perform service and clear elapsed service count for corresponding components.
SERVICE HUMIDITY SYS	Service alert, if enabled, indicating that the humidity system components require regular maintenance. Perform service and clear elapsed service count for corresponding components.
SERVICE PURGE SYS	Service alert, if enabled, indicating that the dry air purge system components require regular maintenance. Perform service and clear elapsed service count for corresponding components.
SERVICE ALTITUDE SYS	Service alert, if enabled, indicating that the altitude system components require regular maintenance. Perform service and clear elapsed service count for corresponding components.
SERVICE XFER SYS	Service alert, if enabled, indicating that the basket transfer mechanism components require regular maintenance. Perform service and clear elapsed service count for corresponding components.

**NOTE:** An audible signal can be associated with the service alerts. See section 10.2, Service Monitors, for detailed information on the service alerts.

**10.2 Service Monitors**

**WARNING** Perform lock-out, tag-out procedures and remove main power from the chamber prior to performing any service procedures. Service should only be performed by qualified service personnel.

Elapsed Service Counter Description	Service Action
AIR CIRCULATOR HRS	<p>Inspect locking collars on fans. Tighten if necessary.</p> <p>Inspect fan blades for damage or loose blades. Replace fan blade if necessary. DO NOT attempt repair.</p> <p>Inspect motor bearings for excessive wear (slop). Lubricate if applicable.</p> <p>Inspect heaters for corrosion and replace if insulators cracked or damaged.</p>
RC BLOWER HRS	<p>Inspect locking collars on blower wheel. Tighten if necessary.</p> <p>Inspect blower wheel for damage or loose blades. Replace wheel if necessary. DO NOT attempt repair.</p> <p>Inspect motor bearings for excessive wear (slop). Lubricate if applicable.</p>
ALTITUDE SYS HRS	<p>Change vacuum pump oil filter.</p> <p>Check oil level in vacuum pump. Check for leaks. Add oil if needed.</p> <p>If applicable, inspect drive belts and replace if worn. Re-tension belts. Inspect motor bearings for excessive wear (slop). Lubricate if applicable.</p>
SYS # COMPRESSOR HRS	<p>Check compressor oil level. Verify static pressures.</p> <p>Clean air cooled condenser if applicable (air cooled units).</p> <p>Inspect condenser water connections if applicable (water cooled units). Verify proper temperature and differential pressure.</p>
HUMIDITY SYSTEM HRS	<p>Inspect water connections and filter cartridge if applicable.</p> <p>Clean humidity water reservoir if option present.</p> <p>If atomizer system, remove spray nozzle and clean. Inspect compressor motor and diaphragm for wear. Clean water filter.</p> <p>Inspect for build-up of deposits on humidity sensor. Clean filter tip of sensor. Use caution so as not to damage sensor tip.</p>
DRY AIR PURGE HRS	<p>Inspect air lines for leaks.</p> <p>Inspect filters and clean if necessary.</p>
HEATER CYCLES	<p>Inspect electrical connections and heater SSR for loose or frayed wiring. Tighten loose connections.</p>

Elapsed Service Counter Description	Service Action
SYS # CMP STARTS	Inspect wiring and power contactors for loose connections. Tighten or repair as necessary.  Inspect compressor mounts/vibration isolators for wear. Tighten loose mounts or replace isolators if worn.
COOL VALVE CYCLES	Inspect valve body for corrosion. Look for cracks in valve stems. Inspect electrical connections on solenoid coil.
RHCOOL VALVE CYCLES	Requires authorized refrigeration service personnel to replace.
HUMIDIFY CYCLES	If boiler system, Inspect electrical connections and heater SSR for loose or frayed wiring. Tighten loose connections.
DEHUMIDIFY CYCLES	Inspect valve body for corrosion. Look for cracks in valve stems. Inspect electrical connections on solenoid coil.
LOW RH VALVE CYCLES	Requires authorized refrigeration service personnel to replace.
DIVE VALVE CYCLES	Inspect valve body and fittings for cracks or leaks
VACUUM VALVE CYCLES	Verify pressure regulator settings.
TRANSFER CYCLES	Inspect transfer mechanism for wear. Adjust slide mechanisms and/or lubricate as necessary.  Inspect cables for fraying and replace if applicable.

**NOTE:** The elapsed service intervals are set based on CSZ recommended operating conditions for the chamber. These intervals may not be suitable to all applications due to varying operating conditions and environmental factors. It is recommended that these be used as a guide only, and that the end user determine and set up their own maintenance program based on use to insure reliable and long term chamber operation.

If you have any questions regarding maintenance procedures or would like recommendations for service procedures or programs, contact Cincinnati Sub-Zero's Service Department.

### 10.3 I/O Assignments

The following table identifies the standard I/O assignments for the EZT-560 controller and the use of each point. Note that this list covers all standard configurations and the use of the inputs and outputs on your chamber is dependant upon chamber type and options present.

#### Digital I/O CPU Connector 1

terminal	I/O ADDR	Operation
BO1-26	I0	Chamber limit safety input. (CHAMBER HI LIMIT) (on in alarm condition)
BO1-24	I1	Optional product safety input. (PRODUCT SAFETY) (on in alarm condition)
BO1-22	I2	Motor overload/drive fault input. (MOTOR OVERLOAD) (on in alarm condition)
BO1-20	I3	Pumpdown input. When system equipped with pumpdown mode, pressure switch 7PS will activate input and enable the system 1 compressor.
BO1-18	I4	System 1 refrigeration pressure safety input. (SYS1 HILO PSI) (off in alarm condition)
BO1-16	I5	System 1 compressor oil pressure safety. (SYS1 LOW OIL PSI) (off in alarm condition)
BO1-14	I6	System 1 compressor discharge temperature safety. (SYS1 HI DISCHARGE TMP) (off in alarm condition)
BO1-12	I7	System 1 compressor protection module. (SYS1 COMP MONITOR) (off in alarm condition)
BO1-10	I10	System 2 refrigeration pressure safety input. (SYS2 HILO PSI) (off in alarm condition)
BO1-8	I11	System 2 compressor oil pressure safety. (SYS2 LOW OIL PSI) (off in alarm condition)
BO1-6	I12	System 2 compressor discharge temperature safety. (SYS2 HI DISCHARGE TMP) (off in alarm condition)
BO1-4	I13	System 2 compressor protection module. (SYS2 COMP MONITOR) (off in alarm condition)
BO1-25	Q0	Air circulator motor output
BO1-23	Q1	RC blower motor output
BO1-21	Q2	System 1 compressor output
BO1-19	Q3	System 2 compressor output
BO1-17	Q4	Chamber light output
BO1-15	Q5	Window/door frame heater output
BO1-13	Q6	Product limit output
BO1-11	Q7	Audible alarm output

**Digital I/O CPU Connector 2**

terminal	I/O ADDR	Operation
BO2-26	I14	Boiler over temperature safety input. (BOILER OVERTEMP) (off in alarm condition)  Basket left (TSB/DTS)
BO2-24	I15	Boiler low water input. (BOILER LOW WATER) (off in alarm condition – ignored with humidity system off)  Basket right (TSB/DTS)
BO2-22	I16	Water reservoir low water input. (RH H2O RESERVOIR LO) (off in alarm condition – ignored with humidity system off)  Basket up (VTS/TSB with air pneumatic transfer mechanism)
BO2-20	I17	System 1 defrost pressure control. Used to control system 1 refrigeration system for cascade condenser cooling control to maintain system 2 pressure.
BO2-18	I20	Defrost temperature switch. Terminates defrost once coil temperature reached.
BO2-16	I21	Door switch. Input on signals door is open. Used to indicate transfer mechanism disabled on VTS/DTS/TSB.
BO2-14	I22	Emergency stop input. (EMERGENCY STOP) (on in alarm condition)
BO2-12	I23	Fluid system temperature safety input. (FLUID SYS TEMP) (on in alarm condition)
BO2-10	I24	Fluid system pressure safety input. (FLUID SYS HIGH PSI) (off in alarm condition)
BO2-8	I25	Fluid system low flow safety input. (FLUID SYS LOW FLOW) (off in alarm condition)
BO2-6	I26	Dehumidification system fault input. (DEHUM SYSTEM FAULT) (on in alarm condition)
BO2-4	I27	Combustible monitor safety input. (COMBUSTIBLE MONITOR) (on in alarm condition)
BO2-25	Q10	Rate-master control output. Used to switch cooling control between system 1 and system 2 on rate-master refrigeration systems.
BO2-23	Q11	System 1 solenoid enable output. Used to enable/disable solenoids for pumpdown mode.
BO2-21	Q12	Defrost solenoid output. Turns on defrost solenoid on systems equipped with defrost.
BO2-19	Q13	System 1 cascade cooling control output. Used to isolate cascade condenser for large horsepower defrost and rate-master system 1 cooling.
BO2-17	Q14	Cooling enable output. Disables cooling in defrost.
BO2-15	Q15	Maximum cooling enable.
BO2-13	Q16	Heating enable output. Disables heat in defrost.
BO2-11	Q17	Maximum heating enable.

**Digital Output Expansion Connector 1**

terminal	I/O ADDR	Operation
BO3-20	Q30	Dehumidify solenoid enable output.
BO3-18	Q31	RH cooling solenoid enable output. Turns on system 1 cooling solenoid on cascade systems that operate system 1 only in humidity mode.
BO3-16	Q32	Humidity system enable output. Turns on water supply solenoids and atomizer air compressor if applicable.
BO3-14	Q33	Maximum humidify enable output.
BO3-12	Q34	Dry air purge control output.
BO3-10	Q35	Air control solenoid enable output. Enables dry air purge control on systems with low RH option.
BO3-8	Q36	Enabled dehumidification control of frozen coil solenoid on systems equipped with low RH option.
BO3-6	Q37	Frozen coil bypass solenoid output. Turns on solenoid to bypass EPR on wet coil for systems with low RH option.
BO3-19	Q40	LN2 supply solenoid control output.
BO3-17	Q41	LN2 control solenoid enable output. Switches primary cooling control from refrigeration to LN2 for ultra temperature operation on specially equipped chambers.
BO3-15	Q42	LN2 boost solenoid. Turns on to assist refrigeration systems on fast change rates.
BO3-13	Q43	Altitude system enable output.
BO3-11	Q44	Altitude system minimum dive output enable. Transfer left output for DTS, TSB chambers.
BO3-9	Q45	Altitude system maximum dive output enable. Transfer right output for DTS, TSB chambers.
BO3-7	Q46	Altitude system minimum vacuum output enable. Transfer hot (up) output for VTS chambers.
BO3-5	Q47	Altitude system maximum vacuum output enable. Transfer cold (down) output for VTS chambers.

**Digital Output Expansion Connector 2**

terminal	I/O ADDR	Operation
BO4-20	Q50	Optional customer event 1 output
BO4-18	Q51	Optional customer event 2 output
BO4-16	Q52	Optional customer event 3 output
BO4-14	Q53	Optional customer event 4 output
BO4-12	Q54	Optional customer event 5 output
BO4-10	Q55	Optional customer event 6 output
BO4-8	Q56	Optional customer event 7 output
BO4-6	Q57	Optional customer event 8 output
BO4-19	Q60	Optional customer event 9 output
BO4-17	Q61	Optional customer event 10 output
BO4-15	Q62	Optional customer event 11 output
BO4-13	Q63	Optional customer event 12 output
BO4-11	Q64	Optional customer event 13 output
BO4-9	Q65	Optional customer event 14 output
BO4-7	Q66	Optional customer event 15 output
BO4-5	Q67	Not Used



## Appendix

## Common Terms and Definitions

**autotune** — A feature that automatically sets process control PID values to match a particular process in a system.

**baud rate** — The rate of information transfer in serial communications, measured in bits per second.

**accuracy** — Closeness between the value indicated by a measuring instrument and a physical constant or known standard.

**offset** — An adjustment to eliminate the difference between the indicated value and the actual process value.

**cascade** — Control algorithm in which the output of one control loop provides the set point for another loop. The second loop, in turn, determines the control action.

**derivative control (D)** — The last term in the PID control algorithm. Action that anticipates the rate of change of the process, and compensates to minimize overshoot and undershoot. Derivative control is an instantaneous change of the control output in the same direction as the proportional error. This is caused by a change in the process variable (PV) that decreases over the time of the derivative (TD). The TD is in units of seconds.

**droop** — In proportional controllers, the difference between set point and actual value after the system stabilizes.

**EIA** — See Electronics Industries of America.

**EIA/TIA -232 and -485** — Data communications standards set by the Electronic Industries of America and Telecommunications Industry Association. Formerly referred to as RS- (Recognized Standard).

**Electronics Industries of America (EIA)** — An association in the US that establishes standards for electronics and data communications.

**fuzzy logic** — A mathematical control algorithm that monitors past response of a system to predict future response and automatically adjust PID parameters in order to adapt to process.

**hysteresis** — A change in the process variable required to re-energize the control or alarm output. Sometimes called switching differential.

**integral control (I)** — Control action that automatically eliminates offset, or droop, between set point and actual process temperature.

**limit or limit controller** — A highly reliable, discrete safety device (redundant to the primary controller) that monitors and limits the temperature of the process, or a point in the process. When temperature exceeds or falls below the limit set point, the limit controller interrupts power through the load circuit. A limit controller can protect equipment and people when it is correctly installed with its own power supply, power lines, switch and sensor.

**Modbus™** — A digital communications protocol owned by AEG Schneider Automation for industrial computer networks.

**Modbus™ RTU** — Remote Terminal Unit, an individual Modbus™-capable device on a network.

**overshoot** — The amount by which a process variable exceeds the set point before it stabilizes.

## Common Terms and Definitions (cont'd)

**PID** — Proportional, integral, derivative. A control mode with three functions: proportional action dampens the system response, integral corrects for droop, and derivative prevents overshoot and undershoot.

**process variable (PV)**— The parameter that is controlled or measured. Typical examples are temperature, relative humidity, altitude, etc. The high process variable is the highest value of the process range, expressed in engineering units. The low process variable is the lowest value of the process range.

**proportional control (P)**— Output effort proportional to the error from set point. For example, if the proportional band is 20° and the process is 10° below set point, the heat proportioned effort is 50 percent.

**ramp** — A programmed increase in the temperature of a set point system.

**range** — The area between two limits in which a quantity or value is measured. It is usually described in terms of lower and upper limits.

**(RTD) resistance temperature detector** — A sensor that uses the resistance temperature characteristic to measure temperature.

**serial communications** — A method of transmitting information between devices by sending all bits serially over a single communication channel.

**set point (SP)** — The desired value programmed into a controller. For example, the temperature at which a system is to be maintained.

**(T/C) thermocouple** — A temperature sensing device made by joining two dissimilar metals. This junction produces an electrical voltage in proportion to the difference in temperature between the hot junction (sensing junction) and the lead wire connection to the instrument (cold junction).

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*Appendix*

- Common Terms and Definitions
- List of Figures
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## **1. Overview**

This guide has been written to aid in the troubleshooting of chamber operational issues and/or malfunctions. Note that not all options and/or features discussed in this guide may be available or applicable to the particular chamber that is being serviced. It is highly recommended that you read this material thoroughly prior to performing any chamber service in order to better assist you in locating the section(s) that apply to the problem at hand.

### **1.1 Safety Information**

Note, caution and warning symbols that appear throughout this manual are to draw your attention to important operational and safety information.

A “**NOTE**” marks a short message to alert you to an important detail.

A “**CAUTION**” safety alert appears with information that is important for protecting the equipment and performance.

A “**WARNING**” safety alert appears with information that is important for protecting you, others and equipment from damage. Pay very close attention to all warnings that apply to the chamber.

### **1.2 How to Use this Guide**

To begin using this guide, start with Section 2, Where Do I Start Looking. This will assist you in finding the correct section for further information on how to diagnose and correct the problem.

**NOTE** Remember to keep it simple. Don't try and solve everything at once. Take each issue one-at-a-time. It may take several “trips” through this guide to correct each problem or locate the root cause of a single fault, but by breaking it down into pieces, you can simplify the process and solve it in less time.

In many instances, one component failure or incorrect control setting can cause various chamber malfunctions that would point you in several different directions, none of which may be correct. Always try and work backwards from what is not working correctly and determine why. Why is this not working, what makes it work and/or how should it work?

**WARNING**



**Certain troubleshooting procedures may require access to live electrical components operating at lethal energy levels. Extreme caution and proper protective gear is required. These procedures should only be performed by qualified service personnel. Failure to follow proper OSHA regulations may result in serious injury or death.**

## 2. Where Do I Start Looking

The EZT-560 Environmental Controller is a mini DCS (Distributed Control System) which uses different hardware layers to perform the various functions needed to operate the chamber. These include the user interface (HMI), system monitoring and protection (PLC), as well as process control (9300 controllers). This type of platform distributes the work load of controlling the chamber into different devices and allows us to break the system down into these layers for troubleshooting which makes diagnosing problems less complicated.

Instead of looking at the system as a whole, look at each component and focus on what task it is performing and whether or not it is doing it right. Start from the component level when tracing a problem and work backwards from what is not working. Some problems are obvious. If I am trying to enter a set point and the touch screen is not responding to my touch, then it is a problem with the HMI. However, when the chamber is not doing something it is supposed to, is it the controller or something else? Over 90% of the time it can be attributed to a wiring fault or single component failure that prevents the system from operating. It isn't the controller.

**Example:** The chamber is at 75°F and the set point is 185°F. The fans are running, but it is not heating up. What is wrong?

Instead of approaching the problem by asking why the controller is not calling for heat, ask why are the heaters not on? Using the electrical schematic for the chamber, locate the power wiring for the heater. Is there voltage to the heaters? Is the heat output on, i.e., is the solid state relay on to supply power to the heater. Is the heater contactor on? Is there a blown fuse?

Start from the heaters and work back. This will allow you to find what is not allowing power to pass to the heaters. It may even be several components, like the contactor and solid state relay, which both get power from a common wire that be shorted or open due to a limit device which just needs manually reset.

Remember, the EZT performs the same function on the chamber as any other controller. It has heat and cool outputs for controlling temperature based on a set point. It has humidify and dehumidify outputs to control humidity based on a set point. These outputs control the same heaters, compressors and solenoids that any other controller would. What it does provide that typical controllers do not, is a user friendly touch screen for entering set points and monitoring chamber temperature and humidity. It also individually monitors many of the chamber safeties in order to provide specific alarm information so you know exactly what is preventing the chamber from running and do not have to search for it.

**NOTE** An alarm condition may be present and not indicated on the EZT if a hardware failure or wiring problem exists. Keep this in mind when there are no obvious fault conditions present that would indicate why the chamber is not working properly.

In order to begin troubleshooting a chamber problem, narrow down the search by determining which section of this guide the problem most likely falls into based on the information provided below.

*Section 3. User Interface (HMI) Troubleshooting*

This section covers typical problems that may arise with the EZT's display such as screen "lock-ups" or the EZT failing to start due to communication or hardware problems.

*Section 4. Resolving Chamber Alarms*

This section covers all alarm messages provided by the EZT in its alarm monitor. Begin with this section to obtain information regarding any unresolved alarm messages that are not able to be cleared, determine what is causing it and correct the problem.

*Section 5. Chamber Operating Problems*

Use this section to diagnosis problems when no alarm messages are present. Why are the compressors not turning on? Why is humidity not turning on when the event is on? This helps you determine if there is a real problem or if the chamber is doing what it is supposed to based on how it is configured.

*Section 6. Process Control Problems*

This section covers issues related to process control. Why is the chamber not controlling to set point? Why is the chamber not following the profile? It provides information on how and why the controller responds to certain conditions and tips on how to improve response time.

*Section 7. Remote PC Communication Problems*

This section covers issues involving the use of the serial, Ethernet and optional IEEE interfaces available on the chamber when trying to connect to a remote PC and establish a communication link for monitoring and/or control.

*Section 8. Deciphering EZT Input/Output (I/O) Operation*

This section reviews the functionality of the inputs and outputs of the EZT and how they are used and controlled. This section can assist you in determining if there is a wiring or hardware problem that may be causing the chamber to not operate properly.

*Section 9. Adjusting EZT Configuration Options*

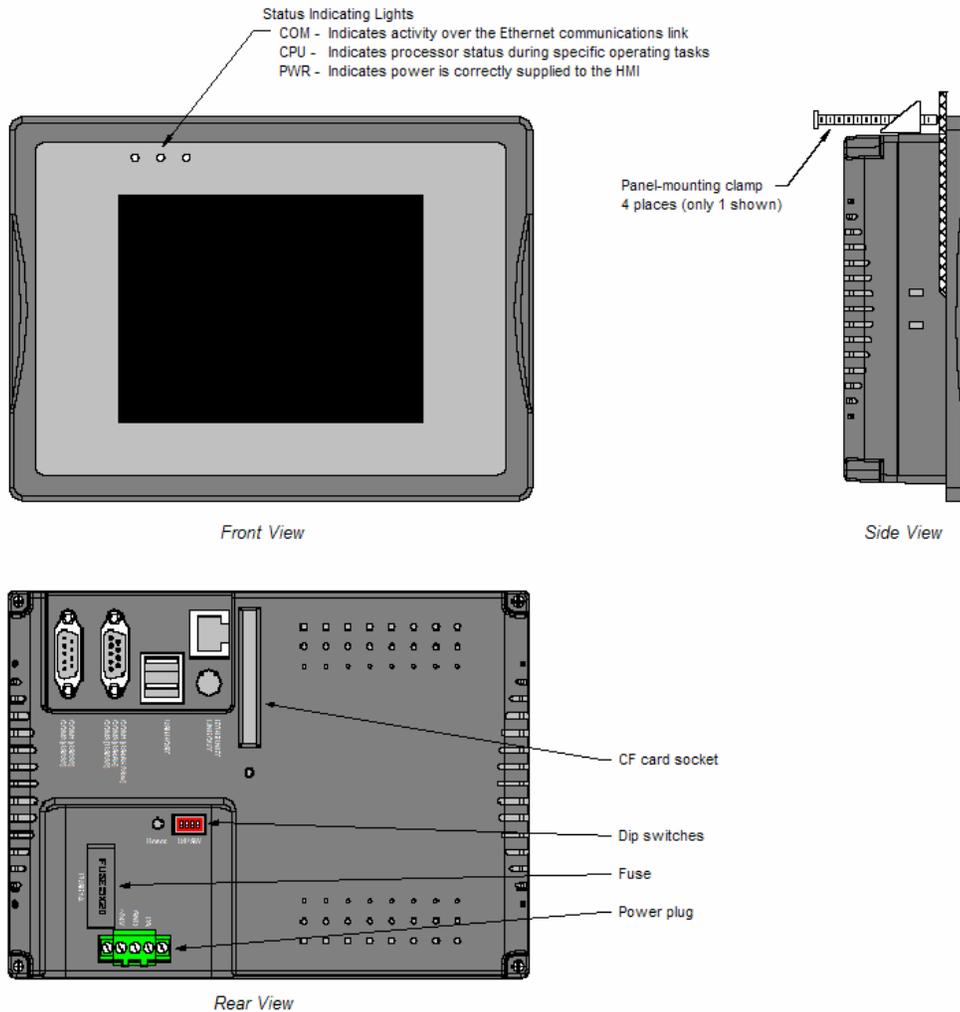
This section reviews the use of the EZT's configurator and how the settings affect the operation of the chamber. This section is for experienced service personnel only. Changing certain settings from the original factory settings can cause damage to equipment or injury to personnel. When in doubt, consult the factory.

### 3. User Interface (HMI) Troubleshooting

The EZT-560's user interface is an embedded Windows CE device. Once powered up, it will follow a typical boot up sequence (similar to any PC running a Microsoft Windows product) and automatically start the EZT560 application. The EZT560 application is what provides the operating screens, loop views, trends, logging, etc., that the user can navigate through to change set points, create and run profiles, and so on.

The HMI and EZT560 application do not operate or perform any control tasks for the chamber. They are used for user input, information gathering and monitoring of chamber operations only. The information is exchanged over an RS485 serial communication link between the HMI and the EZT-560's CPU mounted on the electrical sub-panel. A failure of the HMI or EZT560 application will not cause the chamber to shut down. The CPU will continue to operate the chamber under its last given instructions. In order to stop the chamber, power must be removed from the chamber.

**NOTE** If the HMI fails to boot up properly when power is restored to the chamber, the chamber will not begin operation. The HMI must boot up into the EZT560 application in order for the chamber to start. The CPU will not start the chamber until it receives a signal from the HMI that it has booted up and the EZT560 application is running properly.



**3.1 Common HMI Failures and Corrective Actions**

SYMPTOM	PROBABLE CAUSES	CORRECTIVE ACTIONS
1) <u>Black Screen</u>		
"PWR" indicator is off. "CPU" indicator is off.	Power is off.  Wrong polarity of power source.  Blown Fuse on HMI.	Turn on power.  Check/correct polarity of power source. - positive to +24V terminal - negative (common) to GND terminal  Replace fuse.
"PWR" indicator is on. "CPU" indicator is off.	Screen saver is on.  Bad backlight.	Touch screen to disable screen saver.  Replace HMI.
"PWR" indicator is on. "CPU" indicator is on.	Power "glitch".  Bad USB cable/damaged I-Stick.  Improperly inserted/damaged CF card.  HMI hardware failure.	Cycle power to EZT. Check supply voltage. (must be $24 \pm 1$ Vdc)  Remove I-Stick, replace USB cable.  Verify CF card inserted properly. Replace CF card.  Replace HMI.
2) <u>Blue Screen</u>		
EZT560 application not starting.	CF card missing, improperly inserted or erased.  Windows CE startup directory not properly configured.  Card socket damaged.	Verify CF card is inserted properly. Check CF card for EZT560 operating files.  Check/configure proper startup directory. (see Section 3.1.1)  Check socket for bent/missing pins. Repair/replace HMI.
3) <u>Communications Error</u>		
"Error during write to controller. Check cable or setup/wiring." message displayed at startup.	PLC not loaded with chamber control program.  Communication wiring between HMI and PLC not properly connected.  Serial port not set up properly on HMI.  PLC communication adapter (port 2) not seated properly on PLC/damaged.	Verify/load proper program to PLC. Both "PWR" and "RUN" LED's lit on PLC.  Check wiring/connections. Correct/repair.  Verify/correct serial port 1 mode on HMI. (see Section 3.1.2)  Check connection between adapter and CPU. Replace adapter (port 2).

## EZT-560 Chamber Troubleshooting Guide

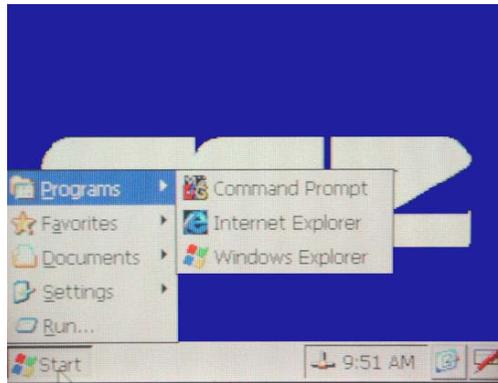


SYMPTOM	PROBABLE CAUSES	CORRECTIVE ACTIONS
<p>"Comm alm at PLC. Check Cable." alarm message.</p>	<p>Communication wiring between HMI and PLC not properly connected.</p> <p>Electrical noise in system or remote PC communicating too fast with EZT.</p>	<p>Check wiring/connections. Correct/repair.</p> <p>Check for proper shielding of communication wiring.</p> <p>Turn off electrically noisy devices.</p> <p>Disconnect remote PC or slow down communication rate from remote PC. (minimum 500ms scan rate)</p>
<p><b>4) <u>Screen Locked Up</u></b></p>		
<p>Screen does not respond to touch.</p>	<p>CE operating system locked up.</p> <p>Touch screen out of calibration.</p> <p>HMI operating temperature exceeded.</p> <p>Touch screen failure.</p>	<p>Cycle power.</p> <p>Calibrate touch screen. (see Section 3.1.3)</p> <p>Ambient temperature around HMI must be between 0°C (32°F) and 45°C (113°F). Turn off EZT. Bring ambient temperature to within allowable range.</p> <p>Replace HMI.</p>
<p><b>5) <u>Screen Difficult to See</u></b></p>		
<p>Screen looks like an Etch-a-Sketch.</p>	<p>Screen contrast out of adjustment.</p> <p>HMI operating temperature exceeded.</p> <p>Screen failure.</p>	<p>Adjust screen contrast. (see Section 3.1.4)</p> <p>Ambient temperature around HMI must be between 0°C (32°F) and 45°C (113°F). Turn off EZT. Bring ambient temperature to within allowable range.</p> <p>Replace HMI.</p>

### 3.1.1 Configure Windows CE Startup Directory

The startup directory must be stored in the “NORFlash” directory in the HMI. This area is backed up to flash memory so it is retained when power is removed, and is automatically started once the boot sequence has been completed on power up.

To check the startup directory, touch the thin gray bar at the bottom of the screen to display the start menu. Touch the “Start” button and select “Programs” and then “Windows Explorer”.



**Figure 3-1 Windows Start Menu**

From “My Computer” open the “NORFlash” directory. The NORFlash directory may contain several folders and/or files; however, we are only concerned with the “Startup” folder. If the startup folder does not exist, then it must be created. If the startup folder does exist, open the folder and make sure the file “Shortcut to EZT560” is in the folder. If it is not, then it must be added.

The CF card holds a copy of the startup folder needed for proper operation. To replace either the missing folder or shortcut, copy the startup folder from the compact flash card to the NORFlash directory. To do so, open the storage card folder from “My Computer”. Touch the “Startup” folder to select it and then select “Copy” from the “Edit” menu. Return to the NORFlash directory and then select “Paste” from the “Edit” menu to paste the startup folder into the NORFlash directory. Cycle power to the EZT so that it can perform its normal boot sequence.



**Figure 3-2 “My Computer” File Access**

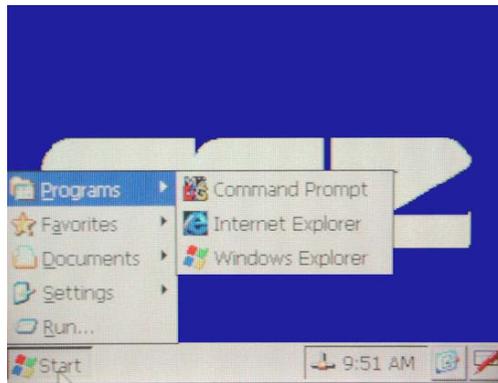
**3.1.2 Configure Serial Port 1 Mode**

Serial port 1, on the back of the HMI, is used to communicate with the PLC over port 2 on the CPU. This is a two wire, RS485 serial link. In order for the link to operate properly, the serial port on the HMI must be set for RS485.



*Figure 3-3 Write Error on Boot*

To check the serial port settings, power down the EZT. Remove the CF card from the back of the HMI and turn the power back on. Allow the HMI to boot up to the Windows desktop. Insert the CF card in the back of the HMI making sure that it is properly oriented. Touch the small gray bar at the bottom of the screen to open up the start menu. Press the “Start” button and select “Windows Explorer” from the “programs” menu.



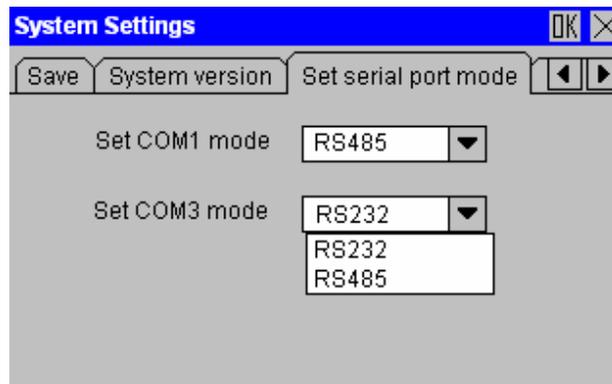
*Figure 3-4 Windows Start Menu*

Open the “StorageCard” folder in order to gain access to the “CECP” utility. The utility has an icon that looks like a hammer.



**Figure 3-5 “StorageCard” File Access**

Open the CECP utility and select the “Set serial port mode” tab. COM1 should be set for RS485. COM3 is used for remote PC communications and its mode does not affect the communications between the HMI and PLC.



**Figure 3-6 Serial Port Settings**

Set the serial port mode for COM1 to RS485 using the drop down selection box. Select the “Save” tab and press the “Save registry” button to save the settings. This must be done in order to save the serial port settings to flash memory so that it is retained when power is turned off. Cycle power to the EZT and allow it to boot up normally.

### 3.1.3 Touch Screen Calibration

If the touch screen is severely out of calibration it can appear as if the HMI is “locked-up”. It may not respond to touch or will make it impossible to accurately select items in order to navigate to the normal screen calibration menu. If this occurs, there are two methods for correcting the screen’s calibration. The first one requires access to the dip switches on the back of the HMI, the other requires the use of a USB compatible mouse.

#### 3.1.3.1 Dip Switch Calibration Procedure

To begin, switch power off to the EZT. Gain access to the rear of the HMI and locate the dip switches to the upper right of the power plug connection. Set dip switch 1 to the “on” (up) position. Restore power to the EZT. Allow the HMI to follow its normal boot sequence. Once the Windows CE image is loaded, the display will automatically start the touch screen calibration routine. Using a stylus, or the tip of a plastic pen cap, touch and hold on the center of each point marked by the crosshairs on the screen.

**CAUTION** Do not use any metal or sharp edged instruments on the screen or permanent damage to the screen may result.

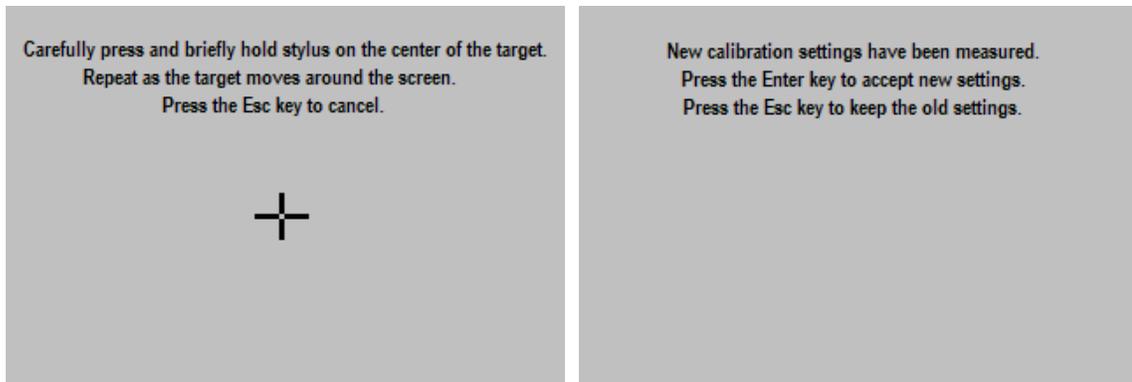


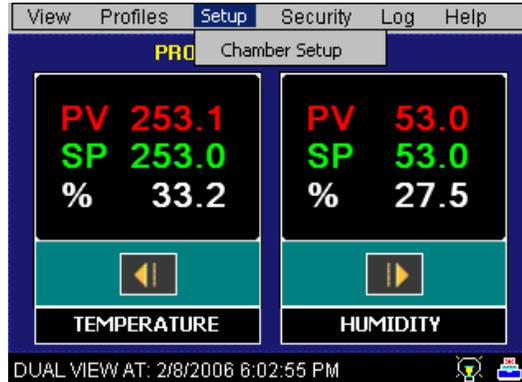
Figure 3-7 Touch Calibration Screen

Once all points have been measured, touch anywhere on the screen to accept the settings and complete the calibration routine. The display will continue its boot up sequence and start the EZT560 application. Set dip switch 1 off.

**NOTE** Dip switch one must be set to off or the calibration routine will start each time power is applied. This will prevent the chamber from resuming operation on a power failure without user intervention.

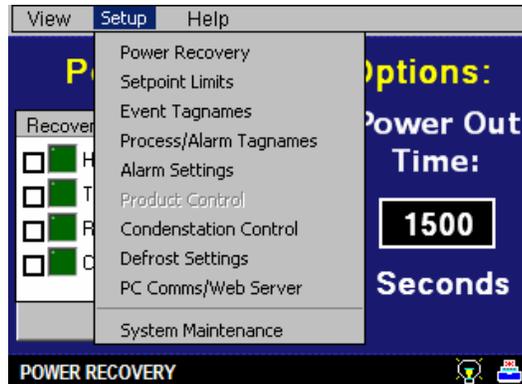
**3.1.3.2 USB Mouse Calibration Procedure**

Begin by connecting a mouse to the USB port to the lower left of the display. Using the mouse, you can navigate the screen just like using a desktop PC. Begin by selecting “Chamber Setup” from the main setup menu.



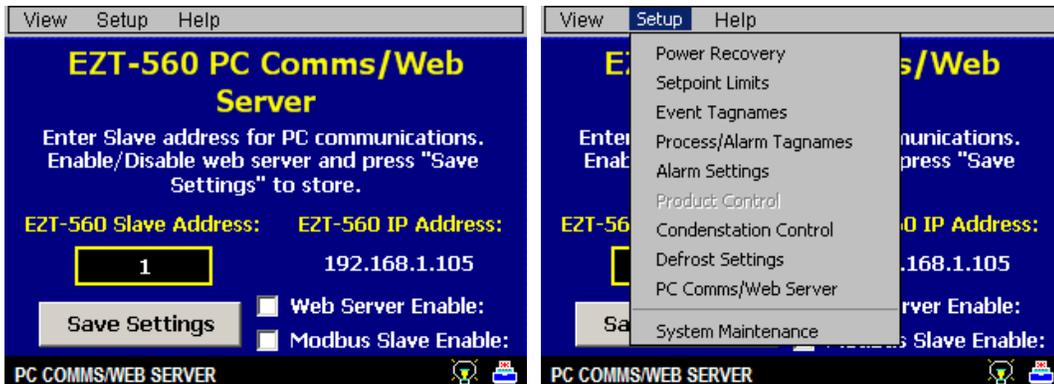
**Figure 3-8 Setup Menu Access**

Select “PC Comms/Web Server” from the setup menu.



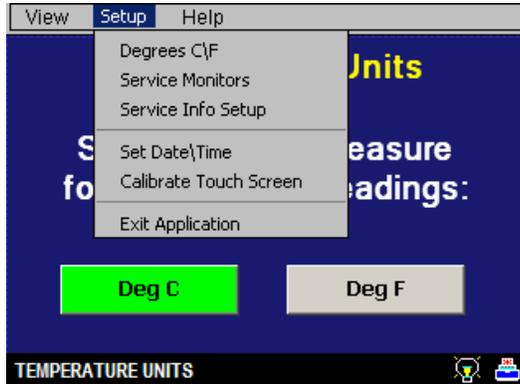
**Figure 3-9 Chamber Setup Menu Access**

Deselect the check boxes, if necessary, for Web Server and Modbus Slave Enable and press the “Save Settings” button. Next, select “System Maintenance” from the setup menu.



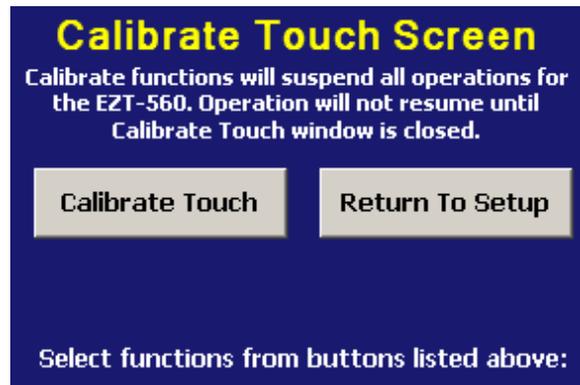
**Figure 3-10 PC Comms/Web Server**

You will be prompted with a message stated that “Maintenance mode will put system in offline condition! Continue?” Select “Yes”. From the setup menu, select “Calibrate Touch Screen”.



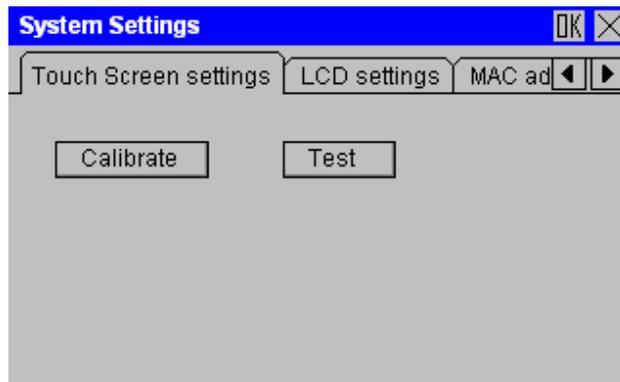
**Figure 3-11 System Maintenance Setup menu Access**

Press the “Calibrate Touch” button.



**Figure 3-12 Calibrate Touch**

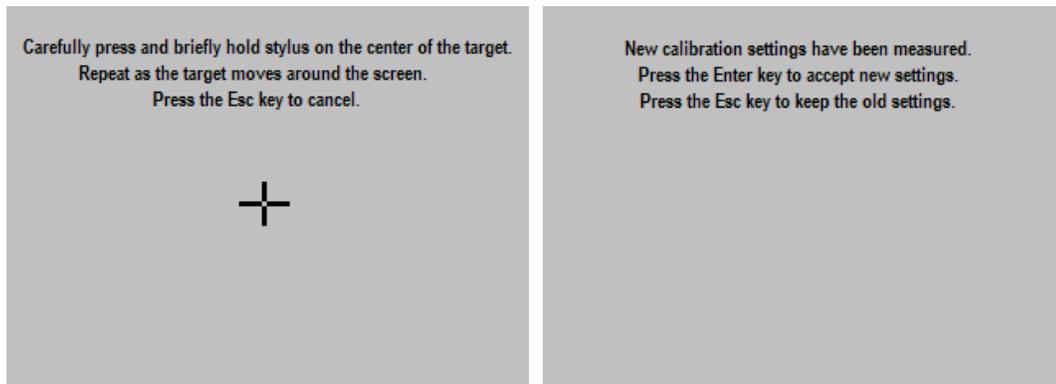
Press the “calibrate” button on the system settings screen to start the calibration process.



**Figure 3-13 Touch Screen Settings**

Using a stylus, or the tip of a plastic pen cap, touch and hold on the center of each point marked by the crosshairs on the screen. Once all points have been measured, touch anywhere on the screen to accept the settings and complete the calibration routine.

**CAUTION** Do not use any metal or sharp edged instruments on the screen or permanent damage to the screen may result.



*Figure 3-14 Touch Calibration Screen*

Close the system settings window by pressing the “OK” button at the top right of the window. You can then return to the normal operating screens and resume operation of the chamber.

**NOTE** If you had to disable communications prior to performing the calibration procedure, be sure to re-enable the communications, so that any software used to monitor or operate the chamber will be functional.

### 3.1.4 Screen Contrast Adjustment Procedure

Begin by selecting “Chamber Setup” from the main setup menu.

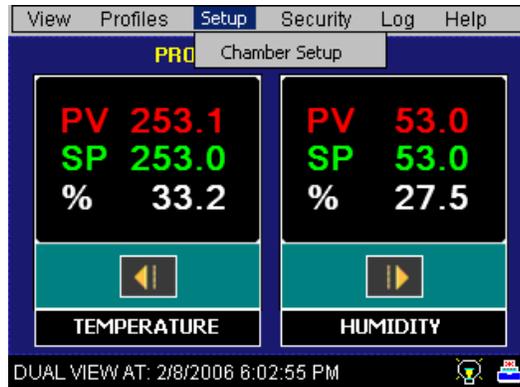


Figure 3-15 Setup Menu Access

Select “PC Comms/Web Server” from the setup menu.

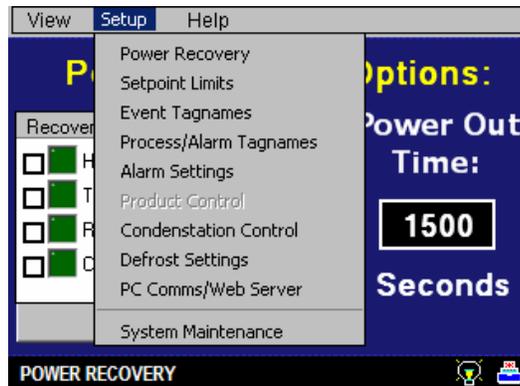


Figure 3-16 Chamber Setup Menu Access

Deselect the check boxes, if necessary, for Web Server and Modbus Slave Enable and press the “Save Settings” button. Next, select “System Maintenance” from the setup menu.

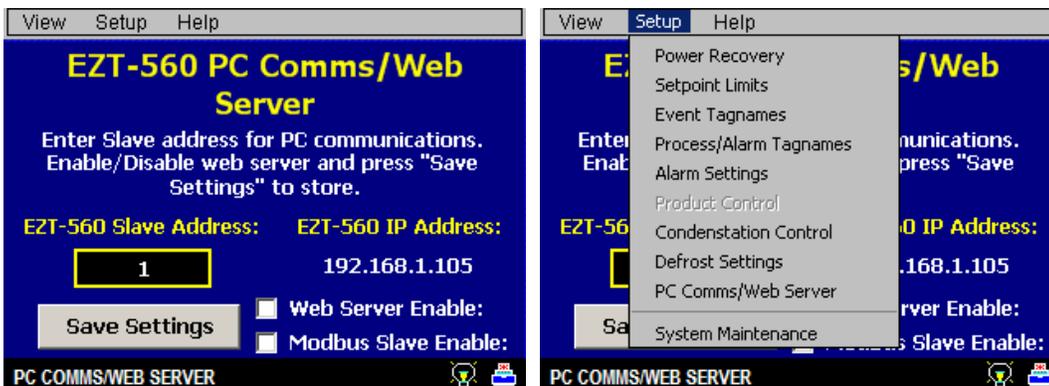
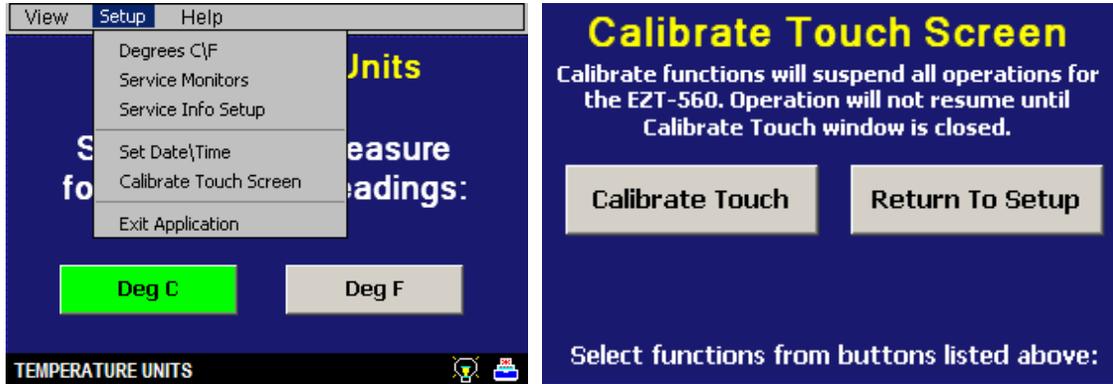


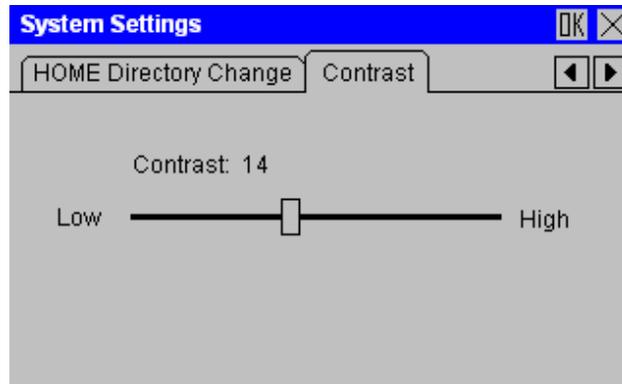
Figure 3-17 PC Comms/Web Server

You will be prompted with a message stated that “Maintenance mode will put system in offline condition! Continue?” Select “Yes”. From the setup menu, select “Calibrate Touch Screen”, then press the “Calibrate Touch” button.



**Figure 3-18 Calibrate Touch Access**

Select the “Contrast” tab from the system settings screen. Use the slider to adjust the screen brightness to the desired level.



**Figure 3-19 Contrast Setting**

Close the system settings window by pressing the “OK” button at the top right of the window. You can then return to the normal operating screens and resume operation of the chamber.

**NOTE** If you had to disable communications prior to performing the calibration procedure, be sure to re-enable the communications, so that any software used to monitor or operate the chamber will be functional.

## **4. Resolving Chamber Alarms**

This section covers known alarms available on all standard CSZ chambers. Note that custom equipment may have features and/or alarms that are specific only to that piece of equipment. Alarms that relate to certain options not present on a chamber indicate that there is a wire crossed somewhere in the system. See Section 8. Deciphering EZT Input/Output (I/O) Operation for assistance on locating the cause.

Using the alarm description, search the alarm table for the alarm description. Included with the alarm description will be information on what causes the alarm and what must be done in order to clear the alarm condition.

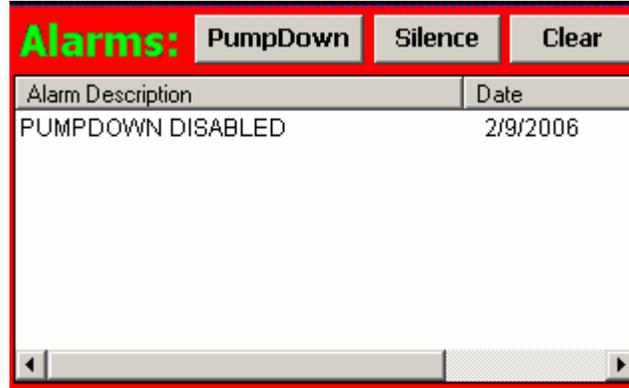
**WARNING**



**The following diagnostic activities may require access to live circuitry. Dangerous accidental contact with line voltage is possible. Only qualified service personnel should be allowed to perform these tasks. Potentially lethal voltages are present inside the unit.**

**4.1 Critical Alarms**

Critical chamber alarms will shut down the chamber and sound an audible alarm. The operating screen background on the EZT display will turn red to provide visual indication of the alarm condition.



*Figure 4-1 Alarm Monitor*

Pressing the “Silence” button will quiet the audible alarm and reset the screen background to blue. If the alarm condition has cleared, the chamber will resume operation. If the alarm condition is still present, the chamber will not restart until the condition is cleared. Pressing the “Clear” button will remove the alarm from the monitor window if the alarm condition has cleared. If the alarm condition is present, the alarm can not be cleared from the monitor window.

**Table 4-1 Common Critical Alarms and Corrective Actions**

SYMPTOM	PROBABLE CAUSES	CORRECTIVE ACTIONS
1) <u>Loop Alarms</u>		
"input" ALARM	Alarm set point exceeded on user configurable alarm for "input" listed.	Allow process value to return within set point limits.  Disable alarm for "input".  Change alarm set point to value greater than process value for alarm type.
"input" SENSOR BREAK	Loose or corroded sensor wiring.  No power to sensor (humidity, altitude). Wrong signal type.  Wrong input type on 9300 controller.  Wrong sensor type.  Bad sensor.	Check wiring. Verify lead connections. Clean if necessary.  Verify power to sensor. Check sensor output signal type.  Check dip switch settings and set input type for sensor used.  Use correct sensor type.  Replace sensor.

## EZT-560 Chamber Troubleshooting Guide



SYMPTOM	PROBABLE CAUSES	CORRECTIVE ACTIONS
LOOP COMMS FAILURE	9300 controller setup incorrectly. Faulty communication wiring. Gateway failure.  Incorrect EZT configurator loop/monitor settings.	See Section 4.1.1 Diagnosing and Correcting Loop Communication Failures.  Verify loop/monitor configuration settings. See sections 9.2 and 9.3. for adjusting EZT configuration settings.
<b>2) Chamber System Safeties</b>		
BOILER OVERTEMP	<b>Boiler over temperature protector tripped.</b>  Water not at proper level.	<b>Manually reset thermostat to clear alarm.</b>  Check water level control float and replace/adjust.
BOILER LOW WATER	Boiler water level low.	Verify water supply to boiler. Check low level float operation.
CHAMBER HI LIMIT	<b>Chamber high limit safety tripped.</b>  Air flow in chamber below design limits.  Air temperature set point above design limits.	<b>Limit must be manually reset or power cycled to chamber to reset.</b>  Verify proper operation of air circulator(s). Remove blockage or lessen product load to achieve proper airflow.  Reduce set point. Do not attempt to operate above design limits.
COMBUSTIBLE (AIR) MONITOR	Optional air monitor detected hazardous condition.	Vent area with fresh air. Possible asphyxiation or explosion hazard exists. Keep personnel clear. Keep sources of ignition away from chamber.
DEHUM SYSTEM FAULT	Optional dehumidifier system fault.	Check manufacturer's manual provided with the chamber for troubleshooting and diagnostic information.
EMERGENCY STOP	Chamber emergency stop or remote stop activated.	Investigate cause of stop. Verify conditions are safe. Reset emergency stop.
FLUID SYS TEMP	<b>Fluid system high temperature safety tripped.</b>  Fluid temperature set point above design limits.  Low fluid level.  Low flow.	<b>Limit must be manually reset or power cycled to chamber to reset.</b>  Reduce set point. Do not attempt to operate above design limits.  Check fluid level in system and add fluid if necessary.  Verify pump pressure and flow. Verify valves are in proper position.

SYMPTOM	PROBABLE CAUSES	CORRECTIVE ACTIONS
FLUID SYS HI PSI	<p><b>Fluid system high pressure safety tripped.</b></p> <p>Restriction in fluid system.</p>	<p><b>Reset high pressure safety.</b></p> <p>Check for debris/clogged filters in fluid system. Verify all isolation valves are open.</p>
FLUID SYS LOW FLOW	<p>Fluid flow safety tripped.</p>	<p>Verify fluid level.</p> <p>Check for restrictions in system.</p> <p>Check pump operation and service if necessary.</p>
MOTOR OVERLOAD	<p>Motor overload tripped.</p> <p>Motor drive (VFD) fault (if present).</p> <p>Blown Fuse.</p>	<p>Requires manual reset.</p> <p>Consult drive manual supplied with chamber for error code and troubleshooting information.</p> <p>Replace fuse. Check motor for overload condition, i.e., bearing wear binding shaft, etc.</p>
PRODUCT SAFETY	<p>Optional product safety limit tripped.</p>	<p>Manually reset limit to clear alarm.</p> <p>Check limit set points and verify properly set for current testing.</p>
TRANSFER ERROR	<p>Basket not in proper position.</p> <p>Bad/out of adjustment position switch.</p> <p>Low air pressure or slipping motor clutch in transfer mechanism.</p>	<p>Check for mechanical obstructions in basket transfer mechanism.</p> <p>Verify basket in proper position. Adjust/replace switch.</p> <p>Verify air supply and pressure. Check clutch/motor assembly.</p>
<b><i>3) Refrigeration Safeties</i></b>		
PUMPDOWN DISABLED	<p>Chamber power off for more than 30 minutes.</p>	<p>Automatically resets in 4 hours. Can be manually reset on alarm monitor screen.</p>
SYS# HILO PSI	<p><b>High or low pressure safety tripped for system # indicated.</b></p> <p>System high or low on charge.</p> <p>Condenser fouled/dirty.</p> <p>Condenser fan not operating (air cooled units only).</p> <p>Low water pressure/flow or high water temperature (water cooled units only).</p>	<p><b>Manually reset high pressure safety. Low pressure automatically resets.</b></p> <p>Check static pressures/sight glass for bubbles. Add/remove refrigerant.</p> <p>Clean condenser.</p> <p>Check motor/fan for proper operation. Replace if necessary.</p> <p>Supply water at proper temperature and pressure/flow rate.</p>

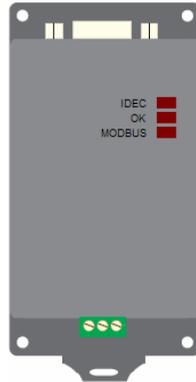
## EZT-560 Chamber Troubleshooting Guide



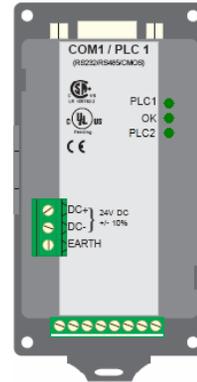
SYMPTOM	PROBABLE CAUSES	CORRECTIVE ACTIONS
SYS# LOW OIL PSI	<p><b>Oil pressure safety tripped for system # indicated.</b></p> <p>System low on oil.</p>	<p><b>Manually reset oil pressure safety.</b></p> <p>Check oil charge/pentane level. Add if necessary.</p>
SYS# HI DISCHARGE TMP	<p><b>Discharge safety tripped for system # indicated.</b></p> <p>Liquid injection valve/solenoid not operating correctly.</p> <p>System low on charge.</p>	<p><b>Automatically resets.</b></p> <p>Check/adjust expansion valve.</p> <p>Check system pressure/sight glass for bubbles. Add charge if necessary.</p>
SYS# COMP MONITOR	<p><b>Compressor protection module tripped for system # indicated.</b></p> <p>Blown fuse.</p> <p>Bad contactor.</p> <p>Liquid injection valve/solenoid not operating correctly.</p> <p>System low on charge.</p>	<p><b>Automatically resets after approximately 30-45 minutes.</b></p> <p>Check compressor fuses.</p> <p>Check contactor/wiring for possible single phasing.</p> <p>Check/adjust expansion valve.</p> <p>Check system pressure/sight glass for bubbles. Add charge if necessary.</p>

### 4.1.1 Diagnosing and Correcting Loop Communication Failures

The EZT-560 “Loop Comms Failure” alarm indicates that there is a problem with communications between the PLC and the 9300 loop controllers. The communications between the PLC and the 9300 controllers is performed by the Gateway module. When this error occurs, the chamber will shut down and will not be able to be restarted until the alarm condition is cleared. The cause of this alarm may lie in one of several areas. To help diagnose where the problem is, follow the sequence of operation below.



Early Model Gateway



Late Model Gateway

#### Gateway Sequence of Operation

When power is applied to the EZT560 via the 24Vdc power supply, the EZT560 will begin its boot-up sequence. At the same time, the Gateway starts its communications program and attempts to communicate with the PLC and 9300 controllers. The “OK” indicator light on the Gateway will be steady on to indicate power is applied and it is running its communications program.

The Gateway is also equipped with two indicator lights to show that the communication connection has been made to the PLC and 9300 controllers. These indicator lights will flash on and off (alternating with each other) at “high speed” indicating that information is being exchanged back and forth between all of the devices.

#### Gateway to PLC Communications

The top indicator light, labeled “IDEC” on early model Gateways and “PLC1” on late model Gateways, will begin flashing on power up and continue flashing at all times. It indicates communications between the Gateway and the PLC. If this light is not flashing, check the connection between the Gateway and the PLC to make sure the cable is connected to the port on the CPU. If the cable is connected, the “OK” indicator is lit and the light is not flashing, the cable may be bad (see note below) or the Gateway is not functioning correctly and needs to be replaced.

**NOTE** When replacing an early model Gateway with a late model Gateway, be sure to use the cable supplied with the new Gateway to connect it to the PLC. DO NOT use the old cable. The cables are not interchangeable between Gateway models.

#### Gateway to 9300 Controller Communications

The bottom indicator light, labeled “MODBUS” on early model Gateways and “PLC2” on late model Gateways, will begin flashing once the EZT560 application starts running on the HMI. It indicates communications between the Gateway and the 9300 controller(s). The light will continue flashing during normal chamber operations. If this light is flashing slowly or irregularly, this indicates a loss of communications to the 9300 controller(s).

**NOTE** When the EZT is in system maintenance mode, communications to the 9300 controllers will be halted. Communications will resume once the user returns to the normal operating screens.

## ***EZT-560 Chamber Troubleshooting Guide***

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*Steady Slow Flash* - If the light flashes approximately once per second at a steady pace, it indicates a loss of communications to all 9300 controller(s). Check the wiring between the Gateway and 9300 controller(s) to make sure that there are no nicks in wiring, shorts or wire crossings. Check to make sure that the 9300 controllers have the proper setup and communication addresses corresponding to the 9300 setup sheet provided with the chamber. If two or more controllers have the same address, this will also cause a communication failure.

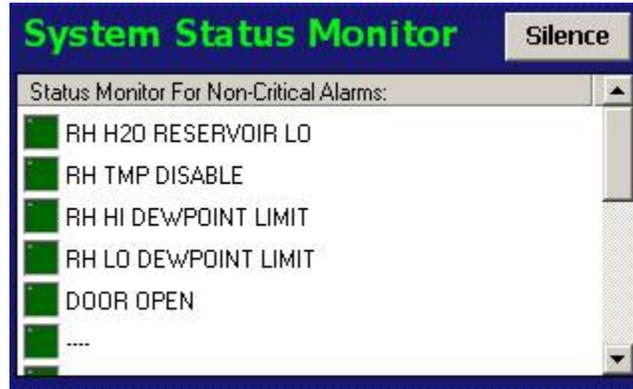
Also verify that the rear connector on each 9300 controller is inserted properly. If the rear connector is not fully inserted, or is inserted improperly, the communications connections may not be making proper contact on the rear connector body and also cause the alarm. After verifying all connections and settings with no change, the Gateway is most likely at fault and should be replaced.

*Irregular Flash Rate* - If the light flashes a few times at high speed, and then a couple flashes on 1 second intervals, and then back to a couple of high speed flashes, and so on, it indicates a loss of communications to one of the 9300 controllers. To locate the problem connection, change the temperature, humidity, altitude, etc. set points and watch the display of the 9300 controllers. If the set point does not change on the corresponding 9300 controller, that is the connection giving the problem. Check the wiring between the Gateway and 9300 controller to make sure that there are no nicks in wiring, shorts or wire crossings. Check to make sure that the 9300 controller has the proper setup and communication address corresponding to the 9300 setup sheet provided with the chamber. If two or more controllers have the same address, this will also cause a communication failure.

Also verify that the rear connector on the 9300 controller is inserted properly. If the rear connector is not fully inserted, or is inserted improperly, the communications connections may not be making proper contact on the rear connector body and also cause the alarm. After verifying all connections and settings with no change, the 9300 controller is most likely at fault and should be replaced.

## 4.2 Status Alarms

Status alarms do not shut down the chamber. They are used to alert the user of certain operating conditions. The alarms may or may not sound an audible alarm. Status monitor alerts are signaled by an intermittent “beeping” of the audible alarm.



**Figure 4-2 System Status Monitor**

Pressing the “Silence” button will quiet the audible alarm. The status condition will have to clear and return in order for the alarm to sound again.

**Table 4-2 Common Status Alarms and Corrective Actions**

SYMPTOM	PROBABLE CAUSES	CORRECTIVE ACTIONS
<i>1) Humidity Monitors</i>		
RH H2O RESERVOIR LO (indicator has audible alert)	<b>Optional humidity water reservoir low.</b>  Jumper wire missing.	<b>Add more water.</b>  Add jumper wire from VCC to input on EZT. If water reservoir option not installed, input must be jumped out to prevent alarm.
RH TMP DISABLE	Humidity system is disabled because the air temperature is outside allowable humidity operational limits.	Turn off humidity system.  Set temperature set point within proper operating range.  Adjust humidity temperature disable set points. See Section 9. Adjusting EZT Configuration Options.
RH HI DEWPOINT LIMIT	Air temperature and humidity set point exceed maximum allowable dewpoint limit for the chamber.	Set temperature and humidity set points to within allowable dewpoint range for the chamber.  Adjust dewpoint limit. See Section 9. Adjusting EZT Configuration Options.

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SYMPTOM	PROBABLE CAUSES	CORRECTIVE ACTIONS
RH LO DEWPOINT LIMIT	Air temperature and humidity set point exceed minimum allowable dewpoint limit for the chamber.	Set temperature and humidity set points to within allowable dewpoint range for the chamber.  Adjust dewpoint limit. See Section 9. Adjusting EZT Configuration Options.
<b>2) <u>Chamber Monitors</u></b>		
DOOR OPEN	<b>Chamber door(s) not closed.</b>  Door switch out of adjustment/bad.	<b>Close chamber door.</b>  Adjust/replace door switch.
<b>3) <u>Service Monitors</u></b>		
SERVICE FANS (indicator has audible alert if enabled)	Air circulator operating hours have exceeded service interval.	Perform service and clear elapsed service count.
SERVICE COND SYS (indicator has audible alert if enabled)	Heating and/or cooling system components have exceeded service interval.	Perform service and clear elapsed service count for affected components.
SERVICE HUMIDITY SYS (indicator has audible alert if enabled)	Humidity system components have exceeded service interval.	Perform service and clear elapsed service count for affected components.
SERVICE PURGE SYS (indicator has audible alert if enabled)	Dry air purge system components have exceeded service interval.	Perform service and clear elapsed service count for affected components.
SERVICE ALTITUDE SYS (indicator has audible alert if enabled)	Altitude system components have exceeded service interval.	Perform service and clear elapsed service count for affected components.
SERVICE XFER SYS (indicator has audible alert if enabled)	Basket transfer mechanism components have exceeded service interval.	Perform service and clear elapsed service count.

## **5. Chamber Operating Problems**

This section provides direction on troubleshooting chamber operation when no alarm condition is present. It is broken into sub-sections for temperature, humidity, altitude control, etc. Locate the section that most closely relates to the problem at hand in order to help diagnose and solve it.

### **Section 5.1 Conditioning System**

This section covers typical problems that may arise with the chamber's heating and refrigeration systems. It includes information regarding the operation of temperature limited sheath heaters for special use as well as information on rate-master and defrost operating conditions in order to help diagnose any problems that may occur with their operation.

### **Section 5.2 Humidity System**

This section covers typical problems that may arise with the chamber's humidity system. It also includes information regarding the operation of the low RH mode (frozen coil) in order to help diagnose any problems that may occur during operation.

### **Section 5.3 Auxiliary Cooling System**

This section covers typical problems that may arise with the chamber's auxiliary cooling system. It includes information regarding the operation of both the boost cooling and cooling control modes in order to help diagnose any problems that may occur during operation.

### **Section 5.4 Dry Air Purge System**

This section covers typical problems that may arise with the chamber's dry air purge system. It includes information regarding the operation of the low RH mode (frozen coil) in order to help diagnose any problems that may occur during operation.

### **Section 5.5 Altitude System**

This section covers typical problems that may arise with the chamber's altitude system.

### **Section 5.6 Fluid System (LC/TSB)**

This section covers typical problems that may arise with the chamber's fluid system. It also includes information regarding hot oil heating systems for special use on explosion proof (EXP) chambers.

### **Section 5.7 Transfer Mechanism (DTS/VTS/TSB)**

This section covers typical problems that may arise with the basket transfer mechanism. It includes information regarding the operation for both air and motor operated systems.

### **5.1 Conditioning System**

When the chamber event is turned on, whether it be a standard ZP, TSB or VTS for example, temperature control is the primary function. The air circulator output will turn on and enable the heating/cooling logic. Even though the air circulator output may vary based on the type of chamber, it performs the same function.

The minimum cool output (Q14) and minimum heat output (Q16) turn on with the chamber event to enable the control circuits for heating and cooling. They are typically only used and wired into the control circuit when the chamber is equipped with defrost. In defrost, the outputs would turn off in order to disable the heating and cooling outputs while defrost is running.

The maximum cool output (Q15) and maximum heat output (Q17) are controlled by the configurator settings. When the cooling or heating output percent exceeds the configurator set point for the on delay period, the maximum output will turn on. They operate as boost outputs, i.e., they are on/off outputs, not proportioning outputs. They connect additional heating and cooling circuits to the control outputs in order to boost chamber performance.

Heating operation is relatively basic; however, the refrigeration system operation is more complicated with staging of compressors, etc. Depending upon options present on the chamber, it may include rate master refrigeration system operation and/or defrost. The sequence of operation then varies from that of a typical chamber.

#### **Temperature Limited Sheath Heaters**

Temperature limited sheath heaters are used in applications where there is, or may be, the presence of a flammable substance within the chamber. These heaters operate at lower surface temperatures than standard nichrome wire, open heating elements and their surface is not electrically "live". This allows a temperature sensor, typically a thermocouple, to be placed on their surface.

The sensor is then connected to a limit device. This limit device monitors the temperature and turns off the power supply to the heater when the surface temperature exceeds the maximum operating limit. The limit device overrides any call from heating by the chamber controller. Once the temperature drops below the operating limit, power is restored to the heaters if heating is still required. The operating temperature limit is dictated by the flammable material. The maximum operating temperature of the heater surface can be no higher than 80% of the auto-ignition temperature of the flammable material in degrees centigrade.

#### **Rate Master Operation**

With rate master, the operation of the refrigeration system varies with temperature. When the air temperature is above -20°C (-4°F) and air temperature set point is -10°C (14°F) or above, the system operates in single stage mode. The system 1 compressor output (Q1), solenoids output (Q11) and the rate master control output (Q10) will be on when cooling is required. The rate master control output is used to switch the cooling output of the 9300 loop controller from the system 2 cooling solenoids over to the system 1 cooling solenoids. The maximum cool output will turn on and off based on the demand for cooling and the control settings in the EZT configurator.

The refrigeration system will switch over to cascade mode when the air temperature drops below 0°C (32°F) and the air temperature set point is below -10°C (14°F). During the switch from single stage to cascade mode, the cascade cooling control output (Q13) will turn on and the maximum cooling output (Q15) will be disabled. This allows some of system 1's capacity to be diverted to the cascade condenser to pre-cool it prior to system 2 starting while still supplying cooling to the chamber. After the stager start delay, system 2's output (Q3) will turn on and the rate master control output (Q10) will turn off.

The cooling output for the 9300 will now be used to control system 2 cooling solenoids. The maximum cool output (Q15) is then re-enabled so that it can turn on system 2's maximum cool solenoids if needed. For safety, when the air temperature is below -20°C (-4°F), the system will only start and run in cascade mode. This prevents system 1's evaporator from becoming a condenser (due to the lower chamber temperature) and causing liquid slugging of system 1's compressor.

**Defrost Operation**

There are two selections for defrost. Defrost can be configured for regular or large horsepower. The large horsepower selection is typically used on systems 7.5HP and larger. The difference between the selections defines how system 1 is controlled in order to cool system 2. With standard defrost, the system 1 compressor is cycled on and off based on system 2 head pressure. With large horsepower defrost, system 1 compressor remains in operation while output Q13 cycles system 1 cascade cooling solenoids on and off to maintain system 2 head pressure.

Defrost can be manually initiated by turning on the defrost event, or it can be automatically started by the EZT based on the defrost settings. When in automatic mode, the defrost timer will begin counting down whenever the air temperature set point is below the defrost set point. Once the timer counts zero, defrost is initiated for one cycle. Upon completion of the cycle, the timer will begin the next timed countdown.

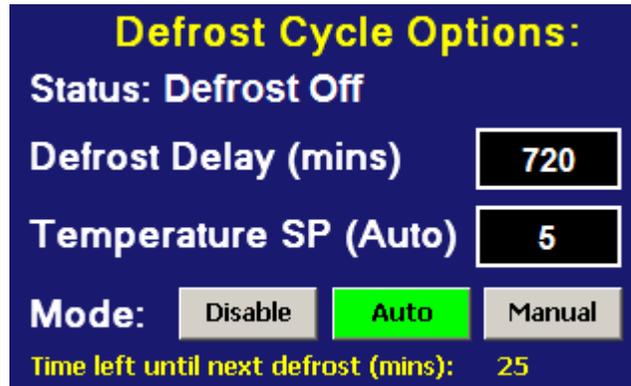


Figure 5-1 Defrost Settings

Once defrost is started, the air circulator output is turned off. The minimum heat and cool outputs are also turned off. This prevents any heating or cooling from taking place. The defrost solenoid output (Q12) will turn on and system 2 will continue operating. This supplies hot gas to the coil. If defrost is set up for regular operation, system 1 compressor will be cycled on and off to provide cooling to system 2 based on the defrost pressure control input (I17). If large horsepower defrost is selected, the system1 compressor output (Q2) will remain on, and the cascade cooling output (Q13) will be cycled on and off to provide cooling to the cascade for system 2.

This process will continue until the defrost temperature switch input (I20) is made indicating that the suction temperature of the coil has warmed up to the defrost temperature. This will initiate a 15 minute timer in the EZT. Defrost will continue for another 15 minutes to insure that the coil is completely defrosted. Once the 15 minute defrost time has elapsed, prechill is started.

In prechill, the defrost solenoid will be turned off and the minimum cooling output (Q14) will be turned on. This will allow the refrigeration system to pre cool the coil prior to starting the air circulators. Once the defrost temperature switch turns off, indicating that the suction line has dropped below the defrost temperature, a one minute timer begins. Once this timer is complete, prechill will terminate, the air circulators will turn back on, and the system will resume normal operation.

**5.1.1 Common Conditioning System Failures and Corrective Actions**

SYMPTOM	PROBABLE CAUSES	CORRECTIVE ACTIONS
Chamber air circulator(s) not turning on.	Chamber event not turned on.  Conditioning system disabled (altitude chambers).  Blown fuse.  Motor overload tripped.  Chamber in defrost (if equipped).  Basket not in correct position (DTS/VTS).  Chamber door open (if door switch enabled in configurator).	Turn on chamber event.  Altitude above controllable limit for temperature. Decrease altitude or turn off altitude system.  Replace Fuse.  Reset overload.  Check defrost status. Allow defrost to complete or terminate defrost.  Check basket position and adjust if necessary. Check basket position sensors, adjust/replace.  Close chamber door.
Chamber not heating.	Chamber event not on.  Conditioning system disabled (altitude chambers).  Blown heater fuse.  Sheath heater limit tripped.  9300 controller output off.  Chamber in defrost (if equipped).	Turn on chamber event.  Altitude above controllable limit for temperature. Decrease altitude or turn off altitude system.  Replace fuse.  Check heater limit. Maximum temperature reached.  Verify proper 9300 controller configuration. Check set point. Replace 9300 controller.  Check defrost status. Allow defrost to complete or terminate defrost.
System 1 compressor not turning on.	Chamber event not on.  Conditioning system disabled (altitude chambers).  Blown fuse.  Compressor internal thermal overload tripped.  Chamber in defrost (if equipped).  Refrigeration system not enabled or compressor percent on set point not exceeded for delay time.	Turn on chamber event.  Altitude above controllable limit for temperature. Decrease altitude or turn off altitude system.  Replace fuse.  Allow compressor to cool. Check refrigeration system/injection valve operation.  Check defrost status. Allow defrost to complete. Compressor will cycle as needed.  Check configurator settings. Refrig system type should match installed system type.

SYMPTOM	PROBABLE CAUSES	CORRECTIVE ACTIONS
System 2 compressor not turning on.	<p>Blown fuse.</p> <p>Compressor internal thermal overload tripped.</p> <p>Chamber in humidity mode.</p> <p>Refrigeration system not enabled or stager start delay not exceeded.</p>	<p>Replace fuse.</p> <p>Allow compressor to cool. Check refrigeration system/injection valve operation.</p> <p>Check humidity system type. System 2 disabled for single stage humidity.</p> <p>Check configurator settings. Refrig system type should match installed system type. Wait for stager start delay period.</p>
Chamber not cooling.	<p>Chamber event not on.</p> <p>Conditioning system disabled (altitude chambers).</p> <p>System low on refrigerant.</p> <p>Cooling solenoid clogged/failed.</p> <p>Expansion valve clogged. Charge in head lost.</p> <p>Refrigeration system capacity exceeded.</p> <p>9300 controller output off.</p> <p>Chamber in defrost (if equipped).</p>	<p>Turn on chamber event.</p> <p>Altitude above controllable limit for temperature. Decrease altitude or turn off altitude system.</p> <p>Check static pressures/sight glass for bubbles. Add refrigerant if necessary.</p> <p>Check solenoid. Clean/replace if necessary.</p> <p>Check expansion valve superheat setting. Clean/replace if necessary.</p> <p>Reduce live load in chamber.</p> <p>Verify proper 9300 controller configuration. Check set point. Replace 9300 controller.</p> <p>Check defrost status. Allow defrost to complete or terminate defrost.</p>
Defrost not starting.	<p>Suction line not below defrost thermostat setting.</p> <p>Defrost thermostat not working.</p>	<p>Check thermostat setting. Defrost not required.</p> <p>Check thermostat set point and operation. Adjust/replace.</p>
Defrost not terminating.	<p>Defrost thermostat not working.</p>	<p>Check thermostat set point and operation. Adjust/replace.</p>

### **5.2 Humidity System**

When the humidity system is enabled, the humidity system output (Q32) will turn on. This turns on the water supply solenoids and atomizer air compressor if applicable. If the refrigeration system is set to run in single stage mode when humidity is on, the RH cool output (Q31) will turn on in order to connect the 9300 cool output to the RH cool solenoid. System 2 compressor will then be turned off as long as humidity is on.

When running in standard humidity mode, not low RH mode (frozen coil), the dehumidify enable output (Q30) will turn on. This allows the 9300 dehumidification output to control the wet coil solenoid. The maximum humidify output (Q33) will turn on whenever the humidification output percentage exceeds the set point in the configurator for the on delay time period.

An alarm delay is added to the boiler low water input (I15) in order to allow it time to fill with water when the humidity system is first turned on. The delay will prevent the alarm from going off for a period of 30 minutes. Should the level not be made in that time, the alarm will sound and shut down the chamber. Once the water level is made, the alarm will sound and shut down the chamber immediately upon losing the input for safety. Should the alarm occur, silence the alarm from the alarm monitor screen and the chamber will begin operating again and restart the 30 minute alarm delay timer.

#### **Temperature Limits**

The EZT limits the humidity system's operational range to a minimum and maximum temperature as set in the configurator. These limits are typically set at freezing and boiling temperatures. Once the air temperature exceeds either limit, the EZT shuts down the humidity system automatically. If the humidity system is shut down due to temperature limitations, the system status monitor will indicate that this has occurred by illuminating the "RH TMP DISABLE" indicator. The humidity system will restart automatically once the air temperature returns to within the set temperature range.

#### **Dewpoint Limits**

In order to protect the refrigeration system and chamber from damage, there are minimum and maximum dewpoint levels that are set in the configurator. These limits in turn define the minimum and maximum relative humidity levels that the chamber will operate to at any given temperature. The EZT uses these limits and internally calculates the minimum and maximum humidity level that the chamber will control to at the current chamber temperature.

Should the user enter a set point outside of those limits, the EZT will coerce the set point to the minimum or maximum value allowed. The system status monitor will then indicate that limiting is taking place and in which direction by illuminating the appropriate LED on the system status monitor screen.

#### **Low RH (Frozen Coil)**

For chambers equipped with the low RH (frozen coil) option, the EZT monitors the temperature and relative humidity set points and calculates the resulting dewpoint. When this value is below the standard wet coil range, the EZT automatically switches to frozen coil mode. This allows the chamber to reach lower humidity levels than what is capable with standard humidity. The EZT does not initiate frozen coil mode until the measured dewpoint in the chamber is below 10°C (50°F). This prevents the coil from loading up with moisture prematurely and reducing the duration of time at which the coil can affectively control low humidity levels in the chamber.

When frozen coil mode is initiated, the frozen coil control solenoid output (Q36) and frozen coil bypass solenoid output (Q37) turn on. The frozen coil control solenoid output transfers control of the frozen coil solenoid to the dehumidification output of the 9300. At this point, the dehumidify enable output (Q30) will turn off so that the normal wet coil solenoid will be disabled.

**5.2.1 Common Humidity System Failures and Corrective Actions**

SYMPTOM	PROBABLE CAUSES	CORRECTIVE ACTIONS
Humidity system not turning on.	Humidity not turned on. Air temperature outside of humidity control range. Altitude system on (altitude chambers). Humidity not enabled in configurator.	Turn on humidity event. Change temperature set point to within allowable humidity control range. Turn off altitude system. Check configurator settings.
Chamber not humidifying.	Maximum dewpoint limit reached. Boiler filling with water/heating up. Blown boiler heater fuse. 9300 controller output off. Atomizer nozzle clogged. Atomizer water supply low. Atomizer air supply low.	Check system status monitor. Chamber operating at maximum humidity level. Check water supply. Allow time for boiler to heat up. Replace fuse. Verify proper 9300 controller configuration. Check set point. Replace 9300 controller. Check/clean atomizer nozzle. Check water supply. Increase flow rate. Verify air compressor operation. Check for leaks/cracks in tubing.
Chamber not dehumidifying.	Minimum dewpoint limit reached. Dehumidification coil logged with moisture. 9300 controller output off. Cooling solenoid clogged/failed. Wet coil EPR valve not set/operating correctly.	Check system status monitor. Chamber operating at minimum humidity level. Check coil. Warm up chamber to remove moisture build-up. Verify proper 9300 controller configuration. Check set point. Replace 9300 controller. Check solenoid. Clean/replace if necessary. Check pressure and adjust/replace if necessary.

## EZT-560 Chamber Troubleshooting Guide

### 5.3 Auxiliary Cooling System

The auxiliary cooling system has two modes of control. It can be set as either a standard boost or as a control. When set as a boost, it will assist the refrigeration system in lowering chamber temperatures quickly. As a control, it will actually take over once the low temperature limit of the refrigeration system is reached and continue cooling down to an ultimate low of the cooling medium.

#### **Auxiliary Cool Boost**

When the auxiliary cooling option is set for boost in the configurator, the auxiliary cooling supply valve output (Q40) will turn on when the event is enabled. The EZT will then monitor the cooling percentage of output. When it exceeds the auxiliary cooling on percentage set point for the on delay time period, the boost cool output (Q42) will turn on. When the percentage of output drops below the on percentage set point, the output will turn off. The supply valve output will remain on as long as the event is on. Only the boost output will cycle on and off for control.

Once the air temperature reaches the low limit set point in the configurator (boost cool disable), the boost cooling output will be disabled to prevent the chamber from going colder than what the refrigeration system can handle to protect the compressors.

#### **Auxiliary Cool Control**

When auxiliary cooling is set for control in the configurator, the auxiliary cooling system will operate according to the boost control logic until the low limit set point is reached. The low limit set point in the configurator (boost cool disable) is the lowest safe operating range for the refrigeration system.

Once the low limit set point temperature is reached, the refrigeration system is shut down and the control solenoid output (Q41) will turn on. This transfers the cooling output from the 9300 controller to the auxiliary cooling solenoid. This allows the chamber to be controlled to temperatures below what the refrigeration system could handle.

#### 5.3.1 Common Auxiliary Cooling System Failures and Corrective Actions

SYMPTOM	PROBABLE CAUSES	CORRECTIVE ACTIONS
Boost cooling not turning on.	<p>Auxiliary cooling event not turned on.</p> <p>Loop percentage of output not exceeding on percentage for delay period.</p> <p>Air temperature at minimum allowable range.</p> <p>Altitude system on (altitude chambers).</p>	<p>Turn on auxiliary cooling event.</p> <p>Check loop output percentage, adjust configurator settings if necessary for performance.</p> <p>Chamber at limits. Can not go any colder.</p> <p>Turn off altitude system.</p>
Chamber not cooling faster with boost cooling on.	<p>Cooling medium (LN<sub>2</sub>/CO<sub>2</sub>) not reaching chamber as liquid.</p> <p>Supply/control valve clogged/failed.</p>	<p>Allow boost cooling to run longer in order for liquid to reach chamber.</p> <p>Insulate supply lines.</p> <p>Install automatic purge system to bleed off gas in order to maintain liquid in supply line.</p> <p>Inspect valve. Clean/Replace if necessary.</p>

**5.4 Dry Air Purge System**

The dry air purge system can work independently or as part of the humidity system. If the chamber is a standard dry unit (non humidity) or the humidity system is off, the dry air purge output (Q34) will turn on when the purge event is turned on. The purge system will run continuously supplying dry air to the chamber until the event is turned off.

If the chamber is equipped with humidity, the dry air purge system output (Q34) will be turned off when the humidity system is turned on. This is done in order to allow the humidity system to control the humidity level. If the purge system was allowed to continue operation, it would be constantly trying to dry the chamber regardless of the humidity set point. The humidity system control logic will allow the dry air purge system to operate during period of 100% dehumidification to help speed the “drying out” process.

For chambers equipped with the low RH (frozen coil) option; the purge system will run during humidity operation. The EZT monitors the temperature and relative humidity set points and calculates the resulting dewpoint. When this value is below the standard wet coil range, the EZT will automatically switch to frozen coil mode. The EZT does not initiate frozen coil mode until the measured dewpoint in the chamber is below 10°C (50°F). This prevents the coil from loading up with moisture prematurely and reducing the duration of time at which the coil can affectively control low humidity levels in the chamber.

When frozen coil mode is initiated, the dry air purge system output (Q34) and air control solenoid output (Q35) turn on. The air control solenoid output transfers control of the purge air supply to the chamber over to the dehumidification output of the 9300 loop controller.

**5.4.1 Common Dry Air Purge System Failures and Corrective Actions**

SYMPTOM	PROBABLE CAUSES	CORRECTIVE ACTIONS
Purge system not supplying dry air to chamber.	Purge system off. No compressed air supply. Purge flow meter adjusted too low. Supply/control valve clogged/failed.	Turn on purge event. Supply compressed air to purge system. Verify/adjust flow meter for proper flow rate. Inspect valve. Clean/Replace if necessary.
Dry air purge not turning on.	Purge event not turned on. Chamber operating in humidity mode. Altitude system on (altitude chambers).	Turn on purge event. Purge automatically controlled. Dry air purge will turn on when required. Turn off altitude.

**5.5 Altitude System**

When the altitude system is enabled, the altitude system output (Q43) will turn on. This turns on the vacuum pump and isolation valves to seal the chamber. The minimum dive output (Q44) and minimum vacuum output (Q46) turn on with the altitude event to enable the control circuits for increasing and decreasing the pressure inside the chamber. They are typically not used and are provided for special applications.

The maximum dive output (Q45) and maximum vacuum output (Q47) are controlled by the configurator settings. When the loop output percent exceeds the configurator set point for the on delay period, the maximum output will turn on. They operate as boost outputs, i.e., they are on/off outputs, not proportioning outputs. They connect additional air and vacuum supply circuits to the control outputs in order to boost chamber performance.

The altitude system automatically disables humidity, auxiliary cooling and dry air purge when it is turned on. These systems can not run when the altitude system is on. The conditioning system is allowed to run until the altitude reaches the conditioning system disable set point set in the configurator. Once this altitude is reached, both heating and cooling is shut down. During the allowed operating range, the air circulator motors will switch to high speed (output Q1) once the high speed fan enable set point is reached. This improves the heating and cooling performance due to the low air density in the chamber.

**5.5.1 Common Altitude System Failures and Corrective Actions**

SYMPTOM	PROBABLE CAUSES	CORRECTIVE ACTIONS
Chamber not increasing in altitude.	Altitude turned off. Vacuum pump not running. Leak in chamber. 9300 controller output off. Vacuum control valve clogged/failed.	Turn on altitude event. Check/replace fuse. Reset overload. Check for leaks. Check door gaskets and latches for tight seal. Verify proper 9300 controller configuration. Check set point. Replace 9300 controller. Inspect valve. Clean/Replace if necessary.
Chamber not decreasing in altitude.	Altitude turned off. No compressed air supply. 9300 controller output off. Air supply control valve clogged/failed.	Turn on altitude event. Check/supply chamber with compressed air. Check pressure regulator setting. Verify proper 9300 controller configuration. Check set point. Replace 9300 controller. Inspect valve. Clean/Replace if necessary.

## **5.6 Fluid System**

Fluid systems can vary considerably between different types of chambers. LC's, TSB's and explosion proof chambers are typical candidates for fluid systems. For LC's and TSB's, it is the only means of heating and cooling the product under test.

Troubleshooting fluid system problems generally ends up with a heating or cooling system diagnosis. As long as fluid is flowing at the proper rate, temperature control falls back to the heating and cooling systems. As long as the pump is operating properly and all isolation valves are open, there isn't much to consider.

### **LC Chambers**

When the chamber event is turned on, the fluid system pump is started in order to keep fluid flowing through the system to condition the test product. The fluid is heated and cooled as it flows through the heater barrel and heat exchanger much like the air across the heater and evaporator in a typical chamber.

The fluid system is equipped with safeties that insure that fluid is flowing through the system prior to allowing heating or cooling of the fluid to commence. This protects the system and components from damage that may occur by operating with no fluid flow. The heating and cooling outputs function in the same manner as a standard chamber, except they are controlling fluid temperature instead of air.

### **TSB Chambers**

When the chamber event is turned on, the fluid system pumps are started in order to keep fluid flowing through the system to condition the test product. Some smaller TSB's merely have mixers in the bath to promote flow over the heaters and evaporator mounted in the baths. The fluid is heated and cooled as it flows through the heater barrel and heat exchanger much like the air across the heater and evaporator in a typical chamber.

The fluid system is equipped with safeties that insure that fluid is flowing through the system prior to allowing heating or cooling of the fluid to commence. This protects the system and components from damage that may occur by operating with no fluid flow. The heating and cooling outputs function in the same manner as a standard chamber, except they are controlling fluid temperature instead of air.

Hot baths are typically for heating only. They do not have any means of cooling the fluid. Cold baths may or may not have heaters in order to warm up and operate at elevated temperatures. Typically, cold baths are for cooling only.

### **Explosion Proof Chambers**

Explosion proof chambers typically use "hot oil" systems as the means for heating the chamber. Explosion proof classifications require that no component, even upon failure, can ignite the flammable substance present. Electric heaters can short or rupture in a failure condition thus causing an explosion. Also, the surface temperature of the heaters is critical to safety. The heater can not operate over 80% of the auto-ignition temperature of the flammable material or this can also cause an explosion.

Hot oil systems may be equipped with independent temperature controls. This control device will maintain the fluid at a preset temperature. The chamber temperature control will then cycle solenoids to control the flow of the fluid into a heating coil in the chamber, thus heating the air. Since the fluid is maintained at a safe temperature, even if the coil were to rupture, there is no source of ignition present.

**5.7 Transfer Mechanism**

Transfer mechanisms are used on thermal shock chambers (DTS/VTS/TSB) to move a basket loaded with test product from one extreme temperature to another. These systems may utilize a single motor or one or more air cylinders to move the basket.

**Motor Operated Transfer Mechanism**

Motor operated transfer mechanisms are typically used on TSB's. They consist of a gear-motor drive with a lever arm attached to the output shaft. The motor direction is switched between clockwise and counterclockwise in order to move the basket back and forth between the baths.

Limit switches are used to indicate each of the three positions, hot, cold and unload. The motor direction is determined by the current position indicated by which position switch is on and the desired position set by the events. The motor runs until the limit switch for the desired position is met.

**Air Cylinder Operated Mechanism**

Air operated transfer mechanisms for DTS and VTS chambers are relatively simple. A single air cylinder is used to move the basket between the two available positions. Because of the design, the basket provides the mechanical stop for the cylinder. The cylinder continues to push on the basket, thus sealing the gasket surface to keep the hot and cold chambers separate. Limit switches are positioned on each end of the cylinder in order to identify the basket position.

TSB transfer mechanisms employing air cylinders are more complicated. They use two cylinders, one for up and down motion and the other for side-to-side motion. Limit switches are placed on each end of both cylinders to provide position information to the EZT. In order to transfer from one bath to the other, the basket is first raised into position. Once the basket is in the up position, the EZT then controls the other cylinder to move the basket left or right over the opposing bath. Once the basket is repositioned over the other bath, it is then lowered into the bath.

**5.7.1 Common Transfer Mechanism Failures and Corrective Actions**

SYMPTOM	PROBABLE CAUSES	CORRECTIVE ACTIONS
Basket not transferring.	Limit switch failure. Basket already in position. Motor clutch slipping. Blown fuse (motor operated). Binding in transfer basket/mechanism. Loss of/low air pressure.	Check limit switches. Adjust/replace. Transfer to other position. Check/adjust clutch tension. Replace fuse. Check cable tension, pulleys, etc. for wear. Repair/replace. Supply proper air pressure. Check pressure regulator/adjust.
Basket not transferring to proper position.	Limit switch failure. Motor leads reversed. Air lines to cylinder reversed.	Verify limit switch operation. Swap motor leads. Swap air lines.

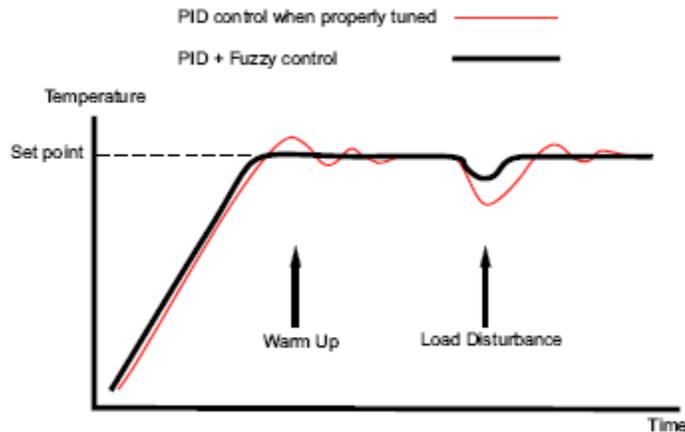
## 6. Process Control Problems

This section covers issues related to the control of chamber process values, i.e., temperature, humidity, altitude, etc. Its purpose is to give you more insight on how the chamber responds to varying load conditions and what it is capable of doing. Once you know how the chamber reacts under certain conditions and why, you may be able to manipulate certain parameters in order to get the desired response from the chamber. One of the main causes for poor process control, is that the controller is not properly tuned for the chamber.

All of the EZT-560 control loops feature one-touch tuning. No more tuning parameters to adjust or settings to change. The EZT-560 loop controls utilize fuzzy logic to continuously adapt to the process in order to maintain it as close as possible to the set point. The EZT-560 only requires base-line knowledge on the performance of the chamber and the test load. In order for the EZT-560 to obtain this performance knowledge, the controller must be tuned using the one-touch tune.

All Cincinnati Sub-Zero chambers are factory tuned; however, the chambers are typically empty, no product load. Unless specific performance tests were performed at the factory for your particular needs, the base-line performance may not be as accurate once a product is placed inside the chamber.

The one-touch tune makes it easy to tune the chamber to the product. If there is a particular point that the chamber is having difficulties with, run that condition and start the tune. If the tune is for base-line adjustment prior to a test, just run the chamber at ambient conditions and press the “AT” button on the single loop display screen for the process to be tuned. The “AT” button will remain green for the duration of the tune to indicate it is working. Once it is complete, you are ready to test product.



**Figure 6-1 Tune Control Response**

As you change product configurations or other loads within the chamber, you can re-tune to the new configuration. All subsequent tests with that configuration will perform optimally. It is recommended that only one loop be tuned at a time so that they do not interfere with the tuning process of another loop.

### **6.1 Why is the Chamber Controlling like That?**

The first step in understanding the chamber's response to a given set of conditions is to understand how the control system works. All controllers, whether it be the EZT, Watlow F4, JC620, Chromolox 2104, etc., all use a form of PID control. You don't have to be an expert or have complete in depth working knowledge of how PID loops work, but it helps to have an understanding of what it does in order to help diagnose control issues.

The term "PID" is an abbreviation for **P**roportional, **I**ntegral and **D**erivative. The terms are also sometimes referred to as gain, reset and rate. These terms refer to mathematical calculations that the controller uses to determine its output. Unlike our ability to "see" what the chamber is doing, i.e., we know what the product is, we know it is a live load versus a dead load, we know how big the chamber is, how much heat it has, the controller has no knowledge of this. Its entire response to a change in set point is based completely off of a math problem using those three terms.

The three terms define the chamber to the controller. In essence, they contain the capacity of the chamber, how much heating and cooling capacity it has for example, what the product load is, what the thermal mass of the chamber itself is, etc. It is a lot of information to put into three terms. This is why a small load change in a chamber has a small affect on control, but a big load change in a chamber can have a large impact. The product load is a portion of the tuning (PID) parameters, the more the product load changes, the more the tuning parameters must change in order to accurately describe the chamber to the controller so it can "see" what the chamber is doing.

Thus, if you change the product load drastically, but do not change the tuning parameters to match, the controller will see the chamber with a small load and not a big one. Then when the chamber does not respond like it would with a small load, the controller will become confused and not control the chamber correctly which could result in a large overshoot or oscillation around set point. All the controller knows is what the set point is, what the process value is, and based on that difference, do the math using the PID parameters and make that answer its output.

All controllers look for a difference between the set point and what the actual value is. Based on this difference, it adjusts its output. Thus, if you make a small set point change, the output will respond slowly. Depending on the capacity of the chamber, it will take time for it to respond and raise or lower the actual value in the chamber to set point. However, if you make a large set point change, the controller may respond by increasing its output very quickly which in turns makes the actual value in the chamber change much faster.

#### **Control Loop Example**

Let us use driving a car for an example of a control loop and use you as the controller in this case. The throttle and brake are your control outputs much like heat and cool in a chamber to control temperature. You are sitting at a traffic light at the on ramp to the freeway, the red light is a set point of zero and your current speed is zero so you do nothing. However, when the light turns green, you get a set point of 65 MPH.

At the green light, your first response is to put the pedal to the metal, 100% output because you are at a dead stop. This is the proportional term response of your control loop, i.e., foot. You have a large difference between your actual speed and your set point speed. As you speed up, you begin letting off of the throttle to maintain a linear relationship between throttle position and speed from 0 to 65 MPH because the difference between your actual speed and the set point is getting smaller. You end up holding your foot at a fixed position anticipating that your speed will match set point, but you fall short.

This is when the integral term of your control loop takes action. You begin slowly depressing the throttle little by little and look at the response of the car (chamber). Each small change increases your speed until you eventually reach set point. As long as nothing changes, you will hold your foot at the same position because you have met set point. However, what if there is a disturbance, you reach a hill (live load in chamber is turned off). The car begins to slow down (temperature drops) so you instinctively begin to depress the throttle again to maintain set point. Once you reach the top of the hill and start down the other side (live load turns back on), the car speeds up (temperature begins to rise). You then have to back off of the throttle to maintain set point.

Now it is time to exit the freeway. At the end of the off ramp is a stop sign. Once you see the stop sign you get a set point of zero so you let all the way off of the throttle because it is a big set point change. However, as you watch the response of the car, you see it is slowing and know it will eventually stop, but not fast enough. The inertia of the car (built up heat) is keeping it moving. If you do not do something, you will overshoot the set point (stop sign) and run into the intersection and cause an accident. This is where your derivative response takes affect. You are anticipating that you will not stop in time so you begin applying the brake (cooling). This causes the car to slow down faster so that you can stop at set point (the stop sign).

### Summary

As you can see from the example, a temperature control loop on a chamber mimics what we do when controlling the speed of our car. Now apply that to your car's cruise control. Imagine how difficult it actually is to maintain the speed of a car when all you have is the set point and actual speed and you can't see what is coming. How big is that hill? Is it steeper on one side than the other? Could you imagine trying to stop? What if all you had was someone telling you to stop because there is a stop sign ahead? Is it 1000ft away or only 100ft? You would sure have to apply the breaks a lot harder when it is only 100ft away,

A control loop is only as good as the control parameters it is given and how well the process can be controlled. The key to controlling any process is designing the process to be controllable. If every time you pressed your gas pedal, the car went a different speed, how do you know where to put it next time to get the same speed?

### **6.1.1 Oscillation Around Set Point**

The typical response to a chamber that oscillates around a given set point, whether it be temperature, humidity, etc., is that it is not tuned properly. That is generally the case if the product load has been changed, but what if it hasn't. What if it is at one particular point? In cases like that, it would make sense to tune the chamber at the problem condition. However, that may cause the chamber to react sluggishly at other operating conditions which may be undesirable.

Oscillation is due to the controller's "overreaction" to the difference between the set point and process variable. When a control loop comes into set point control, some minor oscillation is expected as the control loop adjusts its output. When the oscillations never cease; however, that is a different story. That generally means the controller thinks that the chamber needs a lot of output to make a small change in the process (little available heating and cooling capacity for example), or the process is more sluggish than the controller thinks (large product load which takes a long time to change temperature).

Many times, the only solution is to tune the controller at the worst operating point. This will provide you with the best control over your operating range. The reason that this occurs is simply due to the varying capacity the chamber has at different operating conditions due to losses through the chamber wall, capacity curve of the refrigeration system and other dynamics that are just laws of physics. However, on certain chambers you may have the ability to vary output capacity at certain operating points.

Chambers equipped with min/max outputs split the capacity of the system in half. During minimum operation, half the cooling capacity will be available to control chamber temperature. However, during maximum output, the full 100% of the capacity will be available. The maximum output is turned on when the output percentage of the control loop exceeds the on settings in the configurator. Thus, you can adjust when the full capacity is available. Typically, it is set to 100%. This would require the control loop to call for 100% cooling. The maximum output would operate like a boost and only be active when full cooling was required.

Problems may arise however, when you actually need 75% of the cooling capacity to control a given point. If the minimum only gives you 50%, and you get all 100% at full output, the chamber could oscillate because the control loop is not getting what is required to properly control the chamber. It is either too little or too much. By lowering the on percentage for maximum cool to 50% for example, the full refrigeration system capacity would be available at 50% output, thus when the controller calls for 75%, it is getting 75%.

The question is when should it be set for a boost (100%) and when should it be set for control. That depends on the operating conditions and load in the chamber. If the chamber load is greater than half of the system capacity at any point you are operating, then you may have to adjust the maximum output percentage. Note that it is best to stay on minimum as much as possible because it can be a catch-22. The more capacity you have, the more each increase in output can affect the process. If the capacity increase for each step in output is too much, you can end up with control oscillations then as well.

### **6.1.2 Overshoot**

Overshoot is a difficult beast to tame and tends to cause the most aggravation and hardships when it comes to product testing. The problem arises when we want the chamber to reach set point as quickly as possible, yet stop on a dime. The important thing to consider, is that most good control loops overshoot their set point. It is the amount of overshoot and duration that vary. To reach set point quickly, you must maintain a high output to get there. However, once you get there, the output must drop off quickly so that the chamber can come into set point. If there is a lot of thermal mass in the system, it may cause the chamber to continue past set point like taking your foot off of the gas pedal of your car and it not stopping right away.

Take a humidity boiler for example. It has a large volume of water that must heat up prior to injecting any moisture into the chamber. While the boiler is warming up, the control output may keep increasing because it sees nothing happening in the chamber. All of a sudden, the water starts boiling and moisture begins to enter the chamber. The controller backs off on the humidify output until it eventually turns off, but the water continues to boil due to the thermal mass of the boiler and heaters. This causes the chamber to overshoot its humidity set point. It isn't because the controller was telling it to do the wrong thing, it is because of the delay in how the boiler reacts.

To control the overshoot, the controller must react slower. The problem is that the chamber then responds slower to set point changes because the control output stays low to minimize the overshoot. It is a balancing act. The dynamics of the chamber and product load greatly affect the amount of overshoot that you may have and it can vary with set point. There are two possible way to minimize overshoot, yet still achieve desirable performance.

The first is to ramp the set point rather than make large set point changes. When you make large step changes, the controller reacts with large output changes. The key is to maintain a steady moderate output that builds up less momentum. The difficulty, is that there is no set formula for calculating this rate. It is dependant upon the chamber and product. However, keeping it just under the maximum capacity of the chamber is the most beneficial. Don't let the controller reach maximum output. The chamber can't go much faster anyway, and it prevents the controller reaching that "give it all you got" until we get there.

The other method is applicable to chambers that have min/max output configurations. By setting the maximum output to turn off as soon as possible, like a boost, you cut the chamber capacity in half when you near set point. Thus, as the controller backs off on its output to control into set point, you reduce the amount of capacity it has instantly in half, which helps put the brakes on quickly to reduce the amount of overshoot on large step changes.

### **6.1.3 Set Point Tracking (Ramping)**

One of the misnomers that chamber users have is that they expect a chamber to follow a given profile exactly as it is programmed and if it doesn't, it is not working correctly. The problem is that they do not take into consideration the capacity of the chamber versus the ramp rate that the programmed and how the controller responds to a set point change.

The capacity of a chamber is its ability to increase or decrease a process by a certain amount, whether it be temperature or altitude for example, in a given amount of time. Some capacities also vary over the operating range. The vacuum pump on an altitude chamber for example, has a lot of capacity at low altitude. The chamber responds quickly and the air pressure within the chamber drops rapidly. However, as the pressure drops, the amount of air decreases and the vacuum pump has less and less air to pump. It has to start working harder for each incremental drop in pressure of the chamber. This causes the chamber to lose capacity as the altitude increases.

If you wanted to maintain a linear rate for the entire transition over the operating range of the chamber, you could end up having a very long test. The chamber may do 5Kft a minute up to 50Kft, but if it is only 100ft per minute after that to 100Kft, it limits your transition to 100ft per minute. That is all you have if you want a linear transition. You must use the minimum capacity rate. Most chamber capacities are provided as an average of best to worst and with no product load. Chamber manufactures have no way to rate the chamber any other way because it is unknown as to what the customer will use it for and what they are testing.

Product load also plays a large part in temperature performance. The transition rate of the chamber will vary not only based on refrigeration capacity, but also on the thermal mass of the product. The more heat the product can absorb, or the fact that it generates heat, will slow down the cooling process but speed up the heating process. This will cause a large difference between the heating and cooling rates that the chamber can achieve with that product load.

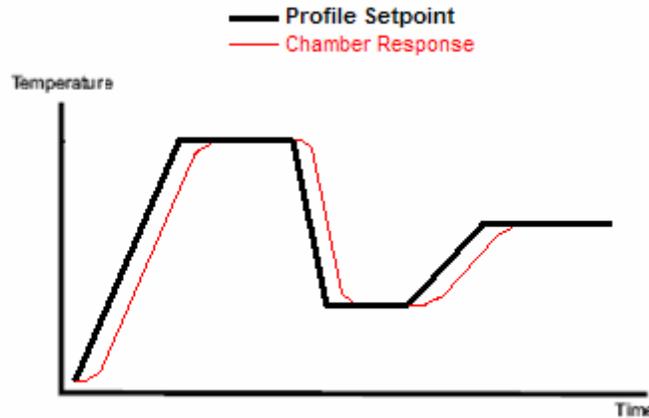
#### **What is the Proper Rate?**

The first step in getting the proper response out of the chamber is to program your ramp step so that the rate of change does not exceed the capacity of the chamber at any point along that step. That does not mean that you should operate at 100% either. Keep in mind that if you are maxing out the chamber, it has no ability to control. It is all the chamber has to keep up. Even the slightest variation can cause the chamber to fall behind. A properly programmed ramp should never exceed 80% of the chamber's capacity at any point along the ramp. Ideally, it should never exceed 50%, but that is impractical.

#### **My Rate is set Correctly so why is the Chamber not Following It?**

The first question to ask is whether or not the chamber is maintaining the ramp rate. Keep in mind that you will always have a lag in the response of the chamber. Remember that the controller must see a difference between the set point and process variable in order to increase its output. When you start a ramp, the difference between the actual process and the set point begins to increase at a set rate. Thus, the controller output will begin to do the same. However, there is a delay between the controller output and the response of the chamber. Heaters have to warm up, coils have to cool down, etc.

However, once the ramp begins, the controller will adjust the output to meet the rate and follow it the rest of the way. The chamber will follow the profile, but it will be offset by the delayed response of the chamber. This is the normal response of the controller. Remember, all it knows is that the set point changed and that it should adjust its output by the PID math calculation.



**Figure 6-2 Profile Ramp Response**

**How do I make the Chamber Respond more like the Profile?**

There is a trick you can use to force the chamber to respond to the profile with less lag. It does require that you add more steps to your profile however. These extra steps are used to force the controller to respond quicker and in a way, give the controller the ability to anticipate the next set point change during the ramp.

All you need to know is what the offset is during the ramp, i.e., what is the difference between the set point and the actual value in the chamber during the ramp step. This is the lag, or offset, that is introduced during the start of the ramp in which the controller output is ramping up to the necessary value to maintain the rate of change in the chamber. Knowing this value, you will need to add two steps for each ramp in the profile in which the lag is undesirable. One before the actual ramp step and one after.

The steps are going to be used to offset the ramp by the lag value. Prior to the ramp step, insert a new step. Make this step with a time of zero in order to make an immediate set point change. The set point for the step is going to be the previous step's set point, the one you are ramping from, with the offset added to it or subtracted from it. You will add the offset if your ramp step is increasing, or subtract it if your ramp step is decreasing. Next, increase or decrease your ramp step's set point by the offset so that you are actually overshooting your desired set point by the offset value.

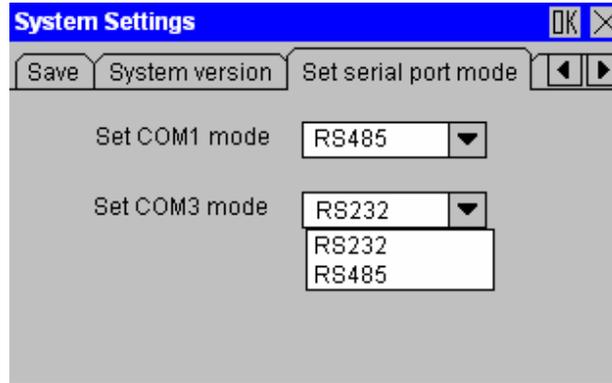
Next, add a step after your ramp step. Make this step a time of zero so it is an immediate set point change, and make the step's set point the desired ending set point of the ramp (your original ramp step's set point). Now when the profile is run and the chamber begins your ramp step, the controller will see an immediate set point change of the offset value. Its output will immediately increase to the output value that was required to hold it during the original ramp. As the set point continues to ramp, the controller will hold the output at this higher level to maintain the chamber closer to set point during the ramp.

As the chamber is reaching the end of the ramp, the set point will continue to increase by the offset amount and overshoot the original set point. This forces the controller to maintain the same output level all the way until the set point is reached. Once the ramp is complete, the second step that was added drops the set point down quickly to the original (desired) set point and the controller immediately backs off its output to minimize overshoot. The one thing to note when doing this, is that you will introduce some oscillation at the end of the ramp; however, it will settle out and the chamber will hold set point.



**7.1 Serial Communications Troubleshooting**

The EZT-560 allows a user to remote monitor and control chamber operations over an RS232 or RS485 communications connection. Only one may be used at a time. The connection type is enabled from the “System Settings” screen.



**Figure 7-2 Serial Port Mode Settings**

The system settings can be accessed through the “Calibrate Touch Screen” menu item under system maintenance and selecting “Calibrate Touch”. You can then select the serial port mode tab to access the port settings. COM3 is used for user communications. Using the drop down menu, it is possible to select the port mode, RS232 or RS485.

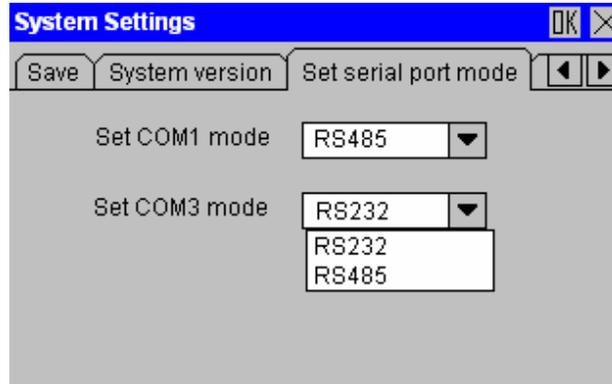
**Table 7-1 Common Serial Communication Problems and Corrective Actions**

SYMPTOM	PROBABLE CAUSES	CORRECTIVE ACTIONS
EZT not responding to commands from PC.	Modbus Slave not enabled.  Wrong slave address.  Wrong serial port mode setting.  Wrong communication port settings in PC or wrong command format.	Enable Modbus slave on “PC Comms/Web Server” screen.  Use slave address set in EZT or change EZT slave address to match.  Verify serial connection used and set mode setting to match (RS232/RS485).  Verify proper protocol used (Modbus) Verify proper serial port settings used in PC.
“Comm alm at PLC. Check Cable.” alarm message.	Remote PC communicating too fast with EZT.	Slow down communication rate from remote PC (minimum 500ms scan rate).
Profile download working but profile is not updating after download.	Write error during transfer.  Incorrect step count or steps transferred.  Profile write to EZT not at correct transfer rate.	Verify proper profile step data format.  Verify total profile steps match number of steps transferred.  Transfer step data at proper rate, 1 step per second.

**7.2 GPIB Communications Troubleshooting**

The GPIB communication option is provided through the use of ICS's Model 4899 GPIB-to-Modbus Controller. The 4899 is an IEEE 488.2 compatible GPIB device that can control Modbus slave devices. It accepts simple GPIB bus commands that are used to create Modbus RTU packets that are transmitted serially to the Modbus slave devices, in this case, the EZT.

When this option is provided, it is connected to the EZT's RS485 serial connection. For the GPIB interface to be used, the EZT must have its serial port mode setting for COM3 set to RS485. The connection type is enabled from the "System Settings" screen.



**Figure 7-2 Serial Port Mode Settings**

The system settings can be accessed through the "Calibrate Touch Screen" menu item under system maintenance and selecting "Calibrate Touch". You can then select the serial port mode tab to access the port settings. COM3 is used for user communications. Using the drop down menu, it is possible to select the port mode, RS232 or RS485.

**Table 7-2 Common GPIB Communication Problems and Corrective Actions**

SYMPTOM	PROBABLE CAUSES	CORRECTIVE ACTIONS
GPIB interface not responding to read/write commands.	4899 power turned off. Wrong bus address. Missing termination character.	Turn 4899 power switch on. Verify 4899 GPIB bus address. Use proper termination character (LF).
"Comm alm at PLC. Check Cable." alarm message.	Remote PC communicating too fast with EZT.	Slow down communication rate from remote PC (minimum 500ms scan rate).
Profile download working but profile is not updating after download.	Write error during transfer. Incorrect step count or steps transferred. Profile write to EZT not at correct transfer rate.	Verify proper profile step data format. Verify total profile steps match number of steps transferred. Transfer step data at proper rate, 1 step per second.

**7.3 Ethernet Communications Troubleshooting**

The EZT-560 allows a user to remote monitor chamber operations anywhere via a PC’s standard web browser. To connect the EZT-560 to a network, just connect the EZT’s Ethernet port to your network using a standard CAT5 cable connection. The EZT will be automatically assigned an IP address via the network’s DHCP server.

You must use the assigned IP address to access the EZT-560. To obtain the correct IP address, go to the PC Comms/Web Server selection under the chamber setup menu. Enter the following link in your PC’s browser address window: <http://IPaddress/ezt.html> (from example address in figure 7.1, <http://192.168.1.105/ezt.html>).

**Table 7-3 Common Ethernet Communication Problems and Corrective Actions**

SYMPTOM	PROBABLE CAUSES	CORRECTIVE ACTIONS
Web page not updating.	Connection to EZT lost.  Page update period not elapsed.	Check EZT connection to intranet.  Wait 30 seconds.
Can not open web page in web browser.	Web server disabled.  IP address entered incorrectly.  Invalid IP address.	Enable web server on “PC Comms/Web Server” screen.  Verify web address format.  Cycle power to EZT. EZT must be connected to intranet upon application of power to receive a valid IP address.
EZT not assigned valid IP address.	Not connected to intranet.  DHCP not set to automatically assign IP address on host server.	Verify connection to intranet.  Contact IT department for assistance.

## 8. Deciphering EZT Input/Output (I/O) Operation

The inputs and outputs of the EZT-560 are predefined for specific functions on all standard chamber designs. This requires that certain inputs and outputs perform different functions based on the chamber type. This section covers all of the standard inputs and outputs of the system and their use based on the chamber type. For each input and output, an individual functional description is provided on how the input or output is used.

The control of the EZT outputs are also defined by which chamber events are enabled. The chamber events are predefined and their use varies according to the type of chamber and options present. The following table defines the standard use of the events.

**Table 8-1 Chamber Events**

EVENT	STANDARD	VTS (TSB)	DTS
1	CHAMBER	HOT CHAMBER (BATH ON)	LEFT CHAMBER
2	HUMIDITY	COLD CHAMBER	CENTER CHAMBER
3	AUX COOL	AUX COOL	AUX COOL
4	PURGE	PURGE	PURGE
5	ALTITUDE	XFR HOT	XFR LEFT
6	-	XFR COLD	XFR RIGHT
7	-	(XFR UNLOAD)	RIGHT CHAMBER
8	RC BLOWER	-	-
9	INITIATE DEFROST	INITIATE DEFROST	INITIATE DEFROST
10	-	-	-
11	-	-	-
12	-	-	-
13	-	-	-
14	-	-	-
15	-	-	-

The chamber loops are also predefined and their use varies according to the type of chamber and options present. The following table defines the standard use of the control loops.

**Table 8-2 Control Loops**

LOOP	STANDARD	VTS (TSB)	DTS
1	TEMPERATURE	HOT CHAMBER (BATH)	LEFT CHAMBER
2	DUT/HUMIDITY/ALTITUDE	COLD CHAMBER (BATH)	CENTER CHAMBER
3	DUT/ALTITUDE	DUT	RIGHT CHAMBER
4	DUT	-	DUT LEFT BASKET
5	-	-	DUT RIGHT BASKET

**8.1 Standard Input Configuration**

CONNECTION	INPUT	STANDARD CHAMBER CONFIGURATION	DTS, VTS, TSB
BO1-26	I0	CHAMBER LIMIT	
BO1-24	I1	PRODUCT SAFETY	
BO1-22	I2	MOTOR OVERLOAD	
BO1-20	I3	SYSTEM 1 PUMPDOWN SWITCH	
BO1-18	I4	SYSTEM 1 HI/LO PRESSURE SAFETY	
BO1-16	I5	SYSTEM 1 OIL PRESSURE SAFETY	
BO1-14	I6	SYSTEM 1 DISCHARGE THERMOSTAT	
BO1-12	I7	SYSTEM 1 COMPRESSOR SAFETY MODULE	
BO1-10	I10	SYSTEM 2 HI/LO PRESSURE SAFETY	
BO1-8	I11	SYSTEM 2 OIL PRESSURE SAFETY	
BO1-6	I12	SYSTEM 2 DISCHARGE THERMOSTAT	
BO1-4	I13	SYSTEM 2 COMPRESSOR SAFETY MODULE	
BO2-26	I14	BOILER HI TEMPERATURE THERMOSTAT	BASKET LEFT
BO2-24	I15	BOILER LOW WATER LEVEL FLOAT	BASKET RIGHT
BO2-22	I16	WATER RESERVOIR LOW LEVEL FLOAT	BASKET UP
BO2-20	I17	SYSTEM 1 DEFROST PRESSURE CONTROL	
BO2-18	I20	DEFROST TEMPERATURE SWITCH	
BO2-16	I21	DOOR SWITCH	
BO2-14	I22	EMERGENCY STOP	
BO2-12	I23	FLUID SYSTEM TEMPERATURE SAFETY	HOT BATH FLUID SAFETY
BO2-10	I24	FLUID SYSTEM PRESSURE SAFETY	COLD BATH FLUID SAFETY
BO2-8	I25	FLUID SYSTEM FLOW SAFETY	BATH LEVEL SAFETY
BO2-6	I26	CARGOCAIRE FAULT	BASKET DOWN
BO2-4	I27	COMBUSTIBLE MONITOR	

**Connection -** This column designates the physical wire connection point to the PLC for the input.

**Input -** This column designates the input address to the PLC as well as the marking used to identify wiring and hardware associated with the input.

### **8.1.1 Input Description of Use**

- Chamber Limit (I0):* The chamber limit input is used to indicate that the chamber temperature safety has tripped. This input is active high, i.e., the input must be on in order for the alarm to be indicated. When active, the EZT shuts down the chamber until the alarm is acknowledged (silence button pressed on alarm monitor screen) and the input is no longer active (requires manual reset of chamber limit device).
- Product Safety (I1):* The product safety input is used to indicate that the redundant product safety has tripped (if equipped). This input is active high, i.e., the input must be on in order for the alarm to be indicated. When active, the EZT shuts down the chamber until the alarm is acknowledged (silence button pressed on alarm monitor screen) and the input is no longer active (requires manual reset of product safety).
- Motor Overload (I2):* The motor overload input is used to indicate that a motor overload relay has tripped off due to a motor overload condition (if equipped). This input is active high, i.e., the input must be on in order for the alarm to be indicated. When active, the EZT shuts down the chamber until the alarm is acknowledged (silence button pressed on alarm monitor screen) and the input is no longer active (requires manual reset of motor overload).
- It may also be used to indicate a failure of a VFD if one is used to control motor speed. If the VFD is at fault, check the manufacturer's manual for troubleshooting and diagnostic information. Typically, pressing the stop/reset button on the drive should clear the fault condition.
- Sys1 Pumpdown Switch (I3):* This input is a control input for pumpdown (if equipped). There is no user indication for this input. When the refrigeration system requires pumpdown, this input is wired to a low pressure switch on the suction line of system 1 compressor. When the pressure rises, the switch closes and turns on the input.
- The EZT then turns on the system 1 compressor output (Q2) until the input turns off. When the input turns off, indicating that the compressor has pumped down, the EZT turns off the system 1 compressor output. During pumpdown, the system 1 solenoids output (Q11) remains off in order to isolate the low side of the refrigeration system so it can be pumped down.
- Sys1 Hi/Lo Pressure Safety (I4):* The system 1 hi/lo pressure safety input is used to indicate that the system 1 compressor has exceeded its high or low pressure operating range. This input is active low, i.e., the input must be off in order for the alarm to be indicated. When active (input off), the EZT shuts down the chamber until the alarm is acknowledged (silence button pressed on alarm monitor screen) and the input is on (requires manual reset of high pressure safety).

- Sys1 Oil Pressure Safety (I5):* The system 1 oil pressure safety input is used to indicate that the system 1 compressor oil pressure is below the proper operating range (if equipped). This input is active low, i.e., the input must be off in order for the alarm to be indicated. When active (input off), the EZT shuts down the chamber until the alarm is acknowledged (silence button pressed on alarm monitor screen) and the input is on (requires manual reset of oil pressure safety).
- Sys1 Discharge Thermostat (I6):* The system 1 discharge thermostat input is used to indicate that the system 1 compressor discharge temperature has exceeded the maximum operating range (if equipped). This input is active low, i.e., the input must be off in order for the alarm to be indicated. When active (input off), the EZT shuts down the chamber until the alarm is acknowledged (silence button pressed on alarm monitor screen) and the input is on (automatically resets after allowed to cool down).
- Sys1 Protection Module (I7):* The system 1 compressor protection module input is used to indicate that the system 1 compressor protection module has detected an improper phase condition/loss or the compressor motor windings have overheated (if equipped). This input is active low, i.e., the input must be off in order for the alarm to be indicated. When active (input off), the EZT shuts down the chamber until the alarm is acknowledged (silence button pressed on alarm monitor screen) and the input is on (automatically resets after built-in timeout period).
- Sys2 Hi/Lo Pressure Safety (I10):* The system 2 hi/lo pressure safety input is used to indicate that the system 2 compressor has exceeded its high or low pressure operating range. This input is active low, i.e., the input must be off in order for the alarm to be indicated. When active (input off), the EZT shuts down the chamber until the alarm is acknowledged (silence button pressed on alarm monitor screen) and the input is on (requires manual reset of high pressure safety).
- Sys2 Oil Pressure Safety (I11):* The system 2 oil pressure safety input is used to indicate that the system 2 compressor oil pressure is below the proper operating range (if equipped). This input is active low, i.e., the input must be off in order for the alarm to be indicated. When active (input off), the EZT shuts down the chamber until the alarm is acknowledged (silence button pressed on alarm monitor screen) and the input is on (requires manual reset of oil pressure safety).
- Sys2 Discharge Thermostat (I12):* The system 2 discharge thermostat input is used to indicate that the system 2 compressor discharge temperature has exceeded the maximum operating range (if equipped). This input is active low, i.e., the input must be off in order for the alarm to be indicated. When active (input off), the EZT shuts down the chamber until the alarm is acknowledged (silence button pressed on alarm monitor screen) and the input is on (automatically resets after allowed to cool down).

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- Sys2 Protection Module (I13):*** The system 2 compressor protection module input is used to indicate that the system 2 compressor protection module has detected an improper phase condition/loss or the compressor motor windings have overheated (if equipped). This input is active low, i.e., the input must be off in order for the alarm to be indicated. When active (input off), the EZT shuts down the chamber until the alarm is acknowledged (silence button pressed on alarm monitor screen) and the input is on (automatically resets after built-in timeout period).
- Boiler Thermostat (I14):*** The boiler high temperature thermostat input is used to indicate that the boiler has overheated. This input is active low, i.e., the input must be off in order for the alarm to be indicated. When active (input off), the EZT shuts down the chamber until the alarm is acknowledged (silence button pressed on alarm monitor screen) and the input is on (requires manual reset of thermostat).
- Boiler Low Water (I15):*** The boiler low water input is used to indicate that the boiler is low on water. This input is active low, i.e., the input must be off in order for the alarm to be indicated. When active (input off), the EZT shuts down the chamber until the alarm is acknowledged (silence button pressed on alarm monitor screen).
- The low water safety has a built in delay to prevent the activating of the alarm until the boiler has been given sufficient time to fill (30 minute delay upon turning on the humidity event). If the boiler has not filled up in the allotted time, the alarm will sound. Once the boiler has reached the proper operating level, the alarm will sound immediately upon loss of level.
- Water Reservoir Low (I16):*** The water reservoir low input is used to indicate that the humidity system water reservoir is low on water (if equipped). This input is active low, i.e., the input must be off in order for the alarm to be indicated. When active (input off), the EZT will sound the alarm to bring operator attention to the chamber. The alarm will sound until acknowledged (silence button pressed on system status screen). This is a notification alarm only and does not shut down the chamber.
- If the chamber has the humidity option, but not the low water reservoir, this input must be wired to VCC. If not, the low water alarm will always be present. Jumping this input out prevents the alarm.
- Sys1 Defrost Pressure Switch (I17):*** This input is a control input for defrost (if equipped). There is no user indication for this input. When equipped with defrost, this input is wired to a pressure switch on the discharge of system 2 compressor. This input is used to control system 1 cooling of system 2. When the input is on, system 1 will cool the cascade condenser for system 2. When the input is off, the EZT turns off cooling to the cascade by either turning of the cascade cooling solenoids (Q13) for large HP defrost or by turning off system 1 compressor for standard defrost.

- Sys1 Defrost Thermostat (I20):*** This input is a control input for defrost (if equipped). There is no user indication for this input. When equipped with defrost, this input is wired to a thermostat on the suction line of the cooling coil. When the refrigeration system is in defrost, this input is used to begin the termination sequence for defrost by signaling that the coil defrost temperature has been met.
- When the input first turns on, the EZT will begin the 15 minute countdown to terminate defrost. The thermostat is typically set for about 10°C (50°F). After defrost times out, the prechill step begins. The refrigeration system will begin to cool the coil. Once the thermostat sees the coil drop below the set point, a 60 second prechill timer will begin. At the end of 60 seconds, the chamber will return to normal operation.
- If the control loop is not calling for 100% cooling, the prechill timer will begin its 60 second countdown regardless of the suction line temperature.
- Door Switch (I21):*** The door switch input is used to indicate if the chamber door is open or closed (if equipped). The "door ajar" status will be displayed on the system status monitor screen. If the door control option is enabled, the EZT will shut down the chamber when the door is opened. This input is active high, i.e., the input is on to indicate an "open door" status.
- Emergency Stop (I22):*** The emergency stop input is used to indicate that the emergency stop has been activated (if equipped). This input is active high, i.e., the input must be on in order for the alarm to be indicated. When active (input on), the EZT shuts down the chamber until the alarm is acknowledged (silence button pressed on alarm monitor screen) and the input is off (requires manual reset of E-Stop button).
- Fluid Temperature Safety (I23):*** The fluid system temperature safety input is used to indicate that the fluid temperature limit has been exceeded (LC chambers). This input is active high, i.e., the input must be on in order for the alarm to be indicated. When active (input on), the EZT shuts down the chamber until the alarm is acknowledged (silence button pressed on alarm monitor screen) and the input is off (requires manual reset of limit device).
- Fluid Pressure Safety (I24):*** The fluid system pressure safety input is used to indicate that the fluid system has exceeded maximum operating pressures (LC chambers). This input is active low, i.e., the input must be off in order for the alarm to be indicated. When active (input off), the EZT shuts down the chamber until the alarm is acknowledged (silence button pressed on alarm monitor screen) and the input is off.
- Fluid Flow Safety (I25):*** The fluid system flow safety input is used to indicate that the fluid system has proper flow (LC chambers). This input is active low, i.e., the input must be off in order for the alarm to be indicated.

When active (input off), the EZT shuts down the chamber until the alarm is acknowledged (silence button pressed on alarm monitor screen) and the input is off.

The EZT has a built in time delay to disable the low flow alarm until the pump has had a chance to start and begin moving fluid (5 seconds). If the input does not turn on within the start delay period, the alarm will be activated.

***Cargocaire Fault (I26):***

The dehumidifier system fault input is used to indicate that there is a problem with the Cargocaire (if equipped). This input is active high, i.e., the input must be on in order for the alarm to be indicated. When active (input on), the EZT shuts down the chamber until the alarm is acknowledged (silence button pressed on alarm monitor screen) and the input is off (requires manual reset/service of dehumidifier unit).

***Combustible Monitor (I27):***

The combustible monitor input is used to indicate that there is a hazardous air mixture within the chamber. This input is active high, i.e., the input must be on in order for the alarm to be indicated. When active (input on), the EZT shuts down the chamber until the alarm is acknowledged (silence button pressed on alarm monitor screen) and the input is off (may require manual reset of combustible monitor).

### ***8.1.1.1 Custom Input Description of Use (DTS, VTS, TSB)***

- Basket Left (I14):*** This control input is used to tell the EZT that the basket (DTS/TSB) is in the left position/hot bath. There is no user indication for this input.
- Basket Right (I15):*** This control input is used to tell the EZT that the basket (DTS/TSB) is in the right position/cold bath. There is no user indication for this input.
- Basket Up (I16):*** This control input is used to tell the EZT that the basket (VTS/TSB) is in the hot chamber/unload position. There is no user indication for this input.
- Hot Bath Fluid Safety (I23):*** The hot bath fluid safety input is used on TSB's to indicate a problem with the hot bath fluid system (pressure/temperature). This input is active high, i.e., the input must be on in order for the alarm to be indicated. When active (input on), the EZT shuts down the chamber until the alarm is acknowledged (silence button pressed on alarm monitor screen) and the input is off (requires manual reset of limit device).
- Cold Bath Fluid Safety (I24):*** The cold bath fluid safety input is used on TSB's to indicate that the cold bath fluid system has exceeded maximum operating pressures. This input is active low, i.e., the input must be off in order for the alarm to be indicated. When active (input off), the EZT shuts down the chamber until the alarm is acknowledged (silence button pressed on alarm monitor screen) and the input is off.
- Bath Level Safety (I25):*** The bath level safety input is used on TSB's to indicate that a bath is low on fluid (if equipped with level sensors). This input is active high, i.e., the input must be on in order for the alarm to be indicated. When active (input on), the EZT will sound the alarm to obtain operator attention but will not shut down the chamber. The alarm will be shown on the system status monitor screen.
- Basket Down (I26):*** This control input is used to tell the EZT that the basket (VTS/TSB) is in the cold chamber/down position. There is no user indication for this input.

**8.2 Standard Output Configuration**

CONNECTION	INPUT	STANDARD	ALTITUDE	DTS, VTS, TSB
BO1-25	Q0	AIR CIRCULATORS	LOW SPEED FANS	COLD CHAMBER (DTS CENTER)
BO1-23	Q1	RC BLOWER	HIGH SPEED FANS	HOT CHAMBER (DTS LEFT)
BO1-21	Q2	SYSTEM 1 COMPRESSOR		
BO1-19	Q3	SYSTEM 2 COMPRESSOR		
BO1-17	Q4	CHAMBER LIGHT(S)		
BO1-15	Q5	WINDOW/DOOR FRAME HEATER(S)		
BO1-13	Q6	PRODUCT LIMIT		
BO1-11	Q7	AUDIBLE ALARM		
BO2-25	Q10	RATE MASTER CONTROL		HOT CHAMBER (DTS RIGHT)
BO2-23	Q11	SYSTEM 1 SOLENOIDS		
BO2-21	Q12	DEFROST SOLENOID		
BO2-19	Q13	SYSTEM 1 CASCADE SOLENOID CONTROL (RATE MASTER/DEFROST)		
BO2-17	Q14	MINIMUM COOL ENABLE		
BO2-15	Q15	MAXIMUM COOL ENABLE		
BO2-13	Q16	MINIMUM HEAT ENABLE		MAX HEAT (DTS RIGHT)
BO2-11	Q17	MAXIMUM HEAT ENABLE		(DTS LEFT)
BO3-20	Q30	DEHUMIDIFY ENABLE		
BO3-18	Q31	RH COOL ENABLE		
BO3-16	Q32	HUMIDITY SYSTEM		
BO3-14	Q33	MAXIMUM HUMIDIFY ENABLE		
BO3-12	Q34	DRY AIR PURGE SYSTEM		
BO3-10	Q35	AIR CONTROL SOLENOID		
BO3-8	Q36	FROZEN COIL CONTROL SOLENOID		
BO3-6	Q37	FROZEN COIL BYPASS SOLENOID		
BO3-19	Q40	LN2 SUPPLY SOLENOID		
BO3-17	Q41	LN2 CONTROL SOLENOID		
BO3-15	Q42	LN2 BOOST SOLENOID		
BO3-13	Q43	NOT USED	ALTITUDE SYSTEM	IN TRANSFER DOOR LOCK
BO3-11	Q44	NOT USED	MIN DIVE	TRANSFER LEFT
BO3-9	Q45	NOT USED	MAX DIVE	TRANSFER RIGHT
BO3-7	Q46	NOT USED	MIN VACUUM	TRANSFER UP
BO3-5	Q47	NOT USED	MAX VACUUM	TRANSFER DOWN

**Connection -** This column designates the physical wire connection point to the PLC for the output.

**Output -** This column designates the output address in the PLC as well as the marking used to identify wiring and hardware associated with the output.

CONNECTION	INPUT	STANDARD	DTS, VTS, TSB
BO4-25	Q50	CUSTOMER EVENT 1	
BO4-23	Q51	CUSTOMER EVENT 2	
BO4-21	Q52	CUSTOMER EVENT 3	
BO4-19	Q53	CUSTOMER EVENT 4	
BO4-17	Q54	CUSTOMER EVENT 5	
BO4-15	Q55	CUSTOMER EVENT 6	
BO4-13	Q56	CUSTOMER EVENT 7	
BO4-11	Q57	CUSTOMER EVENT 8	
BO4-25	Q60	CUSTOMER EVENT 9	
BO4-23	Q61	CUSTOMER EVENT 10	
BO4-21	Q62	CUSTOMER EVENT 11	
BO4-19	Q63	CUSTOMER EVENT 12	
BO4-17	Q64	CUSTOMER EVENT 13	
BO4-15	Q65	CUSTOMER EVENT 14	
BO4-13	Q66	CUSTOMER EVENT 15	
BO4-11	Q67	NOT USED	

**Connection -** This column designates the physical wire connection point to the PLC for the output.

**Output -** This column designates the output address in the PLC as well as the marking used to identify wiring and hardware associated with the output.

### **8.2.1 Output Description of Use**

*Air Circulator(s) (Q0):*

This output is used to turn the chamber air circulator(s) on and off when the chamber event 1 is turned on and off.

If defrost is enabled, this output will turn off the air circulator(s) during defrost and will turn back on once defrost is complete.

*RC Blower (Q1):*

This output is active on RC units and is used to turn the RC blower on and off when the chamber is on and event 8 is turned on and off.

If defrost is enabled, this output will turn off the blower during defrost and will turn it back on once defrost is complete.

*System 1 Compressor (Q2):*

This output is used to turn system 1 compressor on and off based on the demand for cooling or dehumidification. The output turns on when the loop percentage of output exceeds the on percentage for the delay period set in the configurator. The output will turn off the compressor when the loop percentage of output exceeds the off percentage for the delay period set in the configurator.

The output also turns on and off with the pressure switch input (I3) if pumpdown is enabled. If main power is off for more than 30 minutes, the input will be ignored, and the output will remain off, until pumpdown is reset automatically after 4 hours or manually by the operator.

The output is also controlled by the defrost pressure switch (I17). When defrost is enabled, the output will turn system 1 compressor on and off with the input in order to maintain the discharge pressure of system 2 at the proper range during defrost. Note that when large horsepower defrost is enabled, the output will remain on at all times and is not cycled on and off.

*System 2 Compressor (Q3):*

This output is used to turn system 2 compressor on and off based on the demand for cooling. It turns on after the stager start delay time set in the configurator. The timer begins once system 1 output turns on. The output turns off when system 1 output turns off.

During single stage humidity operation, the output is also turned off. The output will remain off until humidity is turned off. The stager start timer will begin again and turn on the output.

During defrost, the output is forced on to maintain system 2 operation in order to provide hot gas for defrosting of the cooling coils. Once defrost is complete, the output will be controlled by normal cooling requirements.

*Chamber Light(s) (Q4):*

This output toggles on and off to turn the chamber light(s) on and off when the light icon on the HMI is pressed.

*Window/Door Frame Heater (Q5):* This output is used to turn the window heater(s) on and off based on the air temperature set point set in the configurator. When the air temperature drops below the set point, the output will turn on after a 1 minute delay. Once the air temperature rises above the set point, the output will then turn off after a 1 minute delay.

The output will also turn on whenever the humidity system is enabled. This keeps the window clear during high dewpoint conditions in the chamber.

*Product Safety (Q6):* This output acts as a “chamber run” verification for the customer to use as a product under test enable. As long as the chamber is running, i.e., controlling temperature, this output will be on. When the chamber is turned off or in a critical alarm condition, this output is off.

*Audible Alarm (Q7):* This output is used to turn the audible alarm on and off under fault conditions.

*Rate Master Control (Q10):* This output is used for rate master refrigeration systems. It is used to switch cooling control between the system 1 and system 2 valves. When the output is turned on, system 1 is being used to provide the cooling to the chamber. When the output is off, system 2 is being used to provide cooling the chamber like a typical cascade system.

*System 1 Solenoids (Q11):* This output is used to turn on the liquid line and hot gas solenoids on system 1 when the unit is equipped with pumpdown. This allows the solenoids to open and close independently of system 1 compressor operation so that the system can be pumped down.

During normal cooling operation, this output will turn on with the system 1 compressor output (Q2). When the refrigeration system is no longer required to run, this output will turn off to isolate the high side of the system while the compressor continues to run in order to pump down the system.

*Defrost Solenoid (Q12):* This output is used to turn on the hot gas defrost solenoid on chambers equipped with defrost. This output will turn on during the defrost period supplying hot gas to the cooling coil.

*Cascade Solenoid Control (Q13):* The system 1 cascade solenoid control output is used on chambers with rate master refrigeration systems. It is used to disable refrigerant flow to the cascade when running in single stage mode.

This output is also used to control cooling of system 2 when in defrost on large horsepower systems. This output will cycle on and off with the defrost pressure switch input (I17) in order to maintain system 2's head pressure in the proper range. This allows system 1 compressor to run continuously so as not to cycle the compressor on and off.

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- Minimum Cool Enable (Q14):* This output is used to enable and disable the cooling output from the 9300 controller, typically on chambers with defrost. When defrost is on, this output will be off to prevent any cooling from taking place in order to defrost the cooling coil.
- Maximum Cool Enable (Q15):* This output is used to enable and disable the maximum cooling solenoids based on the percentage of output set up in the configurator. When the loop output exceeds the maximum output on percentage for the on delay period set in the configurator, this output will turn on.
- Minimum Heat Enable (Q16):* This output is used to enable and disable the heating output from the 9300 controller, typically on chambers with defrost. When defrost is on, this output will be off to prevent any heating from taking place in order to minimize chamber temperature rise.
- Maximum Heat Enable (Q17):* This output is used to enable and disable the maximum heating SSR based on the percentage of output set up in the configurator. When the loop output exceeds the maximum output on percentage for the on delay period set in the configurator, this output will turn on.
- Dehumidify Enable (Q30):* This output is used to enable and disable the control of the wet coil solenoid from dehumidification output of the 9300 controller. In normal humidity mode, this output will be on so that the wet coil solenoid can be cycled on and off. When operating in frozen coil mode (if equipped) this output will turn off in order to allow the dehumidification output of the 9300 controller to control the frozen coil solenoid (Q36).
- RH Cool Enable (Q31):* This output is active on cascade refrigeration systems that operate in single stage mode for humidity. This output will turn on in order to allow the cooling output of the 9300 to control the system 1 cooling solenoid.
- Humidity System (Q32):* This output is used to turn the humidity system on and off with chamber event 2.
- Maximum Humidify Enable (Q33):* This output is used to enable and disable the maximum boiler SSR based on the percentage of output set up in the configurator. When the loop output exceeds the maximum output on percentage for the on delay period set in the configurator, this output will turn on.
- Dry Air Purge System (Q34):* This output is used to turn the dry air purge system on and off with chamber event 4. It will also turn on automatically when the chamber is equipped with the frozen coil (low RH) option, when needed to reach a low humidity condition.
- Air Control Solenoid (Q35):* This output is used when the chamber is equipped with the frozen coil (low RH) option. It is used to switch the purge air supply solenoid control between the dehumidification output of the 9300 controller when the humidity system is on, or the dry purge system output when only dry air purge is on.

*Frozen Coil Control Solenoid (Q36):* This output is used to enable and disable the control of the frozen coil solenoid from dehumidification output of the 9300 controller. In normal humidity mode, this output will be of so that the wet coil solenoid can be cycled on and off (Q30). When operating in frozen coil mode this output will turn on in order to allow the dehumidification output of the 9300 controller to control the frozen coil solenoid.

*Frozen Coil Bypass Solenoid (Q37):* This output is used to turn on the bypass solenoid in order to bypass the EPR valve on the dehumidification coil when running in frozen coil mode.

*LN2 Supply Solenoid (Q40):* This output is used to turn the LN2 supply solenoid on and off based on chamber event 3. If the boost cool system is set for control mode, it will automatically turn on when required in order for the chamber to obtain temperatures below the capabilities of the refrigeration system.

*LN2 Control Solenoid (Q41):* This output is used on chambers that go to ultra low temperatures, i.e., temperatures that exceed the minimum operating temperatures of the refrigeration system.

When “aux cool control” is selected in the configurator, the output will turn on to switch the cooling output of the 9300 to control the LN2 control solenoid. The output is enabled when the air temperature set point and air temperature are below the “boost cool SP disable” set in the configurator.

*LN2 Boost Solenoid (Q42):* This output is used to turn the boost cooling solenoid on and off based on the demand for cooling and settings made in the configurator. It will turn on when the loop output exceeds the “aux cool on percentage” for the on delay time set in the configurator.

*Customer Event Outputs (Q50-66):* These outputs are directly controlled by the customer event selections and their use is dependant upon the settings made by the customer.

These outputs can also be configured as alarm outputs based on the loop alarm settings in the EZT. They can be set to open or close on alarms.

### ***8.2.1.1 Custom Output Configuration (Altitude)***

- Low Speed Fans (Q0):*** This output is used to turn on the chamber air circulator(s) in low speed mode. When the altitude exceeds the “Alt Hi Speed Fan Enable SP” in the configurator, this output turns off so the high speed fan output (Q1) can turn on and control the air circulators.
- High Speed Fans (Q1):*** This output is used to turn on the chamber air circulator(s) in high speed mode. When the altitude exceeds the “Alt Hi Speed Fan Enable SP” in the configurator, this output turns on. When the altitude drops below the set point, this output turns back off so the low speed fan output (Q0) can turn on and control the air circulators.
- Altitude System (Q43):*** This output is used to enable and disable the altitude system and associated components with chamber event 5.
- Min Dive (Q44):*** This output is used to enable and disable the 9300 controller output control of the minimum dive solenoid.
- Max Dive (Q45):*** This output is used to enable and disable the 9300 controller output control of the maximum dive solenoid. When the loop output exceeds the maximum output on percentage for the on delay period set in the configurator, this output will turn on.
- Min Vacuum (Q46):*** This output is used to enable and disable the 9300 controller output control of the minimum vacuum solenoid.
- Max Vacuum (Q47):*** This output is used to enable and disable the 9300 controller output control of the maximum vacuum solenoid. When the loop output exceeds the maximum output on percentage for the on delay period set in the configurator, this output will turn on.

### 8.2.1.2 Custom Output Configuration (DTS, VTS, TSB)

- Hot (left) Chamber (Q0):** This output is used to turn on the left chamber of a DTS or the hot chamber of a VTS using chamber event 1. It is also used to enable both baths for a TSB. When used for a DTS or VTS, the output will turn off during a transfer to stop the fans and then turn back on once the transfer is complete.
- Cold (center) Chamber (Q1):** This output is used to turn on the center chamber of a DTS or the cold chamber of a VTS using chamber event 2. It is not used for a TSB. The output will turn off during a transfer to stop the fans and then turn back on once the transfer is complete.
- Hot (right) Chamber (Q10):** This output is used to turn on the right chamber of a DTS using chamber event 7. The output will turn off during a transfer to stop the fans and then turn back on once the transfer is complete.
- Maximum Heat (right) Enable (Q16):** This output is used to enable and disable the maximum heating SSR for the right chamber of a DTS. When the loop output exceeds the maximum output on percentage for the on delay period set in the configurator, this output will turn on.
- In Transfer Door Lock (Q43):** This output is used to enable a locking mechanism on the chamber door (if equipped) to prevent the door from being opened during a transfer. When the transfer is complete, the output turns off.
- Transfer Left (Q44):** This output is used to turn on the transfer mechanism to move the basket to the left on a DTS or TSB. For a DTS it transfers the left basket into the left (hot) chamber and the right basket into the center (cold) chamber. On a TSB, it transfers the basket from the cold or unload position to the unload or hot position.
- Transfer Right (Q45):** This output is used to turn on the transfer mechanism to move the basket to the right on a DTS or TSB. For a DTS it transfers the right basket into the right (hot) chamber and the left basket into the center (cold) chamber. On a TSB, it transfers the basket from the hot or unload position to the unload or cold position.
- Transfer Up (Q46):** This output is used to turn on the transfer mechanism to move the basket up on a VTS or TSB equipped with a pneumatic transfer mechanism. For a VTS, the basket is transferred into the hot chamber. On pneumatic TSB systems, this lifts the basket out of the baths so that it can move from side to side. It also holds the basket up when the unload position is selected.
- Transfer Down (Q47):** This output is used to turn on the transfer mechanism to move the basket down on a VTS or TSB equipped with a pneumatic transfer mechanism. For a VTS, the basket is moved into the cold chamber. On pneumatic TSB systems, this lowers the basket into the baths once it is positioned over the hot or cold bath.

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### 8.3 PLC Status Indicators

All of the digital input and output points on the PLC have indicator lights that tell whether the input or output is on or off. The lights are numbered for quick identification. By using the status lights, it can help you diagnose a wiring or component problem in the system. For example, if the output light on the PLC is on indicating that the output relay should be on, and the relay is off, it could indicate a bad relay or a problem with the wiring to the relay.

The CPU has connections for all inputs used on a standard system. This includes inputs I0-I17 and I20-I27. It also has the output connections for the first 16 outputs used on standard chambers, Q0-Q7 and Q10-Q17.

The remaining outputs are used depending upon the options present on the chamber. The outputs are added through the use of add on output modules that connect to the right side of the CPU. For chambers without customer events, a 16-point digital output card is added in order to obtain outputs Q30-Q37 and Q40-Q47. If customer event outputs are required, a 32-point card is added in order to get Q50-Q57 and Q60-Q67.

**NOTE** The output numbering is octal based. That means that the outputs increment in groups of 8. The first group is outputs Q0-Q7. The second group is outputs Q10-Q17. The next incremental group starts with the addition of a digital output card. It begins at output Q30. The range of Q20-Q27 is skipped.

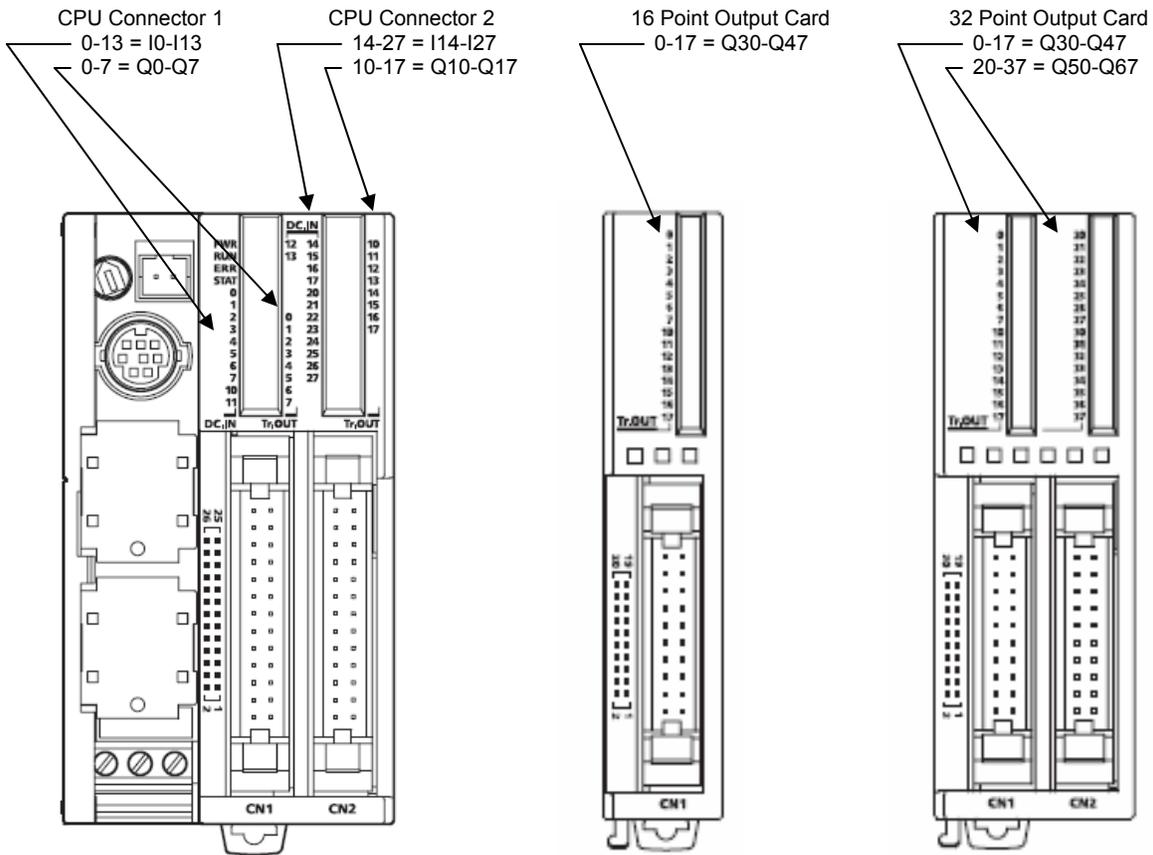
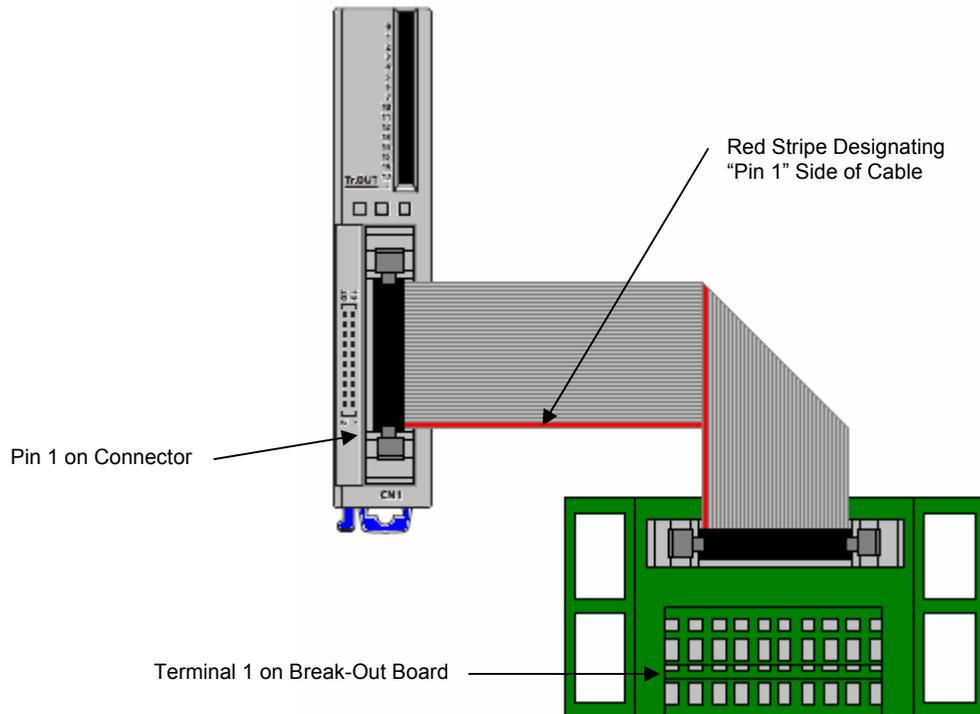


Figure 8-1 PLC Input/Output Indicators

**8.3.1 I/O Ribbon Cable Connections**

The PLC input and output connections are made through ribbon cables to break out wiring boards for individual conductors. The ribbon cables may or may not be keyed. If the cable is not keyed, it can be inserted “upside down”. This will cause the chamber to not function correctly and can cause numerous alarms to appear on the EZT, none of which are real.

The ribbon cables are marked with a red stripe down one side indicating pin 1. When inserting the ribbon cables, make sure that the red stripe is oriented the same direction on both the PLC and the break out board. That is, pin 1 to pin 1 or pin 20 to pin 20 for example.



**Figure 8-2 Ribbon Cable Connection**

## **9. Adjusting EZT Configuration options**

The EZT configurator is used to set the functionality of the EZT to match the chamber type and available options on the chamber. The settings contained in the configurator affect the control of chamber components and systems. Altering these values may only be done by CSZ authorized service personnel.

**WARNING**      **Changing certain configurator settings to values other than those listed on the EZT Configuration sheet provided with the chamber can cause damage to the chamber and present hazards to personnel. Changes to any configurator settings not specifically called out in this manual may only be done with the consent of an authorized CSZ representative.**

**Failure to comply with this WARNING will void the chamber's warranty.**

### 9.1 Accessing the EZT Configurator

To access the EZT configurator, you must quit the EZT560 application and start the configurator program. To do this, you must have the proper security access to exit the EZT application. All chambers leave the factory with a default user name and password. Select "Logon" under the security menu and enter the default password information:

User:       FACTORY  
Password: CONTROL

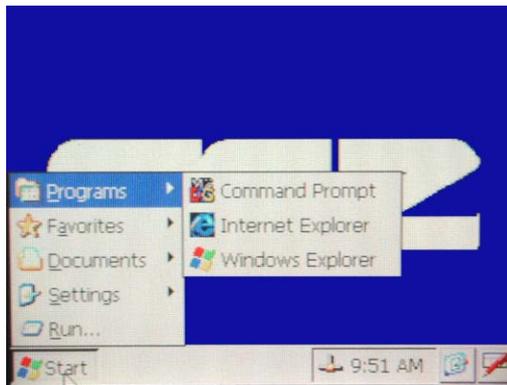
Once you are logged in as "Factory", you have the ability to exit the EZT560 application. To exit the application, select "System Maintenance" from the chamber setup menu. Select "Exit Application" from the system maintenance setup menu. Press the "Exit Application" button to quit the EZT-560 application.



*Figure 9-1 Exit Application*

If security is not enabled, you will not have to log on to gain access to quit the application. However, if security is enabled, and the default password is no longer valid, then you must either obtain the necessary user name and password from the end user of the chamber, or you can bypass the security by turning off power to the chamber.

With the power turned off, remove the compact flash card from the back of the HMI. Turn the power back on and allow the HMI to boot up to the Windows CE desktop (blue screen). Insert the CF card back into the slot in the HMI making sure to insert it in the proper orientation. Touch the thin gray bar at the bottom of the screen to show the Windows task bar and select "Windows Explorer" from the start menu.



*Figure 9-2 Windows Start Menu*

Open the “StorageCard” folder.



**Figure 9-3 Storage Card**

Open the “EZT560” folder.



**Figure 9-4 EZT560 Folder**

Select “EZT560 Config” from the EZT560 folder to start the configurator program.



**Figure 9-5 EZT560 Config**

Once the configurator application starts, it will default to the “Number of Loops/Monitors” screen.

## 9.2 Number of Loops/Monitors

The number of loops/monitors screen is accessed from the “Loops” menu. It is used to configure the EZT for the number of control loops that are present (9300 controllers), how many monitor inputs are used (Eagle input module) and how many analog outputs are on the PLC.

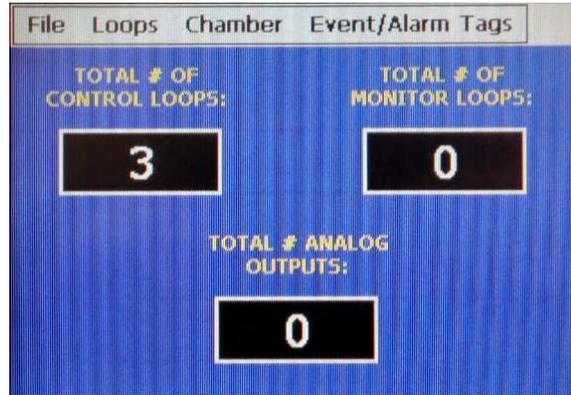


Figure 9-6 Number of Loops/Monitors

Set the number of each item by touching the respective number field. Enter the correct value using the pop-up keypad and press done. The EZT can have up to 5 control loops, 8 monitor loops and up to 4 analog outputs maximum.

**NOTE** Configuring more control loops or monitor loops than are present on the chamber will cause the chamber to shut down with a “loop comms failure” alarm.

### Parameter Descriptions

**Total # of Control Loops:** Sets the number of 9300 control loop displays that are shown on the loop view screens, trend, etc. of the EZT (one for each controlled process, i.e., temperature, humidity, etc.).

**NOTE** The “Loops/Monitor Tagnames” screen is where the mode of the control loop is selected and enabled/disabled. If a loop is being removed, you must first change the loop to disabled and then change the total number of control loops. Only changing the number of control loops will remove the display from the loop view screens but will not disable the loop. If the 9300 controller is then removed, the chamber will shut down on a “loop comms failure” alarm.

**Total # of Monitor Loops:** Sets number of monitor inputs connected to the Eagle module. For each enabled input, another loop is added to the loop view screens, trend, etc. for viewing.

**Total # of Analog Outputs:** Sets the number of analog outputs connected to the PLC. When one or more are enabled, the “Output Calibration” menu item is system maintenance will be enabled in the EZT560 application. This allows the user to set up the analog output for the type and signal range desired for retransmission to another device such as a chart recorder.

### 9.3 Loops/Monitor Tagnames

The “Loops/Monitor Tagnames” screen is accessed from the “Loops” menu. This screen allows you to define what type of control loop it is, what its name is and specific control output settings for the loop.



*Figure 9-7 Loop/Monitor Tagnames*

The arrow keys provided on the upper right of the screen allow you to scroll through all available control loops and monitor loops that have been set on the “Number of Loops/Monitors” screen.

**NOTE** You must press the “Set” button to save changes to the input type. Be sure to press the “Set” button prior to switching to another loop or another configuration screen or any change to the input type will not be saved.

#### Parameter Descriptions

**Input Type:** Sets the type of control loop (temperature, humidity, altitude, etc.).

**WARNING** Do not alter the loop type to any selection other than what is called out on the EZT Configuration form supplied with the chamber or the chamber may not operate properly and damage to equipment can occur.

**Any changes made without prior authorization by CSZ will void the chamber warranty.**

**Tagname:** Sets the name of the loop (what its controlling). This description is used throughout the loop and trend screens as well as input selection for data logging.

**Alm1 Message:** Sets the alarm message that will be used for input alarms. This will be the name displayed on the alarm monitor screen when the user configurable alarm is active.

**Eng Units:** Sets the units for the input (degrees C/F, RH, KFT, etc.). The units are displayed on the single and dual loop display screen.

**Max Heat%:** Sets the loop percentage of output at which the maximum heat output is enabled.

**Max Cool%:** Sets the loop percentage of output at which the maximum cool output is enabled.

- Dec Pos:** Sets how many decimal positions to use when displaying an input (always 1).
- Heat Dly:** Sets the delay in seconds for which the loop percentage of output must exceed the max heat% before the max heat output will turn on.
- Cool Dly:** Sets the delay in seconds for which the loop percentage of output must exceed the max cool% before the max heat output will turn on.

**9.4 Chamber Options**

The “Chamber Options” screen is accessed from the “Chamber” menu. This screen is used to define what type of chamber the EZT-560 is being used on and enables special logic for certain types of chambers.



*Figure 9-8 Chamber Options*

Only one selection can be made at a time. If a new selection is made, the other selection will turn off automatically. For standard temperature and humidity or altitude chambers, all options will typically be off.

Parameter Descriptions

- All Options Off:** Used for all standard temperature/humidity/altitude chambers.
- RC Logic Enabled:** Enables the logic for the RC blower motor. The logic ties event 8 to output Q1 to turn the RC blower motor on and off with the event.
- LC Logic Enabled:** Enables the logic for pump control and fluid system monitoring. The logic turns on output Q1 for the pump with event 1 and enables the input alarm logic for high temperature (I23), pressure (I24) and flow (I25) monitoring.
- VTS Logic Enabled:** Enables the logic for basket position and dual zone control. Loop 1 is set for hot chamber control and loop 2 for cold chamber control. The logic turns on output Q1 for the hot chamber using event 1 while event 2 becomes the cold chamber. Outputs Q46 and Q47 for basket up and down are enabled through events 5 and 6.

Inputs I16 and I26 are used for basket position monitoring for hot and cold chamber positions respectively. The door switch input (I21) is monitored to disable the transfer if either door is opened.

- DTS Logic Enabled:** Enables the logic for basket position and three zone control. Loop 1 is set for the left (hot) chamber control, loop 2 for the center (cold) chamber control and loop 3 is for the right (hot) chamber control. Loops 4 and 5 are set for product control for the left and right basket respectively.

The logic turns on output Q1 for the left chamber using event 1 while event 2 becomes the center chamber. Output Q10 becomes the right chamber control using event 7 with output Q16 being enabled for the max heat output

control. Outputs Q44 and Q45 for basket left and right are enabled through events 5 and 6.

Inputs I14 and I15 are used for basket position monitoring for left and right chamber positions respectively. The door switch input (I21) is monitored to disable the transfer if any door is opened.

**TSB Logic Enabled:** Enables the logic for basket position and dual zone control. Loop 1 is set for the left (hot) bath control and loop 2 for the right (cold) bath control. The door switch input (I21) is monitored to disable the transfer if the lid/door is opened. Inputs I23 and I24 are enabled for the hot and cold bath fluid safeties respectively. If the baths are equipped with low level floats, I25 is used as a low level warning input.

Depending on the transfer mechanism used, different inputs and outputs are used to transfer the basket to each position. For motor operated transfer mechanisms, outputs Q44 and Q45 for basket left and right are used to position the basket. For air cylinder operated transfer mechanisms, outputs Q44 and Q45 are used for the left and right movement with outputs Q46 and Q47 used to control the up and down movement.

Events 5 and 6 with event 7 for the unload position are used to select the three positions. Inputs I14 and I15 are used to monitor the left (hot) and right (cold) positions. Inputs I16 and I26 are used for up and down position monitoring for air cylinder control. On units with a motor operated mechanism, I26 is used for the unload position indication.

**Chamber Door Switch Control:** Sets whether or not the opening and closing of the chamber door (when equipped with a door switch on input I21) turns the chamber off and on. If enabled, when the door is opened, the chamber will shut down. When the door is closed, the chamber will turn back on.

**9.5 Refrigeration Options**

“Refrigeration Options” screen is accessed from the “Chamber” menu. This screen is used to define what type of refrigeration system the chamber has and how the EZT-560 is to control it.



*Figure 9-9 Refrigeration Options*

**NOTE** You must press the “Set” button to save changes to the refrigeration and/or defrost type selections. Be sure to press the “Set” button prior to switching to another configuration screen or any change to the refrigeration and/or defrost type will not be saved.

Parameter Descriptions

**Refrig Type:** Sets the type of refrigeration system installed on the chamber (can be none).

**WARNING** Do not change the refrigeration type to any selection other than what is installed on the chamber and called out on the EZT Configuration form supplied with the chamber or the refrigeration system may not operate properly and damage can occur.

**Cmp On %:** Sets the loop percentage of output required to turn enable the refrigeration system because cooling is required.

**Cmp On Dly:** Sets the delay in seconds for which the loop output must exceed the cmp on % before the refrigeration system is turned on.

**Cmp Off %:** Sets the loop percentage of output required to disable the refrigeration system because cooling is no longer required.

**Cmp Off Dly:** Sets the delay in seconds for which the loop output must exceed the cmp off % before the refrigeration system is turned off.

**Stager Dly:** Sets the stager start delay time in seconds for system 2 on cascade systems.

**Defrost:** Sets the defrost mode based on installed defrost components.  
 - “Defrost On” is used for smaller compressors (typically smaller than 7.5hp)  
 - “Large HP Defrost” is used for larger systems (typically larger than 7.5hp)

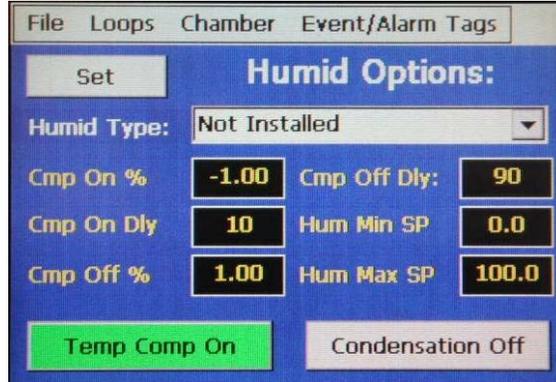
The large horsepower defrost is used to control the cascade condenser liquid line cooling solenoids on cascade systems. It cycles the solenoids on and off to maintain system 2 head pressures rather than cycling the system 1 compressor on and off. Cycling large horsepower compressors is detrimental to the life of the compressor and is not recommended by the manufacturer.

**Pumpdown On/Off:** Enables or disables pumpdown mode.

**Pumpdown Reset Time Out:** Sets the time in seconds for which the chamber can be without power before pumpdown will be disabled and require manual reset or the four hour automatic reset delay.

**9.6 Humidity Options**

The “Humidity Options” screen is accessed from the “Chamber” menu. This screen is used to define what type of humidity system the chamber has and how the EZT-560 is to control it.



*Figure 9-10 Humidity Options*

**NOTE** You must press the “Set” button to save changes to the humidity system type selection. Be sure to press the “Set” button prior to switching to another configuration screen or any change to the humidity system type will not be saved.

Parameter Descriptions

- Humid Type:** Sets the type of humidity system installed on the chamber.
  - “Humidity Installed” is for single stage/tundra systems or cascade systems without a separate RH cooling circuit on system 1.
  - “Single stage humid installed” is for cascade systems that run in single stage mode during humidity (have separate RH cooling circuit on system 1).
- Cmp On %:** Sets the loop percentage of output required to enable the refrigeration system in order to provide dehumidification.
- Cmp On Dly:** Sets the delay in seconds for which the loop percentage of output must exceed the cmp on % before the refrigeration system is turned on.
- Cmp Off %:** Sets the loop percentage of output required to disable the refrigeration system because dehumidification is no longer required.
- Cmp Off Dly:** Sets the delay in seconds for which the loop percentage of output must exceed the cmp off % before the refrigeration system is turned off
- Hum Min SP:** Sets the minimum air temperature set point at which the humidity system will operate. When the air temperature set point and/or air temperature is below this value, the humidity system will be automatically turned off and the system status indicator “RH TMP DISABLE” will be lit.
- Hum Max SP:** Sets the maximum air temperature set point at which the humidity system will operate. When the air temperature set point and/or air temperature is above this value, the humidity system will be automatically turned off and the system status indicator “RH TMP DISABLE” will be lit.

**Temp Comp On/Off:** Enables or disables the humidity sensor temperature compensation algorithm in the EZT depending on whether or not a compensated sensor is used.

**NOTE** The compensation is for a Vaisala HMM30C sensor only. Do not use it for other brands of sensors. This should be disabled when using compensated humidity sensors. If set incorrectly, the EZT will not read the correct humidity in the chamber.

**Condensation On/Off:** Enables or disables the condensation control option. This feature can reduce the formation of condensation during testing on product within the chamber. However, it can greatly reduce the performance of the chamber. This option is used for special circumstances only.

**9.7 Purge/Lo RH Options**

The “Purge/Lo RH Options” screen is accessed from the “Chamber” menu. This screen is used to define what type of purge system is installed on the chamber and what dewpoint limits the humidity system is allowed to control to, if equipped.



*Figure 9-11 Purge/Lo RH Options*

**NOTE** You must press the “Set” button to save changes to the purge system type selection. Be sure to press the “Set” button prior to switching to another configuration screen or any change to the purge system type will not be saved.

Parameter Descriptions

**Purge/Low RH Type:** Sets the type of purge system installed.  
 - “Dry Air Purge” is used when just the air dryer is installed.  
 - “Low RH Option Installed” is used when the frozen coil option is installed.

**Min Dewpoint Limit:** Sets the minimum dewpoint that the chamber will control to. In essence, this limits the minimum humidity level that the chamber can achieve at a given temperature.

This value is used to protect the refrigeration system from liquid refrigerant flood back that can happen when trying to achieve to low of a humidity level at lower air temperatures.

Standard humidity is limited to a 1.7C (35F) dewpoint.  
 The low RH option is limited to a -28.8C (-20F) dewpoint.

**Max Dewpoint Limit:** Sets the maximum dewpoint that the chamber will control to. In essence, this limits the maximum humidity that the chamber can achieve at a given temperature.

This value is primarily used to protect modular walk-ins. The modular walk-in panels can not withstand high temperature and humidity levels.

Standard chambers typically have a setting of 100C (212F).  
 Modular walk-ins are limited to 70C (158F).

## 9.8 Auxiliary Cooling Options

The “Aux Cooling Options” screen is accessed from the “Chamber” menu. This screen is used to define what type of boost cooling the chamber has, if equipped.

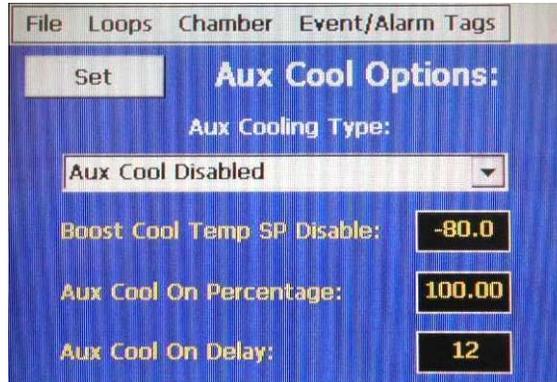


Figure 9-12 Aux Cooling Options

**NOTE** You must press the “Set” button to save changes to the auxiliary cooling type selection. Be sure to press the “Set” button prior to switching to another configuration screen or any change to the auxiliary cooling type will not be saved.

### Parameter Descriptions

**Aux Cooling Type:** Sets the type of boost cooling system installed on the chamber.  
 - “Aux cool boost” is for the standard boost option that is used to assist the refrigeration system.  
 - “Aux cool control” is for chambers that have extended low temperature operation which go colder than the range of the refrigeration system.

**Boost Cool Temp SP Disable:** Sets the temperature below which the refrigeration system is automatically disabled if “aux cool control” is selected. The boost cooling system will then switch to control mode and start controlling temperature below this set point.

If “aux cool boost” is selected, the boost outputs will be disabled below this set point to prevent the chamber from exceeding the limits of the refrigeration system.

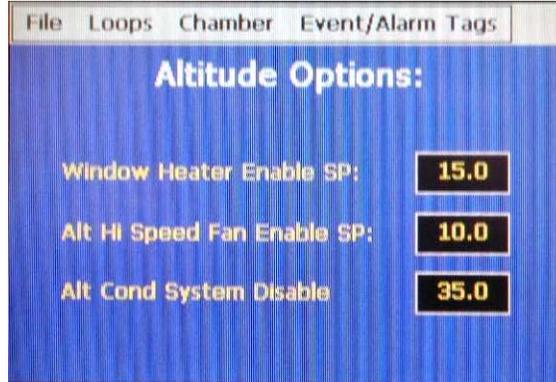
**CAUTION** For boost only mode, this set point must be set no lower than the minimum achievable temperature of the refrigeration system or the compressors can be damaged.

**Aux Cool On Percentage:** Sets the loop percentage of output required to enable the boost cooling output.

**Aux Cool On Delay:** Sets the delay in seconds for which the loop percentage of output must exceed the aux cool on percentage before the refrigeration boost cool output is turned on.

### 9.9 Altitude Options

The “Altitude Options” screen is accessed from the “Chamber” menu. This screen is used to set the limits for the conditioning system if the chamber is equipped with altitude.



*Figure 9-13 Altitude Options*

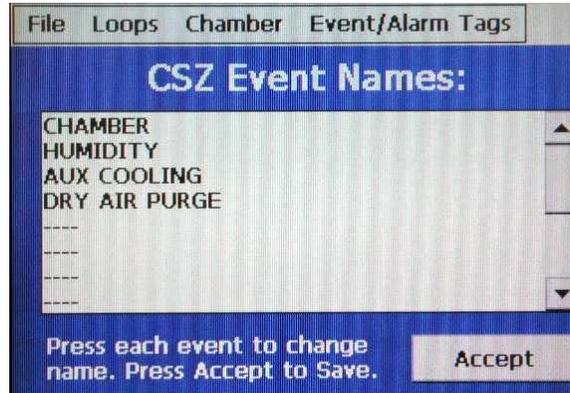
Set the different values by touching the respective number field.

#### Parameter Descriptions

- Window Heater Enable SP:** Sets the temperature below which the window heater turns on.
- Alt Hi Speed Fan Enable SP:** Sets the altitude (in Kft) above which the high speed fans will be turned on.
- Alt Cond System Disable:** Sets the altitude above which the conditioning system will be automatically disabled.

### 9.10 CSZ Events

The “CSZ Events” screen is accessed from the “Event/Alarm Tags” menu. This screen is used to set the names for the events of chamber options present.



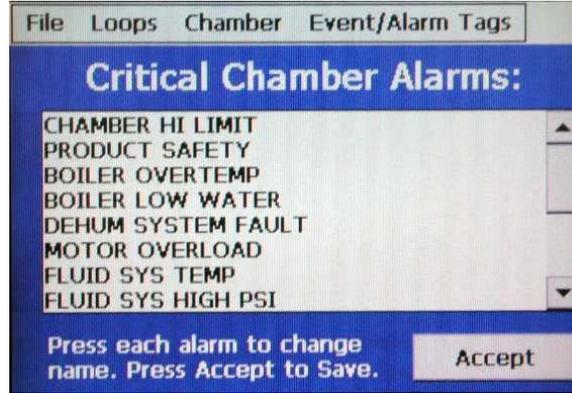
*Figure 9-14 CSZ Event Names*

To change or edit a tag name, touch the position for the event and change the name using the pop-up keypad. Note that event names are limited to 20 characters in length.

**NOTE** Altering the event names from those listed on the EZT Configuration sheet provided with the chamber may make their use unclear and cause operator confusion. Use discretion when altering tag names.

**9.11 Critical Chamber Alarms**

The “Critical Chamber Alarms” screen is accessed from the “Event/Alarm Tags” menu. This screen is used to set the names for the different system alarms in the chamber.



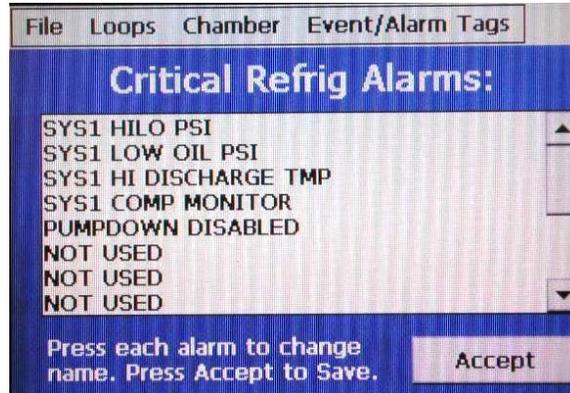
*Figure 9-15 Critical Chamber Alarm Names*

To change or edit a tag name, touch the position for the alarm and change the name using the pop-up keypad. Note that alarm names are limited to 20 characters in length.

**NOTE** Altering the alarm names from those listed on the EZT Configuration sheet provided with the chamber may cause operator confusion when diagnosing alarms. Use discretion when altering tag names.

### 9.12 Critical Refrigeration Alarms

Access the “Critical Refrigeration Alarms” screen from the “Event/Alarm Tags” menu. This screen is used to set the names for the different refrigeration system alarms.



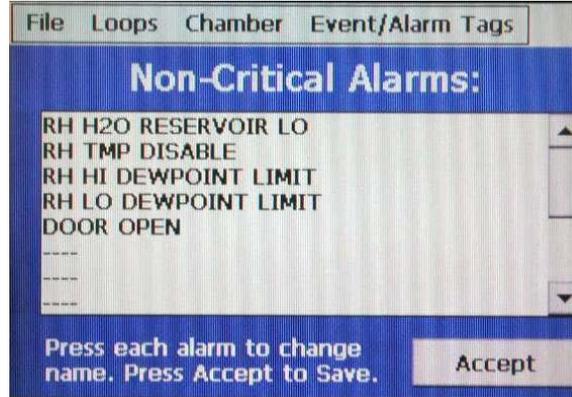
*Figure 9-16 Critical Refrigeration Alarm Names*

To change or edit a tag name, touch the position for the alarm and change the name using the pop-up keypad. Note that alarm names are limited to 20 characters in length.

**NOTE** Altering the alarm names from those listed on the EZT Configuration sheet provided with the chamber may cause operator confusion when diagnosing alarms. Use discretion when altering tag names.

**9.13 Non-Critical Alarms**

Access the “Non-Critical Alarms” screen from the “Event/Alarm Tags” menu. This screen is used to set the names for the different system status alarms such as service monitors.



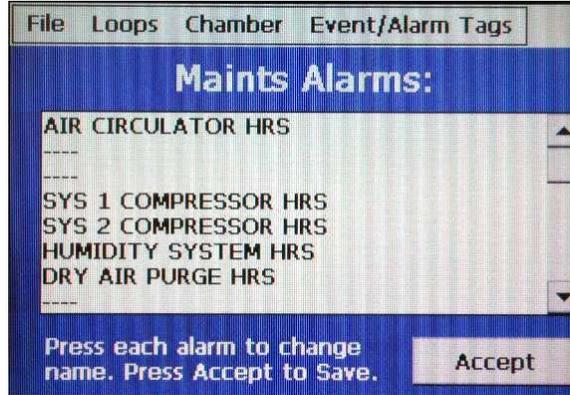
*Figure 9-17 Non-Critical Alarm Names*

To change or edit a tag name, touch the position for the alarm and change the name using the pop-up keypad. Note that alarm names are limited to 20 characters in length.

**NOTE** Altering the alarm names from those listed on the EZT Configuration sheet provided with the chamber may cause operator confusion when diagnosing alarms. Use discretion when altering tag names.

### 9.14 Maintenance Alarms

Access the “Maintenance Alarms” screen from the “Event/Alarm Tags” menu. This screen is used to set the names for the different service monitors of each system component.



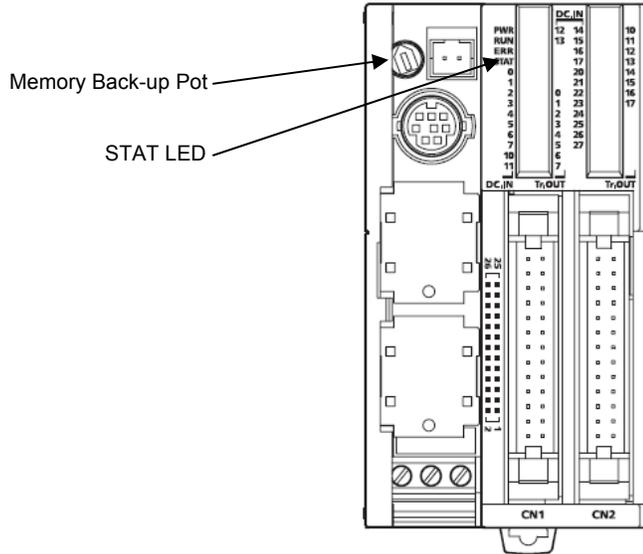
*Figure 9-18 Maintenance Alarm Names*

To change or edit a tag name, touch the position for the alarm and change the name using the pop-up keypad. Note that alarm names are limited to 20 characters in length.

**NOTE** Altering the alarm names from those listed on the EZT Configuration sheet provided with the chamber may cause operator confusion when diagnosing alarms. Use discretion when altering tag names.

**9.15 Completing EZT560 Configuration**

Any changes made in the configurator program must be backed up prior to cycling power to the EZT. First, exit the configurator by selecting “Exit” from the “File” menu. DO NOT cycle power to the controller yet. First, manually back up the settings to EEPROM. To do this, you must rotate the small pot on the CPU module.



**Figure 9-19 EEPROM Configuration Back-up**

Gently turn the pot full counterclockwise, then fully clockwise and back counterclockwise again. The small “STAT” LED on the CPU will blink indicating that the configuration has been saved. You can now cycle power to the EZT and allow it to boot up normally.



## **Appendix**

## Common Terms and Definitions

**autotune** — A feature that automatically sets process control PID values to match a particular process in a system.

**baud rate** — The rate of information transfer in serial communications, measured in bits per second.

**accuracy** — Closeness between the value indicated by a measuring instrument and a physical constant or known standard.

**offset** — An adjustment to eliminate the difference between the indicated value and the actual process value.

**cascade** — Control algorithm in which the output of one control loop provides the set point for another loop. The second loop, in turn, determines the control action.

**derivative control (D)** — The last term in the PID control algorithm. Action that anticipates the rate of change of the process, and compensates to minimize overshoot and undershoot. Derivative control is an instantaneous change of the control output in the same direction as the proportional error. This is caused by a change in the process variable (PV) that decreases over the time of the derivative (TD). The TD is in units of seconds.

**droop** — In proportional controllers, the difference between set point and actual value after the system stabilizes.

**EIA** — See Electronics Industries of America.

**EIA/TIA -232 and -485** — Data communications standards set by the Electronic Industries of America and Telecommunications Industry Association. Formerly referred to as RS- (Recognized Standard).

**Electronics Industries of America (EIA)** — An association in the US that establishes standards for electronics and data communications.

**fuzzy logic** — A mathematical control algorithm that monitors past response of a system to predict future response and automatically adjust PID parameters in order to adapt to process.

**hysteresis** — A change in the process variable required to re-energize the control or alarm output. Sometimes called switching differential.

**integral control (I)** — Control action that automatically eliminates offset, or droop, between set point and actual process temperature.

**limit or limit controller** — A highly reliable, discrete safety device (redundant to the primary controller) that monitors and limits the temperature of the process, or a point in the process. When temperature exceeds or falls below the limit set point, the limit controller interrupts power through the load circuit. A limit controller can protect equipment and people when it is correctly installed with its own power supply, power lines, switch and sensor.

**Modbus™** — A digital communications protocol owned by AEG Schneider Automation for industrial computer networks.

**Modbus™ RTU** — Remote Terminal Unit, an individual Modbus™-capable device on a network.

**overshoot** — The amount by which a process variable exceeds the set point before it stabilizes.

## **Common Terms and Definitions (cont'd)**

**PID** — Proportional, integral, derivative. A control mode with three functions: proportional action dampens the system response, integral corrects for droop, and derivative prevents overshoot and undershoot.

**process variable (PV)**— The parameter that is controlled or measured. Typical examples are temperature, relative humidity, altitude, etc. The high process variable is the highest value of the process range, expressed in engineering units. The low process variable is the lowest value of the process range.

**proportional control (P)**— Output effort proportional to the error from set point. For example, if the proportional band is 20° and the process is 10° below set point, the heat proportioned effort is 50 percent.

**ramp** — A programmed increase in the temperature of a set point system.

**range** — The area between two limits in which a quantity or value is measured. It is usually described in terms of lower and upper limits.

**(RTD) resistance temperature detector** — A sensor that uses the resistance temperature characteristic to measure temperature.

**serial communications** — A method of transmitting information between devices by sending all bits serially over a single communication channel.

**set point (SP)** — The desired value programmed into a controller. For example, the temperature at which a system is to be maintained.

**(T/C) thermocouple** — A temperature sensing device made by joining two dissimilar metals. This junction produces an electrical voltage in proportion to the difference in temperature between the hot junction (sensing junction) and the lead wire connection to the instrument (cold junction).

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