Half Cube™
Model 105A
Temperature Chamber
With F4 Controller and EZ-Zone Limit Controller

Operation and Service Manual

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Chapter 1 – Safety Instructions

Introduction

Follow all CAUTION notices to prevent damage to the chamber or your test sample. Failure to follow all CAUTION notices may void your warranty. CAUTION may also indicate a potentially hazardous situation which, if not avoided, may result in minor or moderate personal injury.

WARNING indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

The safety alert symbol ⚠ precedes a general CAUTION or WARNING statement.

The electrical hazard symbol ⚠ precedes an electric shock hazard CAUTION or WARNING statement.

Installation Safety Notices

⚠ **WARNING:** The power cord is equipped with a NEMA 5-15P grounded/polarized plug. To prevent a shock hazard, DO NOT defeat the ground or polarization feature. This device MUST be plugged into a properly grounded and polarized outlet.

⚠ **CAUTION:** The minimum clearance you should allow for proper ventilation must be at least 12" from the rear of the chamber.

⚠ **CAUTION:** This chamber is designed for operation in a conditioned laboratory environment. Operation above 30°C (85°F) or below 16°C (60°F) ambient room temperature is NOT recommended.

Operation Safety Notices

⚠ **CAUTION:** The "Series F4 User's Manual" is a general manual and is written by the manufacturer, Watlow, for a wide variety of applications and configurations. Not all features or functions are applicable. Only the capabilities of a model F4SH-CKA6-01, as described on page A.7 of the "Series F4 User's Manual" are applicable. The "Retransmit" function is available as an option.

⚠ **CAUTION:** The Series F4 Temperature Controller has been properly configured by TestEquity to match the chamber's system requirements and to perform optimally over a wide range of operating conditions. Improper modifications to these setup values can result in erratic performance and unreliable operation. Setup examples in the "Series F4 User's Manual" are NOT applicable to this chamber. Do not attempt to modify the setup values, unless you thoroughly understand what you are doing. If there is any doubt, please call TestEquity before proceeding.

⚠ **CAUTION:** NEVER select "Full Defaults" in the Series F4 Controller's Factory/Test Menu. This will erase all the correct values which are documented in the "Series F4 Temperature Controller Setup Parameters" section of this manual.

⚠ **CAUTION:** The Series F4 Temperature Controller "Alarm 1" function is NOT used in the chamber's safety system and is NOT connected. The independent Series SD Limit Controller functions as the main protection device.

⚠ **CAUTION:** The Series F4 Temperature Controller "Alarm 2" is configured to lock the refrigeration control system in "full cooling" mode at temperatures below –35°C. Alarm 2 is named FACTORYSET. This alarm setting must NOT be changed under any circumstances!

⚠ **CAUTION:** Always verify that the EZ Zone Limit Controller settings for high and low limits are set to temperatures that are appropriate for your test sample.

⚠ **WARNING:** Do NOT put items in the chamber that could burn or explode at high temperatures. This chamber uses open wire heating elements which generate surface temperatures over 1000ºF. This is NOT an explosion-proof chamber.

⚠ **WARNING:** Do NOT put items in the chamber that can emit corrosive vapors or substances.

⚠ **WARNING:** This chamber is NOT a curing oven. There are NO provisions for venting fumes.

⚠ **WARNING:** The chamber door must remain closed while the chamber is operating. If you need to open the door while the chamber is operating, wear safety goggles to prevent the high velocity airflow from blowing particles or objects into your eyes.

⚠ **WARNING:** This chamber operates at extreme temperatures. Avoid contact with air, objects, and surfaces that are hot or cold to prevent severe burns or frostbite. Protective gloves are recommended.

⚠ **CAUTION:** If your test sample is energized, it may be capable of raising the workspace temperature beyond safe limits. This could occur if your test sample exceeds the live load rating of the chamber or if the chamber's refrigeration system fails. You are responsible for providing thermal protection devices to your test sample.

⚠ **CAUTION:** To prevent damage to your test sample and the chamber's compressor, do not exceed the live load rating of the chamber.

Chapter 2 – Installation

Unpacking

Inspect the shipping container for any signs of visible damage. Notify the carrier and TestEquity immediately if there are signs of shipping damage.

1. Cut the bands that hold the packaging together.
2. Remove the top cover and top foam inserts.
3. Remove the outer box.
4. Carefully lift the chamber off the pallet. This should be done with at least two people.

Preparation For Use

1. Inspect the chamber for signs of shipping damage.
2. Read this entire manual.
3. Select a suitable location to install the chamber.
4. Connect to a 120 VAC, 60 Hz power source with a minimum 15 Amp breaker.
5. Perform following the procedure "How to verify the chamber performance" in the Maintenance chapter of this manual to make sure that no damage has occurred in shipment.

Installation Location

The chamber will produce a moderate amount of heat during normal operation. Locate the chamber in an area with adequate ventilation to prevent excessive heat build-up. The chamber must be on a solid and level surface that is rated to hold at least 100 pounds.

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⚠ **CAUTION:** The minimum clearance you should allow for proper ventilation must be at least 12" from the rear of the chamber.

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Reversible Chamber Door

The chamber door can be mounted to open from the left or right side. The chamber cabinet has mounting holes on both sides for the hinges and door latch. If you reverse the door, see "How to inspect the door seal" in the Maintenance chapter of this manual to make sure the hinges and door latch are adjusted correctly.

Chapter 3 – Operation

Introduction

The Front Panel Switches control power to the temperature controller and all chamber functions.

The Temperature Controller controls the temperature of the chamber. The Temperature Controller automatically turns the refrigeration system on or off as required based on the deviation from temperature set point.

Summary of Chamber Operation

1. Turn the POWER Switch ON.
2. Enter the desired temperature set point on the Temperature Controller.
3. Load your test sample in the chamber.
4. Turn the TEMP Switch ON.

Front Panel Switches

POWER Switch

The POWER Switch controls power to the entire chamber. The POWER Switch illuminates when it is ON.

TEMP Switch

The TEMP Switch enables all chamber functions. When the TEMP Switch is OFF and the Power Switch is ON, only the Temperature Controller is operational. When both the TEMP and POWER Switches are ON, the chamber's temperature conditioning system will function to maintain the temperature set point. The TEMP Switch illuminates when it is ON.

Loading the Chamber

⚠ **WARNING:** Do NOT put items in the chamber that could burn or explode at high temperatures. This chamber uses open wire heating elements that generate surface temperatures over 1000ºF. This is NOT an explosion-proof chamber.

⚠ **WARNING:** Do NOT put items in the chamber that can emit corrosive vapors or substances.

⚠ **WARNING:** This chamber is NOT a curing oven. There are NO provisions for venting fumes.

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⚠ **CAUTION:** To prevent damage to your test sample and the chamber's compressor, do not exceed the live load rating of the chamber.

Live Load Capacity						
Temp	**+23°C**	**0°C**	**–10°C**	**–20°C**	**–30°C**	**–40°C**
Watts	200 W	175 W	165 W	145 W	90 W	10 W

Performance Considerations

The performance of all chambers is significantly affected by the characteristics of your test sample. Factors include size, weight, material, shape, and power dissipation if energized. The test sample should be placed in the chamber in a manner that allows for air circulation. The air plenum is located on the back wall of the chamber, where air is sucked in from the bottom and exits from the top. You should not place the test sample directly on the chamber floor. It should be placed on the shelf. Multiple test samples should be distributed throughout the chamber to ensure even airflow and minimize temperature gradients. If necessary, an additional shelf should be used to evenly distribute the load. Verify that the temperature gradients are within acceptable limits, by measuring the chamber temperature at strategic points using a multipoint thermocouple meter or datalogger.

You may find that the temperature throughout the chamber is even, but always different from what the temperature controller indicates. The correct way to adjust what the temperature controller "displays" compared to what is measured at some point other than the controller's sensor is with the "Calibration Offset" parameter. See page 6.2 of the "Series F4 User's Manual" for details.

Avoiding Moisture

Any time the ambient air is subjected to temperatures below the dewpoint, moisture will condense out of the air. The effect is ice or frost during low temperature operation. When the chamber is heated above 0°C, the ice or frost will turn into water.

To avoid moisture condensation, make sure the port plugs are inserted at all times. Also, avoid opening the chamber door while the chamber is operating at temperatures below room ambient. When a low temperature test is completed, warm the chamber to at least room ambient before opening the chamber door and before removing your test sample.

Internal Test Fixtures

Some applications require internal fixtures to support test samples and provide a convenient method of connecting wires and sensors. Fixtures must be designed to minimize their impact on chamber functionality and performance.

Fixtures should be designed for easy removal to permit maintenance and cleaning of the chamber. The chamber liner should never be drilled or screwed into. This will compromise the integrity of the liner and permit moisture migration due to condensation into the insulation, which will eventually impact performance and lead to premature rusting of the outer cabinet.

Fixtures should be constructed of stainless steel. This also applies to all screws and fasteners. All welds should be passivated. To prevent rust and corrosion, never use iron or mild steel even if it is painted or plated. Aluminum may be used. However, since the specific heat of aluminum is double that of steel, it represents a greater load and will have more impact on the chamber performance.

Make sure that all connectors, wiring, pc boards, and auxiliary components can withstand the temperature extremes that they will be subjected to. In some cases, these components may not be able to last after repeated tests and should be considered expendable.

Chapter 4 – Temperature Controller

Introduction

The Series F4 Temperature Controller can function as either a single set point controller (static mode) or as a programmable profile controller. A four-line LCD display facilitates setup and programming, and presents informative messages about status, error, and alarm conditions. Digital outputs, profiles, and alarms can be named for easy reference. An Information Key gives you quick information about the pages, menus, parameters and values, as well as error and alarm conditions if they occur. The user-interface is organized into five "pages" of menus.

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⚠ **CAUTION:** NEVER select "Full Defaults" in the Series F4 Controller's Factory/Test Menu. This will erase all the correct values which are documented in the "Series F4 Temperature Controller Setup Parameters" section of this manual.

⚠ **CAUTION:** The Series F4 Temperature Controller "Alarm 1" function is NOT used in the chamber's safety system and is NOT connected. The independent EZ Zone Limit Controller functions as the main protection device.

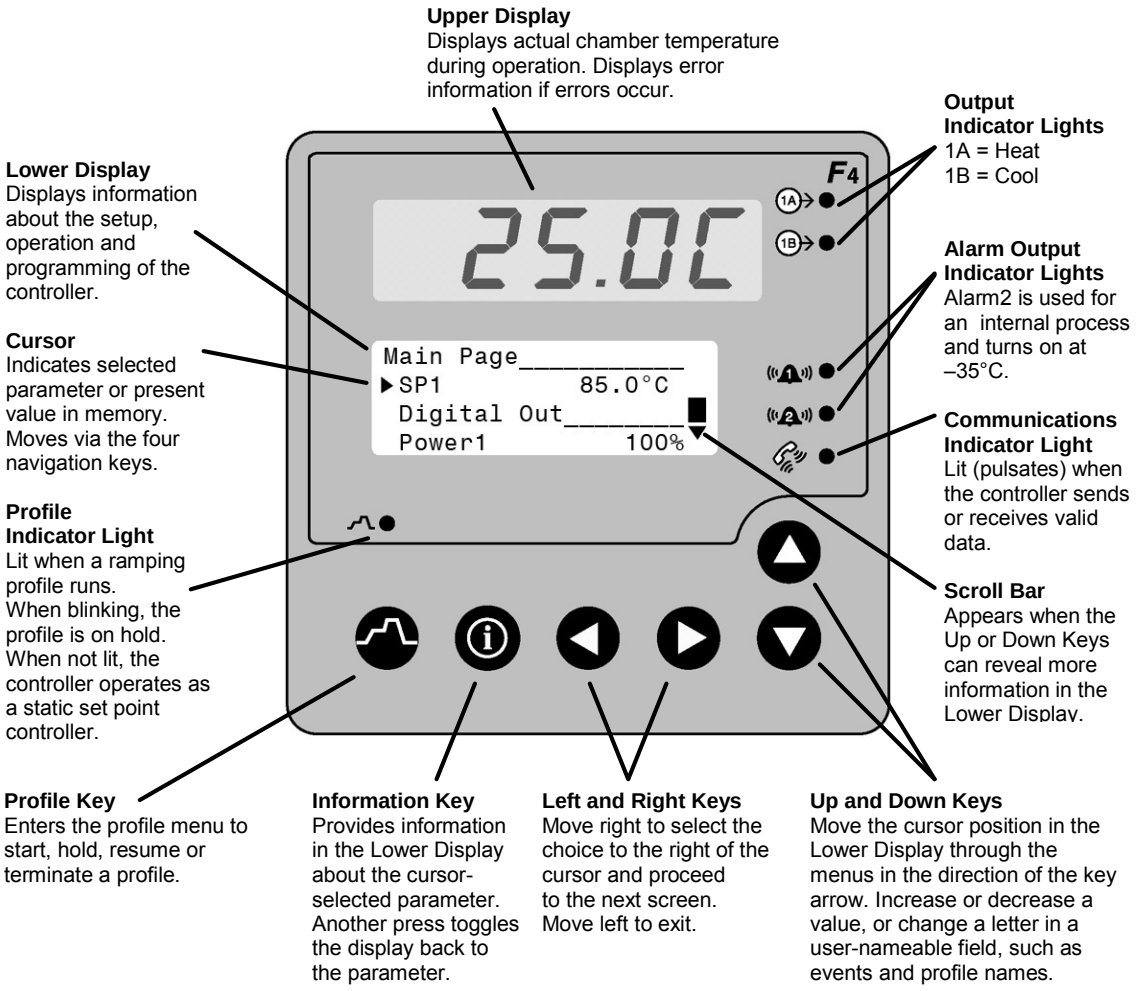
⚠ **CAUTION:** The Series F4 Temperature Controller "Alarm 2" is configured to lock the refrigeration control system in "full cooling" mode at temperatures below –35°C. Alarm 2 is named FACTORYSET. This alarm setting must NOT be changed under any circumstances!

Security Features

The Series F4 Controller has several levels of security to prevent unauthorized users from changing critical configuration parameters. Only the Set Point and Profile menus have "Full Access". TestEquity has configured all other menus to "Password", and have protected them with a password.

TestEquity does not recommend that these security levels be changed for most applications. However, there will be times when entry into these menus is necessary. For example, you may need to gain access to Setup Page in order to change from °C to °F display, or to change the time or date. You must call TestEquity at 877-512-3457 or 805-480-0638 to obtain the password.

Temperature Controller Keys and Displays



Temperature Controller Keys and Displays

To navigate through the menus:

1. Use the ▲ or ▼ key to move the cursor to line up with the item to be selected in a menu on the lower display.
2. Press the ► key to select the item.
3. Enter or change the value, or make a choice with the ▲ or ▼ key.
4. Press the ► key to enter the value or choice.
5. Repeat until you return to the original list.

The ► key again saves the value and proceeds to the next parameter in the series.
The ◄ key saves the value and backs out of the series, and returns to the Main Page.

To edit a parameter, proceed through the series using the ► key without changing values until you find the parameter you want to change. After making the change with the with the ▲ or ▼ key, you may back using the ◄ key out or proceed using the ► key to the end of the series.

Main Page

The Main Page displays manual operating parameters, running program parameters and error messages. It also provides access to the Operations, Profiles, Setup and Factory pages. The following is a list of Main Page parameters and the description of their functions.

Main Page_____	
Current File	Displayed if running a profile, the name of the profile.
Current Step	Displayed if running a profile, the current step of the profile.
► SP1	Static (manual) temperature set point entry. If running a profile, the current set point.
Step Type	Displayed if running a profile, the type of step.
Target SP1	Displayed if running a profile, the target temperature during a ramp step.
WaitFor Status	Displayed if running a profile, the status during a WaitFor step.
Jump Count	Displayed if running a profile, the number of jumps completed.
Time Remaining	Displayed if running a profile, the remaining time of the current step.
DigitalOut	Status of the event outputs 1 to 8. An "8" indicates when cooling system is ON.
Power1	The % of throttle of the heat (positive number) or cool (negative number) output.
Date	Real-time clock date.
Time	Real-time clock time.
TESTEQUITY 105A	Identifies the chamber model number.
Go to Operations	Access to Operations Page
Go to Profiles	Access to Profiles Page
Go to Setup	Access to Setup Page. Not displayed if running a profile.
Go to Factory	Access to Factory Page. Not displayed if running a profile.

Static Set Point Control

The Temperature Controller is in Static Mode when it is not controlling a Profile. When in a Static Mode, the Profile Indicator Light is off (see Fig. 4.1). The Upper Display shows the actual chamber workspace temperature. The Static Set Point (SP1) prompt is accessed from the Main Page.

To enter a Static Set Point:

Press the ▲or ▼ key to position the Cursor next to the SP1 prompt. You may already be at this prompt.

Press the ► key once. You will see Static Set Point1 in the lower display with the current set point indicated below.

Press the ▲or ▼ key to change the temperature set point value.

Press the ► key once to enter the new temperature set point. You are now back to the Main Page.

Main Page_____ ► SP1 85.0°C DigitalOut_____ ▐ Power1 50% ▼	Static Set Point1:____ 85.0 °C ▲ ▼ Adjusts Value ◄ Back ► Next

Profile Programming

The Series F4 Temperature Controller can be programmed to store up to 256 steps into as many as 10 profiles. You do not need a computer to enter a profile – it can be easily done through the controller's front panel keys. A Profile is a set of instructions programmed as a sequence of steps. The controller handles the profile steps automatically, in sequence. As many as 40 different profiles and a total of 256 steps can be stored in non-volatile memory. The 256 steps are grouped by profile. So, one profile could have 256 steps; or 39 profiles could have 6 steps and one could have 22; or 32 profiles could have eight steps each. The maximum number of steps is 256, and the maximum number of profiles is 40.

Step Types

Use the six available step types – Autostart, Ramp Time, Ramp Rate, Soak, Jump and End – to create simple or complex profiles involving all inputs and outputs. The Series F4 prompts you to define each step's properties.

Autostart Step

The use of an Autostart step in a profile is optional. Autostart pauses a profile until the specified date or day, and time (of a 24-hour-clock). Define the Autostart by choosing:

- Day (of the week) or Date,
- Time

To invoke an Autostart step in a profile, you must activate the profile via the Profile Key and select the Autostart step.

Ramp Time Step

Ramp Time changes the set point to a new value in a chosen period of time. Define the Ramp Time step by choosing:

- *Wait for an event or process value
- Event outputs 1 through 7 to turn ON or OFF (For controlling the power to remote devices.)
- Time (in hours, minutes and seconds)
- Temperature Set Point
- PID set (One of five sets of PID tuning parameters. Normally, just leave at PID Set 1.)
- **Guaranteed Soak

Ramp Rate Step

Ramp Rate changes the set point to a new value in a chosen rate of time. Define the Ramp Rate step by choosing:

- *Wait for an event or process value
- Event outputs 1 through 7 to turn ON or OFF (For controlling the power to remote devices.)
- Rate (in degrees per minute)
- Temperature Set Point
- PID set (One of five sets of PID tuning parameters. Normally, just leave at PID Set 1.)
- **Guaranteed Soak

Soak Step
Soak maintains the set point from the previous step for a chosen time in hours, minutes and seconds. Define the Soak step by choosing:

- *Wait for an event or process value
- Event outputs 1 through 7 to turn ON or OFF (For controlling the power to remote devices.)
- Time
- PID set (One of five sets of PID tuning parameters. Normally, just leave at PID Set 1.)
- **Guaranteed Soak

Jump Step
Jump initiates another step or profile. Define the Jump step by choosing:

- Profile to jump to;
- Step to jump to; and
- Number of Repeats

NOTE: If a power-out condition occurs during a profile and more than 20 jump steps are stored in the F4's Profile Program memory, the controller will terminate the profile and turn off all outputs if Continue, Hold or Terminate was selected as the Power Out action. If Profile Reset or Go to Idle Set Point was selected, the controller will take those actions. A pop-up message will warn of this when the 21st jump step is programmed

End Step
End terminates the profile in a chosen state. All profiles must have an End step. It cannot be deleted or changed to another step type. Define the End by choosing Hold, Control Off, All Off or Idle end state.

NOTE: TestEquity recommends having the end step type to be Hold or Idle. TestEquity does NOT recommend using an end step type of Control Off or All Off. This does not turn off the chamber fan. The chamber temperature can reach +55°C just from heat generated by the fan, or even higher if your test sample is energized.

***Wait For step option**
The use of Wait For in a profile is optional. Ramp Time, Ramp Rate and Soak steps can be programmed to wait for a particular chamber temperature or event input condition. The wait conditions must be satisfied before the time clock and the step activity proceeds. Digital inputs must first be configured in the System Menu as Wait For Events, with the condition to be met also specified. Then, to wait for this digital input, you must specify On, meaning the condition as configured in the Setup Page, or Off, meaning the opposite of that condition. The digital inputs have been configured to Off by TestEquity, so this option will not show unless reconfigured.

****Guaranteed Soak step option**
The use of Guaranteed Soak in a profile is optional. The Guaranteed Soak step requires the chamber temperature to be at the set point temperature, within the Guaranteed Soak Band value, before the time clock and the step activity proceeds. The Guaranteed Soak Band is configured by TestEquity for 3.0°C, and this can be changed in the System Menu.

How to Program a New Profile

Go to the Profiles Page.
Move the cursor down the Main Page to `Go to Profiles`, then press the ► key.
	`Main Page_____`
	`► Go to Profiles ▲`
	`  Go to Setup  ▐`
	`  Go to Factory ▼`

Create a new Profile.
The cursor will be on `Create Profile`. Press the ► key.
	`Main>Profile_____`
	`► Create Profile`
	`  Edit Profile  ▐`
	`  Delete Profile ▼`

Name the profile.
You can name your profiles for easy reference if desired. Names can have up to 10 characters. You can also use one of the default profile names (ex. Profile1), and skip this step. To name a profile:
• Press ► to enter the name space and the first position.
• Press the ▲or ▼ to scroll through the alphabet and stop at the letter or number desired.
• Press ► to move to the next position.
• Continue until the name is complete, or until you move through the name space into the next screen.
• Press ► to save the name of the profile.
	`Choose to Name:_____`
	`  No`
	`► Yes`
	
	`Enter Profile Name:_`
	`PROFILE1`
	`  ▲`
	`  ▼ Adjusts Char`
	`  ◄► Save Changes`

Choose the step type.
• There are five step types, each of which must be defined through different parameters. (See "Step Types," earlier in this chapter.)
	`Choose Step1 Type:____`
	`  Autostart`
	`► Ramp Time  ▐`
	`  Soak  ▼`

Define each step type.
• The Series F4 prompts you to define the parameters of each step type. (See "Step Types," earlier in this chapter.)
 	
(Not all choices are shown in this example)
	`Choose to wait:_____`
	`► Step does not wait`
	`  Step waits for...`
	
	`Choose DIGIT OUT1:____`
	`► Off`
	`  On`
	
	`Enter Ramp Time:_____`
	`00:00:01  (H:M:S)`
	`  ▲`
	`  ▼ Adjusts Digit`
	`  ◄► Save Changes`
	
	`Enter Ch1 SP:_____`
	`  85.0 °C`
	`  ▲`
	`  ▼ Adjusts Value`
	`  ◄ Back  ► Next`

Choose the end-state.
• All profiles end with an End step, which is preprogrammed into the new profile. (See "End Step," earlier in this chapter.)
	`Choose End State:_____`
	`  Control Off  ▲`
	`  All Off  ▐`
	`► Idle`

Save your settings.
• Press ◄ to exit the Profiles Page.
• After exiting the Profiles Page, choose ▲ to save profile data.
	`Save profile data`
	`or restore values?`
	`▼ Restore  ▲ Save`

Programming Hints

- The first step in a program should be an initialization step of 1-second, usually at a set point of +23°C.
- The next to last step establishes a condition to end on. For example, you may want to end the program by holding at +23°C, so this step would be to go to +23°C.
- The final step of every profile is End. You cannot delete an End step or change it to another type, but you can insert new steps before it.
- TestEquity recommends having the end step type to be Hold or Idle.
- TestEquity does NOT recommend using an end step type of All Off or Control Off. This does not turn off the chamber fan. The chamber temperature can reach +55°C just from heat generated by the fan, or even higher if your test sample is energized.

Profile Key

The Profile key:

- Initiates the profile mode;
- Initiates the Hold-profile state;
- Initiates the Resume-profile command;
- Initiates the Terminate-profile command.

The Profile Key functions only from the Main Page.

How to Start a Profile

To initiate the profile mode, press the Profile key and answer the questions that follow.

Press the Profile key to enter the Profile Control menu. • The Profile Indicator will begin blinking. • Press the ▲ key for Yes.	Start a Profile? ▼ No ▲ Yes
Select the desired stored profile. • Press the ▲or ▼ to scroll through the list of stored profiles. • Press ► to select the desired profile.	Start Profile:_____ Profile1 ► Profile2 ▐ Profile3 ▼
Select the desired step to start on. • Press the ▲or ▼ to scroll through the list of steps. Generally you would start on Step 1, but you can also start on any other step. • Press ► to select the desired start step and the profile will begin to run. The Profile Indicator will stay lit.	Start:_____ ► Step 1 Ramp Time Step 2 Soak ▐ Step 3 Ramp Time ▼ Main Page_____ ► Profile 2 Running Step 1 ▐ SP1 85.0°C ▼

While running a profile, the Main Page on the lower display will keep you informed about the progress of the profile. Use the ▲or ▼ key to scroll through the list of running profile parameters. You cannot manually change any operating condition while the profile is running.

How to Hold/Resume a Running Profile

To Hold a running profile, press the Profile key to enter the Profile Control menu.
• Then press ▲or ▼ to make your choice for Hold.
• Press ► to select Hold.
• The Main Page will appear with a profile status of Holding. The Profile Indicator will be off.
	Hold Profile:_____
	  Don't Hold
	► Hold
	  Terminate
	
	Main Page_____
	► Profile 2 Holding
	  Step 2 ▐
	  SP1 23.0°C ▼

To Resume profile on hold, press the Profile key to enter the Resume Profile menu.
• Then press ▲or ▼ to make your choice for Resume.
• Press ► to select Resume.
	Resume Profile:_____
	  Continue Holding
	► Resume
	  Terminate

While a profile is on Hold, the current set point can be adjusted at the SP1 prompt on the Main Page. When a profile is resumed during a Ramp step, the controller uses the Static Set Point from the Main Page to calculate the rate of change needed to get to the set point at the end of the step. When a profile is resumed in a soak step, the new set point value will be used as the soak value for the time remaining in the step.

How to Terminate a Running/Holding Profile

Press the Profile key while the profile is running to enter the Resume Control menu.
• Then press ▲or ▼ to make your choice for Terminate.
• Press ► to select Terminate.
	Hold Profile:_____
	  Don't Hold
	  Hold
	► Terminate

If you manually terminate a running profile, the profile ends with a set point of Off. This does not turn off the chamber fan. The chamber temperature can reach +55°C just from heat generated by the fan, or even higher if your test sample is energized.

How to Delete or Re-Name a Profile

Go to the Profiles Page.
Move the cursor down the Main Page to Go to Profiles, then press the ► key.
	Main Page_____
	► Go to Profiles ▲
	  Go to Setup ▐
	  Go to Factory ▼

Choose Delete or Re-Name.
• Press ▲or ▼ to scroll through your choice.
• Press ► to select your choice.
• The controller will prompt you to select the profile you want to delete or re-name.
	Main>Profile_____
	  Edit Profile ▲
	► Delete Profile ▐
	  Re-Name Profile

How to Edit a Profile

Go to the Profiles Page.
Move the cursor down the Main Page to `Go to Profiles`, then press the ► key.
	`Main Page_____`
	`► Go to Profiles`
	`  Go to Setup`
	`  Go to Factory`

Choose Edit Profile.
• Press the ▼ key to choose on `Edit Profile`.
• Then press the ► key.
	`Main>Profile_____`
	`  Create Profile`
	`► Edit Profile`
	`  Delete Profile`

Select the desired stored profile to edit.
• Press the ▲or ▼ to scroll through the list of stored profiles.
• Press ► to select the desired profile.
	`…Edit Profile:_____`
	`  Profile1`
	`► Profile2`
	`  Profile3`

Choose how to edit the step.
• Press the ▲or ▼ to scroll through the list of step edit choices.
• Press ► to select your choice.
	`Choose to:_____`
	`  Insert Step`
	`► Edit Step`
	`  Delete Step`
	`  Done`

To edit a step.
• Press the ▲or ▼ to scroll through the list of steps you want to edit.
• Press ► to scroll through the step parameters and make any desired changes.
	`Edit Step:_____`
	`► Step 1  Ramp Time`
	`  Step 2  Soak`
	`  Step 3  Ramp Time`

To insert a step.
• Choose `Edit Profile` (see step 4 above)
• Press the ▲or ▼ to scroll through the number of the step that the new step will precede.
• Press ► to enter the new step and follow the step parameter prompts.
	`Insert Before:_____`
	`  Step 1  Ramp Time`
	`► Step 2  Soak`
	`  Step 3  Ramp Time`

To delete a step.
• Choose `Delete Step` (see step 4 above)
• Press the ▲or ▼ to scroll through the number of the step you want to delete.
• Press ► to delete the step.
	`Delete Step:_____`
	`  Step 1  Ramp Time`
	`► Step 2  Soak`
	`  Step 3  Ramp Time`

Save your settings.
• Press ◄ successively to exit the Profiles Page.
• After exiting the Profiles Page, choose ▲ to save the new profile values, or ▼ to restore the old values.
	`Save profile data`
	`or restore values?`
	`▼ Restore  ▲ Save`

- Inserting or deleting a step will renumber all steps that follow.
- A Jump Step that jumps to an End Step cannot be deleted.
- An End Step cannot be deleted.
- Inserting a new ramp step usually requires inserting an associated soak step.
- Deleting a ramp step usually requires deleting the associated soak step.

Profile Examples

The following are examples of two typical profiles.

Profile Summary: -40ºC to 85ºC, no ramps, 30 minute soak time, 4 cycles. End with return to +23ºC manual set point.

Step Number	Step Type	Date Day, Time	Wait for	Choose Digit Out 1	2	3	4	5	6	7	Time H:M:S	Rate	Ch1 SP	PID Set	Guar. Soak	Jump to Profile	Step	Repeats	End Type	
1	Ramp Time	—	>	>	>	>	>	>	>	>	00:00:01	—	23.0	1	No	—	—	—	—	
2	Ramp Time	—	>	>	>	>	>	>	>	>	00:00:01	—	-40.0	1	No	—	—	—	—	
3	Soak	—	>	>	>	>	>	>	>	>	00:30:00	—	—	1	Yes	—	—	—	—	
4	Ramp Time	—	>	>	>	>	>	>	>	>	00:00:01	—	85.0	1	No	—	—	—	—	
5	Soak	—	>	>	>	>	>	>	>	>	00:30:00	—	—	1	Yes	—	—	—	—	
6	Jump	—	>	>	>	>	>	>	>	>	—	—	—	—	—	Name	2	3	—	
7	End	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	Idle	23.0

Step Description

1 Establishes a recommended initialization step. Goes to +23ºC as quickly as possible.
2 Goes to -40ºC as quickly as possible.
3 Will hold for 30 minutes. Time will not start until chamber reaches -37ºC (within the 3º Guaranteed Soak Band*).
4 Goes to +85ºC as quickly as possible.
5 Will hold for 30 minutes. Time will not start until chamber reaches +82ºC (within the 3º Guaranteed Soak Band*).
6 Jumps back to step 2. Repeats this 3-times, for a total of 4-cycles.
7 End of program. Controller returns to a +23ºC manual set point.. Test sample is remains OFF via Event 1.

Profile Summary: +50ºC to 0ºC, 1ºC/minute ramp, 1 hour soak time, 100 cycles. Test sample turned ON/OFF depending on step. End with return to +23ºC manual set point.

Step Number	Step Type	Date Day, Time	Wait for	Choose Digit Out 1	2	3	4	5	6	7	Time H:M:S	Rate	Ch1 SP	PID Set	Guar. Soak	Jump to Profile	Step	Repeats	End Type	Idle SP
1	Ramp Time	—	>	On	>	>	>	>	>	>	00:00:01	—	23.0	1	No	—	—	—	—	
2	Ramp Rate	—	>	On	>	>	>	>	>	>	—	1.0	50.0	1	No	—	—	—	—	
3	Soak	—	>	On	>	>	>	>	>	>	01:00:00	—	—	1	No	—	—	—	—	
4	Ramp Rate	—	>	Off	>	>	>	>	>	>	—	1.0	0.0	1	No	—	—	—	—	
5	Soak	—	>	Off	>	>	>	>	>	>	01:00:00	—	—	1	No	—	—	—	—	
6	Jump	—	>	>	>	>	>	>	>	>	—	—	—	—	—	Name	2	99	—	
7	Ramp Rate	—	>	Off	>	>	>	>	>	>	—	1.0	23.0	1	No	—	—	—	—	
8	End	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	Idle	23.0

Step Description

1 Establishes a recommended initialization step. Goes to +23ºC as quickly as possible. Test sample is turned ON via Event 1.
2 Goes to +50ºC at a controlled rate of 1ºC per minute. Test sample is turned ON via Event 1.
3 Will hold for 1 hour. Test sample remains ON via Event 1.
4 Goes to 0ºC at a controlled rate of 1ºC per minute. Test sample is turned OFF via Event 1.
5 Will hold for 1 hour. Test sample remains OFF via Event 1.
6 Jumps back to step 2. Repeats this 3-times, for a total of 4-cycles.
7 After all cycles are completed, establishes the condition to end on. Goes to +23ºC at a controlled rate of 1ºC per minute. Test sample is turned OFF via Event 1.
8 End of program. Controller returns to a +23ºC manual set point.. Test sample is remains OFF via Event 1.

Notes

* Guaranteed Soak Band is set at the factory for 3.0ºC. Can be changed in the System Menu.
> Means no entry or selection is required. Just scroll through this prompt to the next prompt.
— Means prompt does not show for this step type.

Operations Page

The Operations Page provides access to menus for control tuning (PID) and controller alarms. TestEquity has configured the security to require a password for access to all parameters in the Operations Page. You must call TestEquity at 877-512-3457 or 805-480-0638 to obtain the password.

⚠ **CAUTION:** The Series F4 Temperature Controller "Alarm 1" function is NOT used in the chamber's safety system and is NOT connected. The independent EZ Zone Limit Controller functions as the main protection device.

⚠ **CAUTION:** The Series F4 Temperature Controller "Alarm 2" is configured to lock the refrigeration control system in "full cooling" mode at temperatures below –35°C. Alarm 2 is named FACTORYSET. This alarm setting must NOT be changed under any circumstances!

⚠ **CAUTION:** The Series F4 Temperature Controller PID values have been properly configured by TestEquity to match the chamber's system requirements and to perform optimally over a wide range of operating conditions. Improper modifications to these values can result in erratic performance and unreliable operation. Do not attempt to modify the PID values, unless you thoroughly understand what you are doing. Setup examples in the "Series F4 User's Manual" are NOT applicable to this chamber. If there is any doubt, please call TestEquity before proceeding. The correct values are documented in the "Series F4 Temperature Controller Setup Parameters" section of this manual.

⚠ **CAUTION:** The Autotune PID function is not appropriate for use in this chamber. Using this function will result in tuning values that will not work correctly.

Setup Page

The Setup Page provides access to menus for configuring the controller hardware. TestEquity has configured the security to require a password for access to the Setup Page. However, there will be times when entry into these menus is necessary. For example, you may need to gain access to Setup Page in order to change from °C to °F display, or to change the time or date. You must call TestEquity at 877-512-3457 or 805-480-0638 to obtain the password.

⚠ **CAUTION:** The Series F4 Temperature Controller setup values have been properly configured by TestEquity to match the chamber's system requirements and to perform optimally over a wide range of operating conditions. Improper modifications to these values can result in erratic performance and unreliable operation. Do not attempt to modify the setup values, unless you thoroughly understand what you are doing. Setup examples in the "Series F4 User's Manual" are NOT applicable to this chamber. If there is any doubt, please call TestEquity before proceeding. The correct values are documented in the "Series F4 Temperature Controller Setup Parameters" section of this manual.

Factory Page

The Factory Page provides access to menus for controller diagnostics and calibration. TestEquity has configured the security to require a password for access to the Setup Page. However, there will be times when entry into these menus is necessary. For example, you may need to gain access to Factory Page in order to perform a calibration, or to change the security password. You must call TestEquity at 877-512-3457 or 805-480-0638 to obtain the password.

⚠ **CAUTION:** NEVER select "Full Defaults" in the Factory/Test Menu. This will erase all the correct values which are documented in the "Series F4 Temperature Controller Setup Parameters" section of this manual.

Computer Interface

⚠ **CAUTION:** Every setting in the F4 Controller can be accessed via the computer interface. Improper modifications to configuration settings can result in erratic performance and unreliable operation. Setup examples in the "Series F4 User's Manual" are NOT applicable to this chamber. The correct values are documented in the "Series F4 Temperature Controller Setup Parameters" section of this manual.

RS-232C

The F4 Temperature Controller has an RS-232C interface. A DB-9 connector is located on the rear panel. It is wired to accommodate a null-modem cable. To communicate with the controller from a PC, you need to run software that uses the Modbus RTU protocol. Each controller function has a "register" number which can be read or written to (when applicable). These registers are listed Chapter Seven of the "Series F4 User's Manual". RS-232C Modbus programming resources and LabVIEW drivers can be downloaded from http://chamber.testequity.com/rs232.html .

Common Modbus Registers

- The actual chamber temperature reading is Modbus register 100 (Input 1 Value).
- The static temperature set point is Modbus register 300 (Set Point 1).
- The temperature set point during a profile is Modbus register 4122 (Set Point 1, Current Profile Status).
- The decimal points are implied. For example, 1005 is actually 100.5 and -230 is -23.0.

GPIB (optional)

The optional GPIB interface, model TE-1052, consists of an external converter box that connects to the chamber's RS-232C interface. GPIB programming resources and LabVIEW drivers can be downloaded from http://chamber.testequity.com/gpib.html .

Ethernet (optional)

The optional Ethernet interface, model TE-1055, consists of an external converter box that connects to the chamber's RS-232C interface.

Digital Event Outputs

The Temperature Controller has digital outputs which can be configured as Event Outputs to turn remote devices on and off. There are seven Event Outputs which are available for customer use. Output number eight is configured to control the refrigeration compressors and is not available for customer use. The Event Outputs are accessed from the Main Page.

To control the Event Outputs:

1. Press the ▲or ▼ key to position the Cursor next to the DigitalOut prompt.
2. Press the ► key once. You will see Choose Event Output prompt in the lower display.
3. Press the ▲or ▼ key to position the Cursor next to the EventOutput prompt which you want to change. You will be able to select from EventOutput1 through EventOutput7.
4. Press the ► key once to select the desired EventOutput. Then, press the ▲or ▼ key to select On or Off.
5. Press the ► key once to return to the Choose Event Output prompt.
6. Press the ◄ key once to return back to the Main Page.

Digital Output Connections

See page 12.9 of the "Series F4 User's Manual" for details on how to connect to the controller's Digital Outputs.

Chapter 5 Limit Controller

Introduction

The EZ-Zone Limit Controller is a protection device. It turns the chamber OFF if the workspace temperature exceeds either a high temperature or low temperature limit. You can set these limits to correspond to the maximum and minimum temperature that your test sample can safely withstand. This provides protection against someone setting the F4 Controller to a temperature that is unsafe for the test sample. It also provides protection in the unlikely event of a chamber system component failure. The Limit Controller has its own temperature sensor (thermocouple) and functions completely independent of the F4 Controller.

This section provides a brief overview on how to operate the Limit Controller. For more detailed instructions, see the "EZ-Zone User's Manual".

⚠ **CAUTION:** The "EZ-Zone User's Manual" is a general manual and is written by the manufacturer, Watlow, for a wide variety of applications and configurations. Not all features or functions are applicable. Only the capabilities of a model PM3L1AJ-AAAABAA are applicable.

⚠ **CAUTION:** The EZ-Zone Limit Controller has been properly configured by TestEquity to match the chamber's system requirements. Improper modifications to these setup values can result in unreliable and unsafe operation. Do not attempt to modify the setup values, unless you thoroughly understand what you are doing. The correct values are documented in the "EZ-Zone Limit Controller Setup Parameters" section of this manual.

⚠ **CAUTION:** Always verify that the Limit Controller's high and low limits are set to temperatures that are appropriate for your test sample.

⚠ **CAUTION:** If your test sample is energized, it may be capable of raising the workspace temperature beyond safe limits. This could occur if your test sample exceeds the live load rating of the chamber or if the chamber's refrigeration system fails. You are responsible for providing thermal protection devices to your test sample.

Limit Controller Keys and Displays

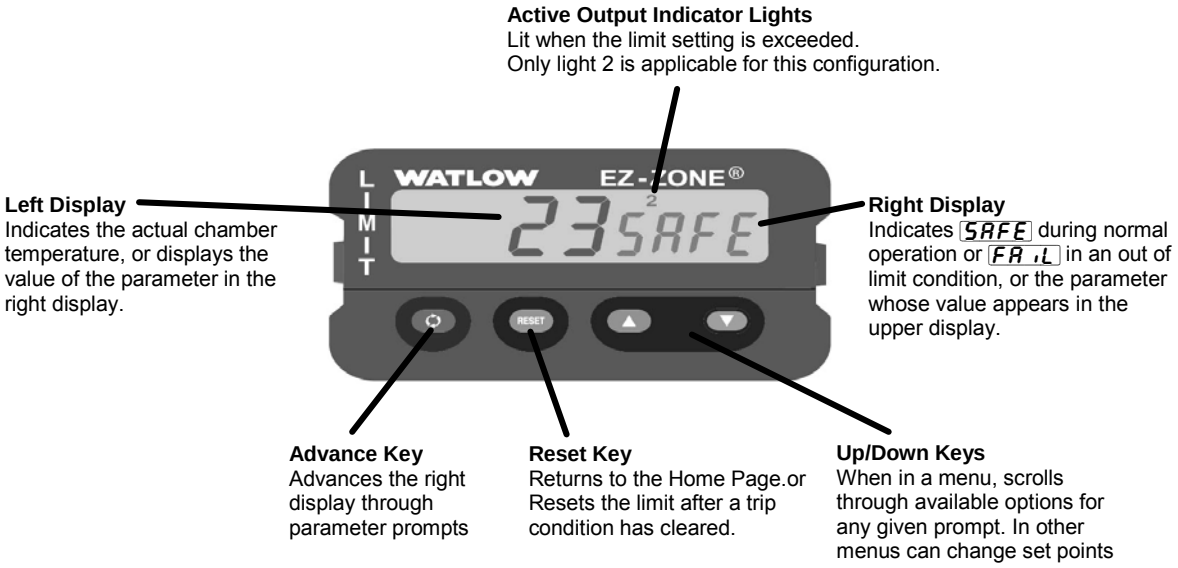


Figure 4.1 – Limit Controller Keys and Displays

How to Set the High and Low Temperature Safety Limits

1. Press the ⟲ key once to get the LLS prompt in the right display. This is the Low Limit Set Point prompt.
2. Press the ▲or ▼ key to enter the desired Low Limit Set Point in the left display. Make sure it is lower than your actual chamber temperature set point, and at least below room temperature to prevent nuisance tripping.
3. Press the ⟲ key once again to get the LHS prompt in the right display. This is the High Limit Set Point prompt.
4. Press the ▲or ▼ key to enter the desired High Limit Set Point in the right display. Make sure it is higher than your actual chamber temperature set point to prevent nuisance tripping.
5. Press the RESET Key to return to the Home Page.
6. The left display will show the actual chamber temperature while the right display will show SAFE as long as the limits are not exceeded.

Resetting an Out of Limit Condition

If the limit is exceeded, the Limit Controller will flash L.H 1 (high limit) or L.L 1 (low limit) in the right display and Atn in the left display, alternating with the actual chamber temperature in the upper display and FA IL in the right display. It will also shut down all chamber functions. The Limit Controller cannot be reset until the temperature returns to within the limit set points. Then, you must press the RESET Key to resume normal operation.

Chapter 6 – Frequently Asked Questions

Why does my chamber heat or cool slower than the published specifications?
Performance is significantly affected by the characteristics of your test sample. Factors include size, weight, material, shape, and power dissipation if energized. The test sample should be placed in the chamber in a manner that allows for air circulation. You should not place the test sample directly on the chamber floor. It should be placed on the shelf. Multiple test samples should be distributed throughout the chamber to ensure even airflow and minimize temperature gradients. If necessary, an additional shelf should be used to evenly distribute the load. You can determine if the chamber is operating properly by following the procedure in "How to verify the chamber performance".

How can I modify the chamber to cool faster or colder?
Unfortunately, there is nothing you can do to improve upon the designed-in performance. TestEquity does NOT recommend using CO_2 or LN_2 in this chamber to achieve colder or faster cooling due to reliability and safety considerations, so it is NOT an available option. Modifying the chamber to add CO_2 or LN_2 will permanently damage the chamber and void the warranty.

Why is there water/ice/snow in the chamber?
Any time the ambient air is subjected to temperatures below the dewpoint, moisture will condense out of the air. The effect is ice or frost during low temperature operation. When the chamber is heated above 0°C, the ice or frost will turn into water. To avoid moisture condensation, make sure the port plugs are inserted at all times. Also, avoid opening the chamber door while the chamber is operating at temperatures below room ambient. When a low temperature test is completed, warm the chamber to at least room ambient before opening the chamber door and before removing your test sample.

My test specification requires convection heat only. Can I turn the circulator motor off?
NO! This will damage the heating and refrigeration systems and void the warranty. You need a "gravity convection oven" for that kind of test.

How accurate is the chamber?
That's a loaded question! There is no "chamber accuracy" specification as such. The answer requires an understanding of several performance parameters.

Control Tolerance – The Temperature Controller uses a thermocouple control sensor, which is located in the intake airflow within the air plenum. Control tolerance is a measure of how much the temperature varies after stabilization at the control sensor. It is a measure of the relative variations, NOT the absolute accuracy of the readout. The control tolerance specification for this chamber is ±0.5°C, or a total of 1°C. For example, the temperature set point may be –10.0°C. The actual temperature varies between –9.9°C and –10.6°C. This corresponds to –0.6°C and +0.1°C or a total of 0.7°C of RELATIVE variations. These specifications are for an empty chamber. The addition of a test sample may effect the control variations. In some instances, the test sample will reduce these variations.

Uniformity – Also known as Gradients. This is a measure of variations in temperature at different locations throughout the chamber interior, at the same time, after stabilization. The uniformity specification for this chamber is ±1.0°C or a total of 2°C, when measured at least 2" away from the chamber interior walls. These specifications are for an empty chamber. The addition of a test sample may affect the temperature uniformity. For example, an energized test sample will produce a higher temperature near the sample.

Controller Accuracy – This is the ability of the temperature controller to accurately display a temperature measurement when compared to a standard. The controller display accuracy is ±1.55°C. However, the total measurement accuracy in the chamber includes the thermocouple sensor wire accuracy. Thermocouple wire accuracy is ±1°C or 0.75% of reading, whichever is greater. Therefore, total system accuracy over the chamber's operating range can be as much as ±2.55°C, although the typical accuracy is often better than ±1.0°C.

Can I operate the chamber on its side?
No, the chamber can only be operated in the upright position. Operating the chamber on its side will cause permanent damage to the refrigeration system and void the warranty.

I'm not going to use the chamber for a while. Is there anything I should do to prepare it for storage?
Perform ALL the steps in the Preventive Maintenance Schedule before placing the chamber into storage. This will ensure that the chamber will be ready to operate when it is taken out of storage. If the chamber has a problem and is still under warranty, these problems should be resolved before being placed into storage, since the warranty period starts from the date of shipment. The chamber should be stored in a conditioned environment. Do not store it outside or where it will be subjected to dirt or excessive moisture.

I haven't used the chamber for a while. Is there anything I should do to prepare it for operation?
Perform ALL the steps in the Preventive Maintenance Schedule before placing the chamber back into service. This will ensure that nothing has been damaged and that a leak has not developed.

Can/Should I put a filter in front of the condenser air inlet?
No, TestEquity does not recommend this. Just follow the maintenance procedures and clean the condenser fins periodically.

How often should I charge the refrigeration system?
This chamber uses a closed-loop refrigeration system. Just like your refrigerator at home, it does not need periodic charging. If the charge is low, this means that there is a leak. Leaks should be repaired before recharging.

What kind of Freon does the chamber use?
The word Freon® is a DuPont registered trade name for their CFC-based refrigerants and is incorrectly used as a generic term for refrigerants. TestEquity chambers do not use CFC-based refrigerants. The system uses R-410A, which is also known as DuPont Suva® 410A.

Chapter 7 – Specifications

Model 105A Chamber Specifications

Temperature Range	–40°C to +130°C
Control Tolerance	±0.5°C, ±0.2°C Typical (Measured at the control sensor after stabilization)
Uniformity	±1.0°C, ±0.5°C Typical (Variations throughout the chamber after stabilization)

Live Load Capacity @	**+23°C**	**0°C**	**–10°C**	**–20°C**	**–30°C**	**–40°C**
(Watts)	200 W	175 W	165 W	145 W	90 W	10 W

Cool Down Transition Time (empty chamber, typical)

	End Temp						
Start Temp to →	**+23°C**	**0°C**	**–10°C**	**–20°C**	**–30°C**	**–35°C**	**–40°C**
+23°C	-----	3 min	5 min	7 min	10 min	13 min	22 min
+85°C	8 min	13 min	15 min	17 min	20 min	23 min	31 min

Heat Up Transition Time (empty chamber, typical)

	End Temp		
Start Temp to →	**+23°C**	**+50°C**	**+85°C**
+23°C	-----	1.5 min	6 min
0°C	2 min	4 min	7.5 min
–20°C	3 min	5 min	8 min
–40°C	4.5 min	7.5 min	11 min

***Note:** Transition times are measured after a 30 minute soak at the start temperature. To calculate rate of change for a particular condition, take the difference between the Start Temp and End Temp and divide by the Transition Time.
Cool Down Example (empty): From +85°C to –20°C = 105°C / 17 min = 6.18°C/min.
Heat Up Example (empty: From -40°C to +85°C = 125°C / 11 min = 11.36°C/min.

Power Requirements	
Input Voltage	120 VAC nominal (110 to 126 VAC), Single Phase, 60 Hz
Current Draw	10 A maximum; Recommended Service 15 A
Workspace Dimensions	12" W x 9" H x 8" D (0.5 cubic feet)
Outside Dimensions	16.5" W x 25" H x 20" D (nominal) Door latch adds 2" to width. Circulator motor housing adds 2" to depth in rear.
Min. Installed Clearance	12" from the rear
Access Ports	2" Port on left and right side (two total), Supplied with foam plugs
Weight	114 pounds

NOTE: Performance is typical and based on operation at 23°C (73°F) ambient and nominal input voltage. This product is designed for use in a normal conditioned laboratory. Operation at higher ambient temperatures will result in decreased cooling performance. Low end limit derates to -38°C when operating above 27°C (80°F) ambient. Operation above 30°C (85°F) or below 16°C (60°F) ambient is not recommended.

F4 Temperature Controller Specifications

Specifications as configured for the TestEquity 105A Chamber

Accuracy & Sensor Conformity*	±1.55°C
Stability	±0.1°C/°C rise in ambient
Digital Inputs	(Four) Contact closure or dc voltage, 10 kΩ impedance
Retransmit Outputs (Optional)	(Two) User-selectable ranges: 0 to 10 VDC, 0 to 5 VDC, 1 to 5 VDC 0 to 20 mA, 4 to 20 mA
Alarm Outputs	(Two) Electromechanical relay; Form C, 2 A @ 20 VDC or 240 VAC max.
Digital Outputs	(7 available for customer use) Open collector output OFF: 42 VDC @ 10 µA max. ON: 0.2 VDC @ 50 mA sink max. Internal supply: 5 VDC @ 80 mA
Communications	EIA-232 and EIA-485 serial communications with Modbus™ RTU protocol
Safety & Agency Approvals	UL/c-UL 916-listed, File #E185611 CE to EN61010 NEMA 4X and IP65 CE EMC to EN50082-2 CE EMC to EN55011
Displays	**Process:** 5, seven-segment red LED. **Interface Display:** 4-line high-definition green LCD; selectable °C or °F
Data Retention	Retention upon power failure via nonvolatile memory (seven years for battery-backed RAM)

***Note:** Total system accuracy in the chamber includes thermocouple wire accuracy. Thermocouple wire accuracy is ±1°C or 0.75% of reading, whichever is greater. Therefore, total system accuracy over the chamber's operating range can be as much as ±2.55°C, although the typical accuracy is often better than ±1.0°C.

Chapter 8 – Maintenance

Preventive Maintenance Schedule

Daily or As Needed

- Clean chamber interior and exterior.
- Listen for abnormal noise or vibration.

Every 6 Months

- Inspect the door seal.
- Clean the condenser.
- Inspect the electrical/refrigeration compartment.
- Verify the chamber performance.

Every 12 Months

- Verify the calibration.

How to clean the chamber interior and exterior

- Wipe or vacuum out all debris.
- Clean surfaces with a damp cloth, mild detergent, or stainless-steel cleaner. Avoid cleaners that are abrasive or leave a residue. NEVER use steel wool.
- If you clean the interior with something other than water, you may want to operate the chamber at high temperature (approximately +85°C) after cleaning. This helps to "bake out" any residue. Remove the port plugs to permit the residual vapors to escape.
- Clean the silicone door gaskets with a damp cloth or mild detergent.
- Clean the exterior painted surfaces with a damp cloth or mild detergent. If you are using a detergent, test a small inconspicuous area to make sure it does not damage the finish.

How to listen for abnormal noise or vibration

You should become familiar with normal operating noises. Being able to recognize changes from normal operating noises can be a valuable way to identify problems and prevent further damage. Examples of noises to be aware of include:

- Circulator motor noise (with compressor off).
- Compressor start-up and running noise.
- Condenser fan noise.
- Valve cycling noise.

How to inspect the door seal

The door and chamber opening have silicone gaskets to minimize thermal losses and moisture migration.

- Inspect the gaskets for dirt and tears.
- Repair minor tears with a high quality RTV silicone such as GE RTV167.
- Check the integrity of the door seal by closing the door on a sheet of paper. With the door closed, slowly pull the paper. You should feel the resistance. Repeat this all around the door at several places.
- If the seal is not tight on the latch side, adjust the latch bracket. The latch bracket is mounted to the chamber, and has slotted holes to permit adjustment.
- If the seal is not tight on the hinge side, adjust the door hinge. The hinges have a slotted hole on the door side to permit adjustment.

How to clean the condenser

1. Unplug the chamber from the power source.
2. Remove the condenser grille from the front of the chamber.
3. Clean the condenser fins with a vacuum cleaner.

NOTE: You may need to clean the condenser more frequently if the chamber is in a dusty environment. You may be able to clean the condenser less frequently if the chamber is in a very clean environment.

How to inspect the electrical/refrigeration compartment

⚠ **WARNING:** Wear safety goggles when inspecting the electrical/refrigeration compartment to protect against a refrigerant line which could break.

1. Unplug the power cord.
2. Remove the top cover.
3. Inspect for signs of refrigeration tubing abrasion.
4. Inspect for oil around refrigeration valves, fittings and joints. This may be a sign of leaks.
5. Inspect for loose hardware and tighten as required.
6. Check for loose wires and burned insulation near terminals.
7. Inspect for signs of insect or rodent infestation. Yes, it does happen!

How to verify the chamber performance

These tests verify the performance of the heating, refrigeration, electrical controls, temperature controller, and air circulation systems. The chamber should meet all published performance specifications if all of these tests are successfully passed.

These tests assume that the Temperature Controller's setup and tuning values have not been changed from the values as shipped from TestEquity. Also, the Limit Controller high limit must be set to over +85°C (+88°C would be fine), and the low limit set to below –37°C.

If the chamber fails any of these tests, it should be removed from service to prevent further damage until the cause of the problem is determined and resolved.

1. The chamber interior should be empty and at ambient temperature, approximately +23°C.
2. Plug the chamber into a 120 VAC outlet. Turn the POWER Switch ON and the TEMP Switch OFF.
3. Set the Temperature Controller Set Point to +85.0°C and turn the TEMP Switch ON.
4. The Temperature Controller's 1A light should be ON continuously and the 1B light should be OFF.
5. The chamber should heat up to about +80°C and begin controlling (1A light cycles ON/OFF) within 5 minutes.
6. The chamber temperature should slowly increase and stabilize to +85°C. It should NOT overshoot beyond +85°C by more than 1.0°C, and the compressor should NOT need to turn ON in order to maintain +85°C.
7. After stabilization, the chamber temperature should vary no more than ±0.5°C, or a total of 1°C.
8. Let the chamber stay at +85°C for 30 minutes.
9. After 30 minutes at +85°C, set the Temperature Controller Set Point to –35.0°C.
10. The Temperature Controller's "DigitalOut" prompt on the lower display should have and "8" to the right of the display. The 1B light should be ON continuously and the 1A light should be OFF. The compressor should also turn ON.
11. The chamber should cool down to about –30°C and begin controlling (1B light cycles ON/OFF) within approximately 23 minutes.
12. The 1B light will ultimately remain OFF and the 1A light should eventually cycle ON/OFF while maintaining –35°C. It should NOT undershoot beyond –35°C by more than 1.0°C, and the compressor should NOT need to turn OFF in order to maintain –35°C.
13. After stabilization, the chamber temperature should vary no more than ±0.5°C, or a total of 1°C.
14. Set the Temperature Controller Set Point to +23°C. The chamber should begin to heat up. The compressor should turn off in 30 seconds.
15. This concludes the chamber performance verification tests.
16. Let the chamber heat up to +23°C before turning the TEMP Switch OFF.

How to verify the calibration

⚠ **CAUTION:** TestEquity does not recommend performing the controller calibration procedures unless you have verified that the controller is actually out of calibration.

TestEquity recommends verifying the calibration before attempting to actually perform a calibration. The microprocessor-based instrumentation used in TestEquity chambers seldom goes out of calibration. If you try to calibrate the instrumentation before determining that calibration is necessary, you may make it worse if done incorrectly.

Variations in temperature throughout the chamber interior are NOT a measurement of accuracy. These variations, called "gradients", are a function of the physical design of the chamber and its airflow, the characteristics of the test sample, and how it is oriented in the chamber. You cannot "calibrate" to improve gradients. The common practice of measuring multiple points in the chamber and adjusting the temperature controller's calibration to correct for these errors is incorrect! The correct way to adjust what the temperature controller "displays" compared to what is measured at some point other than the controller's sensor, is with the "Calibration Offset" parameter. See page 6.2 of the "Series F4 User's Manual" for details. Calibration verification should be performed with the Calibration Offset set to 0.0 (zero).

Total system accuracy in the chamber includes the controller plus the thermocouple wire accuracy. Total system accuracy over the chamber's operating range is typically ±1.55°C, ±1 LSD. The easiest way to verify the instrumentation accuracy is with an independent calibrated temperature sensor and display. Place the sensor inside the chamber, near the chamber's conditioner fan grille. If the readings agree within the specified limits, then no calibration adjustments are necessary.

If calibration of the temperature controller is necessary, refer to page 9.1 of the "Series F4 User's Manual" and follow the instructions for "Thermocouple Input Procedure".

Theory of Operation

Overview

The chamber is heated by a nichrome heater. Cooling is accomplished by a single-stage refrigeration system. The air is circulated by a propeller fan. The heater, evaporator, and fan are located within an air plenum, which is on the back wall of the chamber interior.

Refer to the electrical and refrigeration drawings to identify the items referenced below.

Heating System

The chamber is heated by an open-element nichrome heater (HT1). The heater is located in the air plenum. The temperature controller provides a time-proportioned output to a solid state relay (SSR1). This turns the heater on/off as required to maintain the temperature set point.

A fusible heat limiter (HL) provides failsafe protection against a catastrophic failure by opening the heater circuit at +192°C.

Refrigeration System

Cooling is accomplished by a single-stage refrigeration system. The refrigeration system provides cooling to the chamber interior through a finned evaporator coil, which is located in the air plenum.

The system uses refrigerant R-410A. High pressure liquid refrigerant is fed from the condenser through the liquid line, filter-drier, to the capillary tubes. The capillary tubes feed the finned evaporator coil, which is located in the air plenum where heat is absorbed to provide cooling within the chamber. The capillary tubes reduce the pressure of the refrigerant to the evaporating or low side pressure. The reduction of pressure on the liquid refrigerant causes it to boil or vaporize, absorbing heat which provides a cooling effect. The refrigerant vapor travels through the suction line to the compressor suction inlet. The compressor takes the low pressure vapor and compresses it, increasing both the pressure and the temperature. The hot, high pressure vapor exits the compressor discharge valve and into the condenser. As the high pressure vapor passes through the condenser, it is cooled by a fan, which blows ambient air across the finned condenser surface. The vapor condenses into a liquid and the cycle is repeated.

The temperature controller's cool output cycles the liquid-line solenoid valve (SV1) ON/OFF to control the chamber temperature. When SV1 is ON, liquid refrigerant flows through the main capillary tube to the evaporator, providing full-capacity cooling. When SV1 is OFF, liquid refrigerant flows through a restriction capillary tube before the main capillary tube, providing reduced-capacity cooling. The temperature set point is ultimately controlled by cycling heat against the reduced-capacity cooling, as long as the compressor remains ON.

During a high temperature pulldown, it is possible for excessive hot gas to return to the compressor. The suction line cooling thermostatic expansion valve senses the suction line temperature and injects liquid refrigerant to cool the hot gas within safe limits. At chamber temperatures below –35°C, the F4 controller's Alarm 2 disables the suction cooling expansion valve through SV2, while locking SV1 ON regardless of the controller's cool output status.

Troubleshooting

SYMPTOM	CONDITION	POSSIBLE CAUSES
Chamber does not function.	If POWER and TEMP switches are ON, Limit Controller "2" light is OFF.	a) Relay C1 is defective.
	If POWER and TEMP switches are ON, Limit Controller "2" light is ON.	a) Chamber temperature has exceeded the Alarm limits.
Does not heat up at all.	If controller light 1A is ON, circulator fan is ON.	a) Heat Limiter HL is open. b) Heater HT1 is open. c) Solid State Relay SSR1 is defective. d) Temperature controller is defective.
Heats up too slow.	If temperature controller light 1A is ON. DigitalOut 8 is OFF. Compressor is not running.	a) Chamber interior is overloaded. b) Port plug is not in port. c) Verify that input line voltage measures no less than 110 VAC.
Heat is on all the time.	If temperature controller light 1A is OFF.	a) Solid State Relay SSR1 is defective. b) Temperature controller is defective.
Does not cool at all.	If temperature controller light 1B and DigitalOut 8 are ON. Compressor is running.	a) Refrigerant leak. b) Plugged capillary tube.
	If temperature controller light 1B and DigitalOut 8 are ON. Compressor is not running.	a) Solid State Relay SSR2 is defective. b) Relay C2 is defective. c) Compressor is defective.
	If temperature controller light 1B is ON. DigitalOut 8 is OFF. Compressor is not running.	a) DigitalOut 8 parameters have been changed. Re-enter values as shipped from TestEquity.
Cools too slowly or does not cool down to –40°C.	If temperature controller lights 1B and DigitalOut 8 are ON. Compressor is running.	a) Chamber interior is overloaded. b) Test sample is energized, giving off heat. c) Port plug is not in port. d) Refrigerant leak. e) Solenoid valve SV1 may be defective in closed position. f) Solenoid valve SV2 may be defective in open position. g) F4 Alarm 2 is adjusted too high.
Temperature varies more than ±0.5°C or 1°C total.	If tuning PID control parameters in temperature controller were changed.	a) Re-enter values as shipped from TestEquity.
	If tuning PID control parameters in temperature controller are as shipped from TestEquity.	a) Control parameters may need to be changed for your unique test conditions.
	If tuning PID control parameters in temperature controller are as shipped from TestEquity and only occurs in cool mode.	a) Control parameters may need to be changed for your unique test conditions. b) Solenoid valve SV1 may be defective in open position.
Compressor turns on and off too frequently.	If controller DigitalOut 8 parameters were changed.	a) Re-enter values as shipped from TestEquity.
	If controller DigitalOut 8 parameters are as shipped from TestEquity.	a) Control parameters may need to be changed for your unique test conditions.

Refrigeration System Charging Instructions

⚠ **WARNING:** Repair of the refrigeration system must be performed only by a properly trained mechanic. Do NOT substitute any component. Do NOT substitute refrigerants. Improper repairs will void the warranty.

These instructions are intended as guidelines for repairing TestEquity chambers. Details such as how to attach a gauge manifold are not covered. These are NOT do-it-yourself instructions!

R-410A Charge

The proper charging procedure is as follows:

1. Repair any leaks before recharging. Replace the filter/drier.
2. Evacuate the system to 100 microns. DO NOT GUESS! You must use a micron gauge.
3. Use a charging scale to weigh in 5.5 ounces of R-410A. DO NOT GUESS! You must use a charging scale.
4. Verify the cooling performance as outlined in "How to verify the chamber performance".

Recommended Spare Parts

Replacement parts are available from TestEquity. Parts are generally in-stock and ready for immediate shipment. Next-day delivery is always available. If you cannot risk being out of service for even one day, then you should purchase critical spare parts in advance. Although most parts are standard and available from a variety of local distributors, some parts are either harder to find or custom. The following is a list of the kinds of parts that you may want to purchase in advance.

Electrical Parts
Temperature Controller
Relays
Fuse
Heat Limiter
Circulator Motor and Fan
Switch

Refrigeration Parts
Solenoid Valve
Capillary Tube
Expansion Valve
Condensing Unit

Major Electrical Parts

Description	Mfr	Mfr Part No.	Ref #	Part #	Qty	UOM
Arc Suppressor	ITW Paktron	104M06QC100	AS1, 2	200115	2	ea
Circulator Motor	CUSTOM	200280	FM1	200280	1	ea
Contactor, 1P, 30A	Hartland Controls	HCC-1XT02AA	C1-2	200237	2	ea
Fuse, 3/10A	Bussman	MDL-3/10	F1	200130	1	ea
Heater, Air	CUSTOM	200132	HT1	200132	1	ea
Limit Controller	Watlow	PM3L1AJ-AAAABBT	TCR2	200300	1	ea
Line Cord, 14/3, SJT	Carol	W1950.70.01		200135	1	ea
Relay, SPDT	Omron	G2R-1-T-AC120	CR1	200160	1	ea
Solid State Relay, 10A, 24VDC In	Omron	G3NE-210T-US DC24	SSR1	200177	1	ea
Solid State Relay, 5A	Omron	G3NA-205B-DC5-24	SSR2	200032	1	ea
Switch, SPST, Rocker	Carlingswitch	LRA211-RA-B/125N	SW1, 2	200023	2	ea
Temperature Controller	Watlow	F4SH-CKA0-01AE	TCR1	200001	1	ea

Major Refrigeration Parts

Description	Mfr	Mfr Part No.	Ref #	Part #	Qty	UOM
Accumulator	CUSTOM	CUSTOM	9	100313	1	ea
Capillary Tube, 0.031 x 9 ft.	JB	TC-31	5, 6	100320	2	ea
Condensing Unit	Copeland	M4FL-0033-IAA-017	1	100308	1	ea
Evaporator Coil	CUSTOM	CUSTOM	7	100309	1	ea
Expansion Valve, Suction Cooling	Danfoss	068U2027	8	100314	1	ea
Filter Drier	Danfoss	023Z5048	2	100524	1	ea
Solenoid Valve	Sporlan	E3S123, 1/4 x 1/4 ODM	3	100310	2	ea
Solenoid Valve Coil	Sporlan	MKC-1-120/50-60	4 (SV1, 2)	100011	2	ea

General Parts

Description	Mfr	Mfr Part No.	Ref #	Part #	Qty	UOM
Gasket, Door Side	CUSTOM	300252		300252	1	ea
Door Latch, Chamber Workspace	Southco	A7-10-301-20		300216	1	ea
Fan, Alum, CCW	Air Drive	Grainger 2C954		300282	1	ea
Port Plug, Silicone Foam, 3"	CUSTOM	300374		300374	2	ea
Shelf	CUSTOM	300217		TE-1052	1	ea

Series F4 Temperature Controller Setup Parameters

⚠ **CAUTION:** The "Series F4 User's Manual" is a general manual and is written by the manufacturer, Watlow, for a wide variety of applications and configurations. Not all features or functions are applicable. Only the capabilities of a model F4SH-CKA6-01, as described on page A.7 of the "Series F4 User's Manual" are applicable. The "Retransmit" function is available as an option.

⚠ **CAUTION:** The Series F4 Temperature Controller has been properly configured by TestEquity to match the chamber's system requirements and to perform optimally over a wide range of operating conditions. Improper modifications to these setup values can result in erratic performance and unreliable operation. Setup examples in the "Series F4 User's Manual" are NOT applicable to this chamber. Do not attempt to modify the setup values, unless you thoroughly understand what you are doing. If there is any doubt, please call TestEquity before proceeding.

⚠ **CAUTION:** The alarm outputs of the Temperature Controller are NOT connected to the chamber's safety system. TestEquity does NOT recommend using the Temperature Controller's alarm function as the main protection device.

⚠ **CAUTION:** NEVER select "Full Defaults" in the Factory/Test Menu. "Full Defaults" are NOT the TestEquity configuration parameters for this chamber. If you select "Full Defaults", you must reconfigure all System and Operation Parameters as documented in the TestEquity manual, NOT the "Series F4 User's Manual".

TestEquity has configured the Temperature Controller with the parameters as documented on the following pages.

Series F4 Set Lockout Parameters

The Series F4 Controller has several levels of security to prevent unauthorized users from changing critical configuration parameters. Only the Set Point and Profile menus have "Full Access". TestEquity has configured all other menus to "Password", and have protected them with a password.

TestEquity does not recommend that these security levels be changed for most applications. However, there will be times when "Full Access" is necessary. For example, you may need to gain access to Setup Page in order to change from °C to °F display, or to change the time or date. You must call TestEquity at 877-512-3457 or 805-480-0638 to obtain the password.

Set Lockout Menu
Main Page\Go to Factory\Set Lockout

Set Point	Full Access
Oper. Autotune PID	Password
Oper. Edit PID	Password
Oper. Alarm SP	Password
Profile	Full Access
Setup	Password
Factory	Password

Series F4 System Parameters

System Menu
Main Page\Go to Setup\System

Choose GSB1 Source	Input1
Guaranteed Soak Band 1	3.0 °C (5.4 if °F)
PID Units	US
F or C	C
Show F or C	Yes
Ch1 Autotune SP	90%
Input 1 Fail	0%
Open Loop Ch1	Off
Power Out Time	10 Sec
Power-Out Action	Continue

Analog Input Menu
Main Page\Go to Setup\
Analog Input 1

Choose Sensor	Thermocouple
Type	T
Choose Decimal	0.0
SP Low Limit	-42.0 °C (-43.6 if °F)
SP High Limit	130.0 °C (266.0 if °F)
Calibration Offset	0
Filter Time	1.0 sec
Error Latch	Self-Clear

Digital Input Menu
Main Page\Go to Setup\
Digital Input (1-4)

Name	DIGIT IN (1-4)
Function	Off

Control Output Menu
Main Page\Go to Setup\
Control Output (1A-1B)

\Control Output 1A

Function	Heat
Process Type	Fixed Time
Cycle Time	3.0 sec
Hi Power Limit	100 %
Low Power Limit	0 %

\Control Output 1B

Function	Cool
Process Type	Fixed Time
Cycle Time	10.0 sec
Hi Power Limit	100 %
Low Power Limit	0 %

Alarm Output Menu
Main Page\Go to Setup\
Alarm Output (1, 2)

\Alarm Output 1

Choose to Name	Yes
Name	TEMP ALARM
Type	Process
Source	Input 1
Latching	Alarm Latches
Silencing	Yes
Hysteresis	1.7 °C (3.0 if °F)
Sides	Both
Logic	Open on Alarm
Show Message	Yes on Main Page

\Alarm Output 2

Choose to Name	Yes
Name	FACTORYSET
Alarm Type	Process
Alarm Source	Input 1
Latching	Alarm Self-Clears
Silencing	No
Hysteresis	1.7 °C (3.0 if °F)
Alarm Sides	Low
Alarm Logic	Close on Alarm
Show Message	No

Digital Output Menu
Main Page\Go to Setup\
Digital Output (1-8)

\Digital Output 1 through 7

Name	No
Function	Event Output

\Digital Output 8

Name	No
Function	Compressor
Comp. On % Power	-50%
Comp. Off % Power	70%
Comp. Off Delay	30 sec
Comp. On Delay	10 sec

Communications Menu
Main Page\Go to Setup\
Communications

Baud Rate	9600
Address	1

Custom Main Page Menu
Main Page\Go to Setup\System\
Custom Main Page

P1	Current File
P2	Current Step
P3	Set Point 1
P4	Step Type
P5	Target SP1
P6	Wait For Status
P7	Jump Count
P8	Time Remaining
P9	Digital Outs
P10	% Power 1
P11	Time
P12	Date
P13	Custom Message 1
P14	None
P15	None
P16	None

Static Message Menu
Main Page\Go to Setup
Static Message

Message 1	TESTEQUITY 105A

Series F4 Operations Parameters

PID Set Channel 1 Menu

Main Page\Go to Operations\Edit PID\PID Set Channel 1\
PID Set (1-5)

PID Set 1-5

Prop. Band A	4.0 °C (7.2 if °F)
Reset A	0.30 min
Rate A	0.00 min
Dead Band A	0 °C
Hysteresis	0
Prop. Band B	5.0 °C (9.0 if °F)
Reset B	0.05 min
Rate B	0.00 min
Dead Band B	0
Hysteresis	0

Alarm Setpoints Menu

Main Page\Go to Operations\Alarm Setpoints

TEMP ALARM (See Note 1)

Alarm1 Low SP	-42.0 °C (-43.6 ° if °F)
Alarm1 High SP	130.0 °C (266.0 if °F)

FACTORYSET (See Note 2)

Alarm2 Low SP	-30.0 °C (-22.0 ° if °F)

Note 1: The Alarm1 output of the Temperature Controller is NOT connected to the chamber's safety system. TestEquity does NOT recommend using the Temperature Controller's alarm function as the main protection device.

Note 2: The Alarm2 output of the Temperature Controller is used for an internal process and is not available for customer use.

EZ-Zone Limit Controller Setup Parameters

⚠ **CAUTION:** The EZ-Zone Limit Controller has been properly configured by TestEquity to match the chamber's system requirements. Improper modifications to these setup values can result in erratic performance and unreliable operation. Do not attempt to modify the setup values, unless you thoroughly understand what you are doing. If there is any doubt, please call TestEquity before proceeding.

Setup Menu

Prompt	Function	Setting	Alternate Setting
LoC	Lockout Menu	2	See NOTE 1 below
SEn	Sensor Type	tC	Do Not Change
L in	Linearization	t	Do Not Change
dEC	Decimal	0	Alt. "0.0"
C_F	°C or °F	C	Alt. "F"
r.Lo	Range Low	-44	Do not make any lower
r.h i	Range High	130	Do not make any higher
Fn2	Output 2 Function	L iM7	Do Not Change
L.Sd	Limit Sides	both	Alt. "high" (High only) or "LoW" (Low only)
L.hY	Limit Hysteresis	2	Change not recommended
A.tY	Alarm Type	oFF	Do Not Change
PAr 1	Upper Display	ACPu	Alt. "none"
PAr2	Lower Display	LSt	Alt. "Lh.s" (High Set Point) or "LL.S" (Low Set Point)
Ad.S	Zone Address	1	Not functional for this application

NOTE 1: The Lockout Menu LoC sets the security clearance level as follows:

- 1 Operations Menu, read only
- 2 Operations Menu, set point read/write
- 3 Operations Menu, set point read or write (same as level 2)
- 4 Operations Menu, full access read/write (required to access Calibration Offset below)
- 5 Operations Menu and Setup Menu full access (required to access Setup Menu and Calibration Offset below)

Operations Menu

Prompt	Function	Setting	Alternate Setting
LLS	Low Set Point	-44	Appropriate Low Limit Set Point
LhS	High Set Point	130	Appropriate High Limit Set Point
iCA	Calibration Offset	0	Calibration Offset as required (see NOTE 2 below)

NOTE 2: LoC parameter in Setup Menu must be set for 4 or 5 to access the Calibration Offset parameter.

Chapter 9 – Warranty

TestEquity LLC Limited Warranty

TestEquity LLC (TestEquity) warrants Environmental Chambers (Equipment) manufactured by TestEquity and supplied under this contract to be free from defects in materials and workmanship under normal use and proper maintenance.

TestEquity will repair or replace any defective part for a period of THREE YEARS from the date of invoice. TestEquity reserves the right to require any defective part be returned, freight prepaid, to TestEquity's factory or to inspect any defective part at the Purchaser's site. TestEquity shall have sole discretion to determine whether any part is defective and whether any defective part will be repaired or replaced. This limited warranty shall extend to any standard chamber accessory and component part which is normally sold by TestEquity. Non-standard accessories and component parts specified by the Purchaser shall be warranted only to the extent of the original manufacturer's warranty, if any exists.

If the repair or replacement is performed in the FIRST YEAR from the date of invoice, TestEquity will also pay for the labor associated with the repair at the Purchaser's site, subject to TestEquity's prior approval. During the SECOND and THIRD YEAR of the warranty period, Purchaser will be responsible for the installation and cost of installation of replacement or repaired parts. Purchaser shall notify TestEquity in writing of any alleged defect within 10 days after its discovery within the warranty period. TestEquity reserves the right to satisfy the labor portion of this limited warranty either through its own service personnel or an authorized agent. In order to provide expeditious service, TestEquity reserves the right to satisfy its limited warranty obligation by sending replacement parts to be installed by the Purchaser if they can be installed easily without special tools or training. TestEquity reserves the right to satisfy this limited warranty by requiring the Purchaser to return the Equipment to TestEquity when such return is feasible.

The following parts are excluded from this limited warranty and are sold as-is or are considered expendable: interior light bulb, viewing window, paint and cosmetic surface finishes and treatments, and port plugs.

This limited warranty shall extend in full to Equipment installed within continental United States and Canada. For all other locations, Purchaser is responsible for all labor costs for repairs or parts installation, and for all shipping costs associated with providing replacement parts.

This limited warranty does not cover: (1) Defects or damages arising as the result of shipment by common carriers or private transportation, unless TestEquity undertakes shipment and transportation of the Equipment to Purchaser's site or contractually assumes the risk of damage to the Equipment in shipment; (2) Defects or damages arising out of, or as the result, of mishandling, modification, or improper start up, installation or maintenance of the Equipment (including start up, installation or maintenance not in accordance with TestEquity's written procedures); (3) Defects or damages resulting from, or arising out of, abuse, misuse, neglect, intentional damage, accident, fire, flood, earthquake, or any other act of God.

This warranty as to Equipment is LIMITED to repair or replacement of parts or Equipment in the determination of TestEquity LLC THE FORGOING LIMITED WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES INCLUDING THE IMPLIED WARRANTIES OF FITNESS FOR A PARTICULAR PURPOSE AND MERCHANTABILITY. TestEquity LLC DISCLAIMS ANY LIABILITY FOR ANY DAMAGES RESULTING FROM DELAY OR LOSS OF USE IN SERVICE OR REPAIR, OR FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES ARISING OUT OF OR IN CONNECTION WITH THE USE OR PERFORMANCE OF THE EQUIPMENT, EXCEPT AS STATED IN THIS PARAGRAPH.

This limited warranty cannot be modified in any way except in writing by both TestEquity and Purchaser. Invalidation of any one or more of the provisions of this limited warranty shall in no way affect any of the other provisions hereof, which remain in full force and effect.

This limited warranty shall be extended only to the first Purchaser of this Equipment and is not transferable.

Chapter 10 – Drawings

Electrical Subpanel Component Location