# TEST**EQUITY**

# Model 101H
# Temperature/Humidity Chamber

# 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 F4T 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 Watlow F4T Manuals 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:**   Configuration files are unique to each model chamber and must NEVER be transferred to a different model chamber.

⚠ **CAUTION:**   NEVER select "Factory" in the "Restore Settings From" prompt in the Device Details menu in Composer Software. This will erase all controller configuration settings. The chamber will not work if you do this.

⚠ **CAUTION:**   Always verify that the F4T Limit Alarm 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 or bringing in fresh air.

⚠ **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 four 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. Install the Water Recirculation System Filter Cartridge if it is not already installed.
5. Fill the water reservoir (located on the top of the chamber) with 1-gallon minimum to 2 gallons maximum of supermarket-grade distilled water or deionized water. **Do not use unfiltered tap water! Do not use lab-grade double-distilled water!**
6. Attach the power cord to the receptacle on the chamber. Plug the chamber into the power source as designated on the model label.
7. 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 200 pounds.

⚠ **WARNING:**   The power cord is equipped with a 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.

## *Humidity Water System*

This chamber has a built-in close-loop water recirculation system to provide clean water to the humidity system. If you choose to operate the chamber in a stand-alone mode without any plumbing, the internal reservoir must be filled initially with supermarket-grade distilled water or deionized water. Condensate is pumped through a deionizer filter and returned to the reservoir. The chamber does not need to be plumbed to a drain.

If you plumb the chamber to a source of deionized water, a float valve will always maintain 1.5 gallons of water in the internal reservoir. The water recirculation system remains operational. Condensate is pumped through a deionizer filter and returned to the reservoir. The chamber does not need to be plumbed to a drain.

## Water Fill (when no plumbing is used)

Unscrew the black plastic cover on the top of the chamber and fill the water reservoir with 1 to 2 gallons of supermarket-grade distilled water or deionized water. **Do not use unfiltered tap water! Do not use lab-grade double-distilled water!**

## Plumbed Water Supply (optional installation method)

Attach your water supply hose to the 1/4" NPT Water Inlet fitting on the back of the chamber. The water supply must be regulated to 50 psi or less and contain a shut-off valve. **The water must be filtered through a customer-supplied Deionizer filter to remove the mineral content. The water filter on the chamber does not filter the water from a plumbed supply, it only filters the condensate back to the internal reservoir. Do not use unfiltered tap water! Do not use lab-grade double-distilled water!**

## Maintenance Drain

A 1/2" NPT Maintenance Drain fitting is located on the back of the chamber. It is only used to drain the internal water reservoir for maintenance purposes. Water does not come out of this drain during normal chamber operation, even with a plumbed water supply. See "How to drain the reservoir" in the Maintenance section of this manual for more details.

## Water Recirculation System Filter Cartridge

The Deionizer filter must be installed before using the humidity system. **This does NOT filter incoming water from a plumbed supply. This will only filter water from the condensate pump before it returns to the reservoir.** The Deionizer filter cartridge must be replaced when it is used up. The color of the top half of the cartridge changes gradually from white to brown through continued use. Replacement cartridges are available from TestEquity (our part number 383911).

To replace the cartridge, use a screwdriver to loosen the clamps from the bottom and top of the filter and remove the tubing from the barbed fitting on the filter. Be prepared to catch a small amount of water from the tubes and bottom of the filter with a rag or paper towel. Lift the filter up to disengaged it from the bottom flange and then pull the bottom of the filter towards you. Then, pull the filter out of the top flange. Perform the installation in the reverse order.

**Top of Filter**          **Bottom of Filter**
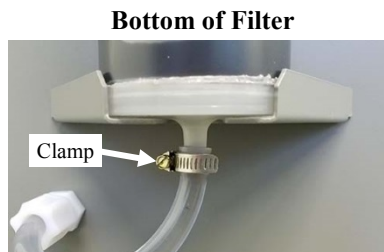
## Chapter 3 – Operation

### *Introduction*

The Front Panel Switch controls power to the F4T Temperature/Humidity Controller and all chamber functions. The "soft" Power button F4T Controller controls all chamber functions.

### *Summary of Chamber Operation*

1. Turn the POWER Switch ON.
2. Enter the desired temperature (and humidity if you are running a controlled humidity condition) set point on the F4T Controller.
3. Load your test sample in the chamber.
4. Press the Power button on the F4T controller to turn the chamber ON.
5. If you are running a controlled humidity condition between +10°C and +85°C, press the Humidity button on the F4T controller to turn the humidity system ON. Make sure there is an adequate amount of water in the reservoir before operating the humidity system.

### *Front Panel Switch and Soft Buttons*

#### POWER Switch
The POWER Switch controls power to the entire chamber.

#### Power Button
The Power button on the F4T Controller turns the chamber ON/OFF. There will be a green check mark on the Power button when it is ON.

#### Humidity Button
The Humidity button on the F4T Controller turns the humidity system ON/OFF. There will be a green check mark on the Humidity button when it is ON.

#### Purge Button
The Purge button turns the optional purge system ON/OFF. Note: Your chamber will have a Purge button even if the option is not installed. There will be a green check mark on the Purge button when it is ON.

#### Light Switch
The Light switch is located on the left side of the light bar. The light bar contains an LED light array. These lights are located on the outside of the door so they are not directly exposed to the internal chamber temperature or humidity extremes. While LEDs have very long life, we recommend you only turn the light ON when needed and then turn it OFF when operating the chamber at temperatures over 50°C (122°F). This is because the exterior surface of the door tends to get very warm which elevates the temperature of the LED light bar.

## *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 or bringing in fresh air.

⚠ **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.

⚠ **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 for Model 101H (uncontrolled humidity mode only)**

| Temp | +23°C | 0°C | –5°C | –10°C | –15°C |
|------|-------|-----|------|-------|-------|
| **Watts** | 300 W | 170 W | 135W | 85 W | 65 W |

## Port Plugs

Foam port plugs are provided with a gray silicone surface on one side. **The port plug must be inserted with the gray silicone surface facing the inside of the chamber.** Port plugs should be considered expendable and be replaced when they no longer provide a good seal.

## 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 left side and exits from the right side. 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 data logger.

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.

## Avoiding Moisture (non-humidity mode)

Any time the ambient air is subjected to temperatures below the dew point, 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 with the gray silicone surfaces facing the inside and outside of the chamber at all times. Any air gaps between the wires going through the ports will create a path for moisture migration and thermal losses. 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.

You CANNOT use the humidity system to control moisture at low temperatures. The humidity system is disabled below +7°C. However, if you have a source of $GN_2$ (gaseous nitrogen) or Dry Air, you can use the Purge system to eliminate moisture condensation at low temperatures.

## 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.

## *Humidity Operation*

**Humidity Mode Enable**
The Humidity mode is enabled through the Humidity button on the F4T Controller. This mode should only be ON if you are performing a controlled humidity test within the temperature humidity range of the chamber as shown in the chart below.

**Standard Humidity Range**
This chamber is capable of controlling humidity from 10% RH to 95% RH over the temperature range of +10°C to +85°C. The lowest possible humidity in the Standard Range is limited to a 6°C dew point.

**Examples of 6°C Dew Point Limit in the Standard Humidity Range**
10°C   76%
20°C   40%
45°C   10%

Below is a chart that shows the achievable range of humidity as compared to temperature. For extended low humidity range below 6°C a dew point condition, see "Purge Option" which follows.

**NOTE: Achieving low humidity levels require you to start with a clean, dry chamber.**



Achievable Range of Temperature/Humidity Conditions
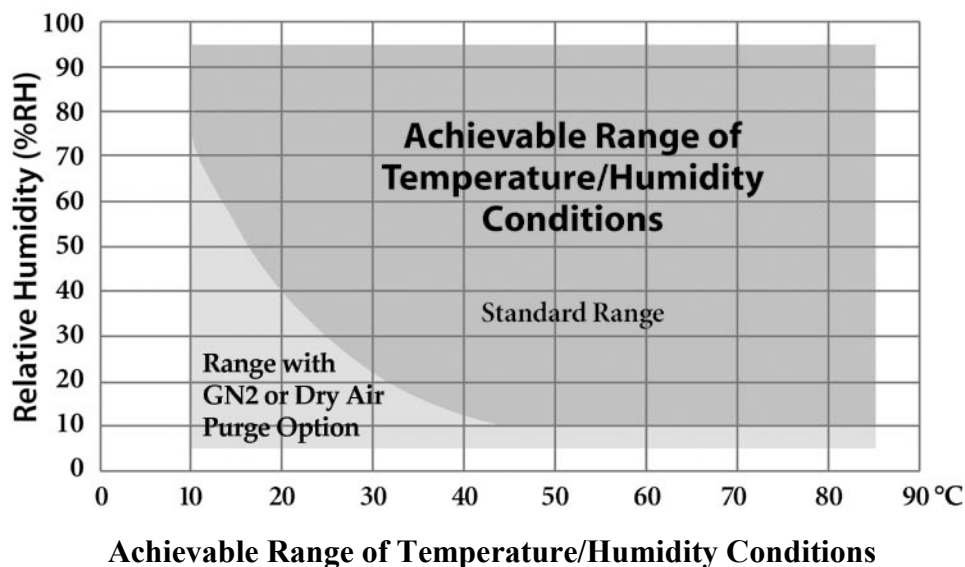
## Temperature Range for Controlled Humidity
If the chamber is outside the temperature range or +7°C and +90°C, the humidity system will be disabled and chamber will operate as though the F4T Humidity button was OFF, even if Humidity button is ON.

## *Purge (optional)*

Optional GN$_2$ (gaseous nitrogen) Purge or optional Dry Air Purge can be used to reduce to possibility of condensation in the chamber and on your test sample, or to achieve humidity control below a 6°C dew-point condition.

⚠ **CAUTION:**   Nitrogen cannot be detected by human senses. Nitrogen is non-toxic. However, if adequate ventilation is not provided, nitrogen will displace air. This can cause dizziness, unconsciousness or death without warning. The chamber must be located in a well-ventilated area. Do not open the chamber door and put your head in it with the GN$_2$ flowing.

## GN2 (Gaseous Nitrogen) Installation (Option TE-1013)
Connect a supply of GN$_2$ with a maximum pressure of 100 psig to the 1/4-inch FPT fitting which is labeled PURGE INLET on the rear panel.

## Dry Air Installation (Option TE-1014 or TE-0017)
Dry Air requires Option TE-1013 as a prerequisite. TE-1014 consists of the Heatless Desiccant Air Drier mounted on the 101H-F caster base. TE-0017 has the air drier mounted on its own caster base for use with the 101H-B. Connect the hose from the Air Drier to the PURGE INLET fitting on the rear panel. Connect the power plug from Air Direr to DRY AIR POWER receptacle on the rear panel. Twist the power plug clockwise to lock it. Connect a supply of compressed air to the 3/8-inch FPT shutoff valve on the Air Drier system. This system requires a 5 cfm supply air flow rate at 100 psig (175 psig max).

**From Air Drier**
Connect the hose from the Air Drier to the PURGE INLET fitting. Connect the power plug from Air Direr to the DRY AIR POWER receptacle. Twist the power plug clockwise to lock it.

**Compressed Air Inlet to Dry Air System.**
Shutoff valve on the Dry Air System is shown in the off position. Valve must be in the on position to operate.
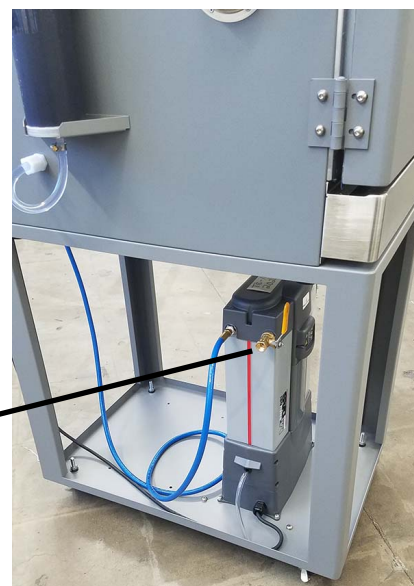
**Dry Air Purge System Installation** (example shows Option TE-1014 on a 101H-F)

## Purge Operation

The Purge mode is enabled through the Purge button on the F4T controller.

If you are running a temperature-only profile to reduce to possibility of condensation in the chamber and on your test sample, Purge can be turned ON or OFF within each profile step. When using purge in a profile, we recommend you turn Purge ON during ramp down, low temperature soak, and ramp up steps. You can turn Purge OFF during a high temperature soak step to conserve $GN_2$ or the Air Drier desiccant.

## Adjusting the Purge Flow



A flowmeter is located on the front panel to adjust the flow of purge gas into the chamber. The flowmeter has a scale, calibrated in SCFM. The flow of purge gas should be adjusted to the minimum amount required to obtain the desired drying in the chamber for your conditions. A suggested starting setting is 1 to 2 SCFM (the picture here shows the flowmeter adjusted for 1 SCFM. We do not recommend setting the flowmeter higher than 3 SCFM.

## Relief Vent

Excess pressure in the chamber workspace is vented through a pressure-relief check-valve which is located behind the panel of the rear compartment. There is no need to vent this externally.

## Chapter 4 – F4T Temperature/Humidity Controller

### *F4T Menus*

This chapter is designed to give you a better understanding of the structure and navigation of the F4T menus as viewed from the front panel.

## Understanding F4T Menus

The graphic below illustrates at a high level the structure of the F4T menus.
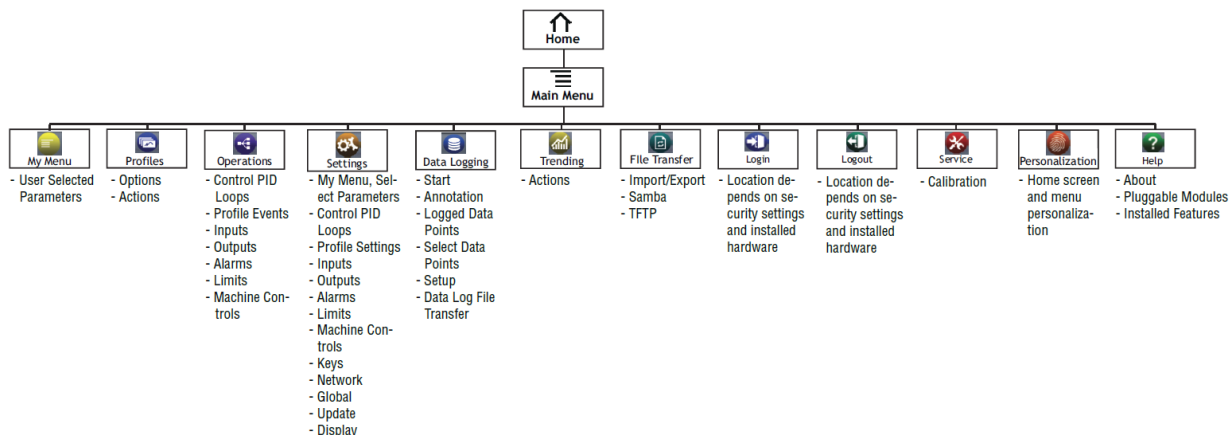
## *Navigating and Understanding the User Interface*

## Home Screen
After powering up the controller a white screen will appear first while initializing. It will then go blank for a short time before the Watlow F4T logo appears. Once the startup process is completed the Home Screen will be presented. The image below shows the Home Screen while a profile is running.
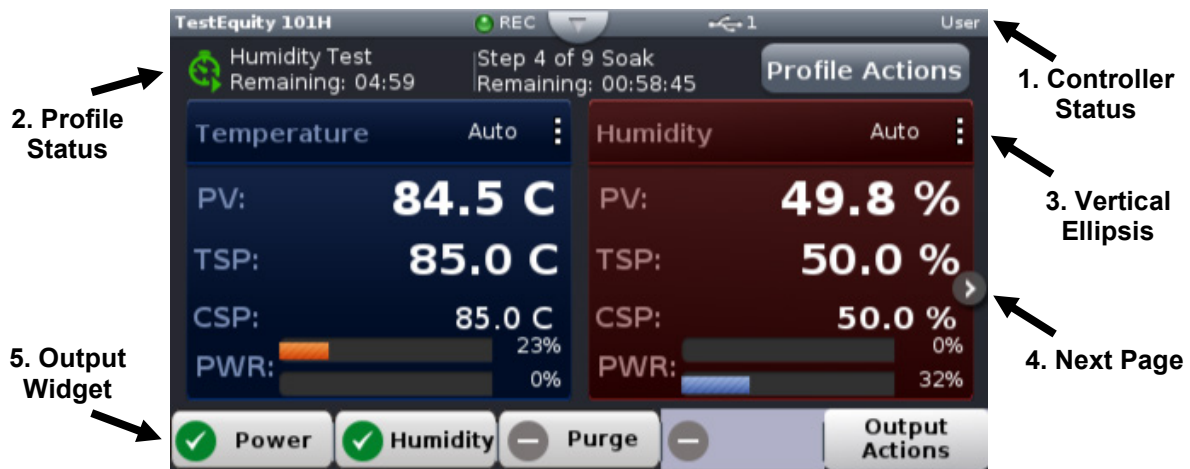


① **Controller Status:** Indicates alarms and errors if they occur. The current security level is shown as "User" (see "Security" section). Also indicates if Data Logging is enabled (REC is enabled in this image) and if a USB thumb drive is plugged into the USB host port (USB icon is present in this image, indicating that a thumb drive is plugged in). The button shown in the center of the status bar allows you to view alarm and error messages when pressed.

② **Profile Status Bar:** Provides visibility and information pertaining to running profiles as well as access to available profile actions (see "Creating and Editing Profiles" section).

③ **Vertical Ellipsis:** Displays current control mode while also providing access to other operational parameters such as the Ramp to Set Point, Autotune, PID Settings, and more (see "Changing Loop Operational Parameters" section).

④ **Next Page:** Home screen has been setup to display multiple pages (loops). The left and right arrows on each side of the home screen provides navigation from one to the other (see "Personalizing the Home Screen" section). Model 101H is configured by TestEquity to have three screens. The first one shows Temperature and Humidity (as pictured above). The second one shows Temperature Only. The third one shows Humidity only.

⑤ **Output Widget Bar:** Function keys and their output status (ON/OFF).

## Home Screen Parameters

Parameters on the Home screen include:

- **Loop name:** "Temperature" and "Humidity" in the above example.
- **Control mode:** "Auto" shown in the above example.
- **Process Value or PV:** Actual Temperature or Humidity.
- **Target Set Point or TSP:** The desired set point in a step when running a profile)
- **Current Set Point or CSP:** The instantaneous set point during a ramp step when running a profile. May be the same value as the TSP)
- **Set Point:** The desired Temperature or Humidity to be maintained by the controller.
- **PWR:** % Output power levels (throttle) for heat and cool (or humidification and dehumidification). The orange PWR bar is the heat (or humidification) throttle. The blue PWR bar is the cool (or dehumidification) throttle.
- **Output Actions:** Allows you to monitor the ON/OFF status of controller outputs.

## Front Panel Navigational Buttons



Four buttons at the bottom of the F4T are displayed as icons shown below. The text in this graphic is shown for clarity only and is not present on the front panel.

- **Home:** Regardless of the screen currently in view, when Home is pressed you will always return to the Home screen (shown on the previous page).
- **Menu:** Pressing the Menu button will provide access to other settings and functions within the controller.
- **Return:** Pressing this button will take you back to the previous screen until the top level of either the Home Screen or the Main Menu is reached.
- **Help:** Displays information about the controller such as part number and software revision.

## Main Menu

The Main Menu provides access to settings and functions within the controller.



- **My Menu:** Quick access to user assignable functions.
- **Profiles:** Profiles are added, accessed, and edited from this menu.
- **Operations:** Contains access to alarms, control setting, profile events, inputs, and outputs.
- **Settings:** Contains access to network settings, global settings (controller name, date, time, °C/°F display), firmware and feature update utilities.
- **Data Logging:** Contains access to settings for data logging.
- **Trending:** Contains access to settings for trend graphing and the trend graph display.
- **File Transfer:** Contains access to USB file transfer utilities for Import/Export of Configuration and Profiles and Export of Data Log files.
- **Login (Logout):** For password entry, shown with a user already logged in.
- **Service:** (not shown, appears when display is scrolled down in this pictured configuration). Provides access to the calibration menu.
- **Personalize:** The home screen layout is modified in this menu. This has been configured by TestEquity to only show if a user is logged in with a password.
- **Help:** (not shown, appears when display is scrolled down in this pictured configuration) Displays information about the controller such as part number and software revision.
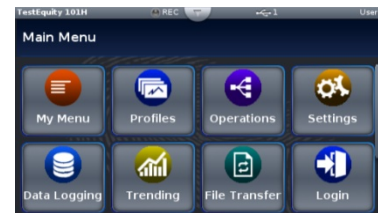
## Chamber Functions (Output Widget)

Chamber functions can be turned ON/OFF using the buttons on the Output Widget. The buttons may be named differently depending on your model chamber. The buttons can be pressed to toggle the functions ON/OFF in Static Set Point (manual) mode or while a profile is running.

The image below shows an F4T with Power, Humidity, and Purge in the output widget.



Below is a summary of the button functions assigned by TestEquity.

## Power Button

The **Power** button on the F4T Controller turns the chamber ON/OFF. There will be a green check mark on the **Power** button when it is ON.

## Humidity Button

The **Humidity** button turns the humidity system ON/OFF.

## Purge Button

The **Purge** button the purge system ON/OFF. **Note:** Your chamber will have a Purge button even if the Purge option is not installed.

## Static (Manual) Set Point

Set Point is the Temperature or Humidity setting that you want the chamber to maintain. The F4T Controller is in Static Set Point Mode when it is not controlling a Profile. The Static Set Point is entered in the **Closed-Loop Set Point** screen.

Model 101H is configured by TestEquity to have 3 screens. The first one shows Temperature and Humidity. The second one shows Temperature only. The third one shows Humidity only.

## Navigating the Closed-Loop Set Point Screen

To enter the **Closed-Loop Set Point** screen, press the area in the **Set Point** box on the Home Screen. The **Closed-Loop Set Point** screen will appear. Values can be added with the numeric keypad or the ↑ or ↓ arrow keys.



Pressing the numeric keys will directly enter a value in the **Closed-Loop Set Point** box. There is no need to clear the existing value first.

Pressing the ↑ or ↓ arrow keys will increment or decrement the existing Closed-Loop Set Point value in 0.1 increments each time the key is pressed.

- **Clear** will clear all entries in the **Closed-Loop Set Point** box.
- **Bksp** (backspace) will clear the last digit in the **Closed Loop Set Point** box.
- **Enter** will enter the values in the **Closed-Loop Set Point** box and return you to the **Home Screen**.
- **Cancel** will return you to the **Home Screen** without changing the Set Point.

## *Ramp to Set Point*

The F4T can ramp to a set point without having to write a profile. The Ramp settings are in the Loop Operational Parameter screen. Pressing the vertical ellipsis or anywhere within the outlined box shown below will provide access to the Loop Operational Parameter screen. Once you are in the Loop screen, scroll to the bottom to find the Ramp Action button.
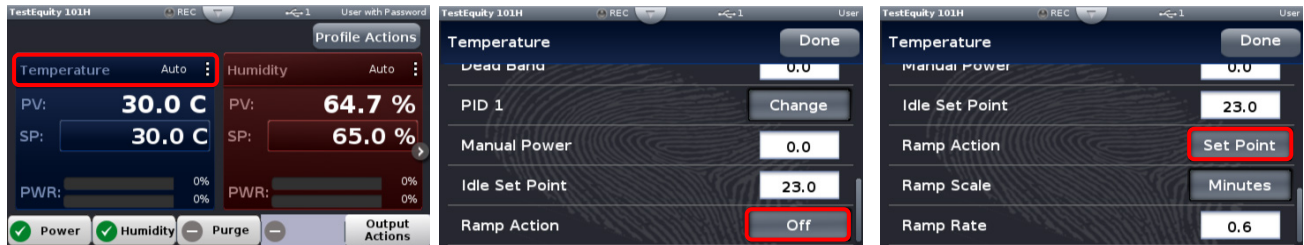


**Ramp Action button is at the bottom of the loop screen. Off was changed to Set Point in this example.**

There are separate settings for the Temperature loop and the Humidity loop. However, we do not recommend entering a humidity ramp. Humidity control is very "laggy" by nature and its ability to follow a ramp will likely be very unpredictable.

**Ramp Action**
Choose the conditions under which the loop ramps its set point. When the set point ramps, it starts at the Process Value and changes gradually to the Set Point setting rather than abruptly changing values. Options for Ramp Action are as follows:
- **Off**: the loop controls to the Set Point immediately
- **Startup**: each time the controller is powered up, the loop ramps the set point. At all other times abrupt changes to the Set Point are allowed
- **Set Point**: upon powering up the Set Point immediately resumes its last value, but the loop ramps the set point each time the Set Point is changed
- **Both**: the loop ramps the set point each time the controller is powered up or the Set Point is changed

**Ramp Scale**
Choose the time units for the Ramp Scale parameter. (Ramp Scale will not show if Ramp Action is set to Off).
- **Minutes** or **Hours**

**Ramp Rate**
Set how quickly the set point ramps. Set the time units for the rate with Ramp Rate. (Ramp Rate will not show if Ramp Action is set to Off)
- **0 to 55,555** (ºC) or **0 to 99,999** (ºF) per minute or hour

## *Temperature Limit Alarm*

The F4T has a built-in independent Limit Alarm. The Limit Alarm 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 temperature controller to a condition 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 temperature controller functions.

⚠ **CAUTION:**   Always verify that the Limit Alarm'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 can raise 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.

## How to Set the High and Low Temperature Safety Limits

The Limit Alarm has separate Low Limit and High Limit Set Points. We recommend setting these at least 5°C beyond the highest and lowest temperatures that the chamber is programmed to reach to prevent nuisance tripping.

To enter the Limit Alarm settings, first press the **Menu** button (second button from the left below the display). Then, press the **My Menu** button.

There will a 15-second delay before **My Menu** is populated if it is the first time you press it after turning the Power switch on.

The screen which follows will provide access to the **Low Limit Set Point** and **High Limit Set Point**. Pressing the **Low Limit** or **High Limit Set Point** value will take you to a numeric key screen where you can enter new values. Press **Done** after the values are entered.
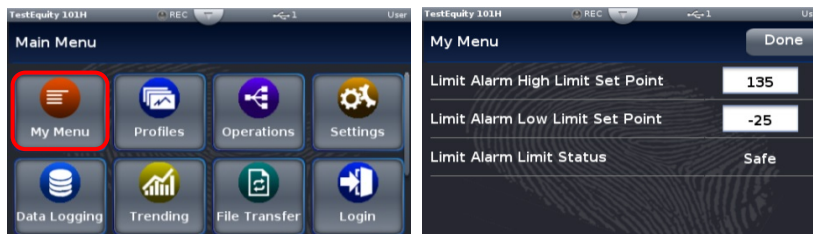
## Resetting an Out of Limit Condition

If an alarm occurs the status bar (top of screen) will indicate its existence by blinking red. A pop-up window will indicate if the error is due to a Limit Low or Limit High condition. Pressing **Dismiss** will remove the pop-up display. The status bar will continue to blink red until the chamber temperature is within safe limits and the **Clear** button is pressed.

Pull the status bar down button to view the alarm message in the **Error** tab. Press **Clear** to clear the alarm after the chamber temperature is within safe limits.
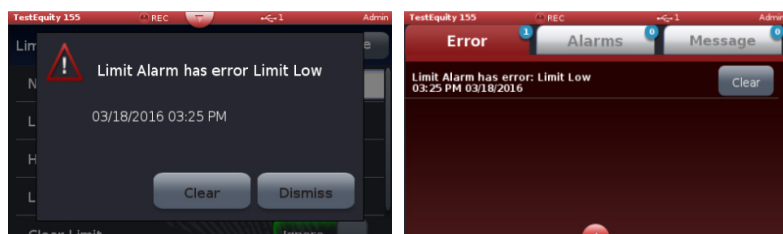


## *Low Water Alarm*

The chamber has an alarm which indicates when the reservoir has low water. There will be an indication on the F4T Controller when the water is low and needs to be refilled. The chamber will continue to operate normally when this alarm is activated. The system will not be damaged if the water is low or empty. However, if the reservoir is completely out of water the system will not be able to add humidity to the chamber when needed to control the humidity set point.

## Low Water Alarm Notification

If an alarm occurs the status bar (top of screen) will indicate its existence by blinking yellow. A pop-up window will indicate Low Water condition.

Pull the status bar down button to view the alarm message in the **Alarm** tab. Pressing **Dismiss** will remove the Low Water Alarm pop-up display.
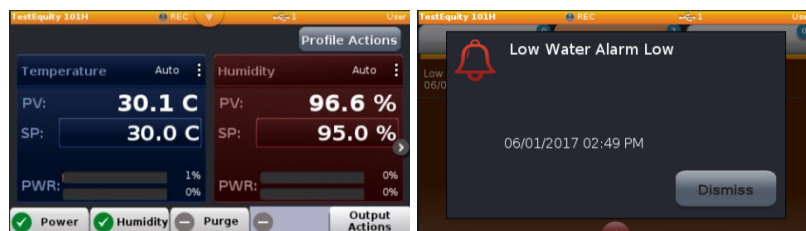


## Resetting a Low Water Alarm Condition

Fill the water reservoir (located on the top of the chamber) with 1 gallon minimum to 2 gallons maximum of supermarket-grade distilled water or deionized water. **Do not use unfiltered tap water! Do not use lab-grade double-distilled water!**

The alarm will self-reset and the status bar will stop blinking when the water level within normal limits.

## *Profile Mode*

## Profile Actions

The profile status bar will appear on the home screen when the controller is powered up. When the Profile Actions button on the Home Screen is clicked, one of three pop-up windows will appear as described below.

### Actions when profile is not running

| | |
|---|---|
| **Run Last** | Starts the last executed profile. |
| **Run Profile** | Brings up a list of profiles by name for selection. |
| **View/Edit Profile Events** | View and edit profile events. |
| **Create Profile** | Create a new profile. |
| **Go to Profile** | Brings up a list of profiles by name for selection. |
| **Clear Profile Status** | Removes the profile icon and step status (profile status bar). |
| **Cancel** | Return to Home screen. |

### Actions when profile is running

| | |
|---|---|
| **Pause** | Suspends running the profile, profile can resume running at the same point. |
| **Terminate** | Stop running a profile, profile cannot resume running, it must be started again. |
| **View/Edit Profile Events** | View and edit profile events. |
| **Go to Profile** | Displays a list of profiles |
| **Cancel** | Return to Home screen. |

### Actions when profile is paused

| | |
|---|---|
| **Resume** | Continue step execution where previously paused and with the previous time remaining. |
| **Terminate** | Stop running a profile, profile cannot resume running, it must be started again. |
| **View/Edit Profile Events** | View and edit profile events. |
| **Go to Profile** | Brings up a list of profiles by name for selection. |
| **Cancel** | Return to Home screen. |

## Profile Parameters

The following settings apply to the entire profile. This screen will appear when **Create Profile** is pressed or when you edit a profile and **View/Edit Details** is pressed.

**Name:** User-entered identifier for the profile. The name follows the profile when it is saved in a file or moved to another controller.
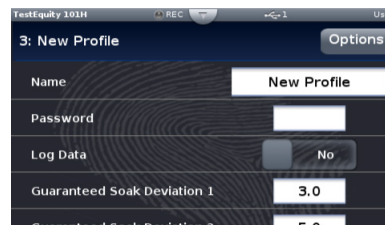
**Password:** User-set code that must be entered prior to editing a protected profile. A password may consist of up to ten characters, may include letters, numbers or symbols and is case sensitive.

**Log Data:** Select **Yes** if you want to log data during the profile.

**Guaranteed Soak Deviation/Guaranteed Soak Values:** The amount by which the actual chamber temperature or humidity is allowed to differ from the set point for steps with Guaranteed Soak Enable set to **On**. In such steps when the actual chamber temperature or humidity differs from the set point by more than this value, the step timer stops running until the actual chamber temperature or humidity returns to within the band defined by the set point plus or minus this value. Each profile can have its own set of Guaranteed Soak values.

## Step Parameters

After you create a profile with the procedure above, press the **Options** button in the upper left side. Then press **Create Steps** in the screen that pops up. You will see one step which is a **Soak** type. Pressing the **Soak** button will allow you to change the step type. If you are editing an existing profile, pressing the step type of any step will allow you to change its type. Pressing the **Actions** button will allow you to Edit Step Parameters, Delete Step, or Insert Step.
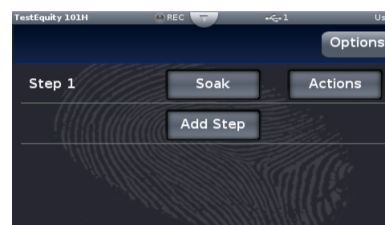
Each new step will automatically be a copy of the previous step. You can then edit the parameters of the new step to suit your profile.

**Step Type**
Set the behavior of the step. Step Type options include:

**Soak:** Maintains the temperature or humidity set point constant for the step's Time.
- **Hours, Minutes, Seconds** (How long the step will hold at this condition)
- **Guaranteed Soak Enable 1** (Temperature)
- **Guaranteed Soak Enable 2** (Humidity)
- **Power, Humidity, Purge, Event 4 through 8** (On, Off, Unchanged from previous step)

**Ramp Time:** Adjusts the temperature or humidity set point gradually from the previous set point to the step's Set Point over the step's Time.
- **Target Set Point Loop 1** (Temperature)
- **Hours, Minutes, Seconds** (Time to ramp from the previous step condition)
- **Guaranteed Soak Enable 1** (Temperature)
- **Target Set Point Loop 2** (Humidity)
- **Guaranteed Soak Enable 2** (Humidity)
- **Power, Humidity, Purge, Event 4 through 8** (On, Off, Unchanged from previous step)

**Rate:** Adjusts the temperature or humidity set point at the user-set Rate of change until it reaches the step's Set Point.
- **Target Set Point Loop 1** (Temperature)
- **Rate** (Degrees per Minute)
- **Guaranteed Soak Enable 1** (Temperature)
- **Target Set Point Loop 2** (Humidity)
- **Rate** (% Humidity per Minute)
- **Guaranteed Soak Enable 2** (Humidity)
- **Power, Humidity, Purge, Event 4 through 8** (On, Off, Unchanged from previous step)

**Wait For Process or Event:** Holds the profile until the specified conditions are met. When multiple conditions are specified, the profile will not proceed until all the conditions are satisfied at the same time.
- **Step Wait for Process Enable 1** (Temperature) (None, Greater Than, Less Than)
- **Wait for Process 1 Value** (Temperature, if Greater Than or Less Than is selected)
- **Step Wait for Process Enable 2** (Humidity) (None, Greater Than, Less Than)
- **Wait for Process 2 Value** (Humidity, if Greater Than or Less Than is selected)
- **Power, Humidity, Purge, Event 4 through 8** (On, Off, Unchanged from previous step)

**Instant Change:** Sets the temperature or humidity set point without ramping from the previous set point and holds that set point for the step's Time. Use this when programming the chamber to go as fast as possible between steps.
- **Target Set Point Loop 1** (Temperature)
- **Hours, Minutes, Seconds** (How long the step will hold at this condition)
- **Guaranteed Soak Enable 1** (Temperature)
- **Target Set Point Loop 2** (Humidity)
- **Guaranteed Soak Enable 2** (Humidity)
- **Power, Humidity, Purge, Event 4 through 8** (On, Of, Unchanged from previous step)

**Jump:** Repeats previous steps in the profile starting at the step set with Jump to Step for the Number of Times set. This option is not available for step 1.
- **Jump Step**
- **Jump Count**
- **Power, Humidity, Purge, Event 4 through 8** (On/Of functions)

**End:** Sets the Temperature or Humidity condition after the profile is complete.
- **User** (program will end with the same Temperature and Humidity Static Set Point values and Event settings that were entered before the profile was run). If you want to select **User**, you should make sure that the Temperature and Humidity Static Set Point values and Event settings are indeed what you want the chamber to be at when the profile ends.
- **Off** (the Temperature and Humidity control mode is set to Off – **Not Recommended, see Note Below!**)
- **Hold** (the Temperature and Humidity Set Point is set to the last value used in the profile). This may be a preferable choice for most applications, since you can define the desired chamber conditions in the next-to-last step in the profile.

**NOTE about selecting an End step of Off:**

If you select an End step of **Off**, this sets the **Control Mode** in the **Loop Menu** to **Off**. This results in the inability to set a **Static (Manual) Set Point**. You would need to enter the **Loop Menu** and change **Control Mode** to **Auto**. See "Changing Loop Operational Parameters" for information on how to access this menu.

## Sample Ramp and Soak Profile

Below is a typical ramp and soak temperature profile. This should give you an idea of how to create your own custom profiles.

If this profile included humidity, the humidity values would be added at the **Set Point 2** prompts. Additionally, **Humidity** would need to be **On** for any step that required humidity to be controlled.

1. Start at 23°C. Stay at 23°C for 30 minutes.
2. Ramp to 85°C in 1 hour.
3. Soak at 85°C for 2 hours, 30 minutes.
4. Ramp to -40°C in 2 hours.
5. Soak at -40°C for 2 hours, 30 minutes.
6. Ramp to 85°C in 2 hours.
7. Jump back to step 3. Repeat cycle 9 times for a total of 10 cycles.
8. Go to 23°C as fast as possible. Wait until the temperatures reaches within 3° before advancing to the next step.
9. End with the chamber turned OFF.

**Entering the above profile from the F4T front panel:**

- From the **Main Page** press **Profile Actions**.
- Then press **Create Profile** on the screen that pops up. This will take you to the **New Profile Screen**.
- In the **New Profile** screen, enter your desired profile name in the **Name** field. You have the choice of entering a password in the **Password** field if desired. In the **Guaranteed Soak Deviation 1** field, enter **3** (this will be used in step 9 above).
- You will now see **Step 1**.
  - o Change step type to **Instant Change**.
  - o Enter **23** for **Target Set Point 1**.
  - o Enter **30** for **Minutes**.
  - o Scroll down to see **Power**. Press **Off** and the press **ON** at the popup. This will automatically be selected as **ON** for all subsequently added steps.
  - o Press **Done**.
- Press **Add Step**. You will now see **Step 2**.
  - o Change step type to **Ramp Time**.
  - o Enter **85** for **Target Set Point 1**.
  - o Enter **1** for **Hour** and **0** for **Minutes**.
  - o Press **Done**.
- Press **Add Step**. You will now see **Step 3**.
  - o Change step type to **Soak**.
  - o Enter **2** for **Hour** and **30** for **Minutes**.
  - o Press **Done**.

- Press **Add Step**. You will now see **Step 4**.
  - Change step type to **Ramp Time**.
  - Enter **-40** for **Target Set Point 1**.
  - Enter **2** for **Hour** and **0** for **Minutes**.
  - Press **Done**.
- Press **Add Step**. You will now see **Step 5**.
  - Change step type to **Soak**.
  - Enter **2** for **Hour** and **30** for **Minutes**.
  - Press **Done**.
- Press **Add Step**. You will now see **Step 6**.
  - Change step type to **Ramp Time**.
  - Enter **85** for **Target Set Point 1**.
  - Enter **2** for **Hour** and **0** for **Minutes**.
  - Press **Done**.
- Press **Add Step**. You will now see **Step 7**.
  - Change step type to **Jump**.
  - Enter **3** for **Jump Step**. Enter **9** for **Jump Count**.
  - Press **Done**.
- Press **Add Step**. You will now see **Step 8**.
  - Change step type to **Instant Change**.
  - Enter **23** for **Target Set Point 1**.
  - Enter **0** for **Hour** and **0** for **Minutes**.
  - Select **Guaranteed Soak Enable 1** to **On**.
  - Press **Done**.
- Press **Add Step**. You will now see **Step 9**.
  - Change step type to **End**.
  - Press **Profile End Step Loop Action 1**, press **User** and change it to **Hold**.
  - At **Power** press **On** and change it to **Off**.
  - Press **Done**.
- Press **Options**.
  - Press **Done** to save the profile.
    or…
  - Press **Run Profile** to run the profile.

## *Data Logging*

### Overview

Data Logging can be enabled at any time and will log a user selectable list of data points. While data logging is enabled, the data log file is stored within either the USB thumb drive or internal memory. Once the file reaches a specified size (if being transferred automatically), it will be sent directly to one of three other destinations (USB thumb drive, TFTP server or a Samba server). The file transfer can also be initiated manually at any time. The file transfer process from internal memory, whether completed automatically or manually, will move all log files from internal memory to the selected destination.

### Data Logging Menu



**Start**
Starts the logging of data.

**Annotation**
Allows you to annotate the log file at a point in time while the data is being logged. For example, if you wanted to annotate when the door was opened you can create a note which states "door opened".

**Logged Data Points**
This menu indicates which data points have been selected.

**Select Data Points**
You can select the parameters which get logged. TestEquity has pre-configured the controller to log the Temperature Set Point, Humidity Set Point, Temperature Process Value, and Humidity Process Value.

**Setup**



- **Logging Status:** indicates if recording is active or not.
- **File Name:** any alphanumeric characters, 63 maximum.
  Note: A new dedicated file is created when data logging starts and the filename format will
  be "file name" "date stamp" "time stamp".csv.
- **Log To:** USB (thumb drive) or Internal Memory.
- **Log Interval:** defines the frequency in which the log will be written, 0.1 second to 60 minutes.
- **Available Logging Memory:** (read-only)
- **Available Logging Time:** (read-only) available time determined by the available memory, logging interval and number of data points that have been selected.
- **File Size Limit:** 20MB when using TFTP or Samba, 1GB when using USB.
- **Memory Full Action:** when log to device defined above is full, Overwrite or Stop.
  Note: Logging to USB allows for Stop only, when memory is full.
- **Date Format:** MM/DD/YYYY or DD/MM/YYYY.
- **Time Format:** 12 or 24 hour clock.
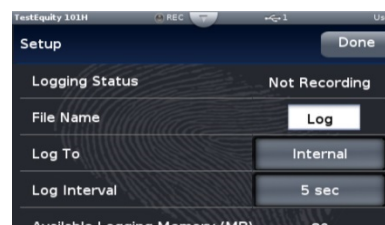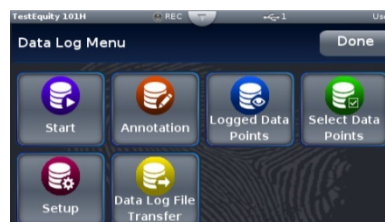
## How to Enable Data Logging

There are three ways to initiate data logging:

**To enable data logging using the front panel:**
1. Press the **Menu** button.
2. Press the **Data Logging** button.
3. Press the **Start** button.

**Note:** A new dedicated file is created when data logging starts and the filename format will be "file name" "date stamp" "time stamp".csv.

**To enable data logging when running a profile:**
1. Select the desired profile, press **Actions** and then **View/Edit Details**. Press **Yes** for **Log Data**.

**Note:** If data logging is already running when the profile starts with data logging enabled the data log filename will remain as stated in the note above with the profile log data concatenated to the currently running data log file. If data logging is not running, a new dedicated data log file is created when the profile starts and ends when the profile stops. The filename format will be "Profile name" "date stamp" "time stamp".csv.

**To enable data logging (during a profile) using the Modbus communications protocol:**
1. Load Modbus register 18888 (Profile Active File Number) with the desired profile number (1 to 40).
2. Load Modbus register 19038 "Log Data" with 106 (yes).
3. Write Modbus registers to the controller.

**To enabling data logging (outside of a profile) using the Modbus communications protocol:**
1. Think about and modify the following Modbus registers if need be:
   a. Memory Full Action, Modbus register 42350 [**Stop** or **Overwrite**]
   b. File Size Limit, Modbus register 42372 [**0** to **80** MB]
   c. Log Interval, Modbus register 42388 [0.1, 0.2, 0.5, 1, 2, 5, 10, 15 and 30 seconds, 1, 2, 5, 10, 15, 30 and 60 minutes]
2. Load Modbus register 42386 "Log Action" with 1782 [**start**].
3. Write Modbus registers to the controller.

## Transferring Data Log Files

You can transfer data log files manually or automatically. If transferring by USB thumb drive, allow time for the F4T to load the USB thumb drive. After it is loaded, the USB thumb drive name will appear.

To transfer **completed** data log files to a USB thumb drive:
1. Insert a USB thumb drive into USB host port on the chamber.
2. Press the **Menu** button.
3. Press the **File Transfer** button. Allow time for the F4T to load the USB thumb drive. After it is loaded, the USB thumb drive name will appear.
4. Press the **Export** button. Then, press **Data Log**.
5. A progress bar will appear. File transfer is complete when the progress bar reaches 100%.
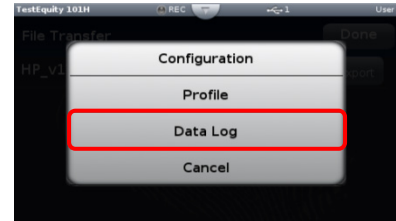
To transfer data log files **before or after** the log is completed:
1. Press the **Menu** button.
2. Press the **Data Logging** button.
3. Press the **Data Log File Transfer** button.
4. Press the **Transfer Files Now by** button.
5. Select **TFTP**, **Samba,** or **USB**.
6. The **Transfer Results** prompt will indicate **Transferring Files** and then **Transfer Compete** when done.
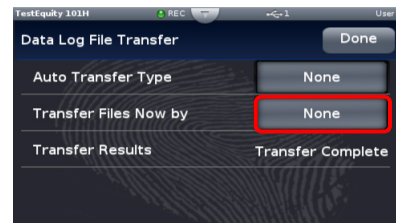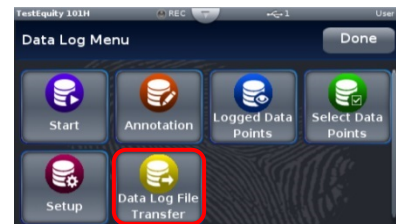
To transfer files automatically:
1. Press the **Menu** button.
2. Press the **Data Logging** button.
3. Press the Data Log File Transfer button.
4. Select **Auto Transfer Type**: **TFTP**, **Samba,** or **USB**.
   NOTE: If TFTP or Samba is selected above, the server must be configured.
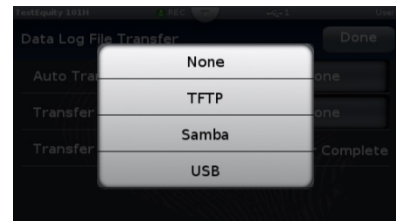
## *Trend Charts*

Graphical Trend Charts provide a display of chamber conditions over time.

Up to four different trend charts can be set up with different settings. If you leave one chart to view another chart, you will lose all previously displayed information.

The trend chart will only record one screen of date before writing over itself. **You cannot retrieve data that is not shown on the screen.** If you want finer resolution and longer-term data, you should use the Data Logging function instead.

To access trend charts, press the **Menu** button and then the **Trending** button. Press the **Actions** button for **Trend Chart 1**. This chart has already been set up by TestEquity to display Temperature, Humidity, Temperature Set Point, and Humidity Set Point.
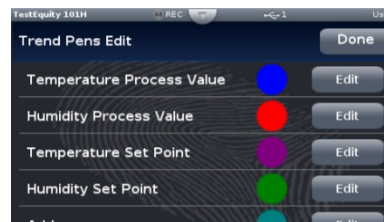
Press **View/Edit Details** to change the Chart Name, Grid Display On/Off, Auto-scaling On/Off, and the Timespan. **If you change Timespan while the chart is running, you will lose all previously displayed information.** You will need to Stop and then Resume the trending for changes in Timespan to take effect.
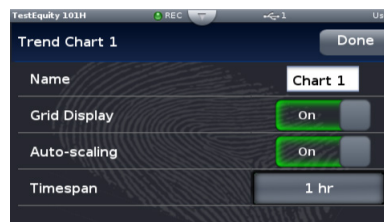
In the **Actions** menu press **View** to view and/or the chart. You can also press the chart name after pressing the **Trending** button to view and/or start the chart. When viewing the chart, you can toggle between the values being charted by pressing the arrow next to the highlighted box on the top of the screen (Humidity Process Value of 90.1% RH in this example). Pressing the arrow will toggle through the value of each assigned parameter being graphed.
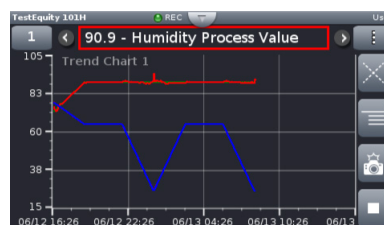
Pressing the box with three horizontal dots on the right side of the screen will give you choices to (listed in order of appearance):
- Turns the grid Off/On.
- Go to choices for View/Edit Details and Edit Pens.
- Take a snapshot (.bmp image) and save it to the USB thumb drive (you must have a thumb drive plugged into the USB port to capture the snapshot).
- Stop/Resume the trending. **If you stop the trending, you will lose all previously displayed information once it is resumed.** In the above image, the bottom button is shown in running condition. When pressed (Stop), it will turn into a right-facing triangle.

You can leave the trend display, view the Home or other screens and come back to the trend display without losing any information if you do not change any of the volatile trend settings. When you go back to the **Trending** menu you will see a clock icon, indicating that the trending information is continuing to be recorded. Pressing **Actions** and **View** (or pressing the **Trending** button and then the active chart name) will return you to the active trend chart.

## *Exporting/Importing Profiles and Configuration via USB*

## Transferring Profile Files
Profiles can be exported and imported as individual files via USB. This is useful for transferring profiles between different chambers and for archival purposes. The profile files contain all the profile steps that would ordinarily be entered via the front panel or Composer software. It does not contain any logged data.

To export a profile file to a USB thumb drive:
1. Insert a USB thumb drive into USB host port on the chamber.
2. Press the **Menu** button.
3. Press the **File Transfer** button.
4. Press **Export**, then press **Profile**.
5. A screen will pop up the names of each stored profile. Press the desired profile name to export it. A progress bar will appear and then indicate 100% when done.

To import a profile file to a USB thumb drive:
1. Insert a USB thumb drive into USB host port on the chamber.
2. Press the **Menu** button.
3. Press the **File Transfer** button.
4. Press **Import**, then press **Profile**.
5. A screen will pop up the names of each stored profile. Press the desired profile name to import it. A progress bar will appear and then indicate 100% when done.

## Transferring Configuration Files
The F4T configuration file contains a "System Image" of all settings that determine how the controller inputs and outputs work and how the display appears. The configuration file also contains all profiles. It does not contain any logged data. The configuration can be exported for archiving purposes. It can also be imported to restore the configuration from a previous archive.

⚠ **CAUTION:**  Configuration files are unique to each model chamber and must NEVER be transferred to a different model chamber.

To export a Configuration file to a USB thumb drive:
1. Insert a USB thumb drive into USB host port on the chamber.
2. Press the **Menu** button.
3. Press the **File Transfer** button.
4. Make sure the Import/Export button is selected for **Export**.
5. Press the **Export** button next to **Configuration**.
6. A progress bar will appear and then indicate 100% when done.

Importing a configuration file is accomplished like the profile import except you select Configuration and then selecting the desired configuration file.

## *Personalizing the Home Screen*

Placement of objects on the home screen can be modified by the user. **You must have a password to enter the Personalization screen. Please contact TestEquity for the password.**

To personalize the Home screen, do the following:
1. From any screen, press the **Menu** button.
2. Press **Personalize**.
3. Press **Basic Personalization**.
4. Select the desired **Home Layout** by pressing **Main Top**, **Main Center**, or **Main Bottom**.

The options include placing them on the bottom, split screen top and bottom or on the top.

1. Tap each page (through 4) in which loop information will be displayed. In the graphic shown, each page has been configured to display from 1 to 4 loops on each page.

2. Define the content blocks (number of loops) that will be displayed on each page.

Defining page 1 to display two loops (content blocks):
- From any screen, press the **Menu** button.
- Press **Personalize**.
- Press **Basic Personalization**.
- Select the desired **Home Layout** by pressing **Main Top**, **Main Center**, or **Main Bottom**.
- Press Page 1.
- Select "**2 Content Blocks**".
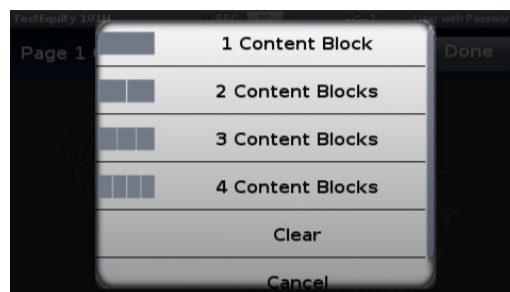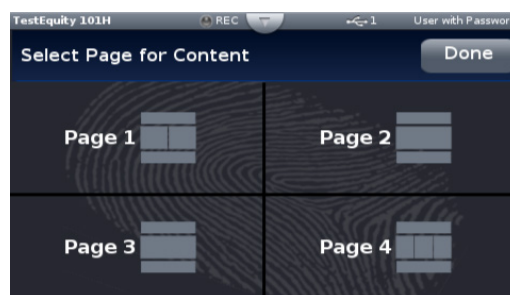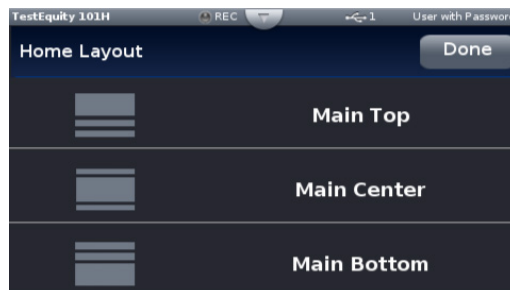
3.  Press on each content block. In this example we selected **Temperature** for the left and **Humidity** for the right. Pressing the **Temperature** or **Humidity** area in the **Loop Content Selection** screen will bring up the ability to select the color.



4.  Press the **Home** screen button to see the result of this operation.



## *Changing Loop Operational Parameters*

Pressing the vertical ellipsis or anywhere within the red outlined box shown below will provide access to the loop name, control mode, PID settings and many other parameters. In a Temperature/Humidity chamber, pressing the corresponding area for the humidity loop will provide access to that loop. You must have a password to change the loop PID tuning parameters.

⚠ **CAUTION:**    The F4T PID tuning 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.
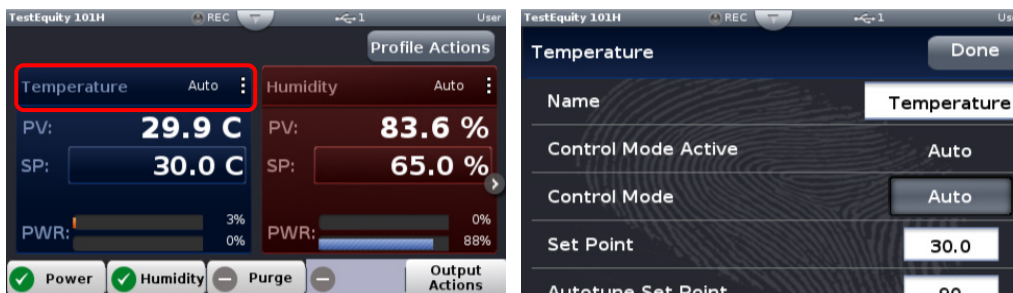
## *Operations Page*

**Control PID Loops**
Provides access to the Loop Operational Parameters as described in the section which proceeds this.

**Profile Events**
Provides access to all Event Outputs. See "Controlling the Events".

**Inputs**
Provides a view of the sensor inputs and any other input which the controller has been configured for.

**Outputs**
Provides a status of the controller's outputs. This screen is read-only.

**Alarms**
Provides a view of the alarm settings.

**Machine Controls**
Provides a view of any internal system variables.
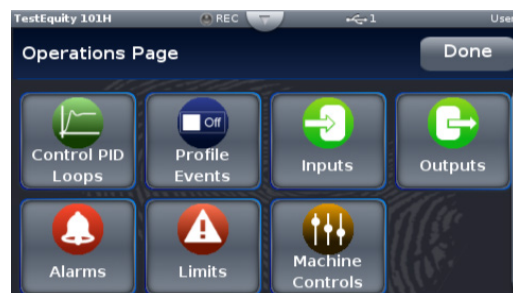
## *Screen Snapshot Utility*

This utility allows you to take a snapshot of any screen. Snapshot functionality is enabled under the Help menu. To turn this function on, press the **?** button and then press the Enable camera icon. The icon will change from Enable to Disable.

Insert a USB thumb drive into the USB host port on the chamber. When Snapshot is enabled, a tap of the **?** button will take a snapshot of the screen and store it on the USB thumb drive. The snapshot file will be saved in a .bmp format.

To disable the Snapshot function, press the Menu button and then the Help icon (you may have to scroll the screen to the end to see the Help icon). Then press the Disable camera icon. The icon will change from Disable to Enable.
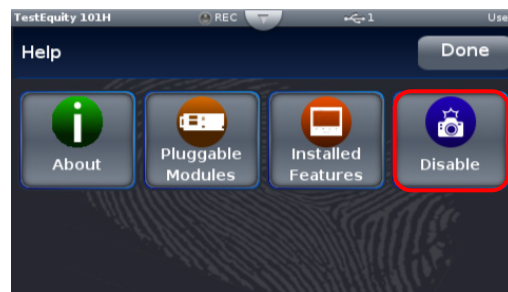
## *Dew Point Utility*

This utility provides a calculation of Dew Point from the chamber temperature and humidity readings. It can be used as a reference only. It serves no other purpose and cannot be graphed, logged, or controlled.

It may be useful to understand Dew Point for several purposes. For example, the low humidity limit of the chamber without GN2 or Dry Air Purge is a 6°C Dew Point. This corresponds to 40% RH at 20°C. If you are already at this condition and are trying to go lower in humidity, you will likely not be able to go much lower.

Another use is to understand why there is condensation on your test sample. If the chamber is at 85°C and 85% RH, the Dew Point will be 81°C. Any surface in the chamber that is just 4°C lower than the air temperature will have condensation on it.

To access the Dew Point calculation, press **Menu**, **Operations**, **Machine Controls**, **Math**, and finally **Math 1**.

There will a 15-second delay before **Machine Controls** is fully populated if it is the first time you press it after turning the Power switch on.

In the example below, **Source Value A** is the chamber temperature (18.5°C), **Source Value B** is the chamber humidity (60.2% RH), and **Output Value** is Dew Point temperature (10.6°C).

## Chapter 5 – Composer Software

### *Installation*

### Overview

Watlow Composer Software can be used to create, edit, and archive profiles. It can also be used to configure the controller. Since the controller is already configured by TestEquity for use in your chamber, configuration instructions are not provided.

### Downloading the Software and System Requirements

Software can also be downloaded directly from www.testequity.com/Composer

In order to install and run this software successfully there are some baseline requirements for PC hardware and operating systems that must be observed. These requirements are listed below:

- 250 Megabytes or more of available hard disk drive space
- 300 Megabytes of available RAM
- Windows® 7 or higher (32 or 64 bit)
- Requires Microsoft® .NET Framework 4.0 (this installs automatically if not already on target machine)

### Installing the Software

To install the software:
1. Double-click the Setup.exe.
2. Select the language of choice and click the OK to proceed.
3. Click the Next button to proceed.
4. After reading the Composer software license agreement click "I accept the terms in the License Agreement" radio button and then click on the Next button to proceed.
5. The next dialog box shows the default directory in which the software will be installed. The install location can be changed by clicking the Browse button and then point to the preferred location.
6. Click Next and then Install.
7. Clicking the Finish button will conclude the installation.

### Network Configuration

See "Chapter 6 – Communications" in this manual for instruction on how to configure the Ethernet communications parameters in the F4T. You might need help from your IT department to configure this to match your computer settings.

## *Composer Welcome Screen Orientation*
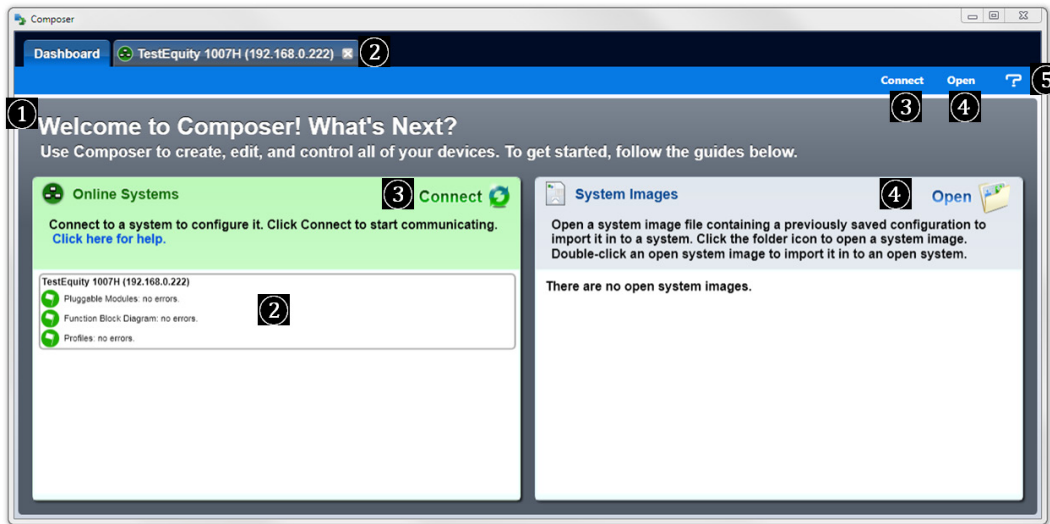
① **Welcome Screen:** Displays options for on-line connections between PC and a controller or opening a previously saved system image.

② **System Screen:** Two columns will be displayed showing connected systems and offline systems.

③ **Connect to a System:** Opens a window showing configured communications ports for selection.

④ **Open a System Image:** Opens a window allowing you to open a previously saved system image to download to a controller.

⑤ **Help:** Allows you to change automatic software update settings, as well as initiate an immediate check for updates (internet connection is required). Clicking on **About** will display technical support contact information and the current firmware versions of the installed software and installed modules.

## *Using Composer Software*

### Establishing an Online Connection to a System Using Ethernet
Connect the chamber to a PC through its Ethernet port.

**Scanning for connected systems:**
From the Welcome or Systems screen click on Connect to a System. A window will open allowing you to select a system. The software will then send a query through the Ethernet port looking for the presence of a controller. If there is a controller present, the software will respond showing the connection that exists. It might take a couple of minutes until the controller is found, especially of the F4T is configured for DHCP instead of a fixed IP address. Double clicking on the system will bring up the System Overview screen shown on the next page.

## *System Overview Screen*

### Dashboard ①

- Clicking on **Dashboard** at any time, will display all devices connected on the system.

### System ②

- Overview
- Save Image
- Save Image As
- Import Image
- Print
- Global Settings
- Security
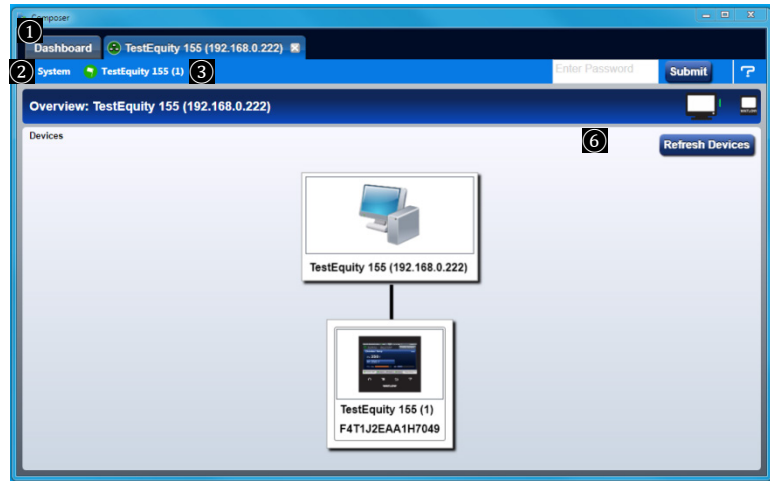
### Device Menus ③

When clicked, a drop down submenu will appear allowing navigation to Device Details, Pluggable Modules, Function Block Diagram, Calibration, and Profile screens.

### Security

The security feature is used to protect the system's configuration and settings from unwanted changes. The Admin user sets what access other users have to the systems features. When security is enabled, a user must enter a password to gain access to protected features through the controller's user interface or Composer software.

There are three configurable user groups and an admin user:

- **User** - no password required, admin sets feature access
- **User with Password** - requires a password, admin sets feature access, is permitted to change the password for this user group.
- **Maintenance User** - requires a password, admin sets feature access, is permitted to change the password for this user group.
- **Admin** - requires a password, has unlimited access to features, sets permissions and passwords for all user groups.

There are four entry levels when trying to acquire access to the controller. Those levels are:

- **User**, no password required with limited access based on settings.
- **User with Password**, password required with limited access based on settings.
- **Maintenance User Password**, password required with limited access based on settings.
- **Admin Password**, password required with full unlimited access.

The admin user can set each user groups' permission to allow full, read-only or no access to the following features:

- **Home**, controls access to controller's home screen.*
- **Control Mode**, controls access to setting the control mode, set points and PID parameters.*
- **Autotune**, controls access to running the autotune feature.*
- **PID Settings**, controls access to the PID settings.*

- **Profiles**, controls access to creating and editing ramp and soak profiles.
- **Global Settings**, controls access to the system's global settings, temperature units, AC line frequency and real time clock setting.
- **Network**, controls access to Ethernet settings.
- **Operations**, controls access to operational parameter settings.*
- **Personalize**, controls access to customizing the controller's home screen.*
- **Data Logging Setup**, controls access to settings for Data Logging.
- **File Transfer**, controls access to transfer of setup, profile, and log files.
- **Diagnostics and Troubleshooting**, controls access to the device details.
- **Setup**, controls access to the pluggable module configuration and the function block diagram.

*This setting limits access to via controller's front panel user interface only, not via Composer.

The image below shows the security levels as configured by TestEquity. You must contact TestEquity to get the passwords for your chamber.



After making all the desired security settings, ensure that the security enabled radio button (top left in the graphic above) is checked. Once security is applied to the controller, only the administrator (Admin) can reconfigure or remove the security.

When the system file is saved, any applied security will be saved with it.

# Save System Image
Located under System ②

## (a) Save
Everything that will be saved is as listed below. After clicking on save image as, the save button will become active (gray to white). This allows a user to make changes to the system image and simply save it to the same location using the same filename.
- Device Details
- Pluggable Modules
- Function Block Diagram in its entirety
- System Security
- Profiles (if any were entered)
- Profile passwords
- All parameters that can be read and written to

## (b) Save As
- Save a system image to a storage device. Saves everything listed above.

**Note:** The real-time clock is not saved or imported.

**Saving a System Image**
To save a system image the first time:
1. On any Composer screen click the Save As button.
2. Use the save as dialog to select the destination folder for the image.
3. Enter the desired filename.
4. Click Save.
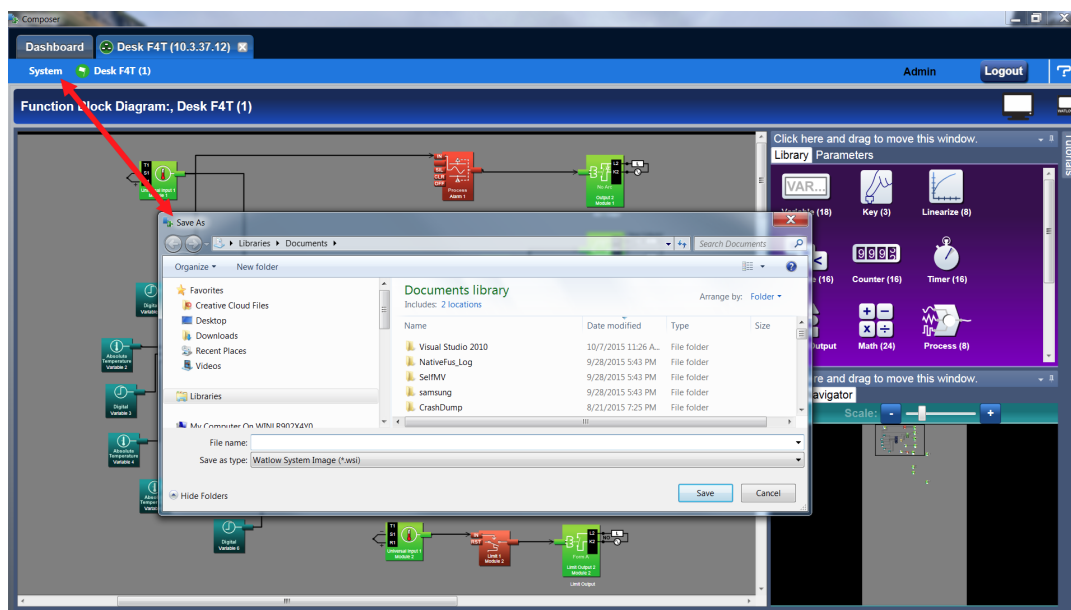


**Note:** The system image filename will always have the extension **wsi** for Watlow System Image and cannot be changed.

# Import System Image

Located under System ②. Restores a system image from a storage device to the controller. The list below shows what is restored:

- Device Details
- Pluggable Modules
- Function Block Diagram in its entirety
- System Security
- Profiles
- Profile passwords
- All parameters that can be read and written to

**Importing a System Image**

**NOTE:** We recommend changing the IP Address Mode to Fixed instead of DHCP when importing a system image. You might need help from your IT department to configure your computer to match this setting.

To import a system image:
1. On any Composer screen click the Import System Image button.
2. Use the open dialog to select the folder location for the previously saved system image.
3. Double-click the desired filename or single-click the filename and then click the Open button.
4. After a system image is imported, we suggest you cycle power to the F4T Controller and restart Composer software.
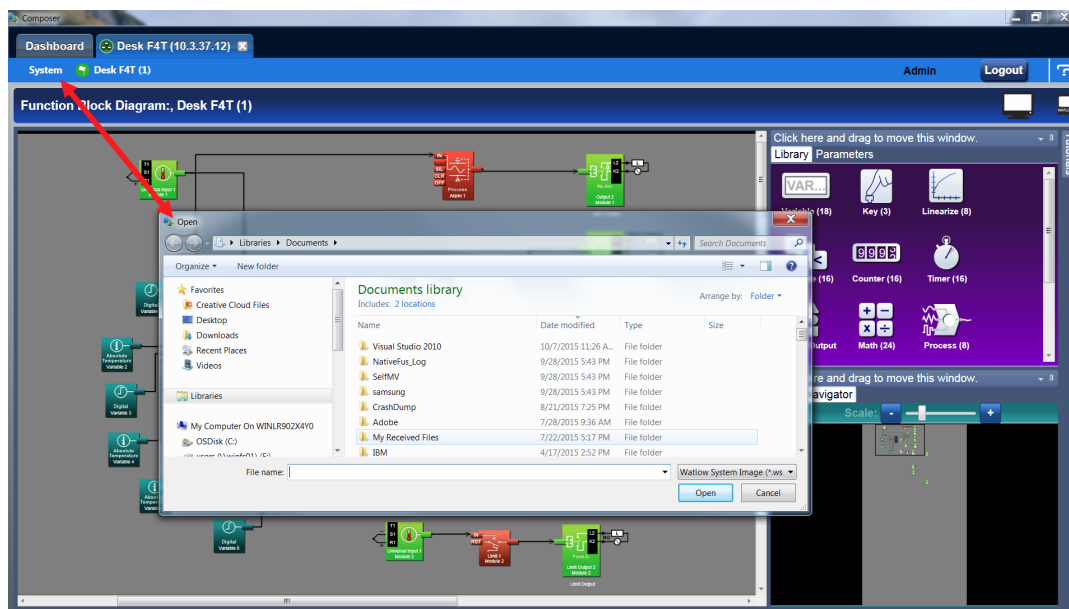
## Global Settings

Located under System ②.

- **Temperature Units** - will determine how the temperature is displayed (Fahrenheit or Celsius) on the front panel of the controller as well as throughout all configuration screens within Composer.
- **AC Line Frequency** - variable time outputs use this setting. This setting is not relevant to TestEquity chambers.
- **Date and Time** - sets the date and time to the current computer time and date or whatever the user enters.

## *Device Details*

The Device Details screen allows a user to make changes to the system settings described below. Descriptions are numbered correspondingly in the graphic below.

## Device Name ①

Changes the name of the controller for easy identification.

**Note:** This name will also be displayed in the upper left corner of the user interface.

## Restore Settings From ②

**None** - no action.
**Factory** - allows a user to bring the controller back to the factory default state. This is **NOT** the TestEquity default state and all configurations will be erased.

⚠ **CAUTION:**   NEVER select "Factory" in the Restore Settings From prompt in the Device Details menu in Composer Software. This will erase all controller configuration settings. The chamber will not work if you do this.

To change any of the settings described above follow the steps below:
1. From the Menu bar click on Zone 1.
2. Within the drop-down menu click on Device Details.
3. Make desired changes (all changes are saved immediately).

## *Pluggable Flex Modules*

This controller can have up to six Flex Modules (FM) installed in the chassis. The presence of each FM must be confirmed and accepted using Composer software. FMs can be fully configured as installed hardware or the user can type in a valid FM part number for later installation. The **Pluggable Module Screen** shows what modules are installed.

TestEquity has already installed and configured the correct modules for your chamber. Since this is not intended to be an ordinary user function, no further instructions will be covered in this manual.

## *Creating and Editing Profiles in Composer Software*

This section describes the features of the Profile View in Composer Software and includes instructions for using it. A profile is a set of instructions consisting of a sequence of steps. When a profile runs, the controller automatically executes its steps in sequence.

**Profile View Orientation:** Describes the layout of the profile screens.

**Profile Parameters:** Settings that apply to a profile.

**Step Parameters:** Settings that apply to a step.

**Opening the Profile View:** Displays the list of profiles in the device.

**Creating Profiles:** Up to 50 profiles can be created.

**Saving a Profile:** Store profiles on the computer to make it easy to load them in other controllers or to restore one that was inadvertently changed or deleted from the controller.

**Loading a Profile:** Loads a profile that was previously saved to the controller's memory.

**Duplicating a Profile:** An easy way to create a new profile similar to one that was created previously.

**Deleting a Profile:** Removes unneeded profiles from the controller memory freeing up space for new profiles.

**Opening the Step Editor:** Displays the details of the step.

**Adding Steps:** Up to 50 steps can be included within any given profile.

**Inserting Steps:** Create a new step at a specific point in a profile.

**Deleting Steps:** Remove a step from a profile.

**Password Protect a Profile:** Avoid unwanted and inadvertent changes to a profile with password protection.

**Changing or Removing a Password from a Profile:** When password protection is no longer needed it can be easily removed.

## Profile View - Screen Orientation

The Profile View has the following features, numbered correspondingly in the graphic below.
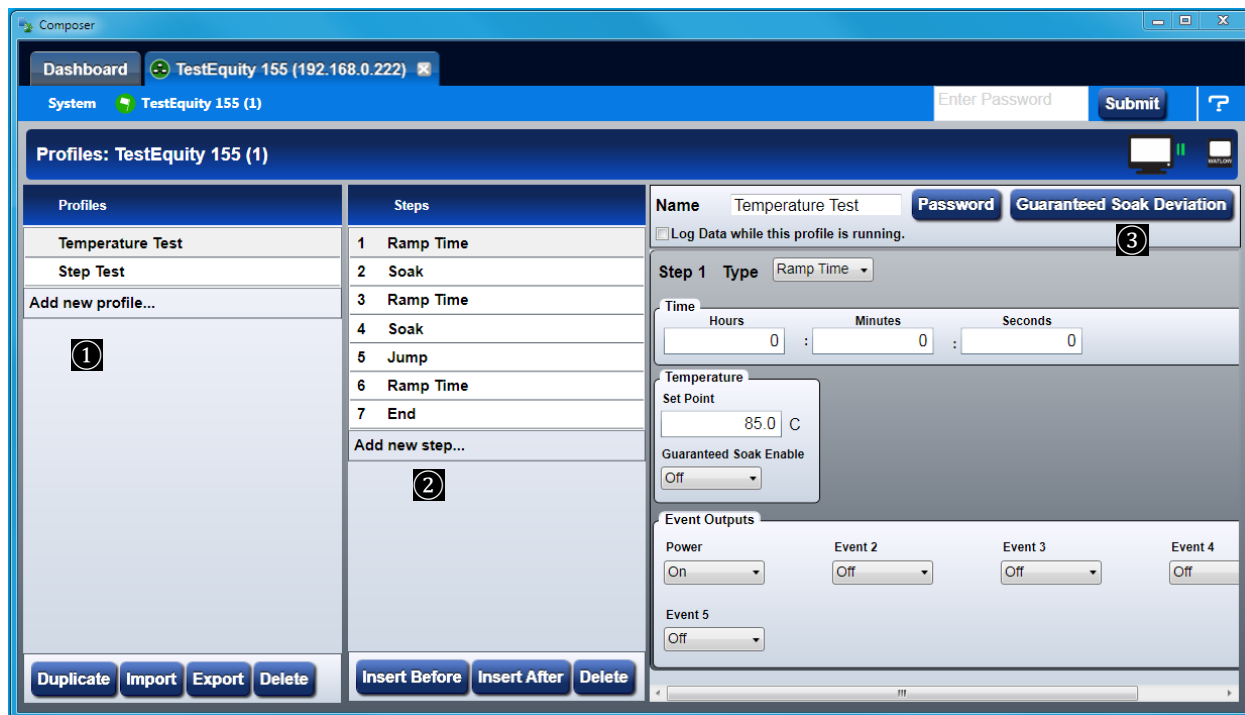


①  **Profile List**

- In this column, a user can view all currently existing profiles as well as whether or not the profile has password protection.
- You can use **Add new profile...** or the buttons at the bottom to delete, duplicate, import, or export profiles.

②  **Step List**

- Shows all currently existing steps for the selected profile ("Temperature Test" in the example above).
- You can use **Add new step...** or the buttons at the bottom to insert or delete a step.

③  **Step Detail**

- Shows all available selections for the selected step while also allowing each to be modified.
- You can give the profile a name as well as apply password protection.

## Profile Parameters

The following settings apply to the entire profile.

### Name

- User-entered identifier for the profile. The name follows the profile when it is saved in a file or moved to another controller.

### Password

- User-set code that must be entered prior to editing a protected profile. A password may consist of up to ten characters, may include letters, numbers or symbols and is case sensitive.

### Guaranteed Soak Deviation/Guaranteed Soak Values

- The amount by which the actual chamber temperature or humidity is allowed to differ from the set point for steps with Guaranteed Soak Enable set to **On**. In such steps when the actual chamber temperature or humidity differs from the set point by more than this value, the step timer stops running until the actual chamber temperature or humidity returns to within the band defined by the set point plus or minus this value. Each profile can have its own set of Guaranteed Soak values.

### Data Logging

- Check "Log Data while the profile is running" to automatically initiated data logging during this particular profile.

## Step Parameters

The following parameters set the behavior of a profile's steps. Only the parameters that apply to the selected step type appear in the step detail.

**Step Type**

Set the behavior of the step. Step Type options include:

- **Rate:** adjusts the temperature or humidity set point at the user-set Rate of change until it reaches the step's Set Point.
- **Soak:** maintains the temperature or humidity set point constant for the step's Time.
- **Jump:** repeats previous steps in the profile starting at the step set with Jump to Step for the Number of Times set. This option is not available for step 1.
- **Ramp Time:** adjusts the temperature or humidity set point gradually from the previous set point to the step's Set Point over the step's Time.
- **State:** sets the temperature or humidity set point to the step's Set Point without ramping from the previous set point and holds that set point for the step's Time.
- **Instant Change:** sets the temperature or humidity set point to the step's Set Point without ramping from the previous set point and holds that set point for the step's Time.
- **Wait For Process or Event:** holds the profile until the specified conditions on the event inputs are met. When multiple conditions are specified, the profile will not proceed until all the conditions are satisfied at the same time.
- **END:** Sets the temperature/humidity set points, and event output conditions when the profile ends.

**Time: Hrs Min Sec:** Set the duration of the step.

**Ramp Time:** Set the speed at which the temperature or humidity set point is increased or decreased to the step's Set Point value.

**Set Point:** Set the value to which the loop's set point is changed by the step.

**Guaranteed Soak Enable**
- Set **On** to prevent step time from elapsing whenever the loop's process value differs from its Set Point by more than Guaranteed Soak Value for the loop.

**Event Input 1 to Event Input 4**
Only applicable if controller has Event Inputs configured. Set the condition on each input for a Wait For step. Event Input options include:
- **None:** do not wait for this input.
- **On:** wait until a digital input is on or true.
- **Off:** wait until a digital input is off or false.
- **Greater Than:** wait until the process value is greater than the setting of the corresponding Input Value parameter.
- **Less Than:** wait until the process value is less than the setting of the corresponding Input Value parameter.

**Input 1 Value to Input 4 Value**
- Set the process value against which the corresponding condition is evaluated in a Wait For step.

**Jump To Step**
- Set the step number at which the profile should begin to repeat steps.

**Number of Times**
- Set the how many times the Jump Loop step repeats the previous profile steps.

**Note:** Number of Times is the number of times the steps are repeated not including the time they are executed prior to reaching the Jump Loop step. For example if step 5 of a six step profile is a Jump Loop with Jump To Step set to 2 and Number of Times set to 1, when the profile is run starting at step 1 it executes steps as follows: 1, 2, 3, 4, 5, 2, 3, 4, 5, 6.

**Event Outputs: Event Output 1 to Event Output 4**
Set the state to which the profile sets each event output at the start of the step. Event Output options include:
- **On:** the step sets the event output on or true.
- **Off:** the step sets the event output off or false.
- **Unchanged:** the step does not set the event output; it remains in whatever state was previously set.

**End Action**
Set what the Temperature or Humidity condition will be after the profile is complete. See page 30 for more information. Options include:
- **User:** program will end with the same Temperature and Humidity Static Set Point values that were entered before the profile was run.
- **Off:** the Temperature and Humidity control mode is set to Off.
  **NOTE:** Selecting **Off** as the End Action is not recommended. See page 30 for more information.
- **Hold:** the Temperature and Humidity Set Point is set to the last value used in the profile.

## Opening the Profile View
To view the profile listing:
1. Click the device to view the device toolbox.
2. Click **Profiles** to bring up the profile listing.

## Creating Profiles
To create a new profile in the controller:
1. Click the **Click to add...** button.
2. If desired, click in the Name field and change the profile's name.

**Note:** A profile name is limited to 20 characters.

## Saving a Profile to a Storage Device
To save a profile:
1. Select the profile by clicking it in the profile list.
2. Click the **Save** button at the bottom of the profile list.
3. Use the Save As dialog to edit the name and select the desired location and click the **Save** button.

**Hint:** Save is an option on the profile pop-up menu.

**Note:** A profile that has a password applied will be saved with the password.

## Loading a Profile
To load a profile previously saved on the computer in to controller memory:
1. Click the **Load** button.
2. Use the open dialog to locate and select the desired profile file.
3. Click Open.

## Duplicating a Profile

To duplicate a profile:

- Right-click the profile and click **Duplicate** in the pop-up menu.

Or

- Click the profile, then click the **Dup** button at the bottom of the profile list.

**Notes:**

- The duplication process automatically appends the duplicated profile to the end of the profile list.
- If a profile is locked with a password and duplicated, the duplicated profile is not pass-word protected.
- The name of the duplicate profile is the original profile's name with the words "Copy of" added to the beginning. The result may be truncated so as not to exceed 20 characters.

## Deleting Profiles

To delete a profile:

- Right-click the profile, click **Delete** in the pop-up menu and then click **OK** to confirm

Or

- Click the profile, click **Delete** button at the bottom of the profile list and then click **OK** to confirm.

Or

- Click the profile, press the **Delete** key on the computer keyboard and click **OK** to confirm.

## Opening the Step Editor

To open the step editor:

- Click any step in the step list.

## Adding Steps

To add a step to a profile:

- Right-click a step and choose **Add** in the pop-up menu

Or

- Click the **Click to Add...** button in the step list.

**Hint:** When clicking on **Add new step...**, if a step is selected, a duplicate of the selected step is added, if no step is selected, a duplicate of the last step is added.

## Inserting Steps

To insert a new step ahead of an existing step:

- Right-click the step and choose **Insert Step Before** in the pop-up menu.

Or

- Click the step and then click the **Insert Before** button at the bottom of the step list.

## Deleting Steps

To delete a step:
- Right-click the step and choose **Delete Step** in the pop-up menu.

Or
- Click the step and then click the **Delete** button at the bottom of the step list.

Or
- Click the step and press the **Delete** key on the computer keyboard.

## Password Protect a Profile

To avoid inadvertent changes to a profile, apply password protection to it.

To set a password for a profile:
1. Click the **Password** button.
2. In the dialog box enter a password (10 characters maximum).
3. Re-enter the same password to verify it.
4. Click **OK**.

**Note:** A password protected profile requires the password be entered to edit but not to copy it or to delete it. If the profile is duplicated, the duplicate is not password protected.

## Changing or Removing a Password from a Protected Profile

To change or remove a profile's password, the password must be known.

To change a profile's password:
1. Select the profile by clicking it in the profile list.
2. Enter the password and click **OK**.
3. Click the **Password** button.
4. Enter a new password (10 characters maximum).
5. Re-enter the same password to verify it.
6. Click **OK**.

To remove a profile's password:
1. Select the profile by clicking it in the profile list.
2. Enter the password and click **OK**.
3. Click the **Password** button.
4. Click the **Remove** button.

# Chapter 6 – Communications

## *Ethernet Parameters*
This section describes how to configure the Ethernet Communications settings in the F4T controller.

## Changing Ethernet Parameters
1. Press the **Menu**, **Settings** and **Network** buttons, in that order.
2. Under **Communications Channels** press **Ethernet**.
3. Change the desired settings.
4. Recycle the power to put the new settings into effect.

## Ethernet Parameters and Settings
The bracketed bold settings below represent the defaults as delivered from the factory:
- **IP Address Mode**: [DHCP], Fixed
    - DHCP, Dynamic Host Configuration Protocol, allows for dynamic distribution of network settings by a DHCP server.
    - Fixed, also referred to as a static IP address, is configured manually for a specified network.
- **Actual IP Address**: [192.168.0.222]
- **Actual IP Subnet**: [255.255.255.0]
    - Subnet, a method used to logically divide and isolate networks.
- **Actual IP Gateway**: [0.0.0.0]
    - Gateway, is a device used on the network to route messages with IP addresses that do not exist on the local network.
- **MAC Address**: xx:xx:xx:xx:xx:xx (Will be different and unique for each controller)
    - MAC address, is a manufacturer supplied address for the network interface card.
- **Display Units**: °F, °C [configured by TestEquity for °C]
- **Modbus® TCP Enable**: [Yes], No
    - Modbus is an industrially hardened field bus protocol used for communications from the controller to other devices on the network.
- **Modbus Word Order**: [High], Low
    - Modbus allows a user to select the word order of two 16-bit words in floating point values.
- **Data Map**: [1], 2
    - Data Map, the user can switch Modbus registers from the comprehensive listing of F4T registers.
    - Map 1 = F4T registers (default)
    - Map 2 = Limited set of F4 compatible registers (for compatibility with software written for the F4)

## *RS-232 Parameters*

This section describes how to configure the RS-232 Modbus Communications settings in the F4T controller.

## Changing RS-232 Parameters

1. Press the **Menu**, **Settings** and **Network** buttons, in that order.
2. Under **Communications Channels** press **Modbus**.
3. Change desired settings.
4. Recycle the power to put the new settings into effect.

## RS-232 Parameters and Settings

The bracketed bold settings below represent the defaults as delivered from the factory:

- **Modbus Address**: [1]
    - Each device is given a unique address. Up to 247 devices can be on the same data link.
- **Baud Rate**: [9600]
    - Must match the baud rate of your computer's serial port and software.
- **Parity**: [None]
    - Must match the parity of your computer's serial port and software.
- **Display Units**: °F, °C [configured by TestEquity for °C]
- **Modbus Word Order**: [High], Low
    - Modbus allows a user to select the word order of two 16-bit words in floating point values.
- **Data Map**: [1], 2
    - Data Map, the user can switch Modbus registers from the comprehensive listing of F4T registers.
    - Map 1 = F4T registers (default)
    - Map 2 = Limited set of F4 compatible registers (for compatibility with software written for the F4)

## *Modbus*

The F4T controller is equipped with Modbus® TCP as an embedded protocol.

## Introduction to the Modbus Protocol

Modbus provides the advantage 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. Each parameter has a unique Modbus register number.

All Modbus registers are 16-bits and are listed in the following table as relative addresses (actual). Some F4T parameters are contained within 32 bits (IEEE Float, signed 32 bit). Notice that only one (low order) of the two registers is listed on the next page. By default, the low order word contains the two low bytes of the 32-bit parameter. As an example, in the table below see Actual Chamber Temperature. Note that it lists register 27586. Because this parameter is a float, it is actually represented by registers 27586 (low order bytes) and 27587 (high order bytes). The Modbus specification does not dictate which register should be high or low order therefore, the controller provides the user the ability to swap this order.

## F4T and F4 Modbus Mapping

For making an easy transition from the F4 to the F4T controller using Modbus, a special set of the most commonly used F4 registers were created. Notice that there are two tables of Modbus registers, they are unique sets of registers (not interchangeable) and the user must select one set or the other when implementing using Modbus.
- Map 1 = F4T registers (default)
- Map 2 = Limited set of F4 compatible registers (for compatibility with software written for the F4)

To change the Modbus mapping using the F4T front panel:
1. From any screen, press the **Menu** button
2. Press the **Settings** button and then the **Network** button
3. Select the **Ethernet** (for LAN) or **Modbus** (for RS-232) communications channel
4. Scroll the screen down to find **Data Map** and select **1** (for F4T) or **2** (for legacy F4 Compatibility Mode).
5. Recycle the power to put the new settings into effect.

## Common Modbus Registers

The following registers are applicable in the F4T Mode (Data Map 1). These are the most common registers that would need to be used in an automation environment.

Some F4T parameters are contained within 32 bits (IEEE Float). Notice that only one (low order) of the two registers is listed. By default, the low order word contains the two low bytes of the 32-bit parameter. As an example, in the table below see Actual Chamber Temperature. Note that it lists register 27586. Because this parameter is a float, it is actually represented by registers 27586 (low order bytes) and 27587 (high order bytes).

| Parameter Name | Register | Data Type and Access (Read or Write) |
|---|---|---|
| Temperature Set Point | 2782 | IEEE Float RW |
| Closed Loop Set Point* | 2810 | IEEE Float R |
| Actual Chamber Temperature | 27586 | IEEE Float R |
| | | |
| Humidity Set Point | 2942 | IEEE Float RW |
| Closed Loop Set Point* | 2970 | IEEE Float R |
| Actual Chamber Humidity | 28906 | IEEE Float R |
| | | |
| Event 1 | 16594 | 16-bit RW |
| Event 2 | 16596 | 16-bit RW |
| Event 3 | 16598 | 16-bit RW |
| Event 4 | 16600 | 16-bit RW |
| Events 1-4 | Off = 62, On = 63 | |

* Instantaneous Set Point during a ramp or profile

**Manual Ramp Parameters (Ramp to Set Point without a profile)**

| | | |
|---|---|---|
| Ramp Action (Temperature) | 2794 | |
| | Off = 62 | |
| | Startup = 88 | |
| | Set Point = 85 | |
| | Both = 13 | |
| | | |
| Ramp Scale (Temperature) | 2796 | |
| | °/Minutes = 57 | |
| | °/Hours = 39 | |
| | | |
| Ramp Rate (Temperature) | 2798 | |

## F4 Compatibility Mode (Data Map 2)

The following common registers are available in the F4 Compatibility Mode (Data Map 2). This will allow you to use software that was written for the original F4 Controller. Only a limited set of parameters are available in this compatibility mode, but it should be sufficient for most applications.

| Parameter Name | Register | Data Type and Access (Read or Write) | |
|---|---|---|---|
| Temperature Set Point | 300 | 16-bit Signed RW | |
| Actual Chamber Temperature | 100 | 16-bit Signed R | |
| Temperature Input Precision | 606 | 16-bit Signed RW | 0 (0), 0.0 (1), 0.00 (2), 0.000 (3) |
| °C or °F | 901 | 16-bit Signed RW | °C (1), °F (0) |
| Humidity Set Point | 319 | 16-bit Signed RW | |
| Actual Chamber Humidity | 104 | 16-bit Signed R | |
| Humidity Input Precision | 616 | 16-bit Signed RW | 0 (0), 0.0 (1), 0.00 (2), 0.000 (3) |
| | | | |
| Temperature Input Error | 101 | 16-bit R | No Error = 0, Error = 1 |
| Humidity Input Error | 105 | 16-bit R | No Error = 0, Error = 1 |
| | | | |
| Event 1 | 2000 | 16-bit RW | Off = 0, On = 1 |
| Event 2 | 2010 | 16-bit RW | Off = 0, On = 1 |
| Event 3 | 2020 | 16-bit RW | Off = 0, On = 1 |
| Event 4 | 2030 | 16-bit RW | Off = 0, On = 1 |
| | | | |
| Profile Action: | | | |
| Resume Profile | 1209 | 16-bit R | |
| Hold Profile | 1210 | 16-bit W | |
| Terminate Profile | 1217 | 16-bit W | |
| | | | |
| Profile Start: | | | |
| Profile Start File # | 4000 | 16-bit W | |
| Profile Start Step # | 4001 | 16-bit W | |
| | | | |
| Profile Action Start: | 4002 | 16-bit W | Create (1) |
| | | | Insert Step (2) |
| | | | Delete Current profile (3) |
| | | | Delete Step (4) |
| | | | Start Profile (5) |
| | | | Delete all Profiles (256) |

## SCPI Programming Mode

SCPI commands are ASCII text strings with a wide array of defined SCPI commands, all of which are not included in this implementation. The SCPI protocol is only available over Ethernet port 5025. The only available SCPI commands for the F4T are shown below.

**For :CLOOP#** – CLOOP1 is Temperature, CLOOP2 is Humidity.
Example :SOURCE:CLOOP1:PVALUE? (read the value for chamber temperature)
Example :SOURCE:CLOOP2:PVALUE? (read the value for chamber humidity)

| Description | SCPI Command | SCPI Values | R/W | Comments |
|---|---|---|---|---|
| Query Temperature units | :UNIT:TEMPERATURE? | C\|F | R | Ethernet display units |
| Set Temperature units to F | :UNIT:TEMPERATURE F | | W | Ethernet display units to Fahrenheit |
| Set Temperature units to C | :UNIT:TEMPERATURE C | | W | Ethernet display units to Celsius |
| | | | | |
| Read Temperature PV (Control loop) | :SOURCE:CLOOP#:PVALUE? | *<floating point value>* | R | Source Value A |
| Query input error | :SOURCE:CLOOP#:ERROR? | ERROR\|NONE | R | Input error status |
| Read SP | :SOURCE:CLOOP#:SPOINT? | *<floating point value>* | R | Set Point Active Closed |
| Write SP | :SOURCE:CLOOP#:SPOINT *<value>* | | W | User Set Point |
| Read Idle SP | :SOURCE:CLOOP#:IDLE? | *<floating point value>* | R | Idle Set Point |
| Write Idle SP | :SOURCE:CLOOP#:IDLE *<value>* | | W | Idle Set Point |
| | | | | |
| Set ramping off | :SOURCE:CLOOP#:RACTION OFF | | W | controls instantly to set point |
| Set ramping on startup | :SOURCE:CLOOP#:RACTION STARTUP | | W | ramps to set point on controller power on |
| Set ramping on set point change | :SOURCE:CLOOP#:RACTION SETPOINT | | W | ramps to set point on change of set point |
| Set ramping on both events | :SOURCE:CLOOP#:RACTION BOTH | | W | ramps to set point on controller power on OR change of set point |
| Write ramp scale to minutes | :SOURCE:CLOOP#:RSCALE MINUTES | | W | ramp rate is per minute |
| Write ramp scale to hours | :SOURCE:CLOOP#:RSCALE HOURS | | W | ramp rate is per hour |
| Read ramp rate | :SOURCE:CLOOP#:RRATE? | *<floating point value>* | R | rate that controller ramps to set point |
| (as above - for backward compatibility) | :SOURCE:CLOOP#:RTIME? | *<floating point value>* | R | |
| Write ramp rate | :SOURCE:CLOOP#:RRATE *<value>* | | W | rate which controller ramps to set point |
| (as above - for backward compatibility) | :SOURCE:CLOOP#:RTIME *<value>* | | W | |
| | | | | |
| Set event output on | :OUTPUT# ON | | W | # = outputs 1-7 |
| Set event output off | :OUTPUT# OFF | | W | # = outputs 1-7 |
| Query event output state | :OUTPUT#? | OFF\|ON | R | # = outputs 1-7 |
| | | | | |
| Select a profile | :PROGRAM:NUMBER *<value>* | 1-40 | W | selects the desired profile to control |
| Read selected profile name | :PROGRAM:NAME? | *<string value>* | R | the selected profile |
| Select a step | :PROGRAM:STEP *<value>* | 1-50 | W | the selected profile |
| start profile | :PROGRAM:STATE START | | W | the selected profile |
| stop profile | :PROGRAM:STATE STOP | | W | the selected profile |
| pause profile | :PROGRAM:STATE PAUSE | | W | the selected profile |
| resume profile | :PROGRAM:STATE RESUME | | W | the selected profile |
| | | | | |
| Identification | *IDN? | "Watlow Electric",*<string value>*,*<integer value>*,*<string value>* | | |
| | (manufacturer) | | R | |
| | (model number) | | | |
| | (serial number) | | | |
| | (firmware level) | | | |

## GPIB and Ethernet Modbus Interface Converters (optional)

## Serial Modbus-to-GPIB Converter (Option 1052)

Your chamber may have been ordered with a GPIB Interface option. GPIB communications is achieved through an ICS Electronics 4899A (external, TestEquity Option 1052) GPIB-to-Modbus Interface Converter. The ICS 4899A converts GPIB commands to serial Modbus commands that are transmitted over RS-232. The GPIB Converter also takes care of calculating block checksums that are required for communications to and from the F4T Controller. For more details, see the documentation that came with the GPIB interface option.

**NOTE:** Composer software will only work with the native F4T Ethernet interface and Data Map 1, not the Serial Modbus-to-GPIB Converter.

## Serial Modbus-to-Ethernet Converter (Option 1056)

Your chamber may have been ordered with a Serial Modbus-to-Ethernet Interface option. GPIB communications is achieved through an ICS Electronics 9099 (TestEquity Option 1056). The programming syntax is the same as the GPIB Interface Converter mentioned above. For more details, see the documentation that came with the Ethernet interface option.

**NOTE:** Composer software will only work with the native F4T Ethernet interface and Data Map 1, not the Serial Modbus-to-Ethernet Converter.

**Why use the Ethernet Converter when the F4T Controller has an Ethernet Interface?**
The native F4T Ethernet Interface uses the Modbus TCP protocol. The 1056 Ethernet Interface Converter converts the controller's RS-232 Modbus interface to Ethernet. The converter takes care of the Modbus packet formatting so the command structure is simplified. The most compelling reason why you would want to use 1056 Ethernet Interface Converter instead of the F4T's native Ethernet interface is if you wanted to program using simple ASCII commands instead of Modbus packets.

## Programming Syntax for the F4T Controller

The following applies if the F4T serial interface is configured for Data Map 1. **This only applies for programming through the GPIB or Ethernet Modbus converters.**

The F4T Controller uses two consecutive register to control a value or to read back a process variable. The two registers hold an IEEE-754 32-bit floating point word. The registers are read and written to in the low word-upper word order. The RF? query reads a 32-bit floating point value from two sequential register in low word-upper word order. The RF? does not require the number of registers to read since it is fixed at two registers.

Some registers in the F4T Controller are 16-bit words.

**Modbus Register Read / Write Commands**

The RF command reads the num value in floating point format to two consecutive registers starting with the low word register. Use this to read 32-bit floating point registers.

**RF?** reg            Read 32-bit floating point register command

The R command reads the numeric value in one register. Use this to read 16-bit registers.

**R?** reg, 1         Read 16-bit register command

The WF command writes the num value in floating point format to two consecutive registers starting with the low word register.

**WF** reg, data    Write register command
                        Reg = Modbus register plus next consecutive register
                        Data = ASCII data written as a direct numerical value

**Examples:**

Write Temperature Set Point      WF 2782, value

Read Chamber Temperature       RF? 27586
Read Closed Loop Set Point      RF? 2810 (instantaneous temperature set point during a ramp or profile)

Turn (Event 1) ON            W 16594, 63      Event 1 is "Power"
Turn (Event 1) OFF           W 16594, 62

**Manual Ramp Parameters (Ramp to Set Point without a profile)**

Ramp Action (Temperature)      W 2794, ## (where ## is one of the four choices below)
Off = 62
Startup = 88
Set Point = 85
Both = 13

Ramp Scale (Temp. °/Minutes)   W 2796, 57
Ramp Scale (Temp. °/Hours)    W 2796, 39
Ramp Rate (Temperature)      WF 2798, value (0 to 99,999)

## Chapter 7 – 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 dew point, 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. A condensate drain is provided to remove condensate from the chamber.

**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 – Control tolerance is a measure of how much the temperature varies over a short term, 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 ±0.3°C, or a total of 0.6°C. The actual temperature where the controller settles might not be arithmetically within the center of the total 0.6°C deviation due to the characteristics of proportional control systems. For example, the temperature set point may be 23.0°C. The actual temperature varies between 22.8°C and 23.4°C. This corresponds to –0.2°C and +0.4°C or a total of 0.6°C of RELATIVE variations. These specifications are for an empty chamber. The addition of a test sample may affect 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 F4T published accuracy is ±2.0°C. However, the total measurement accuracy in the chamber includes the RTD sensor accuracy. RTD sensor 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 ±3°C, although the typical accuracy is actually better than ±1.0°C.

**Can I operate or transport the chamber on its side?**
No, the chamber can only be operated or transported in the upright position. Operating or transporting the chamber on its side may 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. This system uses refrigerant R-449A.

# Chapter 8 – Specifications

| | |
|---|---|
| **Temperature Range** | –18°C to +130°C |
| **Control Tolerance** | ±0.5°C (Short-term variations measured at the control sensor after stabilization) |
| **Temperature Uniformity** | ±1.0°C (Variations throughout the chamber from nominal after stabilization, measured at least 2-inches from the walls, in the range of -15°C to +100°C) |

| | |
|---|---|
| **Standard Humidity Range** | 10% to 95%, in the temperature range of 10°C to 85°C limited by a 6°C Dew Point; See chart for limitation. |
| **Control Tolerance** | ±3%RH (Short-term variations measured at the control sensor after stabilization) |

| **Live Load Capacity @** | **+23°C** | **0°C** | **–5°C** | **–10°C** | **–15°C** |
|---|---|---|---|---|---|
| | 300 W | 170 W | 135 W | 85 W | 65 W |

(Live load capacity is for non-humidity mode)

| **Cool Down Transition Time\*** | | | | **End Temp** | |
|---|---|---|---|---|---|
| **Start Temp to** → | **+23°C** | **0°C** | **–10°C** | **–15°C** | **–18°C** |
| **+23°C** | ---- | 10 min | 17 min | 27 min | ultimate |
| **+85°C** | 10 min | 20 min | 30 min | 47 min | ultimate |

**Heat Up Transition Time\*** 4.8°C/minute from -15°C to +85°C

**\*Note:** Transition times are measured after a 2-hour soak at the respective start temperature with an empty chamber, as indicated on the temperature controller, 23°C ambient. Measured with setpoint beyond the start and end temperatures. Does not include the effect of proportional band when approaching setpoint.

| | |
|---|---|
| **Input Power** | 120 V nominal (110 to 126 VAC), 60 Hz, 1 PH<br>Max Current Draw 10 A, Recommended Minimum Service 15 A |
| **Workspace Dimensions** | 13.8"W x 11.8"H x 11.8"D, 1.1 cubic feet |
| **Outside Dimensions** | **Benchtop Model 101H-B**<br>23.25"W x 36"H x 28.7"D (nominal), 200 lbs.<br><br>**Floor-Standing Model 101H-F**<br>23.25"W x 62.3"H x 28.7"D (nominal), 250 lbs. |
| **Min. Installed Clearance** | 12" from the rear. Full access to left side is required for routine maintenance when draining the internal water tank and changing the water filter. Full access to the top is required to manually fill the internal water reservoir. |
| **Access Ports** | 3" Port on left and right side (two total), Supplied with foam plugs |
| **Sound Level** | 66 dBA (A-weighted, measured 36" from the front) |
| **Air Flow inside Chamber** | 100 SCFM |
| **Heat Load Into Room** | 2000 BTUH (Maximum rated chamber load at maximum cooling rate from high temperature soak.) |
| **Water Requirement** | Built-in reservoir requires an initial fill of 1 to 2 gallons of Single-Distilled or De-Ionized Water. Use of unfiltered tap water will damage the humidity system and void the warranty. Built-in water recirculation system with filter returns condensate to internal water storage tank. May be plumbed to a source of Single-Distilled or De-Ionized Water, maximum 50 psi. Negligible water consumption. Built-in water recirculation system with filter returns condensate to internal water storage tank so no drain line is required. |

**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. Operation above 30°C (85°F) or below 16°C (60°F) ambient is not recommended. Due to continuous product development, specifications are subject to change without notice.

# Chapter 9 – Maintenance

## *Preventive Maintenance Schedule*

**Daily or As Needed**
- Clean chamber interior and exterior.
- Listen for abnormal noise or vibration.

**Every 2 Months or As Needed**
- Drain the Humidity Reservoir.

**Every 3 Months or as Needed**
- Inspect or replace the water recirculation filter cartridge.

**Every 6 Months**
- Inspect the door seal.
- Clean the condenser.

**Every 12 Months**
- Inspect the electrical/refrigeration compartment.
- Verify the chamber performance.
- 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 drain the reservoir

1. Unplug the chamber from the power source.

2. Unscrew the reservoir cover from the top of the chamber and inspect the water. If the water looks dirty or has particulates it should be drained and refilled.

3. If the chamber is connected to a plumbed water source, turn off the water feed.

4. Connect the supplied elbow fitting and hose to the Maintenance Drain.

5. Allow water from this hose to drain into a bucket which can hold at least 2.5 gallons of water. This bucket must be at a level below the chamber to permit water to flow by gravity.

6. Locate the Drain Valve access panel towards the back-left side of the chamber. Remove the screws which hold the access panel in place.

7. Turn the Drain Valve handle counter-clockwise to open the valve. Water will now drain from the hose connected to the Maintenance Drain into the bucket. When the water has finished draining, turn the Drain Valve clockwise to close it. Reattach the access panel.

8. If you are using the chamber in a stand-alone mode without any plumbing, refill the water reservoir with. 1 to 2 gallons of supermarket-grade distilled water or deionized water. **Do not use unfiltered tap water! Do not use lab-grade double-distilled water!**

9. If the chamber is connected to a plumbed and filtered water source, turn the water supply back on. The reservoir will automatically re-fill to the correct level.
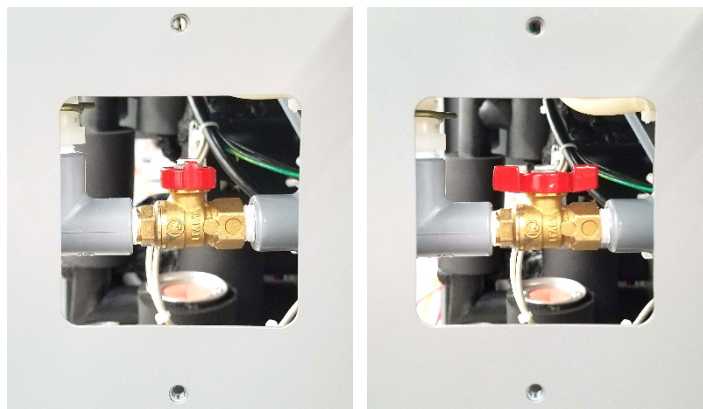


Closed (normal operational) position.     Open (maintenance) position

## How to inspect/change the water recirculation system filter cartridge

1. The color of the top half of the cartridge changes gradually from white to brown through continued use. If the top half is completely brown it should be replaced. Replacement cartridges are available from TestEquity (our part number 383911).

2. Use a screwdriver to loosen the clamps from the bottom and top of the filter and remove the tubing from the barbed fitting on the filter. Be prepared to catch a small amount of water from the tubes and bottom of the filter with a rag or paper towel.

3. Lift the filter up to disengaged it from the bottom flange and then pull the bottom of the filter towards you. Then, pull the filter out of the top flange. Perform the installation in the reverse order.

4. If you are using the chamber in a stand-alone mode without any plumbing, refill the water reservoir per the Water Fill instructions above.

5. If the chamber is connected to a plumbed and filtered water source, turn the water supply back on. The reservoir will automatically re-fill to the correct level.

## 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 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 and rear covers.

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 Performance (Non-controlled humidity mode)

These tests verify the performance of the heating, refrigeration, electrical controls, F4T Controller, and air circulation systems. The chamber should meet all published performance specifications if these tests are successfully passed. These tests assume that the F4T Controller's setup and tuning values have not been changed from the values as shipped from TestEquity. Also, the Limit Alarm high limit must be set to over +85°C (+100°C would be fine), and the low limit set to –25C. 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 an AC outlet which matches voltage rating on the Model/Serial label. Turn the POWER Switch ON.
3. Set the Temperature Set Point to +85.0°C. Make sure the Humidity and Purge buttons are OFF. Press the Power button to turn the chamber ON.
4. The chamber should heat up to about +80°C and begin controlling (orange PWR bar should show less than 100%) within approximately 12 minutes.
5. The chamber temperature should slowly increase and stabilize to +85°C. It should not overshoot beyond +85.5°C.
6. Let the chamber stabilize at +85°C for 30 minutes.
7. After stabilization, the chamber air temperature should vary no more than ±0.3°C, or a total of 0.6°C.
8. After 30 minutes at +85°C, change the Temperature Set Point to –20.0C.
9. The compressor should turn ON and cooling should commence.
10. The chamber should begin controlling (blue PWR bar should show less than 100%) at approximately –15°C in approximately 47 minutes.
11. Change the Temperature Set Point to –15.0C. After stabilization at –15°C for 30 minutes, the chamber air temperature should vary no more than ±0.3°C, or a total of 0.6 °C.
12. Set the Temperature Set Point to +23°C. The chamber should begin to heat up. The compressor should turn off in 2 minutes.
13. Let the chamber heat up to +23°C before turning the Power button OFF.
14. This concludes the chamber temperature performance verification tests.

## How to Verify the Performance (Controlled humidity mode)

These tests verify the performance of the humidification/dehumidification, electrical controls, F4T Controller, and air circulation systems. The chamber should meet all published performance specifications for controlled humidity conditions if all of these tests are successfully passed. These tests assume that the F4T Controller's setup and tuning values have not been changed from the values as shipped from TestEquity. Also, the Limit Alarm high limit must be set to over +85°C (+100°C would be fine). 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. There must be at least 1 gallon of single-distilled or deionized water in the reservoir.

2. Set the Temperature Set Point to 85.0°C, and Humidity Set Point to 85.0% RH. Make sure the Humidity button is OFF and Purge button is OFF. Press the Power button to turn the chamber ON.

3. The chamber should heat up to about +80°C and begin controlling (orange PWR bar should show less than 100%) within approximately 12 minutes.

4. The chamber temperature should slowly increase and stabilize to +85°C. It should not overshoot beyond +86.0°C.

5. Turn the Humidity button ON.

6. The chamber humidity should begin to increase within approximately 5-10 minutes. When the humidity reaches 70% RH it should begin controlling (orange PWR bar should show less than 100%). The humidity will slowly approach 85% RH.

7. After stabilization at 85%RH for 30 minutes, the chamber temperature should be 85.0°C, ±0.5°C. The humidity should be 85.0% RH, ±2.5% on a short-term basis.

8. Next, change the Temperature Set Point to 50.0°C. Leave the Humidity Set Point at 85.0% RH

9. The compressor should turn ON. The humidity will drop at this point.

10. The chamber should cool down to about 55°C and begin controlling (blue PWR bar should show less than 100%) within a short time.

11. The chamber temperature should decrease and stabilize to 50°C. It should NOT undershoot 50°C by more than 1°C. After stabilization for 30 minutes, the chamber temperature should be 50.0°C ±0.3°C, or a total of 0.6°C. It may take approximately 45 minutes to stabilize at 85.0%, ±2.5% RH.

12. Next, change Humidity Set Point to 50.0% RH. Leave the Temperature Set Point at 50.0°C.

13. The chamber humidity should begin to decrease. It may take approximately 45 additional minutes to stabilize at 50.0%, ±2.5% RH.

14. This concludes the controlled-humidity chamber performance verification tests.

## How to Verify the Temperature 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 controller 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 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.

The easiest way to verify the instrumentation accuracy is with an independent calibrated temperature sensor and display. Place the sensor near the chamber's sensors, which are located near the conditioner fan grille. If the readings agree within the specified limits above, then no calibration adjustments are necessary.

If adjustment of the F4T Temperature Controller is necessary, refer to the section for "F4T Controller Calibration".

## How to Verify the Humidity Calibration

TestEquity recommends verifying the humidity calibration before attempting to perform any adjustments. If you try to calibrate the instrumentation before determining that calibration is necessary, you may make it worse if done incorrectly.

A Vaisala HMM100 capacitive-type sensor is used to measure humidity. The HMM100 output is configured for 0-100%RH = 0-20 mA. The HMM100 sensor specifications are:

| Sensor accuracy at –20°C to +40°C* | Sensor accuracy at –40°C to –20°C,  +40°C to +175°C* |
|---|---|
| ±2%RH (0 to 90 %RH<br>±3%RH (90 to 100%RH) | ±2.5%RH (0 to 90 %RH<br>±3.5%RH (90 to 100%RH) |
| *Note: Chamber controlled humidity range is 10°C to 85°C | |

The easiest way to verify the instrumentation accuracy is with an independent calibrated humidity sensor and display. Place the sensor near the chamber's humidity sensor, which is located towards the right side of the conditioner fan grille. If the readings on the F4/F4T Controller agree within the specified limits above, then no calibration adjustments are necessary.

TestEquity recommends the Vaisala HM70 Handheld Humidity/Temperature Meter with the HMP77B Probe for verifying the humidity sensor calibration at all humidity conditions that the chamber can achieve.

If adjustment of the F4T Temperature Controller is necessary, refer to the section for "F4T Controller Calibration"

## Humidity Sensor Calibration and Maintenance

TestEquity highly recommends the Vaisala HM70 Handheld Humidity/Temperature Meter with the HMP77B Probe (combination package HM70F4E1A0DB) for calibrating the humidity sensor at all humidity conditions that the chamber is capable of achieving. Most other products on the market are not adequate for this purpose. Alternatively, the humidity sensor can be calibration with Vaisala HMK15 Humidity Calibrator which uses saturated salt solutions for 11%RH and 75%RH. These items are available from Vaisala Inc. (www.vaisala.com).

The Vaisala HMM100 sensor is calibrated per the procedure in the Vaisala HMM100 User's Guide, which can be downloaded from www.testequity.com/manuals.

The humidity sensor element (Vaisala HUMIKAP 180R) is replaceable. The end of the sensor probe has a stainless steel sintered filter (Vaisala HM47280SP), which can be removed by unscrewing it. Handle the sensor by its outer plastic support. DO NOT TOUCH THE SENSOR PLATE.

## *F4T Controller Calibration*

⚠ **CAUTION:**  Calibrating the F4T Controller requires the electrical compartment to be exposed. Live and potentially lethal voltages will be present. Use extreme caution to prevent injury and death.

⚠ **CAUTION:**  The Power button on the F4T Controller must be OFF (no green check mark) when performing the calibration procedure to prevent a thermal runaway condition.

## Equipment Required

- Precision Resistance Source, 50.00 Ω and 350.0 Ω for Temperature Sensor.
- Precision Milliamp Source, 0.000 mV and 20.000 mA for Humidity Sensor.
- Precision Voltage Source, 0.000 mV and 50.000 mV for Limit Sensor.

## Input Setup and Calibration

Make sure the Power button on the F4T Controller is OFF (no green check mark) before performing the following. Disconnect the chamber from the power source and remove the top cover. See F4T diagram on the next page for the terminal locations.

**For Temperature Sensor Input Calibration**

- Remove the wires from terminals R1, T1 and S1 on F4T Slot 1

- Connect the Precision Resistance source as follows:
One lead to R1 on Slot 1
Other lead to T1 and S1 on Slot 1

- Reconnect the chamber to the power source and turn the Power switch on the front panel ON. The Power button on the F4T must remain OFF.

- To enter the Calibration menu, press the Menu button, then the Service button, then the Calibration button, then the Temperature Sensor "Actions" button. Next, press Perform Field Calibration and follow the on-screen prompts.

**For Humidity Sensor Input Calibration**

- Remove the wires from terminals T1 and S1 on F4T Slot 4. (T1 is Red and S1 is Black)

- Connect the Precision Milliamp source as follows:
+ lead to T1 on Slot 4
– lead to S1 on Slot 4

- Reconnect the chamber to the power source and turn the Conditioning switch (or TEMP switch depending on which model chamber you have) on the front panel to the Event 1 position. The Power button on the F4T must remain OFF.

- To enter the Calibration menu, press the Menu button, then the Service button, then the Calibration button, then the Humidity Sensor "Actions" button. Next, press Perform Field Calibration and follow the on-screen prompt.

**For Limit Sensor Calibration**

- Remove the wires from terminals R1 and S1 on F4T Slot 3

- Connect the Precision Voltage source as follows:
  Positive (+) lead to R1 on Slot 3
  Negative (–) lead to S1 on Slot 3

- Reconnect the chamber to the power source and turn the Power switch on the front panel ON. The Power button on the F4T must remain OFF.

- To enter the Calibration menu, press the Menu button, then the Service button, then the Calibration button, then the Limit Sensor "Actions" button. Next, press Perform Field Calibration and follow the on-screen prompts.
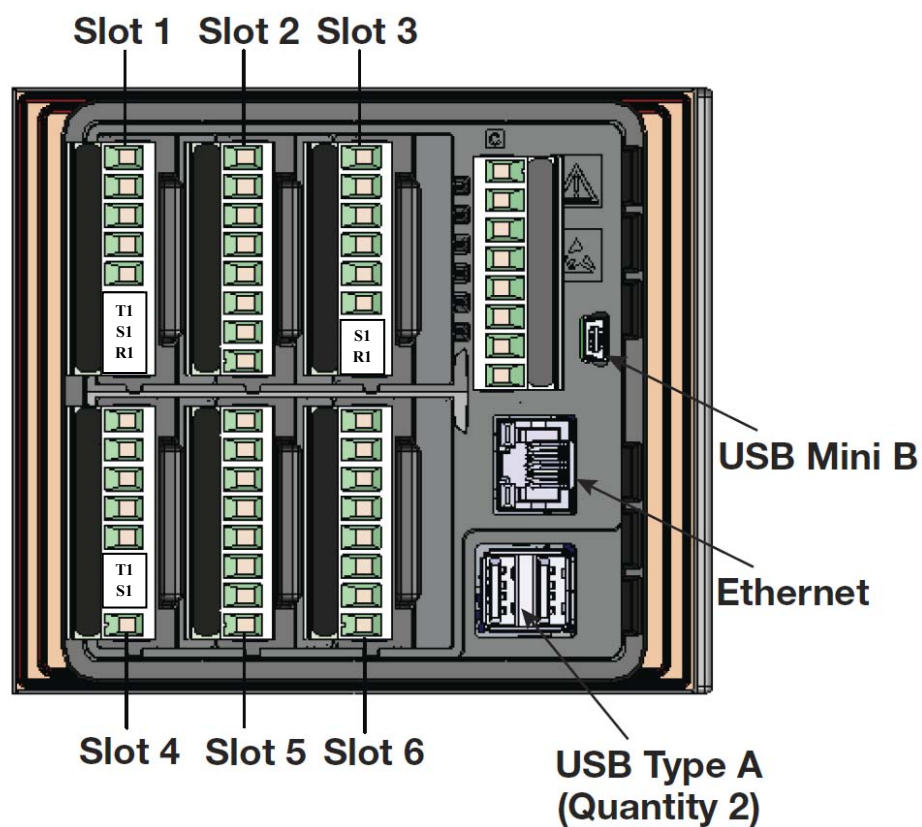
## *Theory of Operation*

### Overview
Refer to the electrical and refrigeration drawings to identify the referenced items described below. The electrical items are referenced with a letter(s) and number. The refrigeration items are referenced with a number only or number followed by a single letter.

### Air Heating System
The chamber is heated by an open-element nichrome heater (HT1). The heater is in the air plenum. The F4T Controller provides a time-proportioned output to 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 +240°C.

### Humidity System
A Mass Transfer Vapor Generator or MTVG (patent-pending) provides both humidification and dehumidification. Humidity conditioning is external to the chamber. The MTVG includes an inlet tube on the bottom which is below the evaporator coil and an outlet tube on the top above the evaporator coil. The pressure difference between the two forces a portion of the air in the chamber to flow from the MTVG inlet to the MTVG outlet. A column between the MTVG inlet and outlet contains refrigeration tubing for dehumidification. The bottom of the MTVG has a small area which contains water and embedded heater for humidification.

Water flows from the built-in reservoir to the Float Valve Assembly through Solenoid Valve SV4. Solenoid Valve SV4 allows water to flow from the Float Valve Assembly to the MTVG when the Humidity mode is ON. Water level in the MTVG is then maintained by the Float Valve Assembly. Water in the MTVG is drained through Solenoid Valve SV3 when the Humidity mode is OFF. Solenoid Valve SV3 will open for 10 seconds when the Humidity mode is first turned OFF, then will close to prevent moisture from inadvertently migrating from the drain to the chamber interior through the MTVG inlet and outlet tubes.

Water is heated by an immersion heater (HT2) in the MTVG to generate vapor. The F4T Controller provides a time-proportioned output to solid state relay (SSR2). This turns the HT2 ON/OFF as required to maintain the humidity set point.

The immersion heater HT2 has an embedded thermocouple which is connected to Input 3 of the F4T Controller to control an Alarm function. This provides failsafe protection against a heater failure in the event of a low water condition by disabling the Humidification output if the immersion heater temperature reaches +125°C. The alarm will self-reset when the heater reaches +100°C.

### Refrigeration System
The F4T Controller turns the compressor ON based on the demand for cooling. Dry-bulb cooling is accomplished through the Capillary Tubes (9) and the finned evaporator coil (15) inside the chamber. The F4T Controller cycles the liquid-line solenoid valve (SV1 or 7/8) ON/OFF as required to maintain the temperature set point.

Dehumidification is accomplished through Capillary Tube (10) and the copper lines which are bonded to the MTVG. The F4T Controller cycles the dehumidify coil liquid-line solenoid valve (SV2, 7/8) ON/OFF through SSR3 to control the amount of dehumidification by condensing moisture from the air. The moisture is condensed within the vertical space inside the MTVG.

The hot gas regulator (5) is adjusted to keep the suction pressure at 8 PSIG when both SV1 and SV2 are off. A suction line cooling thermostatic expansion valve (6) senses the suction line temperature and injects liquid refrigerant to cool the suction return gas within safe limits.

## *Troubleshooting*

| SYMPTOM | CONDITION | POSSIBLE CAUSES |
|---|---|---|
| **Chamber does not function.** | If POWER switch is ON. | a) F4T Power button needs to be turned ON. <br> b) Limit Alarm is tripped. |
| **Does not heat up at all.** | F4T heat PWR bar is 100%, circulator fan is ON. | a) Control Mode is Off instead of Auto. <br> b) Heat Limiter HL is open. <br> c) Heater HT1 is open. <br> d) Solid State Relay SSR1 is defective. |
| **Heats up too slow.** | If F4T Heat PWR bar is 100%. | a) Chamber interior is overloaded. |
| **Heat is on all the time.** | If F4T Heat PWR bar is 0%. | a) Solid State Relay SSR1 is defective. |
| **Does not cool at all.** | Compressor is running. | a) Refrigerant leak. <br> b) Solenoid valve SV1 is defective. <br> c) Plugged capillary tube. |
| | Compressor is not running. F4T Cool & Compressor outputs are ON. | a) Start relay in compressor terminal box is defective. <br> b) Compressor is defective. |
| | Compressor is not running. F4T Cool output is ON & Compressor output is OFF. | a) Control Mode is Off instead of Auto. |
| **Cools too slowly or does not cool down to –15°C.** | Compressor is running. | a) Room is too hot. <br> b) Chamber interior is overloaded. <br> c) Test sample is energized, giving off heat. <br> d) Port plug is not in port. <br> e) Refrigerant leak. <br> f) Capillary tube is plugged. |
| **Temperature varies more than ±0.3°C or ±0.6°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. <br> b) Solenoid valve SV1 may be defective if temperature varies by several degrees. |
| **Cannot achieve high humidity.** | F4T Power and Humidity buttons are ON. | a) No water in the reservoir (Low Water Alarm will also be indicated). <br> b) Chamber temperature is over 90°C or under 7°C. Humidity mode will be disabled by design. |
| **Cannot achieve low humidity.** | F4T Power and Humidity buttons are ON. | a) Achieving low humidity levels require you to start with a clean, dry chamber. <br> b) See page 16 for "Achievable Range of Temperature/Humidity Conditions". <br> c) Chamber temperature is over 90°C or under 7°C. Humidity mode will be disabled by design. |

## *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!

## Refrigerant 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 measure in the correct weight of refrigerant as shown on the Model/Serial label on the back of the chamber. DO NOT GUESS! You must use an accurate charging scale.
4.  Verify the cooling performance as outlined in "How to verify the chamber performance".

## Replacement Parts

Replacement parts are available from TestEquity. Parts are usually in-stock and ready for immediate shipment. Next-day delivery is always available.

## Major Electrical Parts

| Description | Mfr | Mfr Part No. | Ref # | Part # | Qty | UOM |
|---|---|---|---|---|---|---|
| Air Heater, 400W | CUSTOM | 222475 | AH1 | 222475 | 1 | ea |
| Arc Suppressor | ITW Paktron | 104MACQRL150 | AS1 | 200296 | 2 | ea |
| Condensate Pump | Little Giant | 554200 | CP1 | 180528 | 1 | ea |
| Relay, SPST | Hartland Controls | HCR-51XT1AB | CR1-2 | 222429 | 2 | ea |
| Relay, SPDT | Omron | G2R-1-T-AC120 | CR3 | 200160 | 1 | ea |
| Fuse, 1A, Time Delay | Bussman | MDL-1-R | F1 | 222540 | 1 | ea |
| Fuse, 3/10A | Bussman | MDL-3/10 | F2 | 200130 | 1 | ea |
| Circulator Motor Kit | CUSTOM | 100574 | FM1 | 100574 | 1 | ea |
| Condenser Fan | EMB Pabst | W2S130-AA25-01 | FM2 | 222473 | 1 | ea |
| Heat Limiter Assembly | CUSTOM | 222465 | HL | 222465 | 1 | ea |
| Light Bar Assy W/Switch | CUSTOM | 383948 | LED | 383948 | 1 | ea |
| Float Switch | Madison | M8000 | LS1 | 180588 | 1 | ea |
| Humidifier Heater, 200W | Watlow | N4E-9315 | MTH1 | 222470 | 1 | ea |
| Power Supply, LED 8W 12VDC | Meanwell | APV-8-12 | PS1 | 222504 | 1 | ea |
| Resistor, 1 kohm, 25W | Vishay / Dale | RH0251K000FE02 | R1 | 200295 | 1 | ea |
| Humidity Sensor | Vaisala | HMM100-24A1D0 | RHS | 200320 | 1 | ea |
| RTD, Chamber Air Sensor | CUSTOM | 222306 | RTD1 | 222306 | 1 | ea |
| SSR, 24V DC In, AC Out | Omron | G3NE-210T-US DC24 | SSR1-3 | 200177 | 3 | ea |
| SSR, 5V DC In, AC Out | Omron | G3NE-210T-US DC5 | SSR4-7 | 200129 | 4 | ea |
| Switch, Rocker, DPDT | Carlingswitch | 691-RGSCC901-R-B-B-E | SW1 | 222430 | 1 | ea |
| Solenoid Valve, Water Drain | Deltrol | DSVP-12N-2LSX-120A-R3SR | SV3 | 383820 | 1 | ea |
| Solenoid Valve, Water Fill | Asco | 8262H20 120V/60AC | SV4 | 200183 | 1 | ea |
| F4T Temp/Humidity Controller | Watlow | F4T1L2EAA1H2069 | TCR1 | 222536 | 1 | ea |
| Transformer, 20VAC | Hammond | 166D20 | TR1 | 200087 | 1 | ea |
| Power Cord, Right Angle | Quail | 4912.12 | | 222542 | 1 | ea |

## Major Refrigeration Parts

| Description | Mfr | Mfr Part No. | Ref # | Part # | Qty | UOM |
|---|---|---|---|---|---|---|
| Capillary Tube, 0.031 x 120" (x2) | JB | TC-31 | 9 (2 required) | 100320 | 240 | inches |
| Capillary Tube, 0.026 x 80" | JB | TC-26 | 10 | 180564 | 80 | inches |
| Compressor | Emerson Climate | AFE08C4E-1AA | 1 | 180518 | 1 | ea |
| Condenser Coil | CUSTOM | 180522 | 3 | 180522 | 1 | ea |
| Evaporator Coil | CUSTOM | 180523 | 11 | 180523 | 1 | ea |
| Expansion Valve, Suction Cooling | Danfoss | 068U2027 | 6 (TEV1) | 100314 | 1 | ea |
| Filter Drier | Danfoss | 023Z5048 | 2 | 100524 | 1 | ea |
| Hot Gas Regulator | Sporlan | ADRI-1/4-0/55 | 5 (HGR1) | 100497 | 1 | ea |
| Solenoid Valve | Sporlan | E3S120, 1/4 x 1/4 ODM | 7 (SV1, 2) | 100310 | 2 | ea |
| Solenoid Valve Coil | Sporlan | MKC-1-120/50-60 | 8 (SV1, 2) | 100011 | 2 | ea |

## General Parts

| Description | Mfr | Mfr Part No. | Ref # | Part # | Qty | UOM |
|---|---|---|---|---|---|---|
| Caster, Dual Polypro With Brake | McMaster-Carr | 24025T64 | | 383830 | 4 | ea |
| Door Gasket | CUSTOM | 383853 | | 383853 | 1 | ea |
| Door Latch | Southco | A7-10-301-20 | | 300216 | 1 | ea |
| Float Valve Reservoir Assembly | US Plastics | 23222 | | 180530 | 1 | ea |
| Port Plug, Silicone Foam, 3x2" | CUSTOM | 300374 | | 300374 | 1 | ea |
| Shelf with 4 Clips | CUSTOM | TE-1011 | | TE-1011 | 1 | ea |
| Shelf Retainer Clip | Kason | Style 66, #0066000008 | | 300015 | 4 | ea |
| Window, 3 Pane, Heated | CUSTOM | 383848 | | 383848 | 1 | ea |

# Chapter 10 – 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.

TestEquity must initiate field service for in-warranty claims. Purchaser will not be reimbursed for labor if they initiate service on their own without prior approval from TestEquity. Replacement parts must be supplied by TestEquity for in-warranty claims. Purchaser will not be reimbursed for parts they buy on their own without prior approval from TestEquity.

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, port plugs, and refrigerant.

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 11 – Drawings

# Electrical Subpanel Component Location