

Software Installation and User Manual

Universal SuperHeat Controller/Sensor (USHX)

GUI Version: *USHX Modbus GUI v1.14*

Applicable Firmware Version(s):

21.15.82.18.01

21.15.82.18.04

22.15.82.34.03

22.17.82.35.02

Revision 1.12



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Published: September 2018
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1 Before You Begin

1.1 About the USHX Software

The USHX software is a graphical user interface (GUI) tool for DunAn Microstaq’s Universal SuperHeat Controller (USHC) and Universal SuperHeat Sensor (USHS) products used typically in HVAC and refrigeration applications. The USHX product utilizes the Modbus RTU communication protocol for user interaction. The following table shows the features this software includes when used as either a USHC or USHS.

Feature	USHC	USHS
<i>Precise Superheat Control</i>	✓	
<i>Option to Input Desired Target Superheat Setpoint</i>	✓	
<i>Option to Input Desired Dynamic Target Superheat Range</i>	✓	
<i>Pressure Measuring Capability</i>	✓	✓
<i>Evaporator Temperature Measuring Capability</i>	✓	✓
<i>Second Temperature Measuring Capability</i>	✓	✓
<i>Real-time Superheat Calculation</i>	✓	✓
<i>Data Collection Capability</i>	✓	✓
<i>Real-time Data Plotting</i>	✓	✓
<i>Alarm Detection with Notifications</i>	✓	✓
<i>Serial Communication Capability</i>	✓	✓
<i>Multiple-unit Communication Capability</i>	✓	✓
<i>Automatic Voltage Source Detection</i>	✓	✓

1.2 Hardware and System Requirements

The following table provides the hardware and software requirements for installing and using the USHX software.

Hardware Requirements	System Requirements
<ul style="list-style-type: none">• <i>USHX device</i>• <i>USHX wiring harness</i>• <i>Isolated USB to RS485 converter</i>• <i>Laptop or desktop PC</i>• <i>Small flat tip screwdriver</i>• <i>Wire stripper</i>	<ul style="list-style-type: none">• <i>Operating System: Microsoft Windows XP, Windows Vista, Windows 7, Windows 8/8.1, or Windows 10</i>

1.3 About This Manual



This manual is intended to instruct the user how to install, configure, and operate DunAn Microstaq’s Universal SuperHeat Controller/Sensor software – **USHX Modbus GUI v1.14**.

The following table shows a summary of the sections in this document and their descriptions.

Section Title	Description
<i>Before You Begin</i>	This section provides preliminary information that the user should read before proceeding through the document.
<i>Software Installation and Communications Setup</i>	This section provides information about uninstalling, installing, and setting up the software.
<i>Software Functions</i>	This section provides detailed explanations of the functions of the software.
<i>Alarms</i>	This section provides details about alarms the user may potentially encounter and conditions under which they may appear.
<i>Additional Features</i>	This section provides details about additional features in the USHX Modbus GUI.
<i>Appendix</i>	This section provides details and explanation of the control schemes provided by the USHC.

1.4 Document Conventions

The following table shows a list of symbols found in this document and their descriptions.

Symbol	Description
	WARNINGS indicate that the action you are taking could either cause injury to yourself or could harm your products and systems.
	IMPORTANT NOTES appear in the text to indicate additional information that should be noted.

1.5 Acronyms

The following table shows a list of acronyms used in this document.

Acronym	Description
DMQ	DunAn Microstaq, Inc.
F/W	Firmware
GUI	Graphical User Interface
MSEV	Modular Silicon Expansion Valve
HC-MSEV	High Capacity Modular Silicon Expansion Valve
USHX	Universal SuperHeat Controller/Sensor
USHC	Universal SuperHeat Controller
USHS	Universal SuperHeat Sensor
OODB	Out Of DeadBand

2 Software Installation and Communications Setup

This section provides instructions for installing, uninstalling, and setting up the USHX software.

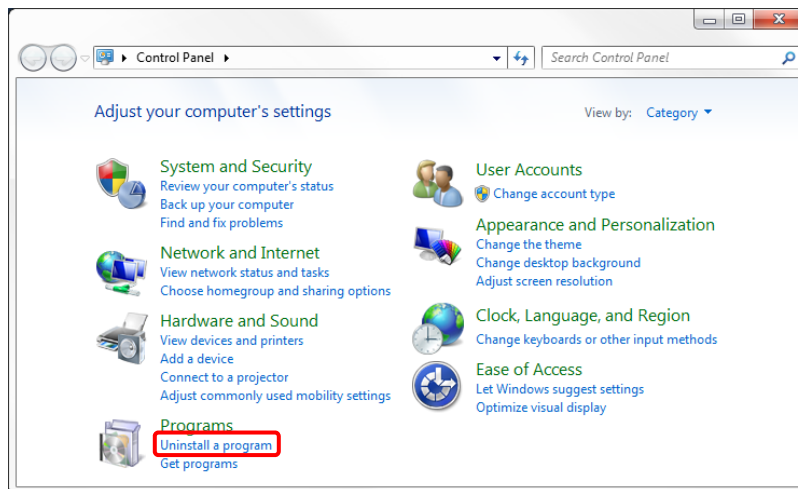


The user must have administrative rights for his or her computer account in order to install or uninstall the USHX software.

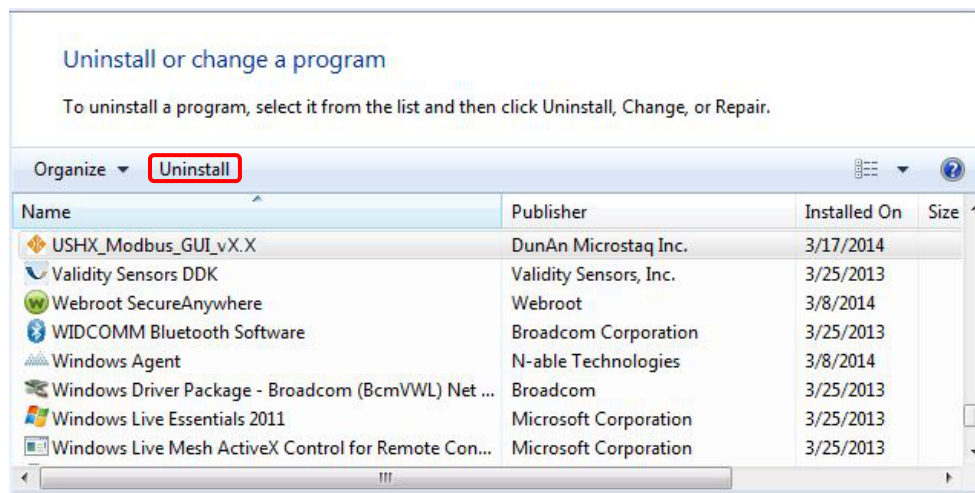
2.1 Uninstalling the USHX Software

Before installing the USHX software, any previous versions of the USHX software must be uninstalled first. To uninstall previous versions of the USHX software (if applicable), complete the following steps:

1. Navigate to the **Control Panel**.
2. Click **Uninstall a program** under **Programs**.



3. Select the **USHX_Modbus_GUI_vX.X** program and click **Uninstall**. Alternatively, **Right Click > Uninstall** will also uninstall the program on current and older versions of Microsoft Windows.



4. The USHX software Removal Utility will run and later prompt the user to confirm the removal of the USHX software and all of its components. Click **yes** to continue with the un-installation.
5. The USHX software un-installation is complete.

2.2 Installing the USHX Software

To install the USHX software, complete the following steps:

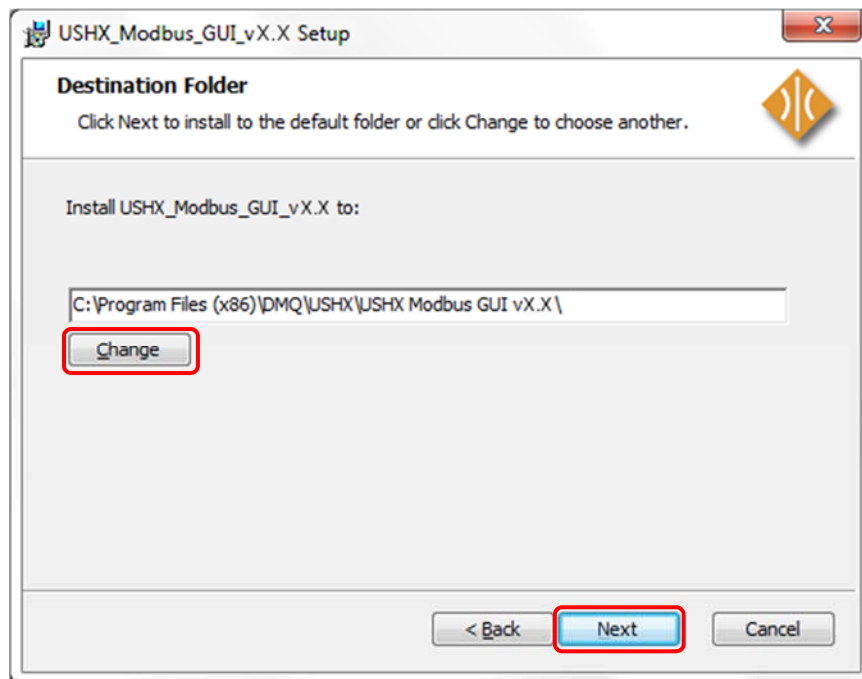
1. Double click **USHX_Modbus_GUI_vX.X_Installer.msi**.
2. The **USHX_Modbus_GUI_vX.X Setup** window appears. Click **Next**.



3. Read the end-user license agreement. Click **Next** to continue once the license agreement is accepted (the check box is checked).



4. The default installation directory is the Program Files folder. Click **Change** to select a different installation location. Once the desired destination folder is listed, click **Next** to continue with the installation.



5. The **User Account Control** window may appear. Click **Yes** to allow the installation to continue.

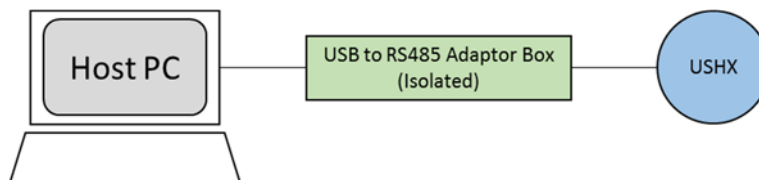
6. Click **Finish** to complete the installation process.



After the installation is complete, a shortcut to the application will be created on the desktop. The program may also be found through the Start Menu at **Start > All Programs > USHX Modbus vX.X**.

2.3 USHX Communications Setup

The HOST PC and the USHX should be connected through an isolated USB-to-RS485 converter box. See the **MSEV/HC-MSEV and USHX Hardware Installation Manual** for more hardware installation details. The following diagram shows the USHX hardware and software setup described above.

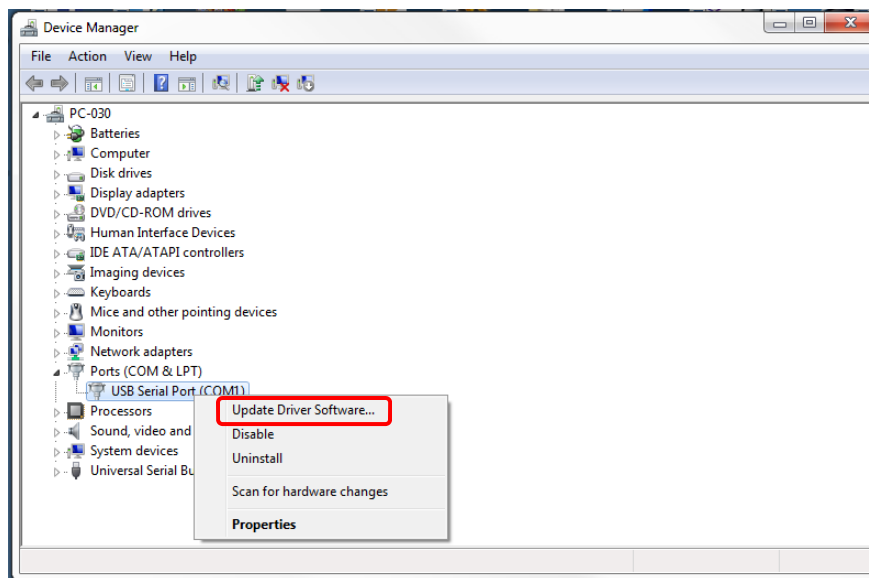


If the USB-to-RS485 converter is being used with the associated computer for the first time, the driver(s) for the device must be downloaded and installed. VirtualSCADA's VSU-485G is one example of a compatible isolated USB-to-RS485 converter. VirtualSCADA, like many manufacturers, hosts its latest drivers on its website. Follow the link below to obtain the driver for this particular device from VirtualSCADA's website.

http://www.virtualscada.com/PRODUCTS/Serial_Converters_USB_RS485.htm

To set up communications between the computer and the USHX through the converter, complete the following steps:

1. Download the converter driver(s) from the Internet or, if applicable, obtain them from a CD/DVD. If the driver(s) is (are) in a compressed file, extract the file(s) to a desired location.
2. Connect the converter to the computer via a USB port.
3. When prompted for the device driver location, navigate to the location of the downloaded driver file(s). If no prompt appears, go to **My Computer > Right Click > Properties > Device Manager > Ports (COM & LPT)**, right click **USB Serial Port**, and select **Update Driver Software** and navigate to the driver file(s). The computer system will update the driver list and install the USB converter automatically. A new virtual COM Port will now be available on the computer.



4. Once the converter driver(s) has (have) been successfully installed, connect the converter to the USHX device to complete the hardware installation process.

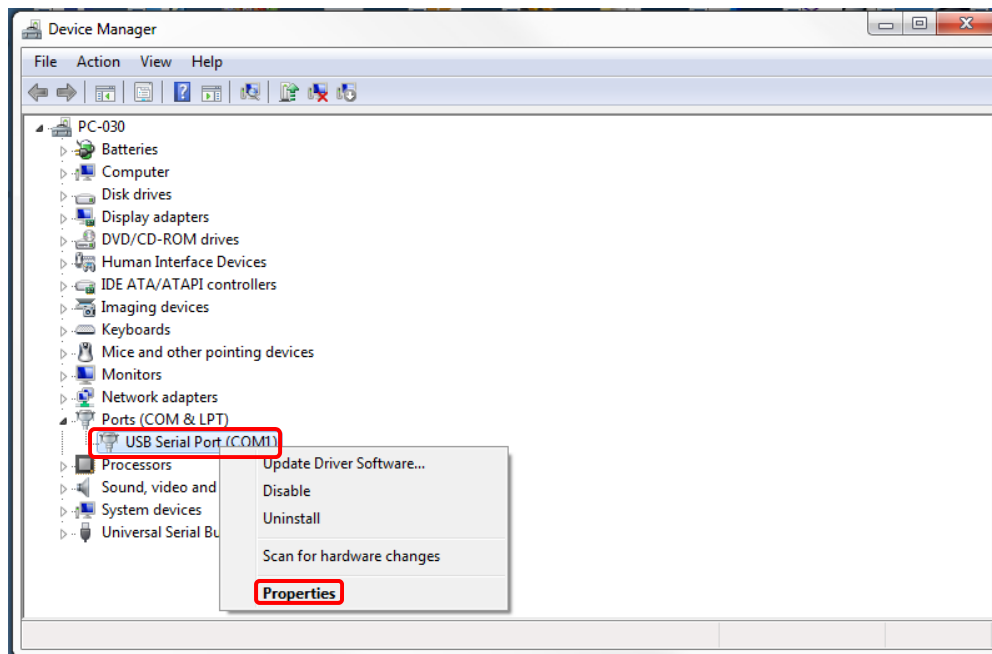
3 Software Functions

This section provides information on the features of the USHX software interface and how to use it properly.

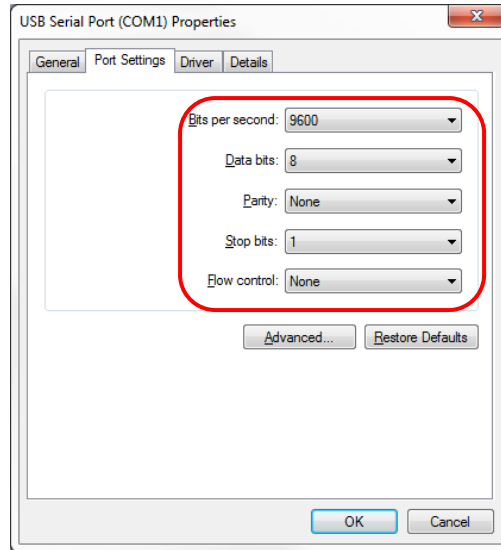
3.1 COM Port Setup

To complete the COM Port setup, follow the steps below:

1. Determine the COM Port number of the converter and check its settings:
 - a. Navigate to the **My Computer** screen (or **Computer** depending on the version of Windows).
 - b. Right click in the white space on the screen and select **Properties**.
 - c. Click the **Device Manager** button. The Device Manager window should appear.
 - d. Locate and click **Ports (COM & LPT)**. A sub-list of ports will be displayed.
 - e. Disconnect the converter from the computer. If one of the communication ports disappears from the list of ports, the driver has been installed successfully. The COM Port that disappears is the one that corresponds with the converter.
 - f. Right click on the COM Port associated with the converter and view its **Properties**.



- g. Ensure that the COM Port properties are set to the same settings as shown below.



2. Enter the COM Port number that is identified in **Step 1** and click **Next**. The figure below uses 1 as an example COM Port number. The box is initially blank by default.



The COM Port selection is limited to ports **1 through 16**. If the COM Port number is not within this range, connect the converter to different ports on the computer until it is within the range.



If the COM Port setup is successful, the user will be brought to the Device ID Setup screen.

3.2 Assigning a New Device ID

The default Device ID of each USHX is '1'. To assign a new Device ID to the USHX, complete the following steps:



If multiple USHX have the same Device ID in a network then ensure that power is being supplied to only one of those USHX at a time. Only the USHX device being assigned a new Device ID should be powered via its wiring harness. Disconnect all other USHX devices from their wiring harnesses before proceeding. Failure to do so will result in errors.

1. Ensure that power is being supplied to the USHX by checking that the wiring harness is firmly attached to the device.



Review the **Multiple USHCs and MSEV/HC-MSEVs or Multiple USHs** section in the **MSEV/HC-MSEV and USHX Hardware Installation Manual** to learn about networking with more than one USHX device.

2. Enter the current Device ID (default=1) and the desired Device ID in the “Old Device ID” and “New Device ID” fields. Type any notes about the device in the “Remarks” field then click **OK**.

Old DeviceID	New DeviceID	Remarks
1	1	Example USHX 1

DeviceID	Serial Number	Remarks
----------	---------------	---------

Buttons: Back, Next, Delete selected item from List, OK

3. If the Device ID is assigned successfully, the connected USHX device information – Device ID, Serial Number, and Remarks (if applicable) – will be shown in the ‘Devices Information from Database’ section underneath the Re-Assign Device ID section.
4. For multiple USHXs, repeat **Steps 2 and 3** to assign Device IDs until all USHXs have been assigned a new Device ID.



Do NOT assign the same Device ID to two or more USHX devices (or possibly other devices). This will create a duplicate Device ID which will cause networking conflicts and result in errors.

3.3 Device Discovery

The Device Discovery feature allows the user to obtain USHX Device IDs when one or more Device IDs are unknown. To use the Device Discovery feature, complete the following steps:



Device Discovery does not work for multiple USHX in a network where one or more USHX have the same Device ID.

1. Ensure that power is being supplied to all USHX by checking that the wiring harnesses are firmly attached to each device.

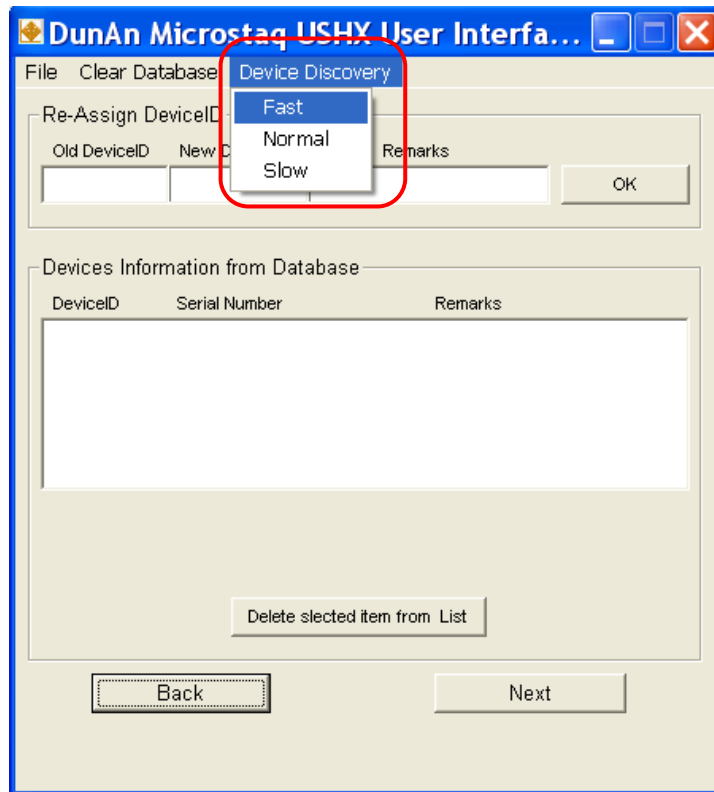


Review the **Multiple USHCs and MSEV/HC-MSEVs or Multiple USHSs** section in the **MSEV/HC-MSEV and USHX Hardware Installation Manual** to learn about networking with more than one USHX device.

2. Select the Device Discovery drop-down menu and choose **Slow**, **Normal**, or **Fast** speed.



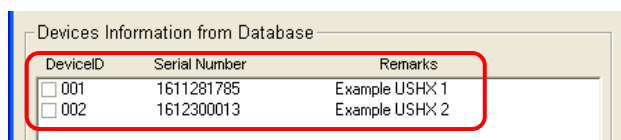
Fast checks for USHX Device IDs once, Normal checks twice, and Slow checks three times (most reliable). The wait time is 15 min, 30 min, and 45 min, respectively.



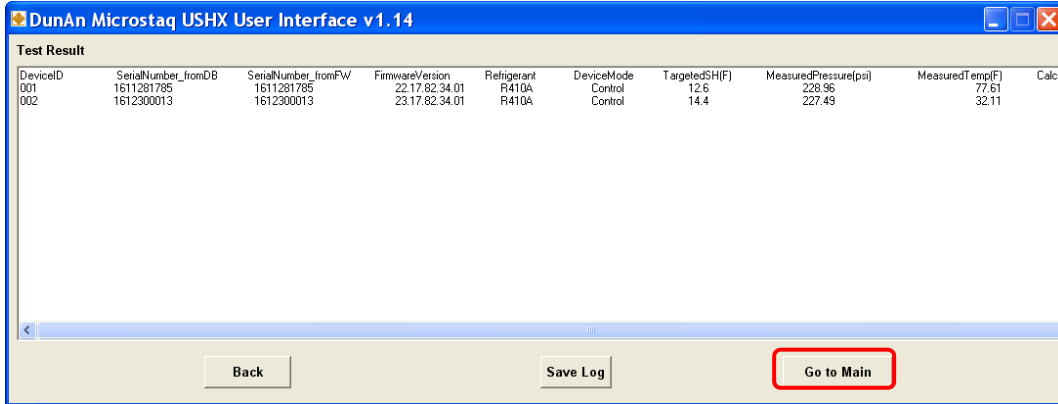
3. Please wait for Device Discovery to complete. Once completed, load the USHX Device IDs into the database by clicking **Yes** on the popup window.

3.4 Start-up and Main Window

1. Once all USHXs have been assigned a Device ID, ensure that all information about the device(s) is correct in the Database section. The figure below shows an example of information accumulated as a result of 2 different USHXs being assigned Device IDs with example Remarks.

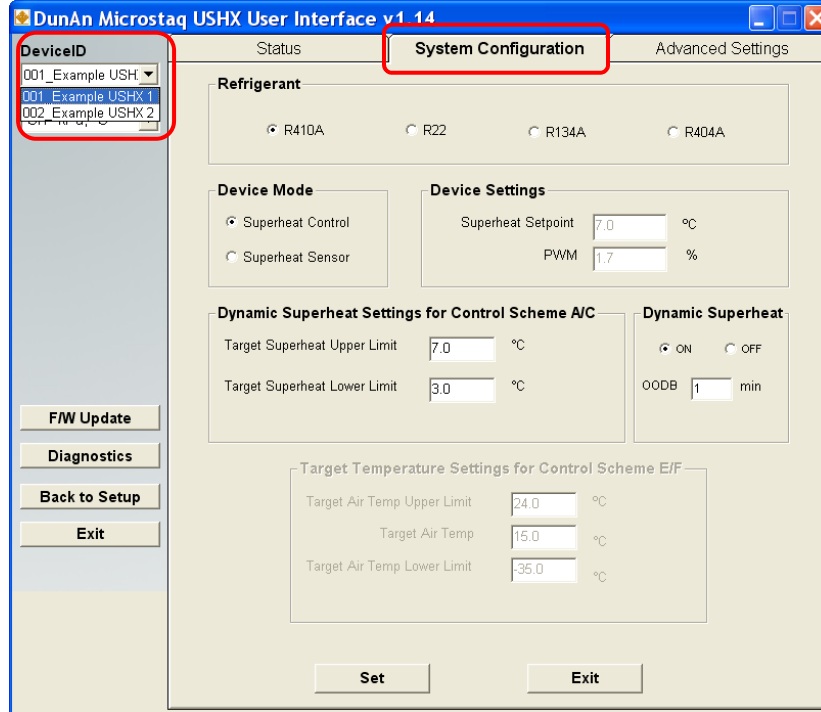


2. Connect and power on all USHXs (that were assigned Device IDs) via their wiring harnesses.
3. Click **Next** to retrieve firmware information (and additional miscellaneous information) from all connected USHX devices. The figure below shows an example in which 2 USHXs are networked and had Device IDs assigned to them.



If a 'mismatch' error message pops up or 'Unknown' appears as data under any of the categories in the above window, contact the manufacturer.

4. Click **Go to Main** on the Test Result window to proceed to the **System Configuration** tab of the main window of the program.



5. The USHX setup is now complete. Select the Device ID of a USHX device from the drop-down menu to see its settings. Select each USHX device individually to configure settings.

3.5 System Configuration

In the **System Configuration** tab, the user may switch the **Device Mode**, change the **Refrigerant** type, and alter additional **Device Settings**. Users can configure **Dynamic Superheat** or **Target Temperature** setting, dependent on the USHX F/W (see F/w compatibility in **Appendix X**). Furthermore, a **F/W Update** may be performed from this tab, but this feature is password protected and only accessible for DMQ maintenance purposes.

Two buttons are located at the bottom of the tab and boxed in the figure below:

- **Set** – This button will set all the selections and changes made by the user.
- **Exit** – This button will bring the user to the **Status** tab.

The screenshot displays the 'System Configuration' tab of the 'DunAn Microstaq USHX User Interface v1.14'. The interface is divided into several sections:

- DeviceID:** A dropdown menu showing '002_Example USHX'.
- Units:** A dropdown menu showing 'SI1- kPa, °C'.
- Refrigerant:** Radio buttons for R410A (selected), R22, R134A, and R404A.
- Device Mode:** Radio buttons for Superheat Control (selected) and Superheat Sensor.
- Device Settings:** Input fields for Superheat Setpoint (8.0 °C) and PWM (1.7 %).
- Dynamic Superheat Settings for Control Scheme A/C:** Input fields for Target Superheat Upper Limit (8.0 °C) and Target Superheat Lower Limit (4.0 °C). A 'Dynamic Superheat' section has radio buttons for ON (selected) and OFF, and an OODB input field set to 1 min.
- Target Temperature Settings for Control Scheme E/F:** Input fields for Target Air Temp Upper Limit (15.0 °C), Target Air Temp (10.0 °C), and Target Air Temp Lower Limit (5.0 °C).

At the bottom of the configuration area, there are two buttons: 'Set' (highlighted with a red box) and 'Exit'.

3.5.1 Universal SuperHeat Controller

To set the system configuration for a USHC, complete the following steps:

1. Select the respective **Device ID** of the USHX that the user wants to configure.
2. For the **Refrigerant**, select the appropriate refrigerant for the current system.
3. For the **Device Mode**, select Superheat Control.



This mode is used with a MSEV/HC-MSEV to control the superheat of the HVAC/R system. In this mode, the control loop of the software is constantly running, and the PWM will adjust automatically so that the system will maintain its target superheat.

- For the **Device Settings**, Input the desired Static Superheat Setpoint (target) value.



In Superheat Control mode, PWM is not manually adjustable. It continuously adjusts to maintain the desired Superheat Setpoint at Static Target Superheat.

The screenshot shows the 'DunAn Microstaq USHX User Interface v1.14' with the 'System Configuration' tab selected. The interface includes a sidebar with 'FW Update', 'Diagnostics', 'Back to Setup', and 'Exit' buttons. The main area is divided into several sections:

- Refrigerant:** Radio buttons for R410A (selected), R22, R134A, and R404A.
- Device Mode:** Radio buttons for Superheat Control (selected) and Superheat Sensor.
- Device Settings:** Input fields for Superheat Setpoint (8.0 °C) and PWM (5 %).
- Dynamic Superheat Settings for Control Scheme A/C:** Input fields for Target Superheat Upper Limit (8.0 °C) and Target Superheat Lower Limit (4.0 °C). A 'Dynamic Superheat' section has radio buttons for ON (selected) and OFF, and an OODB (Out Of DeadBand) input field set to 1 min.
- Target Temperature Settings for Control Scheme E/F:** Input fields for Target Air Temp Upper Limit (15.0 °C), Target Air Temp (10.0 °C), and Target Air Temp Lower Limit (5.0 °C).

'Set' and 'Exit' buttons are located at the bottom of the main configuration area.

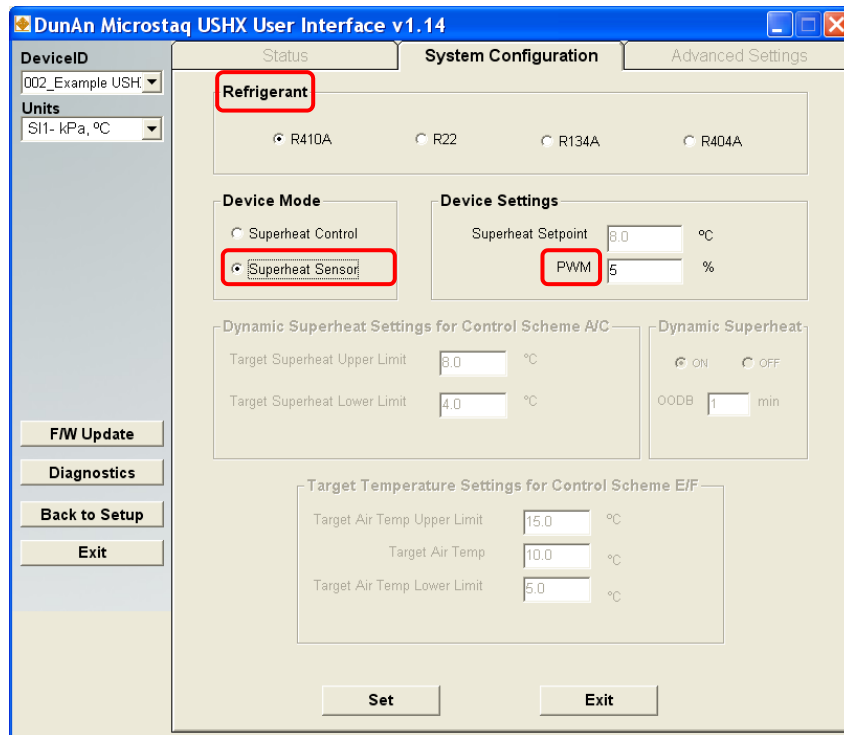
- Under the **Dynamic Superheat** section, select **OFF** for the control loop to operate at a static target superheat setpoint. The USHC controls the system at set static target superheat value. Select **ON** to turn on the **Dynamic Superheat Control** feature. This feature allows the control loop to determine the lowest stable superheat setpoint automatically. The superheat setpoint is adjusted based on whether the calculated superheat is stable or unstable. Superheat is considered stable when the calculated superheat is within a deadband of $\pm 1^{\circ}\text{C}$ from the target setpoint. Similarly, superheat is considered unstable when the calculated superheat is out of the deadband of $\pm 1^{\circ}\text{C}$. When this feature is turned ON, the superheat setpoint starts at the upper limit value. The superheat setpoint will continuously reduce by 0.5°C as long as the calculated superheat is stable at each setpoint or until the **Lower Limit** is reached. When the calculated superheat is unstable for the duration value entered in **OODB (Out Of DeadBand)**, then the superheat setpoint will increase by 0.5°C until stable superheat setpoint is found or until the **Upper Limit** is reached.
- Click the **Set** button to save any changes and set the new parameters. Click **OK** when the confirmation window appears.
- For Advanced Settings setup go to [Section 3.6](#).

- Repeat **Steps 2 through 5** for all DeviceIDs. When this step is finished, the system configuration for the USHC(s) will be complete.

3.5.2 Universal SuperHeat Sensor

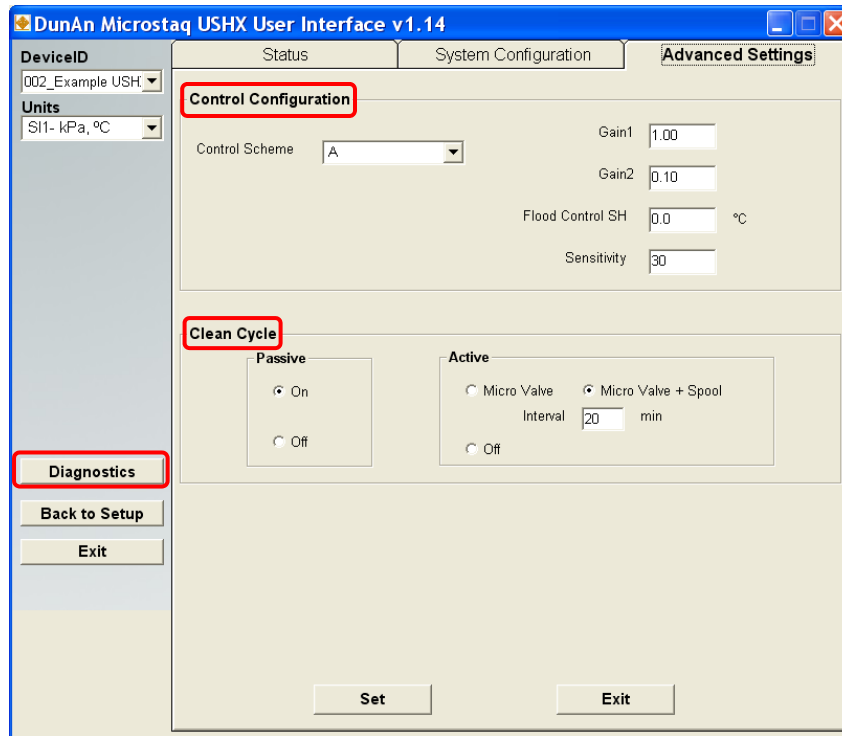
To set the system configuration for a USHS, complete the following steps:

- Select the respective **Device ID** of the USHX that the user wants to configure.
- For the **Device Mode**, select Superheat Sensor.
- For the **Refrigerant**, select the appropriate refrigerant for the current system.
- For the **Device Settings**, input the appropriate PWM and frequency. In Superheat Sensor mode, the Superheat Setpoint setting is disabled and a constant PWM output can be set to the device through the PWM output wires (18 AWG, white).
- Click the **Set** button to save any changes and set the new parameters. Click **OK** when the confirmation window appears.
- Advanced Settings will be grayed out for Superheat Sensor.
- Repeat **Steps 2 through 5** for all Device IDs. When this step is finished, the system configuration for the USHS(s) will be complete.



3.6 Advanced Settings (Only Applicable for USHCs)

In the **Advanced Settings** tab, the user may alter the **Control Configuration** of the system, turn the **Passive and Active Clean Cycles** on or off, and access the **Diagnostics** window. This tab is only applicable to a USHX that is in Superheat Control mode. The **Diagnostics** window is password protected and only accessible for DMQ maintenance purposes.



3.6.1 Control Configuration

The purpose of the **Control Configuration** section is to allow the user to set the control loop parameters. The settings may vary depending on the application.

Parameter	Description	Recommendation
<i>Control Scheme</i>	This provides user to select the control algorithm the firmware will execute.	A (default)
<i>Gain 1</i>	This determines how quickly the control loop responds to fluctuations in superheat.	1
<i>Gain 2</i>	This determines how quickly the control loop brings the superheat to the superheat setpoint.	0.1
<i>Flood Control SH</i>	This is the superheat value below which the PWM goes to 5% (valve closed) to prevent liquid refrigerant to flood back. This value must be lower than the Superheat Setpoint.	0°C or 0°F
<i>Sensitivity</i>	This control parameter is associated with type of application under automatic control.	15 for Refrigeration Systems; 30 for HVAC Systems

3.6.2 Clean Cycle

The function of the **Clean Cycle** feature is to clean the MSEV/HC-MSEV so that debris that collects within the valve can be removed.

Parameter		Recommendation
<i>Passive Clean Cycle</i>		On
<i>Active Clean Cycle</i>	Micro Valve	Off
	Micro Valve + Spool	On
	Interval	20 Minutes

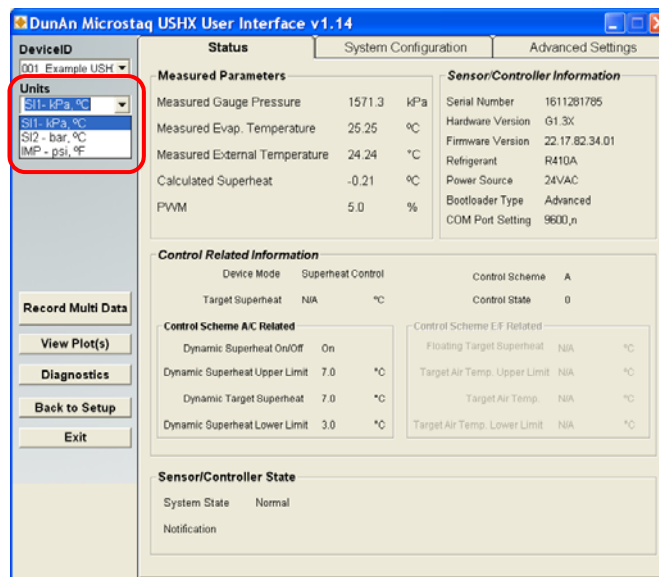
To configure the advanced settings described in [Sections 3.6.1 \(Control Configuration\)](#) and [3.6.2 \(Clean Cycle\)](#), complete the following steps:

1. Input parameter values or select settings as desired. DMQ suggests that the recommended settings are used, although the settings may vary depending on the application.
2. Click the **Set** button to save any changes and set the new parameters. Click **OK** when the confirmation window appears.
3. Repeat **Steps 1 and 2** for all Device IDs. When this step is finished, the advanced settings configuration will be complete.

3.7 Status

The **Status** tab displays the current status of the selected USHX Device ID and relays information about the system to the user.

Select the preferred units of measurement (for pressure and temperature) from the **Units** drop-down menu in the left column of the tab. Values in the tab will automatically be converted and update to reflect changes in units. The default are IMP – psi, °F. This menu is also present in the other tabs.



The table below describes the parameters that are displayed in the **Status** tab.

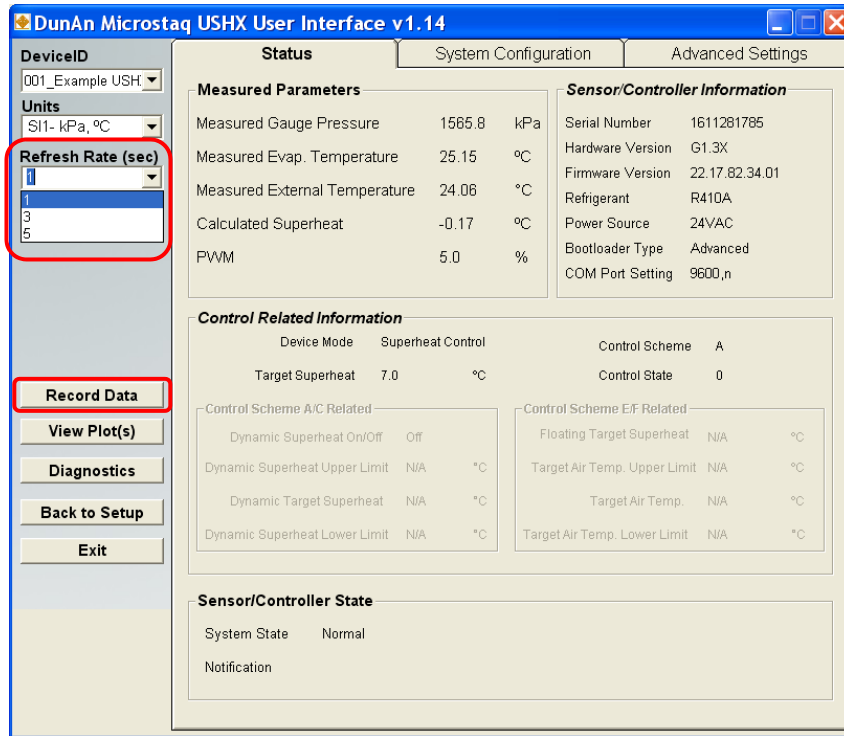
Parameter	Description
<i>Measured Gauge Pressure</i>	This is the measured gauge pressure at the evaporator outlet where the USHX is installed.
<i>Measured Evap. Temperature</i>	This is the fluid temperature (measured by the temperature of the external wall of the copper tubing) at the evaporator outlet where the thermistor is installed.
<i>Measured External Temperature</i>	This is the fluid temperature (measured by the temperature of the external wall of the copper tubing) where the thermistor is installed.
<i>Calculated Superheat</i>	This is the calculated superheat determined in real-time based on pressure and temperature measurements.
<i>PWM</i>	This is the PWM duty cycle applied to the MSEV/HC-MSEV by the USHX.
<i>Sensor/Controller Information</i>	This section displays the Serial Number, Hardware Version, Firmware Version, Refrigerant, Power Source, Device Mode, Control State, Control Scheme, Target Superheat (Superheat Setpoint) of the system, Bootloader Type, and COM Port Settings.
<i>Sensor/Controller State</i>	This is the current system state determined by the USHX in operation. States that may be displayed include: <ul style="list-style-type: none"> • Normal – The USHX is operating normally. • Passive Valve Clean – The MSEV/HC-MSEV is in Passive Clean mode. • Active Valve Clean – The MSEV/HC-MSEV is in Active Clean mode. • Safety Mode – A system or USHX fault has been detected. In this case, the PWM will be fixed at 40%. Contact Manufacturer
<i>Notification</i>	Notifications that are displayed indicate a fault in the system. Conditions under which notifications appear are defined in Section 4.1 (Notifications) .

3.8 Recording Data

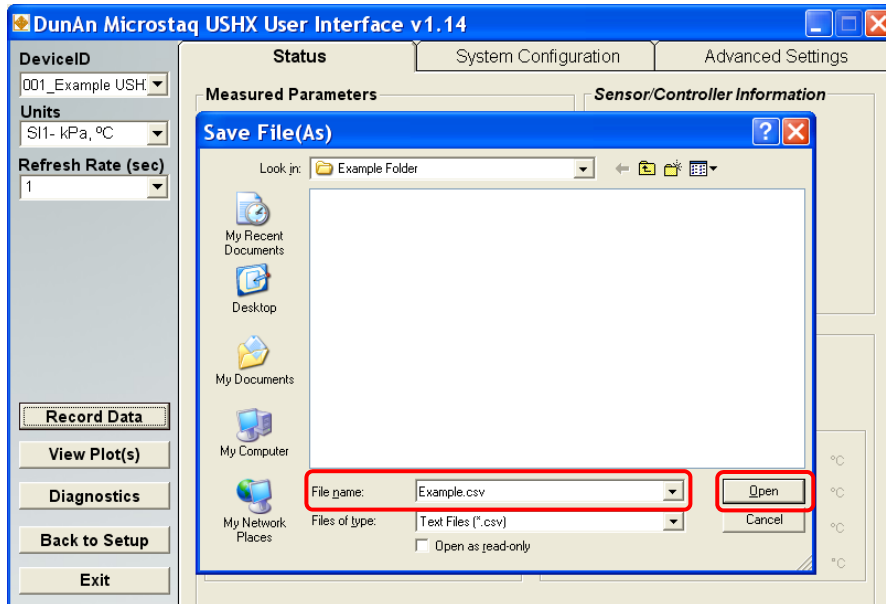
To record data with the USHX, complete the steps below. If more than one USHX is installed, refer directly to [Section 3.8.2 \(Multiple USHXs\)](#) below.

3.8.1 Single USHX

1. Select an appropriate refresh rate for the data collection using the **Refresh Rate (sec)** drop-down menu in the left column of the **Status** tab. The refresh rate selection will impact:
 - a. The status screen refresh rate.
 - b. The rate at which data is recorded.
 - c. The rate at which the run-time plot is updated to show new values.



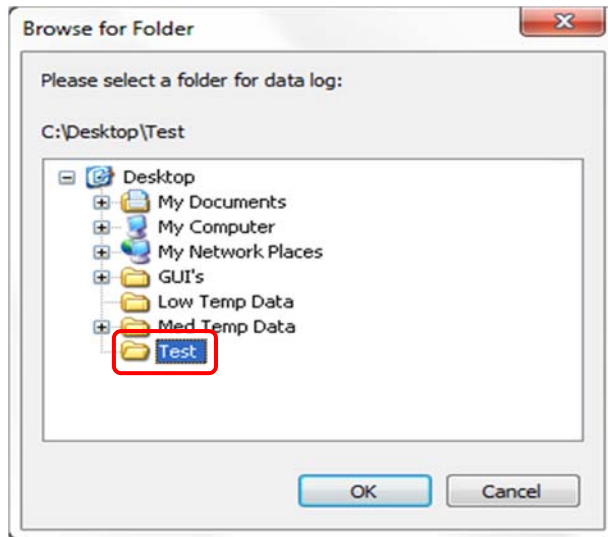
2. Click the **Record Data** button.
3. In the Save File (As) window that appears, select a suitable location to save the file to, enter an appropriate **File Name**, and then click **Open** to begin recording data. The **Record Data** button will be green and state **Recording Data** while data is being recorded.



If data will be recorded for more than 4 hours, DMQ recommends that the user use a 5-second refresh rate.

3.8.2 Multiple USHXs

1. Click the **Record Multi Data** button.
2. In the Save File (As) window that appears, select a folder to save the files to and then click **Open** to begin recording data. The **Record Multi Data** button will be green and state **Recording Multi Data** while data is being recorded.



Comma Separated Value (CSV) files containing the data will be generated and named automatically once the user stops the data collection process. Each CSV will correspond to a different Device ID and contain only that Device ID's data.

8	Date	Time	Device Id	Measured	Measured	Measured	Target Sup	Dynamic	Floating T	Calculate	PWM (%)	Power So	Control St	Control Sc	Dynamic S	Dynamic T	Dynamic	Target Air	Target
9	4/25/2018	14:13:33	Control	227.51	77.11	75.4	12.6	N/A	N/A	-0.59	5	24VAC	0	A	Off	N/A	N/A	N/A	N/A
10	4/25/2018	14:13:34	Control	227.51	77.11	75.33	12.6	N/A	N/A	-0.59	5	24VAC	0	A	Off	N/A	N/A	N/A	N/A
11	4/25/2018	14:13:35	Control	227.54	77.11	75.51	12.6	N/A	N/A	-0.61	5	24VAC	0	A	Off	N/A	N/A	N/A	N/A
12	4/25/2018	14:13:37	Control	227.57	77.11	75.29	12.6	N/A	N/A	-0.61	5	24VAC	0	A	Off	N/A	N/A	N/A	N/A
13	4/25/2018	14:13:38	Control	227.57	77.11	75.4	12.6	N/A	N/A	-0.61	5	24VAC	0	A	Off	N/A	N/A	N/A	N/A
14	4/25/2018	14:13:39	Control	227.49	77.11	75.4	12.6	N/A	N/A	-0.59	5	24VAC	0	A	Off	N/A	N/A	N/A	N/A

The units of measurement for pressure and temperature in all data files are psig and °F, respectively, regardless of the units that the user has selected. This is the case with systems containing either a single USHX or multiple USHXs.

3.9 Plotting Data

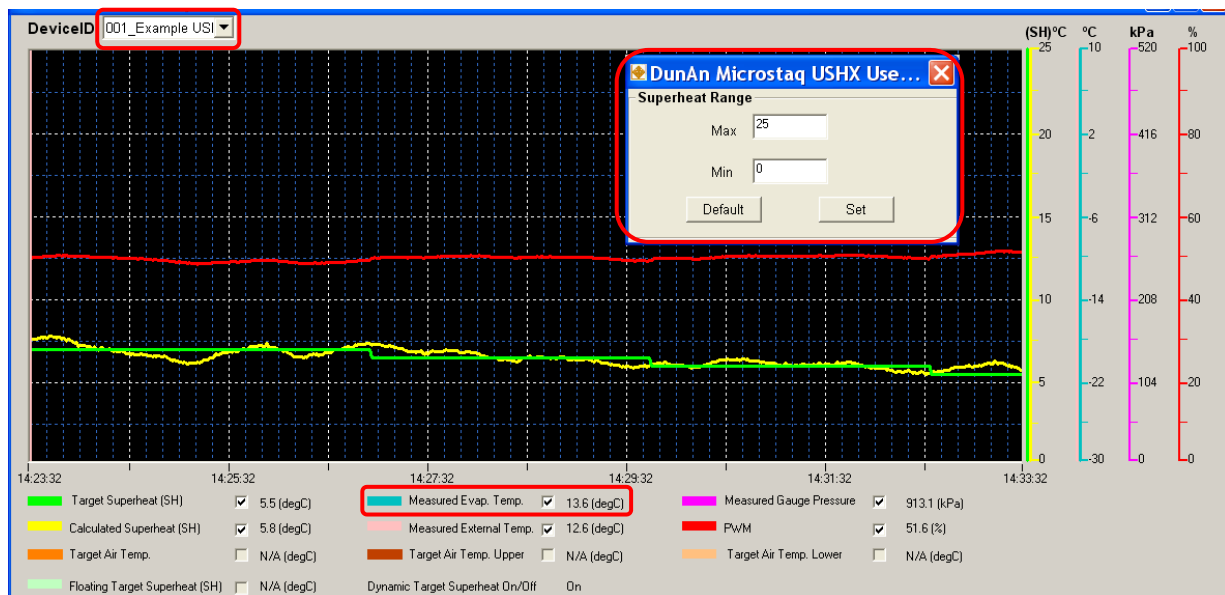
The USHX software is capable of generating a run-time plot of the Targeted Superheat, Calculated Superheat (SH), Measured Evap. Temperature, Measured External Temperature, Measured Gauge Pressure, and PWM. To plot data that is being recorded, complete the following steps:

1. Click the **View Plot(s)** button in the **Status** tab. A plot will appear in a new window with superheat and pressure run-time curves generating in the display.
2. The units of the values graphed in the plot can be changed through the **Units** drop-down menu in the **Status** tab.
3. The range(s) of the axis (axes) of the parameter(s) displayed can be changed by double clicking the corresponding axis (axes). A new window in which the user can input a desired range for the parameter should pop up.
4. The **Refresh Rate (sec)** setting – which is only available when there is only one USHX – proportionally affects the time range of data that is displayed in the plot.



A 1-second refresh rate will plot 10 minutes of data; A 3-second refresh rate, 30 minutes of data; A 5-second refresh rate, 50 minutes of data.

5. The user may choose for all, some, or none of the parameters to be graphed in the plot by checking or un-checking the check boxes beside the parameter labels below the horizontal axis of the plot.
6. When there are multiple USHXs, the plot only displays data pertaining to the Device ID currently selected in the **Device ID** drop-down menu at the top-left corner of the window.



To view the plot window, it is mandatory that the **Status** tab is active. Otherwise, the data collection process will pause and the plot will not be updated.

4 Alarms

The USHX software has the capability to inform the user of hazards, errors, and other information.



Multiple notifications will be displayed if multiple errors are encountered by the USHX at once.

4.1 Notifications

In the **Status** tab, the software will display notifications when errors are encountered. The table below lists the notifications that the user may see and describes the conditions that trigger their appearance.

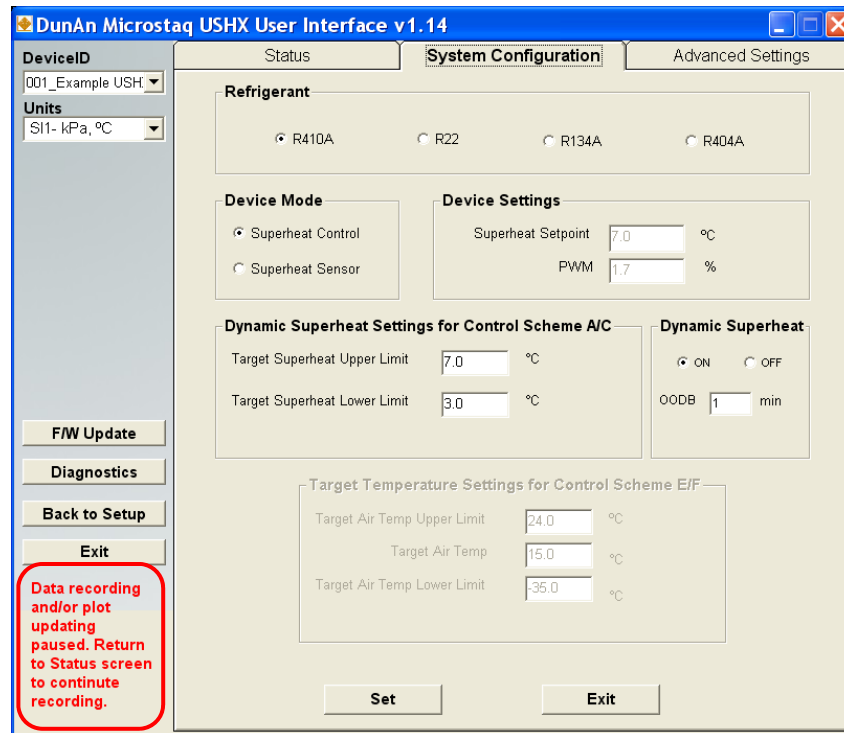
Notification	Description
PWM Toggle	It gets triggered when the PWM is at 95% and no change in superheat. During the PWM toggle, the PWM continuously cycles between 5 and 80%. This safety feature prevents overheating.
High Input Voltage*	The input voltage has exceeded the range of operation.
Low Input Voltage*	The input voltage has fallen below the range of operation.
Primary External Temp. Not within Sensor Range*	The temperature measured by the primary external sensor has exceeded or fallen below the normal operating temperature limits.
Secondary External Temp. Not within Sensor Range*	The temperature measured by the secondary external sensor has exceeded or fallen below the normal operating temperature limits.
Internal Temp. Not within Sensor Range*	The temperature measured by the internal temperature sensor has exceeded or fallen below the normal operating temperature limits.
Pressure Not within Sensor Range*	The input pressure has exceeded the pressure range of the pressure sensor.
Temperature Difference Error	Contact manufacturer if this notification is seen.

* These notifications pertain to errors involving the operating range of the USHX. When any of these notifications are displayed, ensure that the USHX is being operated properly within its design limits as specified in the product datasheet.

4.2 Additional Messages

Additional messages are shown in red text at the bottom-left corner of the **Status** tab. The table below lists additional messages that the user may see and describes the conditions that trigger their appearance.

Message	Description
Message not received completely	There is either a partial loss of data or a compatibility issue between the firmware and the USHX software interface.
Data recording and plot updating is paused. Return to status screen to continue	The user is active in a tab other than the Status tab while data is being recorded and/or plotted. The user should return to the Status tab to continue the data collection process.



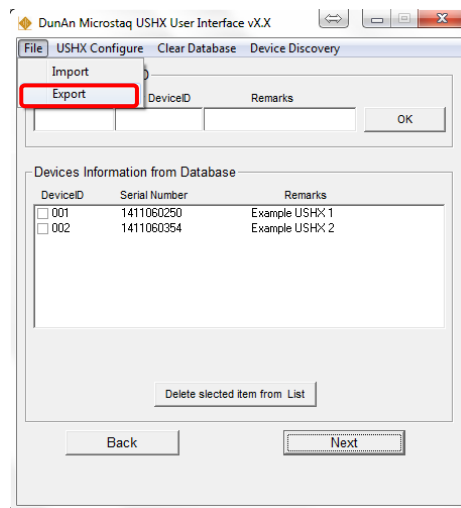
Message	Description
Communication Error Occurred, Reload the page before set parameters	There was a Modbus communication error when changing tabs on the GUI. Please click the yellow 'Reload' button to refresh the page.
Data recording and plot updating is paused. Return to status screen to continue	The user is active in a tab other than the Status tab while data is being recorded and/or plotted. The user should return to the Status tab to continue the data collection process.

5 Additional Features

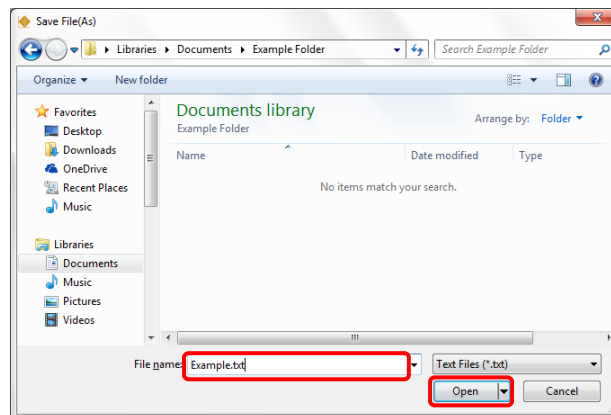
5.1 File Export/Import

The **File Export/Import** feature allows the user to save the database of Device IDs (export the database to a text file) and use it later (import the text file to load the database) if the database is needed again. This feature helps protect the user from the loss of the database, which could occur if the user clears the database by clicking **Clear Database** or if the computer used is changed. It eliminates the need to manually recreate a database, which can potentially be time consuming if there are multiple USHXs networked together. The steps below show how to use the **File Export/Import** feature.

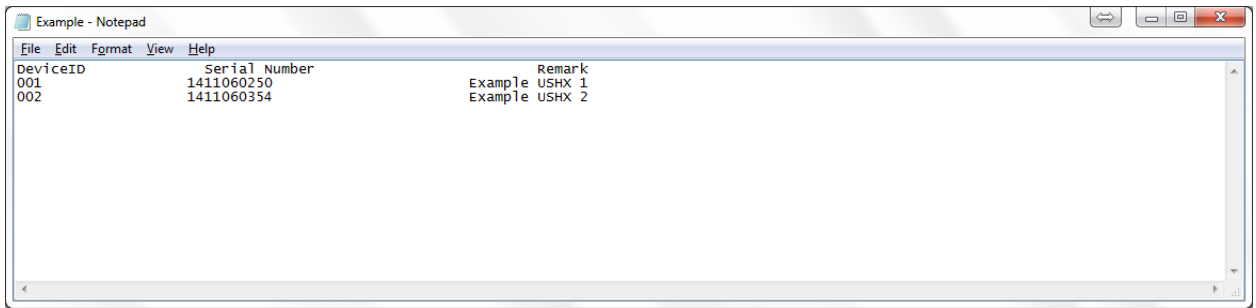
1. Click **File > Export** at the top of the Device ID Setup window seen in [Section 3.2 \(Device ID Assignment\)](#).



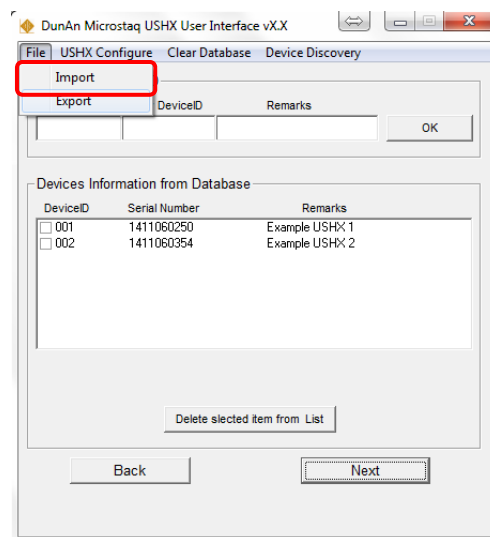
2. In the Save File (As) window that appears, select a suitable location to save the file to, enter an appropriate **File Name**, and then click **Open** to export and save the current database as a text file.



3. The database will be stored in the text file as shown in the figure below.



4. The user can import exported databases by clicking **File > Import** and selecting the appropriate text file.



The **Clear Database** button at the top of the window allows the user to clear all the Device ID information in the database. It is typically used when a new database needs to be created and provides a quick way to delete previous database information all at once. The **Delete selected item from List** button below the Database allows the user to delete the Device ID information of only selected Device IDs within the Database. To select a Device ID, check the box next to it in the Database.

5.2 Device Discovery

The Device Discovery feature allows the user to obtain USHX Device IDs when one or more Device IDs are unknown. To use the Device Discovery feature, complete the following steps:



Device Discovery does not work for multiple USHX in a network where one or more USHX have the same Device ID.

4. Ensure that power is being supplied to all USHX by checking that the wiring harnesses are firmly attached to each device.



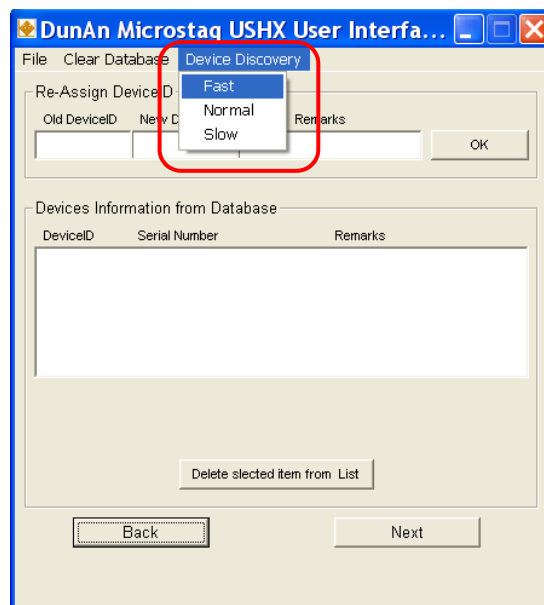
Review the **Multiple USHX-MSEVs** section in the **MSEV and USHX Hardware Installation Manual** to learn about networking with more than one USHX device.

5. Select the Device Discovery drop-down menu and choose **Fast**, **Normal**, or **Slow** speed.

Device Discovery Speed	Wait Time (min)	Reliability
Fast	15	Good
Normal	30	Better
Slow	45	Best



Please be patient as Device Discovery will require the full wait time in order to execute properly. Also, note that the check for Device ID #1 may not display during the Device Discovery process.



6. Please wait for Device Discovery to complete. Once completed, load the USHX Device IDs into the database by clicking **Yes** on the popup window.

6 Appendix – Explanation of Control Schemes A & C

6.1 Control Scheme A

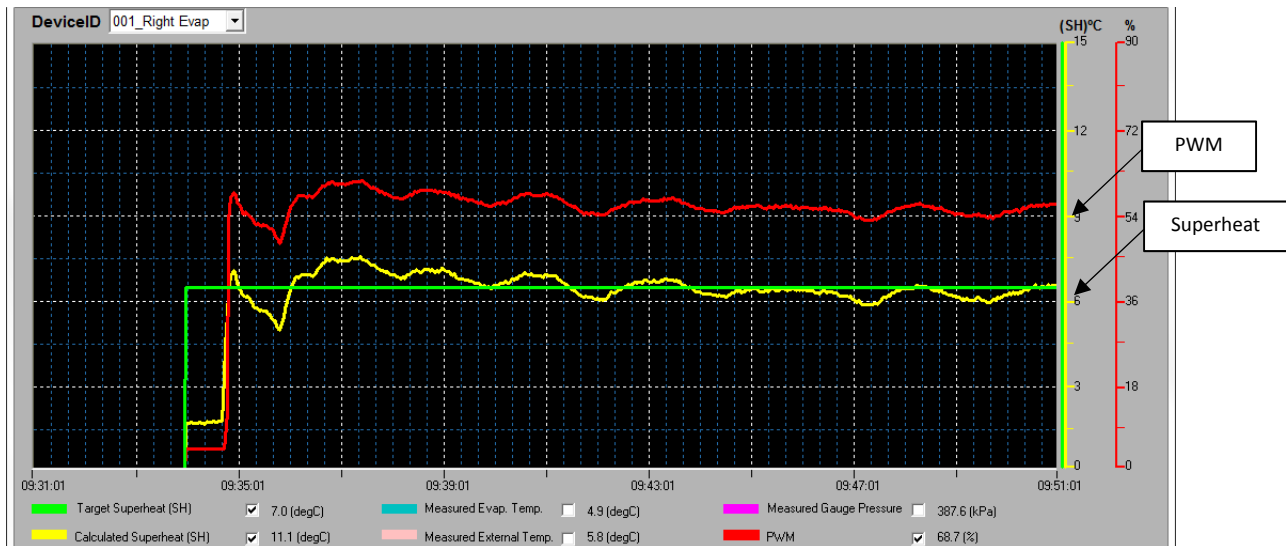
Control Scheme A is the default Control Scheme and used to control the superheat towards a user-defined Superheat Setpoint. This control scheme is applicable for both HVAC and Refrigeration Systems. The Calculated Superheat is the feedback parameter used for closed-loop control. The main feature of this scheme is that the parameters *Gain 1* and *Gain 2* dynamically adjust to achieve precise superheat control. The initial values of *Gain 1* and *Gain 2* in the control algorithm are the values entered through the GUI.

Gain 1:

Gain 1 acts as a proportional gain. The objective of *Gain 1* is to adjust the PWM% proportionally with the magnitude of superheat error (Superheat Setpoint – Calculated Superheat). Its effect on PWM is given by:

$$\text{Gain 1} * (\text{Superheat Setpoint} - \text{Calculated Superheat})$$

With *Gain 1*, PWM adjustments will be more drastic with higher magnitude superheat error. The recommended default value is 1.



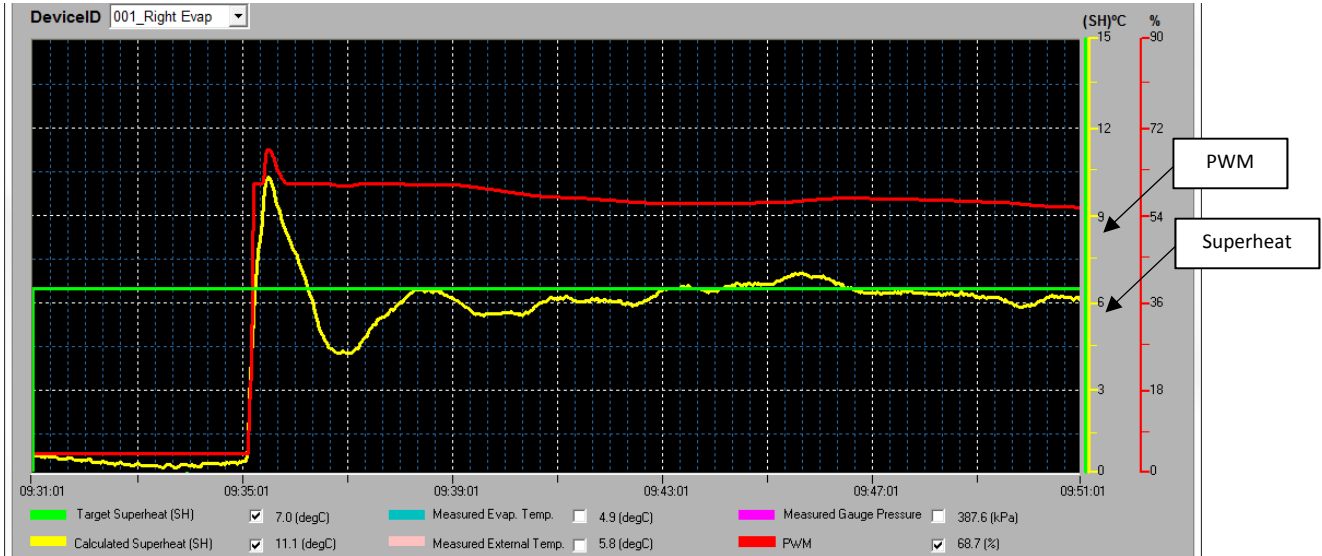
The plot above demonstrates the scenario of *Gain 1* \gg *Gain 2*, in which *Gain 1* dominates. PWM responds to superheat error in a proportional manner.

Gain 2:

Gain 2 acts as an integral gain. The objective of Gain 2 is to gradually trim down the superheat error toward zero. Its effect on PWM is given by:

$$Gain\ 2 * \sum (Superheat\ Setpoint - Calculated\ Superheat)$$

The recommended default value is 0.1.



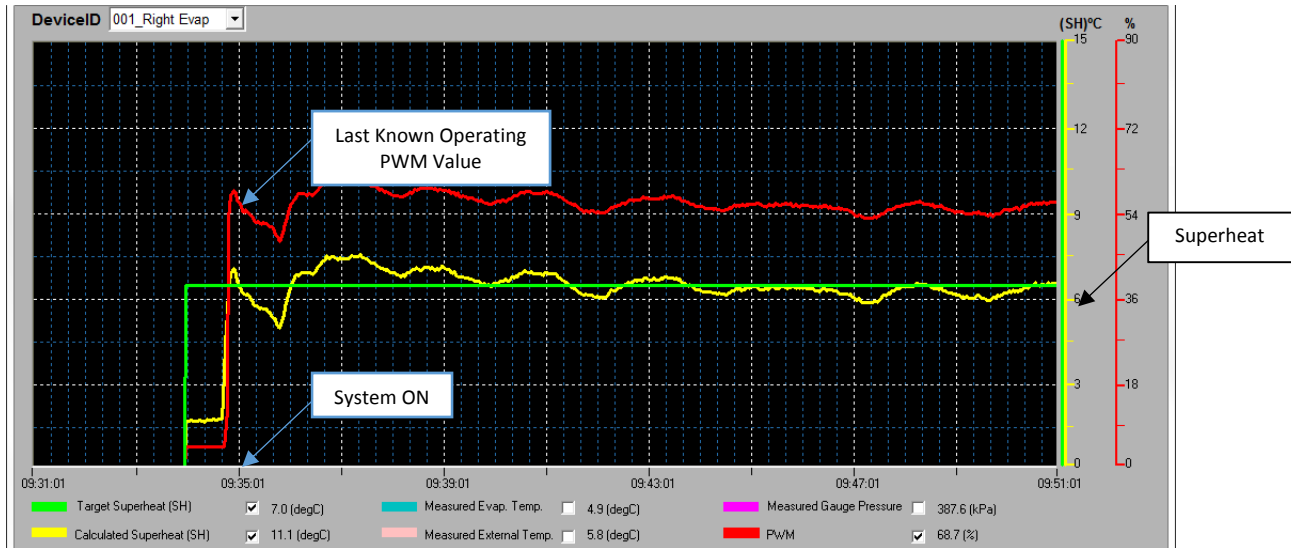
The plot above demonstrates the scenario of Gain 2 >> Gain 1, in which Gain 2 dominates. PWM responds to superheat error as a summation over time.

The below combination of Gain 1 and Gain 2 settings are recommended when default gains do not provide the best results.

Gain 1	Gain 2	Description
1	0.1	Default
0.5	0.05	To make the PWM% adjust slower
5	0.3	To make the PWM% adjust faster

Sensitivity:

Sensitivity is used to detect sudden changes in pressure such as compressor ON, OFF, etc. When the standard deviation of Evaporator Out Pressure goes above the user-defined *Sensitivity* setting, the PWM will default to the last known operating PWM and the control algorithm will resume normal operation. The recommended *Sensitivity* settings are 15 for refrigeration systems and 30 for HVAC systems.



The plot above demonstrates the scenario of compressor ON in an HVAC system. PWM restores to its previous known good value, enhancing the superheat response time.

Flood Control SH:

Flood Control Superheat is used as a safety feature to prevent compressor flood back from occurring in the system. If the system Calculated Superheat falls below the user-defined setting, the PWM will instantly go to 5% to close the valve. When Calculated Superheat goes back above the *Flood Control SH*, the control algorithm resumes normal operation. The recommended setting is 0 °F (0°C).

Passive Clean Cycle:

The *Passive Clean Cycle* is another safety feature. The purpose of the *Passive Cleaning Cycle* is to minimize the contaminant build up for the MEMS microvalve. When this feature is ON, the PWM frequency is adjusted to 5 Hz for 200 milliseconds every 10 seconds. This allows the MEMS microvalve to achieve full stroke and eliminate contaminant buildup. It is recommended to always have this feature ON.

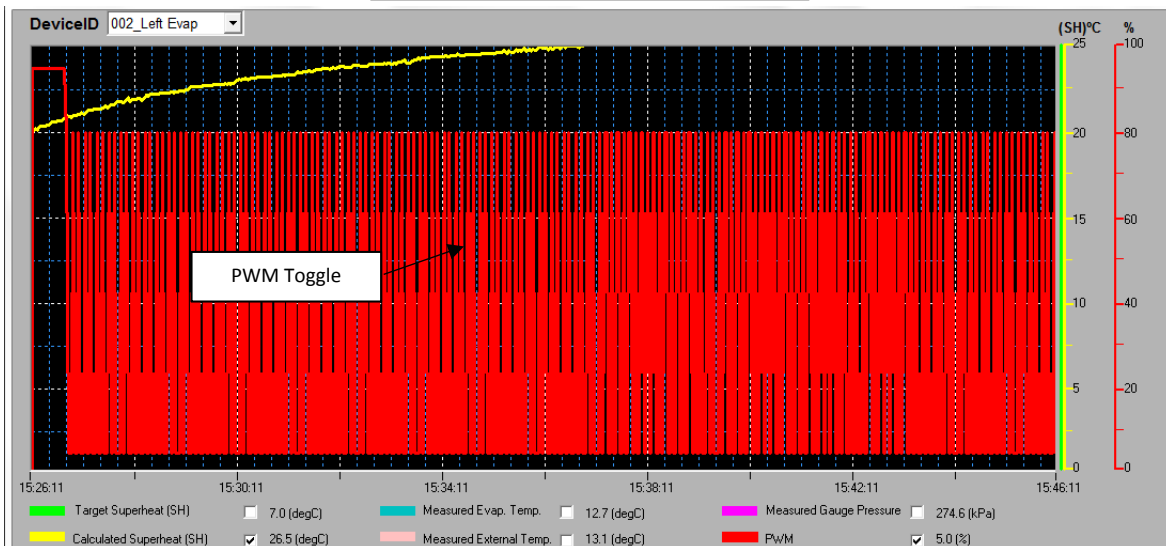
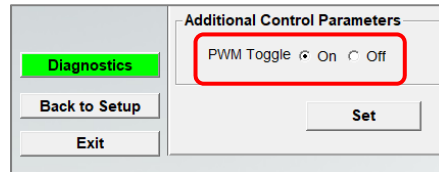
Active Clean Cycle:

The *Active Clean Cycle* is yet another safety feature to minimize the contaminant build up for either ‘MEMS Micro Valve’ or ‘MEMS Micro Valve + Spool’ depending upon user selection. Below describes the difference between these two settings. The recommended option is ‘Micro Valve + Spool’.

Type	Function	Recommended Interval
Micro Valve	Adjust the PWM Frequency to 5 Hz for 5 seconds at a user-defined time interval.	20 minutes
Micro Valve + Spool	Adjust the PWM Frequency to 5 Hz for 5 seconds at a user-defined time interval. For the first second, pulse the MSEV with 80% PWM and 5% PWM in 500 ms durations.	20 minutes

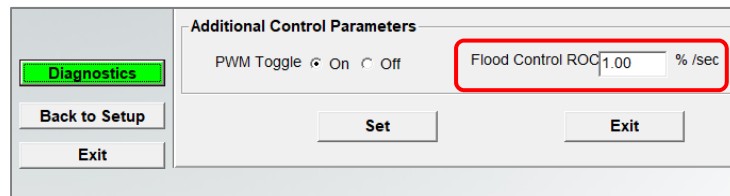
PWM Toggle

The objective of *PWM Toggle* is to conserve power and prevent overheating of the MSEV. It is intended to occur during system OFF and defrost cycles in HVAC-R systems. When the superheat is stable and the PWM value goes above 90% for 30 seconds, *PWM Toggle* is initiated. The USHX will command the MSEV between 80% and 5% PWM indefinitely. When the superheat starts to fluctuate, *PWM Toggle* automatically disables and control algorithm resumes normal operation. The recommended default setting for *PWM Toggle* is ON. It can be turned OFF using the Diagnostics menu. It is password protected, please contact the manufacturer for the password.



Flood Control ROC (Flood Control Rate of Change):

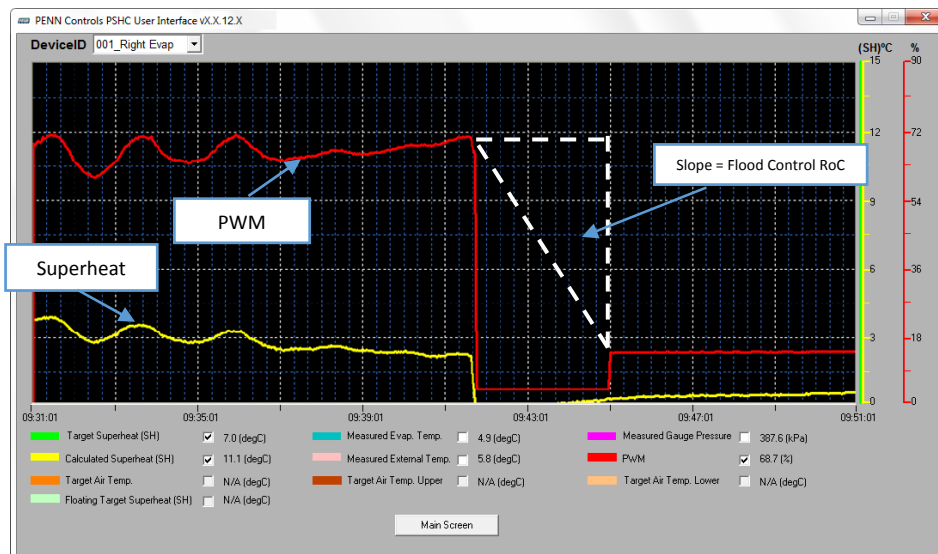
Flood Control ROC is a setting used in conjunction with the *Flood Control SH* parameter. It can be found in the Diagnostics menu.



Flood Control ROC is best explained by example: Let's say your refrigeration system is operating at 60% PWM and the Calculated Superheat falls below the Flood Control Superheat setting. The PWM will then suddenly fall to 5% to increase the superheat. Let's say after 10 seconds the superheat rises back above the Flood Control Superheat value. The system will then resume normal operation. But at what PWM value? 60%? Not quite. This is where the *Flood Control ROC* value is realized. The PWM value that is initialized after a Flood Control cycle is equal to:

$$PWM = \text{Last known PWM} - \text{Flood Control ROC} * \text{Elapsed Seconds}$$

In this example, if the *Flood Control ROC* value is 1%/sec, the PWM initialized after a Flood Control cycle would be equal to $(60 - 1 * 10) = 50\%$.



6.2 Control Scheme C

Control Scheme C utilizes the same control algorithm with the same control parameters as *Control Scheme A* but *with static gains*; Gain 1 and Gain 2 will not dynamically adjust over time. This can be advantageous if *Control Scheme A* begins to overcompensate for disturbances in the system. This control scheme is applicable for both HVAC and Refrigeration systems.