Installation and Operating Instructions for

TANK SYSTEM CONTROLLER

Intertek

FOR YOUR SAFETY: This product must be installed and serviced by a professional service technician, qualified in hot water heater installation and maintenance. Improper installation and/or operation could cause serious injury, property damage, or death. Improper installation and/or operation will void the warranty.

⚠ WARNING	⚠ AVERTISSEMENT
Installer must comply with startup and installation instructions to avoid a dangerous situation.	**D'installation doit se conformer aux instructions d'installation et de démarrage pour éviter une situation dangereuse.**

H2433200-

LAARS® Heating Systems Company

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Section 1 Overview.

The Tank System Controller (TSC) is specifically designed to work with Laars E-Therm Commercial Heat Pump Water Heater systems. These systems consist of one or more heat pumps, stratified storage tanks, a temperature maintenance tank (also called a swing tank), and up to two back-up heaters that may be used.

The overall purpose of the TSC is to have several temperature sensors distributed across the stratified storage tanks, allowing the TSC to operate the heat pump(s) and adjust their discharge temperatures in an efficient and systematic manner. In addition, the TSC can interface with the swing tank to support load shift control (schedule), CTA-2045, and to allow programmable temperature setpoint. The TSC also works with water flow meters to support measurement and verification systems.

There are two kits available, shipped with the following items:

CA023901 – Tank System Controller

- Control panel
- 10 RTD sensors
- 10 thermal sensor wells
- 10 junction boxes
- This manual

The TSC uses five temperature sensors that are distributed across the stratified storage system, and one that is used for the temperature maintenance tank. An additional sensor is used in the piping between the outlet of the cold water makeup tank (closest to the heat pump) and the heat pump inlet. They operate the heat pump(s) and adjust their discharge temperatures in an efficient and systematic manner.

Three optional sensors are provided for advanced control features. See Section 2.C on page 4 for more detail.

CA023902 – Tank System Controller with CTA-2045 Gateway

- Control panel
- 10 RTD sensors
- 10 thermal sensor wells
- 10 junction boxes
- Communication gateway
- Wi-Fi dongle
- DB9 communication cable
- This manual

1.A Safety Notes

Safety Notes are used throughout this manual to bring attention to the presence of hazards with various risk levels and to offer important information concerning the life of this product. There are 3 basic types.

⚠ WARNING	Indicates an imminently hazardous situation which, if not avoided, can or will result in death or serious injury and can or will result in catastrophic property damage.
⚠ CAUTION	Indicates a potentially hazardous situation which, if not avoided, may result in moderate injury and/or property damage.
NOTE:	Indicates instructions that are important to that topic but not related to personal injury or property damage.

⚠ WARNING

This unit must be installed in accordance with the procedures detailed in this manual, or the manufacturers warranty will be voided. The installation must conform to the requirements of the local jurisdiction having authority. Any modifications to this water heater, its controls, or wiring may void the warranty. If field conditions require modifications, consult the factory representative before initiating such modifications.

NOTE: This section covers physical wiring and sensor connections. In addition to physical connections, many control operations require setup within the TSC. See section 3 for control setup and operation.

⚠ WARNING

Electrical Shock Hazard

Electrical shock can cause severe injury, death or property damage. Disconnect the power supply before beginning installation or changing the wiring to prevent electrical shock or damage to the equipment. It may be necessary to turn off more than one power supply to disconnect. All electrical wiring is to be done in accordance with local codes, or in the absence of local codes, with: 1) The National Electrical Code ANSI/NFPA No. 70 - latest Edition, or 2) CSA STD. C22.1 “Canadian Electrical Code - Part 1.” This appliance must be electrically grounded in accordance with these codes.

Section 2 Wiring and Sensor Placement

The Tank System Controller (TSC) is a UL508A certified control system. The controller must be installed following the NFPA 70 - National Electric Code and/ or the Local Authority Having Jurisdiction. Failure to follow these guidelines may result in personal injury and/or property damage.

This section discusses wiring and sensor placement only. Consult the installation manual for the heat pump for all other installation information, such as placement and piping.

Note: This section covers physical wiring and sensor connections. In addition to physical connections, many control operations require setup within the TSC.
See section 3 for control setup and operation.

Figure 1. Enclosure with door closed

2.A Panel Layout

See Figure 2

2.B Main Power Feed

The control requires a single 15A 120VAC circuit for operation. The enclosure has a removable bottom panel to allow the contractor to easily drill out the required conduit penetrations without allowing metal shavings to get stuck in the enclosure and/or damage sensitive electrical components. There is an internal 4-Amp circuit breaker protecting the 24VDC power supply and associated electronics. The 120V circuit is most easily brought into the enclosure on the left side (if facing front) and connected to the appropriate terminals.

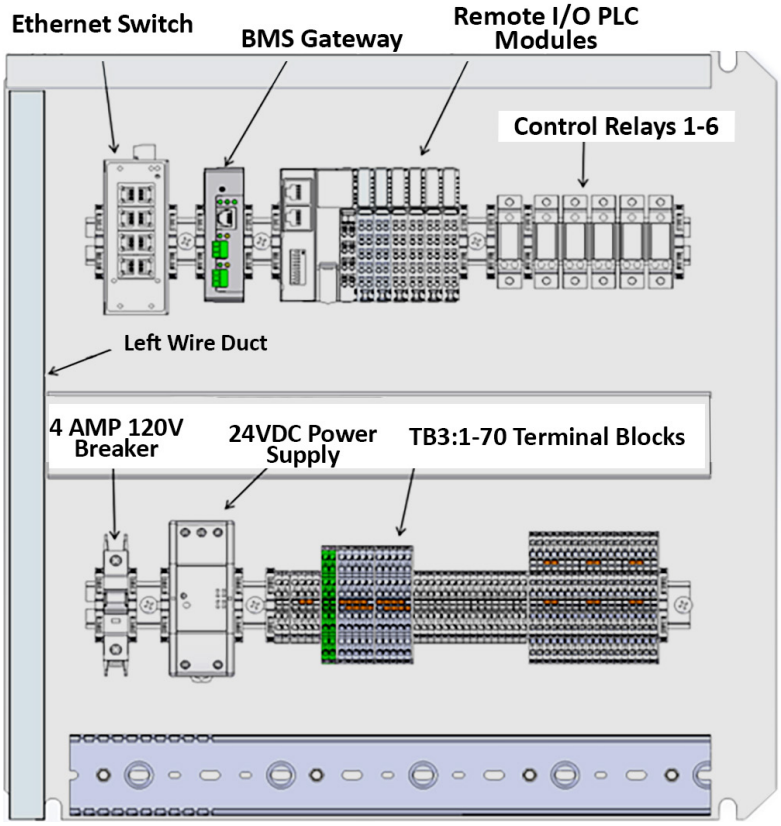


Figure 2. Internal Layout of Enclosure

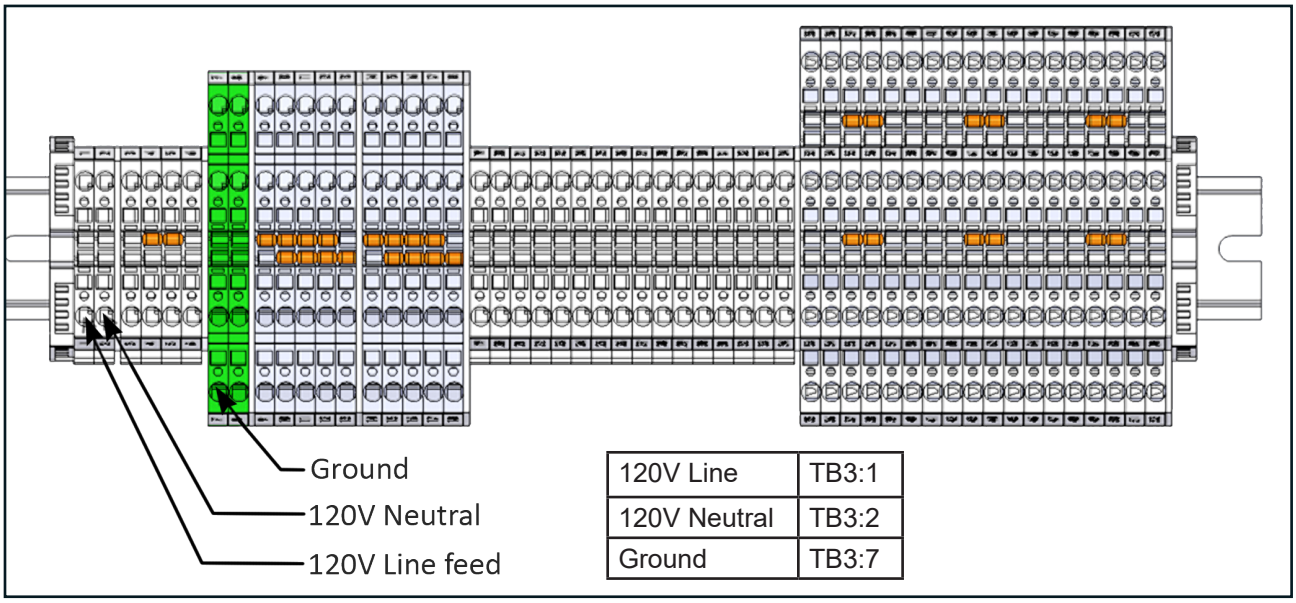


Figure 3. Main Power Feed Terminals

2.C Control Wiring

2.C.1 Wiring HPWH(s) to TSC

The TSC can be connected to a single heat pump, or multiple heat pumps in a system. It can control and stage up to 16 heat pumps in a cascaded system. True redundancy is achieved by running individual Cat 5 or Cat 6 cables between the TSC and each heat pump within the system. There is an Ethernet switch mounted in the TSC enclosure for easy connection to the heat pump and an Ethernet switch mounted in each heat pump control panel for easy connection to the heat pump. There are currently six available spaces on the TSC Ethernet switch for cascading multiple heat pumps. Any open port can be used. When more than six heat

pumps are needed, an additional ethernet switch is required. The Ethernet switch is located in the upper left corner of the TSC enclosure. Drill a hole in the bottom removable panel for the appropriate conduit/cable penetrations. Route the Cat 5 or Cat 6 cable through the left wire duct and terminate at the Ethernet switch.

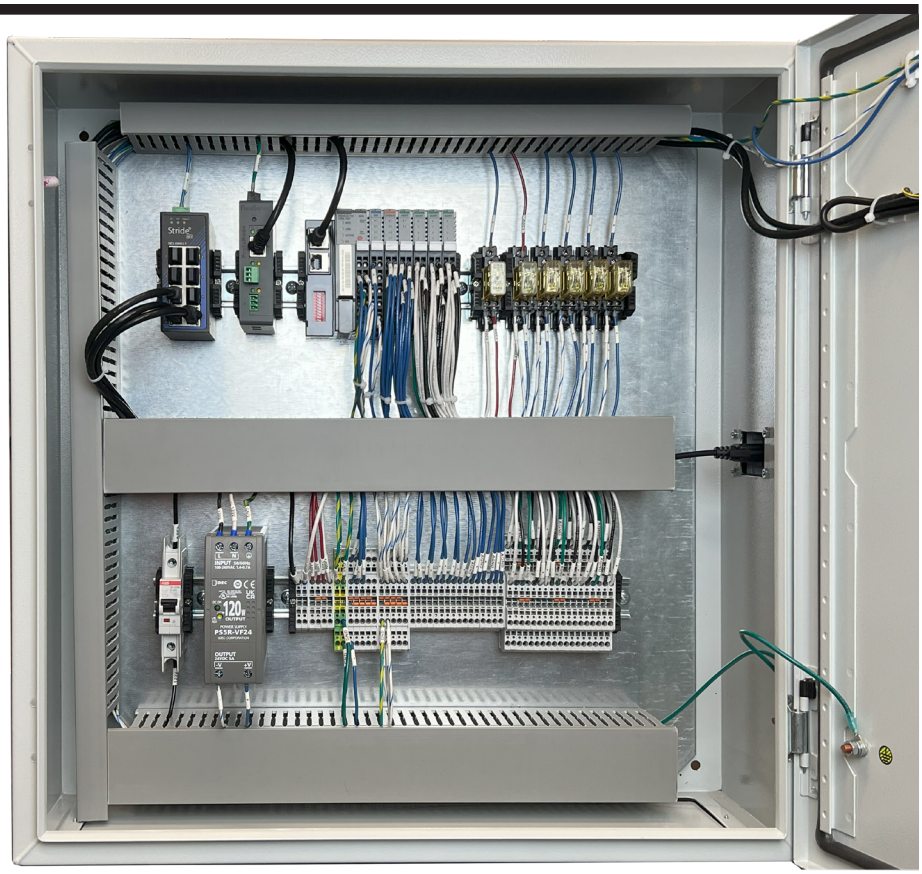


Figure 4. Photo of Internal Layout

2.C.2 Sensor Wiring

The control is shipped with 10 RTD sensors. The sensors have 12” wire leads, which require extension wire added to reach the TSC panel. To save space, double level terminal blocks are used to allow more connections while keeping the enclosure at 24” wide. They are numbered top and bottom for easy identification.

For electrically noisy areas, shielded RTD wire may be required. Examples of extension wire are shown below. Equivalent extension wire is acceptable.

- Automation Direct part number RTDW-22-1U-P-1 (non-shielded)
- Automation Direct part number RTDW-24-1S-F-1 (shielded)

Ten three-position junction boxes are also included, and allow for a watertight seal for making these connections.

The TSC uses up to ten RTD sensors (supplied with the control) across the entire system for controlling setpoints and load shift abilities.

Six sensors (shown as sensors 1 through 6) are to be equally spaced across the storage volume within the stratified storage tank farm. For clarity in this manual, these sensors have been named based on the tank volume percentage within the tank farm.

One optional sensor (shown as sensor 7) can be installed in the swing tank to support its operation.

The three remaining sensors (shown as sensors 8 through 10) can be used with Advance Load Up features for demand response and/or installations within the the Measurement & Verification systems option.

2.C.2.a Sensor Location Details

Required Temperature Sensors:

- Sensor 1: Heat Pump Inlet Protection Sensor - This sensor is to be installed in the piping between the cold water makeup tank and the heat pump(s), preferably within two feet of the tank outlet.
- Sensor 2: Tank Farm 10-15% Sensor Temp – This sensor is to be installed in the sensor well in the tank that most closely matches 10-15% of the total storage water in the system. This sensor will always be placed in the cold water makeup tank.
- Sensor 3: Tank Farm 25-35% Sensor Temp – This sensor is to be installed in the sensor well in the tank that most closely matches 25-35% of the total storage water in the system.
- Sensor 4: Tank Farm 40-50% Sensor Temp – This sensor is to be installed in the sensor well in the tank that most closely matches 40-50% of the total storage water in the system.
- Sensor 5: Tank Farm 60-70% Sensor Temp – This sensor is to be installed in the sensor well in the tank that most closely matches 60-70% of the total storage water in the system.
- Sensor 6: Tank Farm 75-85% Sensor Temp – This sensor is to be installed in the sensor well in the tank that most closely matches 75-85% of the total storage water in the system.

2.C.2.b Optional Swing Tank Temperature Sensor:

- Sensor 7: Swing Tank Sensor – This sensor is to be installed in the sensor well in the swing tank to

support load shift control (schedule), CTA-2045, and to allow programmable temperature setpoint of the swing tank.

2.C.2.c Optional Temperature Sensors for Measurement and Verification:

- Sensor 8: Cold Water Make-Up Temp – This sensor is to be installed in the piping on the cold-water line that feeds the tanks and mixing system (total domestic water usage). This optional sensor must be used in conjunction with a flow meter, as per Section 3
- Sensor 9: Mixing Valve Outlet Temp – This sensor is to be installed in the piping at the mixing valve outlet.
- Sensor 10: Hot Water Return Temp – This sensor is to be installed in the DHW re-circulation return that feeds the swing tank and mixing system (total recirculation water flow). This optional sensor must be used in conjunction with a flow meter, as per Section 3

Sensor connections are shown in table Table 1. Also see Figure 5 that shows all sensor connections.

Sensor Number	White Wire	Red Wire 1*	Red Wire 2*
1	TB3:46	TB3:44	TB3:45
2	TB3:47	TB3:48	TB3:49
3	TB3:52	TB3:50	TB3:51
4	TB3:53	TB3:54	TB3:55
5	TB3:58	TB3:56	TB3:57
6	TB3:59	TB3:60	TB3:61
7	TB3:64	TB3:62	TB3:63
8	TB3:35	TB3:36	TB3:37
9	TB3:40	TB3:38	TB3:39
10	TB3:41	TB3:42	TB3:43
*Red wires are interchangeable			

Table 1. Sensor Locations.

Physical sensor placement is dependent on the system. During the control setup process, the installer will choose the number of stratified tanks, the piping strategy (parallel vs. series), and a choice of one or two back up heaters (if used). Once setup is complete, the homescreen will visually depict the piping, and the distribution of the tank sensors.

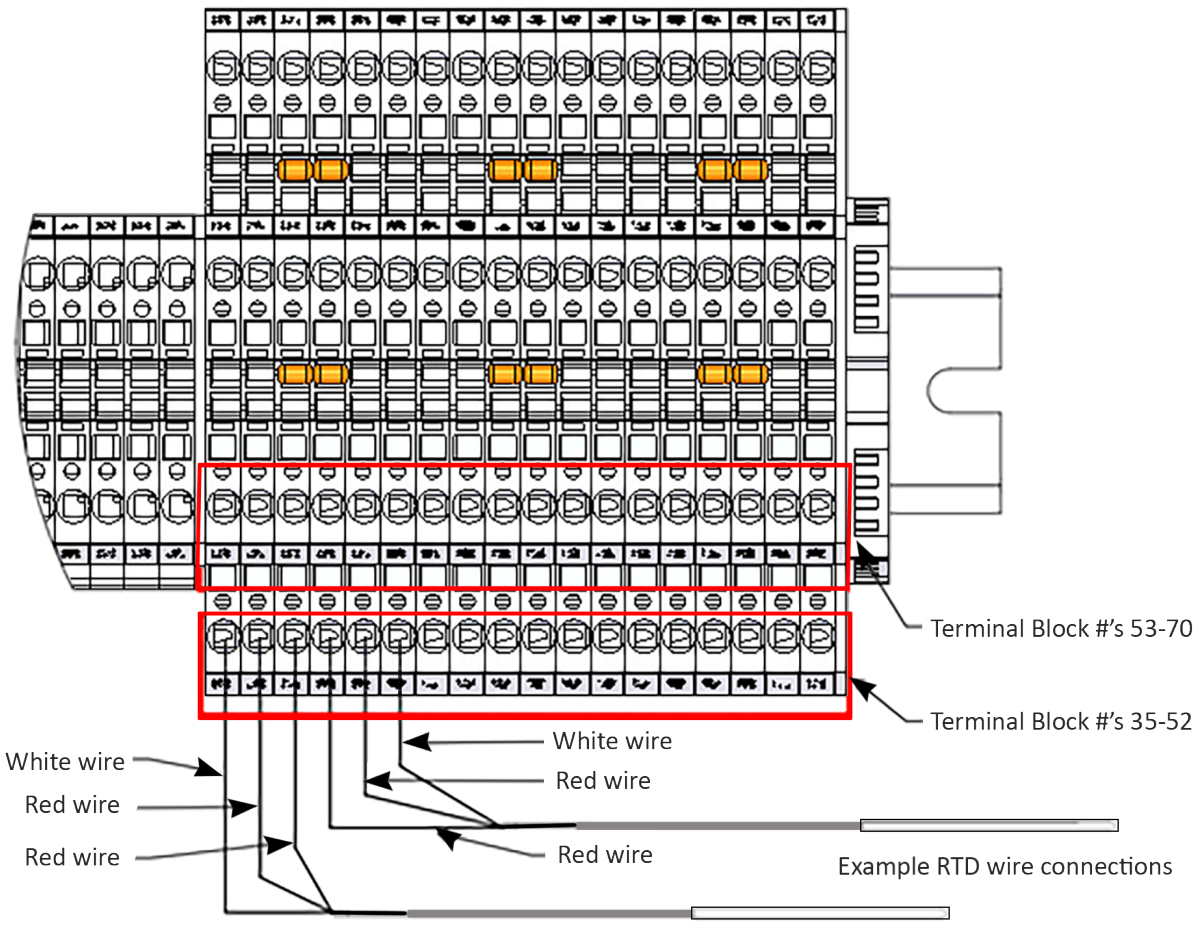


Figure 5. Field Sensor Wiring

2.C.3 Optional Water Flow Meters for Measurement and Verification:

Flow meters are optional system components that are used for the calculation of system efficiency (system COP).

Clamp-on ultrasonic flow meters are recommended for ease of install and service. The flow meter must be 24VDC powered with 4-20mA feedback for integration into the TSC. The meter must be sized for expected water flow range and pipe size/material. Keyence FD-R Series and FD-H Series are recommended.

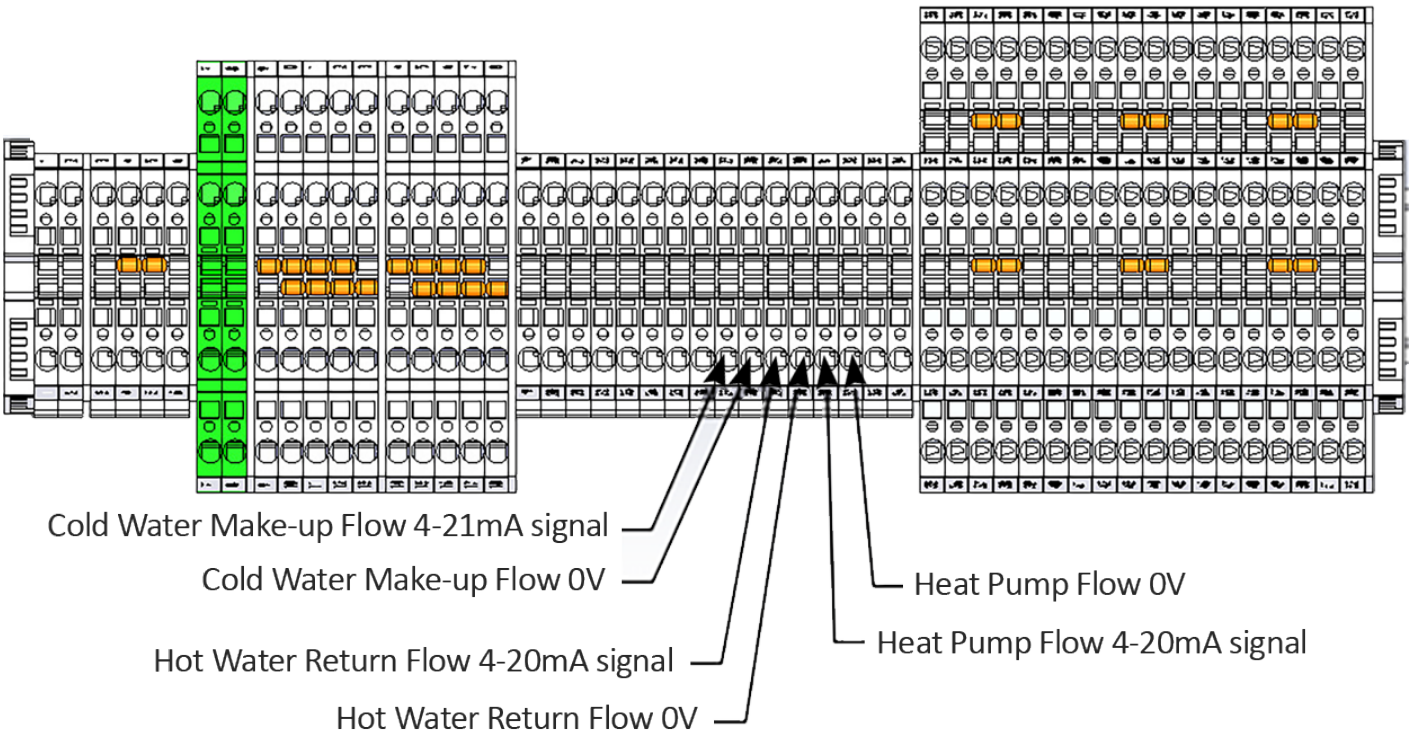
Flow meter manufacturer instructions must be consulted and followed.

For measurement and verification systems, flow meters are installed in three locations within the heat pump system, as shown in Figure 6.

⚠ WARNING

CANCER AND REPRODUCTIVE HARM.
WWW.P65WARNINGS.CA.GOV.

AS REQUIRED BY THE STATE OF CALIFORNIA PROPOSITION 65.

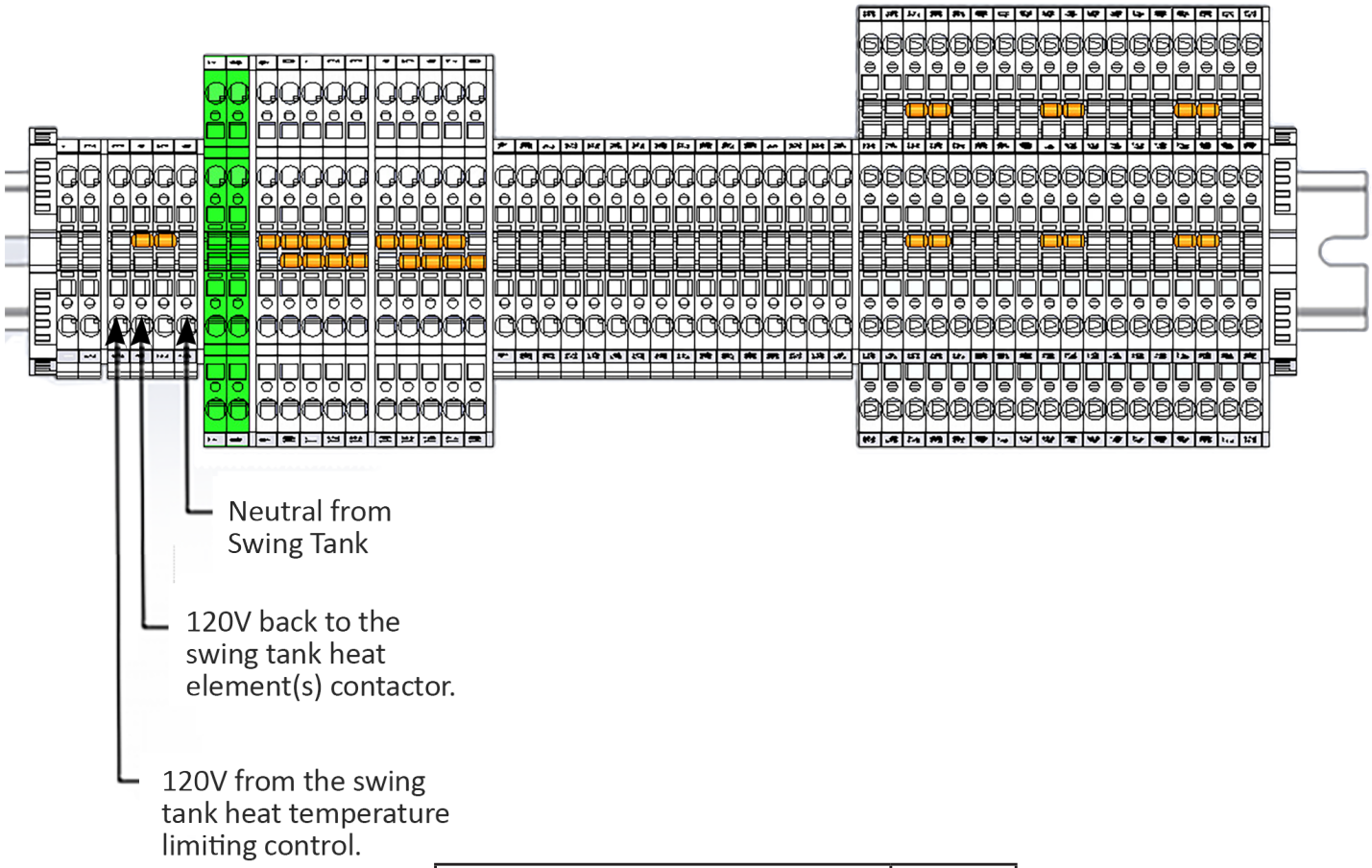


Cold Water Make-up Flow 4-20mA signal	TB3:27
Cold Water Make-up Flow 0V	TB3:28
Hot Water Return Flow 4-20mA signal	TB3:29
Hot Water Return Flow 0V	TB3:30
Heat Pump Flow 4-20mA signal	TB3:31
Heat Pump Flow 0V	TB3:32

Figure 6. Flow Meter Wiring Connections

2.C.4 Swing Tank Wiring Connections

The TSC can integrate a swing tank (also known as a temperature maintenance tank) directly into the PLC to control re-circulation losses, advanced load up features, or to disable the swing tank under critical peak events or grid emergency situations. The swing tank uses an internal 120VAC temperature limit control and 120VAC coil contactors to control and operate the internal resistive heat elements. By intercepting the power coming from the temperature limit control, as shown in Figure 7, the TSC can disable the heating elements, monitor the heat elements run-time, and allow advanced load up to a higher temperature when required. Three (14 AWG minimum) conductors are needed to run between the swing tank control box and the TSC, as shown in Figure 7.

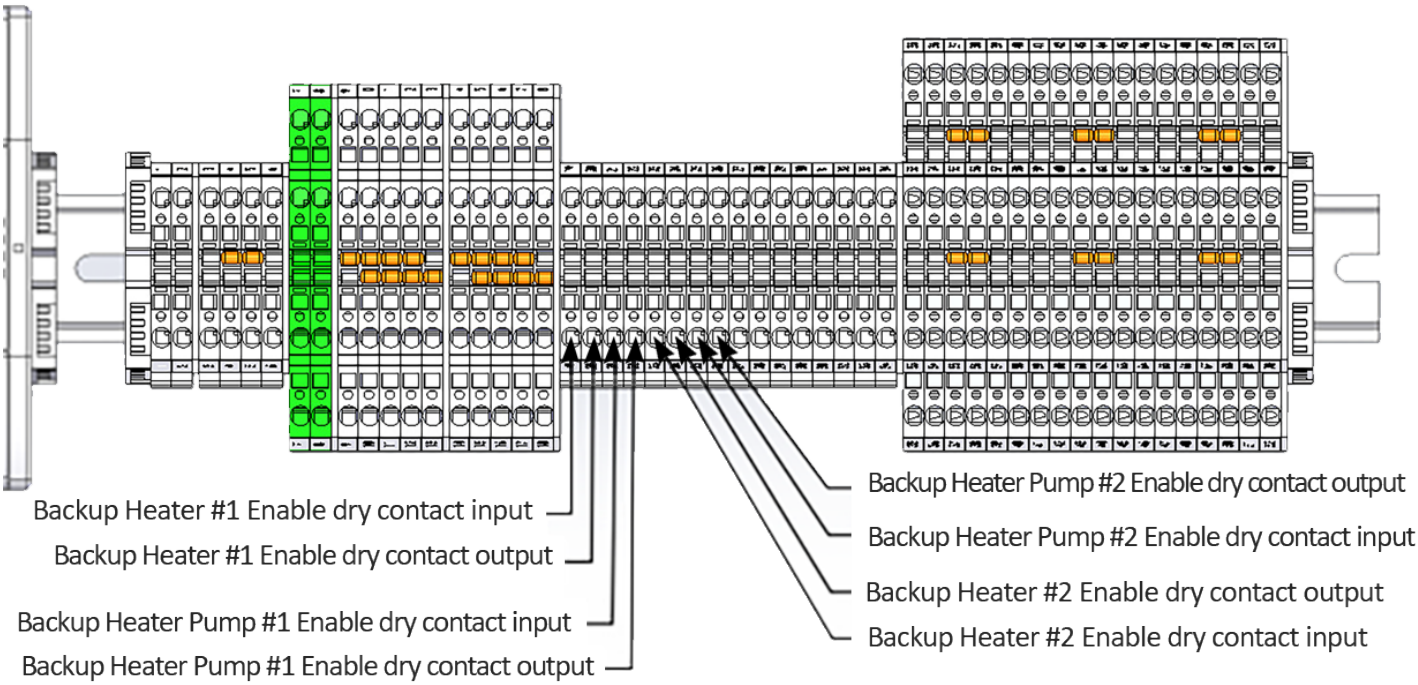


120V (H) From Swing Tank temperature limiting control.	TB3:3
120V (H) Back to Swing Tank heat element contactors.	TB3:4
120V (N) Neutral from Swing Tank	TB3:6

Figure 7. Swing Tank Wiring Connections

2.C.5 Back-up Heater and Back-up Heater Pump Output

The TSC can integrate and control up to two independent back-up heat sources and two independent back-up heater pumps. These are independently driven by the PLC system and system setup within the TSC. Four dry contacts are provided to control these outputs. Each contact has a maximum rating of to 30VAC/VDC. Power to feed these dry contacts is field supplied. See Figure 8 for wiring connections.



Backup Heater #1 Enable dry contact input (max 30VAC/VDC)	TB3:19
Backup Heater #1 Enable dry contact output	TB3:20
Backup Heater Pump #1 dry contact input (max 30VAC/VDC)	TB3:21
Backup Heater Pump #1 Enable dry contact output	TB3:22
Backup Heater #2 Enable dry contact input (max 30VAC/VDC)	TB3:23
Backup Heater #2 Enable dry contact output	TB3:24
Backup Heater Pump #2 Enable dry contact input (max 30VAC/VDC)	TB3:25
Backup Heater Pump #2 Enable dry contact output	TB3:26

Figure 8. Back Up Heater Wiring

2.D Optional CTA-2045 Gateway Wiring

Optional CTA-2045 gateway is used with the TSC for utility demand response.

The CTA-2045 gateway is a 120VAC powered, Wi-Fi controlled gateway that communicates to the utility grid and communicates directly to the PLC via Modbus RTU (RS485). The CTA-2045 gateway is installed separately in the building (preferably near a strong Wi-Fi signal) and will be connected to the PLC enclosure using a standard DB9 cable

Figure 9. CTA-2045 Gateway

The CTA-2045 gateway is shipped with a two-meter DB9 shielded cable for quick connection to the DB9 panel interface on the TSC enclosure, as shown in Figure 10. If longer cable is required, use DB9 male to female extension cable to extend the length

Figure 10. DB9 Communications Cable

Connect the included 120VAC cordset between the gateway and an appropriate 120VAC power receptacle.

Figure 11. DB9 Panel Interface

2.E BMS Connections

Building Management Systems can communicate with the TSC. BACnet IP, BACnet MSTP, Modbus TCP/IP, and Modbus RTU protocols are supported. Refer to the BMS gateway instructions for details on wiring and connectivity.

Table 2 (next 4 pages) shows the BACnet / Modbus Memory Map.

Hot Water Return Temp	Input	2	AI	2	F	
Tank Farm 0%	Input	3	AI	3	F	
Tank Farm 10%	Input	4	AI	4	F	
Tank Farm 25%	Input	5	AI	5	F	
Tank Farm 40%	Input	6	AI	6	F	
Tank Farm 60%	Input	7	AI	7	F	
Tank Farm 75%	Input	8	AI	8	F	
Swing Tank Temp	Input	9	AI	9	F	
Heat Pump Outlet Temp	Input	10	AI	10	F	
Cold Water Makeup Flow	Input	11	AI	11	GPMx100	
Heat Pump Flow	Input	12	AI	12	GPMx100	
Hot Water Return Flow	Input	13	AI	13	GPMx100	
Heat Pump Setpoint	Input	14	AI	14	F	
IWH 1 Enabled	Discrete	0	DI	0		0=Disable,1=Enabled
IWH 2 Enabled	Discrete	1	DI	1		0=Disable,1=Enabled
Swing Tank Enabled	Discrete	2	DI	2		0=Disable,1=Enabled
Heat Pump 1 Heat Demand	Discrete	101	DI	101		0=No Demand, 1=Demand
Heat Pump 2 Heat Demand	Discrete	102	DI	102		0=No Demand, 1=Demand
Heat Pump 3 Heat Demand	Discrete	103	DI	103		0=No Demand, 1=Demand
Heat Pump 4 Heat Demand	Discrete	104	DI	104		0=No Demand, 1=Demand
Heat Pump 5 Heat Demand	Discrete	105	DI	105		0=No Demand, 1=Demand
Heat Pump 6 Heat Demand	Discrete	106	DI	106		0=No Demand, 1=Demand
Heat Pump 7 Heat Demand	Discrete	107	DI	107		0=No Demand, 1=Demand
Heat Pump 8 Heat Demand	Discrete	108	DI	108		0=No Demand, 1=Demand
Heat Pump 9 Heat Demand	Discrete	109	DI	109		0=No Demand, 1=Demand
Heat Pump 10 Heat Demand	Discrete	110	DI	110		0=No Demand, 1=Demand
Heat Pump 11 Heat Demand	Discrete	111	DI	111		0=No Demand, 1=Demand
Heat Pump 12 Heat Demand	Discrete	112	DI	112		0=No Demand, 1=Demand
Heat Pump 13 Heat Demand	Discrete	113	DI	113		0=No Demand, 1=Demand
Heat Pump 14 Heat Demand	Discrete	114	DI	114		0=No Demand, 1=Demand
Heat Pump 15 Heat Demand	Discrete	115	DI	115		0=No Demand, 1=Demand
Heat Pump 16 Heat Demand	Discrete	116	DI	116		0=No Demand, 1=Demand
Heat Pump 1 Inlet Temperature	Input	101	AI	15	F	
Heat Pump 2 Inlet Temperature	Input	102	AI	16	F	
Heat Pump 3 Inlet Temperature	Input	103	AI	17	F	
Heat Pump 4 Inlet Temperature	Input	104	AI	18	F	
Heat Pump 5 Inlet Temperature	Input	105	AI	19	F	

Heat Pump 6 Inlet Temperature	Input	106	AI	20	F	
Heat Pump 7 Inlet Temperature	Input	107	AI	21	F	
Heat Pump 8 Inlet Temperature	Input	108	AI	22	F	
Heat Pump 9 Inlet Temperature	Input	109	AI	23	F	
Heat Pump 10 Inlet Temperature	Input	110	AI	24	F	
Heat Pump 11 Inlet Temperature	Input	111	AI	25	F	
Heat Pump 12 Inlet Temperature	Input	112	AI	26	F	
Heat Pump 13 Inlet Temperature	Input	113	AI	27	F	
Heat Pump 14 Inlet Temperature	Input	114	AI	28	F	
Heat Pump 15 Inlet Temperature	Input	115	AI	29	F	
Heat Pump 16 Inlet Temperature	Input	116	AI	30	F	
Heat Pump 1 Outlet Temperature	Input	201	AI	31	F	
Heat Pump 2 Outlet Temperature	Input	202	AI	32	F	
Heat Pump 3 Outlet Temperature	Input	203	AI	33	F	
Heat Pump 4 Outlet Temperature	Input	204	AI	34	F	
Heat Pump 5 Outlet Temperature	Input	205	AI	35	F	
Heat Pump 6 Outlet Temperature	Input	206	AI	36	F	
Heat Pump 7 Outlet Temperature	Input	207	AI	37	F	
Heat Pump 8 Outlet Temperature	Input	208	AI	38	F	
Heat Pump 9 Outlet Temperature	Input	209	AI	39	F	
Heat Pump 10 Outlet Temperature	Input	210	AI	40	F	
Heat Pump 11 Outlet Temperature	Input	211	AI	41	F	
Heat Pump 12 Outlet Temperature	Input	212	AI	42	F	
Heat Pump 13 Outlet Temperature	Input	213	AI	43	F	

Heat Pump 14 Outlet Temperature	Input	214	AI	44	F	
Heat Pump 15 Outlet Temperature	Input	215	AI	45	F	
Heat Pump 16 Outlet Temperature	Input	216	AI	46	F	
Heat Pump 1 Power	Input	301	AI	47	Watts	
Heat Pump 2 Power	Input	302	AI	48	Watts	
Heat Pump 3 Power	Input	303	AI	49	Watts	
Heat Pump 4 Power	Input	304	AI	50	Watts	
Heat Pump 5 Power	Input	305	AI	51	Watts	
Heat Pump 6 Power	Input	306	AI	52	Watts	
Heat Pump 7 Power	Input	307	AI	53	Watts	
Heat Pump 8 Power	Input	308	AI	54	Watts	
Heat Pump 9 Power	Input	309	AI	55	Watts	
Heat Pump 10 Power	Input	310	AI	56	Watts	
Heat Pump 11 Power	Input	311	AI	57	Watts	
Heat Pump 12 Power	Input	312	AI	58	Watts	
Heat Pump 13 Power	Input	313	AI	59	Watts	
Heat Pump 14 Power	Input	314	AI	60	Watts	
Heat Pump 15 Power	Input	315	AI	61	Watts	
Heat Pump 16 Power	Input	316	AI	62	Watts	
Heat Pump 1 State	Input	401	AI	63		0-60 Compressor Phase
Heat Pump 2 State	Input	402	AI	64		0-60 Compressor Phase
Heat Pump 3 State	Input	403	AI	65		0-60 Compressor Phase
Heat Pump 4 State	Input	404	AI	66		0-60 Compressor Phase
Heat Pump 5 State	Input	405	AI	67		0-60 Compressor Phase
Heat Pump 6 State	Input	406	AI	68		0-60 Compressor Phase
Heat Pump 7 State	Input	407	AI	69		0-60 Compressor Phase
Heat Pump 8 State	Input	408	AI	70		0-60 Compressor Phase
Heat Pump 9 State	Input	409	AI	71		0-60 Compressor Phase
Heat Pump 10 State	Input	410	AI	72		0-60 Compressor Phase
Heat Pump 11 State	Input	411	AI	73		0-60 Compressor Phase
Heat Pump 12 State	Input	412	AI	74		0-60 Compressor Phase
Heat Pump 13 State	Input	413	AI	75		0-60 Compressor Phase
Heat Pump 14 State	Input	414	AI	76		0-60 Compressor Phase
Heat Pump 15 State	Input	415	AI	77		0-60 Compressor Phase
Heat Pump 16 State	Input	416	AI	78		0-60 Compressor Phase
Cold Water Makeup Flow Sensor Alarm	Discrete	10	DI	10		0=No Alarm, 1=Alarm
Hot Water Return Flow Sensor Alarm	Discrete	11	DI	11		0=No Alarm, 1=Alarm
Heat Pump Flow Sensor Alarm	Discrete	12	DI	12		0=No Alarm, 1=Alarm
Cold Water Makeup Temperature Sensor Alarm	Discrete	13	DI	13		0=No Alarm, 1=Alarm
Mixing Valve Outlet Temperature Sensor Alarm	Discrete	14	DI	14		0=No Alarm, 1=Alarm

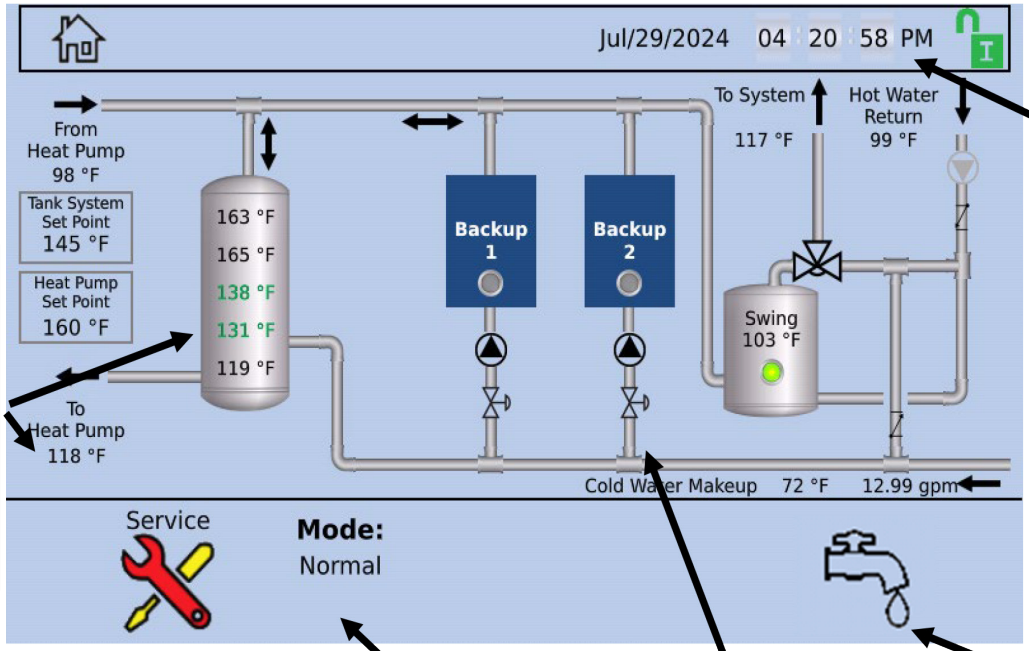
Hot Water Return Temperature Sensor Alarm	Discrete	15	DI	15		0=No Alarm, 1=Alarm
Tank Farm 0% Sensor Alarm	Discrete	16	DI	16		0=No Alarm, 1=Alarm
Tank Farm 10% Sensor Alarm	Discrete	17	DI	17		0=No Alarm, 1=Alarm
Tank Farm 25% Senosr Alarm	Discrete	18	DI	18		0=No Alarm, 1=Alarm
Tank Farm 40% Sensor Alarm	Discrete	19	DI	19		0=No Alarm, 1=Alarm
Tank Farm 60% Sensor Alarm	Discrete	20	DI	20		0=No Alarm, 1=Alarm
Tank Farm 75% Sensor Alarm	Discrete	21	DI	21		0=No Alarm, 1=Alarm
Swing Tank Temperature Sensor Alarm	Discrete	22	DI	22		0=No Alarm, 1=Alarm
Heat Pump 1 Communication Alarm	Discrete	23	DI	23		0=No Alarm, 1=Alarm
Heat Pump 2 Communication Alarm	Discrete	24	DI	24		0=No Alarm, 1=Alarm
Heat Pump 3 Communication Alarm	Discrete	25	DI	25		0=No Alarm, 1=Alarm
Heat Pump 4 Communication Alarm	Discrete	26	DI	26		0=No Alarm, 1=Alarm
Heat Pump 5 Communication Alarm	Discrete	27	DI	27		0=No Alarm, 1=Alarm
Heat Pump 6 Communication Alarm	Discrete	28	DI	28		0=No Alarm, 1=Alarm
Heat Pump 7 Communication Alarm	Discrete	29	DI	29		0=No Alarm, 1=Alarm
Heat Pump 8 Communication Alarm	Discrete	30	DI	30		0=No Alarm, 1=Alarm
Heat Pump 9 Communication Alarm	Discrete	31	DI	31		0=No Alarm, 1=Alarm
Heat Pump 10 Communication Alarm	Discrete	32	DI	32		0=No Alarm, 1=Alarm
Heat Pump 11 Communication Alarm	Discrete	33	DI	33		0=No Alarm, 1=Alarm
Heat Pump 12 Communication Alarm	Discrete	34	DI	34		0=No Alarm, 1=Alarm
Heat Pump 13 Communication Alarm	Discrete	35	DI	35		0=No Alarm, 1=Alarm
Heat Pump 14 Communication Alarm	Discrete	36	DI	36		0=No Alarm, 1=Alarm
Heat Pump 15 Communication Alarm	Discrete	37	DI	37		0=No Alarm, 1=Alarm
Heat Pump 16 Communication Alarm	Discrete	38	DI	38		0=No Alarm, 1=Alarm
Remote I/O Communication Fault	Discrete	39	DI	39		0=No Fault, 1=Fault
Mode Setpoints Data Table Empty	Discrete	40	DI	40		0=No Fault, 1=Fault
Swing Tank Control Fault	Discrete	41	DI	41		0=No Fault, 1=Fault
Tank Farm Temperature Sensors Fault	Discrete	42	DI	42		0=No Fault, 1=Fault

Table 2. BACnet / Modbus Memory Map

Section 3 Control Navigation and Installation Setup

The Home screen

The home screen view displays many of the system operational values and parameters, as well as navigation to the Service menu.



Tank Farm temps. Green indicates current On and Off controlling sensors.

Date and time. Press and hold to edit when logged in.

Press to navigate to the Service sub menus

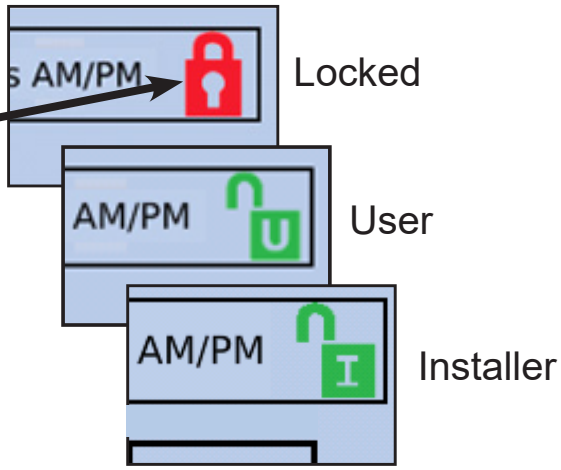
Displays current operating mode

Status of Instantaneous Water Heaters, if installed

Symbol shows at least one heat pump is needed to satisfy a heat demand

3.A Security

The Security Icon is on all screens. It displays the current security level of the control system.



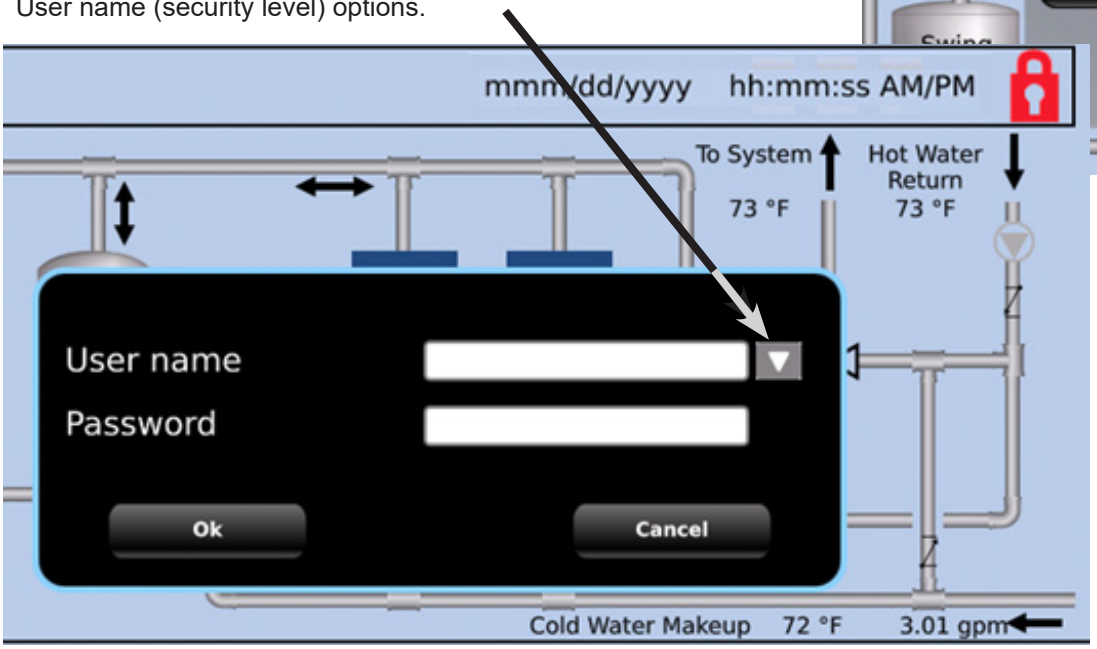
- A closed red padlock indicates a logged-out state and full protection.
- An open green padlock (noted with a U) indicates a user level of protection, granting minimal modifications.
- An open green padlock (noted with an I) indicates that the Installer Level password has been entered.

NOTE: Installer Level access is for factory authorized and trained personnel, and allows for configuration and parameter changes to be made at initial setup and commissioning.

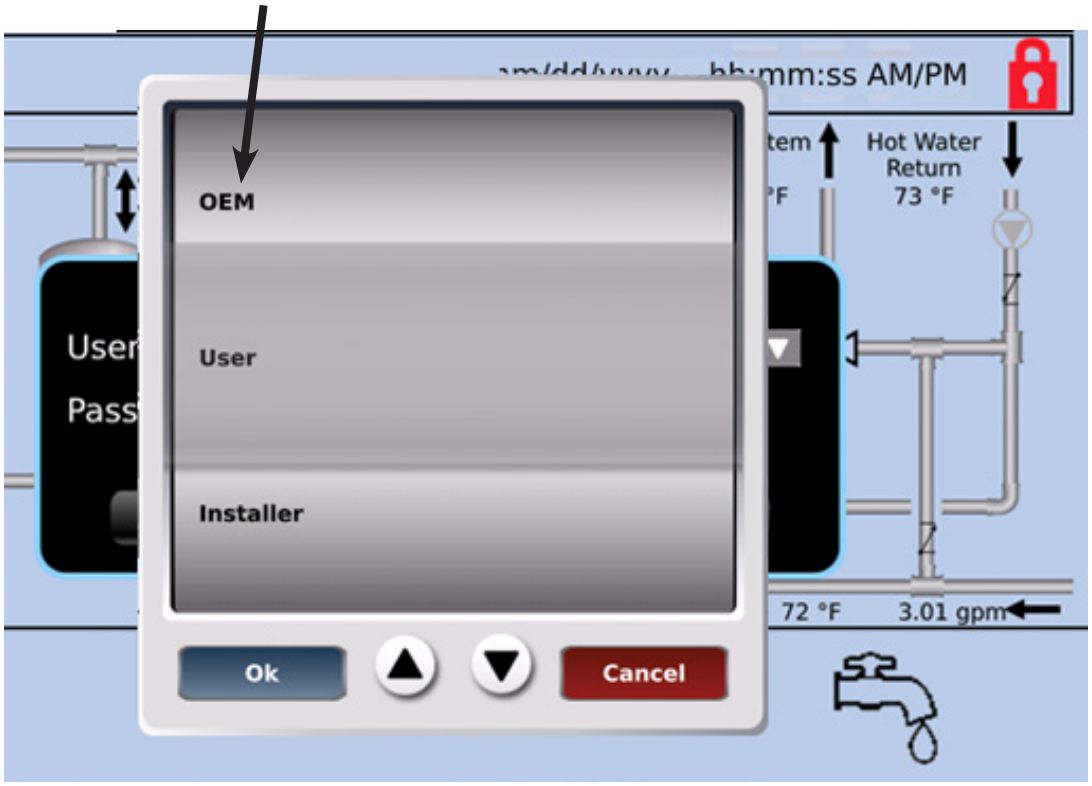
Security (continued)

To change the security level, press and hold the padlock symbol for approximately 3 seconds. Then press the Login button, when it appears.

Press the drop-down symbol to show the User name (security level) options.

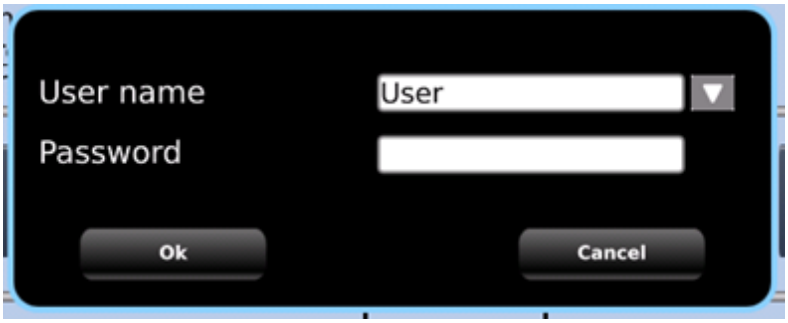


Note that, although shown, OEM level access is available only to factory personnel.



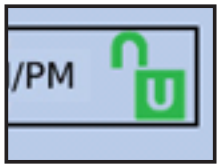
3.A.1 User Security Level

The User security level can be accessed by selecting User in the drop-down.



Enter the password “**user**” and select Ok.

The green unlocked icon, with the letter “U”, will show in the upper right corner of the screen.



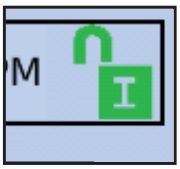
3.A.2 Installer Security Level

For authorized personnel only, the Installer level can be selected.

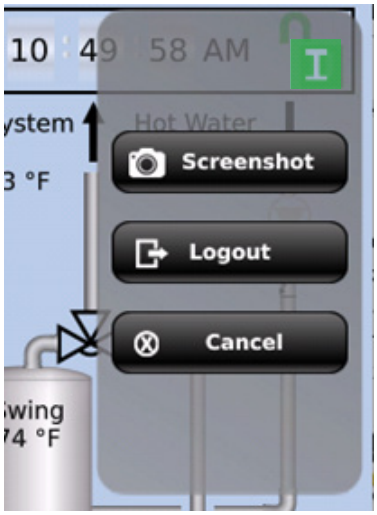
Security (continued)

Enter the password “**inst**” and select Ok.

The green unlocked icon, with the letter “I”, will show in the upper right corner of the screen.

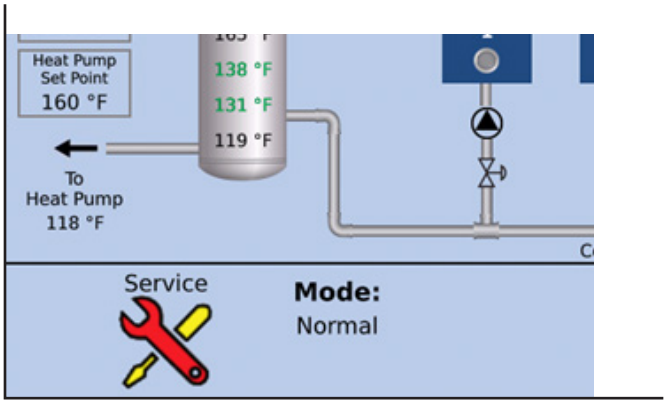


To Logout (red padlock), press and hold the green padlock for approximately 3 seconds, until the following is displayed. Then select Logout.



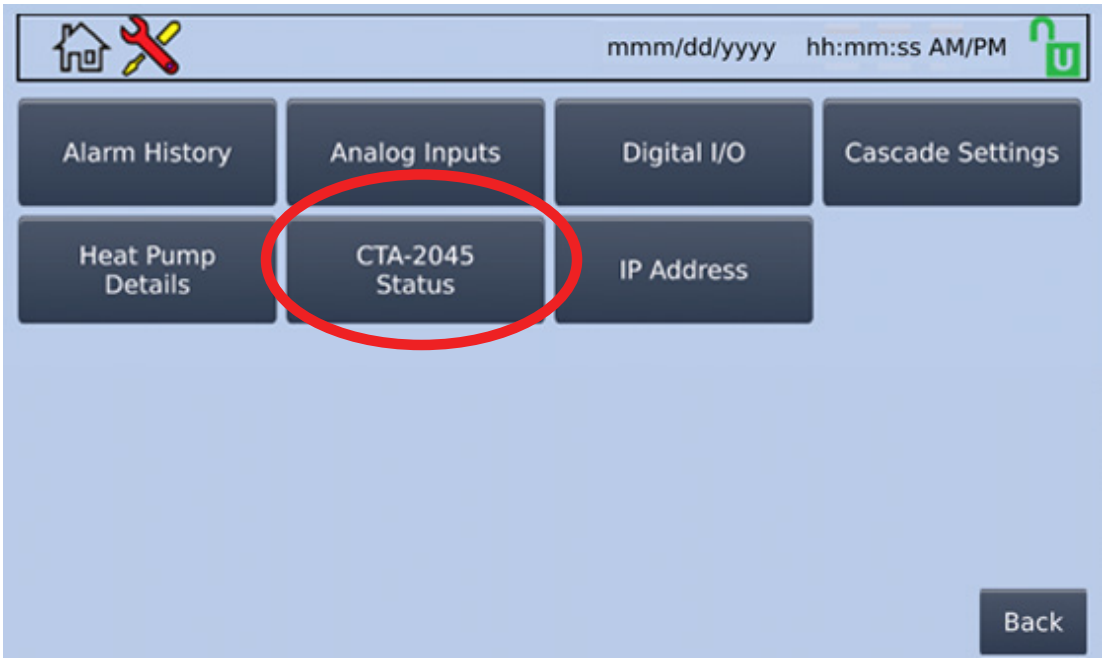
Logout to move between login levels.
Note that the login level will time out after one hour.

3.B Service Menu

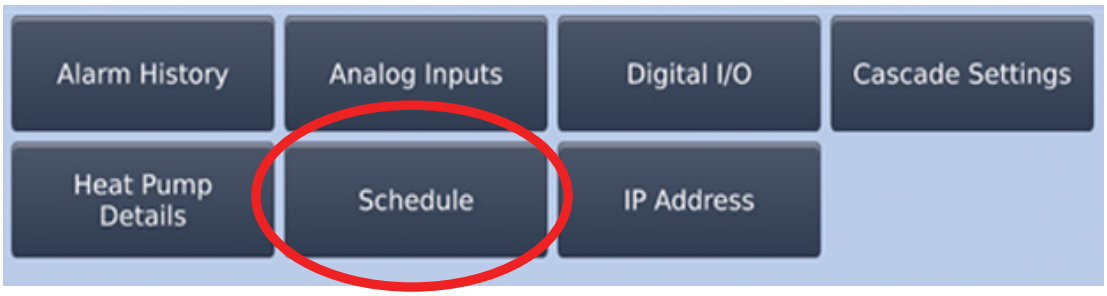


User Level Access:

The Service Menu within the user level shows the following service menu items. Optional CTA-2045 will only show on the TSC with CTA-2045.

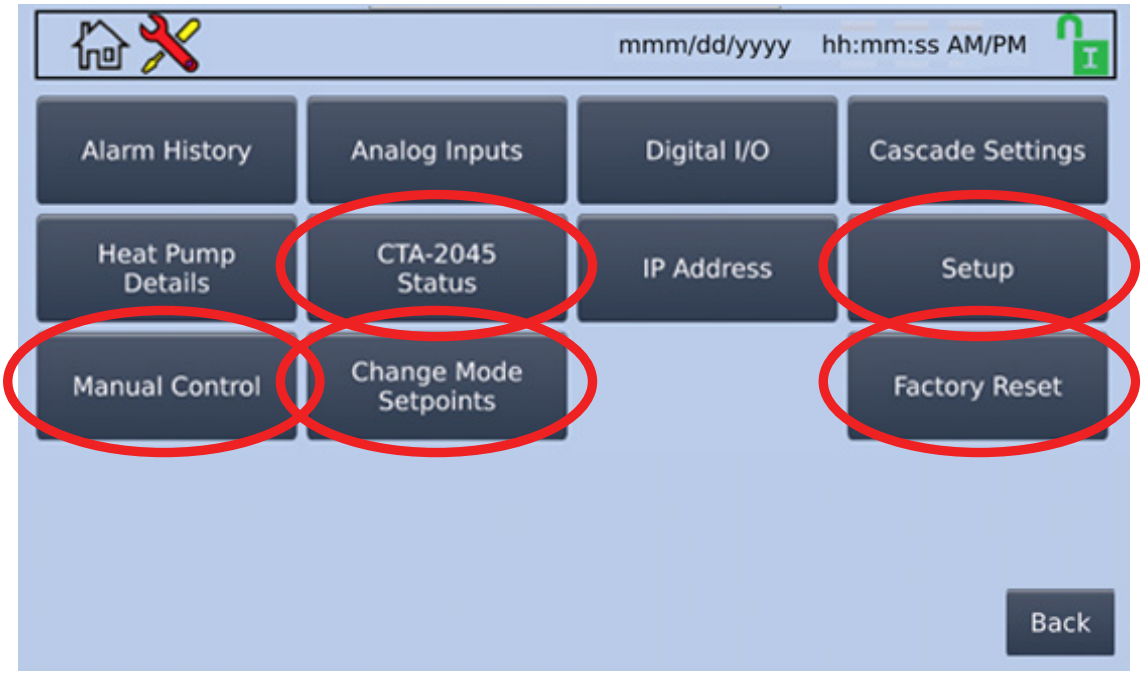


A user defined Schedule is present, when the CTA-2045 option is not configured and/or selected.

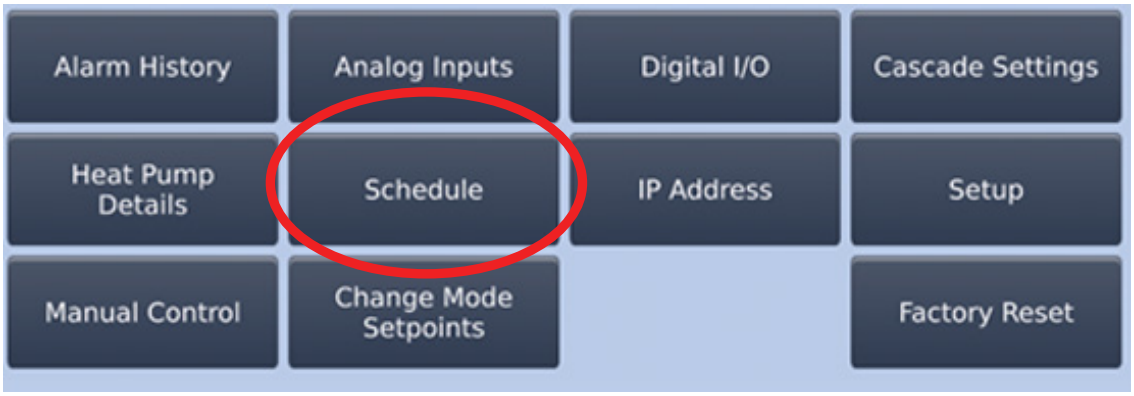


Installer Level Access:

More features are accessible with Installer Level access than with User Level access. “Setup” allows an installer to configure the TSC with all of the system equipment connected to it. “Manual Control” allows the installer to manually operate components, to ensure they respond appropriately to commands. “Change Mode Setpoints” allows the installer to set all of the mode setpoints. “Factory Reset” will return all settings (other than IP addresses) to factory default settings.

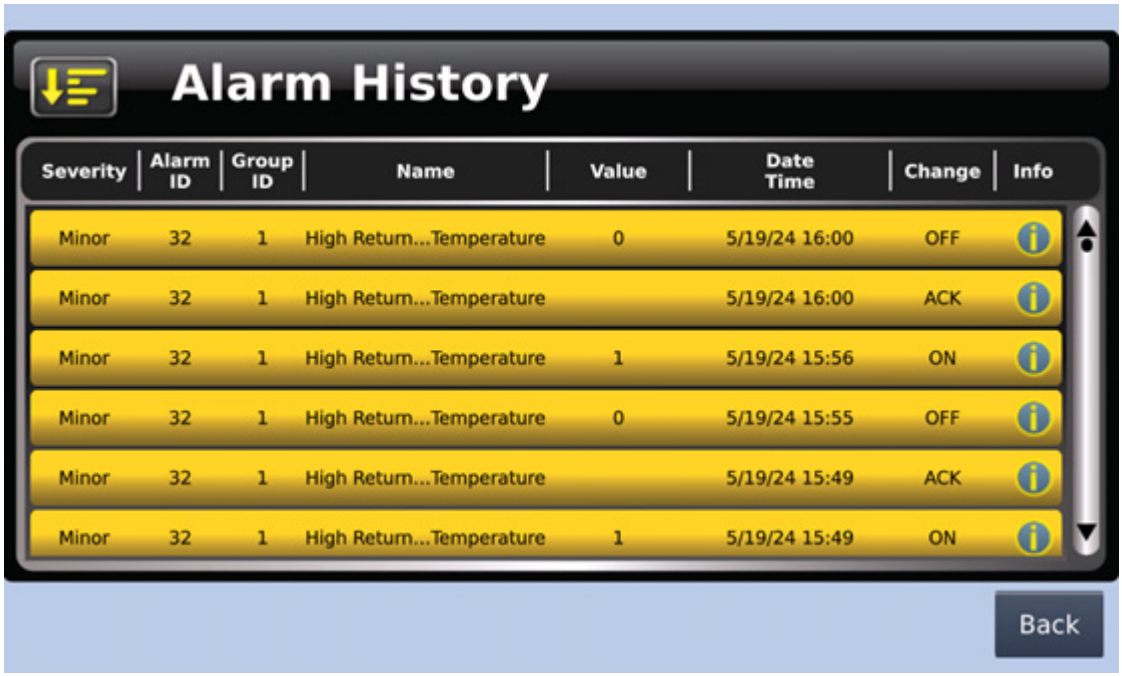


A user defined Schedule is present, when the CTA-2045 option is not configured and/or selected.



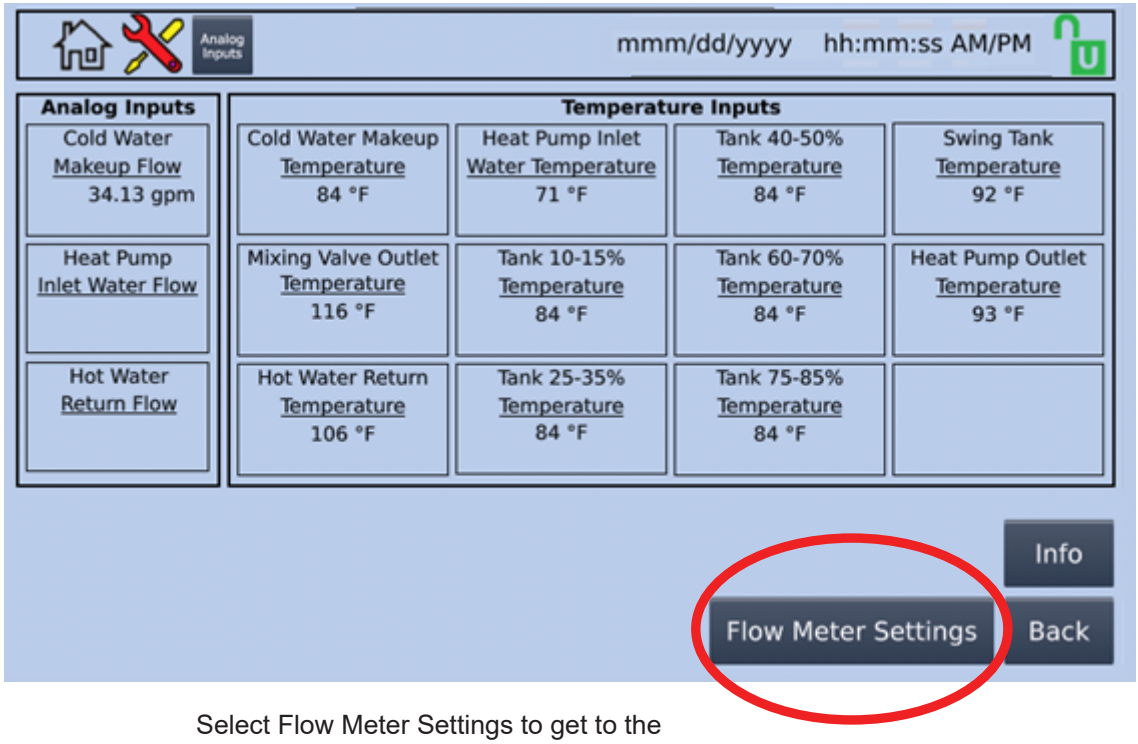
3.B.1 Alarm History

This screen shows full alarm history by date and time. To display details of a listed alarm, press the info (i) button. The arrow button on the upper left corner of the screen will allow the list to be sorted.



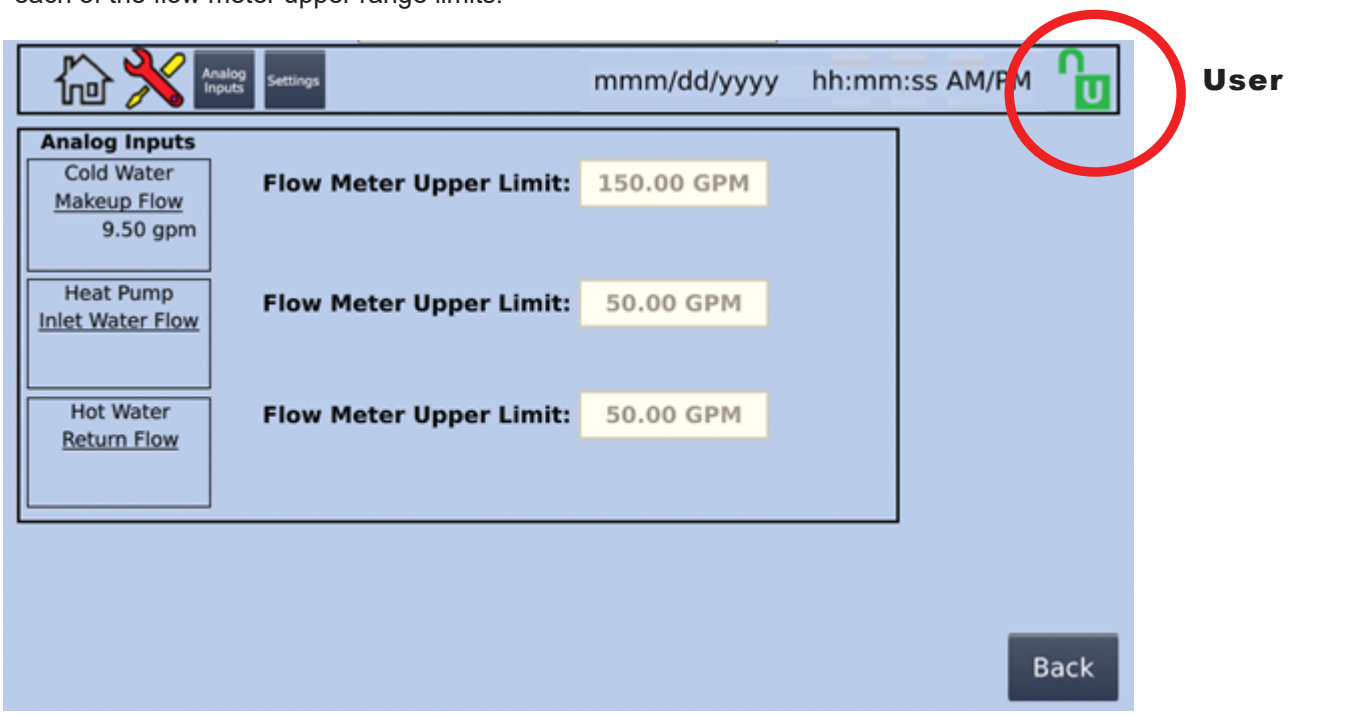
3.B.2 Analog Inputs

The Analog Input Menu shows the status of the temperature and flow sensor inputs to the TSC.

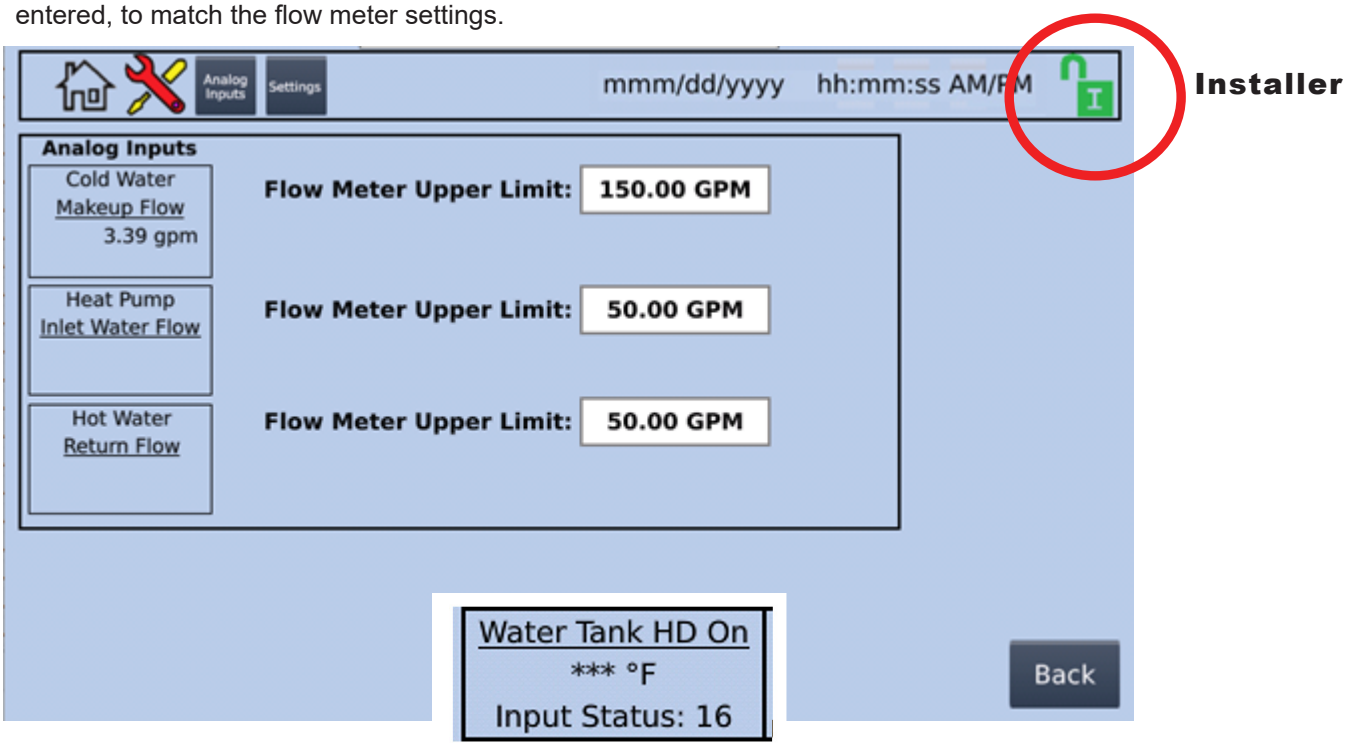


Select Flow Meter Settings to get to the analog input settings.

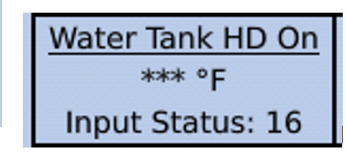
With User Level access, pressing the Flow Meter Settings button displays a read only screen that indicates each of the flow meter upper range limits.

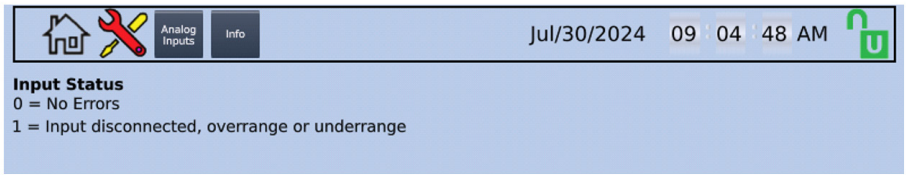


With Installer Level access, pressing this button allows the installer to change the flow meter settings. The upper range limits are shown. If flow meters are used, each upper limit must be entered, to match the flow meter settings.



If an Input Status shows on any parameter on the Analog Input screen, press the Info button to display error descriptions.

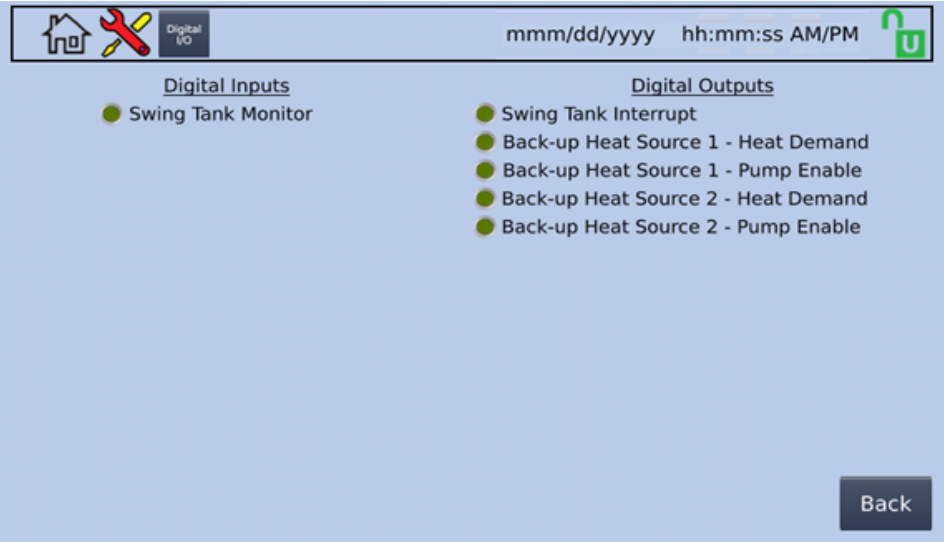




3.B.3 Digital Inputs and Outputs

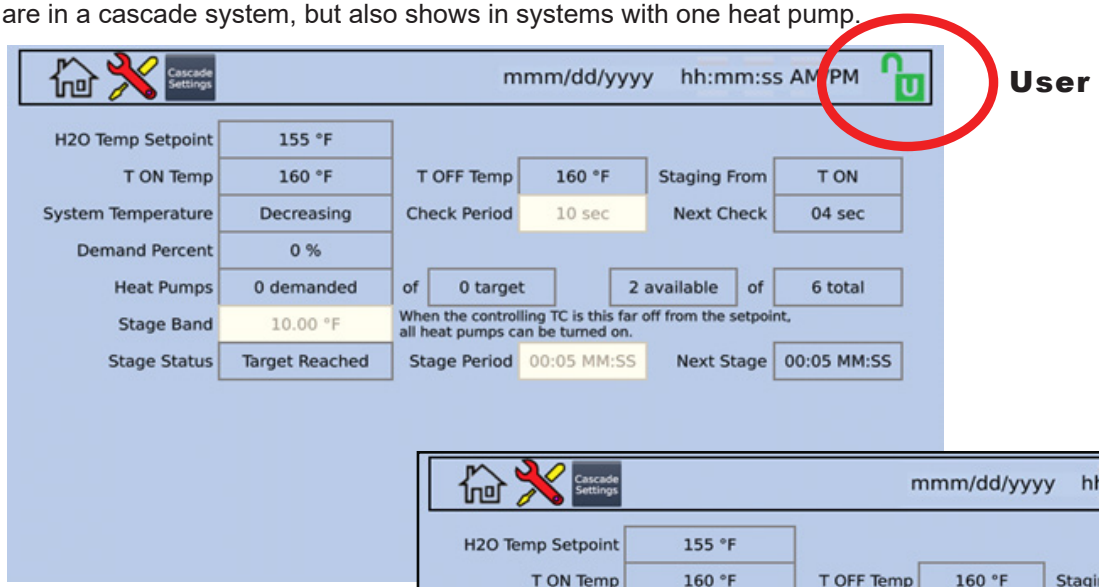
The Digital Inputs column displays the status of the Swing Tank connection. When illuminated, the Swing Tank Monitor indicates that heating elements in the swing tank are energized.

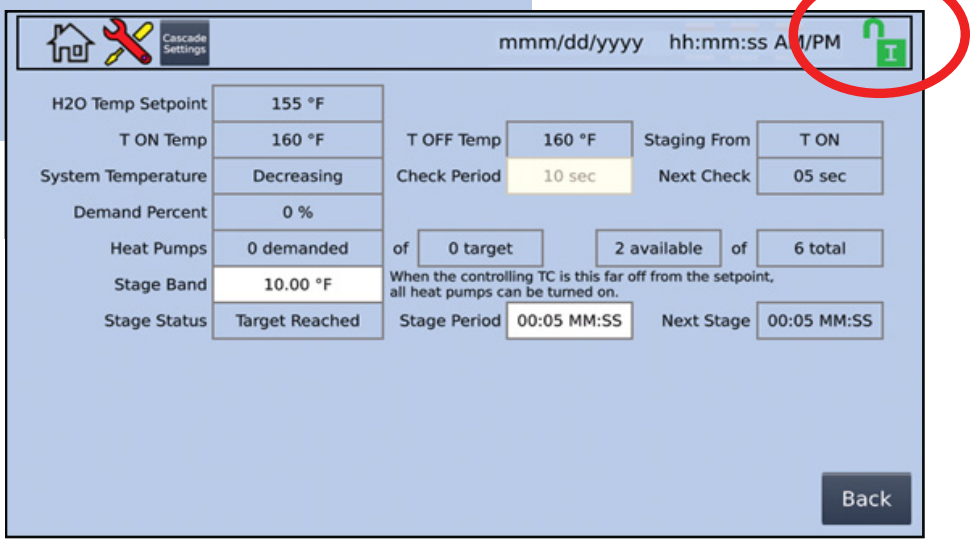
The Digital Outputs column displays the Swing Tank Interrupt status. When illuminated, it indicates that the TSC logic is interrupting the swing tank elements. Back-up Heat Source and Heat Demand and Pump Enable lights are illuminated when the TSC is calling for them to be activated.



3.B.4 Cascade Settings

With User Level access, this is a read only screen that shows the status and control parameters of all cascaded heat pumps. This screen is active when multiple heat pumps are in a cascade system, but also shows in systems with one heat pump.





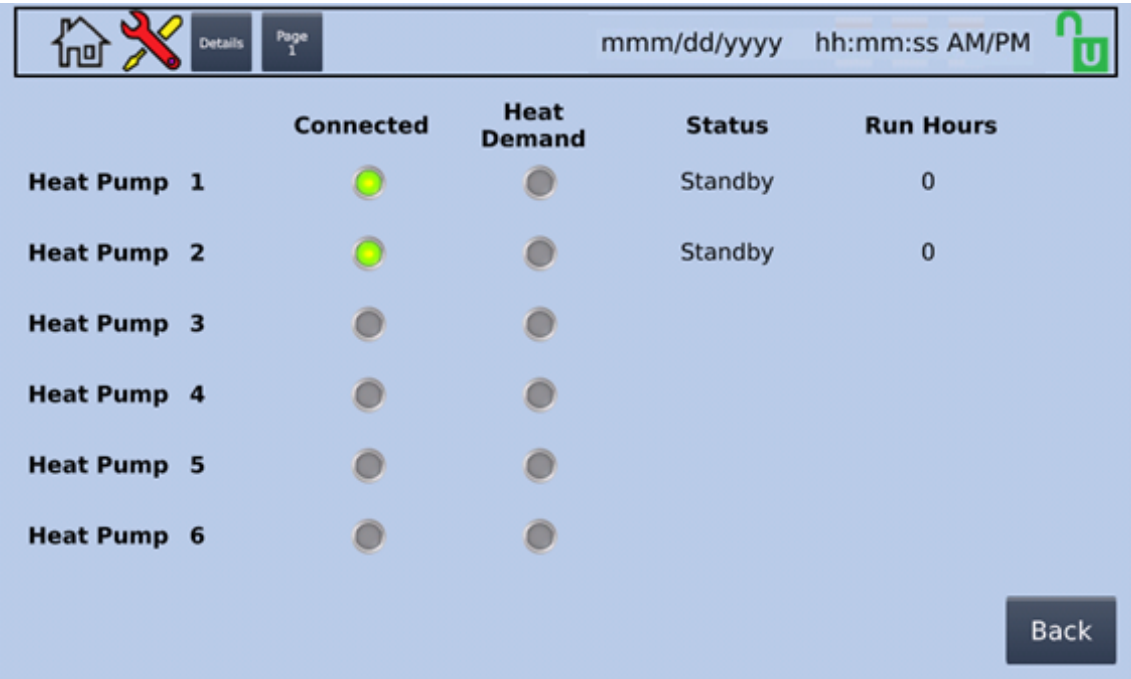
With Installer Level access, the Stage Band temperature and Stage Period time can be modified. The Stage Period is the amount of time before the next heat pump is staged on or off.

3.B.5 Heat Pump Details

This screen (multiple pages if cascading more than 6 heat pumps) shows:

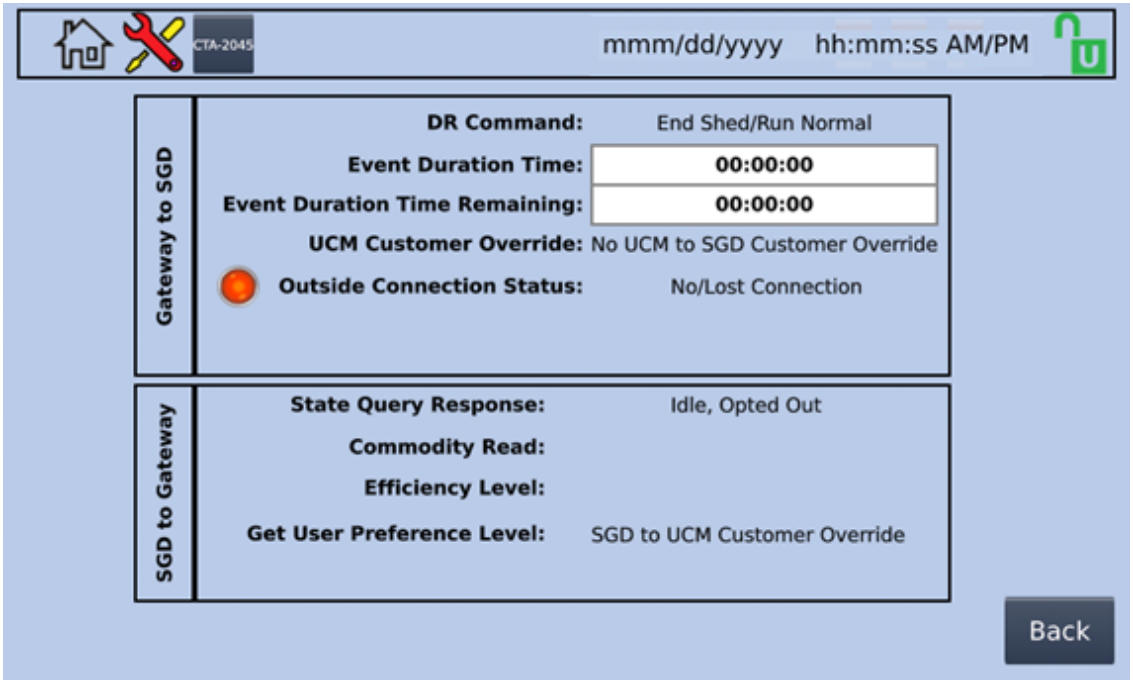
- Available / connected heat pumps
- Whether there is a current heat demand
- Status and run hours of each heat pump.

Note: The cascade control logic enables the heat pump with the lowest recent run hours first in the heat demand staging sequence. When “Connected” is illuminated, it indicates that the heat pump is communicating with the TSC. When “Heat Demand” is illuminated, it indicates that this heat pump is being called for heat.



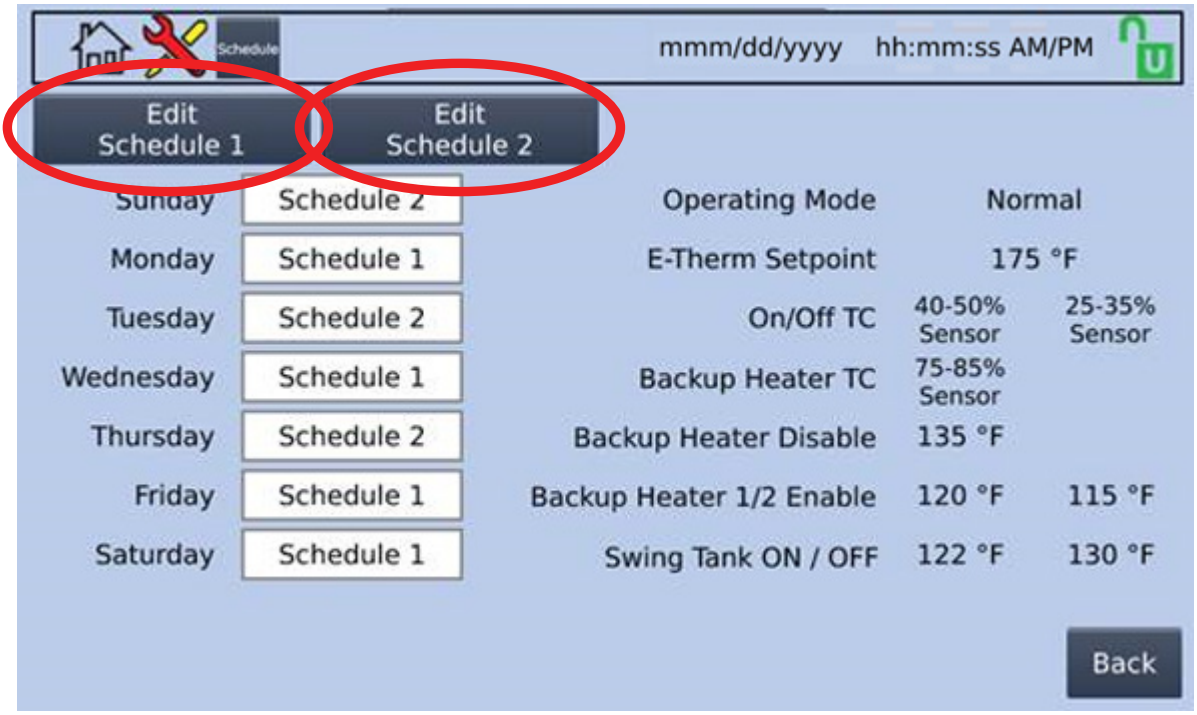
3.B.6 CTA-2045 Status

This status menu is available when a heat pump is configured with the CTA-2045 option. It is read-only diagnostic information. This screen shows information about the connection to and from the CTA-2045 gateway and the TSC (Smart Grid Device, shown as SGD on the screen).

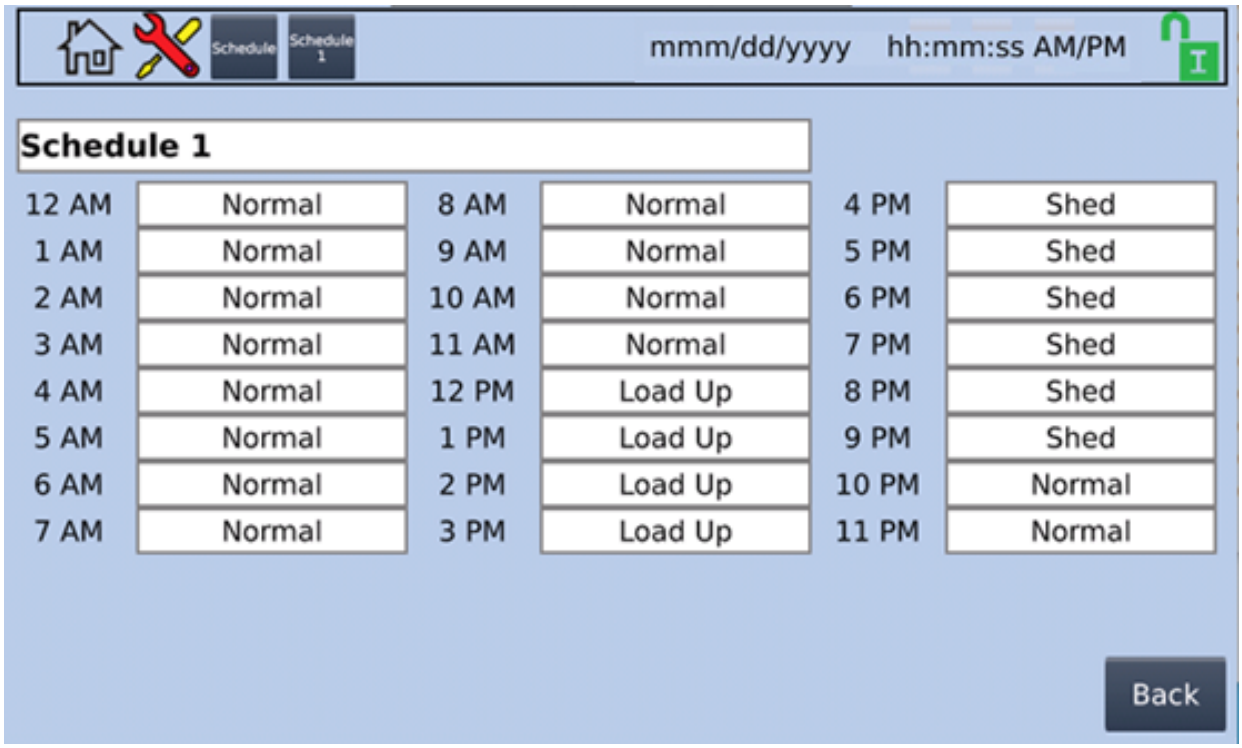


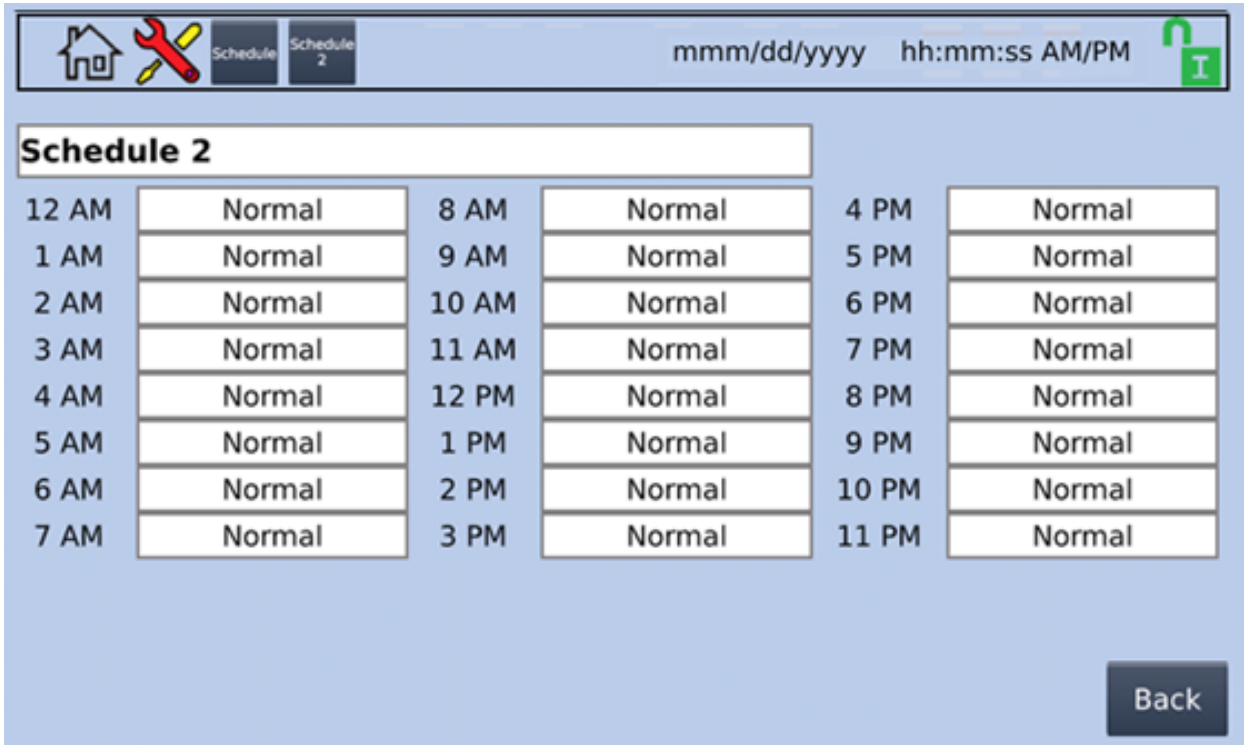
3.B.7 Schedule (Operating Mode)

This menu allows for the option to change the operating mode between Schedule 1 and Schedule 2, for each day of the week. The right side of the screen shows the current operating mode, control sensor setup, and setpoint temperatures of the system (heat pump(s), backup heater(s), and swing tank).



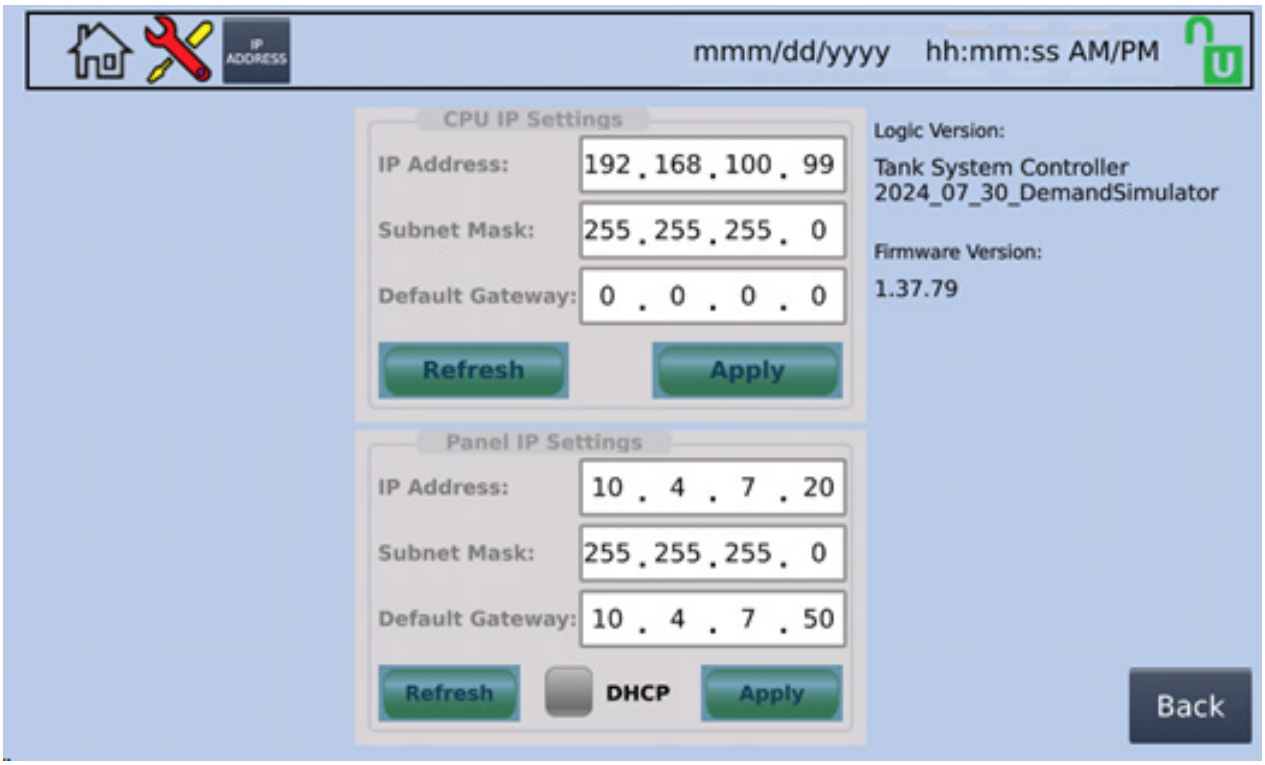
When either Edit button is selected, the following screens allow for changing operating modes on an hourly basis. Select the editable box for each hour to change the mode between Normal, Shed, Load Up, Advance Load Up, and Back Up. Typically, Back Up is not scheduled, but is used only when needed to back up a heat pump that is out of service for maintenance. These operating modes “charge” or “discharge” the storage tanks based on anticipated hourly demand, shifting energy usage to off-peak times, and/or shifting usage to lower energy rate times.



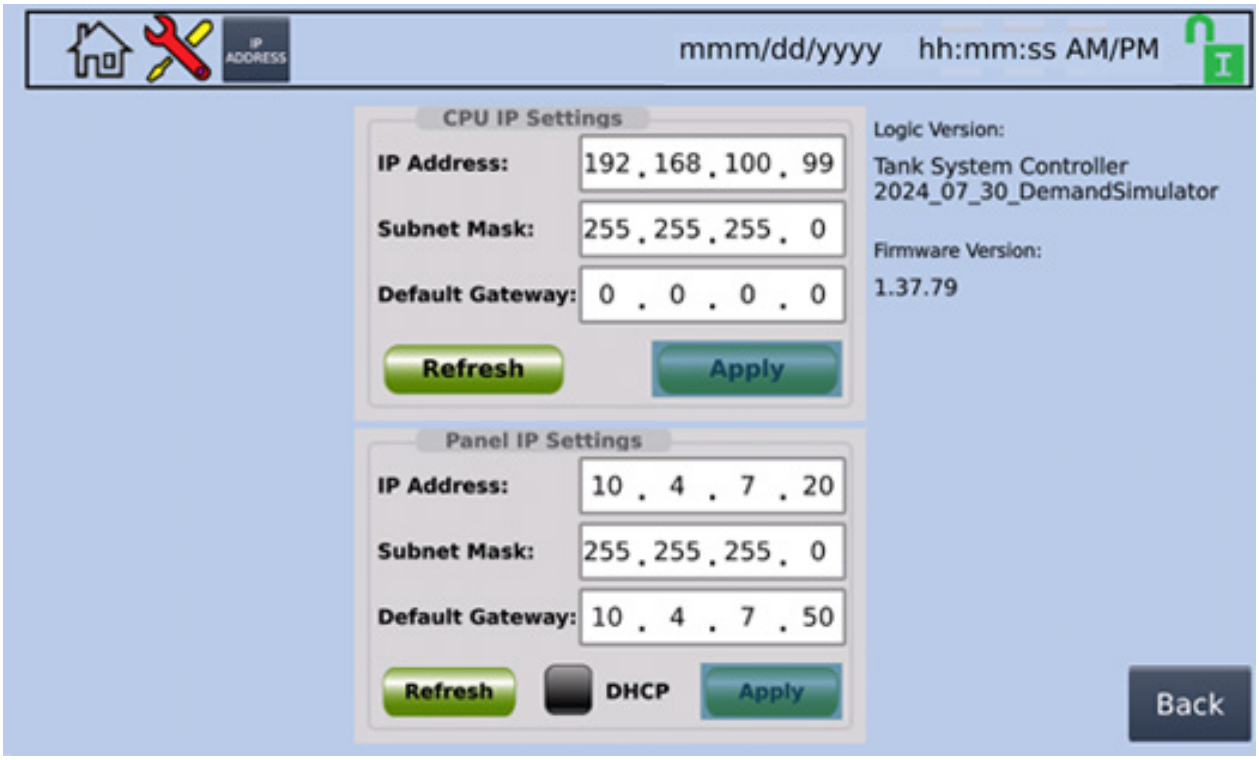


3.B.8 IP Address

The IP Addresses shown are read-only, with User Level access. Additionally, the PLC logic and firmware versions are provided on this screen.



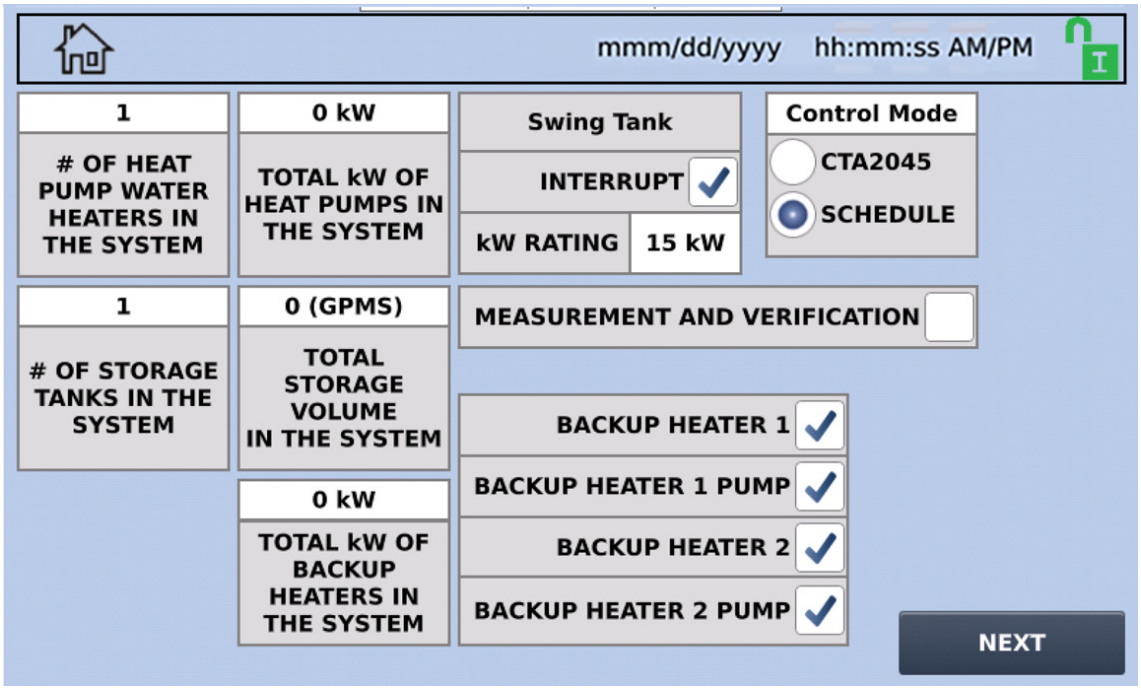
IP Addresses must be set if more than one HPWH is on the same network, as in a TSC system. Installer Level access is required to set up IP Addresses. Each address needs to be unique for each unit on the network. If connecting to the building network, the IT department will need to be involved in providing access and IP schemes which will work within the building network security.



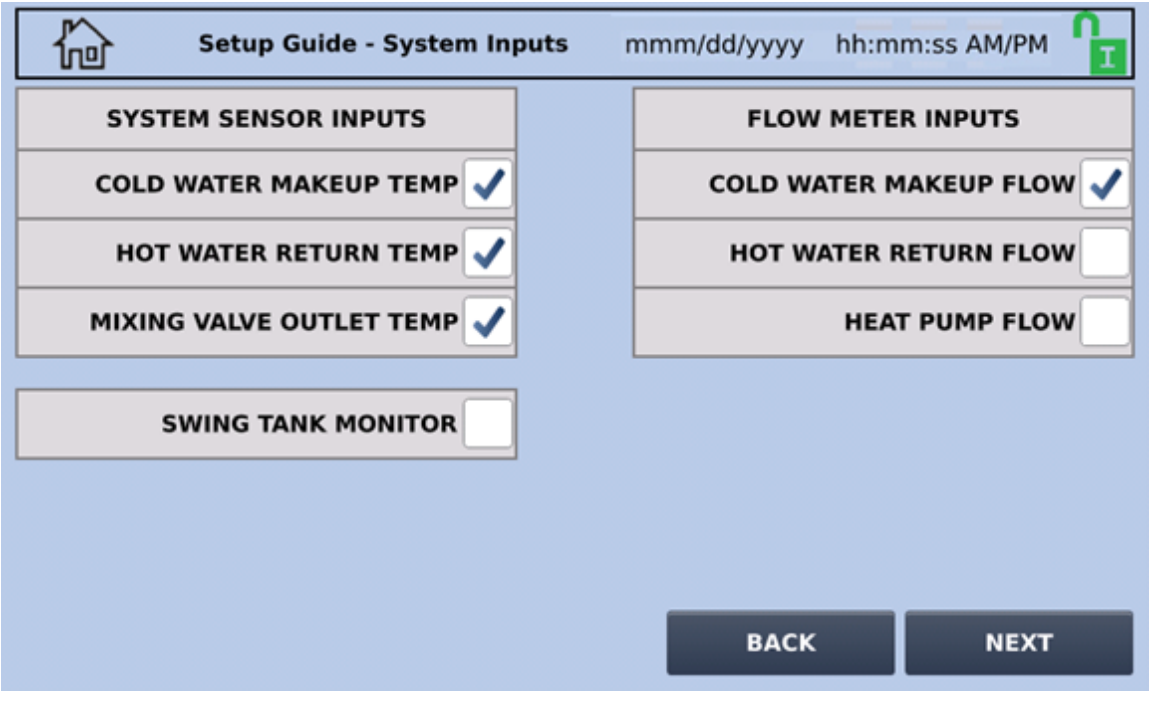
3.B.9 Setup

The following two screens are used for setup and configuration of the tank system. Installer Level access is needed.

On the first screen, the first two columns indicate the number of heat pumps, heat pump capacity, storage tank details, and the total kW of backup heaters (if installed). The rest of the screen relates to the use of a swing tank and its kW rating, Control Mode (using the CTA-2045 option device or user-entered operating mode schedule), use of M&V (measurement and verification requires each heat pump to have a power meter installed), and selection for optional backup heaters and pumps.

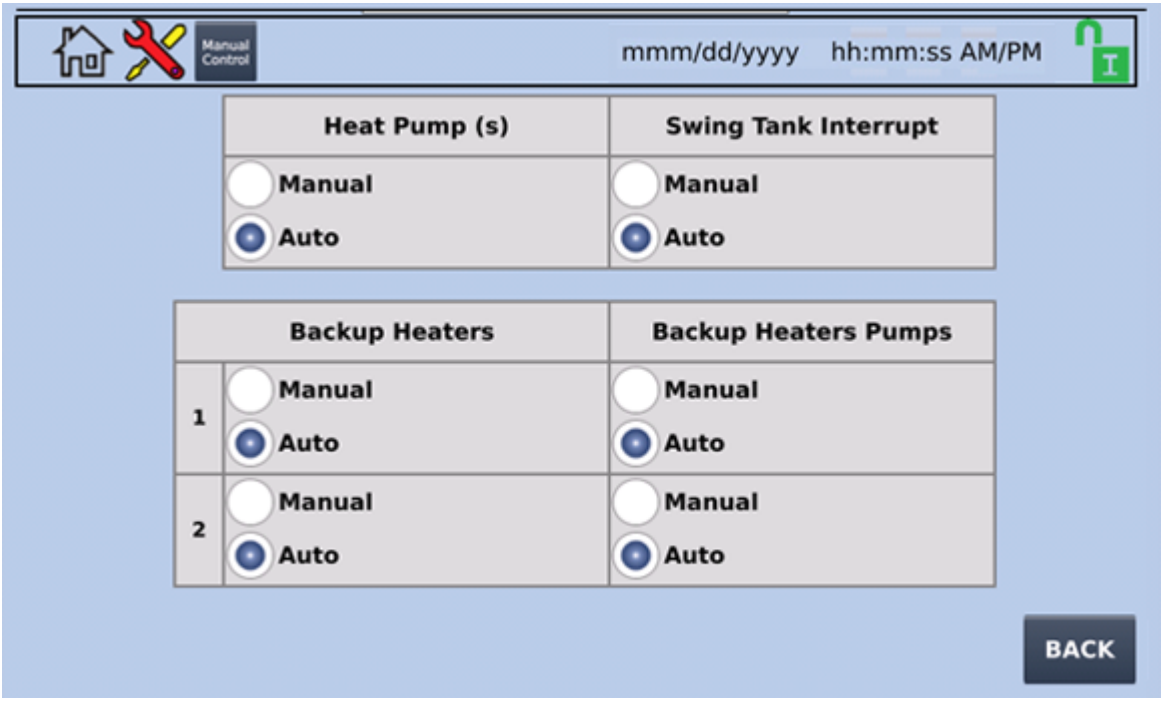


The second screen is used to configure the remaining optional temperature sensors and flow meter inputs. The Swing Tank Monitor provides feedback to the TSC's PLC, for confirmation that the swing tank heater is activated. Note: The measurement and verification functionality is contingent on some of these sensors being setup and installed.



3.B.10 Manual Control

The following screen is helpful for system commissioning, as it allows individual devices to be manually operated by selecting the “Manual” setting. Installer Level access is needed. Before exiting the Installer security level, it’s recommended that all active devices be set to Auto operation/mode.



3.B.11 Change Mode Setpoints

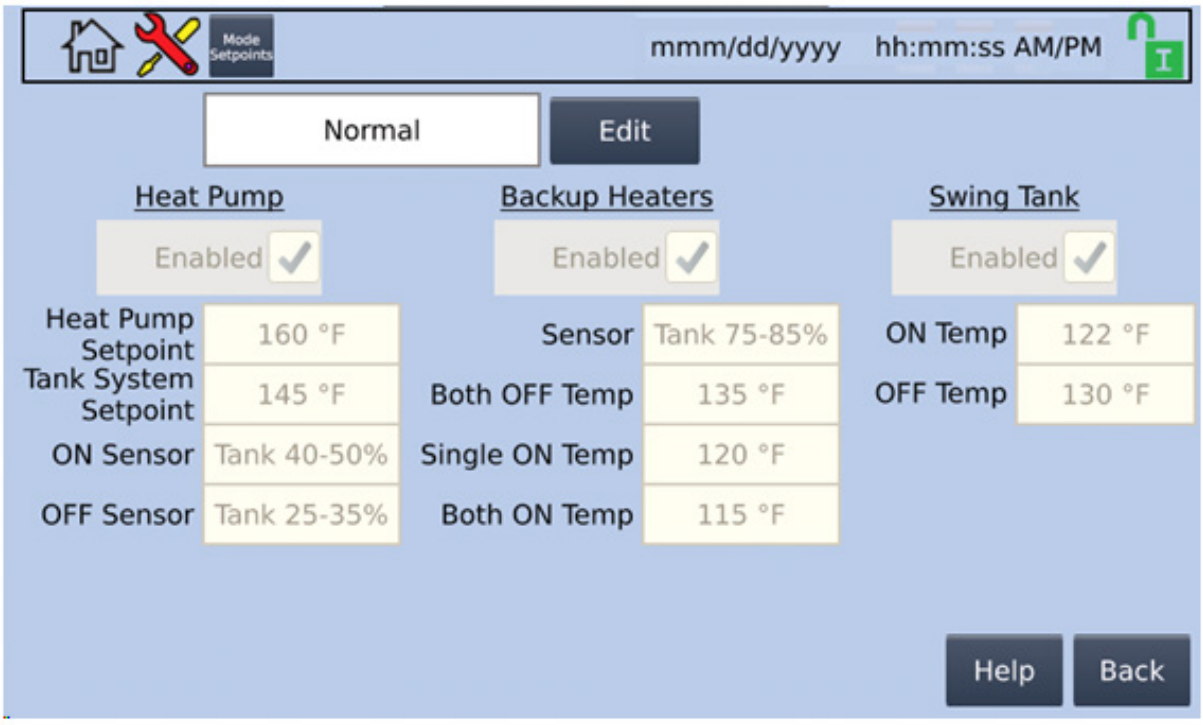
Installer level access is needed to interact with the Change Mode Setpoints screen.

This menu provides the ability to modify the operational setpoints and parameters of the five operating modes (Normal, Shed, Load Up, Advance Load Up, and Back Up). Note: There are two additional modes (Grid Emergency and Critical Peak Event) that can be defined when the CTA-2045 option is used and selected as the Control Mode (found in the Setup menu). All values can be modified by first pressing the Edit button at the top of the screen.

The Heat Pump column provides the ability to change the Heat Pump Setpoint (desired temperature supplied by each heat pump), the Tank System Setpoint (control point used by the On and Off Sensors), and the specific controlled temperature probes desired for each mode's On and Off sensor.

The Backup Heaters column allows for the selection of the controlling temperature probe location, as well as the On and Off Temp values (Note: The "Both On Temp" selection is only necessary when using more than one backup heat source.)

The Swing Tank column allows for the setting of the swing tank On and Off temperature control. This control is based on the temperature reading of the Swing Tank Temperature Sensor.

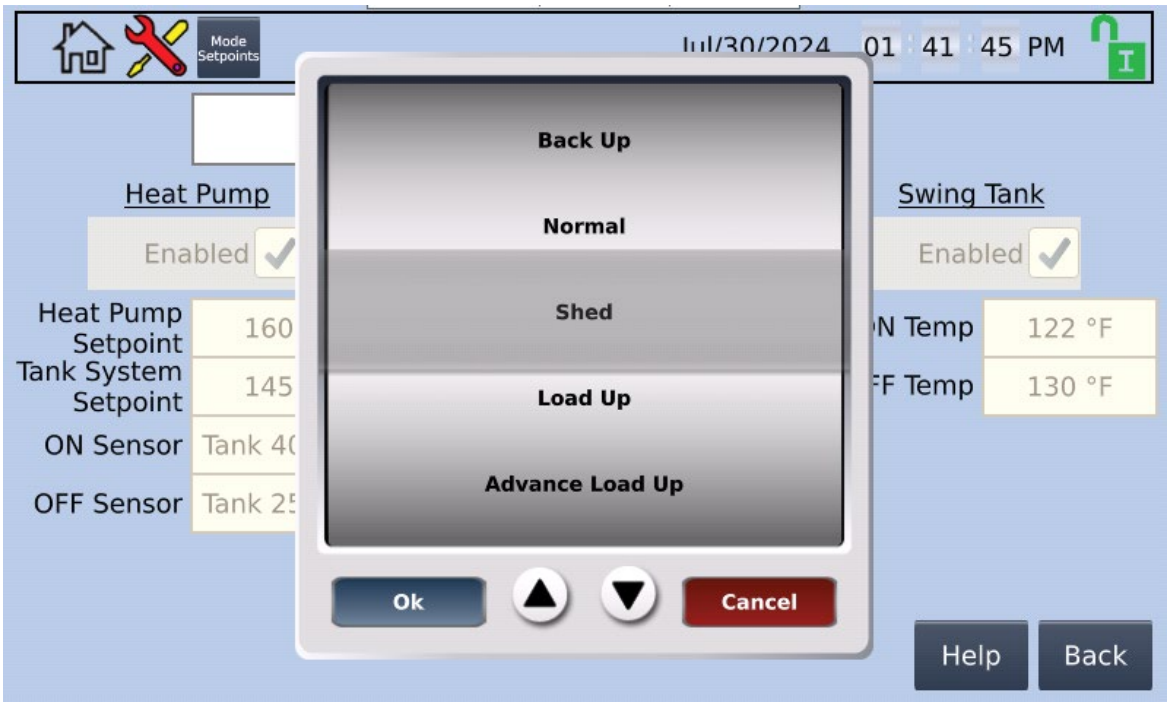


Sensor #	Description	Tank Sensor Location
2	Tank 10-15%	10-15% (Lowest sensor in Tank System)
3	Tank 25-35%	25-35% (Second lowest sensor in Tank System)
4	Tank 40-50%	40-50% (Middle sensor in Tank System)
5	Tank 60-70%	60-70% (Second highest sensor in Tank System)
6	Tank 75-85%	75-85% (Highest sensor in Tank System)

Table 3. Temperature Sensor Key

Change Mode Setpoints (continued)

To change each mode's control attributes, select the box to the left of the Edit button and the following selection choices appear.



All five modes (seven if using CTA-2045 control) are editable, with the ability to change settings. Each mode also allows the installer to enable or disable selecting "Enabled" check box. For example, it would be common to un-check the Back Up heaters in the Shed mode.

3.B.12 Factory Reset

Factory Reset will return all settings (other than IP addresses) to factory defaults. Installer Level access is needed to perform a Factory Reset.

Section 4 Alarms and Faults

Alarms - Annunciation Only				
Annunciated Alarm/Fault	**Description**	**Indicates**	**Corrective Action**	**Alarm ID**
Cold Water Makeup Flow Sensor	Cold Water Makeup Flow Sensor Alarm.	There is an issue with the cold water makeup flow sensor.	If the flow sensor is not intended to be used, unselect it in the setup menu. Otherwise, check for proper wiring and function.	3
Hot Water Return Flow Sensor	Hot Water Return Flow Sensor Alarm.	There is an issue with the return water flow sensor.	If the flow sensor is not intended to be used, unselect it in the setup menu. Otherwise, check for proper wiring and function.	4
Heat Pump Flow Sensor	Heat Pump Flow Sensor Alarm.	There is an issue with the heat pump flow sensor.	If the flow sensor is not intended to be used, unselect it in the setup menu. Otherwise, check for proper wiring and function.	5
Cold Water Makeup Temperature Sensor	Cold Water Makeup Flow Sensor Alarm.	There is an issue with the cold water makeup flow sensor.	Inspect for proper wiring.	6
Mixing Valve Outlet Temperature Sensor	The mixing valve outlet temperature sensor is not reporting valid data.	The sensor is either disconnected or not reading properly.	Inspect for proper wiring.	7
Hot Water Return Temperature Sensor	The hot water return temperature sensor is not reporting valid data.	The sensor is either disconnected or not reading properly.	Inspect for proper wiring.	8
Heat Pump Inlet Water Temperature Sensor	The heat pump inlet water temperature sensor is not reporting valid data.	The sensor is either disconnected or not reading properly.	Inspect for proper wiring.	9
Tank Farm 10% Sensor	The tank farm 10% sensor is not reporting valid data.	The sensor is either disconnected or not reading properly.	Inspect for proper wiring.	10
Tank Farm 25% Sensor	The tank farm 20% sensor is not reporting valid data.	The sensor is either disconnected or not reading properly.	Inspect for proper wiring.	11
Tank Farm 40% Sensor	The tank farm 40% sensor is not reporting valid data.	The sensor is either disconnected or not reading properly.	Inspect for proper wiring.	12
Tank Farm 60% Sensor	The tank farm 60% sensor is not reporting valid data.	The sensor is either disconnected or not reading properly.	Inspect for proper wiring.	13
Tank Farm 75% Sensor	The tank farm 75% sensor is not reporting valid data.	The sensor is either disconnected or not reading properly.	Inspect for proper wiring.	14
Heat Pump 1 Communication	The Tank System Controller has lost communications to Heat Pump #1.	There is a heat pump that is configured in the system but not connected to the Tank System Controller.	Confirm the network configuration of the tank system controller and the heat pump. Ensure that all network cables are connected correctly.	15
Heat Pump 2 Communication	The Tank System Controller has lost communications to Heat Pump #2.	There is a heat pump that is configured in the system but not connected to the Tank System Controller.	Confirm the network configuration of the tank system controller and the heat pump. Ensure that all network cables are connected correctly.	16

Alarms and Faults (continued)

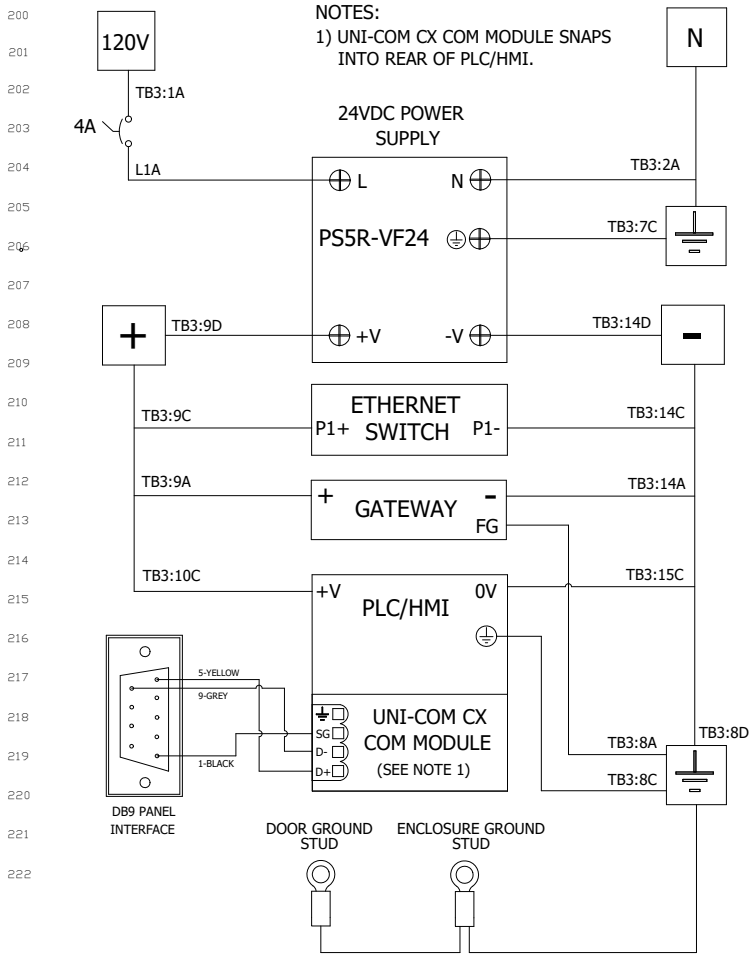
Alarms - Annunciation Only				
Annunciated Alarm/Fault	**Description**	**Indicates**	**Corrective Action**	**Alarm ID**
Heat Pump 3 Communication	The Tank System Controller has lost communications to Heat Pump #3.	There is a heat pump that is configured in the system but not connected to the Tank System Controller.	Confirm the network configuration of the tank system controller and the heat pump. Ensure that all network cables are connected correctly.	17
Heat Pump 4 Communication	The Tank System Controller has lost communications to Heat Pump #4.	There is a heat pump that is configured in the system but not connected to the Tank System Controller.	Confirm the network configuration of the tank system controller and the heat pump. Ensure that all network cables are connected correctly.	18
Heat Pump 5 Communication	The Tank System Controller has lost communications to Heat Pump #5.	There is a heat pump that is configured in the system but not connected to the Tank System Controller.	Confirm the network configuration of the tank system controller and the heat pump. Ensure that all network cables are connected correctly.	19
Heat Pump 6 Communication	The Tank System Controller has lost communications to Heat Pump #6.	There is a heat pump that is configured in the system but not connected to the Tank System Controller.	Confirm the network configuration of the tank system controller and the heat pump. Ensure that all network cables are connected correctly.	20
Heat Pump 7 Communication	The Tank System Controller has lost communications to Heat Pump #7.	There is a heat pump that is configured in the system but not connected to the Tank System Controller.	Confirm the network configuration of the tank system controller and the heat pump. Ensure that all network cables are connected correctly.	21
Heat Pump 8 Communication	The Tank System Controller has lost communications to Heat Pump #8.	There is a heat pump that is configured in the system but not connected to the Tank System Controller.	Confirm the network configuration of the tank system controller and the heat pump. Ensure that all network cables are connected correctly.	22
Heat Pump 9 Communication	The Tank System Controller has lost communications to Heat Pump #9.	There is a heat pump that is configured in the system but not connected to the Tank System Controller.	Confirm the network configuration of the tank system controller and the heat pump. Ensure that all network cables are connected correctly.	23
Heat Pump 10 Communication	The Tank System Controller has lost communications to Heat Pump #10.	There is a heat pump that is configured in the system but not connected to the Tank System Controller.	Confirm the network configuration of the tank system controller and the heat pump. Ensure that all network cables are connected correctly.	24
Heat Pump 11 Communication	The Tank System Controller has lost communications to Heat Pump #11.	There is a heat pump that is configured in the system but not connected to the Tank System Controller.	Confirm the network configuration of the tank system controller and the heat pump. Ensure that all network cables are connected correctly.	25
Heat Pump 12 Communication	The Tank System Controller has lost communications to Heat Pump #12.	There is a heat pump that is configured in the system but not connected to the Tank System Controller.	Confirm the network configuration of the tank system controller and the heat pump. Ensure that all network cables are connected correctly.	26
Heat Pump 13 Communication	The Tank System Controller has lost communications to Heat Pump #13.	There is a heat pump that is configured in the system but not connected to the Tank System Controller.	Confirm the network configuration of the tank system controller and the heat pump. Ensure that all network cables are connected correctly.	27
Heat Pump 14 Communication	The Tank System Controller has lost communications to Heat Pump #14.	There is a heat pump that is configured in the system but not connected to the Tank System Controller.	Confirm the network configuration of the tank system controller and the heat pump. Ensure that all network cables are connected correctly.	28
Heat Pump 15 Communication	The Tank System Controller has lost communications to Heat Pump #15.	There is a heat pump that is configured in the system but not connected to the Tank System Controller.	Confirm the network configuration of the tank system controller and the heat pump. Ensure that all network cables are connected correctly.	29
Heat Pump 16 Communication	The Tank System Controller has lost communications to Heat Pump #16.	There is a heat pump that is configured in the system but not connected to the Tank System Controller.	Confirm the network configuration of the tank system controller and the heat pump. Ensure that all network cables are connected correctly.	30

Alarms and Faults (continued)

Alarms - Annunciation Only				
Annunciated Alarm/Fault	**Description**	**Indicates**	**Corrective Action**	**Alarm ID**
Swing Tank Temperature Sensor	The swing tank temperature sensor is not reporting valid data.	The sensor is either disconnected or not reading properly.	Inspect for proper wiring.	34
High Return Water Temperature	The water returning to the heat pump is above the threshold.	The system will automatically resume operation when the return water temperature returns to normal ranges.	Inspect for proper wiring and that the reading is valid.	32
Faults				
Annunciated Alarm/Fault	**Description**	**Indicates**	**Corrective Action**	**Alarm ID**
Remote I/O Communication Fault	Remote I/O Communication Failure.	PLC cannot communicate with remote I/O device.	Ensure remote IO is connected and configured properly. Ensure there are no other devices on the network with the same IP address as the remote I/O unit.	1
Mode Setpoints Data Table Empty	The "Mode Setpoints" Data Table is likely empty.	There is missing data in the "Change Mode Setpoints" submenu.	Check that the "Mode Setpoints" table is populated with the correct setpoints. These can be edited by navigating to "Home > Service > Change Mode Setpoints"	2
Swing Tank Control	Swing Tank Control Fault.	The swing tank interrupt and swing tank monitor do not agree on the swing tank state.	Ensure that the swing tank control wiring is correct (both swing tank interrupt and swing tank monitor). Ensure that there is remote I/O communication.	31
Tank Farm Temperature Sensors	Tank farm temperature sensors fault.	This indicates that all 6 tank farm sensors have alarmed.	Check wiring of all sensors. It sensors are connected properly, there may be an issue with the RTD I/O module.	33

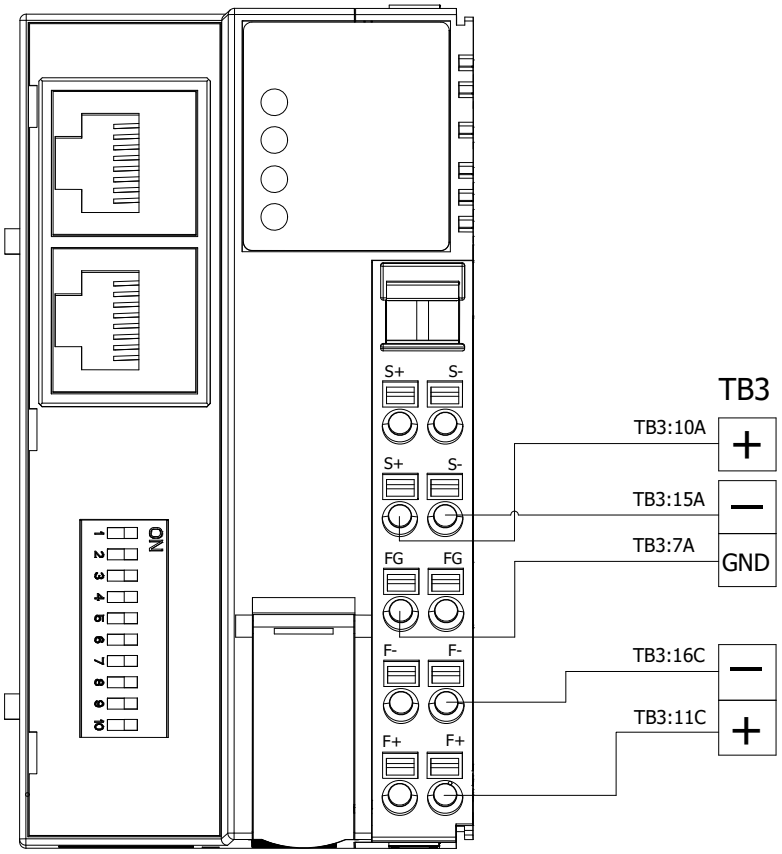
Section 5 Wire Schematics

WIRE LABEL	AWG	COLOR	TYPE
TB3:1A	12	BK	UL 1015
TB3:36A, TB3:39A, TB3:42A, TB3:45A, TB3:48A, TB3:51A, TB3:54A, TB3:57A, TB3:60A, TB3:63A, TB3:66A, TB3:69A	18	BK	UL 1015
TB3:6A, TB3:35A, TB3:40A, TB3:41A, TB3:46A, TB3:47A, TB3:52A, TB3:53A, TB3:58A, TB3:59A, TB3:64A, TB3:65A, TB3:70A	18	W	UL 1015
TB3:8C, TB3:8D, TB3:7A, TB3:8A	18	G/Y	UL 1015
TB3:37A, TB3:43A, TB3:49A, TB3:55A, TB3:61A, TB3:67A	18	G	UL 1015
TB3:14D, TB3:14C, TB3:14A, TB3:15C, TB3:15A, TB3:16C, TB3:16A, TB3:17C, TB3:17A, TB3:18C, TB3:18A, TB3:15B, TB3:15D	18	W/BL	UL 1015
TB3:9D, TB3:9C, TB3:9A, TB3:10C, TB3:10A, TB3:11C, TB3:11A, CR1:9, CR2:13, CR3:13, CR4:13, CR5:13, CR6:13, TB3:19A, TB3:20A, TB3:21A, TB3:22A, TB3:23A, TB3:24A, TB3:25A, TB3:26A, TB3:27A, TB3:28A, TB3:29A, TB3:30A, TB3:31A, TB3:32A, TB3:33A, TB3:34A	18	BL	UL 1015
TB3:3A, TB3:4A, TB3:5A	18	R	UL 1015
L1A	14	BK	UL 1015
TB3:2A	14	W	UL 1015
TB3:7C, TB3:8B	14	G/Y	UL 1015



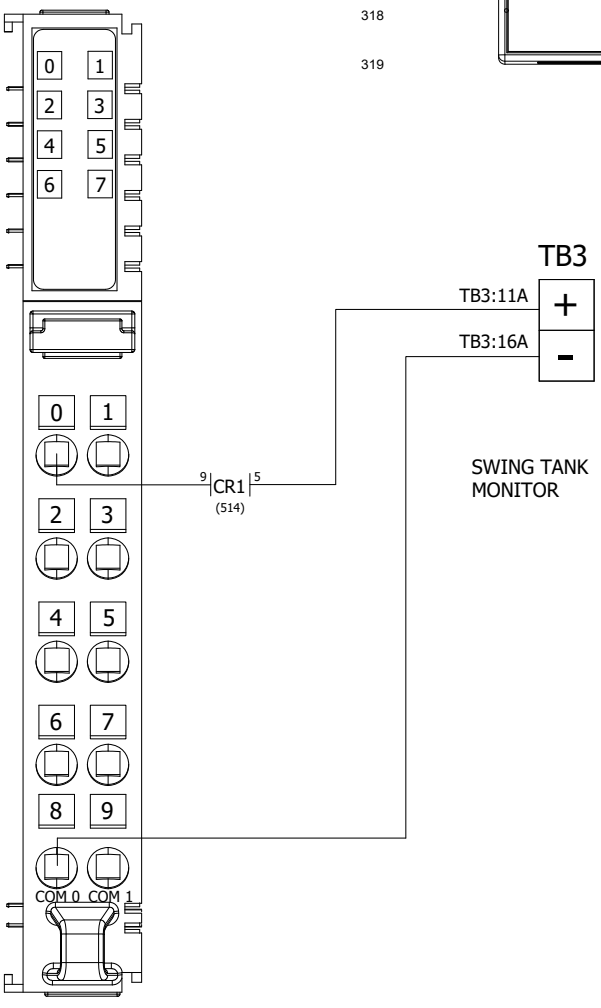
Remote I/O Ethernet Adapter

URB-TCP



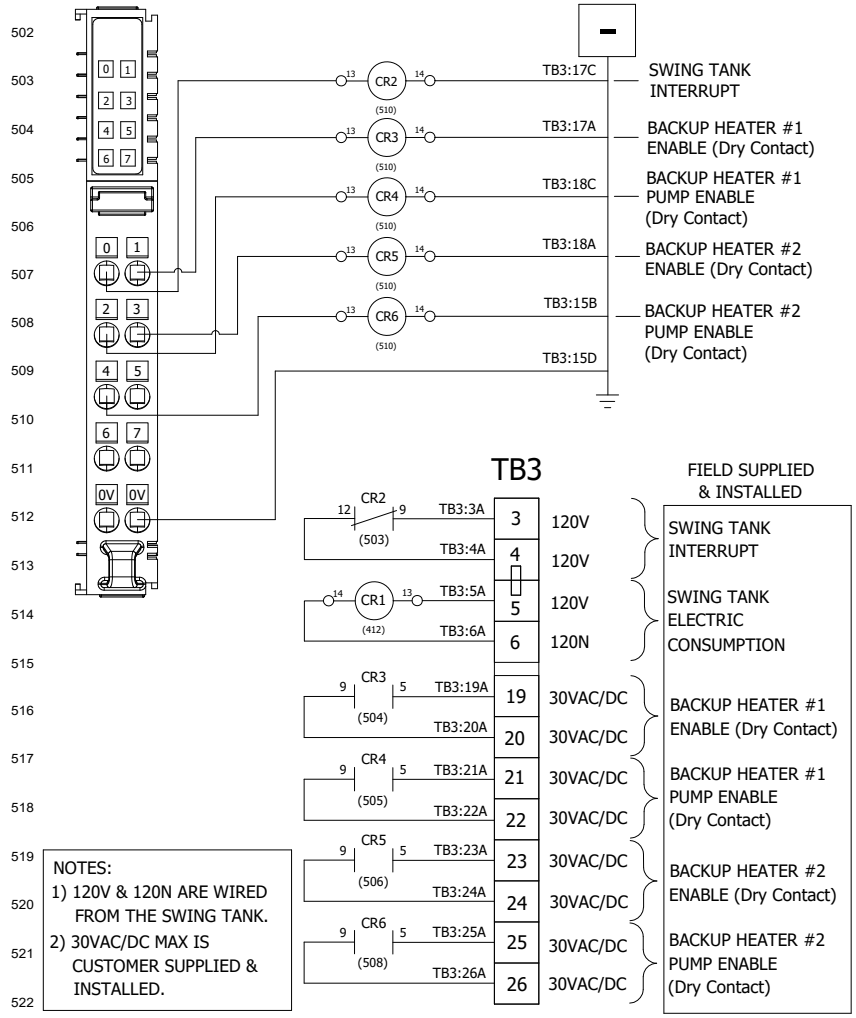
Remote I/O Slot 0

URD-0800



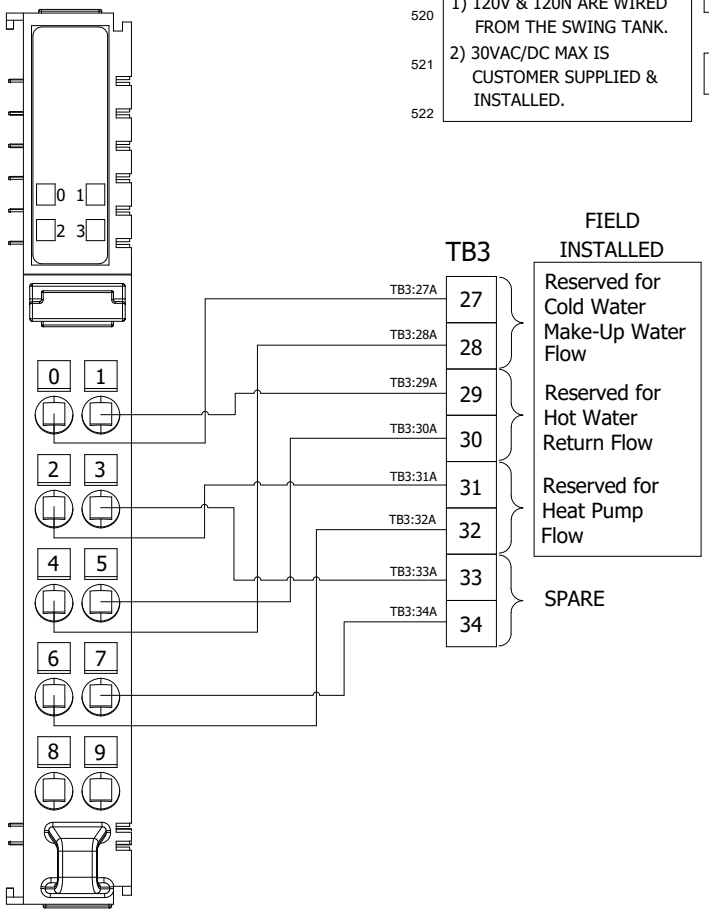
Remote I/O Slot 1

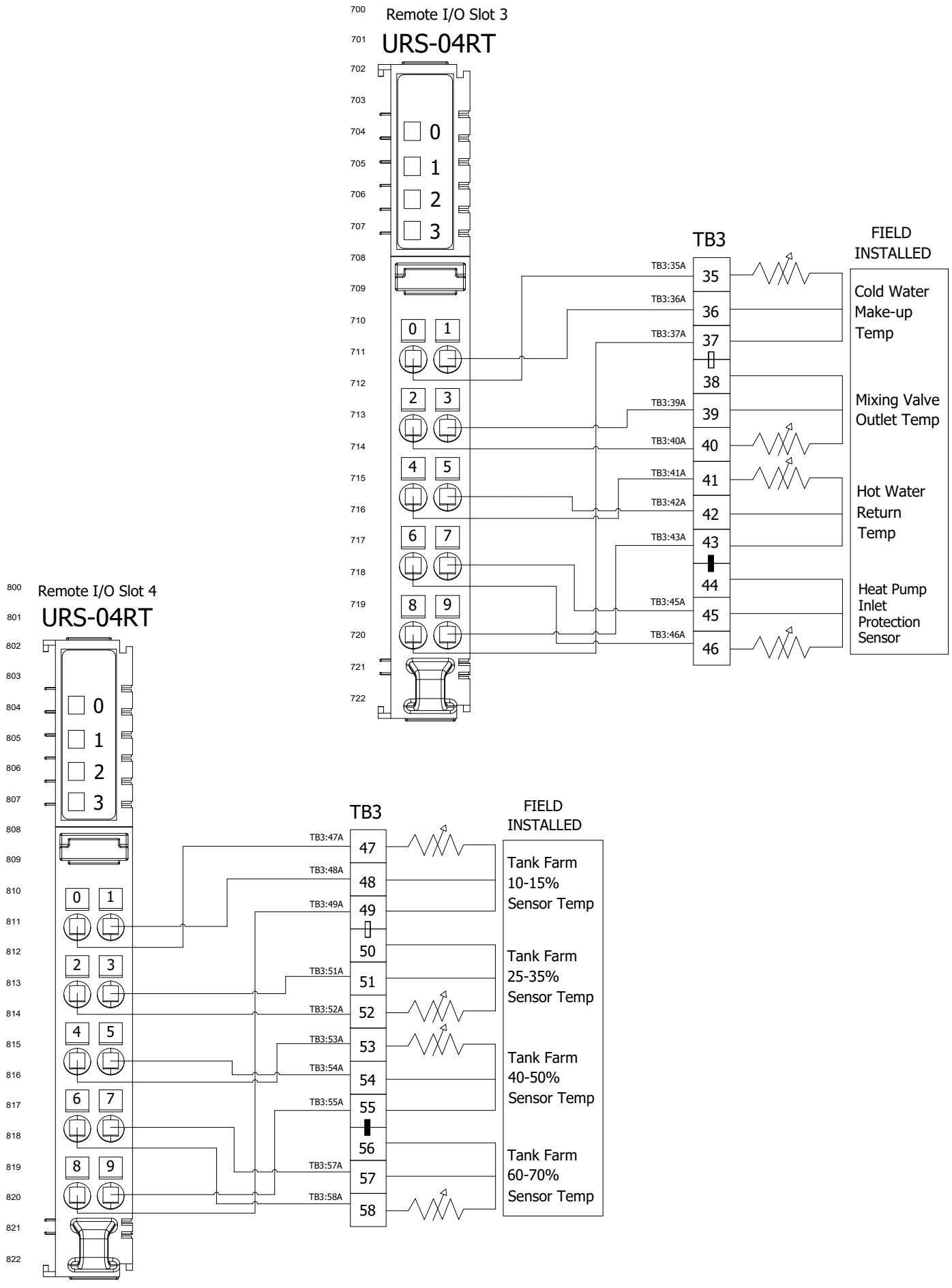
URD-0008CH

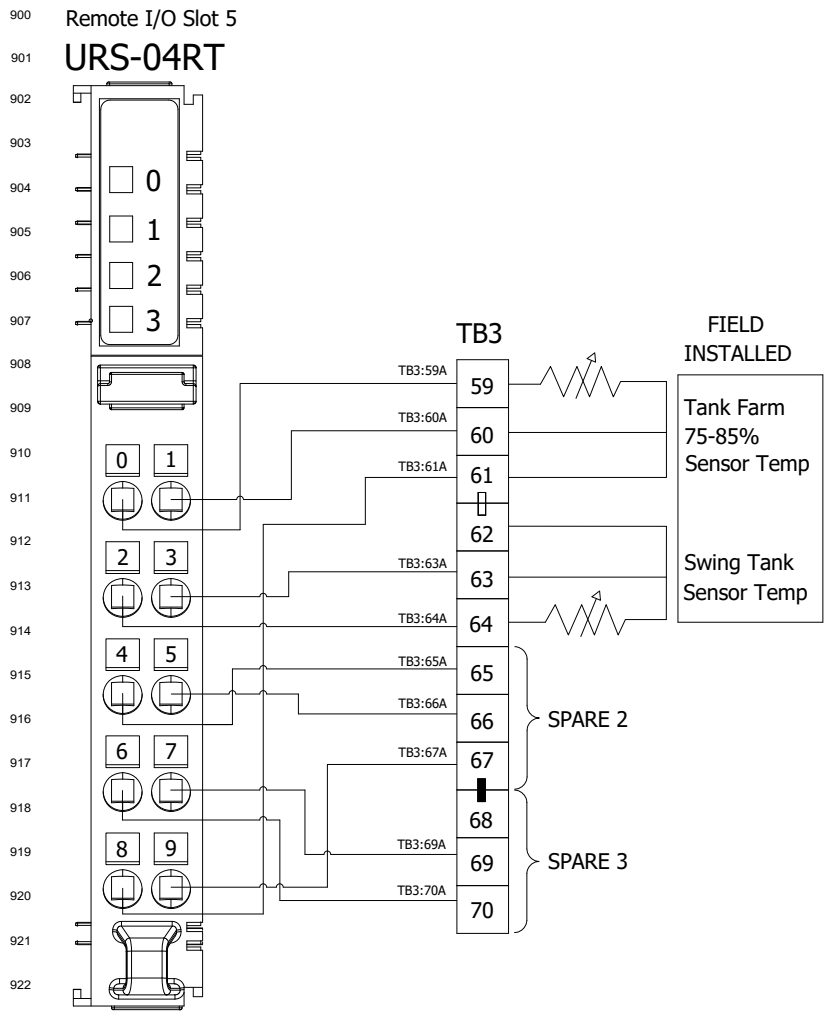


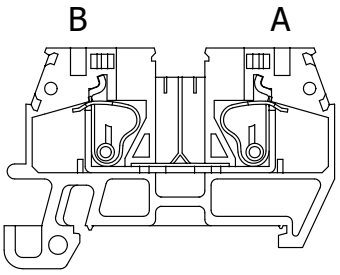
Remote I/O Slot 2

URA-0400T

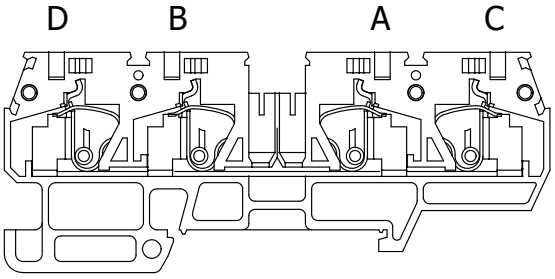



Remote I/O Slot 3
URS-04RT
0
1
2
3
TB3
FIELD INSTALLED
TB3:35A
TB3:36A
TB3:37A
TB3:39A
TB3:40A
TB3:41A
TB3:42A
TB3:43A
TB3:45A
TB3:46A
35
36
37
38
39
40
41
42
43
44
45
46
Cold Water Make-up Temp
Mixing Valve Outlet Temp
Hot Water Return Temp
Heat Pump Inlet Protection Sensor
Remote I/O Slot 4
URS-04RT
TB3
FIELD INSTALLED
TB3:47A
TB3:48A
TB3:49A
TB3:51A
TB3:52A
TB3:53A
TB3:54A
TB3:55A
TB3:57A
TB3:58A
47
48
49
50
51
52
53
54
55
56
57
58
Tank Farm 10-15% Sensor Temp
Tank Farm 25-35% Sensor Temp
Tank Farm 40-50% Sensor Temp
Tank Farm 60-70% Sensor Temp

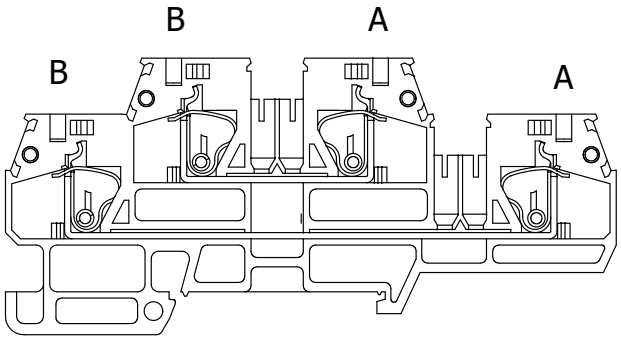

Remote I/O Slot 5
URS-04RT
0
1
2
3
0
1
2
3
4
5
6
7
8
9
TB3
TB3:59A
TB3:60A
TB3:61A
TB3:63A
TB3:64A
TB3:65A
TB3:66A
TB3:67A
TB3:69A
TB3:70A
59
60
61
62
63
64
65
66
67
68
69
70
FIELD
INSTALLED
Tank Farm
75-85%
Sensor Temp
Swing Tank
Sensor Temp
SPARE 2
SPARE 3



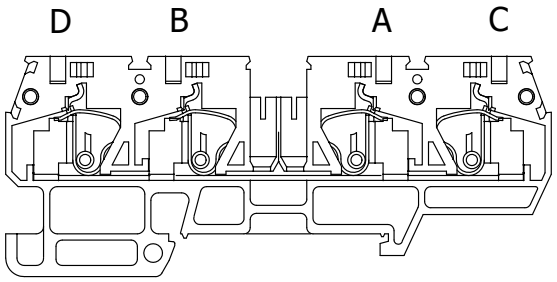
TB3:1 thru TB3:6; TB3:19 thru TB3:34
Single level feed through terminal block.



TB3:9 thru TB3:18
Single level feed through terminal block.
Two connection to two connection.



TB3:35 thru TB3:70.
Double level feed through terminal block. 2 circuits.



TB3:7 & TB3:8
Grounding terminal block.
Two connection to two connection.

Notes:

Dimensions and specifications subject to change without notice in accordance with our policy of continuous product improvement.

Intertek

H2433200-

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