nVent

RAYCHEM

465 Controller for Fire Sprinkler Trace Heating Systems

INSTALLATION, OPERATION AND MAINTENANCE MANUAL

CONTENTS

1.1 INTRODUCTION

This manual provides information pertaining to the installation, operation, testing and maintenance of the nVent RAYCHEM 465 fire sprinkler heat trace controller. The controller is c-UL-us listed for freeze protection of fire suppression system supply piping and branch lines.

Additional copies of this user manual may be ordered separately through your nVent Thermal Management representative or online at **nVent.com.**

This document covers the 465 controller and its available options. This fire sprinkler heat trace controller is designed for the following trace heating products necessary to make up the complete freeze protection system for supply piping and branch lines including sprinkler heads: nVent RAYCHEM XL-Trace cables 5XL-1CR, 5XL-2CR, 5XL-1CT, 5XL-2-CT, 8XL-1CR, 8XL-2CR, 8XL-1CT and 8XL-2-CT heating cables; as well as nVent RAYCHEM RayClic-PC, RayClic-PS, RayClic-PT, RayClic-T, RayClic-S, RayClic-X, RayClic-E, RayClic-LE, RayClic-SB-02, RayClic-SB-04 connection kits and accessories.

1.1.1 Trace Heating Systems for Fire Sprinkler Systems

The design and monitoring of trace heating systems for fire sprinkler systems shall be in accordance with IEEE 515.1. Trace heating systems for fire sprinkler systems shall be permanently connected to the power supply. If backup power is being provided for the building electrical systems, it shall also provide backup power supply for the trace heating system.

The thermal insulation used for the supply piping and branch lines shall be non-combustible and protected with a sealed exterior non-combustible cover that will maintain its integrity when exposed to water discharge as shown below:

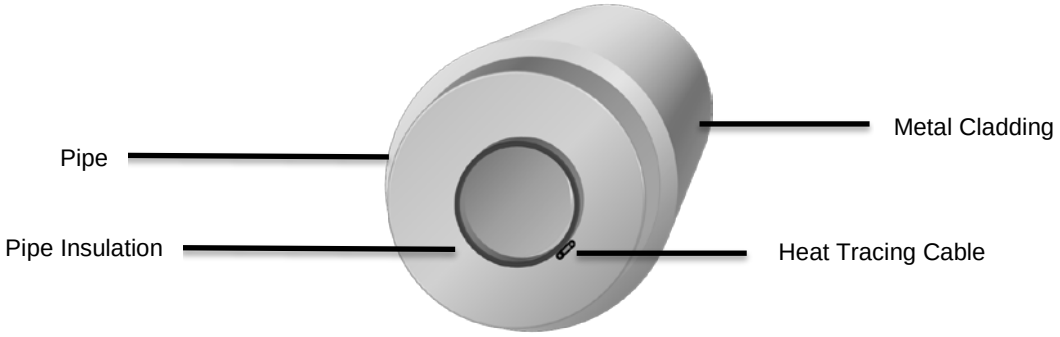


Figure 1.1 – Example of sealed exterior non-combustible cover for the pipe insulation

The thermal insulation for the sprinklers shall be installed to comply with the obstruction requirements of NFPA 13 so that the thermal insulation over the trace heating does not unacceptably obstruct the sprinkler or cover the wrench boss.

When installing XL-Trace trace heating system on branch lines with sprinkler heads follow the methods shown below:

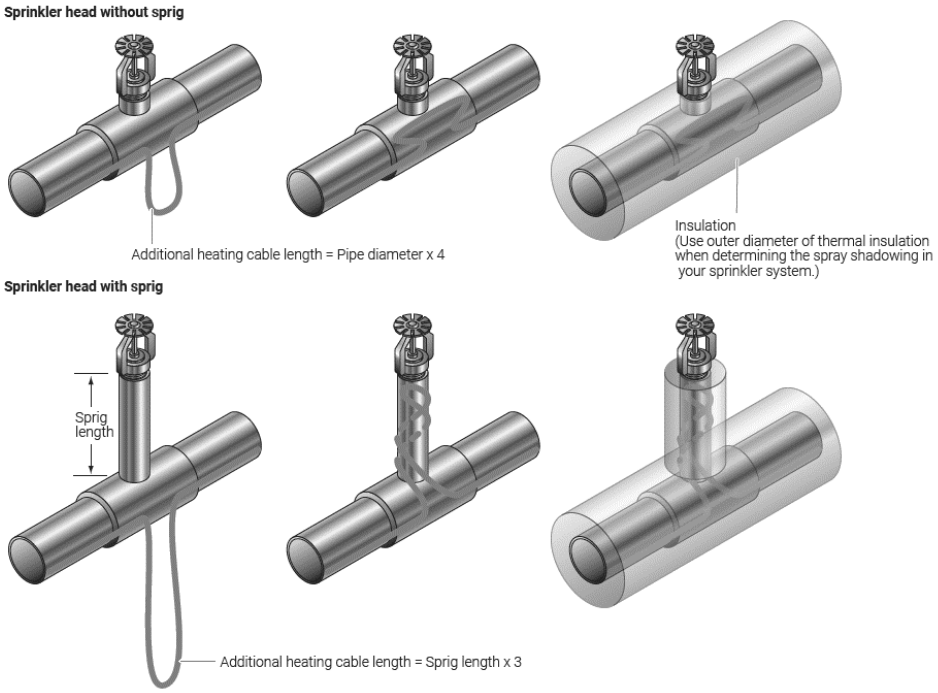


Figure 1.2 – Installing XL-Trace on the sprinklers

Sprigs are typically 1 inch IPS with 0.5 inch thick thermal insulation. The insulation may be oversized to accommodate the heating cable installation, resulting in no greater than 3 inch installed outer diameter (OD). Typically thermal insulation of 2 inch thickness should be used on branch lines and supply piping to balance the heat loss of the system and power output of the trace heating

For upright sprinklers only, the sprinkler heads shall be insulated up to the top of the reducing bushing with a taper of 45° to avoid spray-pattern obstruction, as detailed in Figure 14 of IEEE 515.1-2012.

The minimum sprinkler temperature rating shall be (155°F [68°C]).

1.2 PRODUCT OVERVIEW DESCRIPTION

The 465 controller monitors, controls, and communicates supervisory events and data for one heating cable circuit.

The intended use of 465 controller is to control and monitor heat tracing circuits for fire sprinkler systems. Each unit is a single point controller with a 5" inch color touch screen display for intuitive set up and programming right out of the box. The 465 controller may be used with line-sensing or ambient-sensing and proportional ambient-sensing control (PASC) modes. It measures temperatures with two 2 KOhm / 77°F (25°C), 2-wire Thermistor connected directly to the unit. The controller can also measure ground fault current to ensure system integrity. If the equipment is used in a manner not specified by nVent Thermal Management the protection provided by the equipment may be impaired.

1.2.1 Features

A detailed description of available features may be found in Section 4 of this manual.

Highlights of specific features are as follows:

Touchscreen Display

The touchscreen display provides the operator with large easy to read messages and prompts, eliminating complex and cryptic programming.

Single or Dual Temperature Sensor Inputs

The ability to utilize one or two temperature sensor inputs allows the selection of ambient or line sensing control modes and programming of all temperature parameters.

High and Low Temperature

High and low temperature supervisory events are offered for both temperature sensor inputs.

High Temperature Cutout

High temperature cutout is provided for both temperature sensor inputs.

Low Current Condition

The 465 controller offers a low current condition to identify situations where the heating cable is not pulling adequate current.

Electromechanical Relay (EMR) Output

The 465 controller is equipped with a 24A rated electromechanical relay (EMR) output switch with device failure supervisory status change.

Ground Fault Condition and Trip

Ground fault (GF) current levels are monitored and are displayed in milliamperes (mA). The adjustable ground fault level gives the user the choice of ground fault current levels suitable for the particular installation.

Proportional Ambient Sensing Control (PASC)

The 465 controller includes the Proportional Ambient Sensing Control (PASC) mode to maximize the energy efficiency of the heat tracing system.

Temperature Sensor Failure

Both open and shorted sensors are detected by the controller.

Certification

nVent Thermal Management certifies that this product met its published specifications at the time of shipment from the factory.

Limited Warranty

This nVent Thermal Management product is warranted against defects in material and workmanship for a period of 18 months from the date of installation or 24 months from the date of purchase, whichever occurs first. During the warranty period, nVent Thermal Management will, at its option, either repair or replace products that prove to be defective. For warranty service or repair, this product must be returned to a service facility designated by nVent Thermal Management. The Buyer shall prepay shipping charges to nVent Thermal Management and nVent Thermal Management shall pay shipping charges to return the product to the Buyer. However, the Buyer shall pay all shipping charges, duties, and taxes for products returned to nVent Thermal Management from another country. nVent Thermal Management warrants that the software and firmware designated by nVent Thermal Management for use with the 465 controller will execute its programming instructions properly. nVent Thermal Management does not warrant that the operation of the hardware, or software, or firmware will be uninterrupted or error-free.

Warranty Exclusion/Disclaimer

The foregoing warranty shall not apply to defects resulting from improper or inadequate maintenance by the Buyer, Buyer-supplied software or interfacing, unauthorized modification or misuse, operation outside of the specifications for the product, or improper installation. No other warranty is expressed or implied. nVent Thermal Management disclaims the implied warranties of merchantability and fitness for a particular purpose.

Exclusive Remedies

The remedies provided herein are the buyer's sole and exclusive remedies. nVent Thermal Management shall not be liable for any direct, indirect, special, incidental, or consequential damages, whether based on contract, tort, or any other legal theory.

Conducted and Radiated Emissions: FCC Statement of Compliance

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a commercial/ residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference

to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

CAUTION! Do not modify device. Any changes or modifications made to device that is not expressly approved by nVent could void EMC compliance.

Innovation, Science and Economic Development (ISED) Canada

ICES-003 Compliance Label: CAN ICES-3 (B)/NMB-3(B)

1.3 PRODUCT RATINGS

General		
Area of use	Nonhazardous locations	
Approvals	UL Listed for fire sprinkler systems (VGNJ, VGNJ 7)	
	5XL1-CR, CT 5XL2-CR, CT	8XL1-CR, CT 8XL2-CR, CT
Supply voltage	120 V to 277 V, +/–10%, 50/60 Hz Common supply for controller and heat-tracing circuit	
Enclosure		
Protection	TYPE 12	
Materials	Polycarbonate	
Ambient operating temperature range	32°F to 105°F (0°C to 40°C)	
Ambient storage temperature range	–4°F to 122°F (–20°C to 50°C)	
Relative humidity	0% to 95%, noncondensing	
Control		
Relay type	Single pole single throw	
Voltage, maximum	277 V nominal, 50/60 Hz	
Switching current, maximum	24 A @ 105°F (40°C)	
Control algorithms	EMR: Ambient On/off, proportional ambient sensing control (PASC), Line sensing	
Control range	32°F to 105°F (0°C to 40°C)	
Monitoring		
Temperature	Low range -40°F to 190°F (-40°C to 88°C) or OFF High range 32°F to 190°F (0°C to 88°C) or OFF	
Ground fault	Supervisory range Trip range	20 mA to 200 mA 20 mA to 200 mA

Current	Low condition	0.25 A

Temperature Sensor Inputs

Quantity	Two inputs standard	
Types	Thermistor 2KΩ/77°F (25°C), 2 Wire 10 ft (3 m) long, can be extended to 328 ft (100 m) / 2 x 16 AWG	
Sensor temperature range	-40°F (-40°C) to 194°F (90°C)	
Sensor data	**Temperature (°F)**	**Resistance (KΩ)**
	-40	32.34
	-31	24.96
	-22	19.48
	-13	15.29
	-4	12.11
	5	9.655
	14	7.763
	23	6.277
	32	5.114
	41	4.188
	50	6.454
	59	2.862
	68	2.387
	86	1.684
	104	1.211
	122	0.8854
	140	0.6587
	158	0.4975
	176	0.3807

Supervisory Output

Supervisory relay	Single pole double throw relay, volt-free, rating 1 A/24 VDC, 1 A/24 VAC

Programming and Setting

Method	Programmable touchscreen
Units	Imperial (°F, in.) or Metric (°C, mm)
Touchscreen display	Setpoint, status, sensor temperatures, supervisory condition, settings
Memory	Nonvolatile, restored after power loss
Stored parameters (measured)	Last event, maintain temperature, last event sensor temperatures, control mode
Supervisory conditions	Low/high temperature, low current*

	Ground fault condition, trip*
	Sensor failure, or EMR failure
	Loss of continutiy
	Loss of incoming supply voltage
Other	Password protection

Connection Terminals	
Power supply input	Push-in Cage Clamp 18–10 AWG
Heating cable output	Push-in Cage Clamp 18–10 AWG
Ground	Push-in Cage Clamp 18–10 AWG
Sensors/supervisory relay	Push-in Cage Clamp 22–16 AWG

Mounting	
Enclosure	Mounting DIN Rail 35 mm (Indoor only)

*Note: The 465 controller can't monitor the load current and ground fault current in each cable segment when an external contactor is used. These supervisory conditions are disabled when external contactor is used.

2.1 INTRODUCTION

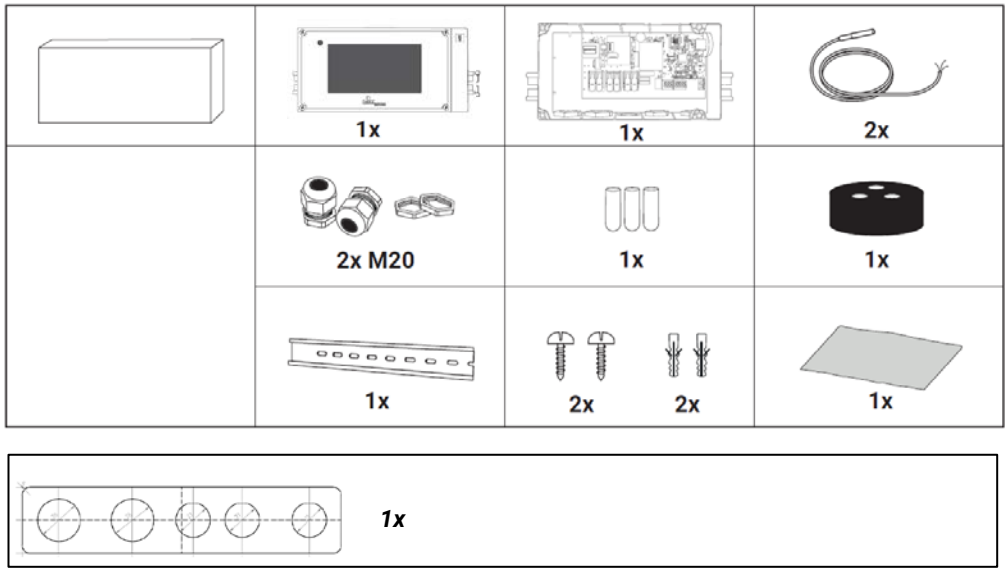
This section includes information regarding the initial inspection, preparation for use, and storage instructions for the 465 controller.

Note: If the 465 controller is used in a manner not specified by nVent Thermal Management, the protection provided by the controller may be impaired.

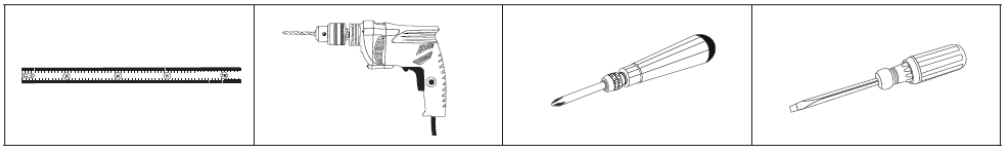
2.2 INITIAL INSPECTION

Inspect the shipping container for damage. If the shipping container or cushioning material is damaged, it should be kept until the contents of the shipment have been verified and the equipment has been checked mechanically and electrically. If the shipment is incomplete, there is mechanical damage, a defect, or the controller does not pass the electrical performance tests, notify the nearest nVent Thermal Management representative. If the shipping container is damaged, or the cushioning material shows signs of stress, notify the carrier as well as your nVent Thermal Management representative. Keep the shipping materials for the carrier's inspection.

Product Contents:



Tools Required:



2.3 INSTALLATION LOCATION

The 465 controller standalone version is approved for TYPE 12 protection class for Indoor-use. Install the controller in an indoor, dry, clean, accessible location. Make sure you install the controller within 328 ft (100 m) of where you want to monitor the pipe or ambient temperature. The ambient temperature sensor shall be installed in the location representative of the ambient temperature of the fire sprinkler system, including elevation. Considerations should include accessibility for maintenance and testing and the location of existing conduits.

2.4 MOUNTING PROCEDURES

The mounting steps are shown in Figure 2.1 A, B, C and D.

Drill conduit entry holes prior to mounting. Conduit entries should be made in the bottom of the enclosure if possible to reduce the possibility of water entry from condensation or leakage. Conduit entries must be drilled or punched using standard industry practices. Use bushings

suitable for the environment and install such that the completed installation remains waterproof. Grounding hubs and conductors must be installed in accordance with Article 250 of the National Electrical Code and Part I of the Canadian Electrical Code. The hubs shall be connected to the conduit before they are connected to the enclosure.

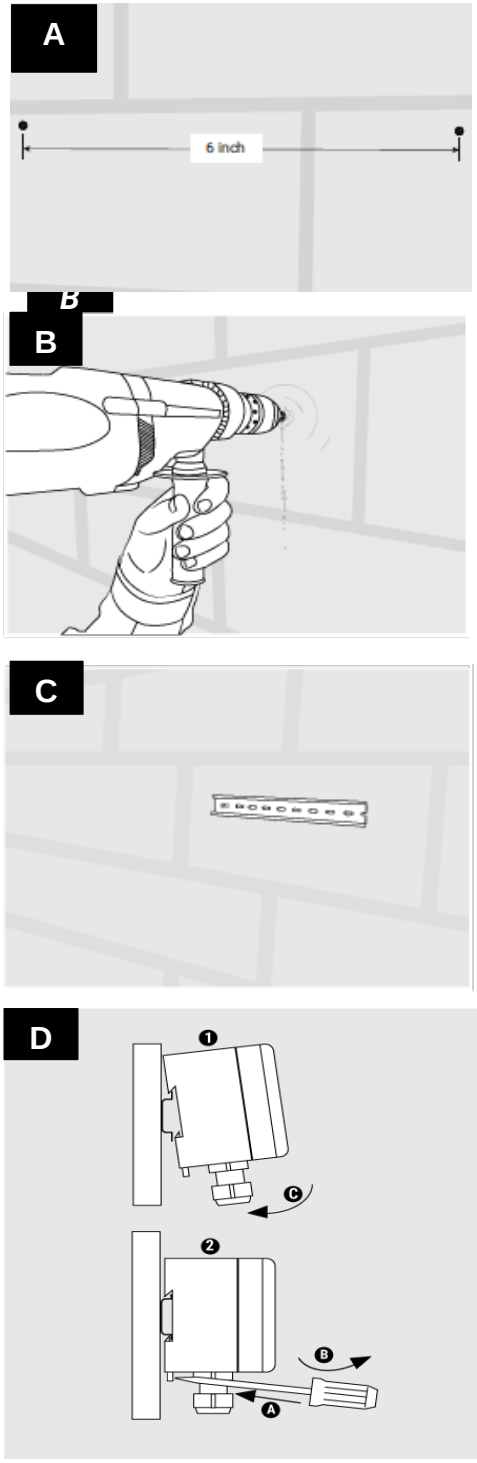


Figure 2.1 – Mounting procedures for the 465 controller

2.5 WIRING

The following drawings provide sample wiring diagrams for the 465 controller and optional accessories. Grounding hubs and conductors must be installed in accordance with Article 250 of the National Electrical Code and Part I of the Canadian Electrical Code.

2.5.1 Power and Load Connections

The 465 controller may be powered directly from a 120 V to 277 V supply.

All of the power terminals are labeled for easy identification. Do not attempt to use wire sizes that exceed the marked terminal ratings and avoid terminating two wires on the same terminal whenever possible.

Note: Follow the industry standard grounding practices. Do not rely on conduit connections to provide a suitable ground. Grounding terminals/screws are provided for connection of system ground leads. The glands/conduits should be inserted into the metal grounding plate provided with the controller.

Power wires are connected to terminals labeled L (line), N (neutral) and PE (Ground).

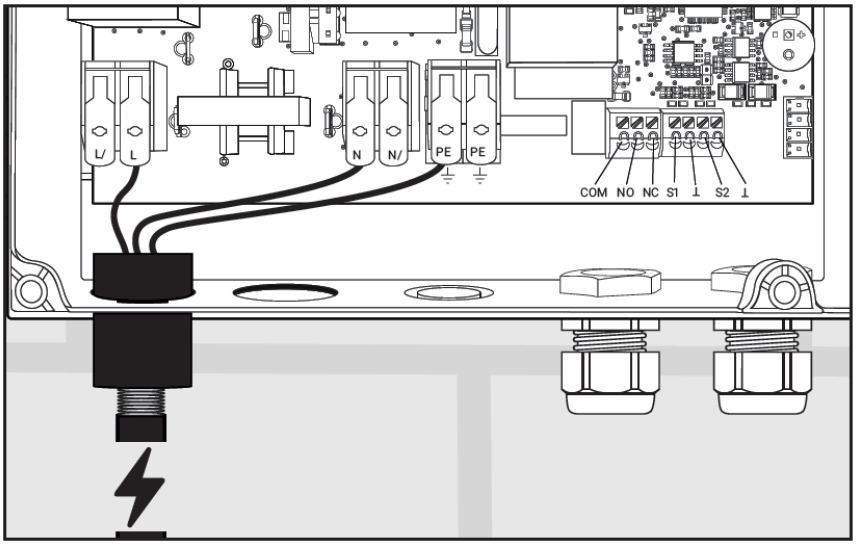


Figure 2.2 – Power Connection

The heating cable conductors are connected to terminals labeled L/, N/ and the braid is connected to PE.

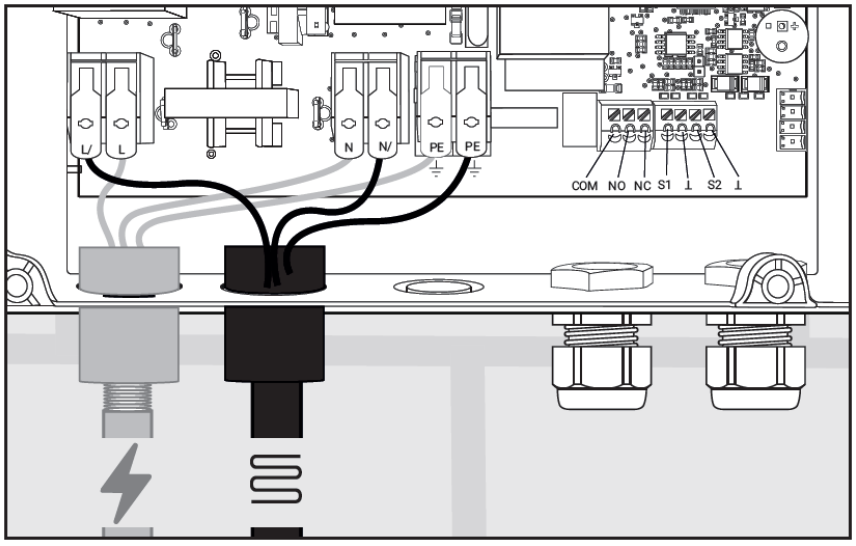


Figure 2.3 – Heating Cable Connection

2.5.2 Temperature Sensor and Extension Cables

The 465 controller has two (2) temperature sensor inputs. Use only 2-wire Thermistor 2 KOhm / 77°F (25°C) sensors provided. Sensor 1 should be connected to terminals S1 and ⊥ while Sensor 2 should be connected to terminals S2 and ⊥. The controller also operates with just one sensor.

Note: The ambient temperature sensor shall be installed in the location representative of the ambient temperature of the fire sprinkler system including elevation.

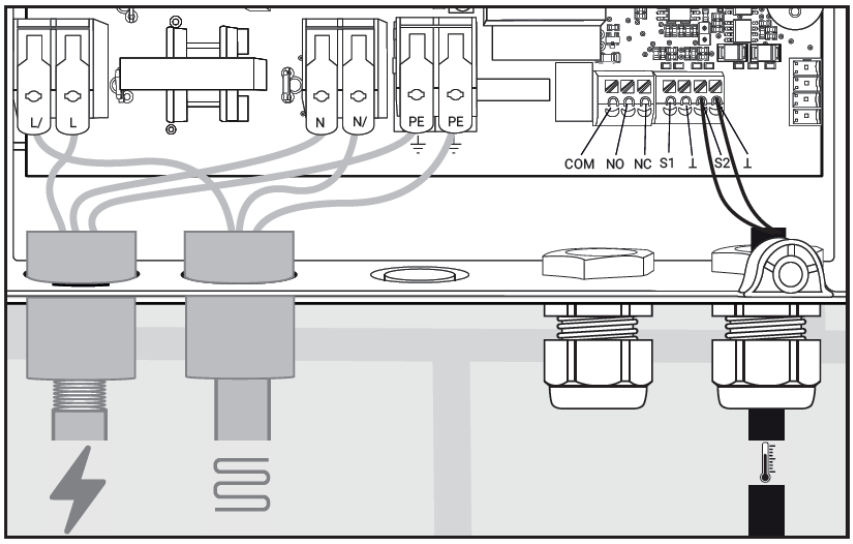


Figure 2.4 – Temperature Sensor Wiring

2.6 SUPERVISORY RELAY CONNECTIONS

The 465 controller includes terminals for one supervisory relay as shown in figure 2.5. It can support both AC and DC power source (please refer to the max voltage and current specifications for the relay above). It may be wired for normally open (N.O.) or normally closed (N.C.) operation.

The contractor shall connect the supervisory indicator to NO, COM to have the relay signal a supervisory condition when it's open. In normal operation the NO contact is closed. In case of power loss or supervisory condition the NO contact is open.

The contractor shall connect the supervisory indicator to NC, COM to have the relay signal a supervisory condition when it's closed. In normal operation the NC contact is open. In case of power loss or supervisory condition the NC contact is closed.

The supervisory relay is used to provide supervisory signal to a fire alarm system for any of the following conditions:

1) Ground fault current
2) Low system temperature
3) High system temperature
4) Temperature sensor failure
5) Internal error
6) Loss of continuity
7) Loss of incoming supply voltage

Note: The supervisory relay is intended to be used for switching low-voltage, low-current signals. Do not use this relay to directly switch line voltages.

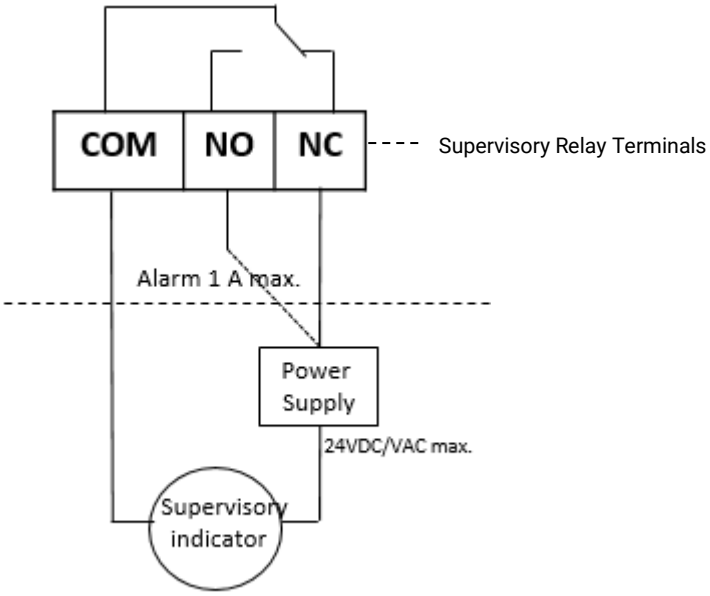


Figure 2.5 – Supervisory Relay Wiring

After all connections are made, connect the network cable from the touchscreen to the port on the controller as shown below:

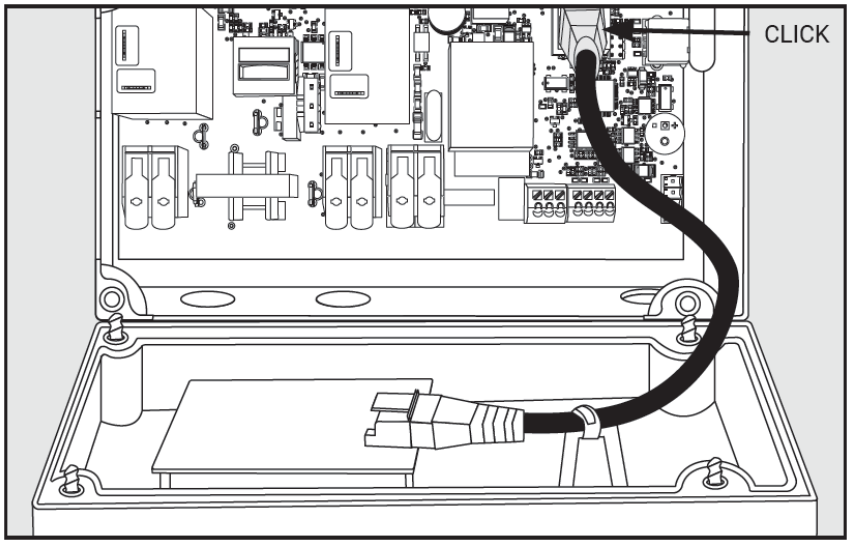


Figure 2.6 – Connect the touchscreen cable to the controller.

Close the lid with screwdriver and turn on the circuit breaker for the circuit. The circuit breaker used for branch circuit protection should be maximum 30A circuit breaker. The power wires used should be of appropriate size for the current rating as per NEC/CEC.

2.7 INITIALIZING THE CONTROLLER

2.7.1 Initial Heating Cable Test

To minimize the risk of damage to the controller due to a heating cable fault, the integrity of the heating cable should be verified by performing the commissioning tests detailed in the appropriate product installation and operating manual. These manuals can be found on nVent.com.

These tests must be performed with the controller output disconnected. Once the cable has been checked, it may be reconnected to the controller and power applied.

3.1 QUICKSTART

When the unit is powered up for the first time, a Quickstart must be executed before the unit is ready to start. The Quickstart helps to set all important settings, the unit will go in main screen mode automatically when done. Quickstart is sufficient for normal operations. More settings are available from the settings menu.

QUICKSTART MENU

Language		Select your language from the language menu.
Units		Select Imperial or Metric units
Connection check		The unit is automatically executing a connection check. It will check the heating cable connection, ambient sensor and pipe sensor connection. A connection of the unit to an external contactor needs to be confirmed by the user. ⚠**WARNING**: The 465 controller can't monitor the load current and ground fault current in each cable segment when an external contactor is used. External ground fault protection must be provided using appropriate GFEPD.
Country		Select a country in this menu.
Date		Use the up/down arrow keys to select the year, month and day.
Time		Use the up/down arrow keys to set the hour and minute.
Voltage		Select voltage.
Cable Type		Select heating cable used in the application.
Sensors Set-up		Setting up Sensors1 and 2 is fully flexible. Assign each sensor to be a line or ambient sensor. Select if you want the circuit to remain on if the given sensor fails by clicking “Power On TS Fail”. Select which sensor you would want to use for high limit cutout. Make sure Sensor 1 is connected to terminals S1 and ⊥. Fine tune the individual sensor settings in the parameters setting menu. If only one sensor is used, leave the other sensor settings blank.
Control Mode		This allows selection of the type of algorithm to be used to maintain the setpoint temperature. Select Ambient On/Off, PASC (Proportional Ambient Sensing Control) or Line Sensing Control. If no ambient or line sensor was assigned, the corresponding control mode will be disabled.
Parameter Settings	Setpoint	This is the temperature that the controller uses to determine whether its output switch should be on or off. Range: 32ºF (0ºC) to 104ºF(40ºC)
	Pipe Diameter	Select the appropriate pipe diameter from the menu.
	Low Temperature	This allows the user to set the low temperature setting for temperature sensor 1 and 2. Range: -40ºF (-40ºC) to 190ºF(88ºC) Default: 35°F (2°C)
	High Temperature	This allows the user to set the high temperature setting for temperature sensor 1 and 2. Range: 32ºF (0ºC) to 190ºF(88ºC)

		Default: 110°F (43°C)
Start Test Program		The test program runs for 30 minutes, during which all parameters will be ignored to check heating cable and connection on site. You can stop the test program at any time.
Key Lock		Key lock gets activated after the quick start process. Please enter the passcode 3000 to unlock the controller.

After QUICKSTART completion, the main menu screen will appear as follows:

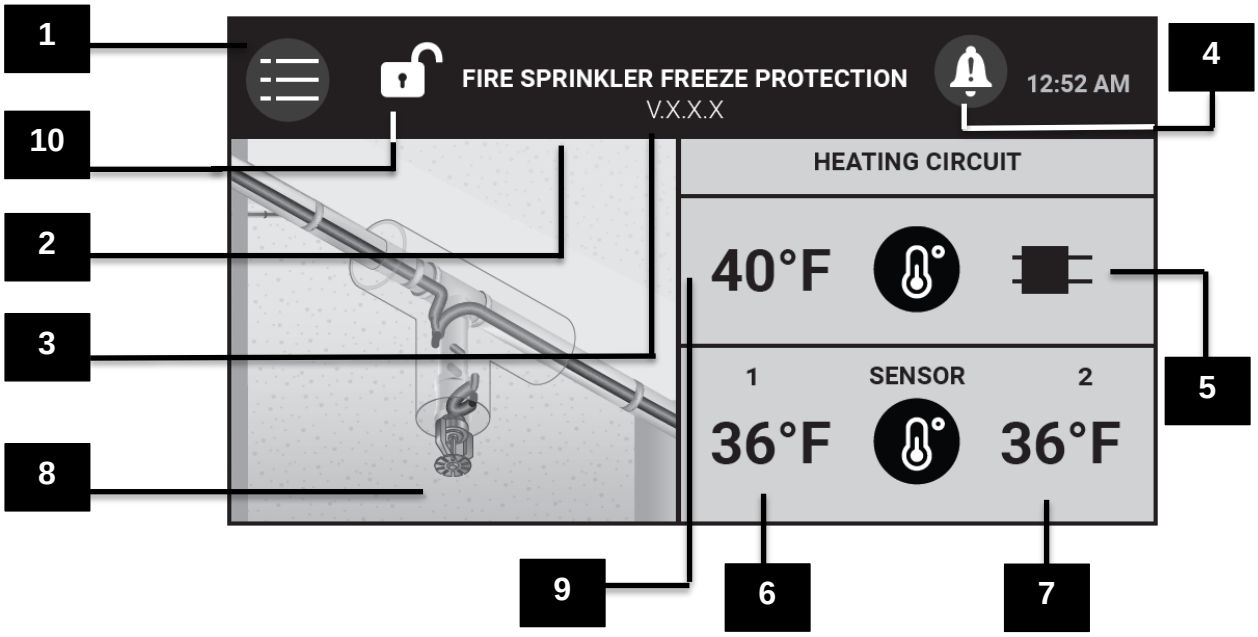


Figure 3.1 – Main Menu Screen

1	Settings Button
2	Application Description
3	Firmware Version
4	Supervisory Event Indicator
5	Heat Cable Power Indicator (red when cable is powered)
6	Sensor 1 Measured Temperature
7	Sensor 2 Measured Temperature
8	Application Picture
9	Control Setpoint
10	Keylock Indicator

The Green LED will blink as follows:

- Normal operation, heater on: 1.5 sec on/0.5 sec off
- Normal operation, heater off: 1 sec on/ 1 sec off
- Supervisory condition: 0.2 sec on/1.8 sec off

Press the Settings button on the Main Menu Screen to get to the Settings Menu.

3.2 SETTINGS MENU

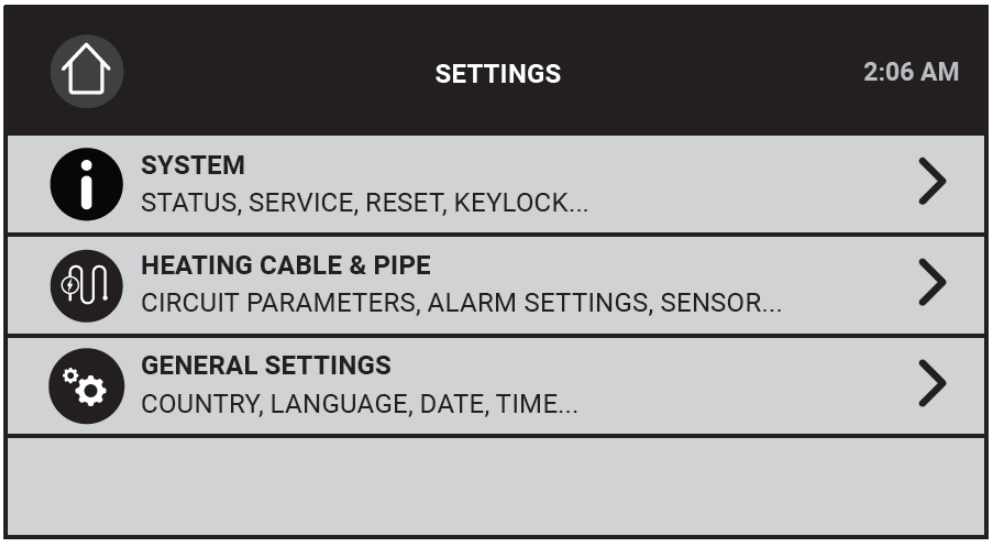


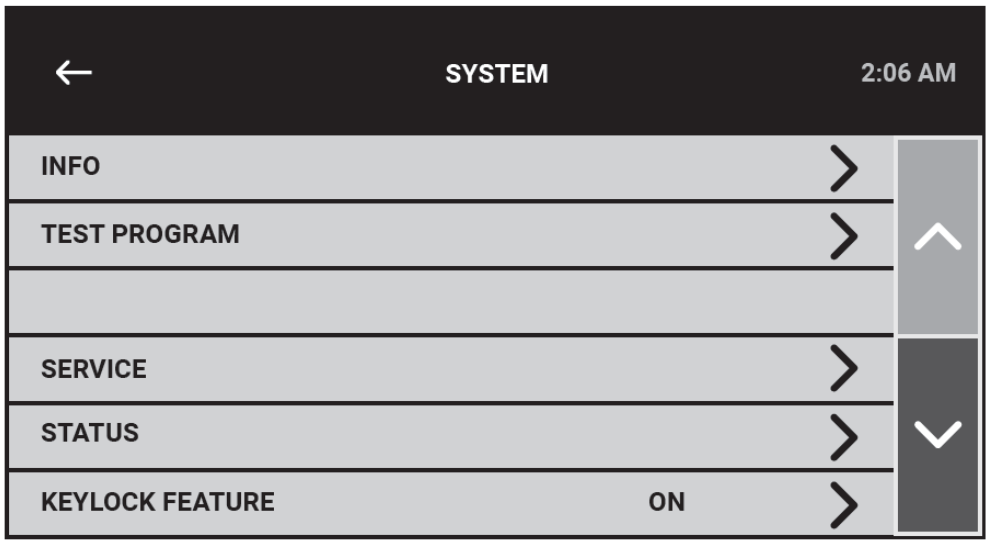
Figure 3.2 – Settings Menu

The settings menu has three sections:

1. The System section allows you to read system information, run test program, service the system such as upgrade the firmware, export event log/energy consumption/temperatures or calibrate the screen, read status of the heat tracing circuit, enable key lock, assign device ID and reset the system to factory settings.
2. The Heating Cable and Pipe section allows you to set circuit parameters such as control mode, set point, sensors, minimum ambient temperature, temperature conditions and filters and ground fault settings.
3. The General settings enables you to select country, language, voltage, date, time, and units.

The details of each section are provided on the next page.

3.3 SYSTEM MENU



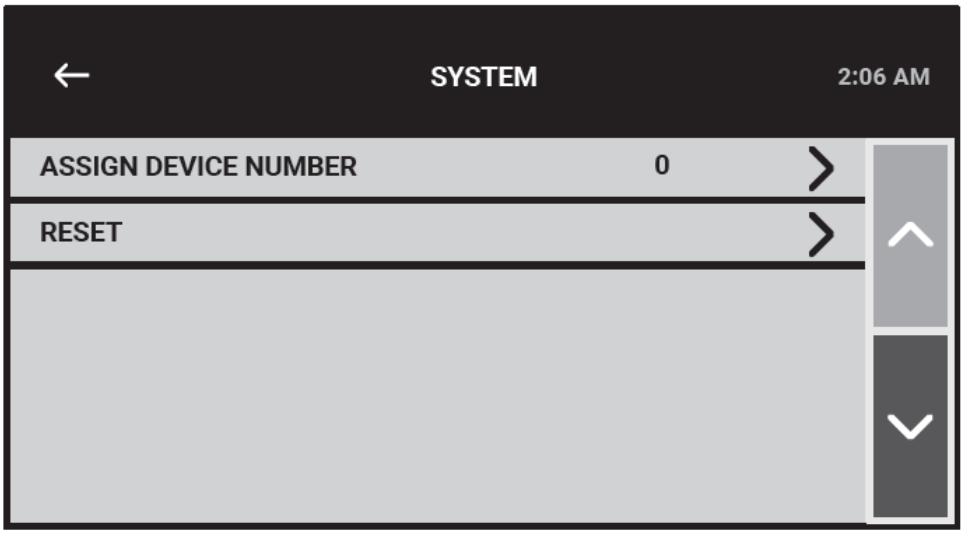


Figure 3.3 – System Menu

3.3.1 Info

Purpose	General info about the unit, name, commissioning date, firmware version, nVent Thermal Management contact info per country.

3.3.2 Test Program

Purpose	The test program runs for 30 minutes, during which all parameters will be ignored to check the heating cable and the connection on site. You can stop the test program at any time.

3.3.3 Service

Purpose	This is a password protected area for user to service the unit. The default password is 2017. Sub-menu includes: Log File: Provides information about the warnings, last event, control mode, heating cable, set point, ambient temperatures measured and time stamp. Calibrate Screen: Press the dot to calibrate the touch screen. USB: USB drive can be used to upgrade the firmware, export temperature, energy consumption, and event log data. Energy Consumption: Displays the energy consumption chart over time. Select Power Adjustment: For Proportional Ambient Sensing Control (PASC), Power Adjustment Factor can be selected. The Range is from 10% to 200%. Default is 100%.

3.3.4 Status

Purpose	Displays the status and parameters for the heat tracing circuit. Displays information such as sensor 1 and sensor 2 temperatures, duty cycle, control mode, load current, GFP current and if the external contactor is connected.

3.3.5 Keylock Feature

Purpose	When key lock is “On”, the setup and timer menus are protected by password. To unlock the unit, enter the predefined password (3000). The unit will automatically lock itself after 10 minutes of inactivity or when Lock “on” key is pressed. Factory default: Key lock is “On” Press the down arrow key to move to the next page of the System Menu

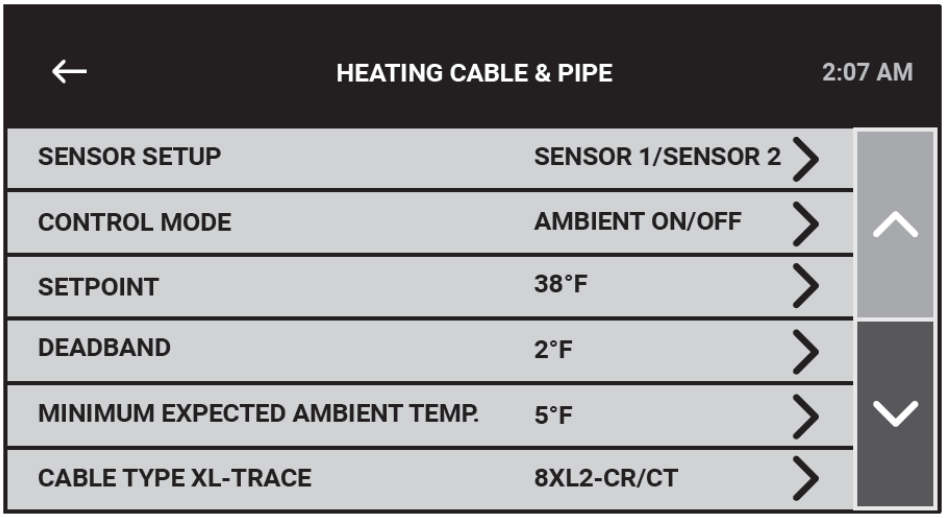
3.3.6 Assign Device Number

Purpose	Assign a 4 digit number to each device as an identifier for that device.

3.3.7 Reset

Purpose	To provide a quick method of resetting the controller’s configuration parameters to the Factory Default parameters. Select “Yes” to activate the Quick install menu and return all settings to factory settings. Quick start process restarts automatically.

3.4 HEATING CABLE AND PIPE MENU



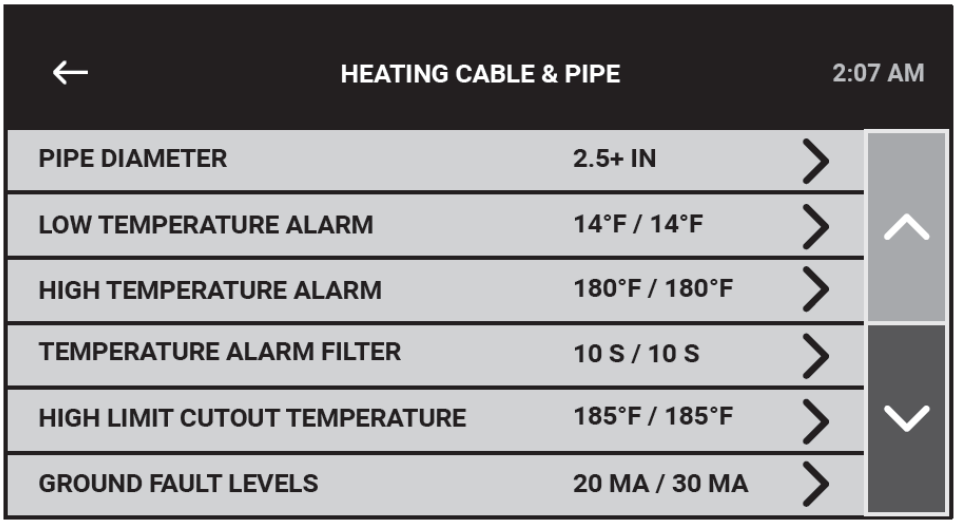


Figure 3.4 – Heating Cable and Pipe Menu

In this menu, every parameter line shows the actual value/attribute for each parameter.

3.4.1. Sensor Setup

Sensor setup allows user full flexibility in configuring the temperature sensors as shown in Figure 3.5 below:

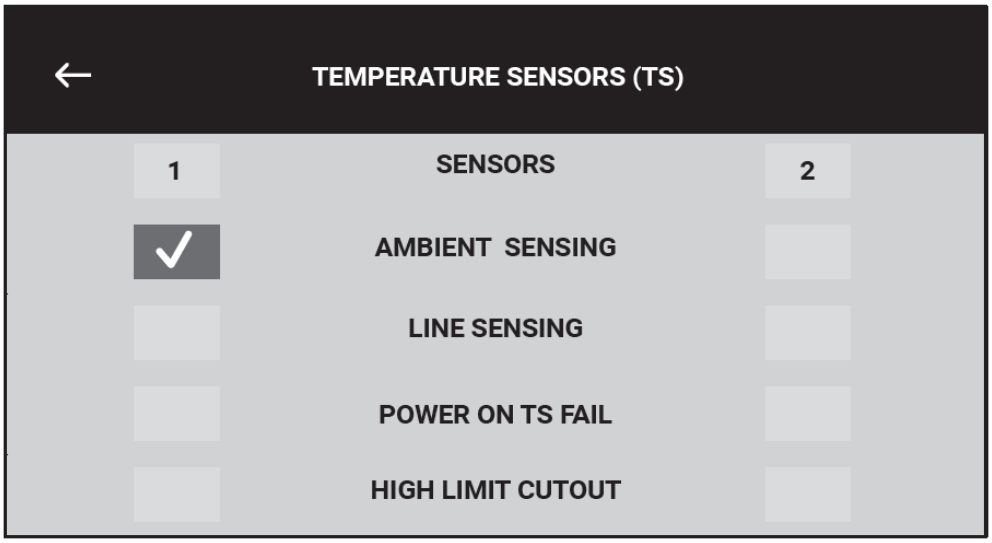


Figure 3.5 – Sensor Setup

The 465 controller allows for two temperature sensors. Assign each sensor to be a line or ambient sensor. If both the sensors are assigned as line or ambient sensors, the controller will control based on the lower measured temperature of the two sensors. Select if you want the circuit to remain on if the given sensor fails by clicking “Power On TS Fail”. Select which sensor you would want to use for high limit cutout. Make sure Sensor 1 is connected to terminals S1 and ⊥.

For Fire Sprinkler freeze protection application, usually one sensor will be ambient sensor and second sensor will be line sensor with high limit cutout enabled. The high limit cutout sensor should be located where the fire sprinkler piping is expected to be the warmest. In the case of sprinkler system with sprigs, the high limit cutout sensor should be located on one of the sprigs.

At least one sensor needs to be connected for the controller to function. The second sensor, if not connected, will be automatically disabled.

Note: The high limit cutout sensor should be located where the fire sprinkler piping is expected to be the warmest.

Note: "High Limit Cutout" feature turns the circuit off when the corresponding sensor reaches the high limit cutout temperature. This feature has a higher priority over the "Power On TS Fail" feature. In other words, the circuit in high limit cutout condition will remain powered off until that condition goes away and the TS Fail condition won't power the circuit on.

3.4.2 Control Mode

Purpose	Sensor setup allows user full flexibility in configuring the temperature sensors as shown in figure 3.5 above:
Setting	Ambient On/Off Mode: Ambient sensor measures the ambient temperature. If the ambient temperature is above the setpoint temperature plus deadband, the relay output is turned off. If the ambient temperature is below the setpoint temperature, the output is turned on. Line Mode: Line sensor measures the line temperature. If the line temperature is above the setpoint temperature plus deadband, the relay output is turned off. If the line temperature is below the setpoint temperature, the output is turned on. PASC: Ambient sensor measures the ambient temperature. The PASC algorithm auto controls the heat output and maintains the temperature at the setpoint. Algorithm will be derived from the following of parameters: • Setpoint: 32°F – 104°F (default 40°F) • Minimum Expected Ambient Temperature : -40°F – 40°F (default 20°F) • Pipe Size: 0.5” / 1” / >2” (default 0.5”) • Power Adjustment Factor: 10% – 200% (default 100%) For more details on PASC please refer to Appendix A.

Note: "Power On TS Fail" feature turns the circuit On if the controlling temperature sensor fails. E.g. in line sensing control mode, the "Power On TS Fail" won't trigger for the ambient sensor failure and vice versa.

3.4.3 Setpoint

Purpose	This is the temperature that the controller uses to determine whether its output switch should be on or off.
Setting/Range	32ºF to 104ºF (0ºC to 40ºC) Factory Default 40ºF (4ºC)

3.4.4 Deadband

Purpose	The deadband is a window of difference between the measured control temperature and the desired control setpoint temperature and provides the decision to turn the output off or on
Setting/Range	1ºF to 8ºF (1ºC to 4ºC) Factory Default 5ºF (3ºC)

3.4.5 Minimum Expected Ambient Temperature

Purpose	This is the minimum expected ambient temperature which will be used to calculate the duty cycle for proportional ambient sensing control mode
Setting/Range	-40ºF to 40ºF (-40ºC to 4ºC) Factory Default 20ºF (-7ºC)

3.4.6 Cable Type

Purpose	Select the type of cable for the heat tracing circuit

3.4.7 Pipe Diameter

Purpose	Select the pipe diameter for the heat tracing circuit	
Setting/Range	0.5 inch,1.0 inch, 2.5+ inch	Factory Default 0.5 inch

3.4.8 Low Temperature

Purpose	This allows the user to select the low temperature supervisory for both the sensors	
Setting/Range	-40ºF to 190ºF (-40ºC to 88ºC)	Factory Default 35ºF (2ºC)

3.4.9 High Temperature

Purpose	This allows the user to select the low temperature supervisory for both the sensors	
Setting/Range	32ºF to 190ºF (0ºC to 88ºC)	Factory Default 110ºF (43ºC)

3.4.10 High Limit Cutout Temperature, Setpoint

Purpose	Set high limit cutout temperature for the selected Sensor (in the sensor set-up). This setpoint is used to turn the circuit off when the sensor reaches the high limit cutout temperature.	
Setting/Range	32ºF to 190ºF (0ºC to 88ºC)	Factory Default 185ºF (85ºC)

3.4.11 Temperature Condition Filter

Purpose	Set time delay filter for temperature condition	
Setting/Range	1 to 200 seconds	Factory Default 10 seconds

3.4.12 High Ground Fault Current

Purpose	This allows the user to set the ground fault current supervisory level. Exceeding this limit will trigger the supervisory event to indicate that a ground fault condition exists in the heating cable circuit. To protect against the risk of fire or shock, ground fault level should be set at the lowest level possible to allow normal operation of the cable.	
Setting/Range	20 mA to 200 mA	Factory Default 20 mA
	Supervisory event time delay filter is factory set as immediate	

3.4.13 Ground Fault Trip Level (HI GF Trip)

Purpose	This allows the user to set the ground fault current trip level. Exceeding this limit will result in the output switch being latched off and the ground fault level trip supervisory activated to indicate a ground fault condition.	
	WARNING: Fire Hazard. Ground fault trip supervisory must not be ignored. To prevent the risk of fire, do not re-energize heating cables until the fault is identified and corrected.	
Setting/Range	20 mA to 200 mA	Factory Default 30 mA

3.5 GENERAL SETTINGS MENU

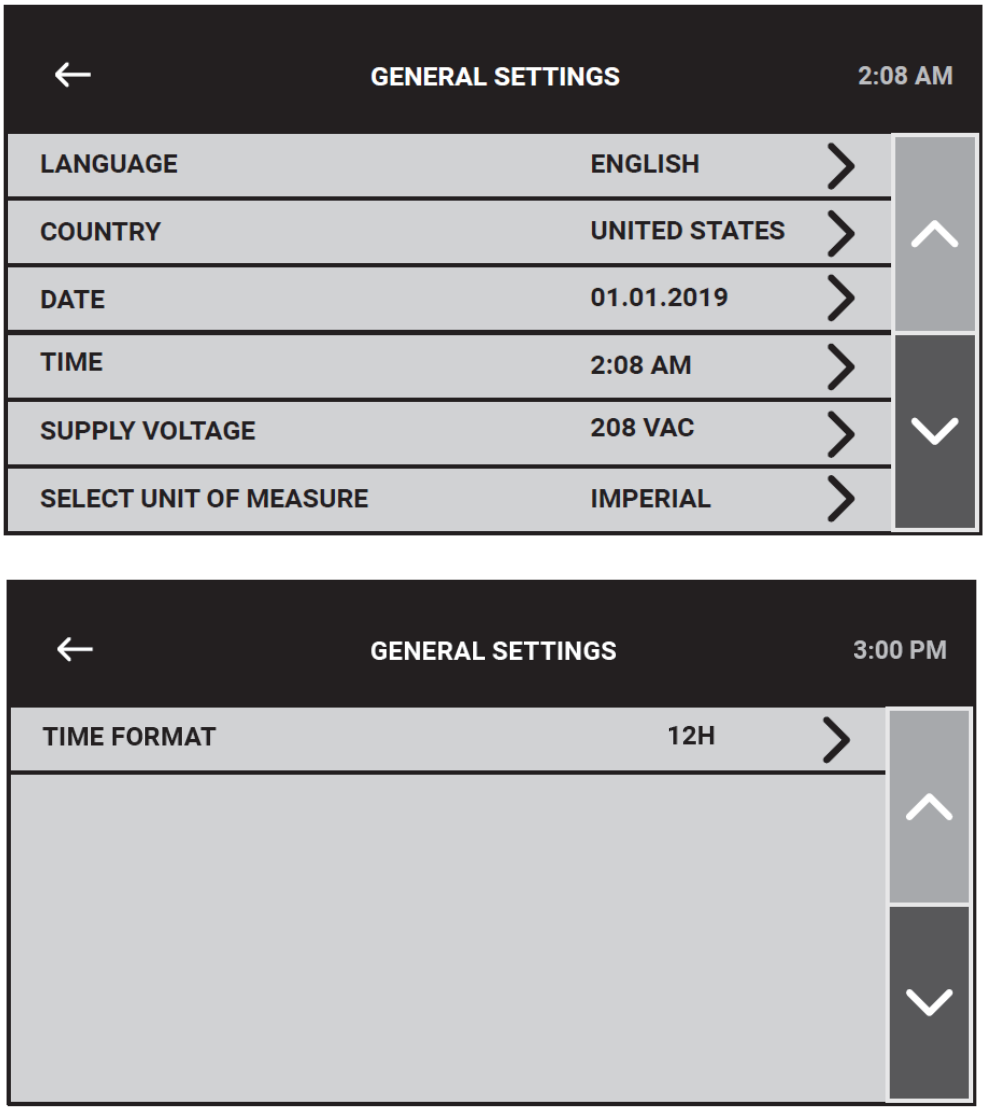


Figure 3.6 – General Settings Menu

3.5.1 Language

Select English or French

3.5.2 Country

Select USA or Canada

3.5.3 Date

Use the up/down arrow keys to select the year, month and day

3.5.4 Time

Use the up/down arrow keys to set the hour and minute

3.5.5. Voltage

Select appropriate voltage for the application

3.5.6 Select Unit of Measure

Select Imperial or Metric units

3.5.7 Time Format

Select 24H (24 hour) or 12H (12 hour) time format

3.6 SUPERVISORY EVENTS

3.6.1 Filter Times

Supervisory Type	Factory Default	Range
Low Temperature	10 seconds	1 to 200 seconds
High Temperature	10 seconds	1 to 200 seconds
Low Current	3 seconds	
High Ground Fault Supervisory	Immediate	
High Ground Fault Trip	Immediate	
Switch Failure	Immediate	
Sensor Failure	10 seconds	
Loss of Incoming Power	Immediate	
Internal Error	Immediate	
Plausibility Check	10 seconds	
High Limit Cutout Temperature	Immediate	

3.6.2 Error Codes

The following are the error codes for different condition and their description.

Error No.	Label	Description
E:1.1	SENSOR1_OPEN	Sensor 1 open
E:1.2	SENSOR1_SHORT	Sensor 1 shorted
E:1.3	SENSOR2_OPEN	Sensor 2 open
E:1.4	SENSOR2_SHORT	Sensor 2 shorted
E:2.1	SENSOR1_TEMP_HIGH	High temperature supervisory Sensor 1
E:2.2	SENSOR2_TEMP_HIGH	High temperature supervisory Sensor 2
E:2.3	SENSOR1_TEMP_HIGH_ CUTOUT	High limit cutout supervisory Sensor 1
E:2.4	SENSOR2_TEMP_HIGH_CUTOUT	High limit cutout supervisory Sensor 2
E:3.1	SENSOR1_TEMP_LOW	Low temperature cutout supervisory Sensor 1
E:3.2	SENSOR2_TEMP_LOW	Low temperature cutout supervisory Sensor 2
E:4.1	LOW_CURRENT	Low current
E:5.1	GROUND_FAULT	Ground fault trip
E:5.2	HIGH GROUND FAULT CURRENT	Ground fault current supervisory
E:6.1	INTERNAL_ERROR	Primary controller failure
E:7.1	ANNUAL_TIME_VERIFICATION	After 1 year if no time verification
E:8.1	PLAUSIBILITY_CHECK_ERROR	Plausibility of Voltage <-> Cable type selection or Control mode <-> Sensor setup

Section 4 TROUBLESHOOTING

The 465 controller may be used as an effective troubleshooting tool to pinpoint problem areas of heating cable circuits. Described below are a few of the more common problem areas, their symptoms, and parameters to check to determine the actual faulty portion of the heating cable circuit.

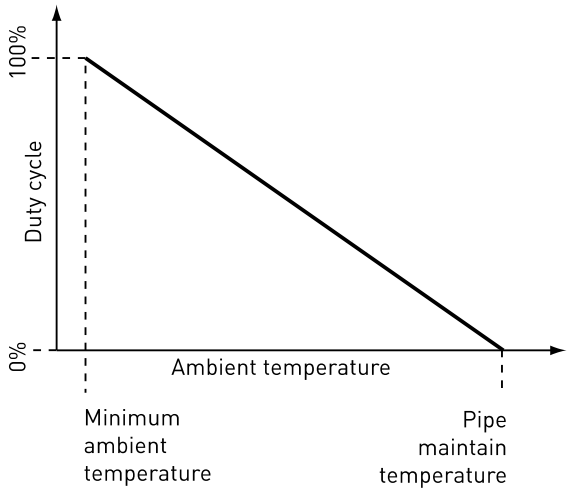
Symptom/Supervisory Condition	Probable Cause	Corrective Action
Sensor failure	Sensor is not a 2-wire NTC Thermistor.	Install correct sensor.
	Damaged sensor or extension cable.	Install new sensor and/or cable.
	Incorrectly wired.	Re-install sensor connections.
Seemingly incorrect temperature	Incorrect sensor used.	Install correct sensor.
	Damaged TEMPERATURE SENSOR or connection cable.	Install new temperature sensor and/or cable.
	465 controller not functioning correctly.	Verify correct reading input. Connect a 2KΩ resistor across S1⊥ or S2⊥ terminals. Apply power to the controller. The indicated or displayed temperature should be about 77°F (25°C).
Unstable or bouncing temperature	Bad, damaged or incorrectly installed temperature sensor extension wire.	Wire used for extension of the temperature sensor should be two-wire. Each of the two lead wires must be of the same gauge.
	Terminal connections are not tight.	Verify tightness of connections.
	temperature sensor or extension cable damaged.	Install new temperature sensor and/or cable
High temperature	Temperature setting too close to maintain temperature.	Increase setting.
	Flow of hot water through pipe.	
	Line Temperature sensor too close to the heating cable on pipe.	Install line temperature sensor on the opposite side of the heating cable on pipe.
	Incorrect heating cable wiring.	Verify heating cable wiring.

Symptom/Supervisory Condition	Probable Cause	Corrective Action
Low temperature	Temperature setting too close to maintain temperature.	Decrease setting.
	Heating cable not sized properly for the application.	Refer to the appropriate heating cable design guide for correct product selection.
	Damaged, wet, or missing thermal insulation.	Replace or install correct thermal insulation.
Temperature sensor failure	Incorrect or damaged field wiring.	Re-install temperature sensor connections.
	Damaged temperature sensors.	Install correct temperature sensor.
Ground fault	Incorrect installation, wet system components or damaged cables.	Perform heating cable commissioning tests outlined in the heat cable operation manuals.
	Incorrect neutral return wiring.	Check that the heating cable circuit neutrals return to the controller and are not connected directly to the distribution panel.
	Setting too close to normal leakage current.	Ground fault level should be set at the lowest level possible, but high enough to allow normal operation of the cable.
	⚠ **WARNING**: Fire Hazard. Ground fault trip supervisory must not be ignored. To prevent the risk of fire, do not re-energize heating cables until the fault is identified and corrected.	
Low current	Low or no source voltage.	Verify correct power distribution.
	Damaged or inoperative heating cable.	Repair or replace heating cable.
	Open connection—wiring problem.	Verify correct power distribution wiring.
	Contactor failed open.	Replace or repair controller.
Switch failure	Output switch has failed “closed”.	Replace or repair controller.

Section 5 APPENDIX A: PROPORTIONAL AMBIENT SENSING CONTROL (PASC)

PASC takes advantage of the fact that the heat loss from a pipe is proportional to the temperature difference between the pipe and the ambient air. This is true regardless of heating cable, insulation type, or pipe size. Once the heat tracing and insulation on a pipe has been designed to balance heat input with heat loss and maintain a particular temperature, the main variable in controlling the pipe temperature becomes the ambient air temperature.

The 465 controller has a control algorithm that uses the measured ambient temperature, desired maintain temperature, minimum ambient temperature assumption used during design, and size of the smallest pipe diameter to calculate how long the heating cable should be on or off to maintain a near-constant pipe temperature. The power to the heat tracing is proportioned based upon on the ambient temperature. If the ambient temperature is at or below the “minimum design ambient plus 3°F” the heating cable will be on 100%. If the measured ambient is at or above the “maintain temperature – 3°F” the heating cable will be on 0%. For any measured ambient between “minimum design ambient” and “maintain temperature,” the heating cable will be on a percentage of the time equal to (maintain temperature – measured ambient) / (maintain temperature – minimum design temperature).



Following parameters are used in calculating the duty cycle in PASC:

Setting	Range	Factory Default
Pipe Size (inch):	½, 1 or, ≥ 2	½-
Setpoint:	32 to 104°F (0 to 40°C)	40°F (4°C)
Min. Expected Ambient Temperature:	–40 to 40°F (–40 to 4°C)	20°F (–7°C)
Power Adjust Factor:	10 – 200%	100%

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