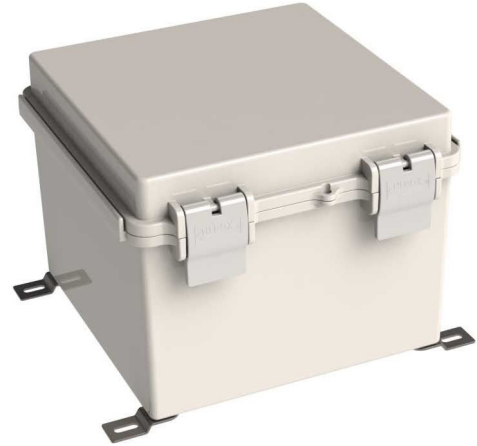




Frio Snow Sensor Installation Guide

AER-1 Aerial Sensor

GUT-1 Gutter Sensor

PVT-1 Pavement Sensor

SM-JB-1 Junction Box and Power Supply



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Key Features

- **Frio S1-A works with up to (6) snow sensors** (S1-A must be on FW version 3.2.0 or later)
- **AER-1 - Aerial Sensor** with anti-nesting spikes
- **GUT-1 - Gutter Sensor** with rust-proof design
- **PVT-1 - Pavement Sensor** installed in ground
- **SM-JB-1 - Junction Box** with power supply that can power up to (6) GUT-1 or AER-1 snow sensors and up to (2) PVT-1 sensors
- **Satellite Contactors** - Configure up to (20) S1-As as satellite contactors for multi-circuit systems
- **Pilot Duty** - Allows one S1-A to control multiple circuits using an external contactor panel



Overview

Frio snow sensors are installed outdoors and detect temperature and the presence of moisture. This provides an indication to the Frio controller that there is snow or ice present. The sensors are compatible with the Frio S1-A controller and communicate to the controller using Modbus. The sensors are connected to a junction box (SM-JB-1) with a 30 feet (10 m.), 24V 4 wires cable (can be extended up to 1000 ft. with 4-wire shielded cable, 18-AWG or larger). The SM-JB-1 junction box includes a 24VAC power supply to provide power to the sensors. From the junction box, the Modbus communication cables are connected to the Frio S1-A controller. The Frio S1-A system can work with any combination of up to (6) total GUT-1, AER-1, or PVT-1 snow sensors. The SM-JB-1 can power up to 6 AER-1 or GUT-1 and up to two PVT-1 snow sensors. Please see the section detailing the SM-JB-1 for additional information on powering the snow sensors.

The Frio system may be configured to control one or more heating circuits. For single circuits, the heater is controlled directly from the Frio S1-A. For multiple circuits, the Frio S1-A can be placed in pilot duty mode and wired to drive a contactor panel which then activates the heating circuits. Alternatively, multiple Frio S1-A controllers can be connected to the primary Frio S1-A controller to act as satellite contractors that turn on when the primary controller calls for heat. For more information on possible configurations check out the section on System Configurations.

Prior to installing the S1-A controller please read the Frio S1 Installation Instructions which can be found at www.frio.co/resources.

For project specific questions or controller inquiries please contact Frio Controls at info@frio.co



NOTE: THE FRIO S1 CONTROLLER, SM-JB-1, AND ALL SNOW SENSORS MUST BE INSTALLED BY A LICENSED ELECTRICIAN OR QUALIFIED PROFESSIONAL IN ACCORDANCE WITH LOCAL AND NATIONAL ELECTRICAL CODES. THE CONTROLLER AND POWER SUPPLY MUST BE CONNECTED TO A CERTIFIED CIRCUIT BREAKER RATED FOR 30 A OR LESS. NO OTHER TYPES OF DEVICES MAY BE PLACED ON THE CIRCUIT BREAKER. REVIEW OPERATIONS MANUAL BEFORE INSTALLATION.

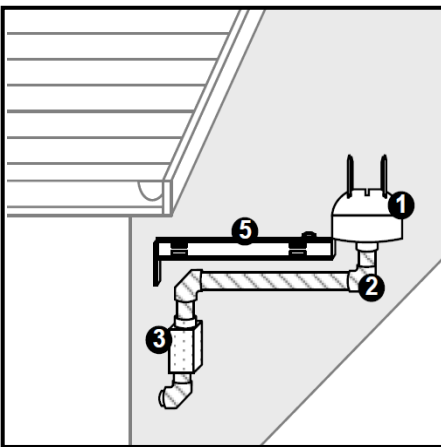
AER-1 Aerial Sensor

The AER-1 is an aerial Snow and Ice sensor. The plastic "igloo" shape design and heated sensor face help to assure reliable snow/ice detection by preventing snow from accumulating around the sensing area. The AER-1 includes four anti-nesting spikes that can be placed holes on the top side of the sensor to keep birds away. The included sensor cap helps to keep the sensing area clean from dust and dirt during summertime when the snow melting system is not in use.

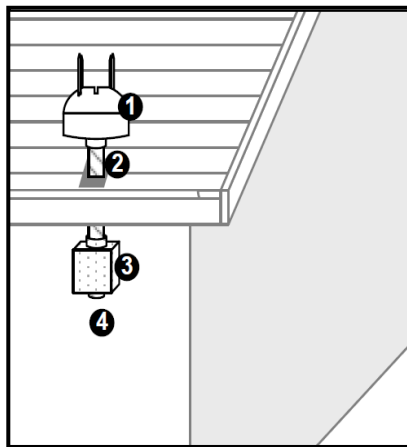
The AER-1 can be mounted on a vertical piece of conduit or by using the optional wall mount bracket (AER-WM). The AER-1 can be mounted on a vertical piece of conduit or by using the optional wall mount bracket (AER-WM).

AER-1 Installation

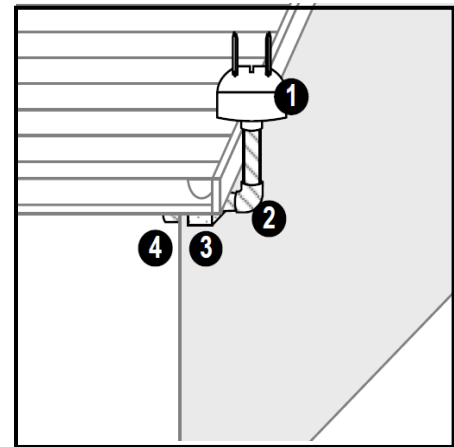
Mount the AER-1 Aerial sensor vertically and in a clear area so that falling snow will land on the sensor.



Wall Mount Installation



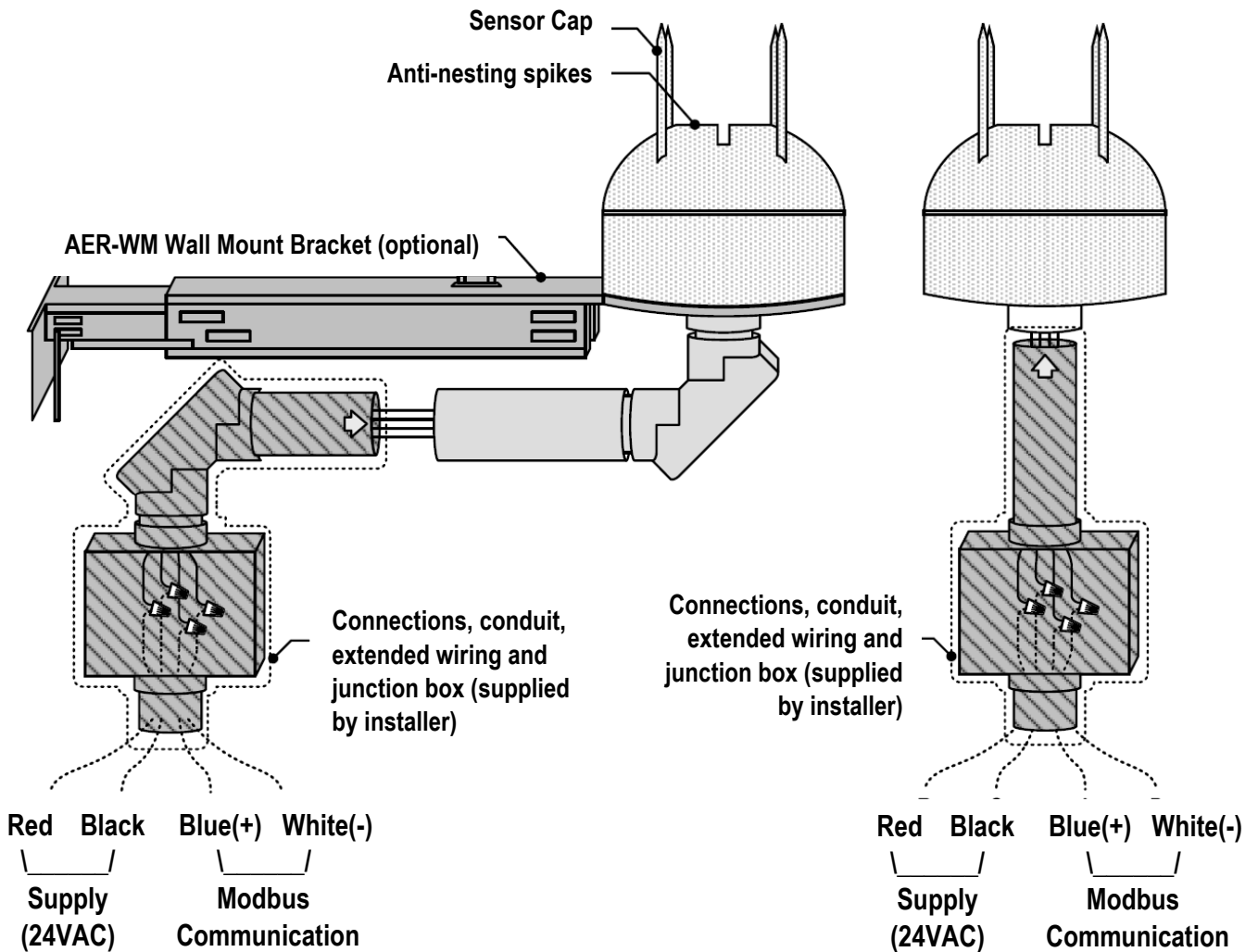
Roof Installation



Roof Side Installation

- 1 AER-1 Aerial Sensor
- 2 Waterproof conduit (supplied by installer). Use non-metallic, UL listed flexible conduit ¾". Maximum length between AER-1 and junction box should not exceed 24".
- 3 Junction Box (supplied by installer)
- 4 Wiring (2 x 24VAC supply, 2 x Modbus Communication)
- 5 AER-WM Mounting Bracket (optional)

AER-1 Wiring Connections

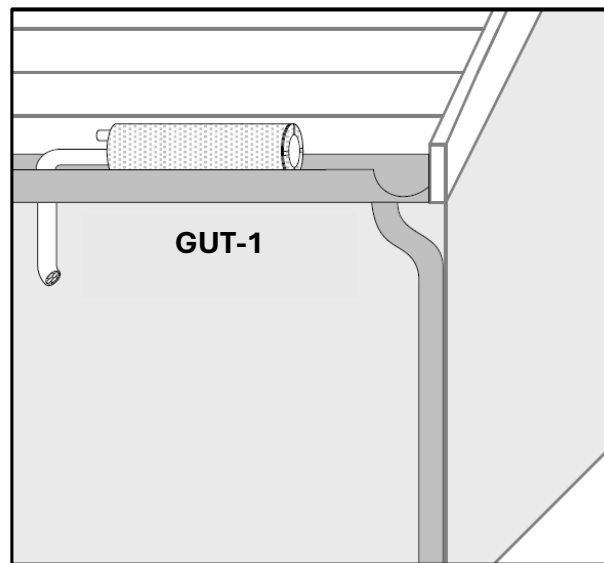


GUT-1 Gutter Sensor

The GUT-1 is a snow and Ice sensor for roof and gutter installations. The rust-proof metallic cylinder shape design and heated sensing face help to assure reliable snow/ice detection by preventing snow from accumulating around the sensing area.

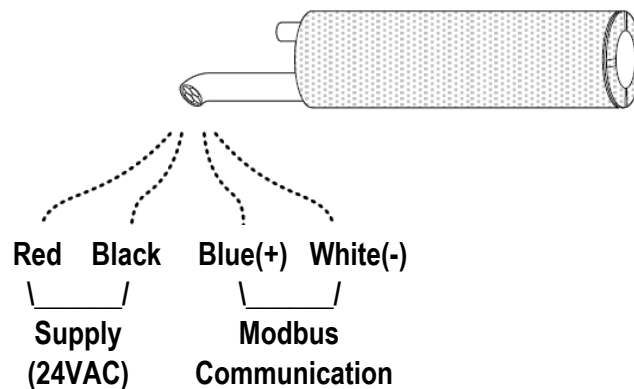
GUT-1 Installation

Mount the GUT-1 gutter sensor horizontally in the bottom of the gutter so that snow, ice, and melt water will contact the sensor face. Take care to protect the sensor wires from damage. Cut or damaged wires can lead to sensor failure.



Gutter Installation

GUT-1 Wiring Connections



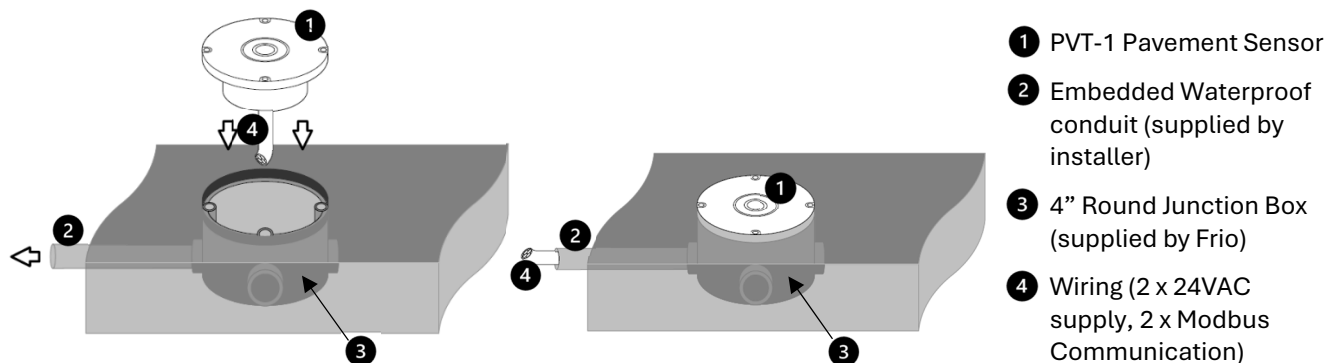
PVT-1 Pavement Sensor

The PVT-1 is a reliable snow and ice sensor for pavement installations. Installed in the ground, it measures detects moisture, and sends a signal to the Frio S1-A controller. The PVT-1 requires an ambient temperature sensor, which can be either the Thermistor which is included with the S1-A or a user provided RTD. The S1-A uses the moisture signal from the PVT-1 in combination with the ambient temperature signal to activate the heating system.

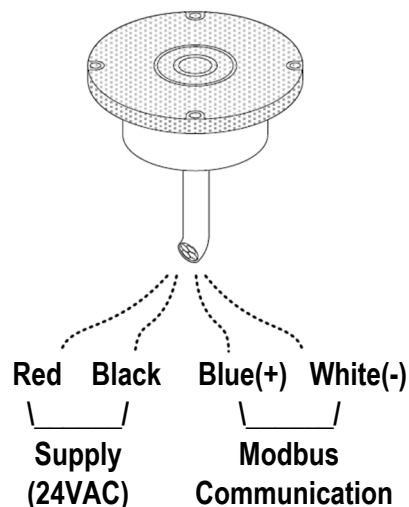
The rust-proof metallic cylinder shape design and heated sensing face help to assure reliable snow/ice detection by preventing snow from accumulating around the sensing area. The sensor is mounted via four screws to a standard PVC 4" diameter round junction box, allowing easy removal for service and maintenance.

PVT-1 Installation

First install the round junction box and conduit in the surface that will be heated (i.e. pavement, driveway, sidewalk, etc.). Ensure the round junction box is mounted such that the PVT-1 Pavement Sensor will be level with the finished surface. When the surface is cured, mount the PVT-1 Pavement sensor into the round junction box and run the sensor cable through the embedded conduit to the SM-JB-1.



PVT-1 Wiring Connections





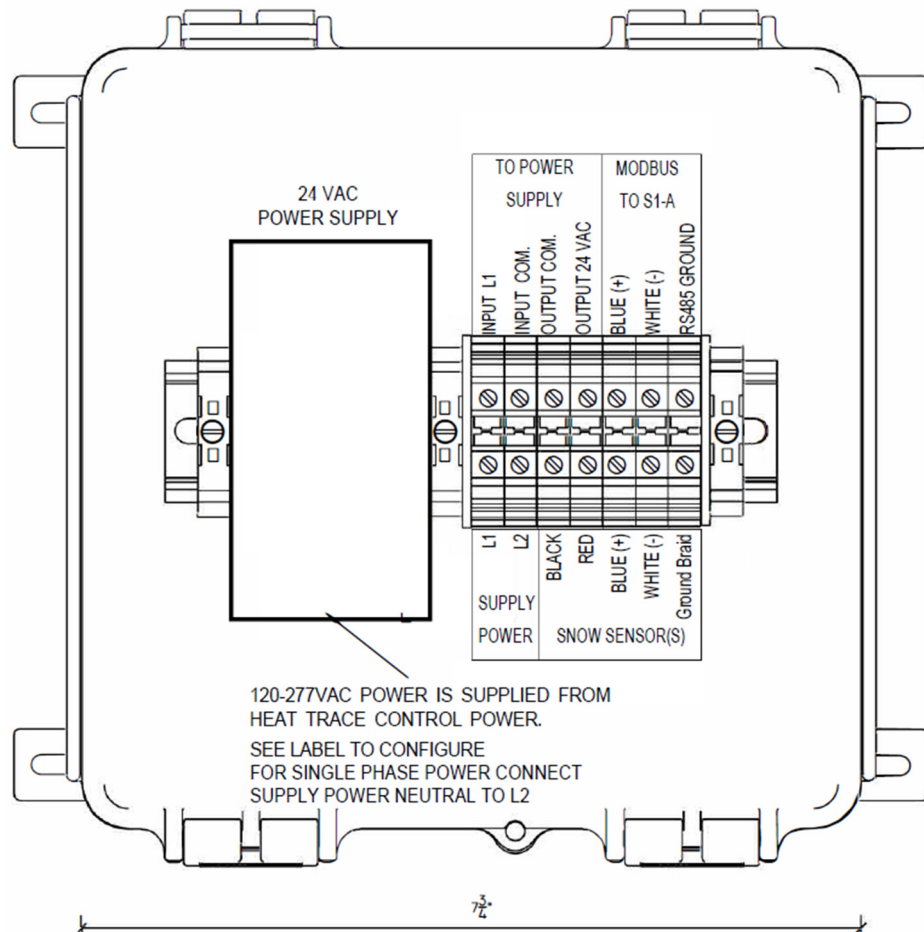
SM-JB-1 Junction Box and Power Supply

The SM-JB-1 is a junction box with a 24VAC power supply to power a heater that prevents the sensor surface from freezing. The JB-SM-1 has terminal blocks to combine multiple snow sensors onto a single RS485 circuit to connect back to the S1-A. You may power the JB-SM-1 using 120VAC, 208VAC, 240VAC, or 277VAC. If you are using single phase power, ensure the neutral is connected to L2. You may power the JB-SM-1 from the same circuit that feeds the S1-A controller. The S1-A can read up to (6) total sensors of any type. However, the SM-JB-1 can only power up to (6) AER-1 or GUT-1 sensors and up to (2) PVT-1 sensors. For systems with multiple PVT-1 sensors, additional JM-JB-1 junction boxes may be required to ensure the sensors receive adequate power. Possible combinations are shown in the table below.

Combinations with (1) SM-JB-1	Combinations with (2) SM-JB-1	Combinations with (3) SM-JB-1
(6) AER-1 or GUT-1 (any mix) (2) PVT-1 (1) PVT-1 and (1) AER-1	(4) PVT-1 (3) PVT-1 and (1) AER-1	(6) PVT-1 (5) PVT-1 and (1) AER-1

SM-JB-1 Installation

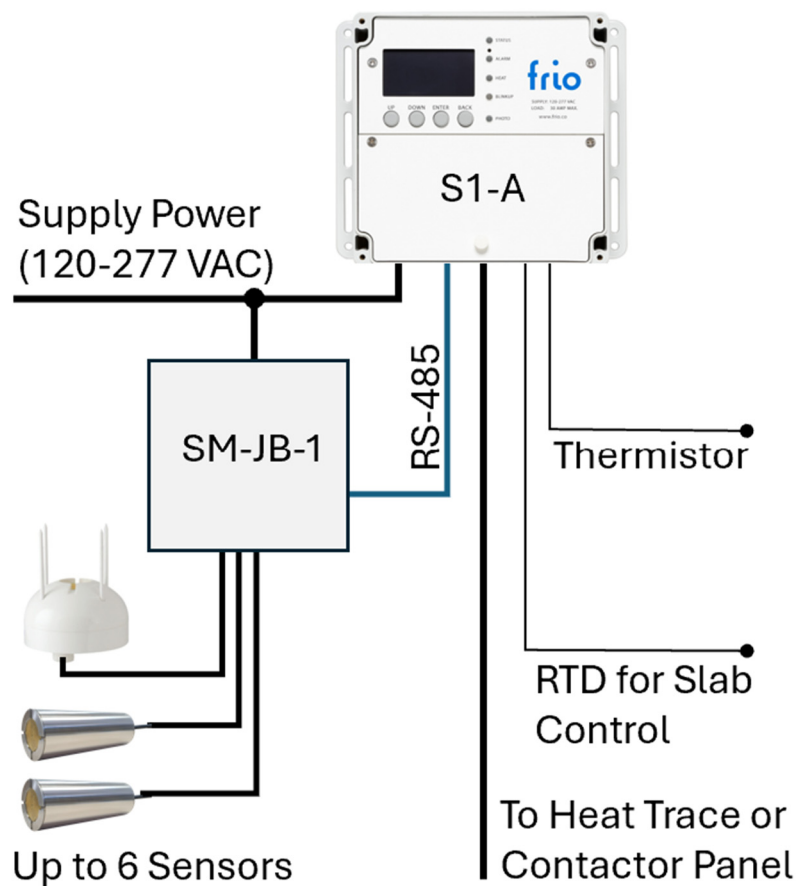
1. Connect all the snow sensor wires that will be connected to the S1-A controller (up to 6 sensors per controller) to the terminal blocks.
2. Connect the SM-JB-1 MODBUS output to the RS485 connection on the S1-A.
3. Read the label on the power supply and connect the correct color primary wire to INPUT L1. Make sure to safe off the unused power supply wires.
4. Connect the Supply Power wires to L1 and L2 (Confirm that if you are using a neutral it is connected to L2).



System Configurations

Single Circuit

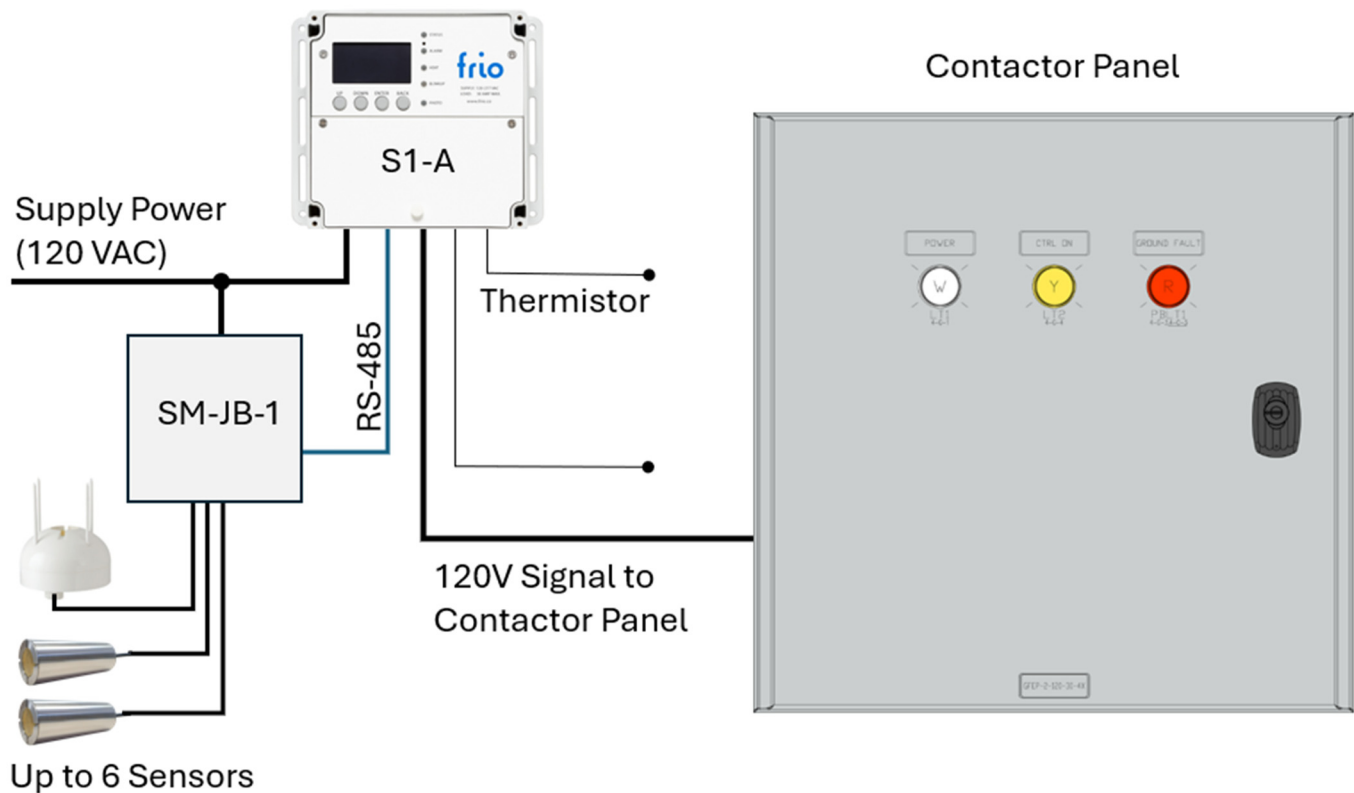
- **Summary:** The primary controller directly controls the heating circuit.
- **Sizing:** 1 circuit per control zone
- **Considerations:** Single circuit control is best for smaller systems and systems where each control zone consists of a single heating circuit which is configured as a primary controller





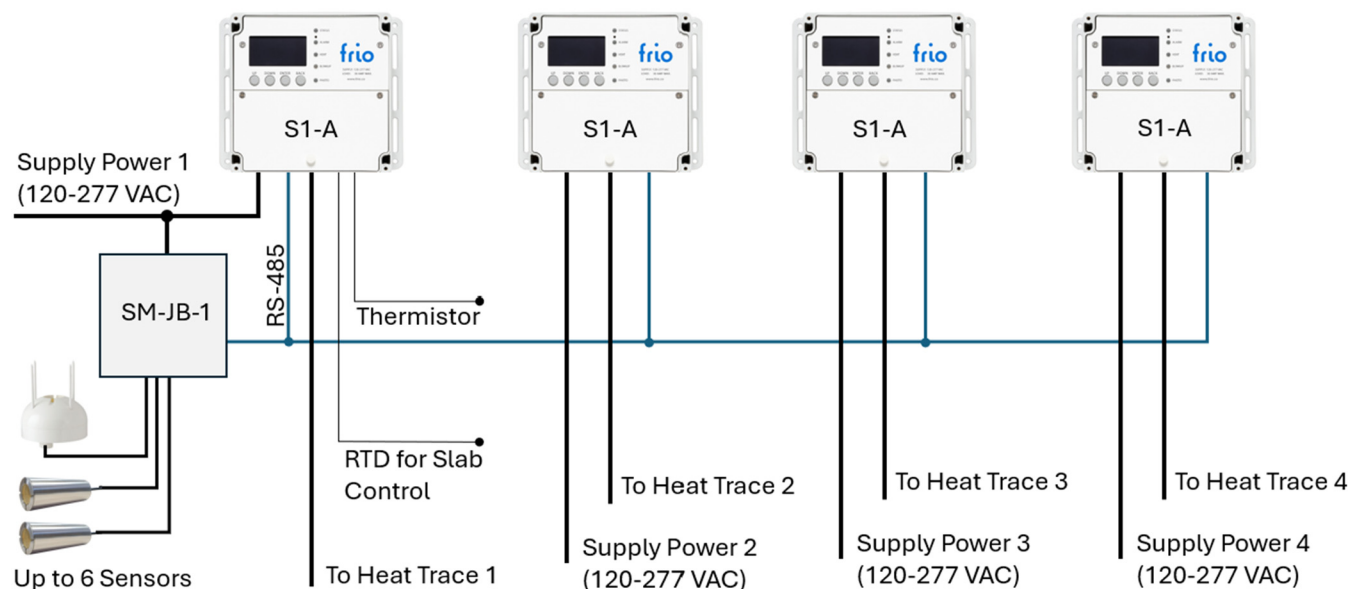
Pilot Duty Mode with Contactor Panel

- **Summary:** Primary controller drives a contactor panel that powers the heating circuits.
- **Sizing:** 2-12 circuits per control zone with Frio panels (12+ circuits with custom panels)
- **Considerations:** Pilot duty mode allows the primary controller to send a 120VAC signal to activate a contactor panel which turns on multiple heating circuits. Frio offers contactor panels with Ground Fault Protection (GFEP) in 2, 4, 6, 8, and 12 circuit configurations. Standard panels include 30A contactors, and custom panels can be built with 40A or 50A contactors. Pilot duty mode works with a wide range of contactor panels available from multiple manufacturers provided they are controlled by a 120VAC relay. To understand whether pilot duty will work with your panel design, or to inquire about custom panels, please contact Frio.



Satellite Contactors

- **Summary:** The primary controller takes the sensor inputs and drives up to (20) additional S1-A controllers configured as satellite contactors. This allows multi circuit systems to run on a single snow sensor. For example, a 6-circuit system could be set up with a single GUT-1 sensor connected to the primary S1-A controller. Five more S1-A controllers would then be connected to the primary S1-A controller as satellite contactors. In this configuration, all six controllers would turn on when the GUT-1 senses snow or ice.
- **Sizing:** 2 to 21 30A circuits per control zone
- **Considerations:** The primary controller must be an S1-A configured as a Modbus client (master). Up to 20 additional S1-As acting as satellite contactors, can then be connected to the primary controller via an RS-485 Modbus connection and configured as servers (slaves). Satellite contactors will mirror the primary controller, turning on when it calls for heat. Each satellite controller must be programmed with a unique Modbus address.



NOTE: Instructions on programming Satellite Contactors can be found on page 14.



Programming the S1-A Controller

NOTE: Frio snow sensors are only compatible with S1-A controllers operating on firmware version 3.2.0 or later. The FW version of your controller can be found under DEVICE INFO. If you have any questions about using your S1-A controller with snow sensors or require a firmware update, please contact Frio Controls.

Prior to programming the S1-A Controller:

1. Install the snow sensors in a suitable location.
2. Install the SM-JB-1 and make all wiring connections.
 - a. Connect all snow sensors to the SM-JB-1.
 - b. Make the 3-wire Modbus RS485 connection between the SM-JB-1 and the S1-A.
 - c. Connect supply power to the SM-JB-1.
3. Install the S1-A (Read the Frio S1 installation Instructions which can be found at www.frio.co/resources).
 - a. Connect supply power to the S1-A.
 - b. Connect the Thermistor or RTD as an ambient temperature sensor if you are using a PVT-1 Pavement Sensor or plan to use a temperature sensor as the primary fallback option. Ensure the sensor is located outdoors where it will read the ambient temperature.
 - c. [Optional] Connect the dry-contact alarm output to your building system (BMS/BAS).

Programming the Primary S1-A Controller

1. Turn on the supply power to the SM-JB-1.
2. Turn on the supply power to the S1-A and wait for the device to boot up.
3. Press any button to enter the MAIN MENU. Use the UP and DOWN buttons to navigate to SNOW SENSORS and press ENTER.
 - a. Select AUTO-DETECT SENSORS and press ENTER.
 - b. Select YES to start the sensor scan. The device will scan for ~10 seconds.
 - c. If sensors are detected they will be displayed on the screen along with the sensor type and address.
 - d. If no sensors are found, the screen will display “(0) sensors detected”.
4. Navigate back to the MAIN MENU and select SETTINGS.
 - a. From the SETTINGS MENU set the control mode to “Local Snow Melt”.
5. Configure the temperature sensors [If you are not using temperature sensors you may skip this step]
 - a. When using the PVT-1 Pavement sensor or Ambient Fallback mode, set either the THERMISTOR or RTD to “Ambient” and configure the SETPOINT and DEADBAND.
 - b. When using Slab Temperature mode, set either the THERMISTOR or RTD to “Slab” and configure the SETPOINT and DEADBAND.
6. Configure the Fallback Mode
 - a. Set the Failure State to ON or OFF. If you do not connect a temperature sensor, the system will fall back into the FAILURE STATE if the connection to the snow sensor is lost. If you connected a temperature sensor in the step above, the device would go into the FAILURE STATE if both the snow sensor and the temperature sensor are lost.
7. [Optional] Configure HIGH/LOW CURRENT alarms from the ADVANCED SETTINGS menu.



Configuring S1-A Satellite Contactors

NOTE: The Frio S1-A controller (primary controller) can drive up to 20 S1-A controllers set up as satellite contactors. The primary S1-A controller must be operating on firmware version 3.2.0 or later. To find the FW version of your controller, press any button to enter the MAIN MENU and navigate to DEVICE INFO. If you have any questions about using your S1-A controller with satellite contactors or require a firmware update, please contact Frio Controls at info@frio.co and provide the device serial number.

Prior to programming S1-A Controllers as satellite contactors:

1. Install the Primary S1-A controller and snow sensors as detailed on the previous page.
2. Install the S1-A satellite contactors. (Read the Frio S1 installation Instructions which can be found at www.frio.co/resources).
3. Make the 3-wire Modbus RS485 connection between the Primary S1-A controller and the S1-A satellite contactors.

Programing the S1-A Controllers as satellite contactor

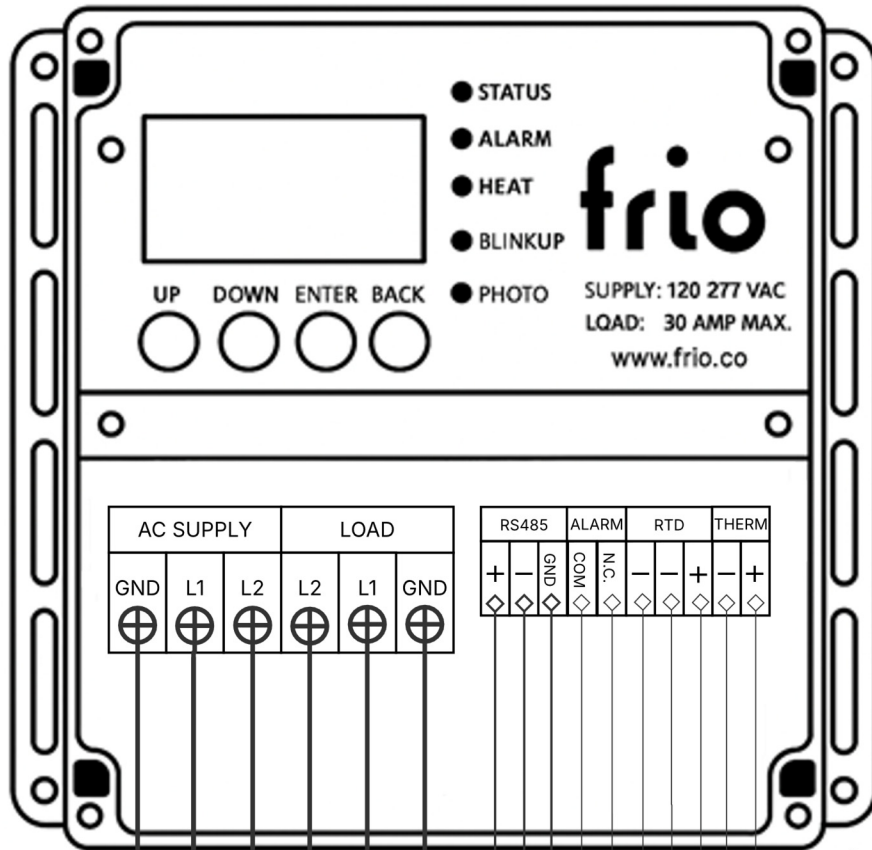
1. Turn on the supply power to all S1-A satellite contactors.
2. Press any button to enter the MAIN MENU. Use the UP and DOWN buttons to navigate to the SETTINGS MENU, and then to the ADVANCED SETTINGS MENU. Select MODBUS and press ENTER to enter the MODBUS MENU. Program the Modbus settings as follows:
 - a. MODE: "Server"
 - b. DEVICE ADDRESS: Assign the device a unique Modbus address in the range of 1-20, inclusive
 - c. BAUD RATE: "38400"
 - d. PARITY: "None"
 - e. STOP BITS: "1"
3. Navigate back to the MAIN MENU and select SETTINGS.
 - a. From the SETTINGS MENU set the control mode to "Always ON".
4. Repeat these steps for each S1-A satellite contactor.



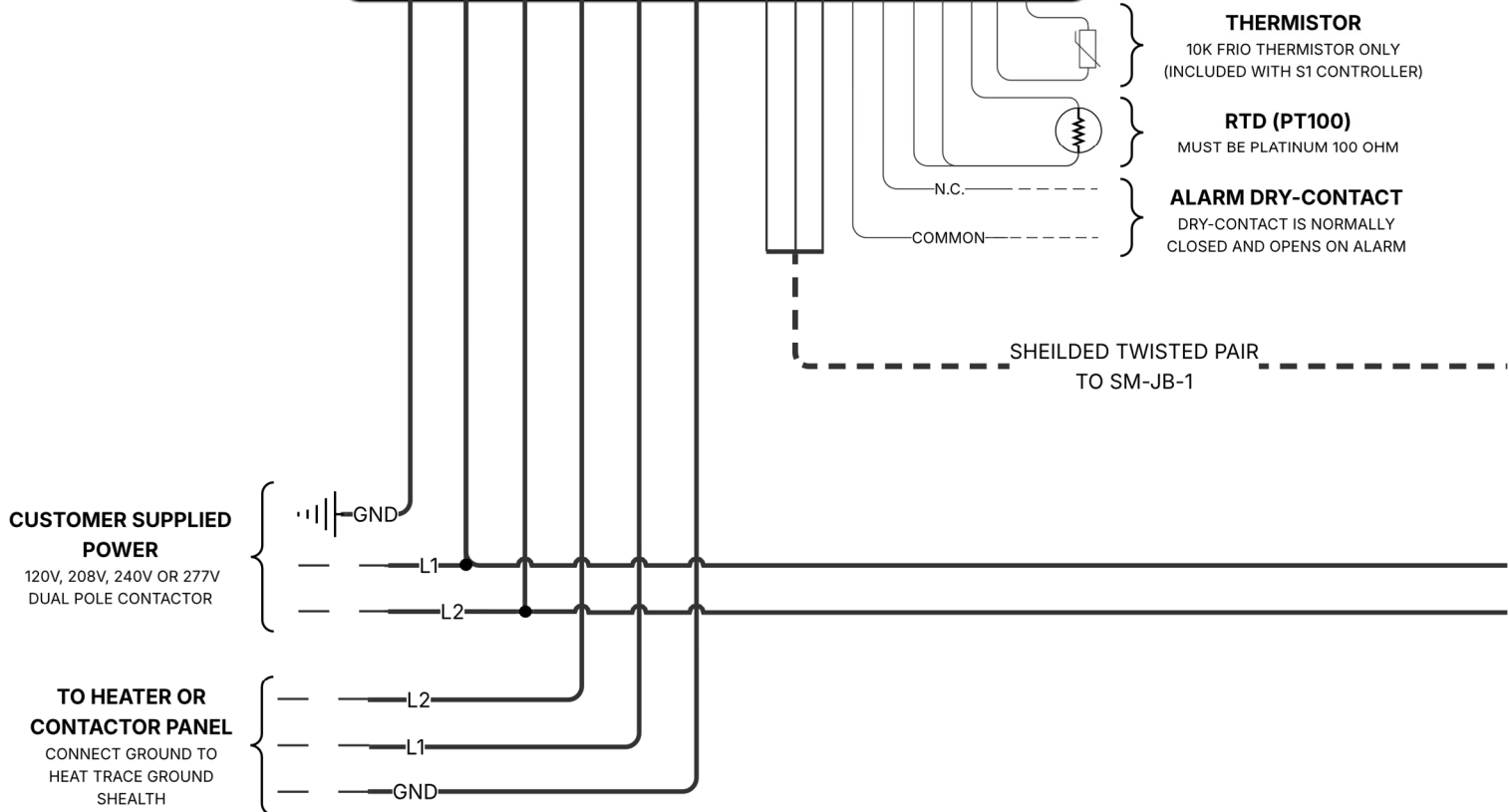
NOTE: Ensure all satellite contactors that are connected to a single S1-A have a unique address.

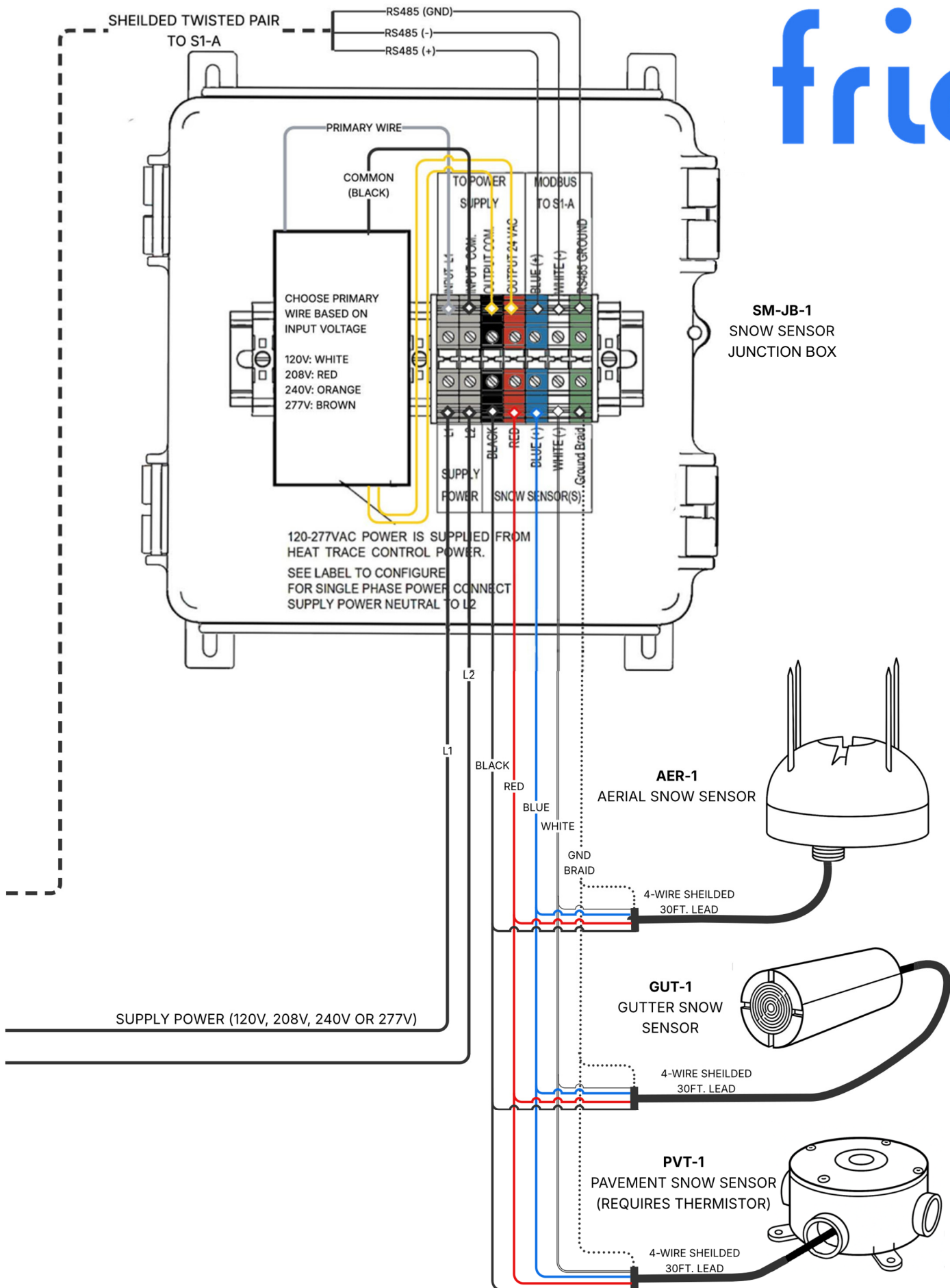
Programing the Primary S1-A Controller

1. Turn on the supply power to the Primary S1-A Controller. Configure snow sensors prior to the next step.
2. Press any button to enter the MAIN MENU. Use the UP and DOWN buttons to navigate to the SETTINGS MENU and then to the ADVANCED SETTINGS MENU. Select SATELLITE CONTACTORS and press ENTER.
3. Select AUTO-DETECT S1's and press ENTER. The device will scan for all available satellite contactors. The scan take approximately 20 seconds.
 - a. If S1s are detected, the screen will display the number of S1s detected. A list of S1s and device addresses will be visible on the Satellite Contactors menu
 - b. If no S1s are detected, the screen will display "zero (0) S1s detected"



FRIO S1-A







Slab Control, Fallback Mode, and Hold on Time

Slab Control

Slab temperature control allows users to maintain the snow melting surface at a constant temperature. This configuration requires a sensor embedded in the slab. The optimal slab temperature setting for your system will depend on heater power, slab depth, and sensor placement. Higher slab temperatures will result in quicker melt out, while lower slab temperatures will result in less energy use and lower operating costs.

For surface melting systems using just an aerial sensor, the thermistor that comes with the Frio S1 can be used as the slab sensor. **For systems using the pavement sensor, the thermistor is used as an ambient temperature sensor and an RTD must be included to be used as the slab temperature sensor.**

Fallback Mode

All snow melt control methods offer two fallback modes in case the sensor or internet connection is lost:

- **Ambient Fallback (Recommended):** When the system is configured with an ambient temperature sensor, it will automatically fall back to ambient control if the sensors or internet connection is lost. This ensures that the system will continue to operate if freezing conditions are present, but will prevent the system from operating during warm weather. This fallback mode provides users time to troubleshoot and fix their system while ensuring the system operates with relative efficiency. The Frio S1-A and S1-B controllers include a thermistor which can be used as the ambient sensor to provide this fallback mode.
- **ON/OFF Fallback:** For systems without an ambient temperature sensor, or in the case where all sensors have failed, users can set a fallback mode of Heater ON or Heater OFF. For critical systems such as egress and gutters, Frio recommends setting this mode to Heater ON. For large, high-power systems such as driveways, Frio recommends this be set to Heater OFF.

Hold-on Time

Frio's snow melt control methods include a user-settable hold-on time which keeps the heating system active after snow is no longer detected. The hold-on time will depend on the system installation and type. It is best to experiment with your system to determine the best hold-on time.

Longer Hold-on Time (6-10 hrs.)

- Critical egress and busy walkways
- Systems in high-snow areas
- Lower powered systems or embedded systems that are buried deep

Shorter Hold-on Time (2-6 hrs.)

- Energy conscious users (i.e. residential driveway)
- High powered systems with quick melt times