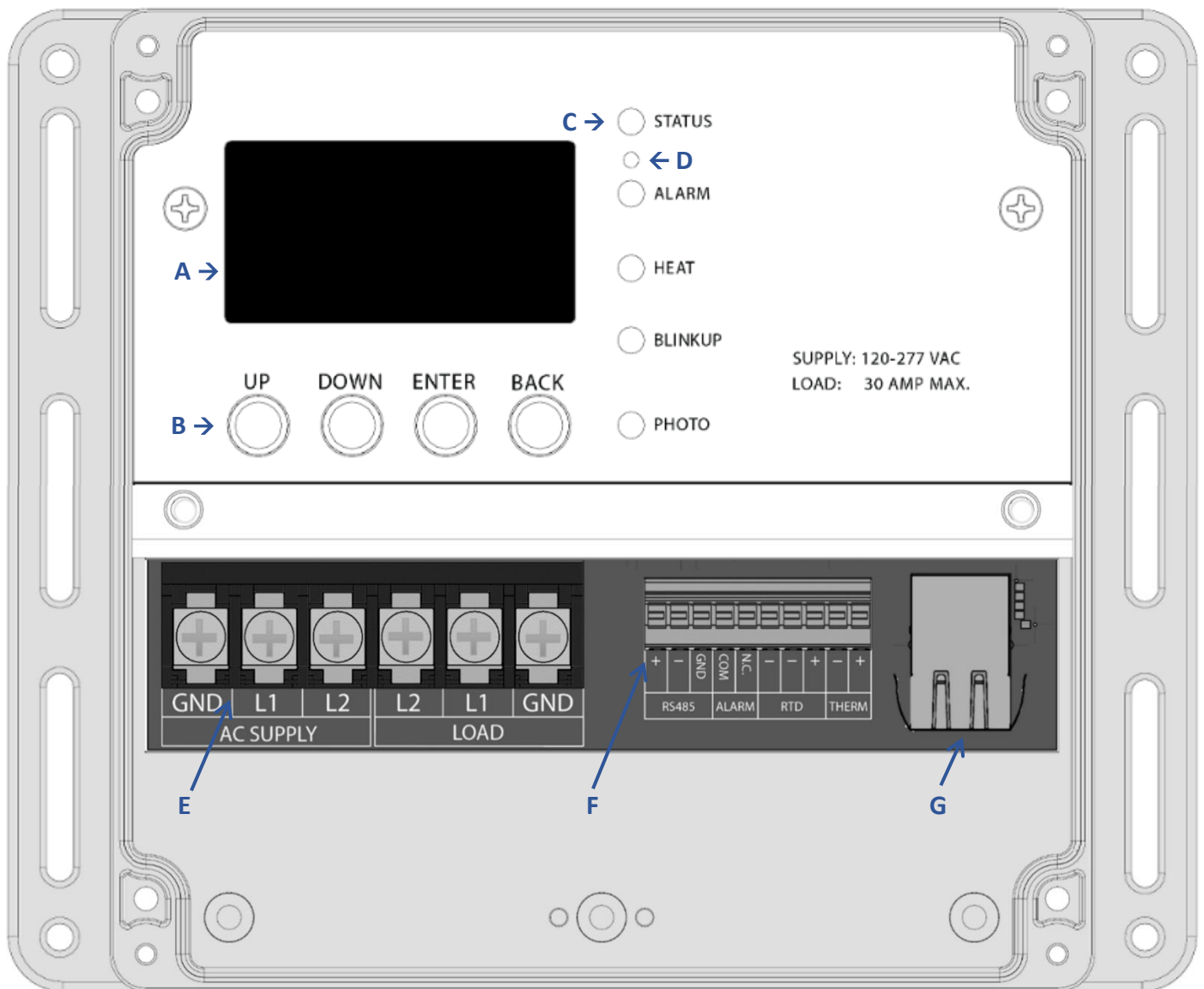




## Controller Operating Manual

# 1 DEVICE DIAGRAM



## HMI (Human Machine Interface)

- A. Screen
- B. Buttons
- C. LEDs
- D. Device Reset

## Wiring Area

- E. High Voltage Connections
- F. Low Voltage Connections
- G. Ethernet Connection

# TABLE OF CONTENTS

|       |                                                |    |
|-------|------------------------------------------------|----|
| 1     | Device Diagram .....                           | 2  |
| 2     | Introduction .....                             | 5  |
| 2.1   | Overview .....                                 | 5  |
| 2.2   | Intended Use.....                              | 5  |
| 2.3   | Disclaimer.....                                | 5  |
| 2.4   | Contact Information.....                       | 5  |
| 3     | S1 System Overview.....                        | 6  |
| 3.1   | Hardware Variants .....                        | 6  |
| 3.1.1 | Frio S1-A: Wi-Fi and Ethernet.....             | 6  |
| 3.1.2 | Frio S1-C: Cellular .....                      | 6  |
| 3.2   | Control Modes .....                            | 6  |
| 3.2.1 | Freeze Protection .....                        | 6  |
| 3.2.2 | Temperature Maintenance .....                  | 6  |
| 3.2.3 | Manual Control .....                           | 7  |
| 3.2.4 | Cloud Control .....                            | 7  |
| 3.3   | Ground Fault Equipment Protection (GFEP) ..... | 7  |
| 3.3.1 | GFEP Overview .....                            | 7  |
| 3.3.2 | Adjusting the GFEP Trip Level .....            | 8  |
| 3.3.3 | Fire Protection Mode .....                     | 8  |
| 3.3.4 | Testing the GFEP circuit .....                 | 8  |
| 3.4   | Communication.....                             | 8  |
| 3.4.1 | S1-A Internet Connection.....                  | 8  |
| 3.4.2 | S1-C Cellular Internet Connection.....         | 11 |
| 3.4.3 | Modbus and BACnet .....                        | 11 |
| 3.4.4 | Dry Contact .....                              | 13 |
| 3.5   | Alarms .....                                   | 13 |
| 3.5.1 | User-Settable Alarms .....                     | 14 |
| 3.5.2 | Sensor Failure Alarm .....                     | 14 |
| 3.5.3 | Power Loss Alarm.....                          | 14 |
| 3.5.4 | Network Loss Alarm .....                       | 14 |
| 3.5.5 | GFEP Alarm.....                                | 14 |
| 3.5.6 | Active Alarms .....                            | 15 |
| 3.5.7 | Resetting Alarms .....                         | 15 |
| 3.6   | Sensors .....                                  | 15 |

|       |                                               |    |
|-------|-----------------------------------------------|----|
| 3.6.1 | RTD .....                                     | 15 |
| 3.6.2 | Thermistor .....                              | 15 |
| 3.7   | Device Info .....                             | 15 |
| 3.8   | System Ratings .....                          | 16 |
| 3.9   | Agency Approvals.....                         | 17 |
| 4     | Installation Instructions .....               | 18 |
| 4.1   | Step 1: Initial Inspection and Planning.....  | 18 |
| 4.2   | Step 2: Assembly and Mounting .....           | 18 |
| 4.3   | Step 3: Low Voltage Connections .....         | 19 |
| 4.4   | Step 4: Heat Trace and Power Connection ..... | 19 |
| 4.5   | Step 5: Start Up and Configuration .....      | 19 |
| 4.6   | Step 6: Internet Connection (BlinkUp).....    | 20 |
| 4.7   | Step 7: Ground Fault Test .....               | 20 |
| 4.8   | GFEP TEST FORM.....                           | 21 |
| 5     | Menus, Navigation and Operation.....          | 22 |
| 5.1   | LEDS.....                                     | 22 |
| 5.2   | Main Screen .....                             | 22 |
| 5.3   | Main Menu.....                                | 22 |
| 5.4   | Settings.....                                 | 23 |
| 5.4.1 | Advanced Settings.....                        | 23 |
| 5.4.2 | Alarm Settings .....                          | 24 |
| 5.4.3 | Default Settings.....                         | 24 |
| 5.5   | Start Up .....                                | 25 |
| 5.6   | Power Loss .....                              | 25 |
| 5.7   | Rebooting the Device.....                     | 26 |
| 5.8   | Clearing Device Settings.....                 | 26 |
| 5.8.1 | Restore Factory Default Settings .....        | 26 |
| 5.8.2 | Clear Network Credentials .....               | 26 |
| 5.9   | Screensaver .....                             | 26 |
| 5.10  | Offline Devices .....                         | 26 |
| 6     | Firmware Upgrades.....                        | 27 |

## 2 INTRODUCTION

This operating manual provides a complete overview of the S1 IoT Heat Trace Controller, including an installation guide and all relevant information required to use the controller. The Frio S1 shall only be used for the purposes described in this manual and must be installed by a trained service professional in compliance with all applicable local electrical codes, according to the instructions contained herein. For more information, including device terms and conditions and limited warranty information, please visit [www.frio.co](http://www.frio.co).

### 2.1 OVERVIEW

The S1 is a single-circuit IoT heat trace controller for snow melting, freeze protection, and temperature maintenance applications. The device can drive up to a 30A resistive load to control electric heat trace systems operating between 100 VAC and 277 VAC. The S1 comes in an outdoor-rated enclosure tested to IP67 standards.

Wi-Fi, Ethernet, and Cellular (available on the S1-C) capability allow the S1 to connect to the Frio cloud platform via the internet, enabling smart, cloud-based control. When connected to the cloud, the S1 will upload system status and receive operational commands. The Frio cloud platform integrates weather data, system feedback, and proprietary control algorithms to automatically maximize system effectiveness and efficiency. Multiple S1 devices can be joined together in the Frio cloud platform, allowing centralized control of multiple heat tracing systems.

The cloud connection enables advanced monitoring and notification of your heating system. Data on key performance characteristics are monitored over time, and anomalies or excursions are flagged and reported. The Frio cloud platform offers customizable SMS and email notifications so that the user can be alerted immediately if there are any issues with the system. Users can access their S1 device remotely via the Frio cloud platform to check status, activate the system, or run a diagnostic test, eliminating the need to physically check the heater control system. If an internet connection is not available, the S1 can operate in an offline configuration.

### 2.2 INTENDED USE



**NOTE: THE FRIO S1 HEAT TRACE CONTROLLER MAY ONLY BE USED TO CONTROL SELF-REGULATING HEAT TRACE, MINERAL INSULATED (MI) HEAT TRACE, OR OTHER TYPES OF UL RECOGNIZED HEAT TRACE THAT ARE DESIGNED TO OPERATE CONTINUOUSLY. THE CONTROLLER MAY BE USED FOR FREEZE PROTECTION, TEMPERATURE MAINTENANCE, AND SNOW MELTING SYSTEMS. THE CONTROLLER MUST BE INSTALLED BY A LICENSED ELECTRICIAN OR QUALIFIED PROFESSIONAL IN ACCORDANCE WITH LOCAL AND NATIONAL ELECTRICAL CODES. THE CONTROLLER MUST BE CONNECTED TO A CERTIFIED CIRCUIT BREAKER RATED FOR 30 A OR LESS, WITH NO OTHER DEVICES ON THE CIRCUIT BREAKER.**

### 2.3 DISCLAIMER

Frio makes absolutely no representations or warranties, either expressed or implied, with respect to the contents of this manual or the products describe herein. Frio specifically disclaims any implied warranties of merchantability or fitness for a particular purpose. Frio does not warrant the products described herein will meet the user's requirements nor does it give any warranty about the results that may be obtained by using the products. Frio reserves the right to make changes or improvements to the products described in this manual and to revise this publication at any time. Frio is under no obligation to notify any person or organization of such changes, improvements, or revisions.

### 2.4 CONTACT INFORMATION

Please send all inquiries to [info@warmzone.com](mailto:info@warmzone.com) or to the address below:

**12637 South 265 West, Suite 100  
Salt Lake City, UT 84020**

## 3 S1 SYSTEM OVERVIEW

The following sections describe the features available on the Frio S1 when operating with Firmware Version 2. For Frio S1 devices operating with different firmware versions, please visit [www.warmzone.com](http://www.warmzone.com) to download the appropriate operating manual. You may check the device firmware under **Device Info** on the **Main Menu**.

### 3.1 HARDWARE VARIANTS

The Frio S1 device is available with two different communication modules, the S1-A with Wi-Fi and Ethernet communication, and the S1-C with Cellular communication. The S1-A is available in two configurations, the S1-A-0001 with all features, and the S1-A-2001 which does not include RS485 local communications or RTD sensing capabilities. To check which device you have, look at the model number located on the product label.

#### 3.1.1 Frio S1-A: Wi-Fi and Ethernet

Both Frio S1-A configurations can connect to the Frio cloud platform via Wi-Fi 802.11 Dual Band 2.4GHz & 5GHz or wired ethernet connection using a Cat 5 or Cat 6 cable. The devices use an FCC certified Wi-Fi Module and have been tested to the requirements laid out in FCC Part 15 Subpart B.

#### 3.1.2 Frio S1-C: Cellular

The Frio S1-A can connect to the Frio cloud platform via cellular connection via multiple carriers. The device uses an FCC certified cellular module and has been tested to the requirements laid out in FCC Part 15 Subpart B.

### 3.2 CONTROL MODES

The S1 device operating on Firmware Version 2 has four available control modes; Freeze Protection, Temperature Maintenance, Manual Control, and Cloud Control. Future firmware versions will include additional control modes. If your device is operating on a firmware version other than Firmware Version 2, please visit [www.warmzone.com/blog/topic/product-literature/](http://www.warmzone.com/blog/topic/product-literature/) for the appropriate operating manual.

#### 3.2.1 Freeze Protection

Freeze protection mode can be used to prevent water in pipe systems from freezing. In freeze protection mode, the S1 will activate the heat trace circuit when the active temperature sensor reads a value below the temperature set point. The S1 will then turn off the heat tracing circuit when the active temperature sensor reads a value above the temperature setpoint plus the dead-band. The dead-band is used to prevent the system from turning on and off rapidly if the temperature hovers near the setpoint. The user may set either the RTD or Thermistor as the active temperature sensor to be used for control. They may also select “Lowest” which will use the lower of the two temperature readings as the control input. Both the temperature setpoint and the dead-band of the system can be set by the user. The dead-band is added to the temperature setpoint such that the system will turn on when the temperature falls below the setpoint and will turn off again once the temperature rises above the setpoint plus the dead-band. Freeze protection mode can be used in either an Ambient sensing configuration or a Pipe sensing configuration. In the Ambient configuration, the active temperature sensor must be placed in a location such that it will accurately detect the lowest ambient temperature the system will see. Do not place the temperature sensor in direct sunlight or near a source of artificial heat such as a vent. In the Pipe sensing configuration, the active temperature sensor should be placed on the pipe on the opposite side from the heat trace.

#### 3.2.2 Temperature Maintenance

Temperature maintenance mode can be used to control a heat tracing system within a set temperature range. In temperature maintenance mode, the S1 will activate the heat trace circuit when the active temperature sensor reads a value below the temperature set point. The S1 will then turn off the heat tracing circuit when the active temperature

sensor reads a value above the temperature setpoint plus the dead-band. The dead-band is used to prevent the system from turning on and off rapidly if the temperature hovers near the setpoint. The user may set either the RTD or Thermistor as the active temperature sensor to be used for control. They may also select “Lowest” which will use the lower of the two temperature readings as the control input. Both the temperature setpoint and the dead-band of the system can be set by the user. The dead-band is added to the temperature setpoint such that the system will turn on when the temperature falls below the setpoint and will turn off again once the temperature rises above the setpoint plus the dead-band. The active temperature sensor must be placed in a location where it can accurately read the temperature of the system.

### 3.2.3 Manual Control

Manual control is available in two options, Always On, or Always Off. In always on mode, the device will remain on indefinitely. In always off mode, the device will not turn on unless the user activates the manual override feature. To manually activate the device using the Force On feature, select **Force System On** from the **Main Menu**, then choose the time that you would like the device to be on. The device may be forced on for 5 minutes, 1 hour, or 24 hours. To cancel the Force On command, select **Cancel Force On** from the **Main Menu**. The Force On feature may also be used with any of the other control modes selected. Users may also force the device on or off via the Frio Cloud platform as described below. Future firmware versions will allow for manual remote activation via a local network over RS485.

### 3.2.4 Cloud Control

Frio S1 devices that are connected to the internet can take advantage of the Frio cloud platform, including cloud-based control. The cloud platform allows users to view device status and operational logs remotely, including information on the connection, heater state, and active and past alarms. Users can perform a remote test/reset from the cloud platform to clear active alarms. Users can also view and adjust device settings from the cloud platform.

Users can control devices from the cloud platform by setting an override which will hold the device ON or OFF for a user-specified period. Overrides can be set for a maximum of 21 days. If a device loses power during the override period, then subsequently regains power, the override will continue until the end of the set override period. An override that was set from the HMI will reset on power loss. An override set from the cloud will survive power loss once the device reconnects and will continue as an override until the end time set by the user is reached.

Freeze protection and snow-melting systems may be controlled automatically via the cloud platform using Frio’s proprietary control algorithms which use a combination of device information and weather data to optimize heater performance and efficiency. For more information on cloud-based snow-melting control please visit the Frio Cloud platform.

## 3.3 GROUND FAULT EQUIPMENT PROTECTION (GFEP)

The Frio S1 device includes integrated Ground Fault Equipment Protection (GFEP) and had been tested to the UL 1053 end product standard. Ground Fault Equipment Protection is designed to shut off power to the heater in the event of leakage current in excess of the GFEP threshold.

### 3.3.1 GFEP Overview

The GFEP circuit measures the sum of the current on the two conductors feeding the heater and compares this value to a set trip level. If the value exceeds the set trip level, the controller will open the relay, shutting off the heating circuit. Since the current flowing out to the heater should equal current flowing back from the heater, measured ground fault current should be near 0 mA. If the value is greater than 0 mA, that is an indication that leakage current is flowing to some other part of the system. Some leakage current can be expected with heat trace; however, systems with high leakage current are dangerous and should not be used. The default setting for the GFEP Trip Level is 30 mA.

### 3.3.2 Adjusting the GFEP Trip Level

The GFEP Trip Level on the Frio S1 controller is adjustable from 30 mA to 300mA. Frio does not recommend setting the GFEP threshold above 30 mA. In limited circumstances and always under the guidance of a licensed electrician, the GFEP threshold may be set to a value above 30 mA. To do this, select **Settings** from the **Main Menu**, then select **Advanced Settings** from the **Settings Menu**. Select **Ground Fault Protection** from the **Advanced Settings Menu**, then select **GFEP Trip Level**. Enter the desired trip level, then confirm to set the GFEP Trip Level.



**NOTE: FRIO DOES NOT RECOMMEND SETTING THE GFEP THRESHOLD ABOVE 30 mA.**

### 3.3.3 Fire Protection Mode

Fire protection mode disables the GFEP circuit such that, in the event of a ground fault condition, the system WILL NOT turn off the heating circuit but will still send an alarm via the dry contact. Fire protection mode is intended to be used only in situations where the user would prefer to damage the heat trace system instead of risking turning off the heating system due to a ground fault condition.



**NOTE: FRIO DOES NOT RECOMMEND USING FIRE PROTECTION MODE TO DISABLE THE GROUND FAULT EQUIPMENT PROTECTION CIRCUIT.**

To enable Fire Protection Mode, select **Settings** from the **Main Menu**, then select **Advanced Settings** from the **Settings Menu**. Select **Ground Fault Protection** from the **Advanced Settings Menu**, then select **Fire Protection Mode**. When Fire Protection Mode is turned on, the GFEP circuit is disabled.

### 3.3.4 Testing the GFEP circuit

To test the GFEP circuit, follow the step-by-step instructions in section 4.7 of this manual.

Periodic testing of the GFEP circuit is required in most settings. The results of the test are to be recorded on a test form such as the one provided with the S1 Installation Instructions in Section 4. The tester shall record on the form the date the test was performed and the results and shall ensure the form is retained by those in charge of the building's electrical installation to be available to the authority having jurisdiction.

## 3.4 COMMUNICATION

The Frio S1 device is capable of communication with the Frio cloud platform when an internet connection is available. The device also supports Modbus communications via a three-wire RS 485 connection and BACnet communications via IP or MS/TP using a third-party gateway (not available on the S1-A-2001). The network connection may be disabled via the HMI.

To disable the network connection, select **Networking** from the **Main Menu**, then select **Turn Off Networking**. You will be asked if you want to **Disable** networking? Select **Yes** to disable the network. To reenale the network connection, follow the same directions and select **Yes** when asked if you want to **Enable** networking.

### 3.4.1 S1-A Internet Connection

The Frio S1-A connects securely to the internet via a Wi-Fi connection or a wired ethernet connection, as described in sections 3.4.1.1 and 3.4.1.2.

#### 3.4.1.1 Ethernet

The S1-A can connect to the Frio cloud platform via an ethernet connection and supports 10Mbps and 100Mbps operation. For firewall requirements, please review section 3.4.1.3 below. Use the Frio Mobile App to configure a Frio S1-A device connected to ethernet via the BlinkUp process.



### 3.4.1.2 Wi-Fi

The Frio S1-A is designed to use 802.11n Wi-Fi operating in the 2.4GHz band or the 5GHz band. It is also compatible with older 2.4GHz 802.11b, 802.11g, and 802.11a networks.

To connect a Frio S1-A device to a Wi-Fi Network use the Frio Mobile App. The mobile app will allow you to configure the device via the BlinkUp process and connect to a Wi-Fi network. BlinkUp will be active for 5 minutes when the device is powered on and will be disabled 10 seconds after the device connects to the network. To manually activate BlinkUp select **Networking** from the **Main Menu**, then select **Rerun BlinkUp**. To clear the Wi-Fi credentials from the device, select **Networking** from the **Main Menu**, then select **Clear Network Credentials**. You will be asked if you want to **Clear All Credentials?** Select **Yes** to clear the Wi-Fi credentials and restart the BlinkUp process.

For security reasons, Frio S1-A devices cannot be configured to operate as a Wi-Fi hotspot (access point). The Frio S1-A is capable of determining what kind of security — WEP, WPA, or WPA2 — is being used by the network it is attempting to connect to. It supports all of these ‘consumer’ security mechanisms.

If you configure a Frio S1-A device to connect to your password-protected Wi-Fi network but subsequently downgrade the security of the network by removing the password, the device will no longer connect to the network. To reconnect, the device must be reconfigured with a blank password. This is by design. It is intended to prevent your device (and other devices on the network) from being ‘captured’ by a rogue Wi-Fi access point masquerading as your network router. It can do this by transmitting the same SSID as your network but at a higher signal strength, but without the password, which the assailant does not know.

The Frio S1-A does not currently support enterprise-level Wi-Fi authentication, 802.1x, which requires that you log in with a username and password as well as the customary SSID. An end-user will not be able to connect a Frio S1-A device in such an environment at this time. There are ways to use the Frio S1-A in enterprise environments, however. Many enterprises provide WPA2 Personal-based networks for guest access and to support other devices, such as network printers, which do not support WPA2 Enterprise. Please check with your IT department.

The Frio S1-A does not support networks that present an HTML form in which the user enters login details before network access is granted. Some consumer routers use this approach, but it is most commonly encountered with public hotspots and some guest networks in corporate environments.

While the Frio S1-A is connecting to a wireless network, the heater will turn off briefly. If the system is calling for heat, the heater will turn back on after either a successful or failed reconnect attempt.

### 3.4.1.3 Static Network Configuration

The Frio S1-A supports static network configurations and access through proxy servers on both WiFi and Ethernet connections. To configure a static network configuration or proxy server, select the appropriate option while setting up your device using the Frio mobile app. The ‘Static IP’ section requires the entry of an IP address, netmask, gateway address and at the address of at least one DNS server, all in quad numeric form, eg. 192.168.0.1. If the connection is not working, try including both the primary and secondary DNS servers. The ‘Proxy’ settings page requires a server address and a port number at minimum.

### 3.4.1.4 Firewall Requirements

The Frio S1-A is a Wi-Fi and Ethernet compatible device that only makes outbound connections. Firewall configuration is required if the firewall stops outbound connections. This is rarely the case in consumer routers but commonplace in corporate environments. The device communication makes use of the ports shown in the table on the following page, which need to be open through a firewall.

| Port  | TCP | UDP | Usage                                                      |
|-------|-----|-----|------------------------------------------------------------|
| 31314 | ✓   |     | Initial device-server connection                           |
| 993   | ✓   |     | Fallback device-server connection #1                       |
| 443   | ✓   |     | Fallback device-server connection #2                       |
| 80    | ✓   |     | Fetch device firmware                                      |
| 53    |     | ✓   | Allow DNS look-ups — Systems with non-default DNS settings |

The S1-A will attempt to connect via TCP port 31314. If this fails, it will attempt to use TCP port 993, which is typically open by default for email traffic. Should both 31314 and 993 be closed, it will try 443. The S1-A does not use UDP. Port 80 is used to request and transfer impOS™ updates. This port is typically open by default for HTTP/HTTPS communications.

### 3.4.1.5 S1-A BlinkUp Codes

The Frio S1-A provides users with information on the internet connection via the BlinkUp LED. The table below includes status codes that can be shown via the BlinkUp LED.

|                                 |                                   |             |                                            |
|---------------------------------|-----------------------------------|-------------|--------------------------------------------|
| Ready for activation            | 500ms                             | 500ms       | Repeat                                     |
| BlinkUp Successful              | For three seconds                 |             |                                            |
| Device waiting for Ethernet     | 500ms                             | 500ms       | 250ms 250ms Repeat                         |
| Searching for Wi-Fi network     | 500ms                             | 500ms       | 500ms 250ms 250ms 250ms Repeat             |
| Joining Wi-Fi network           | 500ms                             | 500ms       | 500ms 250ms 250ms 250ms 250ms 250ms Repeat |
| Getting IP address              | 500ms                             | 250ms 250ms | Repeat                                     |
| Resolving server name           | 500ms                             | 250ms 250ms | Repeat                                     |
| Connecting to server            | 500ms                             | 500ms       | 500ms 250ms Repeat                         |
| Connected to server             | 500ms                             | 500ms       | Repeat                                     |
| Proxy address or port incorrect | 500ms                             | 500ms       | 250ms 250ms 250ms 250ms Repeat             |
| Proxy credentials rejected      | 500ms                             | 500ms       | 250ms 250ms 250ms 250ms 250ms              |
| Device lost connection          | 500ms                             | 500ms       | Repeat                                     |
| Device deliberately offline     | 500ms                             | 250ms 250ms | 250ms Repeat                               |
| Updating Firmware               | Continuous for duration of update |             |                                            |
| Normal operation                | LED not illuminated               |             |                                            |

### 3.4.2 S1-C Cellular Internet Connection

The Frio S1-C connects to the internet via cellular connection as described in the following section. Use the Frio Mobile App to configure a Frio S1-C device via the BlinkUp process. BlinkUp will be active for 5 minutes when the device is powered on and will be disabled 10 seconds after the device connects to the network. To manually activate BlinkUp select **Networking** from the **Main Menu**, then select **Rerun BlinkUp**. After device activation via BlinkUp, the Frio S1-C will automatically connect to a cellular network via LTE bands 2, 4, 5, 12. The Frio S1-C device also has 3G fallback on UMTS bands 5, 4, 2. Typically, the device will take 30 seconds or longer to boot the modem and connect to the cellular network (there is a 120-second timeout in place). If you are using the Frio S1-C for the first time or in a new country, it may take longer. The BlinkUp LED will stop flashing after 180 seconds, which means the status is not visible after this point. Please be patient, especially on first connect, and allow the device several minutes for a first connection. If the first connection does not work, press the device reset button or power cycle the device. If you cannot get the device to connect, try moving the device to an area with a better signal. While the Frio S1-C is connecting to a cellular network, the heater will turn off briefly. If the system is calling for heat, the heater will turn back on after either a successful or failed reconnect attempt.

#### 3.4.2.1 S1-C BlinkUp Codes

The Frio S1-C provides users with information on the cellular connection via the BlinkUp LED. The table below includes status codes that can be shown via the BlinkUp LED.

|                             |                                   |       |        |       |        |       |        |        |        |        |
|-----------------------------|-----------------------------------|-------|--------|-------|--------|-------|--------|--------|--------|--------|
| Ready for activation        | 500ms                             | 500ms | Repeat |       |        |       |        |        |        |        |
| BlinkUp Successful          | For three seconds                 |       |        |       |        |       |        |        |        |        |
| Waiting for modem           | 500ms                             | 500ms | 500ms  | 250ms | Repeat |       |        |        |        |        |
| Waiting for SIM             | 500ms                             | 500ms | 500ms  | 250ms | 500ms  | 250ms | 500ms  | 250ms  | Repeat |        |
| Registering with a cell     | 500ms                             | 500ms | 500ms  | 250ms | 250ms  | 250ms | 500ms  | Repeat |        |        |
| Cell Registration Denied    | 500ms                             | 500ms | 500ms  | 500ms | 500ms  | 500ms | Repeat |        |        |        |
| Connecting via PPP          | 500ms                             | 500ms | 500ms  | 250ms | Repeat |       |        |        |        |        |
| Checking PPP connection     | 500ms                             | 500ms | 500ms  | 250ms | 250ms  | 250ms | 250ms  | 250ms  | 500ms  | Repeat |
| Connected to server         | 500ms                             | 500ms | Repeat |       |        |       |        |        |        |        |
| Device lost connection      | 500ms                             | 500ms | Repeat |       |        |       |        |        |        |        |
| Device deliberately offline | 500ms                             | 250ms | 250ms  | 250ms | Repeat |       |        |        |        |        |
| Updating Firmware           | Continuous for duration of update |       |        |       |        |       |        |        |        |        |
| Normal operation            | LED not illuminated               |       |        |       |        |       |        |        |        |        |

### 3.4.3 Modbus and BACnet (not available on the S1-A-2001)

The Frio S1 Heat Trace Controller can is capable of BACnet IP and BACnet MS/TP communication via an SMC Gateway (FS-EZ3-MOD-BAC). The Frio S1 features a Modbus RTU Slave Interface to allow communication to the SMC Gateway. Up to 20 S1 controllers can be serially connected to one SMC Gateway. A list of BACnet objects available for each Frio S1 controller is included on the following page. For the more information on BACnet, contact us at [info@warmzone.com](mailto:info@warmzone.com).

### 3.4.3.1 BACnet Points List

| Object     | Name               | Type          | Units    | Range/Options                                                                                      | Read/<br>Write | Description                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|------------|--------------------|---------------|----------|----------------------------------------------------------------------------------------------------|----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>AI1</b> | Current            | Analog Input  | Amps     | 0-50 A                                                                                             | R              | Current consumption of connected heat trace.<br><i>NOTE: The controller is only rated to 30 A</i>                                                                                                                                                                                                                                                                                                                                                      |
| <b>AI2</b> | Voltage            | Analog Input  | Volts AC | 0-300 V                                                                                            | R              | Voltage measurement from power supply to controller.<br><i>NOTE: The controller is only rated to 277 V</i>                                                                                                                                                                                                                                                                                                                                             |
| <b>AI3</b> | RTD Temp C         | Analog Input  | °C       | -100°C to 600°C                                                                                    | R              | Temperature reading from RTD in Celsius, if connected.<br><i>NOTE: If RTD is not connected the read value will be 65535.</i>                                                                                                                                                                                                                                                                                                                           |
| <b>AI4</b> | Thermistor Temp C  | Analog Input  | °C       | -40°C to 105°C                                                                                     | R              | Temperature reading from thermistor in Celsius, if connected.<br><i>NOTE: If Thermistor is not connected the read value will be 65535.</i>                                                                                                                                                                                                                                                                                                             |
| <b>AI5</b> | RTD Temp F         | Analog Input  | °F       | -148°F to 1112°F                                                                                   | R              | Temperature reading from RTD in Fahrenheit, if connected.<br><i>NOTE: If RTD is not connected the read value will be 65535.</i>                                                                                                                                                                                                                                                                                                                        |
| <b>AI6</b> | Thermistor Temp F  | Analog Input  | °F       | -40°F to 221°F                                                                                     | R              | Temperature reading from thermistor in Fahrenheit, if connected.<br><i>NOTE: If Thermistor is not connected the read value will be 65535.</i>                                                                                                                                                                                                                                                                                                          |
| <b>AI7</b> | Controller Mode    | Analog Input  | No Units | 0 = ALWAYS_OFF<br>1 = ALWAYS_ON<br>2 = THERMOSTAT_FP<br>3 = THERMOSTAT_TM<br>4 = CLOUD_CONTROL     | R              | Current controller setting.<br><ul style="list-style-type: none"> <li>ALWAYS_OFF = Local manual control heater is always OFF.</li> <li>ALWAYS_ON = Local manual control heater is always ON.</li> <li>THERMOSTAT_FP = Local thermostat control for freeze protection</li> <li>THERMOSTAT_TM = Local thermostat control for temperature maintenance</li> <li>CLOUD_CONTROL = Cloud-based control for all smart control modes</li> </ul>                 |
| <b>AI8</b> | State              | Analog Input  | No Units | 0 = CLOUD_CONTROL<br>1 = LOCAL_CONTROL<br>2 = OVERRIDE<br>3 = CRITICAL_ERROR<br>4 = MODBUS_CONTROL | R              | Current operational state of the control state machine. See the table on the following page for possible State/Sub-state combinations.                                                                                                                                                                                                                                                                                                                 |
| <b>AI9</b> | Sub-state          | Analog Input  | No Units | 0 = THERMOSTAT_FP<br>1 = THERMOSTAT_TM<br>2 = ALWAYS_ON<br>3 = ALWAYS_OFF<br>4 = CLOUD_CONTROL     | R              | Current operational sub-state of the control state machine. See the box on the following page for possible State/Sub-state combinations.                                                                                                                                                                                                                                                                                                               |
| <b>BI1</b> | Alarm              | Binary Input  | No Units | 0 = No Alarms<br>1 = One or more alarms present                                                    | R              | Alarm summary indicating whether any alarms are present on the device.                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>BI2</b> | Heater Relay State | Binary Input  | No Units | 0 = Relay is open, heater is OFF<br>1 = Relay is closed, heater is ON                              | R              | Current state of the heater.                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>AO1</b> | Force On/Off       | Analog Output | No Units | 0=DO_NOTHING<br>1=FORCE_ON<br>2=FORCE_OFF                                                          | R/W            | Forces relay into On/Off state, ignoring the device's control mode.<br><ul style="list-style-type: none"> <li>DO_NOTHING = Device will operate according to the control mode in settings</li> <li>FORCE_ON = Device will enter the MODBUS_CONTROL/ALWAYS_ON State/Sub-state</li> <li>FORCE_OFF = Device will enter the MODBUS_CONTROL/ALWAYS_OFF State/Sub-state</li> </ul> <i>NOTE: Modbus override takes priority over local and cloud override.</i> |

### 3.4.3.2 Device State/Substate Table

| State          | Sub-State     | Description                                                                                                                                      |
|----------------|---------------|--------------------------------------------------------------------------------------------------------------------------------------------------|
| CLOUD_CONTROL  |               |                                                                                                                                                  |
|                | CLOUD_CONTROL | Device online and controlled by the Frio Cloud Platform                                                                                          |
|                | THERMOSTAT_FP | Offline fallback to thermostat control for freeze protection                                                                                     |
|                | THERMOSTAT_TM | Offline fallback to thermostat control for temperature maintenance                                                                               |
|                | ALWAYS_ON     | Offline fallback to always ON                                                                                                                    |
|                | ALWAYS_OFF    | Offline fallback to always OFF.                                                                                                                  |
| LOCAL_CONTROL  |               |                                                                                                                                                  |
|                | THERMOSTAT_FP | Local thermostat control for freeze protection                                                                                                   |
|                | THERMOSTAT_TM | Local thermostat control for temperature maintenance                                                                                             |
|                | ALWAYS_ON     | Local manual control heater is always ON.                                                                                                        |
|                | ALWAYS_OFF    | Local manual control heater is always OFF                                                                                                        |
| OVERRIDE       |               |                                                                                                                                                  |
|                | ALWAYS_ON     | Heater ON due to Local or Cloud override command                                                                                                 |
|                | ALWAYS_OFF    | Heater OFF due to Local or Cloud override command                                                                                                |
| CRITICAL_ERROR |               |                                                                                                                                                  |
|                | ALWAYS_OFF    | The system has a critical error and the heater is OFF<br><br>NOTE: User must perform a manual test/reset cycle to exit the critical error state. |
| MODBUS_CONTROL |               |                                                                                                                                                  |
|                | ALWAYS_ON     | Heater is ON due to Modbus force on command                                                                                                      |
|                | ALWAYS_OFF    | Heater is OFF due to Modbus force off command                                                                                                    |

### 3.4.4 Dry Contact

The Frio S1 is equipped with a dry contact to provide users with a low voltage alarm output option. The dry contact is normally closed and opens when the Frio S1 has an alarm signal or losses power. The contacts are rated for 2 A maximum at 250 VAC and are compatible with 14-24 AWG wires. Users can set which alarms are enabled as described in the following section. All enabled alarms will activate the dry contact.

## 3.5 ALARMS

The Frio S1 has eight alarms described in the following sections. If an alarm is present the Alarm LED will light up and the normally closed dry contact will open. There are four user-settable alarms: *High Current*, *Low Current*, *High Temperature*, and *Low Temperature*. There are three system alarms which are automatically enabled and cannot be configured by the user: *Sensor Failure*, *Power Loss*, and *Network Loss*. Lastly there is the Ground Fault Equipment Protection alarm (*GFEP Alarm*). Online systems may be configured to notify users of alarm conditions through the Frio cloud platform. Users may also use the cloud platform to view information about each alarm. All alarms must be reset at the device via the HMI.

A summary of available alarms is available in the table below.

| Alarm            | Type          | Default Enabled | Default Threshold | Range     | Increment | Delay   | Default Delay |
|------------------|---------------|-----------------|-------------------|-----------|-----------|---------|---------------|
| Low Current      | User-Settable | No              | 0.1 A             | 0-30 A    | 0.1 A     | 0-500 s | 5 s           |
| High Current     | User-Settable | Yes             | 30 A              | 0-30 A    | 0.1 A     | 0-500 s | 300 s         |
| Low Temperature  | User-Settable | No              | 28 °F             | 0-300 °F  | 1 °F      | 0-500 s | 300 s         |
| High Temperature | User-Settable | No              | 140 °F            | 0-300 °F  | 1 °F      | 0-500 s | 300 s         |
| Sensor Failure   | System Alarm  | Yes             | False             | -         | -         | No      | -             |
| Power Loss       | System Alarm  | Yes             | False             | <50 VAC   | -         | 3s      | 3s            |
| Network Loss     | System Alarm  | Yes             | False             | -         | -         | 1 hr    | 1 hr          |
| GFEP Trip        | GFEP          | Yes             | 30 mA             | 30-300 mA | 5 mA      | No      | -             |

### 3.5.1 User-Settable Alarms

User-settable alarms are designed to provide the user with a method to monitor their system and to understand if the system is operating outside of normal bounds. These alarms may be enabled or disabled via the HMI and include *High Current*, *Low Current*, *High Temperature*, and *Low Temperature*. Enabled alarms will open the dry contact when set. With the exception of *High Current*, user-settable alarms are not enabled by default and must be enabled by the user. To configure user-settable alarms, select **Settings** from the **Main Menu**, then select **Advanced Settings** from the **Settings Menu**. Select **Alarms** from the **Advanced Settings Menu**, then select the alarm you would like to adjust.

For each user-settable alarm, you will be able to enable the alarm, set the threshold, and set the delay. The delay is provided to reduce nuisance alarms. When using the *High Current* alarm with self-regulating heat trace, it is highly recommended to use a delay of at least 300s to avoid alarming due to inrush current when the heat trace is activated. The *High Current* alarm is a critical alarm and will shut off the heater automatically if the alarm is enabled. It is also a latching alarm and must be reset via the HMI. Non-critical user-settable alarms (*Low Current*, *High Temperature*, and *Low Temperature*) may be set to Latching or Non-latching in the alarm settings. This setting will apply to all enabled non-critical alarms. Non-latching alarms are automatically reset when the alarm condition is resolved.

### 3.5.2 Sensor Failure Alarm

The *Sensor Failure* alarm is a critical alarm that is enabled if the device is in a control mode that relies on a local temperature sensor. If the sensor fails, the device will go into the failure state. To configure the failure state, select **Settings** from the **Main Menu**, then select **Failure State** from the **Settings Menu**. The failure state may be set to ON or OFF. The default setting for the failure state is ON. If the sensor returns to normal operation, the system will revert from the failure state and resume using the sensor for control. However, the *Sensor Failure* alarm is latching, so the alarm will remain present until it is reset via the HMI. If the device is set to “Lowest” and one sensor fails, the device will use the other sensor and display a Sensor Failure Alarm. If both sensors fail, the device will enter the failure state.

### 3.5.3 Power Loss Alarm

In the event of a power loss, or if the supply voltage drops below 50 VAC for more than 3 seconds, the device will enter power loss mode. In power loss mode, the normally closed dry contact will open and the HMI will display “POWER LOSS” until the onboard supercapacitor empties. A “last-gasp” communication is sent to the cloud platform on connected systems. This enables the device to tell the cloud that it has lost power. When the device is reconnected to power, the power loss alarm is automatically reset. More information on power loss mode can be found in section 5.6.

### 3.5.4 Network Loss Alarm

If the device has been through BlinkUp and networking is enabled, the network loss alarm will be enabled and a loss of network will trigger an alarm. There is a one-hour delay to prevent nuisance alarming if the network drops momentarily. If the device is in a cloud control mode and the network is lost, it will revert to a preselected local control mode.

### 3.5.5 GFEP Alarm

When the ground fault current exceeds the GFEP Trip Level, the GFEP system will alarm, open the dry contact, and shut off the heating system. The GFEP alarm is a critical alarm that is latching and must be reset by the user via the HMI where it will show under Active Alarms as GFEP Trip. When the alarm is reset by a user, the device will automatically run a GFEP test and must pass in order to clear a GFEP alarm.

When the device is in fire protection mode, the system will not turn off the heating system when the ground fault current exceeds the GFEP Trip Level, but the system will still activate the GFEP alarm and open the alarm dry contact.

In this case, the GFEP alarm will be latching and must be cleared via the HMI where it will show under Active Alarms as GF High Current.

### 3.5.6 Active Alarms

Active alarms can be viewed from the HMI by selecting **Active Alarms** from the **Main Menu**. The active alarm page on will display all active alarms. The user may select an alarm to view: *Duration* (the time since the alarm condition started), *Returned?* (whether the alarm condition ceased/returned to normal).

### 3.5.7 Resetting Alarms

To reset the alarms, select **Active Alarms** from the **Main Menu**, then select **Reset All**. You will then be prompted to **Test/Reset Now**, select **Yes** to initiate a GFEP test and reset the alarm conditions. The GFEP test must be successful in order to reset the alarms.

## 3.6 SENSORS

The Frio S1 device includes internal sensors that monitor supply voltage, operating current, and ground fault current. Information from these sensors is used for control of the system, system monitoring, alarms, and GFEP. The Frio S1 also includes two optional external temperature sensors: an RTD and a thermistor.

### 3.6.1 RTD (not available on the S1-A-2001)

The Frio S1-A-0001 and the S1-C are compatible with all 3 wire pt100 RTDs. RTD lead wires must be 18-24 AWG shielded twisted pair. The Frio S1-A-2001 does not accept an RTD input.

### 3.6.2 Thermistor

The Frio S1 should only be used with the Frio thermistor. The Frio thermistor is a 10k NTC thermistor with  $\pm 1\%$  accuracy. The Frio thermistor has an operating range of  $-40^{\circ}\text{C}$  to  $105^{\circ}\text{C}$  and an international protection rating of IP68. The Frio thermistor is RoHS Compatible Thermistors. Each Frio thermistor comes with 2m leads, which may be extended as required using twisted shielded pair 24 AWG wire. The lead wire is black TPE, and the thermistor tip is encapsulated using black TPE.

## 3.7 DEVICE INFO

Device info can be viewed under **Device Info** on the **Main Menu**. Available information includes.

| Device Info | Description                                                                                         |
|-------------|-----------------------------------------------------------------------------------------------------|
| FW Version  | Device firmware version                                                                             |
| P/N         | Device part number                                                                                  |
| S/N         | Unique device serial number                                                                         |
| Device ID   | Unique device ID number                                                                             |
| Networking  | Displays the radio state (ON, OFF)                                                                  |
| Enrolled    | Displays whether the device is enrolled with the Frio Cloud platform (Yes, No)                      |
| Connection  | Connection type, (Wi-Fi, Cellular, Ethernet, or None if not connected )                             |
| IP          | Device IP address (Wi-Fi and Ethernet)                                                              |
| Gateway     | Device gateway address                                                                              |
| DHCP        | The DHCP server's IP address (Wi-Fi and Ethernet)                                                   |
| Network     | The network the devices is currently connected to (Wi-Fi only)                                      |
| rsi         | Received signal strength indicator, a negative value closer to 0 shows stronger signal (Wi-Fi only) |
| Channel –   | The Wi-Fi channel on the router (Wi-Fi only)                                                        |
| Link        | "10M" or "100M". Only present when link detected (Ethernet only)                                    |



### 3.8 SYSTEM RATINGS

|                                                                                                                                                                                            |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Power Ratings</b>                                                                                                                                                                       |
| Supply Voltage: 120 to 277 Nominal VAC 50/60 Hz.                                                                                                                                           |
| Single phase power only (Note: 277 VAC is phase-to-neutral in 480/277 VAC 3- phase)                                                                                                        |
| Double-pole relay is safe for 240 VAC with two hot legs                                                                                                                                    |
| Maximum Load: 30 A resistive                                                                                                                                                               |
| Wire size: 10-18 AWG                                                                                                                                                                       |
| <b>GFEP</b>                                                                                                                                                                                |
| Programable from 30 mA to 300 mA (default 30 mA)                                                                                                                                           |
| Manual and automatic test                                                                                                                                                                  |
| Fire protection mode allows user to disable GFEP                                                                                                                                           |
| <b>Sensor Inputs</b>                                                                                                                                                                       |
| Frio Thermistor: 2-Wire shielded pair 24 AWG leads, 10k NTC thermistor with $\pm 1\%$ accuracy, operating range of -40°C to 105°C, leads and thermistor tip are black TPE, IP68, and RoHS) |
| RTD: Compatible with 3-Wire pt100 RTD lead size 14-24 AWG                                                                                                                                  |
| <b>Low Voltage Outputs</b>                                                                                                                                                                 |
| Dry Contact Alarm: Normally Closed, Open on Alarm (contacts rated for 2 A max at 250 VAC, 14-24 AWG)                                                                                       |
| <b>Connectivity</b>                                                                                                                                                                        |
| S1-A: WI-FI 802.11 Dual Band 2.4 GHz & 5 GHz and Ethernet (RJ45, Cat 5 or 6) See operating manual for firewall information                                                                 |
| S1-C: Cellular only                                                                                                                                                                        |
| TIA/EIA 485 (RS-485): Frio Modbus (Isolated 3-wire 2 x Signal w/ GND, 14-24 AWG)                                                                                                           |
| BACnet MS/TP or IP via third-party gateway provided by Frio                                                                                                                                |
| <b>Enclosure/Environment</b>                                                                                                                                                               |
| Enclosure tested to IP67                                                                                                                                                                   |
| Operating Temperature -30 °C to 70 °C                                                                                                                                                      |
| Dimensions with mounting feet: H: 6.29 in. D: 3.625 in. W: 7.55 in.                                                                                                                        |
| <b>Agency Ratings</b>                                                                                                                                                                      |
| UL 1053, CSA Standard C22.2 No. 14 (Ground-Fault Sensing and Relaying Equipment)                                                                                                           |
| Complies with FCC Part 15 Subpart B                                                                                                                                                        |
| <b>User Interface</b>                                                                                                                                                                      |
| 2.42 in. OLED display 128 x 64 pixels                                                                                                                                                      |
| Four button interface                                                                                                                                                                      |
| Four LEDs with one phototransistor used for BlinkUp process during installation                                                                                                            |
| Menus are in English only                                                                                                                                                                  |
| Imperial or Metric units                                                                                                                                                                   |
| <b>Warranty</b>                                                                                                                                                                            |
| Two-year limited warranty – view more warranty information at <a href="http://www.frio.co/legal">www.frio.co/legal</a>                                                                     |



### 3.9 AGENCY APPROVALS

Both the S1-A and S1-C heat trace controllers conform to UL Standard 1053 and are certified to CSA Standard C22.2 No. 14 for Ground-Fault Sensing and Relaying Equipment.

Both the S1-A and S1-C devices comply with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.



**NOTE: THE S1-A AND S1-C HAVE BEEN TESTED AND FOUND TO COMPLY WITH THE LIMITS FOR A CLASS A DIGITAL DEVICE, PURSUANT TO PART 15 OF THE FCC RULES. THESE LIMITS ARE DESIGNED TO PROVIDE REASONABLE PROTECTION AGAINST HARMFUL INTERFERENCE WHEN THE EQUIPMENT IS OPERATED IN A COMMERCIAL ENVIRONMENT. THIS EQUIPMENT GENERATES, USES, AND CAN RADIATE RADIO FREQUENCY ENERGY AND, IF NOT INSTALLED AND USED IN ACCORDANCE WITH THE INSTRUCTION MANUAL, MAY CAUSE HARMFUL INTERFERENCE TO RADIO COMMUNICATIONS. OPERATION OF THIS EQUIPMENT IN A RESIDENTIAL AREA IS LIKELY TO CAUSE HARMFUL INTERFERENCE IN WHICH CASE THE USER WILL BE REQUIRED TO CORRECT THE INTERFERENCE AT HIS OWN EXPENSE.**

## 4 INSTALLATION INSTRUCTIONS



**NOTE: THE CONTROLLER MUST BE INSTALLED BY A LICENSED ELECTRICIAN OR QUALIFIED PROFESSIONAL IN ACCORDANCE WITH LOCAL AND NATIONAL ELECTRICAL CODES. THE CONTROLLER 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.**

### 4.1 STEP 1: INITIAL INSPECTION AND PLANNING

1. Inspect the Frio S1 controller for any damage that may have occurred during shipping.
2. Layout and plan the heat tracing system, including all sensors, wiring, conduit, and junction boxes.
3. Determine the controller location. The controller should be mounted on a fixed vertical surface. The controller may be mounted outside but should not be mounted in direct sunlight to reduce the chance of condensation forming in the controller.

### 4.2 STEP 2: ASSEMBLY AND MOUNTING

1. Once you have determined the wiring layout and conduit sizes, mark the bottom face of the controller for power and sensor connections. If the controller is mounted outside, use only NEMA Type 4X (or higher) liquid-tight conduit fittings and cable glands.
2. Drill holes on the bottom face of the controller (mount fittings inside of the dashed line shown in Figure 1) and mount your conduit and cable fittings. Do not drill holes within 0.5" of the edge of the enclosure. After drilling the holes, ensure that all plastic shavings have been removed from the controller.
3. Mark hole locations on the vertical surface where you will mount the controller according to the dimensions shown in Figure 2. Ensure the mounting surface is flat, permanent, and the controller is protected from damage.
4. Mount the controller to the vertical surface.

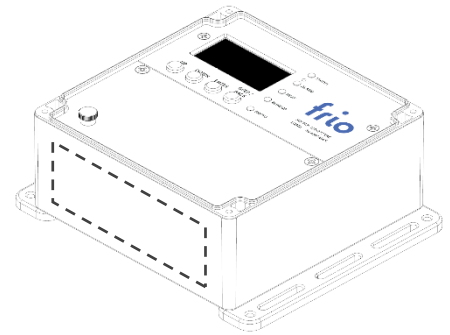


Figure 1: Frio S1 controller showing the bottom side where to drill wiring holes.

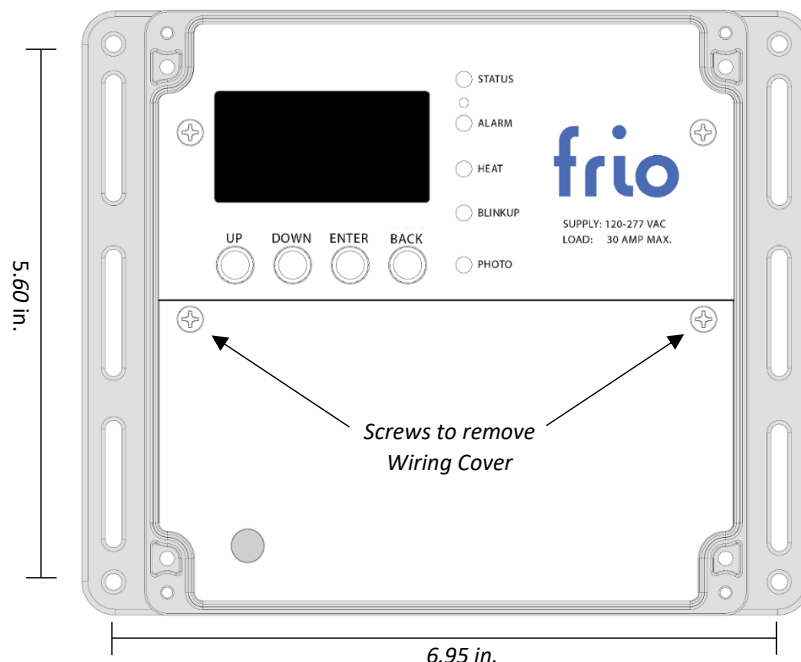


Figure 2: Top View of the Frio S1 controller showing mounting hole dimensions.

### 4.3 STEP 3: LOW VOLTAGE CONNECTIONS

1. Once the controller is mounted, you may remove the clear plastic enclosure cover and the white wiring cover. Always ensure that the wiring cover is in place before energizing the controller.
2. Connect low voltage sensor and communications wires according to the image in Figure 3.
3. For more information on sensor compatibility and setup, please consult the owner's manual.

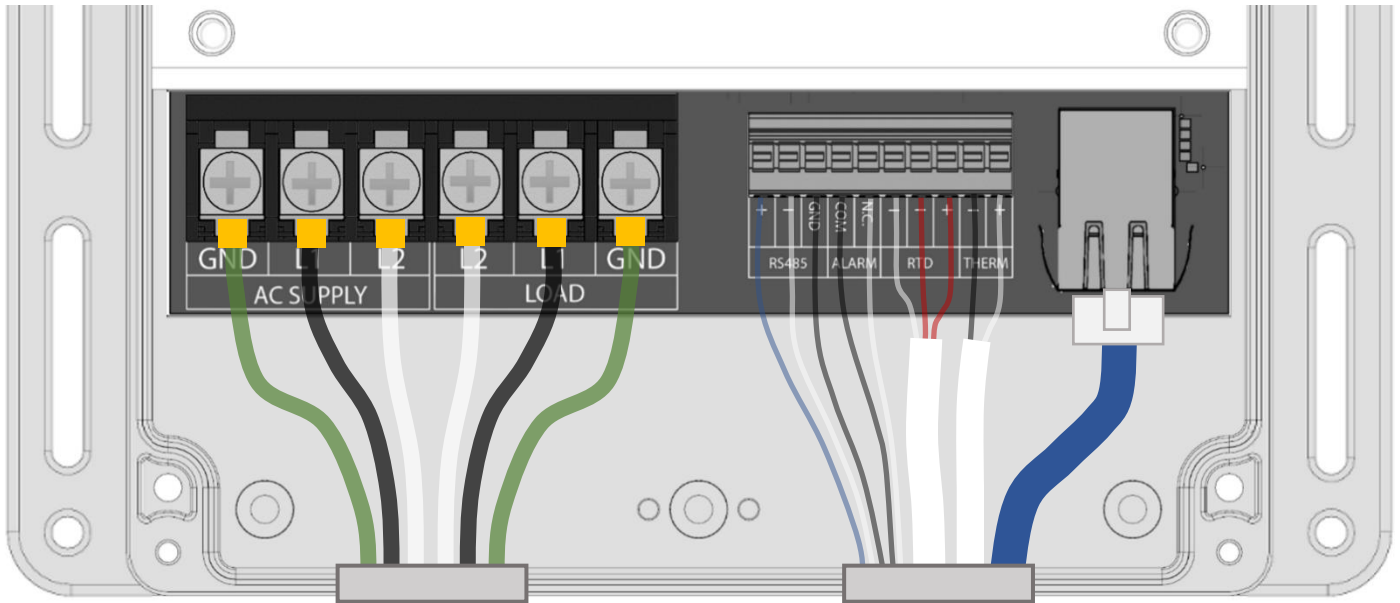


Figure 3: Top view of the Frio S1 controller with the wiring cover removed, showing all possible wiring connections.



**NOTE: THE SYSTEM SHOULD NEVER BE ENERGIZED WHEN THE WIRING COVER IS NOT IN PLACE.**

### 4.4 STEP 4: HEAT TRACE AND POWER CONNECTION

1. Ensure the circuit breaker that will power the controller is turned off.
2. Use a Megger Test device to check the integrity of the heat trace in accordance with the heat trace manufacturer's instructions.
3. Connect heat trace leads as shown in Figure 3. The ground sheath of the heat trace must be connected to the ground terminal on the controller.
4. Connect the power leads as shown in Figure 3. The ground connection on the controller must be properly connected to ground in accordance with local and national electrical codes.
5. All power connections and wires should be installed in accordance with all local and national electrical codes. Use crimp connected spade terminals to ensure proper mounting in the power terminal blocks.

### 4.5 STEP 5: START UP AND CONFIGURATION

1. Close the wiring cover before energizing the system.
2. Energize the system by turning on the circuit breaker for the heat tracing circuit.
3. Press any button to access the **Main Menu**, then select **Settings** to configure the device. Refer to section 5.4 of the S1 Operating Manual for available settings and consult section 3 to determine the control mode and configuration that will best serve your purpose.

#### 4.6 STEP 6: INTERNET CONNECTION (BLINKUP)

1. Download and Login to the Frio App.
2. Complete App Setup and enter all required information.
3. Connect to the S1 Controller via BlinkUp as directed in the Frio App.
4. Follow the in-app instructions to connect the Frio S1 controller to the internet and the Frio Cloud Platform.

#### 4.7 STEP 7: GROUND FAULT TEST

The Frio S1 controller includes built-in Ground Fault Equipment Protection (GFEP). The GFEP circuit must be tested during installation. To test the GFEP circuit, follow the instructions below.

1. Press any button on the controller to enter the **Main Menu**.
2. Select **GFEP Test** and press enter.
3. You will be prompted to **Test GFEP now** to test the GFEP circuit, select **Yes**.
4. The controller will display **RUNNING GFEP TEST** during the test and **TEST SUCCESS** for a successful test. If the test is not successful, the device will display **TEST FAILED**. If the GFEP test fails, turn off the system at the breaker and disconnect the heat trace. Rerun the test with nothing connected to the load terminal blocks. If the test is successful with nothing connected, there is a wiring error or a fault with the heat trace.
5. If the test is successful with heat trace connected, record the test on the GFEP Test Form on the next page, and ensure that the GFEP Test Form is retained by those in charge of the building's electrical installation in order to be available to the authority having jurisdiction.

## 4.8 GFEP TEST FORM

| DATE | GFEP TEST RESULT | TEST PERFORMED BY | COMPANY |
|------|------------------|-------------------|---------|
|      |                  |                   |         |
|      |                  |                   |         |
|      |                  |                   |         |
|      |                  |                   |         |
|      |                  |                   |         |
|      |                  |                   |         |
|      |                  |                   |         |
|      |                  |                   |         |



**NOTE: THIS TEST FORM MUST BE RETAINED BY THOSE IN CHARGE OF THE BUILDING'S ELECTRICAL INSTALLATION IN ORDER TO BE AVAILABLE TO THE AUTHORITY HAVING JURISDICTION.**

## 5 MENUS, NAVIGATION AND OPERATION

Sections 5.1 through 5.4 provide a layout of all available information that can be accessed via the HMI. Press any button to enter the Main Menu and use the UP, DOWN, ENTER, and BACK buttons to navigate through the menus and change settings. For more information, please review the relevant section of the Operating Manual.

Sections 5.5 through 5.6 provide information on what the device does on start up or in the event of a power loss.

Sections 5.7, 5.8, and 5.9 cover rebooting the device, clearing device settings and offline devices.

### 5.1 LEDS

There are 5 LED light pipes on the front faceplate of the Frio S1.

- Status – LED will blink RED if there is an alarm regardless of network status. If there are no alarms present, the LED will be GREEN if the device is online, BLUE if the device is intentionally offline, and ORANGE if the device is trying to connect to the network.
- Alarm – LED will be RED when an alarm is present.
- Heat – LED will light up YELLOW when the heater output is active. (Some devices may have a RED Heat LED)
- BlinkUp – See sections 3.4.1 and 3.4.2 for BlinkUp Codes
- Photo – Phototransistor used for BlinkUp process and to wake the device from screensaver mode. Ensure phone screen covers this area during BlinkUp. To wake the device from screensaver mode, flash a light or wave your hand over the Photo transistor.



**NOTE: During bootup, the status LED will show WHITE and the heat LED will show YELLOW. This is only a part of the boot process and does not indicate heater activation.**

### 5.2 MAIN SCREEN

The main screen displays information about the device at all times including:

- Current – Displays the current draw of the heating system
- Temperature – Displays the temperature of the control temperature sensor
- Network Status – Provides network connection status (Connected, Connecting, Disabled, or Error)

### 5.3 MAIN MENU

Press any button to enter the **Main Menu** and use the UP, DOWN, ENTER, and BACK buttons to navigate through the menus. Options on the main menu are:

- Force System On – Not available if the device is in Alarm
  - *Select ON time* – Select the force on period (5 min, 1 hour, 24 hours, Cancel)  
NOTE: When the device is forced on you will see the following: Cancel Force On
  - *Cancel?* – Cancel the force on (Yes, No)
- GFEP Test
  - *Test GFEP Now?* – Select to test the GFEP system (Yes, Cancel)
- Active Alarms – Shows a list of active alarms, see section 3.5.4 for more details.
  - *Rest All* – Clears and resets all alarms, select Yes to initiate a GFEP test and reset the alarm conditions. The GFEP test must be successful in order to reset the alarms.
- Device Info – See section 3.7 for available device information.

- Networking – Adjust Network Settings
  - *Rerun BlinkUp* – Reruns the BlinkUp process to provision the device (YES, NO)
  - *Turn On/Off Networking* – Disables device networking (YES, NO). Network credentials are saved, such that when networking is re-enabled, the device should automatically reconnect to the network.
- *Clear Network Credentials* – Clears the device's network credentials (YES, NO). A new BlinkUp will need to be performed in order to reconnect to any network.



**NOTE: ALL NETWORK AND CONNECTION INFORMATION WILL BE LOST, AND THE DEVICE WILL NEED TO BE CONFIGURED VIA BLINKUP AGAIN.**

## 5.4 SETTINGS

The following settings may be changed from the **Settings** page on the **Main Menu**.

- *Mode* – Select the desired control mode (Freeze Protection, Maintain Temperature, Always On, Always Off)
- *Sensor* – Select the control sensor (None, RTD, Thermistor, Lowest)
- *Sensor Location* – Select the sensor location (Pipe, Ambient)
- *Setpoint* – Select the desired temperature set point (0-300 °F)
- *Deadband* – Select the desired temperature dead-band (1-35 °F)
- *Failure State* – Select how the system should operate in the case of a sensor failure (ON, OFF)
- *Temp. Units* – Select the temperature units (°F, °C)

### 5.4.1 Advanced Settings

The following advanced settings may be changed from the **Advanced Settings** page on the **Settings** menu.

- *Ground Fault Protection* – The default and recommended GFEP Trip Level is 30 mA.
  - *GFEP Trip Level* – Select the desired GFEP Trip Level (30-300 mA)
  - *Fire Protection Mode* – Use this option to disable the GFEP circuit (NO, YES)



**NOTE: IT IS NOT RECCOMENDED TO SET THE GFEP TRIP LEVEL ABOVE 30 mA.**



**NOTE: FIRE PROTECTION MODE DISABLES THE GFEP TRIP CIRCUIT. THIS CONFIGURATION IS NOT RECCOMENDED AND MUST BE USED IN CONJUNCTION WITH THE DRY CONTACT ALARM SIGNAL TO ALERT THE SYSTEM OPERATOR TO A GROUND FAULT CONDITION**

- *Modbus* – Configure Modbus communication. Settings must match gateway and Modbus network settings.
  - *Enabled* – Turns on Modbus communications (ON, OFF)
  - *Device Address* – Sets the Modbus device address that cooresponds to the gateway profile. Must be unique for each Frio S1 on a single gateway.
  - *Baud Rate* – Sets the baud rate for the modbus network (9600, 19200, 38400, 57600)
  - *Parity* – Sets the Modbus parity bit (None, Even, Odd)
  - *Stop Bits* – Sets the number of stop bits (1, 2)
- *Screen Saver* – Configure the device screensaver
  - *Enabled* – Turns on the screensaver (ON, OFF)
  - *Delay* – The delay in minutes before the screensaver turns on (5-min intervals)
  - *Mode* – Sets the screensaver mode (Animation, Text, Screen Off)
- *Restore Default Settings* – Reset the device to the factory default settings (Cancel, Yes)



#### 5.4.2 Alarm Settings

Alarm settings are available under Alarms on the **Advanced Settings** menu.

- *Latch All* – Select this option to set all non-critical alarms to latching (NO, YES)
- *High Current* – Configure the high current alarm
  - *Enabled* – Determine if the alarm is enabled (NO, YES)
  - *Threshold* – Set the alarm threshold (0-30 A)
  - *Delay* – Set the alarm delay (0-500 s)



**NOTE: WHEN USING THE HIGH CURRENT ALARM WITH SELF-REGULATING HEAT TRACE, IT IS HIGHLY RECOMMENDED TO USE A DELAY OF AT LEAST 300 SECONDS TO AVOID ALARMING DUE TO INRUSH CURRENT WHEN THE HEAT TRACE IS ACTIVATED.**

- *Low Current* – Configure the low current alarm
  - *Enabled* – Determine if the alarm is enabled (NO, YES)
  - *Threshold* – Set the alarm threshold (0-30 A)
  - *Delay* – Set the alarm delay (0-500 s)
- *High Temperature* – Configure the high temperature alarm
  - *Enabled* – Determine if the alarm is enabled (NO, YES)
  - *Threshold* – Set the alarm threshold (64-300 °F)
  - *Delay* – Set the alarm delay (0-500 s)
- *Low Temperature* – Configure the low temperature alarm
  - *Enabled* – Determine if the alarm is enabled (NO, YES)
  - *Threshold* – Set the alarm threshold (0-300 °F)
  - *Delay* – Set the alarm delay (0-500 s)

#### 5.4.3 Default Settings

| Menu                                               | Setting                | Default    | Range          |
|----------------------------------------------------|------------------------|------------|----------------|
| <b>Settings</b>                                    |                        |            |                |
|                                                    | Mode                   | Always Off |                |
|                                                    | Sensor                 | None       |                |
|                                                    | Sensor Location        | Pipe       |                |
|                                                    | Setpoint               | 38 °F      | 0 °F - 300 °F  |
|                                                    | Deadband               | 2 °F       |                |
|                                                    | Failure State          | ON         |                |
|                                                    | Temperature Units      | °F         |                |
| <b>Networking</b>                                  |                        |            |                |
|                                                    | Networking             | ON         |                |
| <b>Advanced Settings (Ground Fault Protection)</b> |                        |            |                |
|                                                    | GFEP Trip Level        | 30 mA      | 30 mA - 300 mA |
|                                                    | Fire Protection Mode   | OFF        |                |
| <b>Advanced Settings (Alarms)</b>                  |                        |            |                |
|                                                    | Latch All              | NO         |                |
|                                                    | High Current Enabled   | YES        |                |
|                                                    | High Current Threshold | 30 A       | 0-30 A         |
|                                                    | High Current Delay     | 300 s      | 0-500 s        |
|                                                    | Low Current Enabled    | NO         |                |
|                                                    | Low Current Threshold  | 0.1 A      | 0-30 A         |
|                                                    | Low Current Delay      | 5 s        | 0-500 s        |

|                                        |                      |           |               |
|----------------------------------------|----------------------|-----------|---------------|
|                                        | High Temp. Enabled   | NO        |               |
|                                        | High Temp. Threshold | 140 °F    | 0 °F - 300 °F |
|                                        | High Temp. Delay     | 300 s     | 0-500 s       |
|                                        | Low Temp. Enabled    | NO        |               |
|                                        | Low Temp. Threshold  | 28 °F     | 0 °F - 300 °F |
|                                        | Low Temp. Delay      | 300 s     | 0-500 s       |
| <b>Advanced Settings (Modbus)</b>      |                      |           |               |
|                                        | Enabled              | OFF       |               |
|                                        | Device Address       | 1         |               |
|                                        | Baud Rate            | 38400 bps |               |
|                                        | Parity               | None      |               |
|                                        | Stop Bits            | 1         |               |
| <b>Advanced Settings (Screensaver)</b> |                      |           |               |
|                                        | Enabled              | ON        |               |
|                                        | Delay                | 15        | 5-60 min      |
|                                        | Mode                 | Animation |               |

## 5.5 START UP

All S1 devices perform a network connection attempt immediately when power is connected. This process may take up to 30 seconds, during which the screen will be blank, the status LED white and the heat LED red, although the heater will not be turned on. The BlinkUp LED will blink according to the connection status codes listed in sections 3.4.1 and 3.4.2. After the device checks for a connection it will display the Frio logo on the main screen while loading device firmware from memory. Loading the firmware can take several seconds. When the firmware is loaded, the display will show the main screen and the device is ready to use.

If the device has never been connected to a network or if the network credentials have been cleared, the BlinkUp LED will flash orange after power on. While the BlinkUp LED is flashing orange you may BlinkUp the device using the Frio mobile App. To initiate BlinkUp after the device has finished startup (i.e. after the BlinkUp LED has turned off), select **Networking** from the **Main Menu**, then select **Rerun BlinkUp**. You will be asked if you want to **Provision the device now?** Select **Yes** to rerun BlinkUP and provision the device.

## 5.6 POWER LOSS

The device includes an onboard backup power source to provide up to one minute of additional runtime in the case of a power loss. Connected devices will use this time to send a last gasp message to the cloud platform with information related to the power loss.

When the device is disconnected from power, the display will show “POWER LOSS”. When the screen goes blank the onboard power supply is exhausted and the device is completely turned off.



**NOTE: DO NOT OPEN THE WIRING COVER UNTIL THE SCREEN IS BLANK AND THE DEVICE IS COMPLETELY TURNED OFF.**

An override that was set from the HMI will be reset on power loss. An override set from the cloud will resume as soon as the device reconnects and will continue until the original end time set by the user.

## 5.7 REBOOTING THE DEVICE

In the unlikely event that the device freezes up or has other issues, you can reboot the device in one of two ways.

First, you can power cycle the device by turning the power to the device off from the circuit breaker. Wait until the power loss screen goes blank and all lights on the device are off. Turn power to the device back on to restart.

Second, you can use a small diameter pin to press the reset button located in between the status and alarm LEDs. This will power cycle the processor and reboot the device.

Please contact Frio to notify us of any issues that cause the device to freeze up.

## 5.8 CLEARING DEVICE SETTINGS

Users may reset the device to factory default settings and clear the network credentials from the device if needed. Restoring the factory default settings does not clear the network credentials. Clearing the network credentials does not reset any other device settings. To completely clear the device of all settings, the user should restore the factory default settings and then clear the network credentials.

### 5.8.1 Restore Factory Default Settings

To restore the factory default settings, select **Settings** from the **Main Menu**, then select **Advanced Settings** from the **Settings Menu**. Select **Restore Default Settings** from the **Advanced Settings Menu**. You will be asked if you want to **Reset and Reboot?** Select **Yes** to reset the device to the factory default settings.

### 5.8.2 Clear Network Credentials

To clear the Wi-Fi credentials from the device, select **Settings** from the **Main Menu**, then select **Advanced Settings** from the **Settings Menu**. Select **Network Settings** from the **Advanced Settings Menu**, then select **Clear Network Credentials**. You will be asked if you want to **Clear All Credentials?** Select **Yes** to clear the Wi-Fi credentials and restart the BlinkUp process. You will need to Blink Up the device again in order to connect to a network.

## 5.9 SCREENSAVER

The Frio S1 has a screensaver setting to limit “burn-in” and extend the lifetime of the OLED display. The screensaver will start after the delay period which can be set from the screensaver menu. To exit screensaver mode, the user either needs to wave a hand or light in front of the PHOTO sensor or press any button. There are three options for the screensaver: “Animation” which displays a moving Frio logo, “Text” which displays instructions on how to wake the device, and “Screen Off” which turns the screen completely off. For the longest screen life, Frio recommends the “Screen Off” setting.

## 5.10 OFFLINE DEVICES

To use the device offline without connecting to the internet, simply perform all setup steps except for network provisioning. Do not use the Frio App to give the device network credentials.

Frio recommends disabling networking on offline devices as this will disable the network connection alarm.

Offline devices will not have access to the Frio Cloud platform and will not be able to use any cloud features. Offline devices will not have access to any firmware updates.

## 6 FIRMWARE UPGRADES

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Firmware updates will occur automatically as long as the device is connected to the internet. Updates do not change device settings. A copy of the previous firmware version is retained on the device. If the update fails or the device is disconnected during the update, the previous firmware version will be reloaded until the device is able to retry the update at a later time. When an update occurs, the device will restart, shutting off the heating system if it is on. Once the update is complete, the device will resume normal operation. Updates typically take less than one minute to complete.