

# Interface Manual

## Sentinel Node Analog

*SignalFire Model: Sentinel-Analog-XXXX*



The SignalFire Sentinel Node is an Intrinsically Safe device with the following features:

- Powers a single 4-20mA at 13.5V or a single 1-5V sensor at 12.5 or 18.0V (software selectable)
- Low power operation from an intrinsically safe high capacity lithium primary battery pack
- Optional solar battery system for routing nodes, high power draw sensors, or rapid data collection
- Sends data to a SignalFire Buffered Modbus Gateway
- Settable Modbus ID
- -AES 128bit Encryption

## Specifications

Enclosure Size	3.5" tall × 5.0" wide × 5.0" deep
Power Source	Internal IS Lithium battery pack SignalFire Part Number: 3BIS  External Solar battery system ( <b>not for use in 4-20mA mode</b> ) SignalFire Part Number: Sentinel-HCSolar  DC-DC converter SignalFire Part Number: DCDC-Sentinel  Other external power supply meeting the power entity parameters from the control drawing.
Temperature Rating	-40°C to +60°C
Radio Frequency	902-928MHz ISM Band, FHSS radio, internal antenna
Compliance	Certified for use in Class I, Division 1 groups C and D. EXi [EXi] FCC/IC Certified.



**WARNING: Use of this equipment in a manner not specified by the manufacturer may impair the protection provided by the equipment.**



**WARNING: The use of any parts not supplied by the manufacturer violates the safety rating of the equipment.**

The associated apparatus provides intrinsically safe outputs.  
L'appareil associé fournit des sorties à sécurité intrinsèque.

Refer to control drawing "Sentinel – Control Drawing – HART and Analog" under Technical Documents for requirements when used in a Class I Division 1 area.

**SIGNALFIRE**  
— WIRELESS TELEMETRY —

Marlborough, MA USA  
www.signal-fire.com

**S/N:SG000001**  
Model: SENTINEL-ANALOG-XXXX



**Intertek** 4003827

**CLASS I, DIVISION 1 GROUPS C, D**  
**TEMP CODE: T3**  
**AMBIENT TEMP: -40°C to +60°C**  
CONFORMS TO UL STD 913  
CERTIFIED TO  
CAN/CSA STD C22.2 NO. 157  
FCC ID: W8V-SENTINEL  
IC: 8373A-SENTINEL

**ENTITY PARAMETERS**

Exi  
[Exi]

<b>INPUT POWER:</b>	<b>OUTPUT (J3):</b>
Vmax = 5.9 Vdc	Voc = 21 Vdc
I <sub>max</sub> = 3.1A	I <sub>sc</sub> = 90.2 mA
Pmax = 0.8 W	Ca = 1.16 uF
Ci = 29.4 uF	La = 17.4 mH
Li = 14.2 uH	

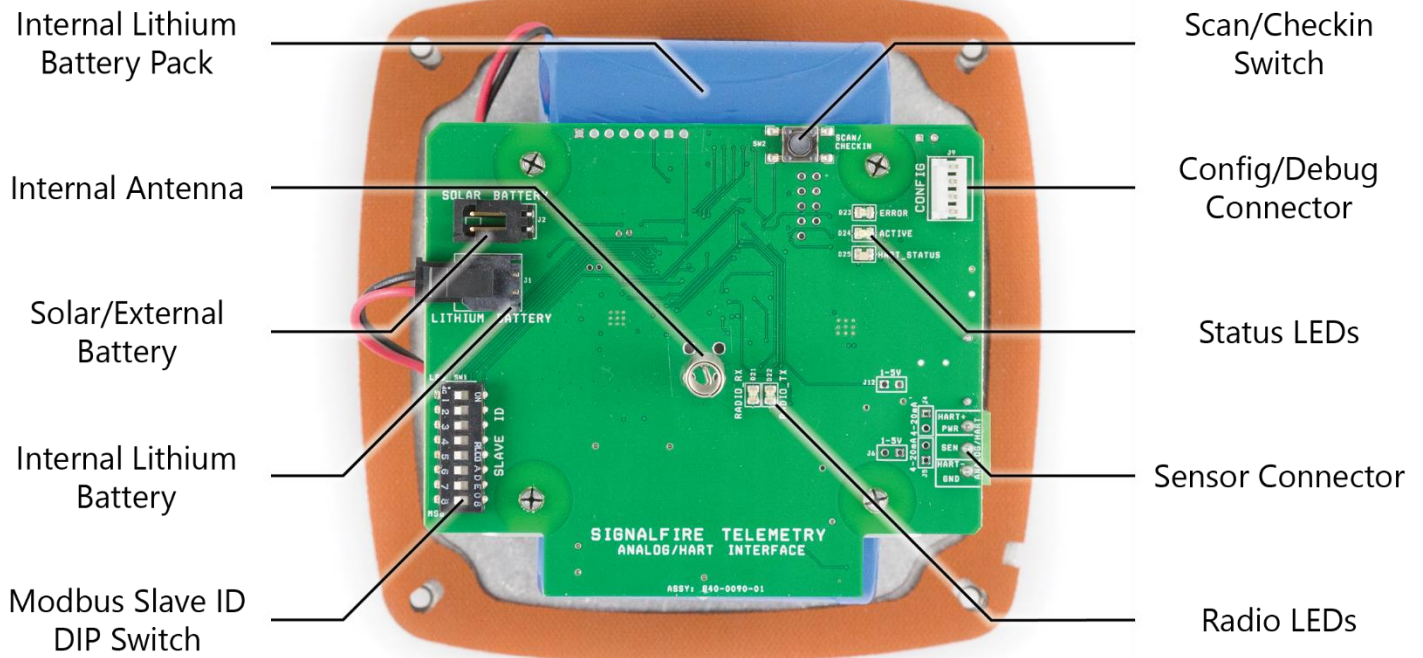
**INTRINSICALLY SAFE**  
**SECURITE INTRINSEQUE**  
INTRINSICALLY SAFE WHEN CONNECTED  
PER SIGNALFIRE DRAWING 960-0026-01

**WARNING: POTENTIAL  
ELECTROSTATIC DISCHARGE  
HAZARD! SEE INSTRUCTIONS**

**AVERTISSEMENT: DANGER  
POTENTIEL DE DECHARGES  
ELECTROSTATIQUES: VOIR LES  
INSTRUCTIONS**

**WARNING: USE OF ANY BATTERY  
OTHER THAN SIGNALFIRE 810-0008-02  
or SENTINEL-SOLAR  
MAY IMPAIR INTRINSIC SAFETY**

**AVERTISSEMENT: LA SUBSTITUTION  
DE COMPOSANTS PEUT COMPROMETTRE  
LA SECURITE INTRINSEQUE**



### Radio LEDs

- The Radio TX LED (**green**) flashes each time a radio packet is sent. This LED will blink rapidly while searching for the radio network.
- The Radio RX LED (**red**) blinks on each received radio packet.

### Status LEDs

- The Active LED (**green**) will blink at boot up and will blink rapidly when the sensor is being powered.
- The ERROR LED (**red**) will blink to indicate an error condition.

### Scan/Checkin Button

- If this button is pressed the Sentinel will apply power to the sensor for the configured sensor on time, read the analog sensor value and send the collected sensor data to the gateway.

## Setup

The nodes need to be set up for correct operation before being fielded. The configurable items include:

- Network selection
- Check-in period selection
- Modbus ID setting
- Sensor on time/supply voltage

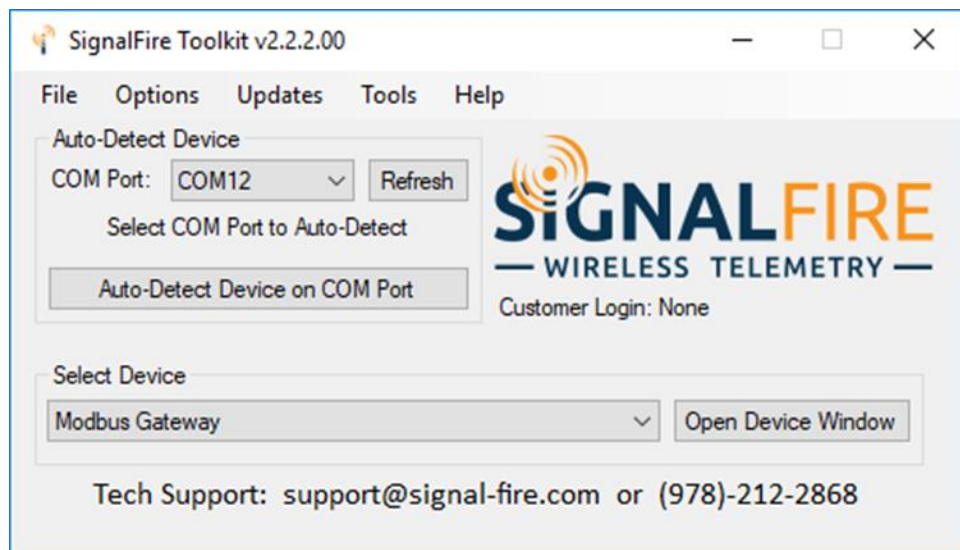
All settings are made using the SignalFire Toolkit PC application and a serial programming cable. The Modbus ID can also be set using the DIP switch (in older models only).



**WARNING: Perform the steps in this section (Setup) in a safe location only.**

### Using the SignalFire Toolkit

The SignalFire Toolkit application can be downloaded at [www.signal-fire.com/customer](http://www.signal-fire.com/customer). After installation, launch the software and the main toolkit window will open:



Select the COM port associated with the Sentinel Node and click "Auto-Detect Device on COM Port." This will open the device configuration window, where all device settings can be configured.

Sentinel Analog (4-20mA)

File Settings Updates Tools Help

COM Port: COM4 Refresh

Connect/Update

Product: ANALOG(4-20mA)  
 Slave ID: 10  
 Node Name: not set  
 Radio Connectivity: Connected -45d...  
 Mainboard Version: 0.61  
 Radio Version: 2.50 (sleeping)  
 Radio Address: 50000  
 Corporate ID: <Encrypted>  
 Radio Mode: Sleeping  
 Radio Network: 3  
 Radio Network Group: 0  
 Radio Power (dBm): 2  
 Checkin Interval: 1 minute  
 State Change Checkin: N/A  
 Sensor On Time (sec): 2  
 Sensor Power Mode: HIGH  
 Scale A Type: None  
 Scale A Low Value: N/A  
 Scale A High Value: N/A  
 Alarm High Set (uA): 18000

Set Encryption Key  
 Enable Encryption  
 Key: signalfire

Reported Sensor Values

Address	Description	Value
3000	Sensor (raw counts)	8847
3001	Sensor Current (uA)	4000
3002	Sensor Voltage (mV)	0
3003-3004	Sensor (scaled)	0.00000
3005	Alarm High Notification	0
3006	Alarm Low Notification	0
3007	Alarm High Set (uA)	18000
3008	Alarm Low Set (uA)	0
65532	Battery Voltage (mV)	3493

Update Reported Sensor Values

Settings

Slave ID: 10 Set  
 Node Name: Set  
 Radio Mode: Sleeping Set  
 Radio Network: 3 Set  
 Radio Network Group: Set  
 Checkin Interval: Set  
 State Change Checkin: Set  
 Sensor On Time (sec): 2 Set  
 Sensor Always On Set  
 Sensor Power Mode: HIGH Set  
 Scale A Type: None Set  
 Scaling A Low Value: Set  
 Scaling A High Value: Set

Alarm Thresholds(uA)

High: 18000 Set  
 Low: Disabled Set

New Battery Life Estimate: Unknown  
 Sensor Current (mA):  
 Warning: 4-20mA Mode cannot be powered by the Sentinel-Solar system.

Success

- |   |                                   |   |                          |
|---|-----------------------------------|---|--------------------------|
| 1 | Serial Port Settings              | 2 | Sentinel Information     |
| 3 | Set Corporate ID / Encryption Key | 4 | Status of Last Operation |
| 5 | Reported Sensor and HART Values   | 6 | Sentinel Settings        |
| 7 | Battery Life Estimate             | 8 | Alarm Threshold Settings |

## Network Setting

The network is set using the SignalFire Toolkit. The network, network group, and corporate ID/encryption key settings must match those of the gateway for them to communicate.

Radio Network: 3  
Radio Network Group: 0  
Set

## Encryption

To protect your over-the-air data and prevent tampering, SignalFire networks come with encryption. Legacy products use a Corporate ID, but can be switched over to use an encryption key if the firmware and ToolKit are up to date.

To set up a legacy Sentinel to use encryption, click the checkbox labeled **Enable Encryption** inside the **Set Corporate ID** box. All newer Sentinels come with this option enabled with "signalfire" as the default encryption key.

Set Corporate ID  
 Enable Encryption  
Corporate ID: 7  
Set  
Help

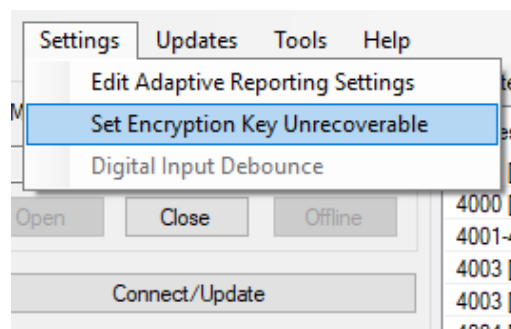
Corporate ID

Set Encryption Key  
 Enable Encryption  
Key: signalfire  
Set  
Help

Encryption Enabled

The box will then change into a **Set Encryption Key** box, and it will prompt instead for the encryption key you would like to use. Note that keys may not contain spaces or angle brackets. Enter it and then press **Set**. If you are setting up a new network, you will need to set the encryption key on all of your devices. If you are adding a Sentinel to a legacy network, you can simply set the Corporate ID without clicking the Enable Encryption box, and it will remain compatible with the older system.

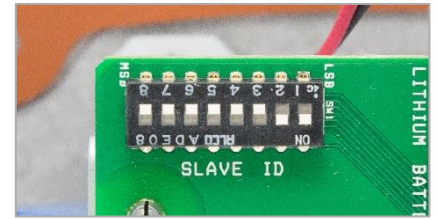
It is also possible to hide your encryption key so it cannot be read. This is the most secure option, but if you forget your key, there is no way to recover it – you have to reset the key on every device on its network. To enable this option, select **Set Encryption Key Unrecoverable** under the **Settings** menu.



Setting the encryption key to be unrecoverable.

## Modbus ID

The Modbus ID can be set with the SignalFire Toolkit, or with the DIP switch located on the device on older models. The DIP switch takes an 8-bit binary input which is converted into a Modbus ID from 1 to 240. In the picture below switch 1 and 2 are on, which is 00000011 and results in a Modbus ID of 3. The least significant bit (LSB) is on the right and is labeled 1 above the row of switches. The Sentinel must be power cycled after setting the DIP switch. Note: The DIP switch must be set to 0 (all switches off) in order to set the Modbus ID with the SignalFire Toolkit.



## Sensor Settings

The Sentinel Node will supply either 18.0 Volts (**HIGH**) or 12.5 Volts (**LOW**) in 1-5V mode, selectable in the SignalFire Toolkit. In 4-20mA mode **HIGH** is automatically selected and is the only option, it will supply a minimum of 13.0V to the sensor at full load of 20mA. The sensor warm-up time must also be configured. The default is 2 seconds which is used for most pressure and other simple sensors. Radar sensors often require a longer warm-up time. Contact your sensor manufacturer or SignalFire for details.

Selecting a sensor voltage of **LOW** (12.5V) in 1-5V mode will result in longer battery life; however some sensors require higher voltage.

The Scale A values can also be configured. The **Scaling A Low Value** will correspond with lowest reading from the sensor, either 4mA or 1V depending on the mode. The **Scaling A High Value** will correspond with the highest reading from the sensor, either 20mA or 5V depending on the mode. The **Scale A type** should always be set to the current mode of the sensor.

State Change Checkin	<input type="checkbox"/>	Set
Sensor On Time (sec)	<input type="text" value="2"/>	Set
<input type="checkbox"/> Sensor Always On		
Sensor Power Mode	LOW	Set
Scale A Type	4-20mA	
Scaling A Low Value	<input type="text" value="2"/>	Set
Scaling A High Value	<input type="text" value="50"/>	

*Configuring the sensor settings.*



## Alarm Thresholds

The Sentinel-Analog optionally has alarm threshold registers that when configured will indicate if the most recent analog reading is above or below the configured threshold. If the Sentinel is in 1-5V mode the thresholds are configured in mV, if the Sentinel is in 4-20mA mode the thresholds are configured in uA. For example, for a 4-20mA sensor with the Alarm High threshold configured for 18000uA, any reading above 18mA will cause the Alarm High Notification Register to read 1.

The image shows a window titled "Alarm Thresholds". It contains two rows of controls. The first row has a checkbox labeled "High" followed by an empty text input field. The second row has a checkbox labeled "Low" followed by another empty text input field. At the bottom center of the window is a button labeled "Set".

## Analog Sensor Zero Settings

The sensor can be zeroed and/or a negative deadband configured via the Analog Sensor Zero menu under the Tools dropdown. A zero offset is applied to the raw analog sensor reading. The default is "0". The current zero offset can be read or erased. It can also be reset with the "Set" button.

The image shows a window titled "Analog Sensor Zero". It is divided into several sections. The top section, "Analog Sensor Configuration", has three radio buttons: "4 - 20mA Sensor" (selected), "1 - 5V Sensor", and "Scaled Units". Below this is the "Zero Offset" section, which includes a "Zero Value" input field followed by "mA", a "Set" button, and "Read" and "Erase" buttons. Underneath are labels for "Non-Zeroed Reading:" and "Zero Offset:", both followed by "mA". The "Negative Deadband" section has an empty input field, a "Get" button, and a "Set" button. At the bottom, a status bar reads "Timed out reading zero offset value".

*Zero Offset and Negative Deadband settings*

A negative deadband zone can be applied to the scaled floating point reading to remove small negative values. The default is "0". The deadband zone can be set in whole number increments which works as follows: Any negative reading within the defined "deadband" will be reported as zero. Any values below the deadband will be reported as the actual value.

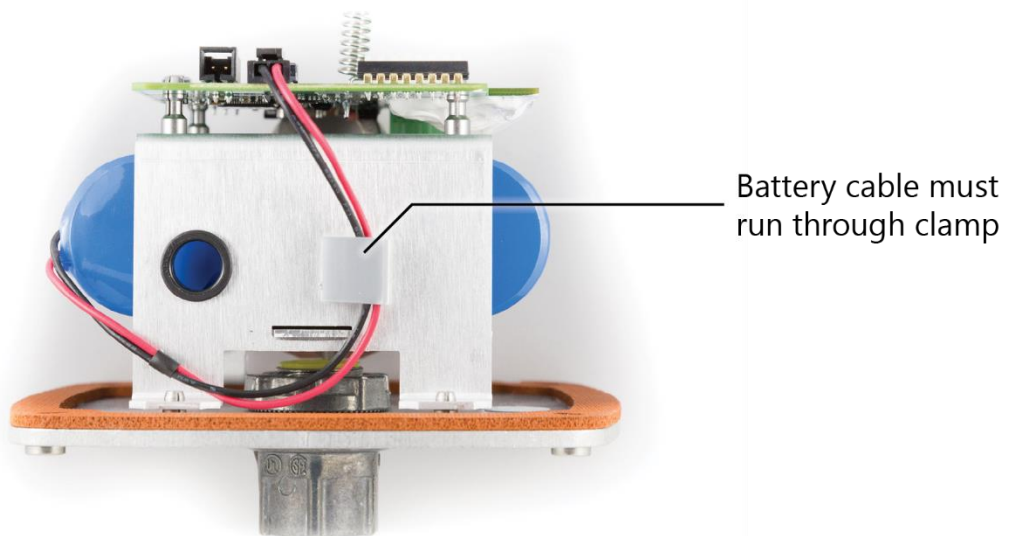
## Sensor Connections

# 10

### Wiring Requirements

To ensure intrinsic safety is maintained it is required that the installer follow these guidelines when connecting sensors to the SignalFire node. See pictures for proper wire routing examples.

- Sensor wires entering the enclosure must be run as pictured.
- The battery wire must be routed through the battery cable hold-down clamp.
- Strip the wires so that there is minimal exposed un-insulated wire when inserted into the screw terminal.
- All wiring should be neat and orderly.



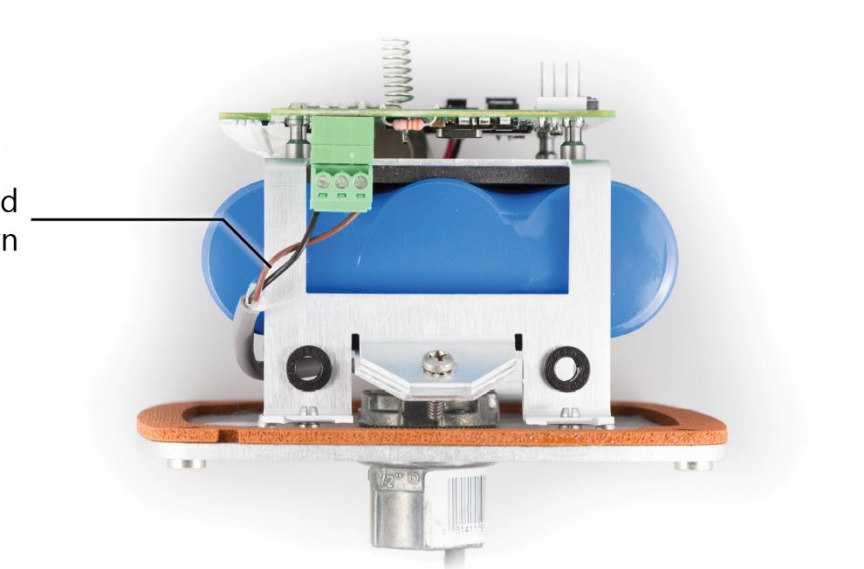
Plug the internal lithium battery pack into the connector labeled LITHIUM BATTERY as show below. Be careful to insert the battery connector as pictured with the locking tab facing up.

**Forcing the battery connector in backward or into the SOLAR BATTERY connector can damage the battery pack fuse making it inoperable.**



Only connect either the Lithium batter OR the Solay battery. **Never connect both at the same time.**

Sensor cable should be routed as shown



### 4-20mA Mode

To set the Sentinel Analog to 4-20mA mode: install the jumpers on the pins labeled "4-20mA" and leave the pins labeled "1-5V" open as pictured below, then power cycle the system.

The 4-20mA sensor is a 2-wire interface between the Sentinel Node and the sensor. The positive (Sensor+) at the sensor is connected to the top terminal on the Sentinel Node. The negative terminal (Sensor-) is connected to the center terminal of the Sentinel Node. The left/bottom terminal (Ground) may be left unconnected, or if the shielded cable is used it may be connected to the shield.



SENSOR +

SENSOR -

## NAMUR Mode

# 12

The Sentinel Analog can be used to operate with NAMUR low-power switches when in 4-20mA mode. To enable this function, select **Configure for NAMUR** under the Settings toolbar menu. When in this mode, the Sentinel outputs a lower voltage, and is configured to alarm at a threshold of 1400uA.

The screenshot shows a 'Settings' window with various configuration options. Two areas are highlighted with red boxes: the 'Alarm threshold' section, which has 'High' checked and '1400' entered in the adjacent field, and the 'Sensor Power Mode' dropdown menu, which is currently set to 'LOW'. Other visible settings include Slave ID (1), Node Name, Radio Mode (Sleeping), Radio Network (0), Radio Network Group (0), Checkin Interval (1 minute), State Change Checkin, Sensor On Time (sec) (1), Sensor Always On (unchecked), Scale A Type (None), and Scaling A Low/High Values.

When the switch is covered, it will output  $\sim 2200\mu\text{A}$  or greater and set register 3005 to a 1. When the switch is uncovered, it will output  $\sim 1000\mu\text{A}$  or less and set register 3005 to a 0.

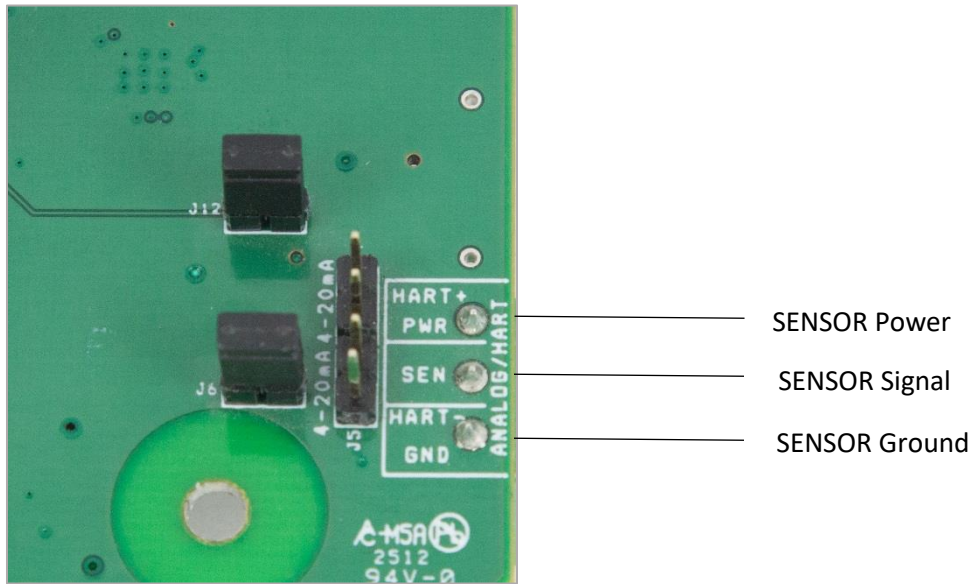
To disable this feature, select **Set Sensor Power Mode HIGH** under Settings. This only sets the Sensor Power Mode back to High and does not disable the 1400mA alarm threshold.

This option is not available in 1-5V mode.

## 1-5V Mode

To set the Sentinel Analog to 1-5V mode: install the jumpers on the pins labeled "1-5V" and leave the pins labeled "4-20mA" open as pictured below, then power cycle the system.

The 1-5V sensor is a 3-wire interface between the Sentinel Node and the sensor. The positive (**Sensor Power**) at the sensor is connected to the top terminal on the Sentinel Node. The negative (**Sensor Ground**) is connected to the bottom terminal of the Sentinel Node. The middle terminal (**Sensor V Out**) is connected to the voltage signal output from the sensor.



## Remote Modbus Register Mapping

The Sentinel Node sends data to a SignalFire Telemetry Modbus Gateway. The data that is sent to the gateway is available at the gateway in registers where it can then be read by a Modbus RTU. Consequently, the node needs to have a unique (to the network it is in) Modbus ID which the gateway will use to store its unique data.

### Modbus Registers

Every check-in period, the sensors are read and data is sent to the gateway. The gateway will save the data under the set Modbus ID in 16-bit registers. The register map for this system is below.

### Register Map

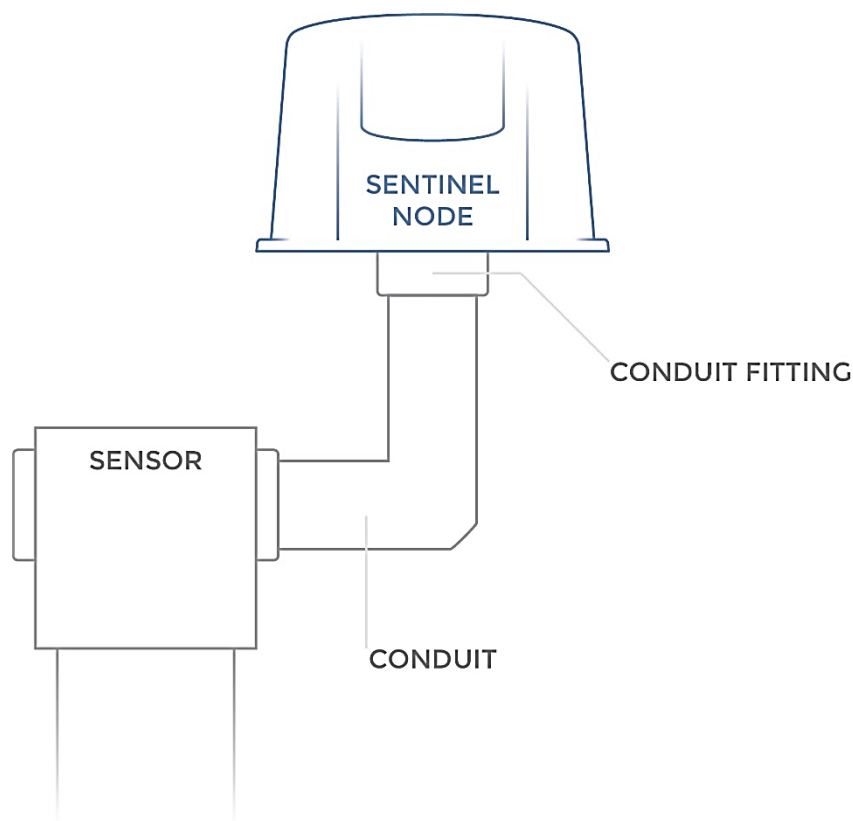
Register Number	Register Address (Offset)	Description
43001	3000	A/D Counts (12bit legacy format)
43002	3001	Loop current in $\mu$ A (Reported as 0 if set to 1-5V mode)
43003	3002	Loop voltage in mV (Reported as 0 if set to 4-20mA mode)
43004-43005	3003-3004	Custom Scaling of Loop (two registers) (32bit Float)
43006	3005	Alarm High Notification (0=no alarm, 1=in alarm)
43007	3006	Alarm Low Notification (0=no alarm, 1=in alarm)
43008	3007	Alarm High Setpoint in mV or $\mu$ A
43009	3008	Alarm Low Setpoint in mV or $\mu$ A
49987	9986 or 65523	Status (0=no errors, 1=low battery, 2=failed sensor read, 3=low battery and failed sensor read)
49988	9987 or 65524	Major revision number for the mainboard
49989	9988 or 65525	Minor revision number for the mainboard
49990	9989 or 65526	Major revision number for the radio
49991	9990 or 65527	Minor revision number for the radio
49992	9991 or 65528	High 16 bits of SFTS node address
49993	9992 or 65529	Low 16 bits of SFTS node address (the radio ID)
49994	9993 or 65530	Modbus ID readback
49995	9994 or 65531	Received signal strength of last packet from the Sentinel
49996	9995 or 65532	Battery voltage of the Modbus client, in millivolts
49997	9996 or 65533	Minutes until this device will time out, unless new data is received
49998	9997 or 65534	Number of registers cached for this device
49999	9998 or 65535	Remote device type. 42 for Sentinel Analog

## Mounting and Care

The unit comes with a watertight ½" NPT conduit fitting on the bottom mounting plate. The Sentinel is then directly mounted to the sensor with a short section of conduit.

### Direct Mount to Sensor with Short Conduit

This mounting method uses a short conduit run from the sensor and the unit is held in place by the conduit.



**WARNING: The Sentinel must be mounted in a location free of high vibrations. Over time vibrations can damage the Sentinel or battery pack, which could impair its safety ratings. Do not mount directly to continuous vibrating equipment such as pumps or compressors.**

## Internal Lithium Battery Replacement

Battery Packs can be changed with the node in place.

1. Open the cover from the enclosure.
2. Unplug the battery from the PCB, by depressing the locking clip on the connector.
3. Loosen the screw holding the battery door and slide the old battery out.
4. Slide in the new battery pack and tighten the battery door screw.
5. Connect the battery to the main PCB battery connector.
6. Install the enclosure cover.



**WARNING: Use of any battery other than the SignalFire part number 810-0008-02 will impair the protection provided by the equipment.**



**WARNING: If the internal battery is installed the external solar battery system or other power source may not be connected!**

## Cleaning Instructions

The outside of the enclosure may be cleaned with water, mild soap, and a damp cloth as needed. High pressure washing is not recommended.



**WARNING: Electrostatic Discharge Hazard! Care must be taken to avoid the potential of creating a charge on the enclosure or antenna. Do not wipe with a dry cloth. Do not brush against the enclosure with clothing or gloves.**





**WARNING: Only connect to the debug port in a safe area!**

Debug and configuration information is available if a connection is made via the debug port on the main board. A USB converter cable (available from SignalFire) must be used for this interface.

Debug and advanced configuration may be done using the SignalFire Toolkit PC application.

### Technical Support and Contact Information

SignalFire Telemetry  
 140 Locke Dr, Suite B  
 Marlborough, MA 01752  
[support@signal-fire.com](mailto:support@signal-fire.com)  
 (978) 212-2868

Revision	Date	Changes/Updates
1.2	10/11/12	Initial release
1.4	10/30/13	Corrected sensor voltage description, and wiring description
1.5	11/7/14	Updated entity parameters
1.6	6/4/15	Updated Design
1.7	8/1/16	Added section on encryption
1.8	2/24/17	Updated pictures
1.9	9/12/17	Added detail on new Alarm Threshold feature
1.10	12/12/17	Added Analog Sensor Zero Settings section. Added Alarm Thresholds screenshot. Updated Sensor Settings screenshot. Added Modbus register 65523 for Low Battery Alarm.
1.11	1/21/2019	Updated pictures and screenshots Added NAMUR mode Minor formatting updates
1.12	3/31/2022	Update Register 49987 description.
1.13	6/3/22	Added detail on battery connection

Changes or modifications not expressly approved by SignalFire Telemetry, Inc could void the user's authority to operate the equipment.

This device complies 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.

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one of the following measures:

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

Only the supplied coil antenna (Part number 810-0012-01) which is permanently soldered to the PCB may be used. This antenna has a maximum gain of 3dB.

### **WARNING!**

#### **FCC and IC Radiation Exposure Statement:**

This equipment complies with FCC's and IC's RF radiation exposure limits set forth for an uncontrolled environment under the following conditions:

1. This equipment should be installed and operated such that a minimum separation distance of 20cm is maintained between the radiator (antenna) & user's/nearby person's body at all times.
2. This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a maximum (or lesser) gain approved for this transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.r.i.p.) is not more than that necessary for successful communication.

*Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante.*

*This device complies with Industry Canada licence-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.*

*Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes : (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.*