

# Interface Manual

## Sentinel Modbus

*SignalFire Model: Sentinel-485-XXXX*



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

- RS485 connection to a single Modbus RTU sensor device
- Configurable Modbus register polling map
- Can power an attached Modbus sensor at 8V or 13V with configurable warm-up time
- 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
- AES 128bit Encryption

## Specifications

2

Enclosure Size	3.5" tall × 5.0" wide × 5.0" deep
Power Source	Internal IS Lithium battery pack <i>SignalFire Part Number: 3BIS</i>  External Solar battery system <i>SignalFire Part Number: Sentinel-HCSolar</i>  DC-DC Converter <i>SignalFire Part Number: DCDC-Sentinel</i>  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 – Modbus, Thermocouple, RTD, and Float Stick" 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: SM000001**



Model: SENTINEL-485-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

<b>INPUT POWER:</b>	<b>OUTPUT (J11):</b> [Exi]
V <sub>max</sub> = 5.9 Vdc	V <sub>oc</sub> = 14.7 Vdc
I <sub>max</sub> = 3.1 A	I <sub>sc</sub> = 119.14 mA
P <sub>max</sub> = 0.8 W	C <sub>a</sub> = 3.86 uF
C <sub>i</sub> = 29.43 uF	L <sub>a</sub> = 10.02 mH
L <sub>i</sub> = 13.5 uH	

**INTRINSICALLY SAFE**  
**SECURITE INTRINSEQUE**  
INTRINSICALLY SAFE WHEN CONNECTED  
PER SIGNALFIRE DRAWING 960-0027-01

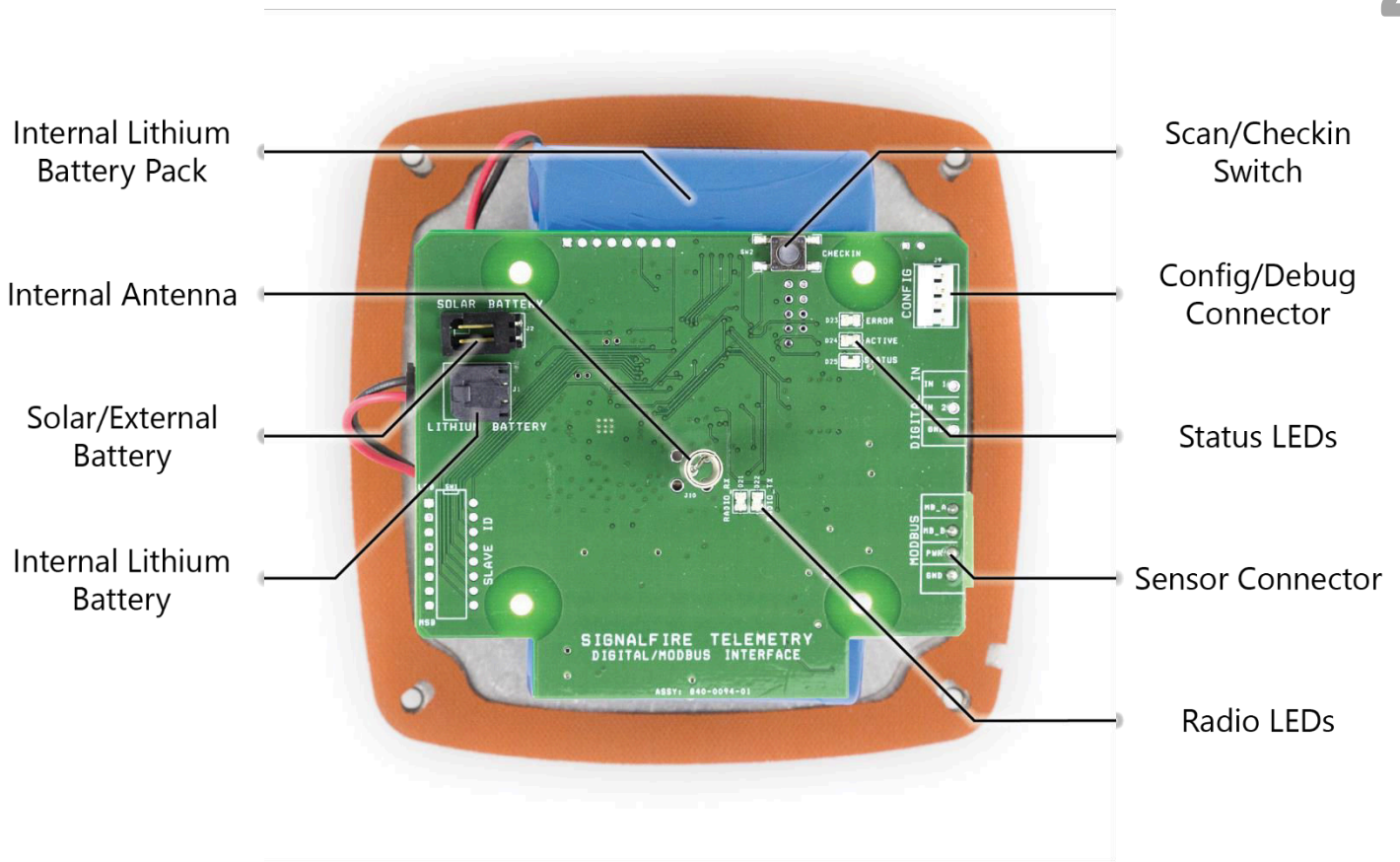
**WARNING: POTENTIAL  
ELECTROSTATIC DISCHARGE  
HAZARD! SEE INSTRUCTIONS**

**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**

**WARNING: SUBSTITUTION OF  
COMPONENTS MAY IMPAIR  
INTRINSIC SAFETY**



## 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 and read.
- The ERROR LED (**red**) will blink to indicate an error condition.

## Scan/Checkin Button

- If this button is pressed the Sentinel will power the sensor on for the configured time, read the pre-configured Modbus registers from the sensor, and forward those values 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 registers to be polled
- Modbus sensor power on time

All settings are made using the SignalFire Toolkit PC application and a serial programming cable.



**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 Modbus

File Options Settings Updates Tools Help Passed

COM Port: COM8 Refresh

1  Open Close Offline

Connect/Update

Product MODBUS  
Node Name mySentMB  
Radio Connectivity Connected -87d...  
Mainboard Version 0.66  
Radio Version 2.51 (sleeping)  
Radio Address 21029  
Corporate ID Encrypted>  
Radio Mode 2  
Radio Network 2  
Radio Network Group 2  
Radio Power (dBm) 14  
Checkin Interval 2 minutes  
Modbus Baud Rate 9600  
Modbus UART Mode 8N1  
Command Timeout (ms) 1000  
Command Pause (ms) 100  
Sensor On Time (sec) 0.25  
Sensor Power Mode LOW

2

Set Encryption Key Help  
 Enable Encryption Set  
Key: signalfire 3

Settings  
Node Name mySentMB Set  
Radio Mode Sleeping Set  
Radio Network 2 Set  
Radio Network Group 2 Set  
Slave ID 12 Set  
Checkin Interval 2 minutes Set  
Sensor On Time (sec) 0.25 Set  
 Sensor Always On  
Sensor Power Mode LOW Set

Reported Sensor Values

Address	Description	Value
65523	Status Register	0
65532	Battery Voltage (mV)	3421

4

Update Reported Modbus Values

Modbus Program Steps

Baud Rate 9600 Command Timeout (ms) 1000 Find Sensor Modbus ID  
UART Mode 8N1 Command Pause (ms) 100

Double-click on "Passed" Status for register view.

	Function Code	Register Address	Count*	Status
▶ 1	0x03 - Read Holding Register	3990	2	Passed
2	0x03 - Read Holding Register	3996	1	Passed
3	0x03 - Read Holding Register	4005	2	Passed
4	0x03 - Read Holding Register			Unknown
5	0x03 - Read Holding Register			Unknown
6	0x03 - Read Holding Register			Unknown
7	0x03 - Read Holding Register			Unknown
8	0x03 - Read Holding Register			Unknown
9	0x03 - Read Holding Register			Unknown
10	0x03 - Read Holding Register			Unknown
11	0x03 - Read Holding Register			Unknown
12	0x03 - Read Holding Register			Unknown
13	0x03 - Read Holding Register			Unknown
14	0x03 - Read Holding Register			Unknown
15	0x03 - Read Holding Register			Unknown
16	0x03 - Read Holding Register			Unknown
17	0x03 - Read Holding Register			Unknown
18	0x03 - Read Holding Register			Unknown

5

\*NOTE: Count is limited to 25 registers per step. (If using Enron Modbus, limit is 12.)

Read Steps from Sentinel Write Steps to Sentinel Clear Table Run Modbus Program Steps  
Load Steps from File Save Steps to File

Register Addressing Mode  
 Zero Based Addressing: 40001 is entered as 0  
 One Based Addressing: 40001 is entered as 1

Success

1 COM Settings

4 Register Values

2 Node Information

5 Current Program Steps

3 Configurable Node 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

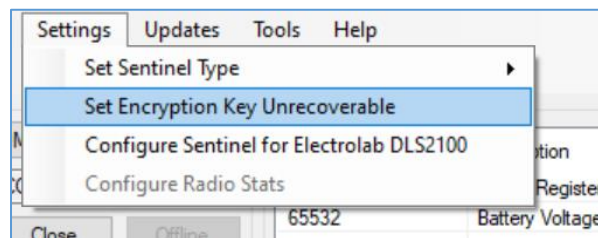
*Corporate ID*

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.

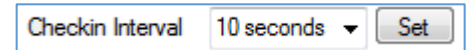
It is also possible to hide your encryption key so it cannot be read. This is the most secure option, but if you forget your key, there is no way to recover it – you have to reset the key on every device on its network. To enable this option, select **Set Encryption Key Unrecoverable** under the **Settings**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



*Setting the encryption key to be unrecoverable.*

## System Check-In Period

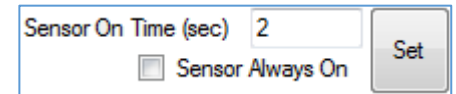
This setting controls how often the node will read the Modbus device and forward the register data to the gateway.



Checkin Interval 10 seconds ▼ Set

## Modbus Sensor Warm-up Time

The sensor warm-up time controls how long power is applied to the Modbus sensor prior to data collection. The default is 2 seconds which is used for most simple sensors, some may require longer warm-up times. Contact your sensor manufacturer or SignalFire for details.



Sensor On Time (sec) 2  
 Sensor Always On Set

## Operating Mode

The Sentinel Modbus node requires that the Sentinel is configured with a list of Modbus registers to be read from the attached sensor using the SignalFire Toolkit application prior to installation.

The preconfigured set of registers is automatically read from the Modbus sensor device and forwarded to the Modbus gateway on a pre-defined schedule (1 minute to 5 minutes is typical). The register data is then buffered in the gateway and is available to be read by the RTU at any time at the same Modbus ID as the attached Modbus device. Unlike other Sentinels, **the Sentinel Modbus will not appear on the Gateway's list of nodes unless it has at least one program step.**

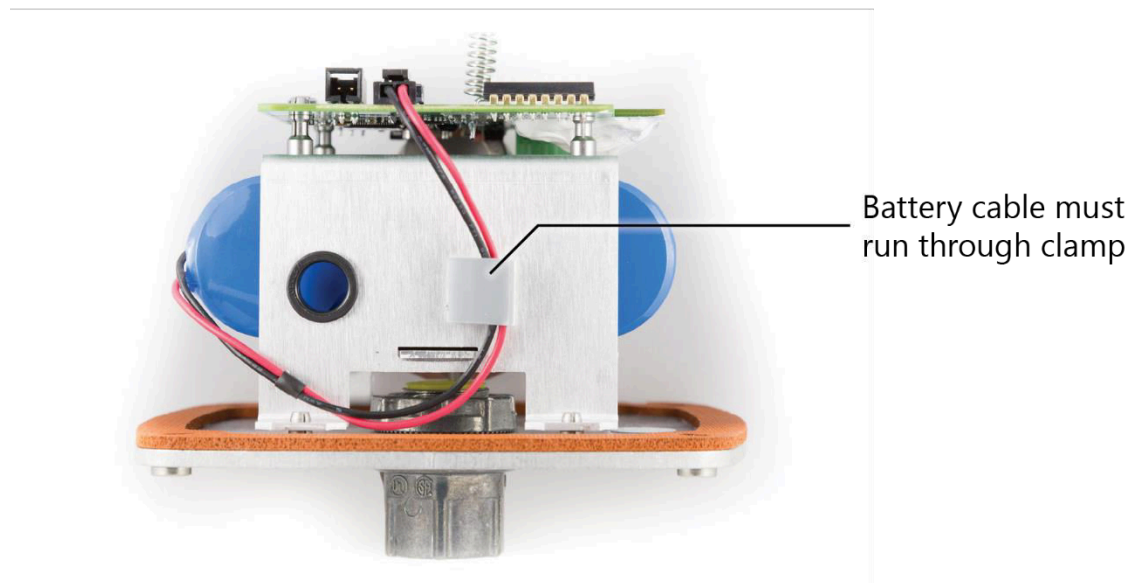


## Sensor Connections

### 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.



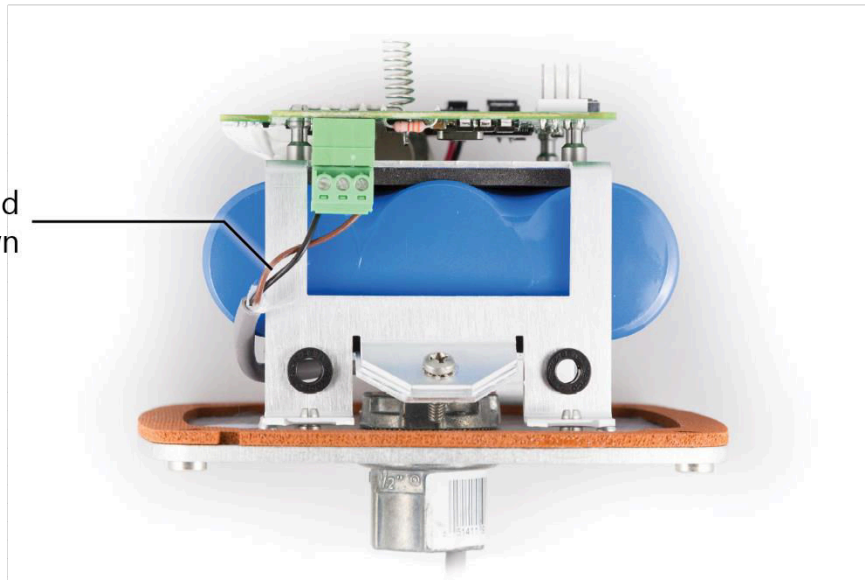
Plug the internal lithium battery pack into the connector labeled LITHIUM BATTERY as show below. Be careful to insert the battery connector as pictured with the locking tab facing up.

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

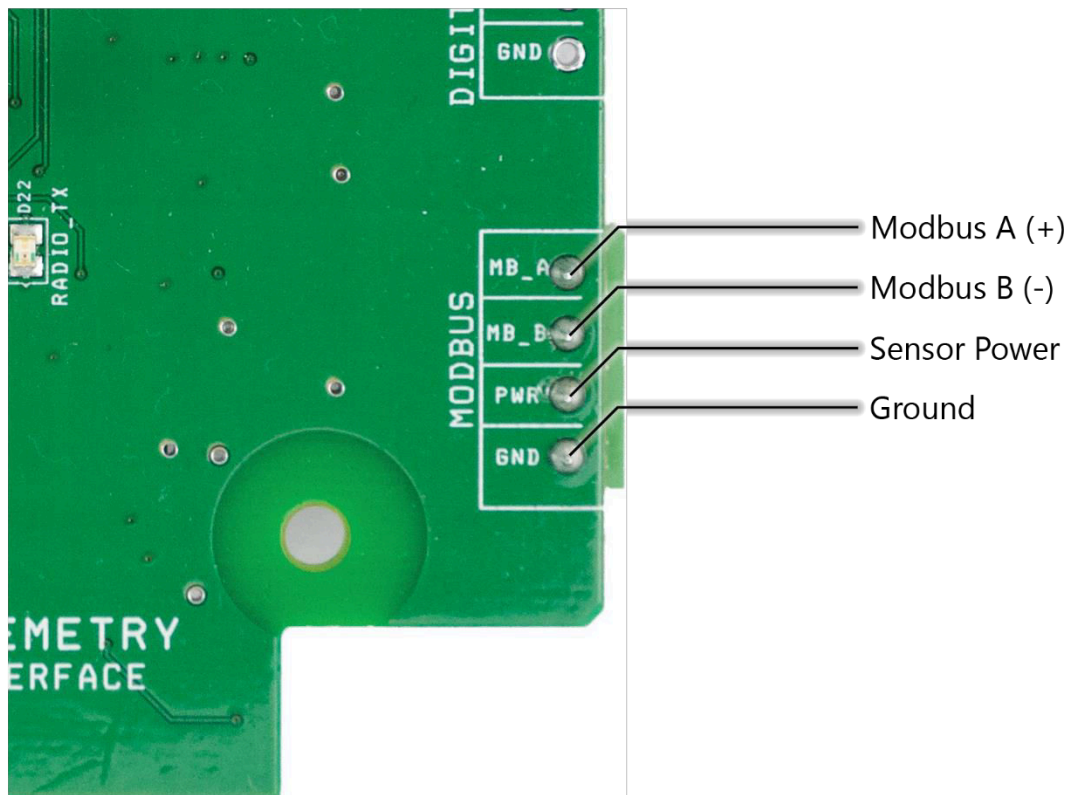


Only connect either the Lithium batter OR the Solya battery. **Never connect both at the same time.**

Sensor cable should be routed as shown

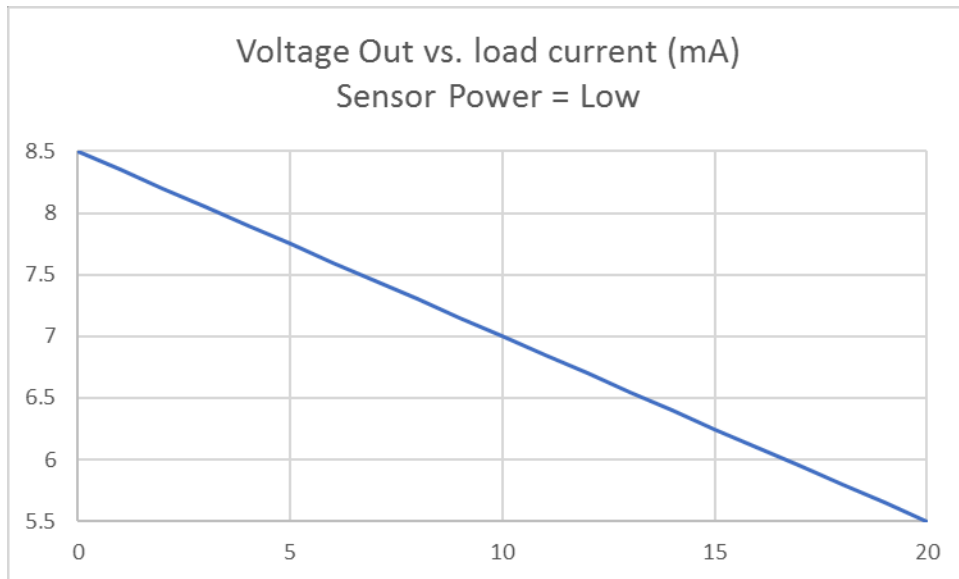
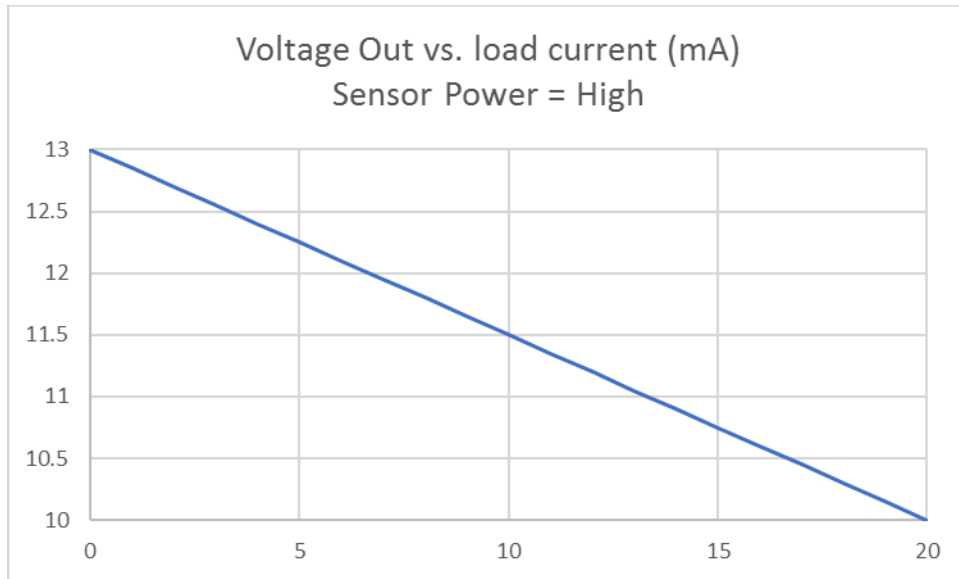


## Sensor Connection



The Sentinel Modbus node has a single terminal block for connection to a Modbus sensor.

The Sentinel has a current limiting resistor of 150 ohms. The voltage available to the sensor depends on the sensor current load. See the graphs below for details:



**If the Sentinel-Solar is used the maximum load current is limited to 14mA.**

## Communication Settings

The Sentinel Modbus needs to have its serial RS-485 parameters set to match the device it's communicating with. Default settings are a baud rate of 9600bits/s, UART mode 8N1 (8 data bits, no parity bit, 1 stop bit), command timeout of 1000ms, and command pause of 100ms. This should be sufficient for most devices but check your device's datasheet to confirm. Note that the Gateway and Sentinel's RS-485 settings are unrelated and do not need to match.

The Modbus ID should match the ID of the connected Modbus device. Click **Find Sensor Modbus ID** if the ID of the connected sensor is unknown.

Make sure that there are no duplicate Modbus IDs in a given network; the gateway will only cache one set of data for each Modbus ID, so the duplicate will be overwritten.

## Modbus Program Steps Configuration

The register set to poll on each check-in must be defined using program steps. The Sentinel Modbus can have up to 34 program steps. A program step consists of a function code, starting address, and number of consecutive registers.

Possible function codes are:

- 0x01: Read discrete output (limit: 1 coil)
- 0x02: Read discrete input (limit: 1 coil)
- 0x03: Read holding register
- 0x04: Read input register
- 0x05: Write discrete output

The register address entered is subtracted by the offset in the Register Addressing Mode. The offset can be 0 or 1. For example, with One Based Addressing, a holding register of address 3990 should be entered as function code 0x03, address 3991.

	Function Code	Register Address	Count*	Status
▶ 1	0x03 - Read Holding Register	3990	2	Passed
2	0x03 - Read Holding Register	3996	1	Passed
3	0x03 - Read Holding Register	4005	2	Passed
4	0x03 - Read Holding Register			Unknown
5	0x03 - Read Holding Register			Unknown
6	0x03 - Read Holding Register			Unknown
7	0x03 - Read Holding Register			Unknown
8	0x03 - Read Holding Register			Unknown
9	0x03 - Read Holding Register			Unknown
10	0x03 - Read Holding Register			Unknown
11	0x03 - Read Holding Register			Unknown
12	0x03 - Read Holding Register			Unknown
13	0x03 - Read Holding Register			Unknown
14	0x03 - Read Holding Register			Unknown
15	0x03 - Read Holding Register			Unknown
16	0x03 - Read Holding Register			Unknown
17	0x03 - Read Holding Register			Unknown
18	0x03 - Read Holding Register			Unknown

\*NOTE: Count is limited to 25 registers per step. (If using Enron Modbus, limit is 12.)

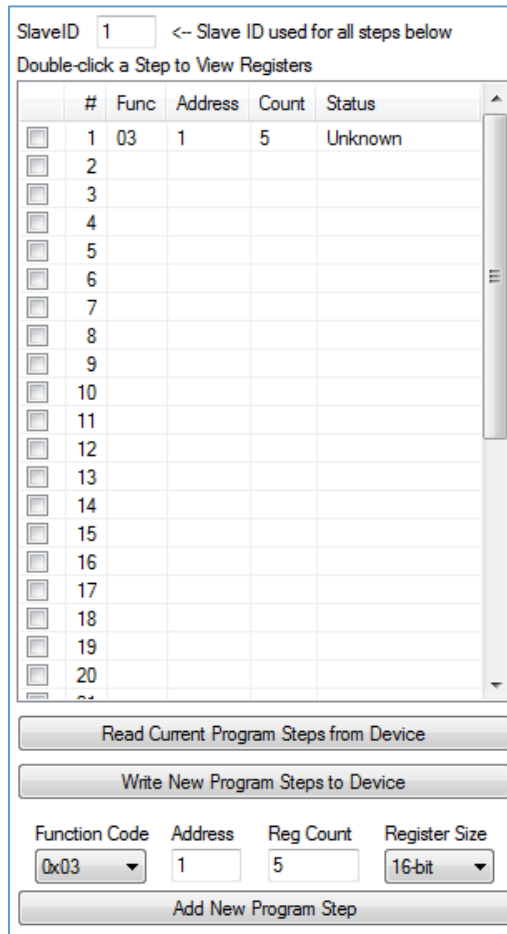
A count of 25 registers per step can be set unless using Enron Modbus. In that case, the limit is 12 registers per step. Keep in mind that one 32-bit floating point register should be read as two 16-bit registers. When writing the steps to the Sentinel, a warning will pop-up if too many registers are requested.

Click **Read Steps from Sentinel** to view the current program steps in the table. To add a new program step, fill in the next empty line. To delete a step, click on the line number and press the Delete key. Lines can also be copy/cut and pasted. Once all the desired program steps have been entered, click **Write Steps to Sentinel** to save the changes.

### Modbus Program Steps Configuration (Legacy)

If using toolkit version 2.2.18 or earlier, the menu to enter program steps will be different.

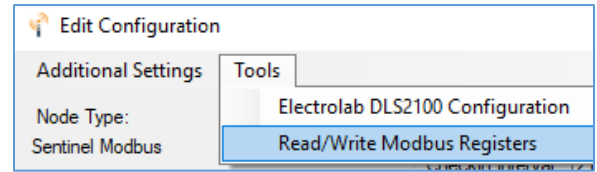
Click **Read Current Program Steps from Device** to view the current program steps in the table. They can then be deleted or re-ordered using the buttons to the right of the table. To add a new program step, fill in the 4 boxes at the bottom, and click **Add New Program Step**. If the step is valid, it will be added to the table. Finally, click **Write New Program Steps to Device** to save the changes.



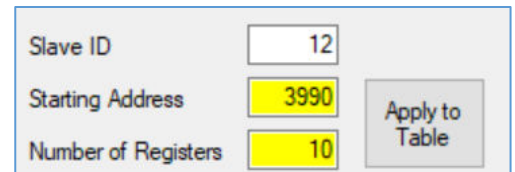
*Note:* In the legacy menu, the Register Addressing Mode is locked to One Based Addressing, so 3990 should be entered as 3991.

## Read/Write Modbus Registers

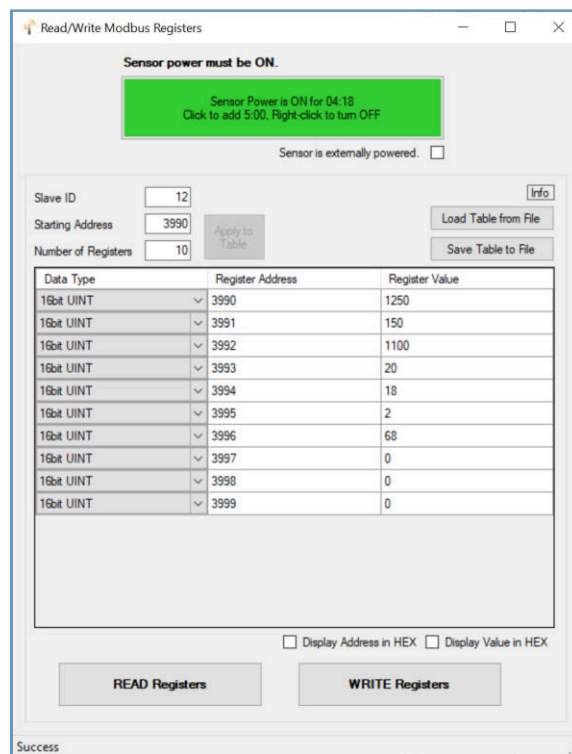
Modbus registers of devices that have an RS-485 interface can be read and written through the Gateway when the device is in remote configuration mode. This is useful for testing or for setting configuration parameters in the end Modbus device. For information on remote configuration, see the Gateway manual. Once the Modbus remote configuration window has been brought up, select 'Tools' and then 'Read/Write Modbus Registers.'



Create the register list by entering the Modbus ID (defaults to the Modbus id of the device), starting address, number of registers and click Apply to Table. The form will populate with the number of registers starting at the start address and a default data type of unsigned 16-bit integer.



Click 'READ Registers' to read the current Modbus registers from the device. The Data Type and Register Value fields can be edited, and the changes will be highlighted. Click WRITE Registers to write the changes to the Modbus registers in the device.



Both 16-bit (default) and 32-bit register sizes are supported. Whenever Modbus registers are read, the register size is changed to match the incoming data. The Data Type pull-down only lists data types that support the register size and unsupported data types in the register list are changed to the default data type for the register size.

## 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.

In addition to the pre-configured registers read from the attached sensor, the Sentinel will send system information in 16-bit registers listed in the table below. This data is accessible at the same Modbus ID as the connected Modbus device.

### Status Registers

Register Number	Register Address (Offset)	Description
49986	9985 or 65522	Checkin Interval (in seconds)
49987	9986 or 65523	Status (0=no errors, 1=low battery (3V Threshold), 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. 45 for Sentinel Modbus

Note: The status registers are only available from the 49987-49999 (9986-9998) address range if the Gateway is running firmware 7.52 or higher. 49986 (9985) is available if the Gateway is running firmware 8.28 or higher.



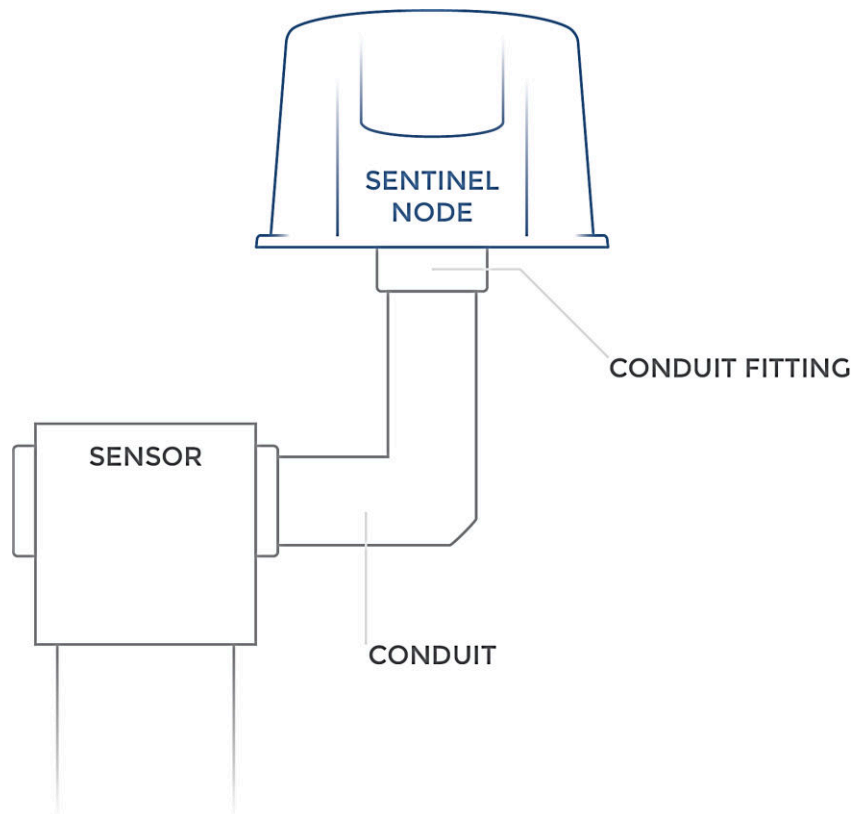
## Mounting and Care

# 16

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.**

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.



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

### Technical Support and Contact Information

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

### Revision History

Revision	Date	Changes/Updates
1.1	10/09/12	Initial release
1.2	11/7/14	Updated entity parameters
1.3	6/5/15	Updated design
1.4	8/1/16	Added section on Encryption
1.5	3/6/17	Added graphs for sensor voltage
1.6	9/13/17	Updated warnings
1.7	1/17/2019	Updated low battery register to general status register Minor formatting updates
1.8	3/25/2020	Remote Modbus R/W
1.9	7/9/2020	Updated Modbus program steps menu, new checkin register
1.10	5/24/2021	Specified low battery alarm threshold
1.11	1/20/2022	Updated screen shots. Added usage of <b>Find Sensor Modbus ID</b> button. Added description of register count.
1.12	6/3/22	Added detail on battery connection

## APPENDIX - FCC and IC Statements

# 19

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.*