

Interface Manual

Sentinel Node 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

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.






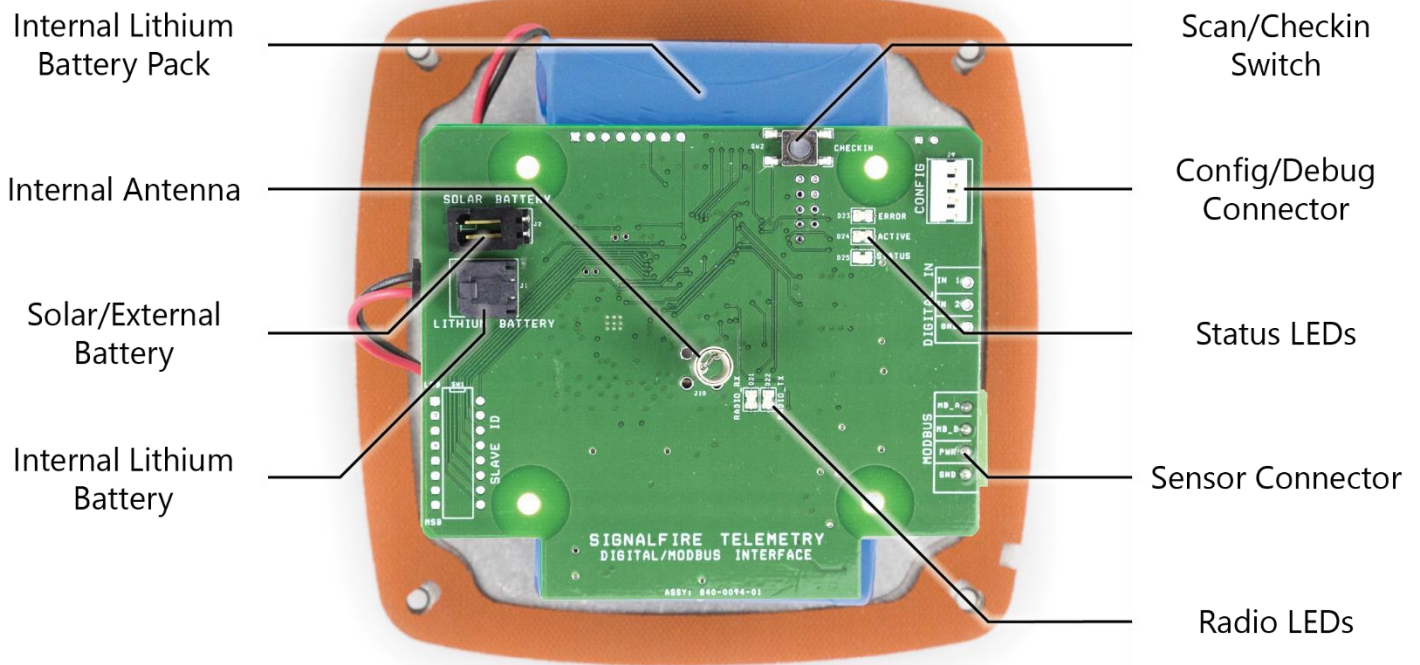
WARNING: The use of any parts not supplied by the manufacturer violates the safety rating of the equipment.

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 	
 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 INPUT POWER: OUTPUT (J11): [Exi] Vmax = 5.9 Vdc Voc = 14.7 Vdc Imax = 3.1 A Isc = 119.14 mA Pmax = 0.8 W Ca = 3.86 uF Ci = 29.43 uF La = 10.02 mH Li = 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

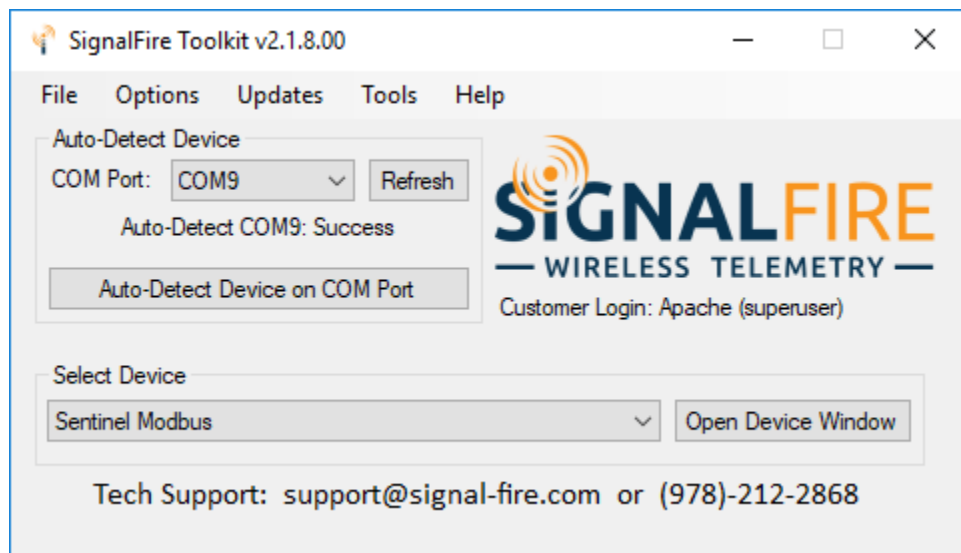
All settings are made using the SignalFire Toolkit PC application and a serial programming cable.



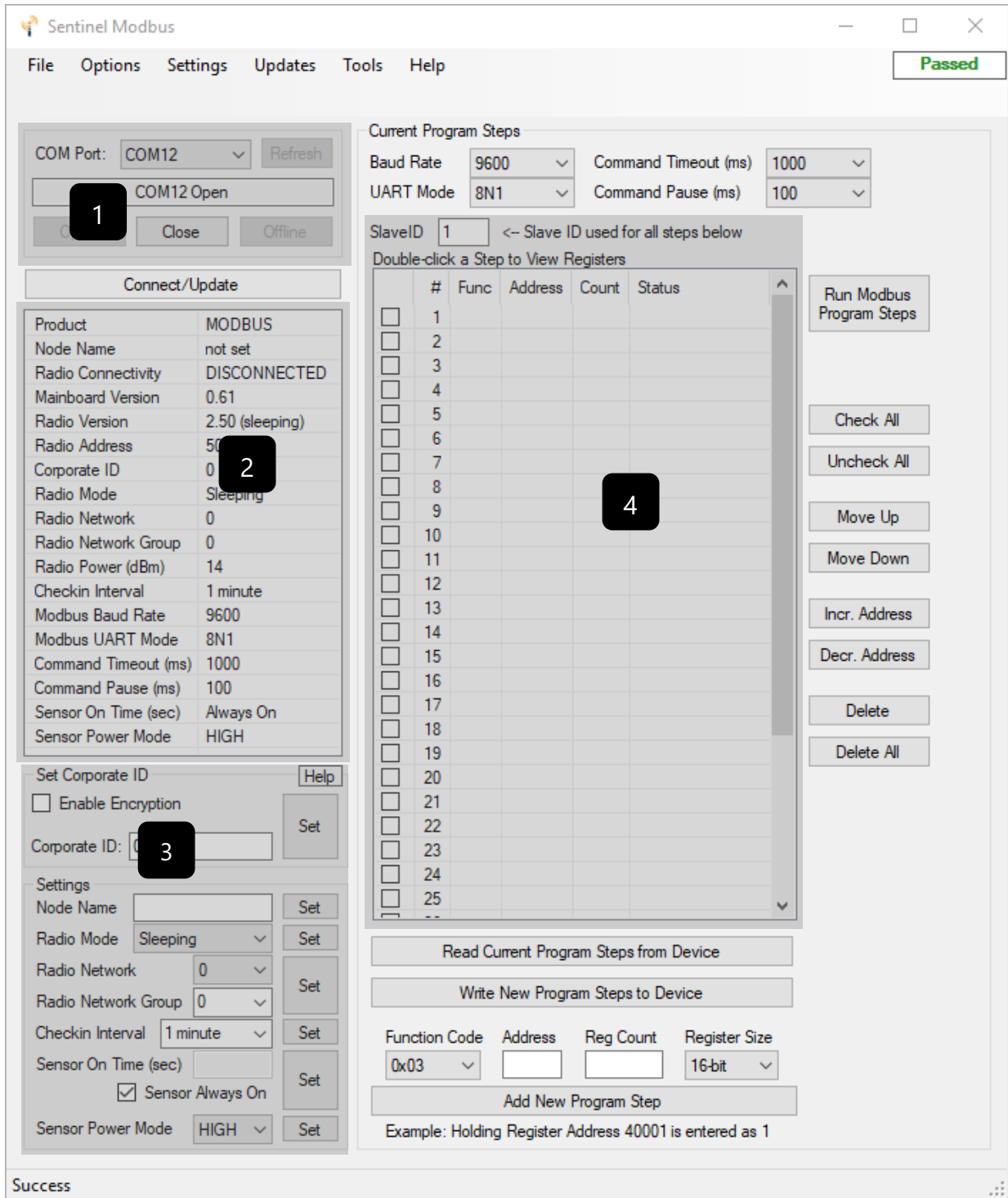
WARNING: Perform the steps in this section (Setup) in a safe location only.

Using the SignalFire Toolkit

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



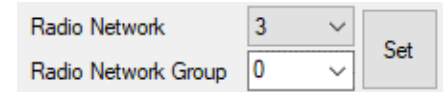
Select the COM port associated with the Sentinel Node and click "Auto-Detect Device on COM Port." This will open the device configuration window, where all device settings can be configured.



- ① COM Settings
- ② Node Information
- ③ Configurable node settings
- ④ Current Program Steps

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.**

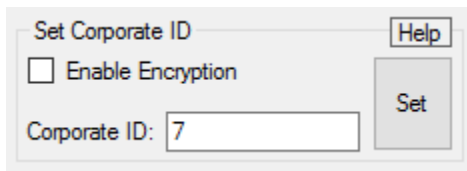


Radio Network 3
Radio Network Group 0

Encryption

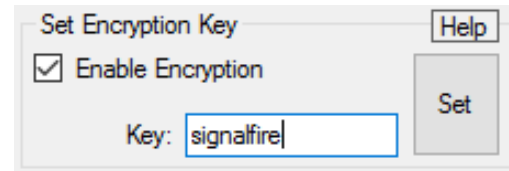
To protect your over-the-air data and prevent tampering, SignalFire networks come with encryption. Legacy products use a Corporate ID, but can be switched over to use an encryption key if the firmware and ToolKit are up to date.

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

Corporate ID

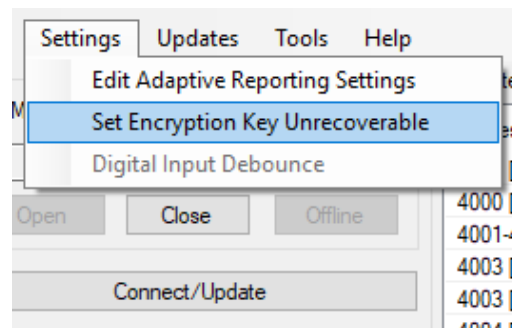


Set Encryption Key
 Enable Encryption
Key: signalfire

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

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.

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. 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 On Time (sec)
 Sensor Always On

Modbus Program Steps Configuration

The register set to poll on each check-in must be defined using program steps. A program step consists of one of the following Modbus opcodes:

- 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

Up to 34 program steps can be programmed. Any response from a Modbus device (data or exception) will be forwarded to the Modbus Gateway and cached. 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 5 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.

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

Note: The register address entered is subtracted by the Address Offset field to the right of the table. Typically, the offset is 1. For example, a holding register of address 3990 should be entered as function code 0x03, address 3991. Keep in mind that one floating point register should be read as two 16-bit registers.

SlaveID <-- Slave ID used for all steps below

Double-click a Step to View Registers

	#	Func	Address	Count	Status
<input type="checkbox"/>	1	03	1	5	Unknown
<input type="checkbox"/>	2				
<input type="checkbox"/>	3				
<input type="checkbox"/>	4				
<input type="checkbox"/>	5				
<input type="checkbox"/>	6				
<input type="checkbox"/>	7				
<input type="checkbox"/>	8				
<input type="checkbox"/>	9				
<input type="checkbox"/>	10				
<input type="checkbox"/>	11				
<input type="checkbox"/>	12				
<input type="checkbox"/>	13				
<input type="checkbox"/>	14				
<input type="checkbox"/>	15				
<input type="checkbox"/>	16				
<input type="checkbox"/>	17				
<input type="checkbox"/>	18				
<input type="checkbox"/>	19				
<input type="checkbox"/>	20				

Read Current Program Steps from Device

Write New Program Steps to Device

Function Code Address Reg Count Register Size

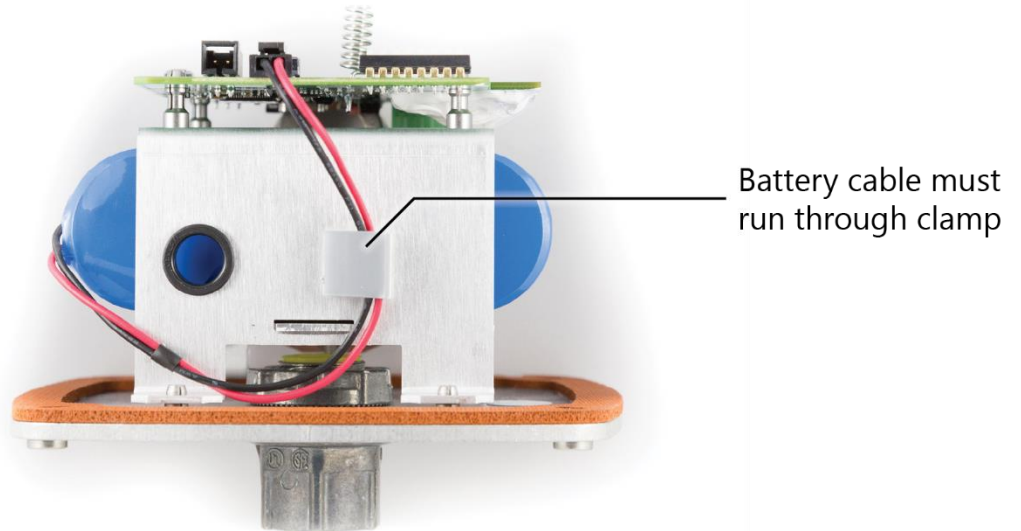
Add New Program Step

Sensor Connections

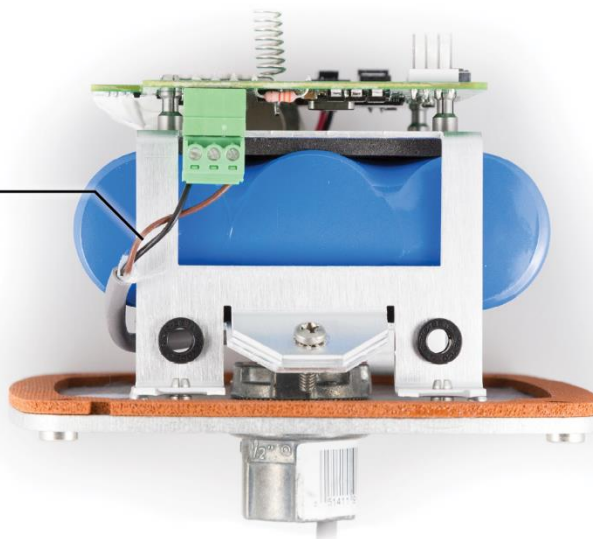
Wiring Requirements

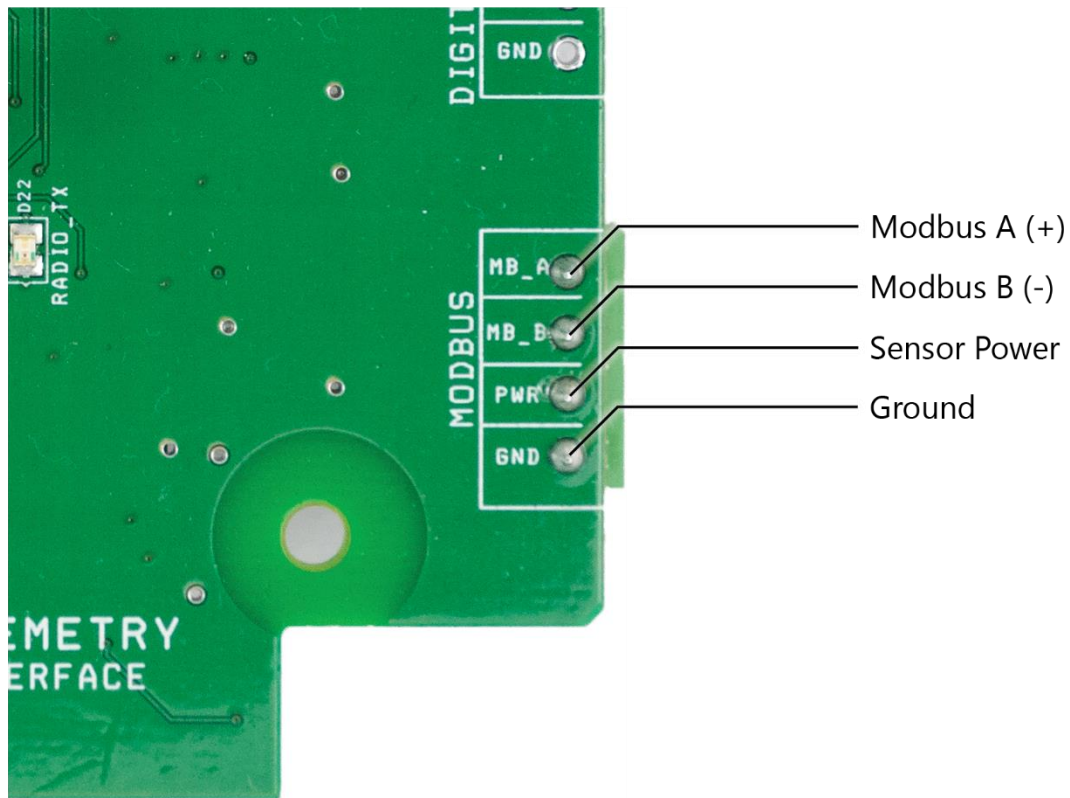
To ensure intrinsic safety is maintained it is required that the installer follow these guidelines when connecting sensors to the SignalFire node. See pictures for proper wire routing examples.

- 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.



Sensor cable should be routed as shown

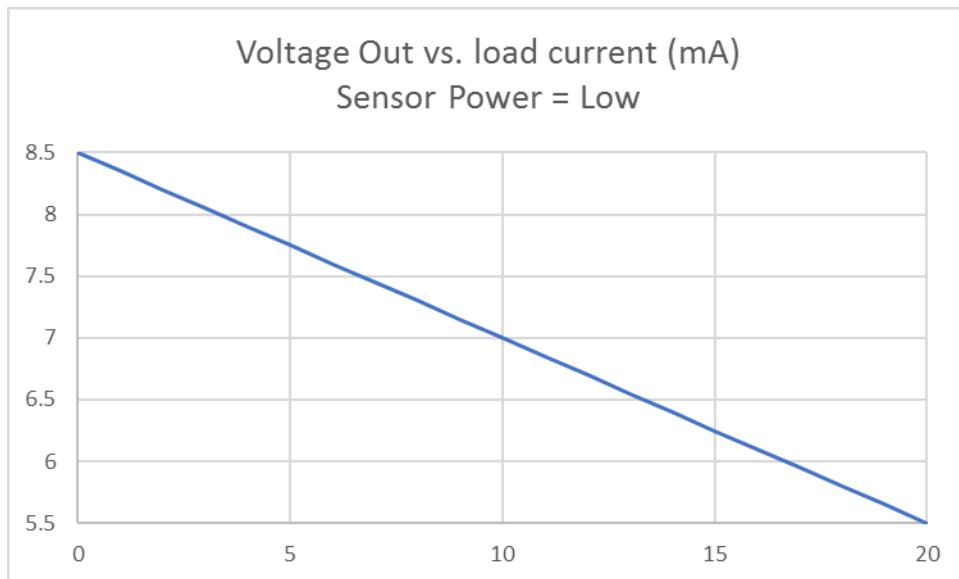
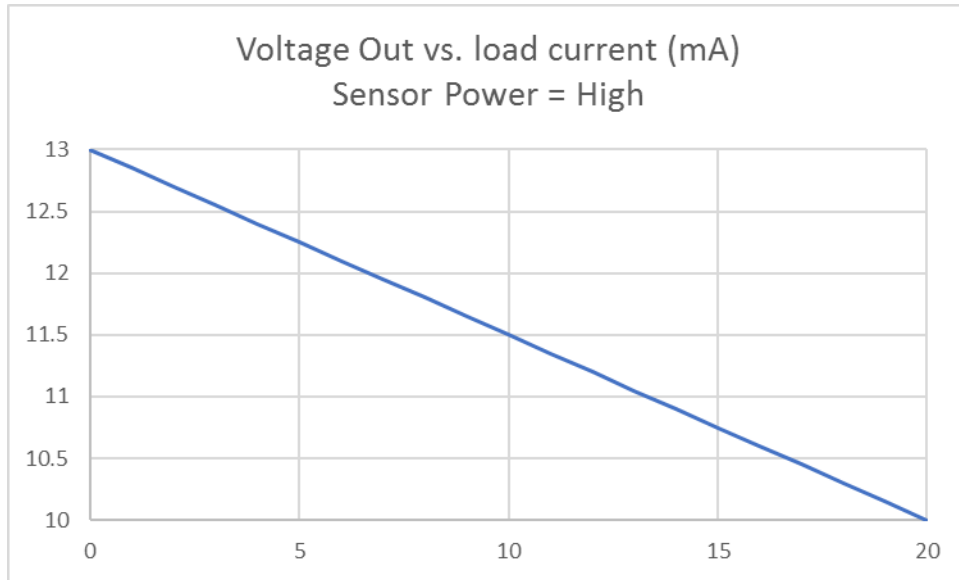




The Sentinel Modbus Node has a single terminal block for connection to a Modbus sensor.

If any of the Sentinel's Modbus program steps fails, it will set the Status register (see page 13) to '2'.

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.

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 Slave ID as the connected Modbus device.

Status Registers

Register Number	Register Address (Offset)	Description
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	Slave ID readback
49995	9994 or 65531	Received signal strength of last packet from the slave
49996	9995 or 65532	Battery voltage of the Modbus client, in millivolts
49997	9996 or 65533	Minutes until this slave will time out, unless new data is received
49998	9997 or 65534	Number of registers cached for this slave device
49999	9998 or 65535	Remote device type. 45 for Sentinel Modbus

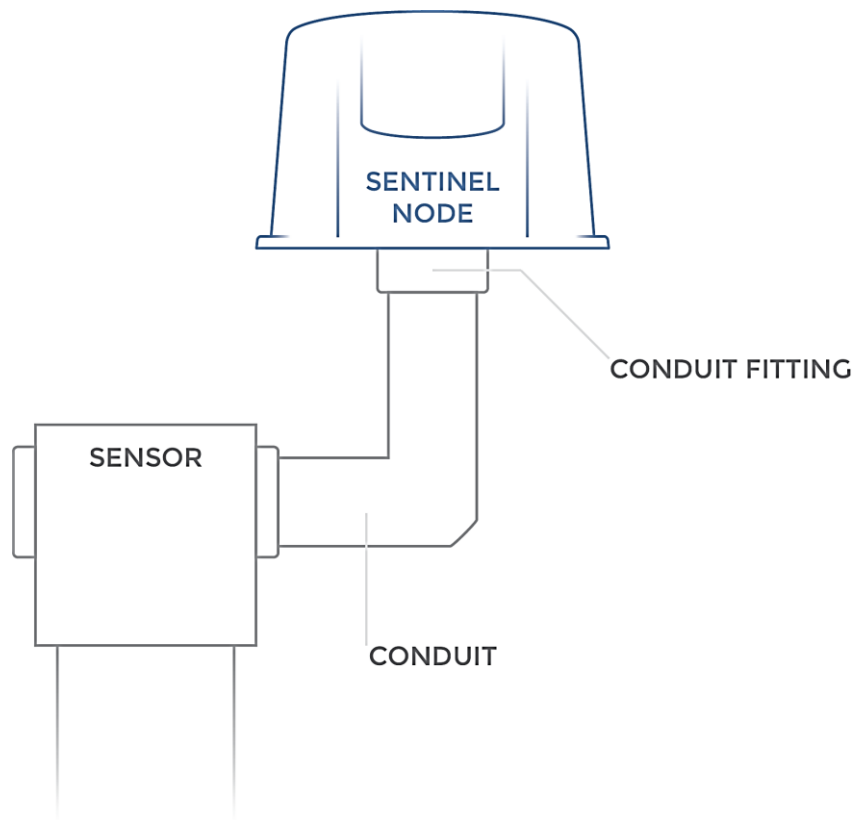
Note: The status registers are only available from the 49987-49999 (9986-9998) address range if the gateway is running firmware 7.52 or higher.

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
(978) 212-2868
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

APPENDIX - FCC and IC Statements

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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.