Interface Manual

Sentinel Node HART

SignalFire Model: Sentinel-HART-XXXX

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

- Powers a single HART sensor at 12.5VDC or 18.0VDC (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
- -AES128bit 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 *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:SH000001
Model: SENTINEL-HART-XXXX

C ETL US LISTED
Intertek 4003827

CLASS I, DIVISION 1 GROUPS C, D
TEMP CODE: T3
AMBIENT TEMP: –40ºC to +60ºC

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]

INPUT POWER:	OUTPUT (J3):
Vmax = 5.9 Vdc	Voc = 21 Vdc
Imax = 3.1 A	Isc = 111 mA
Pmax = 0.8 W	Ca = 1.16 uF
Ci = 34.2 uF	La = 11.5 mH
Li = 14.2 uH	

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

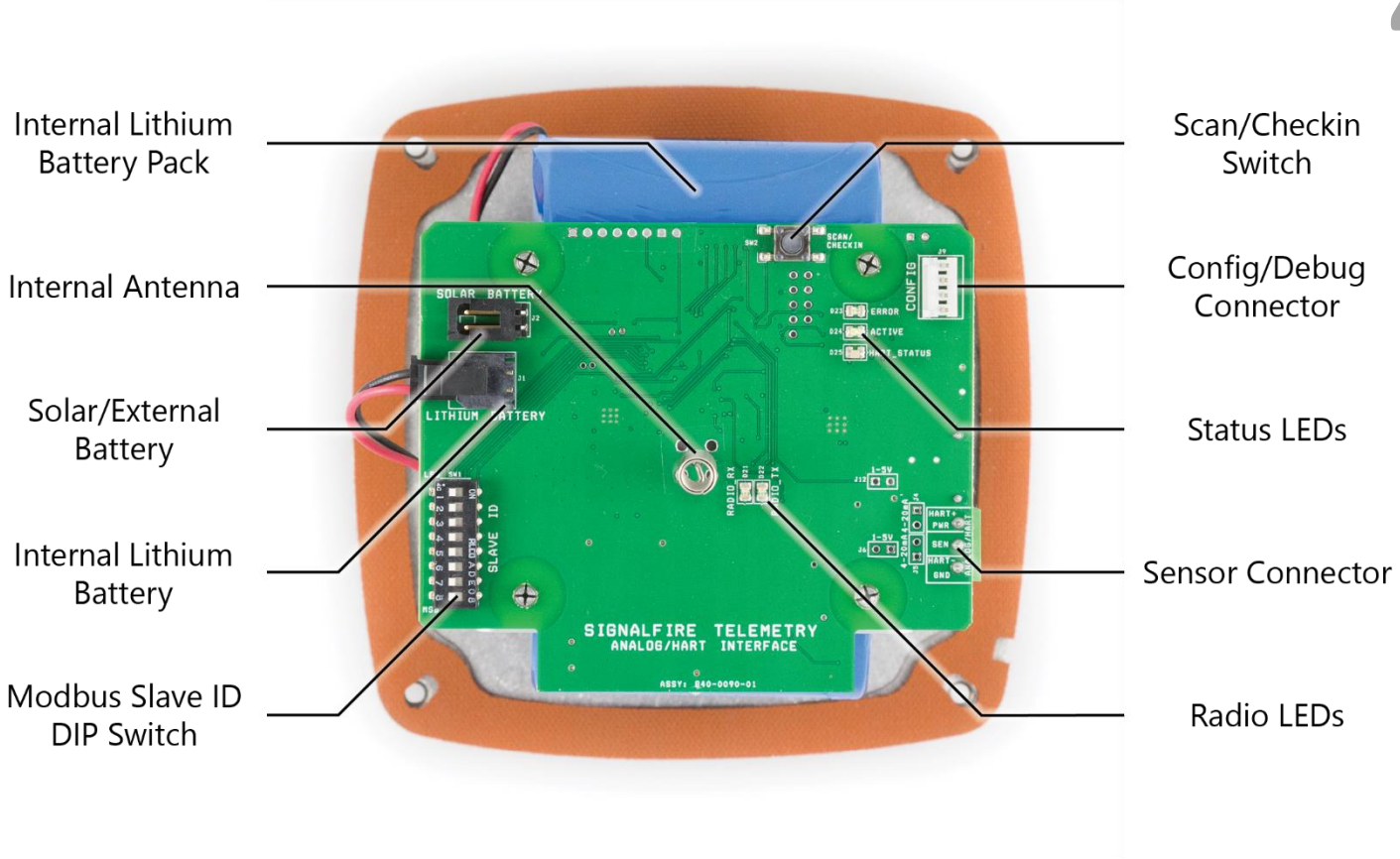
WARNING: POTENTIAL ELECTROSTATIC DISCHARGE HAZARD! SEE INSTRUCTIONS

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

Connections and Components



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 HART_STATUS LED will blink once to indicate a HART sensor is connected after a HART scan is completed. A HART scan is conducted at each power-up or when the Scan/Checkin button is pressed.
- 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 and scan for the HART sensor. If the Hart sensor is detected the HART_STATUS LED will blink once and its data will be read. The Sentinel will also 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:

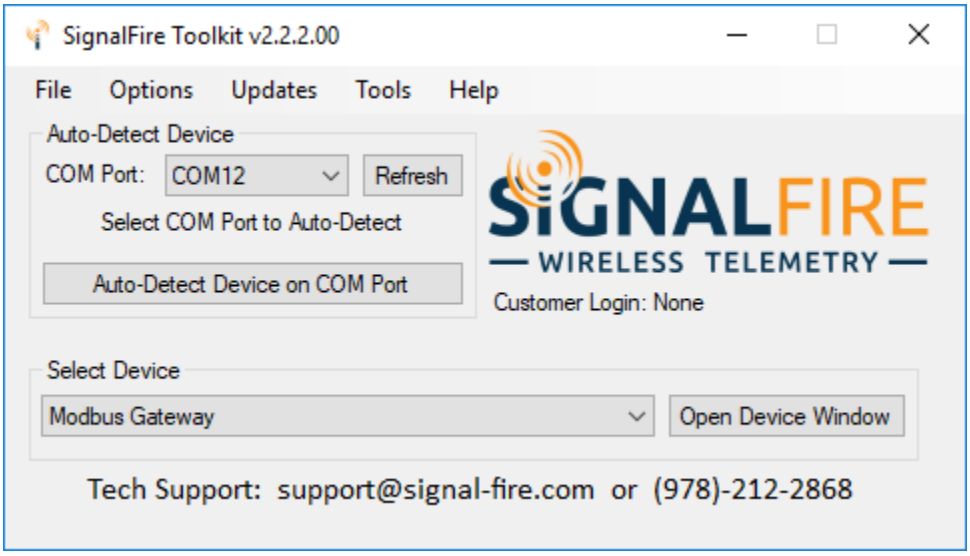
- Network selection
- Check-in period selection
- Modbus ID setting
- Sensor on time/supply voltage

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).

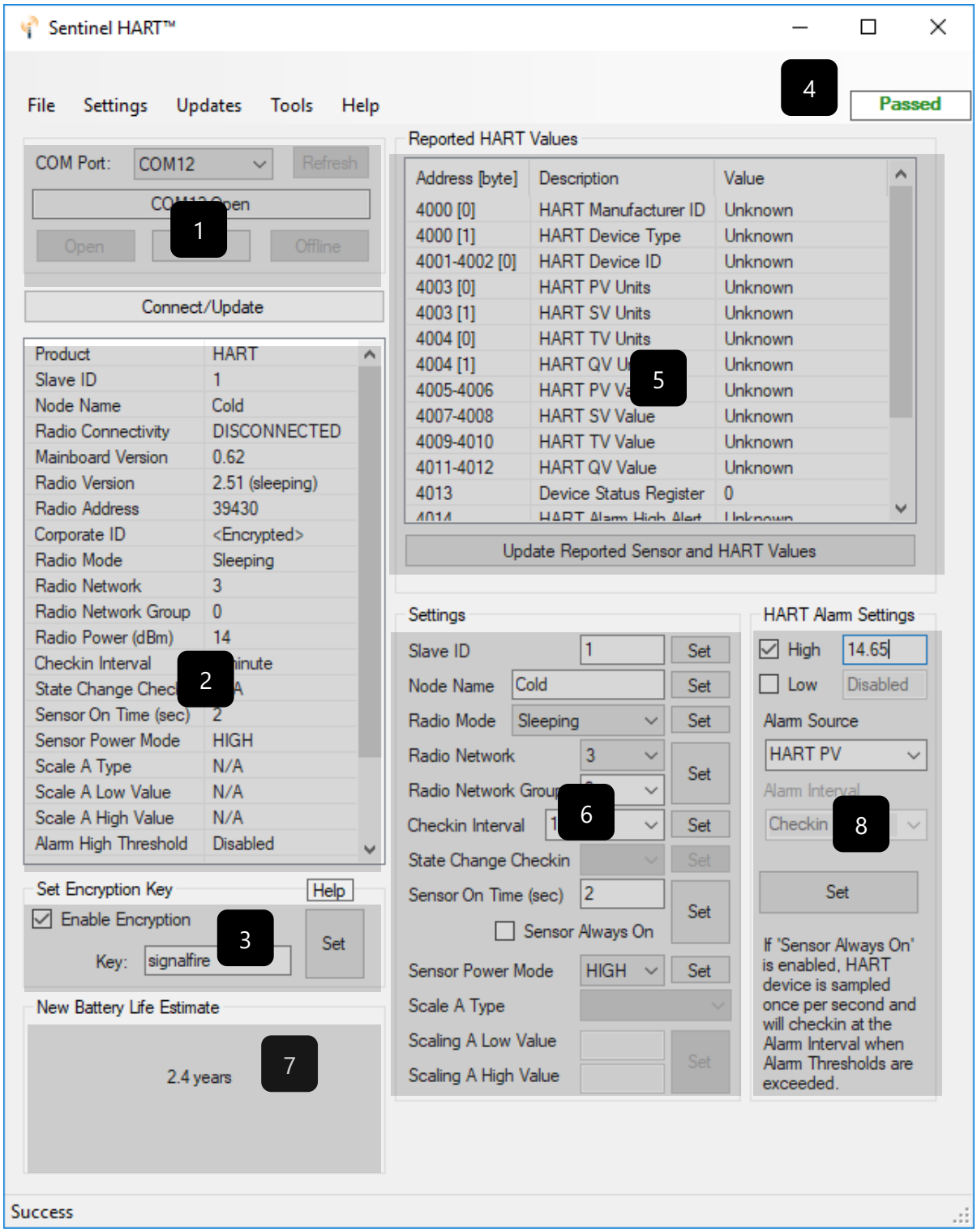
WARNING: Perform the steps in this section (Setup) in a safe location only.

Using the SignalFire Toolkit

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



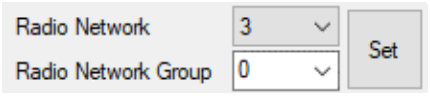
Select the COM port associated with the Sentinel Node and click "Auto-Detect Device on COM Port." This will open the device configuration window, where all device settings can be configured.



1	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 Settings

Network Setting

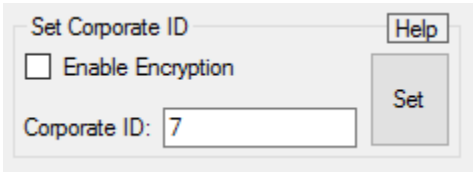
The network is set using the SignalFire Toolkit. **The network, network group, and corporate ID/encryption key settings must match those of the gateway for them to communicate**.



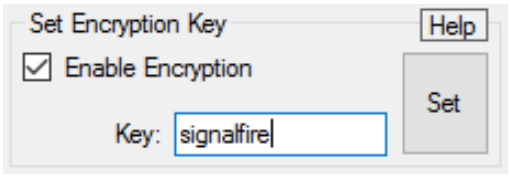
Encryption

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.



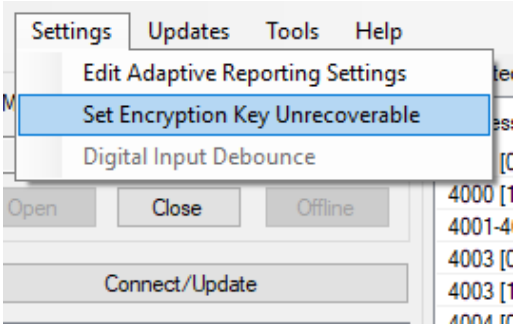
Corporate ID



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.

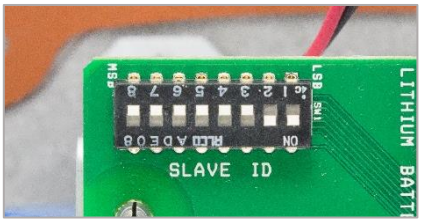
It is also possible to hide your encryption key so it cannot be read. This is the most secure option, but if you forget your key, there is no way to recover it – you have to reset the key on every device on its network. To enable this option, select **Set Encryption Key Unrecoverable** under the **Settings**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

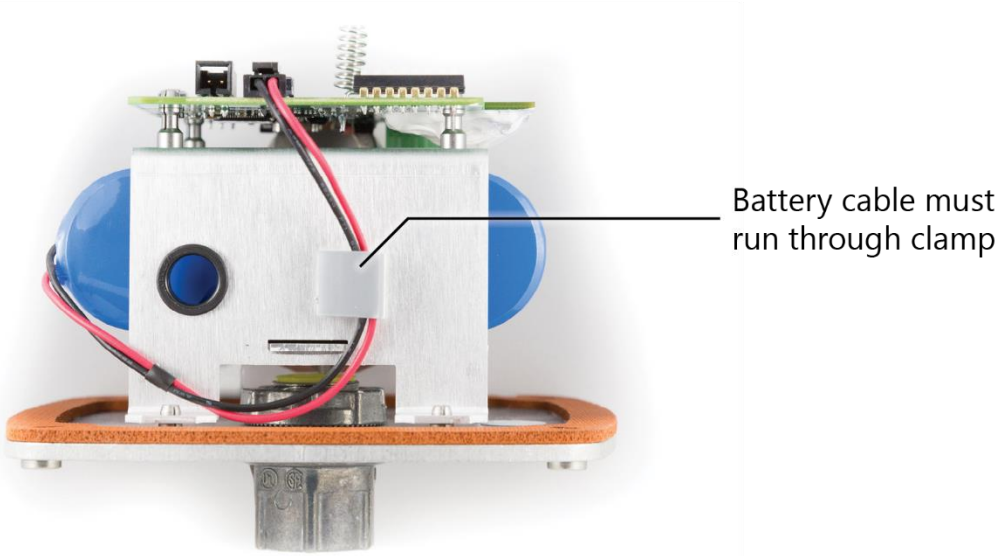


Battery Sensor Connections

Wiring Requirements

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

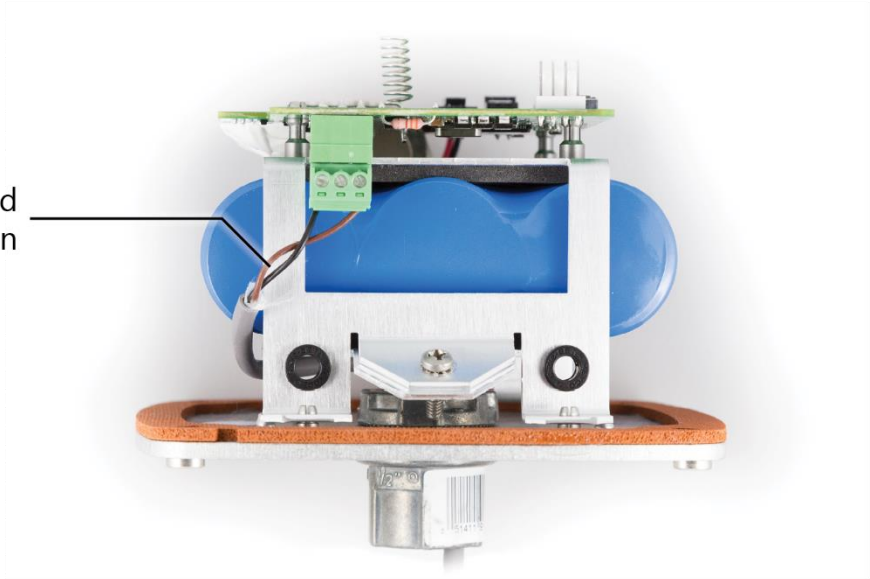
- Sensor wires entering the enclosure must be run as pictured.
- The battery wire must be routed through the battery cable hold-down clamp.
- Strip the wires so that there is minimal exposed un-insulated wire when inserted into the screw terminal.
- All wiring should be neat and orderly.



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.

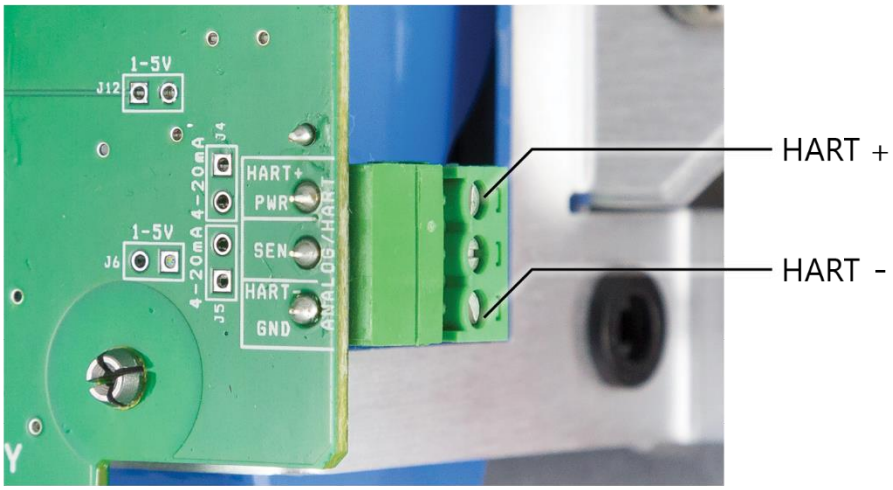
Forcing the battery connecter in backward or into the SOLAR BATTERY connector can damage the battery pack fuse making it inoperable.

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



HART Sensor Connection

A single sensor operating in HART multi-drop mode may be connected to the Sentinel Node. **The HART Sensor must be configured for HART ID 1.** The Sensor HART ID may be configured using the SignalFire Toolkit; see Page 10 for details.

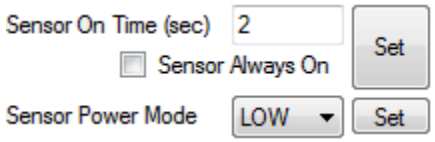


The HART sensor is a 2-wire interface between the Sentinel Node and the HART sensor. The positive (**HART+**) terminal of the sensor is connected to the top terminal on the Sentinel Node. The negative (**HART-**) is connected to the bottom terminal of the Sentinel Node. The middle terminal of the node should be left unconnected.

Sensor Settings

The Sentinel Node will supply either 18 volts (**HIGH**) or 12 volts (**LOW**) to the sensor, selectable in the Toolkit. The Sensor On Time must be configured to account for the time to warm up the sensor for an accurate reading. 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** (12V) will result in longer battery life, but some sensors require higher voltage.

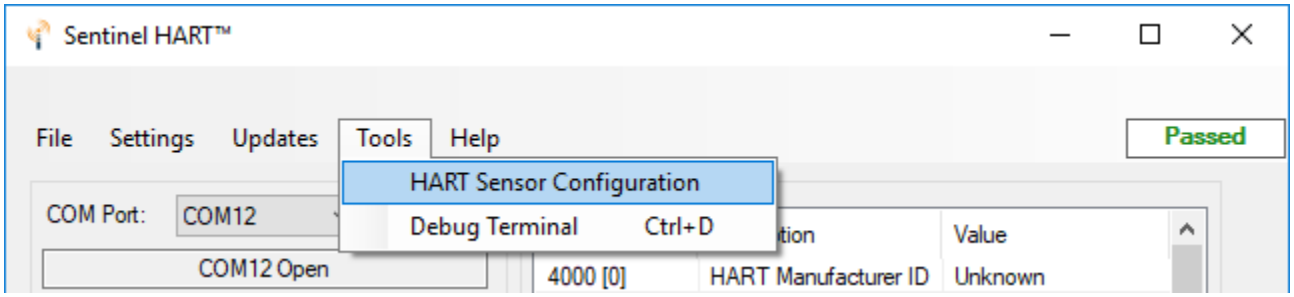
It is possible to power a HART sensor full time if the Sentinel-Solar system is being used. This is useful for rapid data collection on a sensor that has a long warm-up time. This is set in the SignalFire Toolkit as **Sensor Always On**.



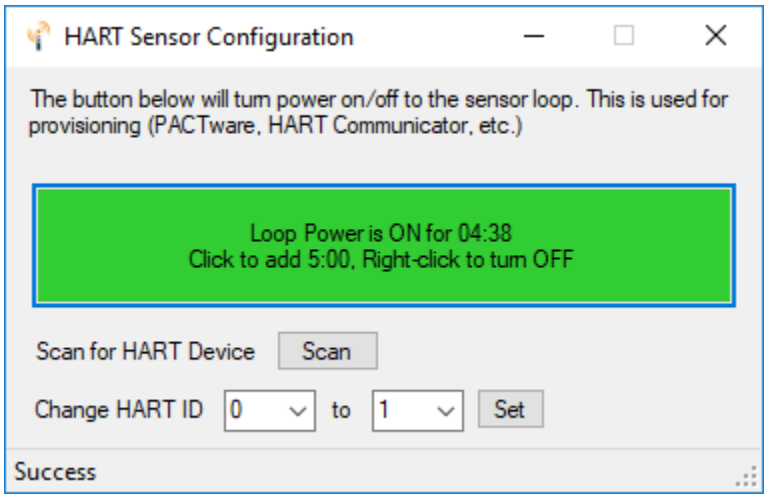
HART Sensor Configuration

The Sentinel requires that the attached HART sensor is configured to HART ID 1 "multi-drop" mode. The sensor may be configured using a HART modem or built in display/buttons. Alternatively, the Sentinel provides tools that allow the HART ID of the attached sensor to be changed.

To set the HART ID, go to the **Tools** dropdown menu and select **HART Sensor Configuration**.



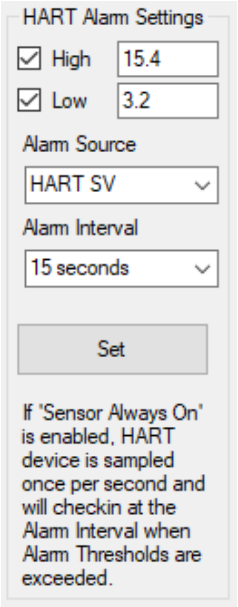
If the sensor is not set to **Sensor Always On**, first click the large button to power the sensor for configuration. Each click will power the sensor for 5 minutes, or until turned off. If the attached sensor has a warm-up time wait until the sensor is fully powered on before the next step.



To change the HART ID the initial ID must be known. To find the ID, click **Scan**. Most sensors default to 0. To change the ID, select the existing ID on the left, select 1 on the right, and click the **Set** button.

HART Alarms

Starting with firmware version 0.62 and ToolKit version 2.2, the Sentinel HART can be set to send an alarm flag based on one of its variables. To use the HART alarms feature, the sensor must be configured to "always on", which typically requires solar or DC power. To enable the alarm, check the High or Low box under Alarm Settings, enter in the desired threshold value, and select which variable to use as the reference. If the sensor is always on, the Sentinel takes a reading every second, and sends a check-in to the Gateway every 5 or 15 seconds depending on how it's configured. Otherwise, the Sentinel checks in as normally scheduled.



In the example shown, if the SV falls below 3.2 it sets the Low Alarm register to 1, and if the SV rises above 15.4 it sets the High Alarm register to 1. Because the sensor is always on, if either threshold is crossed, the Sentinel will check in every 15 seconds instead of every minute as configured.

Remote Modbus Register Mapping

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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
44001	4000	HART ID 1: Manufacturer's ID Code/Device Type (ID=MSB, Device=LSB)
44002	4001	HART ID 1: Device ID Number (ID high bite = MSB, ID mid byte = LSB)
44003	4002	HART ID 1: Device ID Number, HART Status (ID low byte = MSB, Status = LSB)
44004	4003	HART ID 1: PV & SV Units Code (PV=MSB, SV=LSB)
44005	4004	HART ID 1: TV & QV Units Code (TV=MSB, QV=LSB)
44006-44007	4005-4006	HART ID 1: Primary Variable (PV) (two registers) (float)
44008-44009	4007-4008	HART ID 1: Secondary Variable (SV) (two registers) (float)
44010-44011	4009-4010	HART ID 1: Tertiary Variable (TV) (two registers) (float)
44012-44013	4011-4012	HART ID 1: Quaternary Variable (QV) (two registers) (float)
44014	4013	HART Sensor communication status. 1=Comms OK, 0=No Comms
44015	4014	HART Alarm High Alert
44016	4015	HART Alarm Low Alert
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. 43 for Sentinel HART

Note: The status registers are only available from the 49900-499999 (9987-9998) address range if the gateway is running firmware 7.52 or higher.

Register Map Added when Nivelco Thermopoint Sensor Detected*

Register Number	Register Address (Offset)	Description
44017	4016	Error Flags (see Table 1)
44018	4017	Status Flags (see Table 1)
44019	4018	Number of Sensors
44020	4019	Units
44021	4020	Sensor 1 Data
44022	4021	Sensor 2 Data
44023	4022	Sensor 3 Data
44024	4023	Sensor 4 Data
44025	4024	Sensor 5 Data
44026	4025	Sensor 6 Data
44027	4026	Sensor 7 Data
44028	4027	Sensor 8 Data
44029	4028	Sensor 9 Data
44030	4029	Sensor 10 Data
44031	4030	Sensor 11 Data
44032	4031	Sensor 12 Data
44033	4032	Sensor 13 Data
44034	4033	Sensor 14 Data
44035	4034	Sensor 15 Data

*If a Nivelco Thermopoint sensor is installed, it will be automatically detected and send in the additional registers.

Table 1

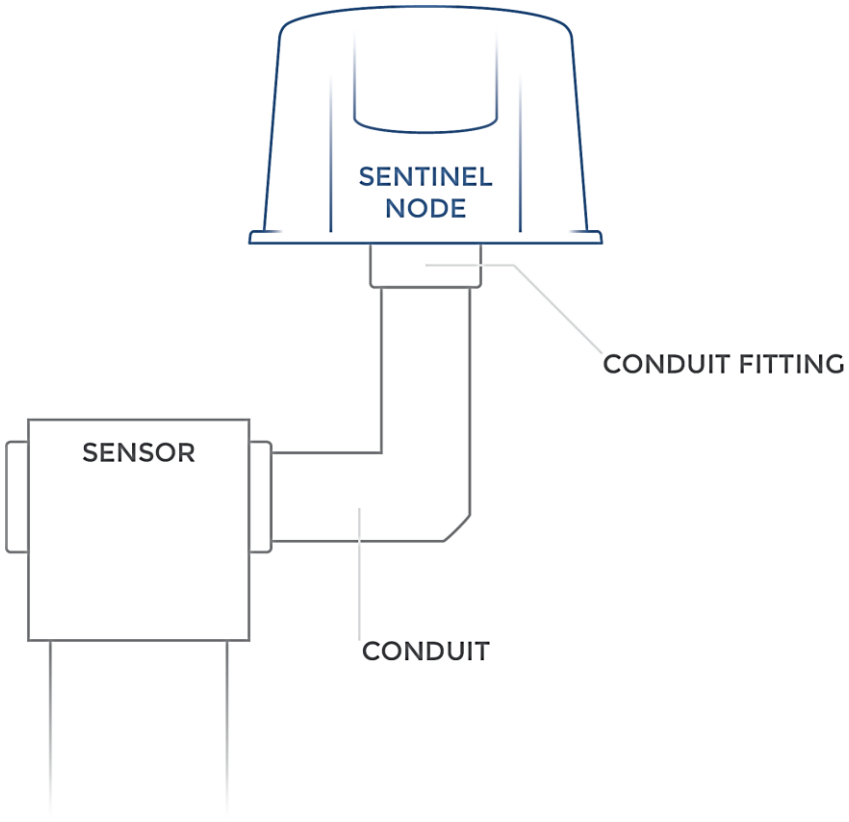
Bit Position	Error Flags	Bit Position	Status Flags
0	No sensor	3	Manual prog. is active
1	EEPROM comm failure	4	Remote prog. is active
2	EEPROM CRC error	6	User psw. present
7	Analog card comm failure	8	User sec. level is locked
8	Sensor zero address detected	9	Factory sec. level is locked
9	Sensor multiple addresses	10	Display available
10	Sensor missing address	13	Calibration mode is active
11	Sensor bus short circuited	14	Readout is valid

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 change 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
1.2	10/11/12	Initial release
1.3	6/24/13	Added selection on HART Sensor configuration via the SignalFire Toolkit
1.4	11/7/14	Updated entry parameters
1.5	6/4/15	Updated design & minor revisions
1.6	3/14/16	Edits to register map
1.7	8/1/16	Added section on encryption
1.8	9/13/17	Updated installation warning
1.9	9/5/18	Added HART Alarm settings
1.10	2/8/19	Minor formatting updates
1.11	10/2/19	Add Modbus Registers for Nivelco Thermopoint Sensor
1.12	3/31/22	Update Register 49987 description.
1.13	6/3/22	Added detail on battery connection

APPENDIX - FCC and IC Statements

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.