Interface Manual
Sentinel Modbus with 2DI

SignalFire Model: Sentinel-485-2DI-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
- Two digital inputs, perfect for high level alarms
- Reports state of dry contact inputs, open/closed, totalizer. Report on state change
- Can power an attached Modbus sensor at 5.3V or 7.6V 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

<table>
<thead>
<tr>
<th><strong>Specs</strong></th>
<th><strong>Details</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Enclosure Size</strong></td>
<td>3.5” tall × 5.0” wide × 5.0” deep</td>
</tr>
<tr>
<td><strong>Power Source</strong></td>
<td>Internal IS Lithium battery pack&lt;br&gt;<strong>SignalFire Part Number:</strong> 810-0008-02</td>
</tr>
<tr>
<td></td>
<td>External Solar battery system&lt;br&gt;<strong>SignalFire Part Number:</strong> SENTINEL-SOLAR</td>
</tr>
<tr>
<td></td>
<td>Other external power supply meeting the power entity parameters from the control drawing.</td>
</tr>
<tr>
<td><strong>Temperature Rating</strong></td>
<td>-40°C to +60°C</td>
</tr>
<tr>
<td><strong>Radio Frequency</strong></td>
<td>902-928MHz Ism Band, FHSS radio, internal antenna</td>
</tr>
<tr>
<td><strong>Compliance</strong></td>
<td>Certified for use in Class I, Division 1 groups C and D. EXi [EXi] FCC/IC Certified.</td>
</tr>
</tbody>
</table>

**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 960-0076-01 for requirements when used in a Class I Division 1 area.
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 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.
Operating Mode

The Sentinel Modbus-2DI node will report the status of the digital inputs as a set of Modbus registers at its configured Modbus slave ID. The Sentinel may also be configured using the SignalFire Toolkit application with a list of Modbus registers to be read from the attached sensor. Note that the attached Modbus sensor must be set to the same Modbus slave ID as the Sentinel.

The preconfigured set of registers is automatically read from the attached 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.

If the check-in on state change option is set, the Sentinel will read the programmed Modbus register set and forward all data to the Gateway on any state change on either of the digital inputs.

When configured for a non-sleeping radio (radio always on) real-time Modbus reads/writes may be done from the Gateway to the end Modbus device. Note that this mode of operation requires a high capacity solar battery system (Sentinel-HC-Solar).
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.
1. COM Settings
2. Node Information
3. Configurable node settings
4. Command successfully passed to node (displays fail if unsuccessful)
5. Current Program Steps
Network Setting

The network is set using the SignalFire Toolkit. The network, network group, and corporate ID settings must match those of the gateway (and other nodes) in order for them to communicate (the corporate ID is pre-programmed at factory).

Encryption

Starting with Sentinel version 0.50, it is possible to encrypt over-the-air transmissions to prevent tampering. Encryption keys replace the Corporate ID system, so it is important that all devices connected to a Gateway have the same encryption key as well as network and network group number.

To set up a Sentinel to use encryption, click the checkbox labeled Enable Encryption inside the Set Corporate ID box:

The encryption key box. For more details, click the Help button.

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. This will cause the Sentinel to drop its network, and only attempt to join networks that use the same encryption key. 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.

Setting the encryption key.

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 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.

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. A common sensor for this Sentinel is the ElectroLab 2100, this device requires only a 0.25 second warm up time.
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 MODBUS_READ_COILS (limit: 1 coil)
- 0x03 MODBUS_READ_HOLDING_REGISTERS
- 0x04 MODBUS_READ_INPUT_REGISTERS
- 0x05 MODBUS_WRITE_SINGLE_COIL

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.

Note: The register address entered is subtracted by the Address Offset field to the right of the table. Typically, the offset is 1.

It is important to make sure that, in a given network, there are no duplicate slave IDs. The gateway will only cache one set of data for each Slave ID, so the duplicate will be overwritten.
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.
Modbus Sensor Connection

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

Digital Inputs Connection

The Sentinel Node has two digital input channels; one or both may be used.

Each counter input may be open collector type (sinking ground), dry contact inputs, or voltage pulse type. The inputs can count up to 2000 Hz.

The digital outputs may be connected to the board as shown in the following diagrams:

Dry Contact Connection

Open Collector Connection

Voltage Pulse Connection
The counts accumulate and the current counts are stored into non-volatile memory every two hours. If the system is reset the counts will revert to the last stored value from non-volatile memory.

The system also reports the state of the contact closure input (open or closed) at the time of check-in.

**Digital Input Debounce**

In cases where it is desired to accurately totalize digital input counts it may be necessary to enable the digital input debounce timer. The debounce timer is useful when dealing with dry contacts that may otherwise produce extra counts when they close. To enable the digital debounce, open the configuration window for the node in the SignalFire Toolkit and select **Digital Input Debounce** from the **Settings** menu. A typical value for a dry contact would be 100mS. Any extra counts due to contact bounce within the debounce time setting will be ignored.

**Digital Input State Latch**

The state latch feature is useful in cases when the state of one or both of the digital inputs is “latched” to a value for a configurable number of seconds. This is useful in cases where a fast transition would be sensed by the Sentinel but may happen too quickly to be read from the Gateway. The state latch feature is configured using the ToolKit. For example with if the state latch is set to latch closed for 3 seconds, then any close sensed on the digital input will be reported as closed for 3 seconds even in the input opens in less than 3 seconds.
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.

Register Map

<table>
<thead>
<tr>
<th>Register Number</th>
<th>Register Address (Offset)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>43011-43012</td>
<td>3010-3011</td>
<td>32-bit Hardware counter, 3010=high word (two registers)</td>
</tr>
<tr>
<td>43013</td>
<td>3012</td>
<td>Digital Input state (1=closed, 0=open)</td>
</tr>
<tr>
<td>43014</td>
<td>3013</td>
<td>Average frequency over the last check-in period times 10</td>
</tr>
<tr>
<td>43015</td>
<td>3014</td>
<td>Frequency over 2 seconds at check-in time times 10</td>
</tr>
<tr>
<td>43016</td>
<td>3015</td>
<td>Ave. counts per minute over the check-in period times 10</td>
</tr>
<tr>
<td>43017-43018</td>
<td>3016-3017</td>
<td>32-bit Hardware counter, 3016=high word (two registers)</td>
</tr>
<tr>
<td>43019</td>
<td>3018</td>
<td>Digital Input state (1=closed, 0=open)</td>
</tr>
<tr>
<td>43020</td>
<td>3019</td>
<td>Average frequency over the last check-in period times 10</td>
</tr>
<tr>
<td>43021</td>
<td>3020</td>
<td>Frequency over 2 seconds at check-in time times 10</td>
</tr>
<tr>
<td>43022</td>
<td>3021</td>
<td>Ave. counts per minute over the check-in period times 10</td>
</tr>
<tr>
<td>49988</td>
<td>9987 or 65524</td>
<td>Major revision number for the mainboard</td>
</tr>
<tr>
<td>49989</td>
<td>9988 or 65525</td>
<td>Minor revision number for the mainboard</td>
</tr>
<tr>
<td>49990</td>
<td>9989 or 65526</td>
<td>Major revision number for the radio</td>
</tr>
<tr>
<td>49991</td>
<td>9990 or 65527</td>
<td>Minor revision number for the radio</td>
</tr>
<tr>
<td>49992</td>
<td>9991 or 65528</td>
<td>High 16 bits of SFTS node address</td>
</tr>
<tr>
<td>49993</td>
<td>9992 or 65529</td>
<td>Low 16 bits of SFTS node address (the radio ID)</td>
</tr>
<tr>
<td>49994</td>
<td>9993 or 65530</td>
<td>Slave ID readback</td>
</tr>
<tr>
<td>49995</td>
<td>9994 or 65531</td>
<td>Received signal strength of last packet from the slave</td>
</tr>
<tr>
<td>49996</td>
<td>9995 or 65532</td>
<td>Battery voltage of the Modbus client, in millivolts</td>
</tr>
<tr>
<td>49997</td>
<td>9996 or 65533</td>
<td>Minutes until this slave will time out, unless new data is received</td>
</tr>
<tr>
<td>49998</td>
<td>9997 or 65534</td>
<td>Number of registers cached for this slave device</td>
</tr>
<tr>
<td>49999</td>
<td>9998 or 65535</td>
<td>Remote device type. 53 for Sentinel Modbus with 2DI</td>
</tr>
</tbody>
</table>
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.
Configuration / Debug

⚠️ 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
43 Broad St C-300
Hudson, MA 01752
(978) 212-2868
support@signal-fire.com

Revision History

<table>
<thead>
<tr>
<th>Revision</th>
<th>Date</th>
<th>Changes/Updates</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>6/9/16</td>
<td>Initial release</td>
</tr>
<tr>
<td>1.1</td>
<td>9/14/17</td>
<td>Added section on encryption, updated warnings</td>
</tr>
</tbody>
</table>
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.i.r.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 par l’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 isotope rayonnée équivalente (p.i.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.