

Interface Manual

Modbus-Stick

SignalFire Number: MBS-CBBL



The SignalFire Modbus-in-a-Stick has the following features:

- RS485 connection to Modbus devices (RS232 Modbus interface can be special ordered)
- Wide range DC power input. 6 to 36VDC
- Configurable check-in period and network address
- Configurable Modbus register polling and/or transparent register mode
- Modbus register writes to remote nodes
- Full time mesh node can forward messages from other SignalFire devices including sleeping nodes
- Sends data to SignalFire Modbus Gateway
- Integrated 500mW FHSS 900MHz ISM band radio and high gain antenna
- AES 128bit Encryption

Connections

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The Modbus-in-a-Stick is supplied with a 6 conductor cable. The connections are as follows:

Wire Color	Connection
RED	Positive Power (6 to 36 VDC)
BLACK	Ground
GREEN	RS-485 "A", 9600 Baud (default)
BROWN	RS-485 "B", 9600 Baud (default)
ORANGE	RS-232 Debug/Programming TX, 9600 Baud
YELLOW	RS-232 Debug/Programming RX, 9600 Baud

When configured as a RS232 Modbus stick (base marked "232"), Green = Stick RX, Brown = Stick TX. Ground must also be connected when using RS232 interface.

Status LED

The Modbus-in-a-Stick has one LED available for field diagnostics.

LED	Description
Slow Flash (3 second pause)	System is running and in communication with radio network
Fast Flash (0.5 second pause)	System is running but no network found
Solid On	System Fault, needs service

Operation

The Modbus-in-a-Stick supports two modes of operation, a preconfigured register set, and an automatic scanning “transparent” mode. The Modbus stick can be used in either mode or a combination depending on the system requirements.

Pre-Configured Register Set Mode

This mode of operation is most useful for large data sets, and frequent polling of a set register map. This mode requires that the Modbus Stick be configured with the register map with the configuration utility at the time of installation.

In this mode, the pre-configured 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. This is the most efficient and robust mode of operation.

Transparent Modbus Mode (version Modbus_r38 and Gateway version 7.37 and later only)

This mode requires no Modbus setup at the Modbus Stick and can be used with a smaller number of registers that only need to be read or written infrequently. All standard Modbus opcodes are supported.

Upon initial power-up the Modbus Stick will automatically poll all slave IDs (1-240) to discover attached devices. Any devices found will be reported to the gateway so that a wireless link will exist to the Modbus device. This scan is automatically repeated every hour in the event that an additional device is added to the bus. The scan may also be initiated from the Modbus Stick’s debug port, or remotely from the Modbus Gateway. See the Modbus Gateway manual for register details.

Alternatively, one or more Modbus Program steps can be entered for a given slave ID so that the Slave ID will be known to the Gateway.

When the RTU polls the gateway for a Modbus register, if the register is buffered (meaning it was pre-configured) the buffered value is returned. If the register value is not buffered, but the Modbus slave ID is known, the request is forwarded over the SignalFire wireless network to the Modbus sensor, the response is forwarded back to the gateway and delivered to the RTU. Due to the multi-hop wireless network, latency will be introduced. It is required that the RTU’s timeout be on the order of 5-10 seconds to allow for maximum possible networks delays. This limits the effective amount of data that can be pulled.

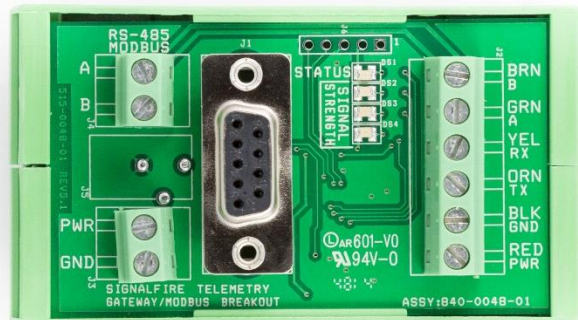
Setup

The Modbus-in-a-Stick requires initial configuration over the debug port. This is done using the SignalFire Toolkit PC application to configure the device over a serial port.

The following items must be configured:

- Network Selection / encryption settings
- Check-in Period Selection (*Pre-Configured Register set mode only*)
- Modbus Slave ID and register configuration (*Pre-Configured Register set mode only*)

Breakout Board

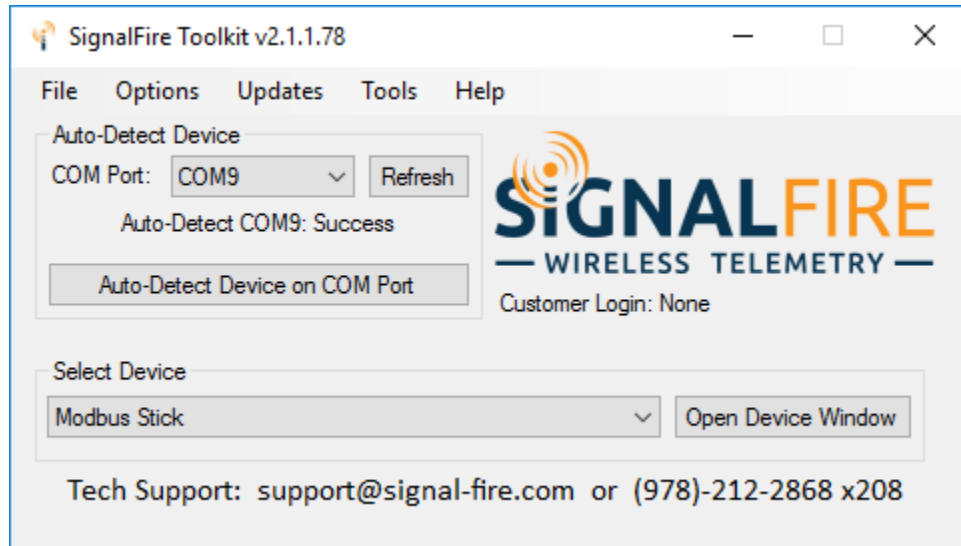


The breakout board above is included with the standard Modbus Stick and provides for easy wiring and a DIN rail mount. **PWR** and **GND** can be wired into the breakout board, as well as RS485 A/B.

The **STATUS LED** will blink at 1 sec when offline, and 3 sec when connected. The **Signal Strength** LEDs give a relative RSSI reading. The breakout board also has a built in DB9 RS232 port for easy configuration via the SignalFire Toolkit.

Configuration

To begin configuration, open 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 Modbus Stick and click "Auto-Detect Device on COM Port." This will open the device configuration window, where all device settings can be configured.

Modbus Stick — □ ×

File Options Settings Updates Tools Help Passed

COM Port:

Product	MODBUS
File Transfer	not supported
Radio Connectivity	Connected -70d...
Mainboard Version	0.81
Radio Version	2.50
Radio Address	9999
Corporate ID	<Encrypted>
Radio Network	2
Radio Network Group	2
Radio Power (dBm)	-20
Radio Range	Short Range
Modbus Baud Rate	9600
Modbus UART Mode	8N1
Command Timeout (ms)	1000
Command Pause (ms)	100
Node Name	not set
Checkin Interval	1 minute

Set Encryption Key

Enable Encryption

Key:

Settings

Radio Range

Radio Network

Radio Network Group

Checkin Interval

Node Name

Reported Sensor Values

Address	Description	Value
65523	Status Register	0
65532	Battery Voltage (mV)	9142

Modbus Program Steps

Baud Rate Command Timeout (ms)

UART Mode Command Pause (ms)

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

	Slave ID	Function Code	Register Address	Count*	Status
1	20	0x03 - Read Holding Register	1100	4	Timed Out
2	20	0x03 - Read Holding Register	1118	10	Timed Out
3	20	0x03 - Read Holding Register	1200	8	Timed Out
4	22	0x03 - Read Holding Register	1100	4	Timed Out
5	22	0x03 - Read Holding Register	1118	10	Timed Out
▶ 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

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

Register Addressing Mode

Zero Based Addressing: 40001 is entered as 0

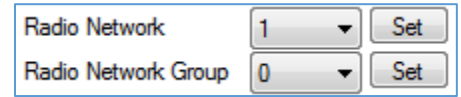
One Based Addressing: 40001 is entered as 1

Success

Modbus-in-a-Stick configuration window

Network Setting

The network address can be used to create separate networks using multiple gateways (that are in close proximity with one another). The network is set using the SignalFire Toolkit. The Network Group setting is used when more than 8 networks are needed. Both the network and network group must match those of the gateway to communicate.

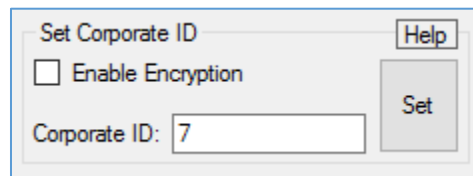


A screenshot of a dialog box titled "Network Setting". It contains two rows of controls. The first row has a label "Radio Network", a dropdown menu showing the value "1", and a "Set" button. The second row has a label "Radio Network Group", a dropdown menu showing the value "0", and a "Set" button.

Encryption

Starting with Modbus-Stick version r72, 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.

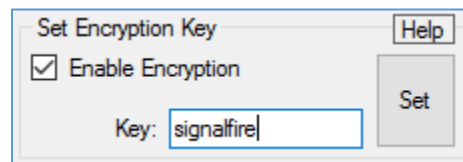
To set up a Modbus-Stick to use encryption, click the checkbox labeled **Enable Encryption** inside the **Set Corporate ID** box:



A screenshot of a dialog box titled "Set Corporate ID". It has a "Help" button in the top right corner. Below the title, there is a checkbox labeled "Enable Encryption" which is currently unchecked. Below the checkbox is a text input field labeled "Corporate ID:" containing the number "7". To the right of the input field is a "Set" button.

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

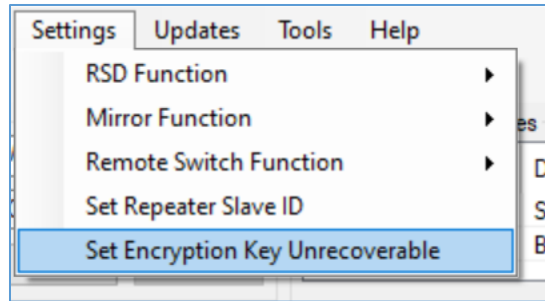
The box will then change into a **Set Encryption Key** box, and it will prompt instead for the encryption key you would like to use. Note that keys may not contain spaces or angle brackets. Enter it and then press **Set**. This will cause the Modbus-Stick to drop its network, and only attempt to join 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 Modbus-Stick 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.



A screenshot of a dialog box titled "Set Encryption Key". It has a "Help" button in the top right corner. Below the title, there is a checkbox labeled "Enable Encryption" which is checked. Below the checkbox is a text input field labeled "Key:" containing the text "signalfire". To the right of the input field is a "Set" button.

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 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
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RS-485 Modbus Communication

Communication Settings

The Modbus Stick needs to have its serial RS-485 parameters set to match the device it's communicating with. Default settings are a baud rate of 9,600bits/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.

Modbus Program Steps			
Baud Rate	9600	Command Timeout (ms)	1000
UART Mode	8N1	Command Pause (ms)	100

Note that the Gateway and Modbus Stick's RS-485 settings are unrelated and do not need to match.

Modbus Program Steps Configuration

The register set to poll on each check-in must be defined using program steps. The Modbus Stick 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

Click **Read Steps from Device** 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 Device** to save the changes.

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

	Slave ID	Function Code	Register Address	Count*	Status
▶ 1	20	0x03 - Read Holding Register	1100	4	Timed Out
2	20	0x03 - Read Holding Register	1118	10	Timed Out
3	20	0x03 - Read Holding Register	1200	8	Unknown
4	22	0x03 - Read Holding Register	1100	4	Unknown
5	22	0x03 - Read Holding Register	1118	10	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

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

Register Addressing Mode

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

The Slave IDs should match the ID of the connected Modbus devices. 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.

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.

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 Modbus Stick, a warning will pop-up if too many registers are requested.

Modbus Program Steps Configuration (Legacy)

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

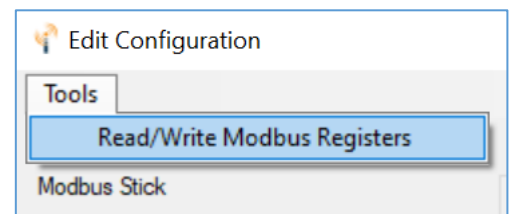
Click **Read Current Program Steps from Device** to view the current program steps in the table. They can then be deleted or re-ordered using the buttons to the right of the table. To add a new program step, fill in the 4 boxes at the bottom, and click **Add New Program Step**. If the step is valid,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

The Slave IDs should match the ID of the connected Modbus devices. 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: 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 Slave ID (defaults to the slave 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.

 A screenshot of a form titled "Read/Write Modbus Registers". It contains three input fields: "Slave ID" with the value "8", "Starting Address" with the value "3000", and "Number of Registers" with the value "10". The "Starting Address" and "Number of Registers" fields are highlighted in yellow. To the right of these fields is a button labeled "Apply to Table".

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.

Data Type	Register Address	Register Value
16bit UINT	3000	25
16bit INT	3001	-25
32bit UINT	3002	70000
32bit UINT	3003	
32bit INT	3004	-70000
32bit INT	3005	
32bit FLOAT	3006	17.85
32bit FLOAT	3007	
16bit UINT	3008	9
16bit UINT	3009	10

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

In addition to any pre-configured registers, the Modbus Stick will send system information in 16-bit registers in the table below. This data is accessible at any of the one or more Slave IDs connected to the Modbus Stick.

Register	Register Address (Offset)	Description
49986	9985 or 65522	Checkin Interval (in seconds)
49987	9986 or 65523	Low Battery Alarm (0=no errors, 1=low battery)
65524	9987 or 65524	Major revision number for the mainboard
65525	9988 or 65525	Minor revision number for the mainboard
65526	9989 or 65526	Major revision number for the radio
65527	9990 or 65527	Minor revision number for the radio
65528	9991 or 65528	High 16 bits of SFTS node address
65529	9992 or 65529	Low 16 bits of SFTS node address (the radio ID)
65530	9993 or 65530	Slave ID readback
65531	9994 or 65531	Received signal strength of last packet from the slave
65532	9995 or 65532	System voltage of the Modbus client in millivolts
65533	9996 or 65533	Minutes until this slave will time out, unless new data is received
65534	9997 or 65534	Number of registers cached for this slave device
65535	9998 or 65535	Remote device type (0 for Modbus Client Node)

Revision History

Revision	Date	Changes/Updates
5.4	7/23/13	Initial revision
5.5	6/24/15	Updated Design
5.6	8/3/16	Added section on encryption
5.7	3/31/20	Remote Modbus R/W
5.8	7/9/2020	Updated Modbus program steps menu, new checkin register
5.9	1/20/2022	Updated screen shots. Added description of register count.

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.

This device has been designed to operate with only the permanently attached internal antenna, having a maximum gain of 5 dB. No other antenna may be used.

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.