RF END-Node & HUB-Node

Wireless 900 MHz RS-485 Network

socomec

Innovative Power Solutions

Contents

1. System Overview

The RF wireless system is designed to replace Ethernet LAN network infrastructure and Modbus RS-485 multidrop wiring runs with a secure local wireless network. The system is designed as a "star" or "Wheel" network with a Modbus Master physically connected to the RF HUB-Node which remotely communicates with wireless End Nodes. Each end node services a local device or wired RS-485 sub-network of devices with up to 48 Slave addresses. This document describes requirements and usage models for wireless data collection between an external polling system (Modbus Master) and existing devices (Modbus Slaves).

The RF wireless system is fundamentally a Modbus repeater. The HUB-Node performs address parsing (if necessary) and passes messages from an external Modbus host to remote slaves and returns their responses. The HUB-Node supports Modbus RTU (serial) or TCP (Ethernet) connectivity. The HUB-Node can operate in two different _Modes_: Repeater or Prefetcher. The behavior of the RF wireless system is configured using a PC utility (RF-View) and is targeted toward the typical objectives of energy management systems. The physical and logical relationships are depicted below.
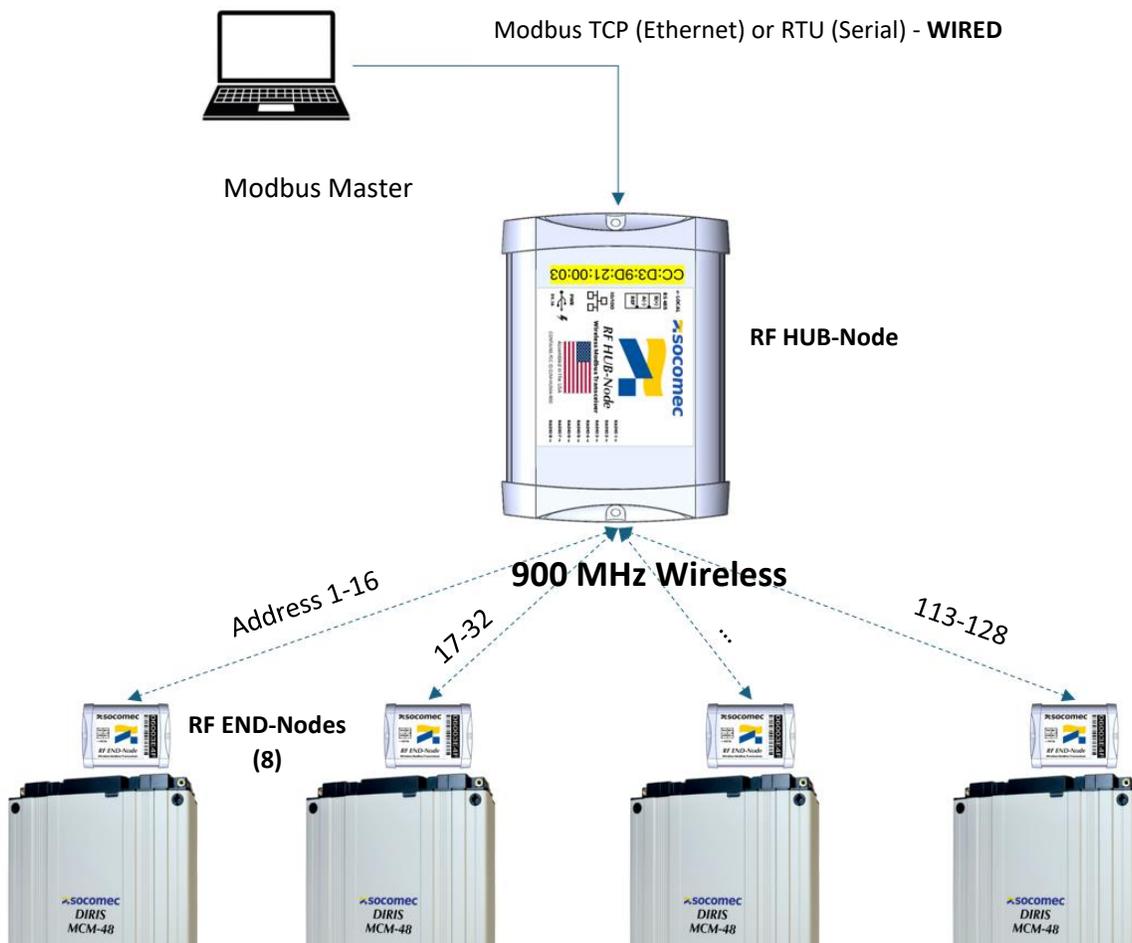
2. RF HUB-Node

The external connections for the RF HUB-Node are shown and detailed below.

Serial LED

RS-485

Ethernet

Power LED

USB-C (Power)

External Antenna

Activity LED (8)

← LOCAL

RS 485
B(+)
A(-)
REF

10/100

RF HUB-Node
Wireless Modbus Transceiver

RADIO 1→
RADIO 2→
RADIO 3→
RADIO 4→
RADIO 5→
RADIO 6→
RADIO 7→
RADIO 8→

PWR

5V, 1A

Assembled in the USA
CONTAINS FCC ID OJM-HUMA-900
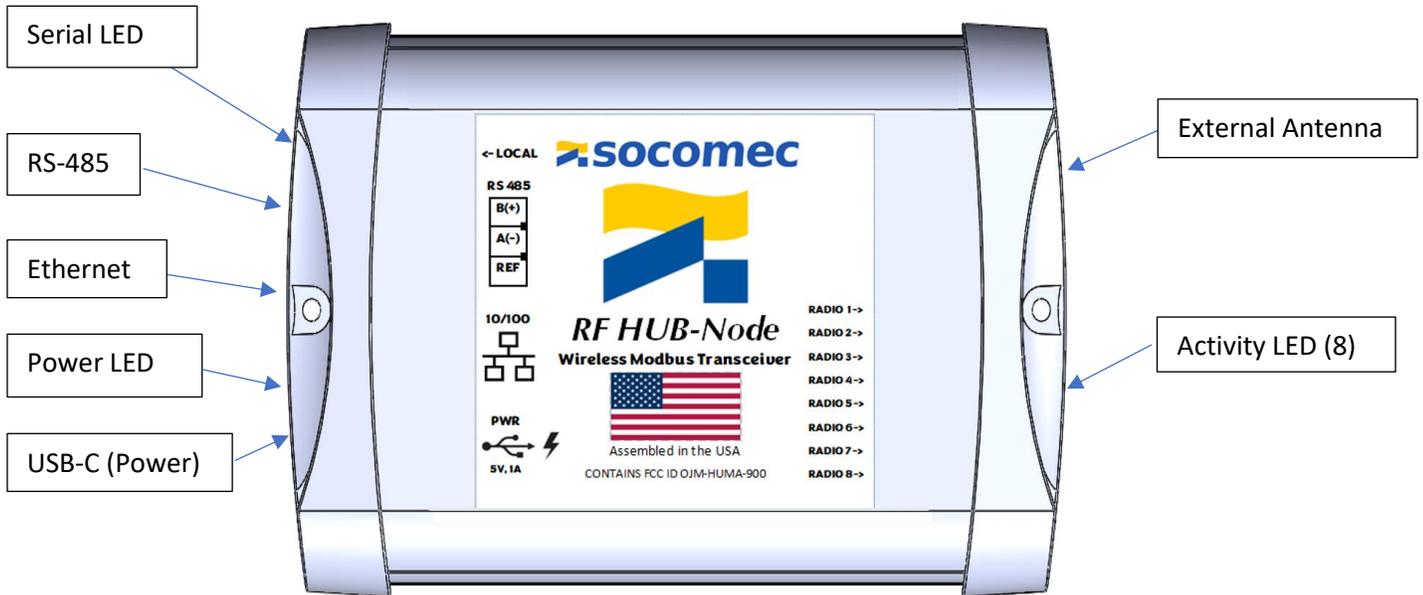
Wired End
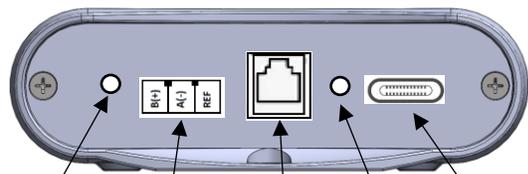
Wireless End

Serial LED   RS-485   Ethernet   Power LED   USB-C (Power)
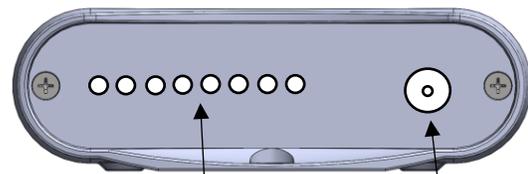
Activity LED (8)   External Antenna

2.1   Power requirements

The RF HUB-Node is normally powered from an external miniature 5 VDC wall adapter. A **UL LISTED** 5 VDC power supply is provided. This solution has been selected to avoid bulky wall transformers that are prone to becoming disconnected. The power supply must be capable of supplying 1 A continuous. If a replacement power adapter is used, be sure it is a UL listed model which ensures it contains safety and isolation circuitry.
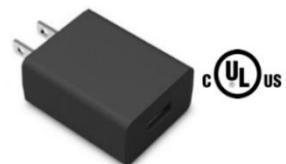
During installation and testing or under special installation circumstances a computer will be directly connected to the RF HUB-Node. When used in this way the computer USB port provides communication and power to the RF HUB-Node. The RF HUB-Node will draw 500 mA of current which is compatible with the USB 2.0 standard. The use of USB port expanders may prevent the RF HUB-Node from drawing the current it needs to operate the Radio. The product is being supplied with a cable having type A (computer) to Type C connections. End users will need to supply an alternate cable if the host PC does not have a type A port.

2.2 Universal Serial Bus (USB)

In response to the international standardization initiative the RF HUB-Node uses a USB type C connector. The host computer (laptop) end will either be Type A (also waning in popularity) or a Type C connection designed to signal a need for 500 mA to the host. Physical references for the relevant connector type types are shown below. The system does not make use of Mini or Micro USB connectors. The underlying protocol in all cases is USB 2.0.

	USB Pitfalls
(i)	• Some USB type C cables are intended for charging devices only and don't contain data conductors.
	• Modbus RTU is not currently supported over the USB interface.
	• The use of USB hubs or port expanders may not provide the RF HUB-Node enough current to operate, especially if testing the radio connection. Best practices are to connect to the host PC directly.

Trouble Shooting USB

The PC Windows driver used with the RF System is included in Windows 8 and beyond. There are some known resource conflict / arbitration issues that may prevent your computer from recognizing the meter. Please see the appendix materials for additional information.

2.3 Ethernet Connection

When configured for Modbus TCP the RF HUB-Node expects Modbus host traffic on this port. The IP address of the RF HUB-Node allows static or DHCP addressing and is configured through the software tool (RF-View).

The RF System is compatible with 10-BASE-T/100BASE-T Ethernet systems and supports auto-negotiation and auto-MDX.

	Ethernet • RF-View (configuration software) communicates over USB, not Ethernet. • The system default is DHCP. Static addresses can be set using RF-View • Direct PC to RF Hub Node Ethernet connections will require Static addressing with IP assignments on the same sub net. • Modbus TCP systems will typically use a feature called "Pre-Fetch" below in this manual.

2.4   RS-485 Serial Connection

The RF HUB-Node can be used to expand an existing serial RS-485 network or used to create an isolated sub network.

The B(+) and A(-) are internally biased to +275mV to maintain the correct idle conditions for RS-485. The Reference terminal is internally connected to the USB (power) ground through a 120 ohm resistor. This terminal should be connected to the ground or reference terminal at both end connections.

B(+) A(-) Ref

2.5   LED Behavior

Status indicators on the RF HUB-Node and RF END-Nodes can reveal the health of the system:

- **Heartbeat LED**: A blue pulsing LED indicates internal power is good and code is running normally.
- **Serial LED**: LED is illuminated upon incoming Modbus RTU requests and turned off when response is sent.
- **Ethernet Jack:** The Ethernet jack has two LEDs. Amber LED is typically steady and reflects connection status. The green LED blinks when traffic is present.
- **Radio LEDs (8)**: The LED for each targeted Radio is illuminated upon outgoing request and turned off when response is fully processed. During normal operations this LED will "blink" for each Modbus message and is typically less than 1 second in duration. If this LED remains illuminated for more than 1 second it indicates that a response was not received. The attempt will time out and continue after 3 seconds.

2.6   Serial Settings

The suggested Modbus communications settings are shown below for the 4 operating modes of the RF HUB-Node.

Modbus TCP

Modbus TCP **WITH PreFetch**   Modbus TCP **WITHOUT PreFetch**

Modbus RTU - 115 kbaud

Modbus RTU **WITH PreFetch**   Modbus RTU **WITHOUT PreFetch**

	Modbus Read Multiple Register Limits
(i)	• The longest register block that the RF HUB-Node can process in one "Read Multiple Holding Register" command is 92 registers (184 bytes).
(i)	**Best Practices** • Although the RF System is a generic system, it is designed to be used with the DIRIS MCM power meters using the "Optimized Radio Block" of Registers for highest data throughput.

2.7   Transmission Speed

Internally (between RF HUB-Node and RF END-Nodes) the RF system communicates at 19,200 bps which is the fastest speed allowed under FCC for transmitting power at +25dbm. Externally the baud rate depends on which interface is active but is expected to operate at a higher speed than the attached Slave devices. This is possible because the RF HUB-Node is buffering and reformatting the messages.

Ethernet: 10/100 mbps

RS-485: 115,200 bps

For serial systems the RF system must use an 8-N-1 data format.

8-N-1 is a common shorthand notation for a serial port parameter setting or configuration in asynchronous mode in which there is one start bit, eight (8) data bits, no (N) parity bit, and one (1) stop bit. As such, 8-N-1 is the most common configuration for PC serial communications today.

2.8   Antenna Connection

The antenna connection on the RF HUB-Node node uses a reverse polarity SMA connector. This connector type is specified by the FCC to enforce regulatory compatibility with the transmitter power. The RF HUB-Node is supplied with a 66mm magnetic base having a built in 4m (12ft) coax cable and a coil whip antenna. This antenna is a high gain model (+3.8 dBi) with a flat response curve.

Socomec may suggest a different model than the type illustrated for unique situations.

2.9   Antenna Location

The 4-meter cable length and magnetic base give the installer flexibility in mounting location. For best reception the antenna should be located vertically (straight up or straight down) and located such that it is not directly behind obstructions relative to the position of the end nodes it is communicating with.

The higher off the ground the antenna is placed the better the reception distance. In some cases, the antenna can be located above the "false ceiling" where the space is relatively open.

3. RF END-Node

The external connections for the RF END-Node are shown and detailed below.

RS-485 / Power

LED

Serial #

External Antenna

SOCOMEC

DSN #

VDC B(+)
GND A(-)
<- LOCAL

RF END-Node
Wireless Modbus Transceiver
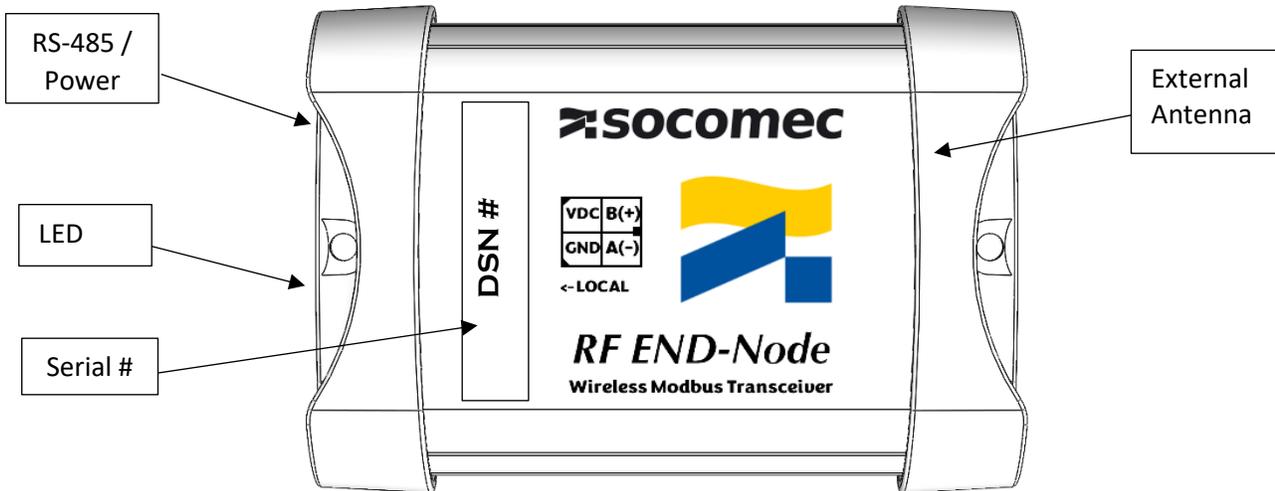
Wired End
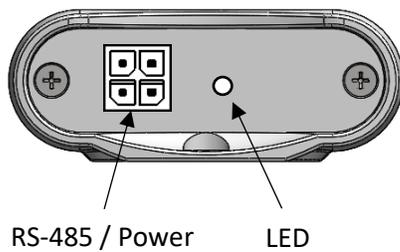
Wireless End

RS-485 / Power   LED
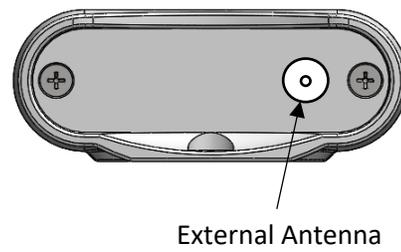
External Antenna

3.1   Power Requirements

The RF END-Nodes use a single 4 position connector (Molex Micro Fit Jr) to provide both power and RS-485 communications to the device. This connector can be purchased as a cable assembly (Molex # 0451350401) which matches the color code of other Socomec DIRIS MCM devices. The voltage must be in the range of 5-28 VDC. The peak power draw is 2 watts.

PWR	COM
+DC	B(+)
GND	A(-)

3.2   RS-485

The Molex cable houses the RS-485 data pair for communication to a serial slave device. The Molex cable connector will plug in directly to the DIRIC MCM power meter.

(i)	The use of the RF END-Node with other devices is facilitated by cutting off one end and splicing the cable or connecting it to a terminal block.

3.3   Antenna Connection

The antenna connection on the RF END-Node node uses a reverse polarity SMA connector. This connector type is specified by the FCC to enforce regulatory compatibility with the transmitter power.
The RF END-Node is supplied with a 66mm magnetic base having a built in 4-meter coax cable and a coil whip antenna. This antenna is a high gain model (+3.8 dBi) with a flat response curve. It's the same antenna used with with the RF HUB-Node.

3.4   Antenna Location

The 4-meter cable length and magnetic base give the installer flexibility in mounting location. For best reception the Antenna should be located vertically (straight up or straight down) and located such that it is not directly behind obstructions relative to the position of the end nodes it is communicating with. The higher off the ground the antenna is placed the better the reception distance. In some cases, the antenna can be located above the "false ceiling" where the space is relatively open. Another common location is on top of nearby electrical cabinets.

3.5   Serial Settings

Internally (between RF HUB-Node and RF END-Nodes) the RF system communicates at 19,200 bps which is the fastest speed allowed under FCC for transmitting power at +25dbm. **The baud rate for external serial communications between the RF END-Node and Modbus SLAVE DEVICES MUST be configured for 19200 baud.**

Modbus slave devices connected to the RF END-Node must be configured for data packets formatted in 8-N-1. 8-N-1 is a common shorthand notation for a serial port in asynchronous mode with one start bit, eight (8) data bits, no (N) parity bit, and one (1) stop bit. 8-N-1 is the most common configuration for PC serial communications today.

3.6 System Roles

The RF HUB-Node can assume different roles depending on the desired connectivity as described below.

3.6.1 Repeater

Modbus commands (either Modbus TCP or RTU) are parsed according to the slave address and split up into groups of 16 or 48. Modbus commands are reformatted (including a new CRC) and directed to each physical Radio based on the address range (see example table below). Modbus Slave addresses only need to be unique within the RS-485 sub network of a particular radio. It is expected that Modbus end devices will use default addressing 1 – 16, or 1 – 48. This system avoids the complexity and hassle of setting each slave to a unique base address.

Modbus Address Range [0x]	Radio #	Slave Address
001 – 016 [01 – 10]	1	001 – 016
017 – 032 [11 – 20]	2	001 – 016
…	…	001 – 016
113 – 128 [71- 80]	8	001 – 016

When used as a repeater (no prefetch) all commands are sent over the air and responded to one at a time. The RF system checks for data integrity and makes several attempts if the slave doesn't respond or if the data is corrupted. Each Modbus command from the host **MUST** wait for a period of time defined as the *Response Timeout* between commands. This period needs to be set for the longest allowable valid message response time which can theoretically be up to 4 seconds when each transmission is the longest allowable and has attempted the maximum number of retries both for outgoing and incoming messages. A more typical maximum would be 2 seconds. The Response Timeout is set by the controlling host / master software.

3.6.2 Prefetcher (autonomous sub master)

The Prefetch feature allows the user to select a Modbus data range and interval that allows the RF HUB-Node to change its role from a repeater only to an autonomous Modbus sub-Master. The RF HUB-Node will collect the requested Prefetch data for enabled elements (Loads) and hold the data in memory. If an external Modbus Host request comes to the RF HUB-Node for one of the data registers within the configured PreFetch register block, the value from memory will be returned and no additional radio call will be made to the RF END-Nodes.

The two largest benefits of the Prefetch System are:

- Improved Data Reliability. In this mode the RF HUB-Node will make multiple attempts to retrieve the data if for some reason the system doesn't get a response. This reduces or eliminates the need for the host system to respond to missing data on its own.

- Rapid Response to Modbus HOST. The Modbus host does not need to wait for the "over the air" traffic to get a reply. It receives the latest value in memory from the RF HUB-Node typically within 8 ms. The data will be slightly old (up to the request interval). This is usually satisfactory for interval recording of energy or power.

The RF-View software includes a test utility that displays approximately how much time a prefetch interval takes to execute which allows users to test system response time before defining the polling interval.

3.7   Modbus Radio Timing Diagrams

The diagrams below illustrate the timing difference between repeater and prefetch cycles both running at 1 min intervals and the difference this makes to the timing characteristics of the host.

Classic Modbus Cycle
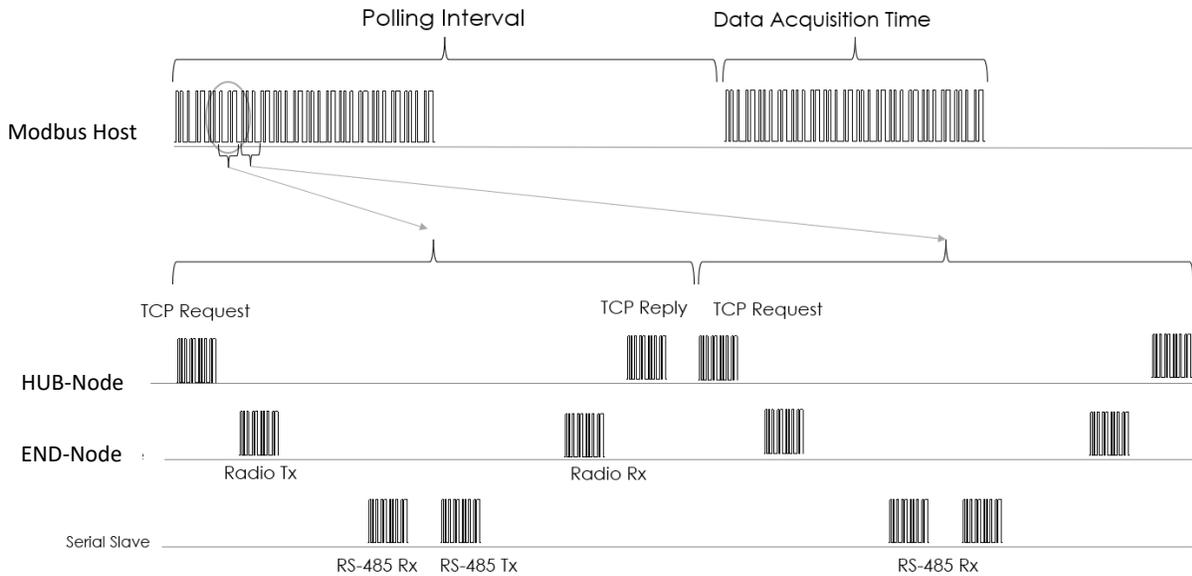
Prefetch Modbus Cycle
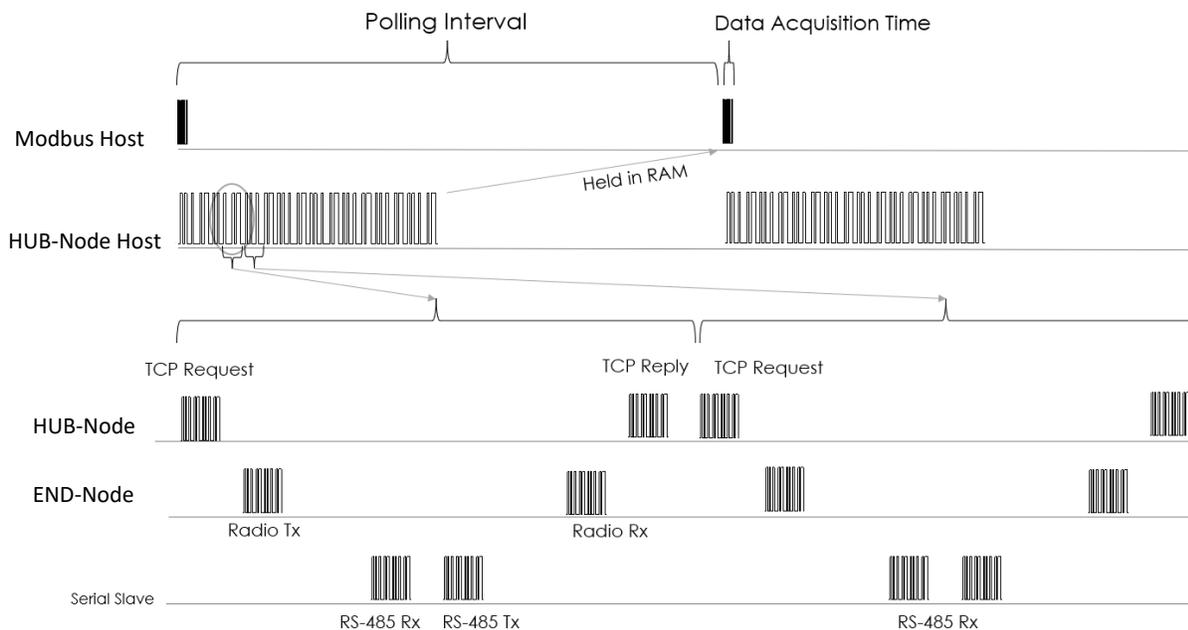
4. Configuring the RF System

The RF System is configured using the RF-View software, a PC Windows program allowing to configure and test the wireless communication of the RF system. The configuration is made by connecting the laptop to the RF HUB-Node.

4.1 Installation of RF-View

The RF-View application can be downloaded as a zip folder from the Socomec website at the following link: https://www.socomec.us/en-us/resource-center/resource-type/software-95#main-wrapper
Best practices are to copy the zip folder to your local computer and then then unzip it. Double click the "RF-View xx.exe" file to start installation.

Name

📁 bin

📁 license

📁 supportfiles

📄 nidist.id

💻 RF-View 1.0.exe

⚙️ RF-View 1.0.ini
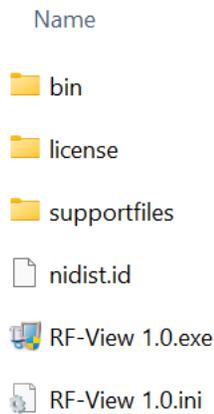
 The application will install a "Run Time Engine" if installed for the first time. Initial installation takes a few minutes, subsequent installation (upgrades) takes less than 30 seconds.

⚠	**PC Security / Virus Checkers** • PC security measures can interfere with the installation procedure causing it to fail. • The installation may take more than one attempt after clearing files identified by a virus checker. • The PC permissions may need to be elevated to Administer to provide access to needed locations.

RF Hub Node

Destination Directory
Select the installation directories.

All software will be installed in the following locations. To install software into a
different location, click the Browse button and select another directory.

Directory for RF Hub Node

| C:\Program Files (x86)\RF-View_2.0\ | Browse... |

Directory for National Instruments products

| C:\Program Files (x86)\National Instruments\ | Browse... |

[<< Back] [Next >>] [Cancel]

RF Hub Node

Start Installation
Review the following summary before continuing.

Adding or Changing
• RF Hub Node Files

Click the Next button to begin installation. Click the Back button to change the installation settings.

[Save File...] [<< Back] [Next >>] [Cancel]

The RF-View application should identify itself as a verified publisher under a certificate issued to Continental Control Systems.

Upon successful completion of the installation process a shortcut will appear on the desktop as shown below. Use this icon or launch the software as RF-View under the windows icon.

RF-View_2.0

4.2 RF-View Application

For best results, plug the intended RF HUB-Node into a USB port and ensure that it is the only unit connected to the computer. Use of underpowered USB expansion ports may cause the system to cycle or fail to power up. The RF HUB-Node requires 500 mA of current and is best connected directly to the computers USB 2.0 (compatible) peripheral port.

<u>Offline Mode</u>

After launching RF-View, the application searches for an RF HUB-Node connected via USB. This process can take up to 10 seconds. If no RF HUB-Nodes are found, the following window will appear.
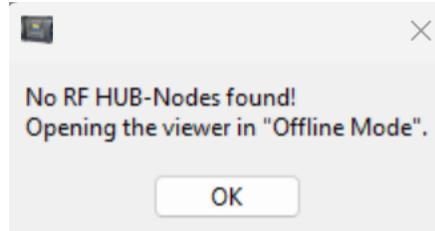
If the application doesn't find an RF HUB-Node, it will still allow some operations such as Creating, Saving and Retrieving configuration files as described below in the Online mode section but the usefulness of the application is very limited and is usually triggered accidentally when opened before the device is connected.

OFFLINE mode is active if the "Write, Read, and Generate Report" buttons are greyed out. The firmware version field will also be blank.

OFFLINE Mode (only file operations accessible)

<u>Online Mode</u>

After launching, if the application identifies a connected RF HUB-Node, it will retrieve the settings from this system and display them. This process may take up to 10 seconds. Please allow the application to populate the settings before clicking buttons or changing tabs.

<u>Software version</u>

The RF-View Window Title bar indicates the version of the application itself in the upper left-hand corner.

If the RF-View software successfully connected to an RF HUB-Node, the firmware version of the connected RF-HUB-Node will be displayed in the upper right portion of the window.

4.3 RF-View Tabs

The RF-View application is navigated using two tabs: Configuration and Testing.

- **Configuration:** Allows to configure the wireless architecture: pairing RF END-Nodes to the RF HUB-Node and for each RF END-Node, defining which load (Slave ID) the RF HUB-Node needs to collect data from.

- **Testing:** Allows to test the effectiveness of the RF system and verify the signal strength between the RF HUB-Node and its RF END-Nodes.

4.3.1 Configuration tab

Radio Settings

<u>Enable</u>

This selection box is the on/off selector for each RF END-Node. This is handy to quickly turn a particular Radio channel on or off while testing. Remember to press the SAVE SETUP to Access Point button in order to take effect.

<u>Radio SN (Serial Number)</u>

Each RF END-Node has a unique address (Serial Number) which is printed on the top cover of the enclosure. The address is shown in hexadecimal format. Radios are interchangeable, it is up to the user to define which radio is associated with which set of Modbus slave addresses. The example at right shows that the address of Radio # 1 is 06001D29

.
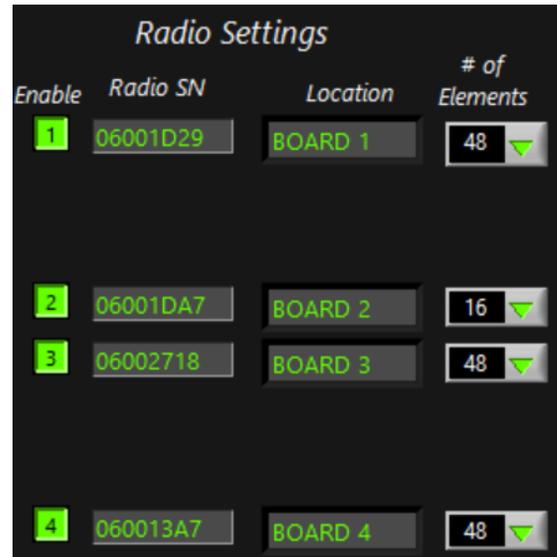
<u>Location</u>

The location field is a "User Field" that allows the entry of a familiar description. This field is **NOT USED** in the reporting of data. Best practice is to the enter the same name here that was assigned to the DIRIS MCM meter for each "SYSTEM DESCRIPTION".

Element / Slave ID Matrix

- Number of Elements
- Enabled Slave IDs
- Local Address

<u># of Elements</u>

The RF HUB-Node can be programmed to treat each RF END-Node as a group of 16, or 48 sequential Modbus addresses.

(i)	Best practice is to use groups of 16 whenever the DIRIS MCM meter is configured to measure three phase loads. 48 can be selected if the meter is used for single phase, spilt phase or a combination or loads that will exceed 16.

Enabled Slave IDs

The RF HUB-Node can be thought of as a "look up table" or a "switch board operator". Each RF END-Node End is associated with a Modbus Slave ID Address block. The RF system can use up to 240 addresses and provides a visual map of the entire address space. The system is designed to segment this space into sequential groups of 16 or 48. The address space is designed to be continuous. If a gap is desired in the address space a disabled radio block can serve as a "spacer" as shown below. The Enable button should be "off" and no ID's selected as shown below.

Local Address

The RF HUB-Node uses a map with address 1-240 which indicates the Modbus Slave ID (Modbus address) from the perspective of the HOST. This address is critical from a programming perspective but may be confusing from a wiring perspective. To help with that a "Local Address" in the range of 1-16, or 1-48 is shown to the right of the Slave ID matrix. In the screen snippet below the first load in a DIRIS MCM meter will be considered as "address 1" by the Modbus Slave device but referred to as "address 145" by the Host Modbus Master. The Local address will be more important for use by installers while the Global address will be important by the script programmer.
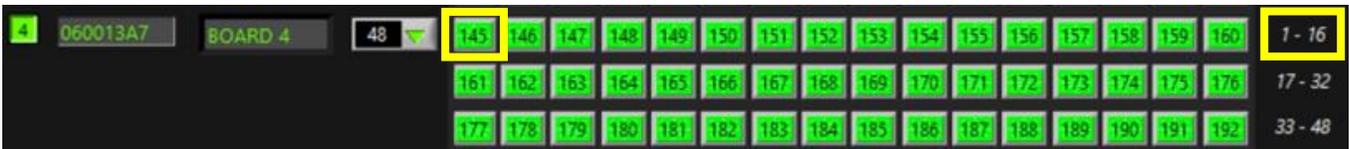
⚠	Do NOT change the Modbus BASE SLAVE ID Index at the end device. The RF system is expecting all end devices to start at address 1. Part of the function of the HUB-Node is to reformat data messages under this assumption.

ⓘ	The software is designed to detect address conflicts and won't send an invalid table to the RF HUB-Node.

Configuration Actions

The Configuration actions buttons appear at the top of the display and refer to group operations of settings.

Write Setup to RF HUB-Node

Clicking this button writes all the configuration items visible on this page to the non-volatile memory of the RF HUB-Node.

⚠	Remember To CLICK the "Write Setup to HUB-Node" button for changes to take effect before switching tabs or closing the application! This may take a few seconds.
ⓘ	The data items are written over the USB connection at 115 kbaud and can take several seconds. If the operation is interrupted by disconnecting the USB cable or closing the application, the RF HUB-Node could be left in a non-operational state.

Read Setup from RF HUB-Node

Clicking this button reads all the configuration items associated with this page and updates the display as the data comes in. When opening the RF-View application or switching back to this tab, the software responds as if this button has been clicked to reflect the contents of the connected device.

Write to File

Clicking this button writes all the configuration items visible on this page to a file located on your PC. The file is human readable in any text application such as Notepad.

A File Path Window will appear showing where the file will be stored using a default path. The location can be changed by the user. A default file name will be generated based on the concatenation of three strings, <date>, ,<file type>,<location ID>. This name can be overwritten if a different scheme is desired.
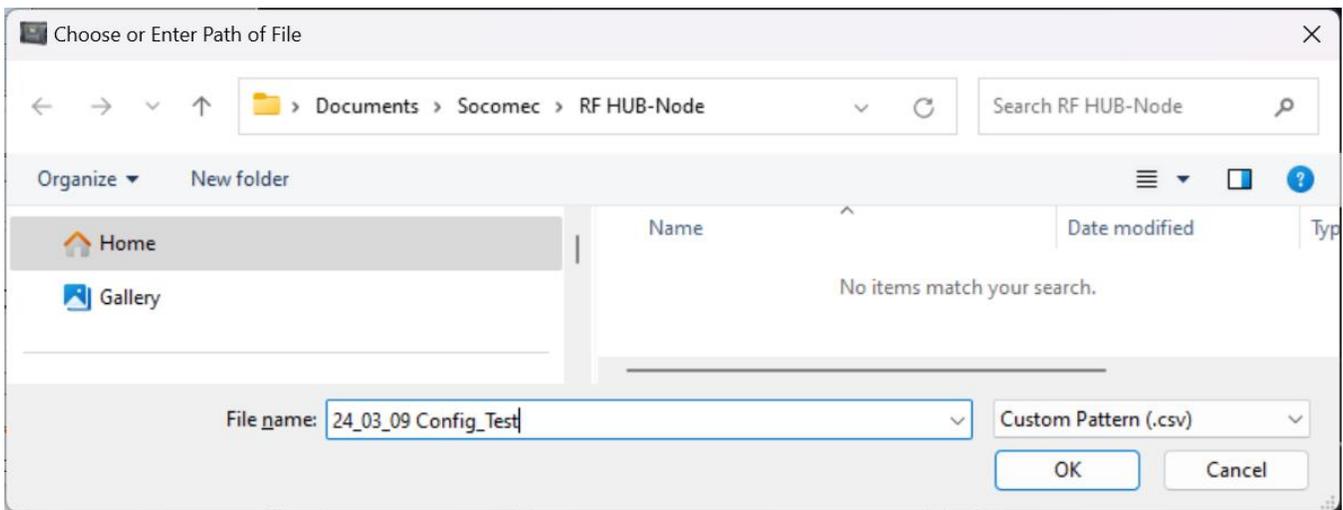
A File Path indicator will appear showing the complete path the stored file.
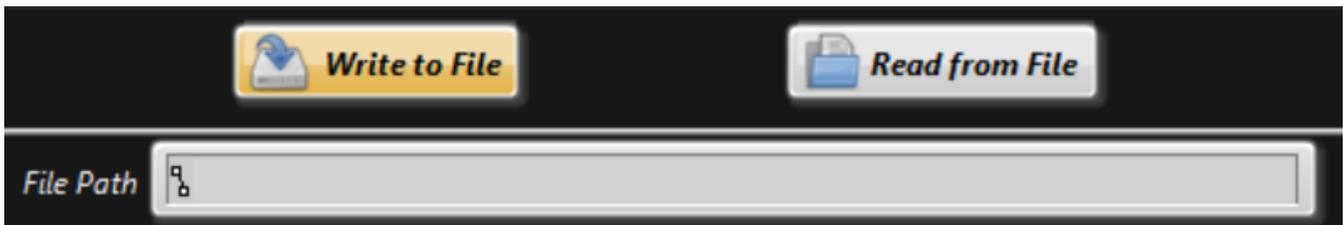
ⓘ	The files generated by the RF-View application are designed to be used as documentation and are human readable and editable. Be careful if making changes to this file not to introduce any unwanted characters such as commas.

Read from File

Clicking this button reads a previously saved configuration file containing the items visible on this page. The file type is .csv (comma separated values) which your PC may associate with an application such as excel.
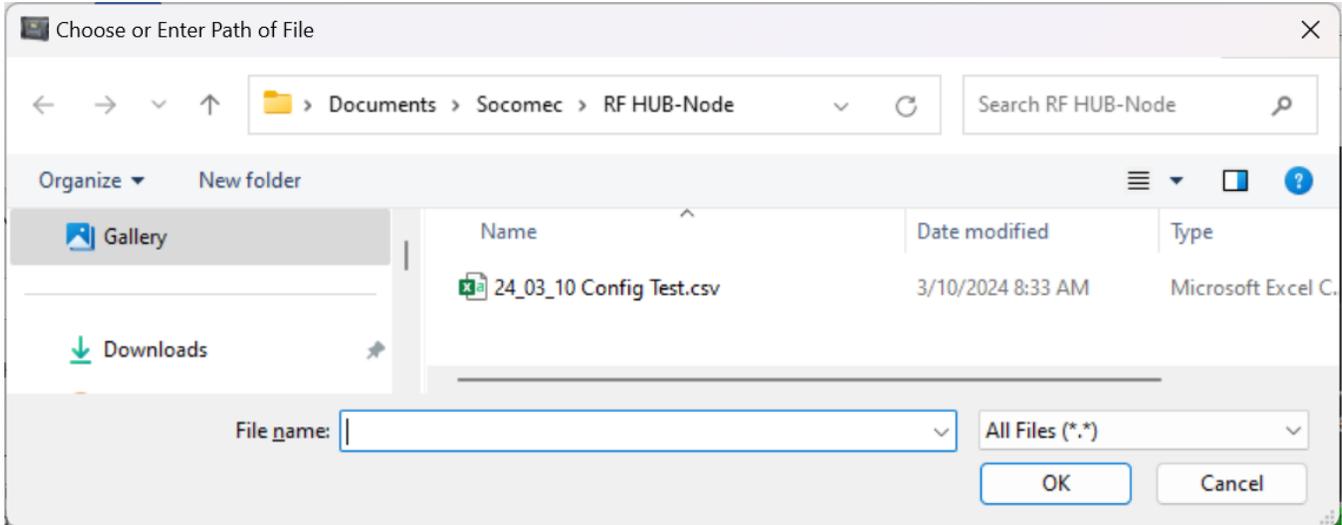
Generate Report

After the system is fully configured and has been range tested a site report can be generated by clicking this button. The RF HUB-Node will request the System Description at register block 333-348 for each enabled RF END-Node and then the Load Descriptions at register blocks 1501-1508 for each enabled load.

ⓘ	The Site Report is intended to be used as the "As Build" documentation for a location. This file provides the Master (HOST) Slave ID address and system description as read from the connected DIRIS MCM power meter. This process can take several minutes and will timeout if 5 minutes elapses.

Prefetch Settings

The Prefetch Feature allows the user to select a block of registers for the RF-HUB-Node to collect autonomously at a predetermined interval, storing the returned data in memory. This feature is enabled when the "Enable" selection box is highlighted. Data will be collected from each enabled load in the Slave ID matrix shown on the configuration tab. A table is maintained in memory and updated when new data is read. If the RF END-Node cannot be reached, the data in the table will retain the last retrieved value. This behavior is typically preferrable to recording a zero or throwing an exception error.	
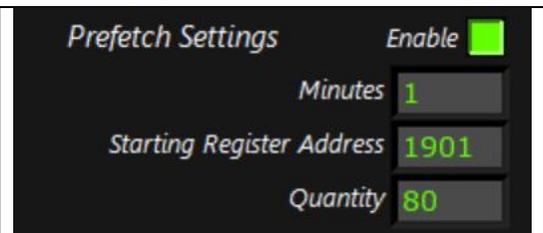
If a Modbus Host request comes to the RF HUB-Node for one of the data registers <u>within</u> the Prefetch block, the value <u>from memory</u> will be returned quickly to the host without making a new radio call. If a Modbus request or command comes in that is <u>outside</u> the Prefetch Block, the RF HUB-Node will cease the prefetch activity and send the incoming message out over the air as a priority. The Prefetch cycle will then begin again on the next 1 minute boundary.

The two largest benefits of the Prefetch System are:

- Improved Data Reliability. In this mode the Access Point will make a second attempt to retrieve the requested data at the end of the cycle if for some reason the system doesn't get a response on the first attempt.

- Rapid Response to Modbus HOST. The Modbus host does not need to wait for the "over the air" traffic to get a reply. It is served the latest value in memory from the RF HUB-Node typically within 10 ms. The data will be slightly old (up to the request interval). This is usually satisfactory for interval recording.

	The collection time for the Prefetch cycle is proportional to the number of enabled RF END-Nodes and can exceed the requested interval time. If this happens, the system will wait until the next minute boundary and then begin a new cycle. For example, a system that takes 80 seconds to collect the site data will run every 2 minutes even though a 1 minute interval has been selected.

RF HUB-Node Ethernet settings

If the RF HUB-Node is connected to the LAN network, it must have a unique IP address. The RF HUB-Node can be configured to use a Static IP address or use Dynamic addressing by receiving an address from a DHCP sever. The process of attaining a dynamic IP address from the server may take some time. The contents of the IP address in the RF-View will indicate the previously assigned address or a default value. If using DHCP and needing to know this address, it is recommended to hit the "Read Setup from HUB-Node" ten seconds or more after establishing the connection with a router.

RF HUB-Node Ethernet Settings:
IP Address 192.168.1.36   DHCP
Subnet Mask 255.255.255.0   MAC Address CC:D3:9D:21:00:01
Gateway Address 192.168.1.1
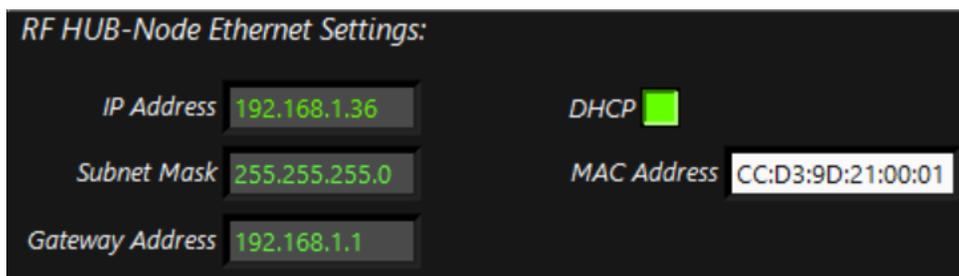
If using a static IP address the assignments for IP address, subnet masks and gateway can be manually entered and the DHCP box deselected.

MAC Address

The MAC address of every RF HUB-Node is unique and set at the factory. The MAC address will be in the range registered by Continental Controls as shown below.

MAC Address Details

Company Continental Control Systems

Address 2150 Miller Drive Suite A
Longmont CO 80501
US

Range CC:D3:9D:20:00:00 - CC:D3:9D:2F:FF:FF

Type IEEE MA-M

Local PC Connection

If the RF HUB-Node is to be connected directly to a PC (without a DHCP server), the PC and RF HUB-Node must be on the same IP subnet. This is accomplished by launching the cmd window on your PC and issuing the command: ipconfig. The computer will show the Ethernet adapter settings for your computer, an example shown below.

```
IPv4 Address. . . . . . . . . . . : 192.168.1.51
Subnet Mask . . . . . . . . . . . : 255.255.255.0
```

Select a unique address on the same subnet and confirm that the proposed address has not been assigned by conducting a ping at that address. If the ping times out then this address can safely be assigned to your RF-HUB-Node. Enter these credentials in the RF HUB-Node Ethernet Settings and write them to the RF-HUB-Node. Confirm the connection has been established by repeating the ping test. If successful, a local Modbus utility can be used to collect data. Consult your IT department if this process is outside your experience.

Serial Communications

The RF HUB-Node can also be connected to an RS-485 network using the serial connector. Because the RF HUB-Node can be used as a repeater or can be connected to an isolated adapter this circuitry is designed as a RS-485 Master device and includes both a 120 ohm termination resistor and a bias network to form a 250 mV signal bias at idle conditions.
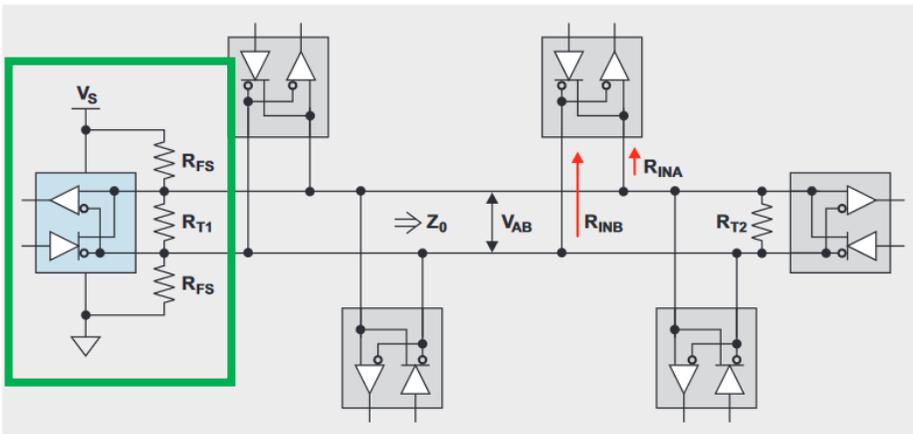
	RS-485
ⓘ	• The HUB-Node includes a 120 ohm termination resistor. Do NOT add an external resistor. • The reference terminal is connected to ground through a 120 ohm resistor and may help if the common mode signal is out of the transceiver range of +5 to -9 VDC.

4.3.2   Testing tab

The effectiveness of the RF system can be tested in real time using the Range Testing utility.

Note: Range test operates on Modbus Slaves connected to end node radios that are enabled via the configuration screen. Please ensure the end nodes are powered and connected to Modbus Slave devices and configured for 19200 baud 8N1.

Range Testing

Upon clicking the Start Test button, the system will rotate through the enabled RF END-Nodes and request data from the first (local Address 1) load or device. The requested data is selectable between "Report Slave ID" or "Read Holding Register 1". Holding register 1 is used when using the RF system is being used with simple devices that support a simplified Modbus model.
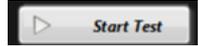
If there is a working Modbus slave powered and connected to the RF END-Node, a response will show up in the table. The text string will momentarily appear.

(i)	The RF END-Node does not respond to the Range Test on its own, it is required that the connected Slave device is powered on and has the correct communication settings which include 19,200 baud, 8N1 data formatting at Base address 1

For each successful response, the RF System will display the response "Socomec, Inc., MCM-48" for example and characterize the signal strength status by assigning it one of three colors, Green, Orange, Red, or Magenta. It is recommended to allow the Range test to run for a few minutes. Signals that are temporarily in the Orange, Red, or Magenta range are allowable. Status indicators that are permanently Red may reflect spotty data collection. A Magenta indicator means that no response was received at all.

Radio Signal Strength

The signal strength is also charted for each received radio response and reported in the units of dBm ranging from -10 to -120. A color chart is provided at the right-hand side of the plot. Normal signal strengths are in the -60 to -95 range for typical application. The ultimate limit of communication for this system is -108 db although the error rate will be unacceptable at this low signal level.

> ⓘ The RF System uses a signal hoping scheme, each radio exchange is using a different band within the 902 – 928 MHz spectrum. The antenna performance is not constant across these frequencies contributing to a normal spread of +/- 5db over time.

Ambient 900 MHz Signals

In addition to the signal strength of received messages, the Range Testing utility will indicate the strength of 915 MHz signals it detects between radio transmissions. The noise level is indicated with a small (x). The normal value of this signal is -100 to -120dBm. Signals above this indicate that there are other devices in the vicinity using the same frequency channel. The RF system checks for the presence of ambient signals > -70 dBm and will delay broadcast if it detects traffic on the same channel to avoid collisions and corrupting data in neighboring systems.

Signal Response Time

Below the plot of signal strength is a similar looking plot indicating the round-trip transit time of requested messages. The transit time is a good indicator of the number of internal transmission attempts required for a successful response request. Both the RF HUB-Node and the END-Node will make three broadcast attempts if it does not receive the expected internal message acknowledgment reply. High variability in this chart indicates either range limitations (observed with low signal strength) or radio interference or signal reflections if retries are required even when the signal strength is good. 300-500 ms is the typical round-trip time for a single message (depending on message length) if no retries occur. Response times above this indicate that the system is re-broadcasting.

Prefetch Test

The Prefetch feature allows the user to measure the "acquisition loop time" of all the data defined in the "Prefetch" section from the configuration tab (shown again right) and the number of Slave ID's or Loads at the site. The purpose of this tab is to ensure that the requested data volume can be collected within the desired interval. If the requested interval is shorter than the acquisition time, then the Modbus host will receive "repeated values" for every data point as the RF-HUB-Node response reflects the latest value it has gathered.

> ⓘ **The Prefetch must be DISABLED to conduct this timing test!!,** otherwise the test itself will retrieve messages from memory and falsely indicate a loop time of only a few seconds.

During the timing test, a progress bar indicates that the test is underway and when finished the total elapsed measurement time is reported. Communication status for each address in the enable matrix is displayed. Successful communication is indicated by a green indicator. A red indicator signifies that the test didn't receive a response.

Once the prefetch cycle time has been characterized and documented the feature is enabled by returning to the Configuration tab and clicking the "Enable" button followed be writing this configuration to the RF HUB-Node.

ⓘ	If more data is desired than the RF system can support (roughly 50 MB per day) a second RF HUB-Node can be deployed. Radio interference between two parallel systems has been shown to be minimal.

Data Time Resolution

When the prefetch feature is enabled, the system will report the same value for each register for a duration equal to the interval time. The image to the right shows a single variable updating every few seconds when used as a repeater (left side) and then holding a static value that is updated at the polling interval when reconfigured under prefetch. (right side). Prefetch isn't needed if collecting only a few data points.
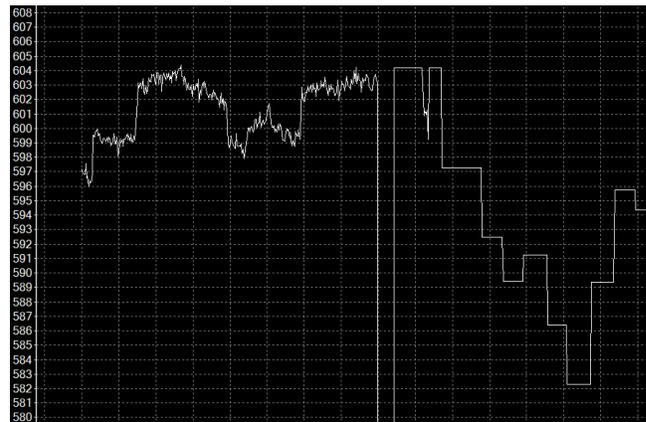
Firmware Upgrade

The operational firmware on the RF HUB-Node can be updated using a built-in utility. Firmware images are distributed as .bin files. Press the File Icon image to launch a file browser and navigate to the location of the desired file.

RF-View will conduct some file compatibility and hardware version checks to ensure that the binary file is valid for the connected RF HUB-Node. If the selected file is not compatible the window below will notify the user.
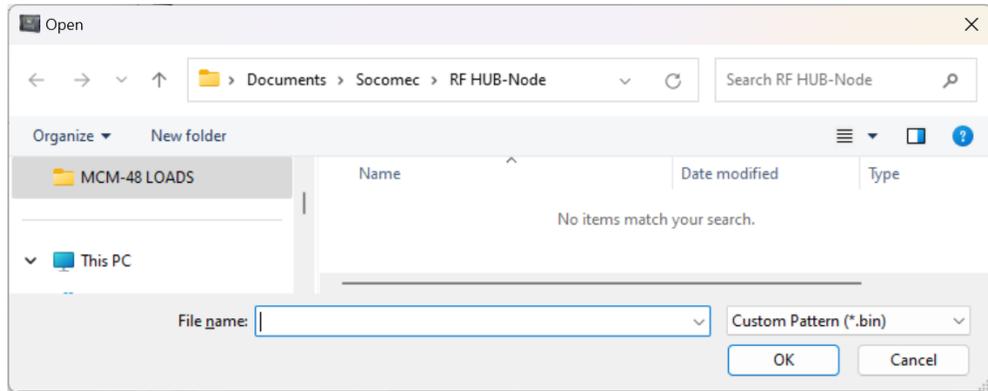
If the selected file is verified, the "Upgrade" button will become available. The process can still be canceled if a mistake has been made.
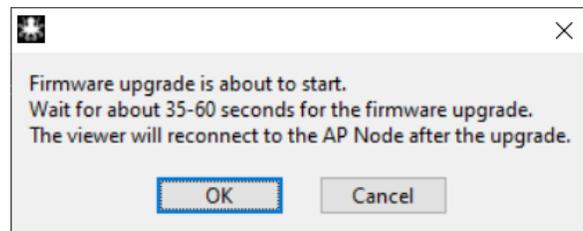
Firmware loading is indicated by a progress bar and completes in roughly one minute. Interrupting the power to the RF HUB-Node while firmware is loading will result in an inoperable unit. The system will re-establish connection with the RF-View application when the upgrade is complete.
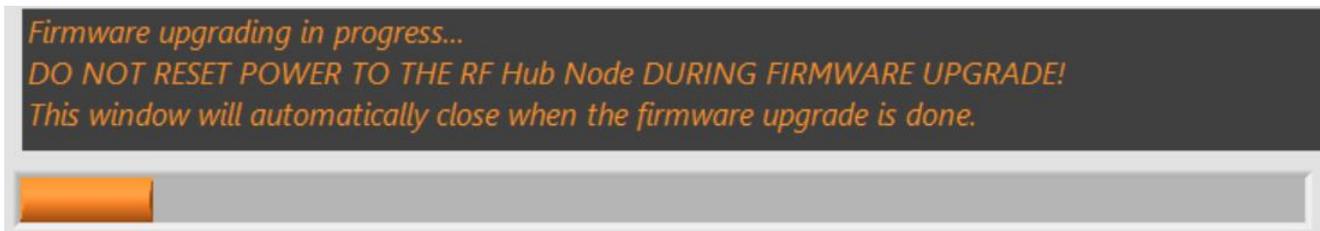
If you need any assistance, please email our support team at tech.us@socomec.com.
For all other inquiries, contact info.us@socomec.com.

For more information on our other products and solutions, visit our website at www.socomec.us

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