MONNIT®

Monnit Wireless Sensors
Serial Modbus (RTU/ASCII) Gateway
For Version 3.3

User's Guide

Contents

1.0   Serial Modbus Gateway Overview

The Monnit Serial Modbus Gateway (SMG) acts as a data concentrator for Monnit wireless sensor networks. This device allows you to connect up to 50 wireless sensing devices, per gateway, to your existing serial Modbus RS-232C and RS-485 sensing and control infrastructures.

Monnit has recognized the importance of using open standards like Modbus, allowing Monnit wireless sensors to be used in the majority of industrial applications. Modbus is often used to connect a supervisory computer with a remote terminal unit (RTU) in supervisory control and data acquisition (SCADA) systems. Modbus allows for communication between many devices connected to the same wired network. Therefore, Monnit SMG's allow for seemingly unlimited wireless expansion of a traditional wired network.

A system incorporating a Monnit SMG consists of the following:

- Modbus Master – PLC, SCADA, etc.
- Existing RS-232C or RS-485 Infrastructure.
- Monnit Serial Modbus Gateway (SMG).
- Monnit Wireless Sensors

For information about the Modbus TCP interface, please refer to documentation regarding the Ethernet Gateway v3.0.

RP SMA Antenna

Durable, Impact-Resistant, IP65 and NEMA 4X Rated Enclosure

5-Wire Connection
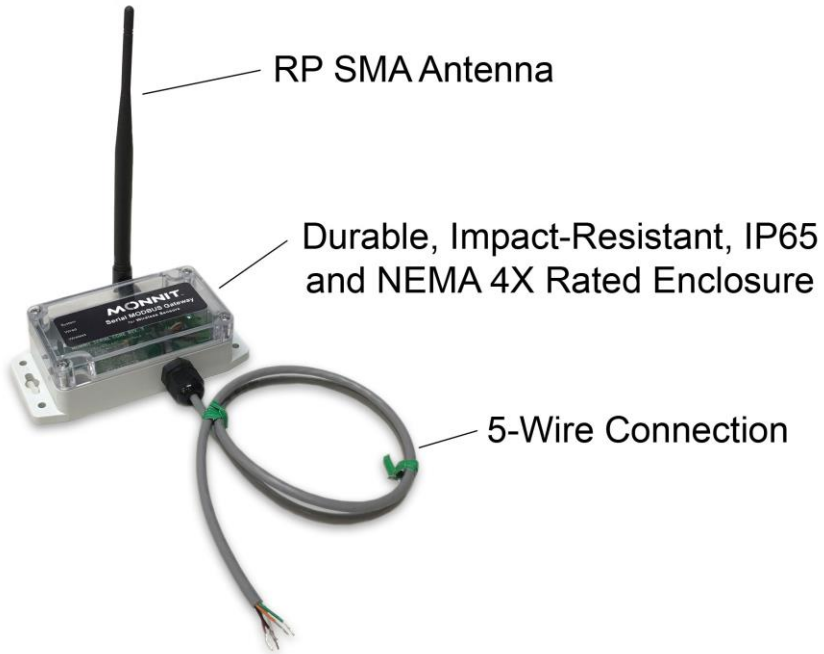
Contains FCC ID: ZTL-RFSC1 & IC: 9794A-RFSC1

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 device has been designed to operate with an approved antenna listed on page 11, and having a maximum gain of 5.1 dBi. Antennas not included in this list or having a gain greater than 5.1 dBi are strictly prohibited for use with this device. The required antenna impedance is 50 ohms.

To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (EIRP) is not more than that required for successful communication.

FCC Approval (USA) *- Refer To Page 34 for FCC Requirements.*
IC Approval (Canada) *- Refer To Page 35.*

Features

- Works with Monnit 900, 868 and 433MHz Sensor Networking Solutions
- Communicates with Modbus RTU / ASCII Protocols
- Supports RS-232C / RS-485 Interfacing
- 3 LED Indicators (System, Wired and Wireless)
- NEMA 4X / IP65 Rated Enclosure
- RP SMA Antenna Connector (Antenna Included)

Example Network Integration

Monnit wireless sensors integrate with existing Modbus systems allowing for additional environmental variables to be monitored.
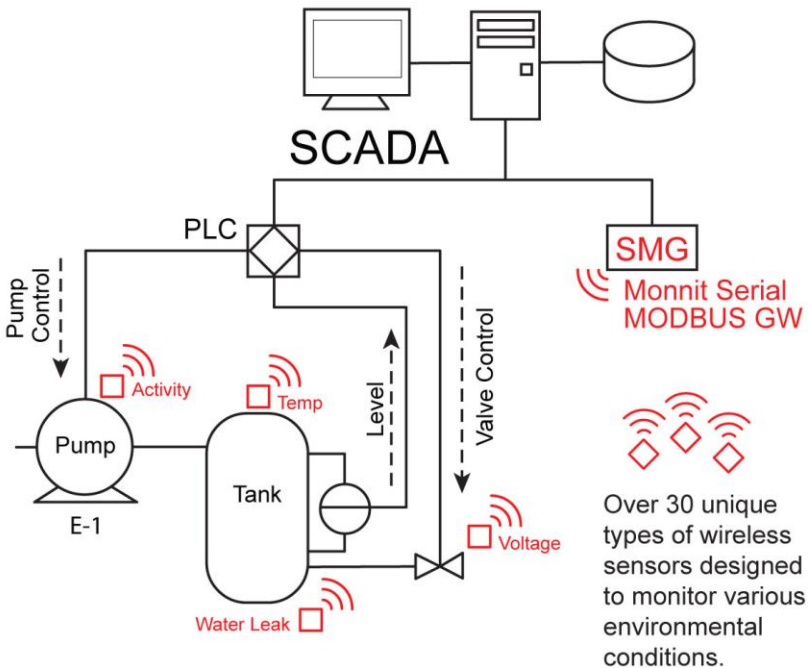
Monnit Serial Modbus Gateway Specifications

General

Monnit APN Interface Support	RFSC1 Module by Monnit Frequencies: 433, 868 and 900 MHz (Future support for WiFi and 500 mW modules)
Antenna	Connector: RP-SMA Gain: 3.0 dBi Standard

3 Wire Communication Interface

RS-232C	TXD (OUT), RXD (IN), and Ground / Common
RS-485	D+, D-, and Ground / Common
Protocol Selector	Jumper for RS-232 and RS485

Power

Input Voltage Range	4.5 - 36.0 VDC
Minimum Current Required	100mA (500mA Recommended)

Mechanical

Reset Feature	Communication / Factory Settings Reset Jumper
Indicator Lights	Dual Color LEDs
Enclosure	Durable, Impact-Resistant UV Stabilized Polycarbonate (IP65 of IEC 529 and NEMA 1, 2, 4, 4x, 12 and 13 Rated)
Dimensions	179.60 x 90.68 x 41.30 mm
Weight	16 ounces

Environmental

Operating Temperature	-40 to +85 °C (-40 to +185 °F)
Storage Temperature	-40 to +85 °C (-40 to +185 °F)

2.0 Connecting The Serial Modbus Gateway Hardware

This section contains details on how to connect the Serial Modbus Gateway (SMG) for testing and use.

The SMG has a communication select jumper. No Jumper is RS-485, jumper on is RS-232C.

The SMG has a 5 wire connector already installed and ready for connection. The table below shows the wire mapping.

SMG 5-Wire Connector	
Red:	4.5 – 36 VDC
Black:	Power ground
Orange:	RS-232C: TXD gateway's transmitter data connection. Connect the Modbus master's receiver. RS-485: D+ Non-inverting 485 transmitter/receiver.
White:	Signal ground, internally connected to power ground.
Green:	RS-232C: RXD gateway's receiver data connection. Connect the Modbus master's transmitter. RS-485: D- Inverting 485 transmitter/receiver.
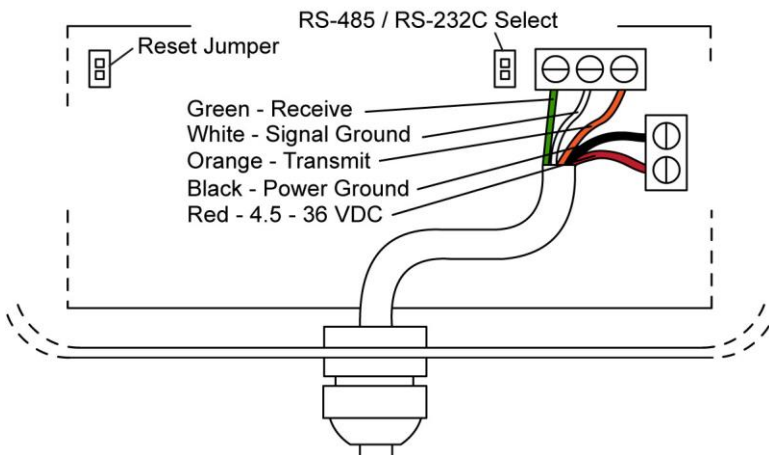
2.1 Connecting the Serial Modbus Gateway to the USB Programming Dongle:

Monnit provides Modbus configuration software that presents a GUI to the user and makes interfacing to the Modbus gateway easy. Monnit also provides a USB to RS485 dongle to connect the hardware to a PC. To use the USB to RS485 dongle, connect the wires from the Modbus gateway as shown in the illustration below.

Black USB Version
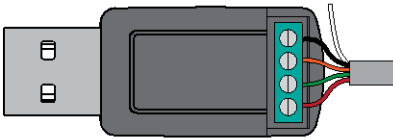
White – Signal Ground
(Not Connected)

Black – Power Ground
Orange – Transmit
Green – Receive
Red - 4.5 - 36 VDC

Clear USB Version
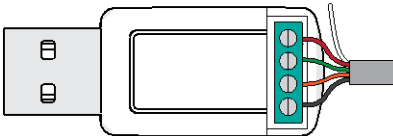
White – Signal Ground
(Not Connected)

Red - 4.5 - 36 VDC
Green – Receive
Orange – Transmit
Black – Power Ground

Note: The white wire is not used with the USB programming dongle. The white should be left unconnected but protected to prevent accidental shorting.

* Any COM port in a computer may be used with the software.

The USB driver for this device can be downloaded at: http://www.ftdichip.com/Drivers/VCP.htm.

Select the version that is compatible with your PC operating system.

2.2   Serial Modbus Gateway Indicator Lights
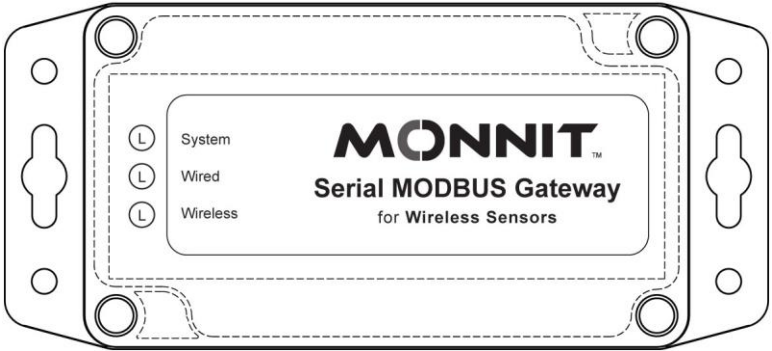
<u>System</u> - Indicates gateway status. A green light indicates ready and working, a red light indicates there is a hardware problem.

<u>Wired</u> - Indicates connectivity with Modbus system. A green light indicates ready and working, a red light indicates there is a problem. A flashing green light indicates active communication.

<u>Wireless</u> - Indicates wireless sensor network activity. A green light indicates ready and working, a red light indicates that no network has been formed (no sensors are registered). A flashing green light indicates radio traffic from the sensors.

Indicator Light Sequences:

<u>Startup</u> - All indicators flash red and green for ~4 seconds.

<u>Internal Memory Failure</u> - All indicators stay red after startup.

<u>COM Reset</u> - "Wired" indicator will flash red (1x/sec).

<u>Factory Reset</u> - All indicators will flash red quickly (5x/sec).

3.0   Modbus Protocol Implementation

See for details on the official protocol and function code.

The Serial MG supports 2 transmission modes: RTU and ASCII.

Modbus Interfaces will support the following commands: (FC refers to Modbus Function Codes).

    FC = 1: Read Coils
    FC = 5: Write Single Coil
    FC = 15: Write Multiple Coils
    FC = 3: Read Holding Registers
    FC = 6: Write Single Register
    FC = 16: Write Multiple Registers

All other commands, exceptions, or other interface features are not supported.

Note: Raw addressing starts at 0. For FC-specific addressing, the address starts at 1 for coils and 40001 for holding registers. Denoted in the literature as 0 / 1 or 1 / 40001.

3.1   Register Size

Modbus permits the use of a variety of register size specifications. This device uses the standard 16-bit unsigned integer for its register size. Additionally, register-data representation can take the form of multi-register data types (i.e. 32-bit integer). These will be specified specifically for all registers that require additional formatting.

3.2   Multi-byte Formatting

Modbus has specified the use of 'Big-Endian' representation for addresses and data items. This means that when a numerical quantity larger than a single byte is transmitted, the most significant byte is sent first.

3.3   Communication Defaults

- Modbus slave ID or Modbus address: 95 or 0x5F
- Modbus-RTU, 8 data bits, No Parity, 1 Stop bit (8-N-1), 19200 baud

3.4   Communication Settings Reset Jumper

MUST OPEN ENCLOSURE TO ACCESS

If the device's communications settings are unknown, it is possible to reset the communication settings by placing a jumper on the RESET jumper position when the gateway is not powered. This jumper is scanned at power up or reset.

- Open jumper: Normal operation, Wireless and Modbus communications allowed to function.
- Closed jumper: Communications interface reset.

If the jumper is detected closed, the device must be power-cycled, with the jumper in the open position, before the device is allowed to operate normally. During COM reset the "Wired" indicator light will flash red indicating that the reset procedure is happening.

3.5   Factory Reset Jumper

MUST OPEN ENCLOSURE TO ACCESS.

While in communication reset state, if the device remains powered and the reset jumper is deliberately removed and replaced twice, a factory reset will occur on the device. All indicators will flash red quickly (5x/sec) indicating that the device has been successfully reset. Power-cycle the device with the jumper in the open position to allow normal operation.

NOTE: a factory reset will remove all known sensors and settings from the device.

4.0 Using the Gateway - Coil and Register Map

This device has various coils and registers that allow the user to access gateway and wireless device feature. Here is a brief listing of the accessible coil and register map.

Resource Name	Acronym	Function Code	Raw Address
Gateway Coils	GWC	1-5	0-4
Wireless Device Coils (50 total sets of 4 coils)	WDC [0] thru WDC [49]	2001-2200	2000-2199
Gateway Registers	GWR	40001-40010	0-9
Wireless Device List (50 total sets of 2 registers)	WDL [0] thru WDL [99]	40101-40200	100-199
Fast Read Registers (50 total sets of 7 registers)	FRR [0] thru FRR [99]	41001-41350	1000-1349
Wireless Device Registers (50 total sets of 50 registers)	WDR [0] thru WDR [99]	42001-44500	2000-4499

Please see the reference section for more detailed information.

4.1 Verifying that the Wireless is Active

Read the "WACTIVE" Gateway Coil. (Function Code address = 1, Raw Address = 0). A true coil denotes that the system is configured sufficiently to communicate to wireless device(s). A false coil means the gateway does not have any registered wireless devices (WDL is empty).

4.2   Resetting the Gateway

Write the "RST_DEVICE" Gateway Coil (Function Code address = 2, Raw Address = 1) to TRUE. The device will reset one second after receiving this command. This resets all wireless device data in the FRR. Additionally, if any gateway settings (baud rate, Modbus address, communication mode) were modified, this causes these settings to take effect.

4.3   Resetting the Wireless Network

Write the "RST_WNET" Gateway Coil (Function Code address = 3, Raw Address = 2) to TRUE. The gateway will take approximately 30 seconds to complete the wireless network reset after the acknowledging this command. No serial commands will be acknowledged during this time (wired LED is red). This operation optimizes the RF configurations for best performance and clears out all devices from the WDL. The gateway will not be active until at least one wireless device is registered.

4.4   Resetting to Default Communications Settings

Write the "RST_COM" Gateway Coil (Function Code address = 4, Raw Address = 3) to TRUE. After setting this coil to true, a device reset command must be issued (or power cycling) before any of the new settings will take effect.

Resets the baud rate, mode, and device ID back to defaults, which are respectively: 19200, RTU: 8-N-1, 95.

4.5   Resetting the Gateway to Factory Settings

Write the "RST_FACTORY" Gateway Coil (Function Code address = 5, Raw Address = 4) to TRUE. After setting this coil to true, the device will reset automatically one second after the write coil command is acknowledged. No manual reset is required.

4.6 Viewing and Modifying Modbus Communication Settings

The BAUDRATE Gateway Register (Function Code 40006, Raw Address 5) contains the baud rate setting. Encoded options are:

0 : 2400
1 : 4800
2 : 9600
3 : 19200
4 : 38400
5 : 57600
6 : 115200

Example: Writing a value of 2 to this register will effectively change the baud rate to 9600.

The COMMODE Gateway Register Function Code address = 40007, Raw Address =6) contains the following encoded options:

0 : RTU : 8-N-2
1 : RTU : 8-N-1
2 : RTU : 8-E-1
3 : RTU : 8-O-1
4 : ASCII : 7-N-2
5 : ASCII : 7-E-1
6 : ASCII : 7-O-1

Example: Writing a value of 2 to this register will effectively change the communication mode to RTU: 8-E-1.

The ADDRESS Gateway Register (Function Code address = 40008, Raw Address =7) contains the address used by the Modbus interface. Values of 1-247 are permitted to be written.

Modifications to these registers are applied after a power-cycle or gateway reset sequence.

Please see Ref.4 for more information.

4.7 Setting Gateway Time

GWTIME, consisting of GWTIME_H and GWTIME_L @ 40011-40012 or RAW 10-11, is a UInt32 value that by default represents the time in seconds from the point the gateway was powered on or reset. A user, that has access to some form of external time reference, can write to these registers to set time. It is required that GWTIME_H is written before GWTIME_L is written. Once GWTIME_L is written the gateways time is officially updated with the contents of GWTIME_H/L. Reading these register will retrieve the gateway's time in seconds.

The reference time used to set this time only needs to be meaningful to the application it is used in. Most applications do not require the Serial Modbus Gateway to reference any time. If an application uses wireless device synchronization settings, then the time must be set. As an example, Current time is September 1st, 2016 at 17:05:15. If September 1st, 2016, 00:00:00 was referenced as the beginning time, then the GWTIME can be set to (17 * 3600) + (5 * 60) + 15 = 61515. If January 1st, 2016, 00:00:00 was referenced as the beginning time, then GWTIME can be set to (245 * 24 * 3600) + (17 * 3600) + (5 * 60) + 15 = 21229515. Both time references result in accurate synchronization of remote wireless devices.

4.8 Viewing Registered Wireless Devices

The WD_CNT Gateway Register (Function Code address = 40004, Raw Address =3) contains the number of registered devices in the Wireless Device List (WDL). A Value of 0 here denotes that no devices are registered and the wireless is disabled.

The WDL consists of 50 set of 2-paired registers that represents the Serial Identifier (SID) for the register device. These registers can be read to discover the location of a specific device in the list (SLOT).

Note: You need to have registered at least one sensor to view/edit wireless device register data (WDR). Please see Ref.4 for more information.

4.9   Adding a Wireless Device to the Gateway

Each Monnit device has a 32-bit serial identifier (SID). To add a wireless device, this SID is written to the intended SLOT (two registers at a time) in WDL registers.

Note: The two SLOT ID registers must be written to using FC = 16 (Write to Multiple Registers) otherwise an error will be generated. See section 3.0 for more details.

SLOT IDs can only be added one at a time.

For example: If you have sensor 43527 in hand and you wanted to add this to SLOT 0, you would write the following.

| 40101 / 100 | 0 |
| 40102 / 101 | 43527 |

To move a wireless device from one slot to another, the SID of the wireless device only needs to be written to the new SLOT. The old SLOT will be erased and prepared for future use.

To delete a wireless device from the list, write a 0,0 into the SLOT and the device will be erased and the SLOT is prepared for future use.

When registering the first wireless device, the second LED will go red signifying there is no wired communication available, then the third LED will start flashing while the wireless network resets. Please wait approximately 30 seconds (until all LEDs turn green, signifying a successful network reset) after registering the first device, before attempting any other tasks.

If the WDL SLOT is written to incorrectly, a "Modbus IO error message" is returned.

Please see Ref.3 for more information.

4.10 Verifying Wireless Device Activity

After a device is registered, the SLOT it was registered at can be verified by reading the WDL. Once the slot is known, a user can read the WDC [SLOT], WDR [SLOT], and FRR [SLOT] associated with the wireless device.

If a wireless device is registered, but is not actively communicating, the ACTIVE coil @ WDC[SLOT] offset 0 will be false.

When a wireless device is actively communicating, the ACTIVE coil @ WDC[SLOT] offset 0 will be true.

4.11 Viewing Wireless Device Data (Fast Read Method)

All Monnit Wireless Devices have two pieces of commonly useful data:

1) if a threshold is breached or if the device is in an exception state
2) the acquired data measurement.

Using the FRR, a user can quickly collect new data generated by multiple devices registered on the gateway. The purpose of these registers is to allow for efficient access to the remote wireless device's most current data.

When new data is available from any Wireless device the FRR is updated with the newly reported values. The FRR will zero itself out if *no new* data is received within a defined period. The defined period is specified in the Wireless Device Registers offset 18.

Any write to the first address in the FRR will zero out the latest measurement and age. These records consist of seven (7) registers per wireless device. The format of these records are: AGE, DATA_0, DATA_1, DATA_2, DATA_3, BATTERY, RSSI.

Fnct. Code ADDRESS = 41001+ (7 * SLOT)
Raw ADDRESS FORMULA = 1000+(7 * SLOT)

Please see Ref.5 for more information on these registers.

4.12   Viewing Wireless Device Data (Advanced method)

For a user to see more data about a devices exception and activity status, the ACTIVE coil @ WDC[SLOT] offset 0 and EXCEPTION coil @ WDC[SLOT] offset 1 can be queried.

WDC F.C. FORMULA=2001+(4*SLOT)+OFFSET
WDC RAW ADDR FORMULA=2000+(4*SLOT)+OFFSET

Please see Ref.2 for more information on these coils.

For a user to see the detailed data from a device, read register WDR [SLOT] offset 5 - 15. This will return device battery voltage, signal strength, and specific status and data from the device.

WDRF.C.FORMULA=42001+(50* SLOT) + OFFSET
WDR RAW ADDR FORMULA=2000+(50 * SLOT) + OFFSET

Please see Ref.6 for more details on these registers.

4.13 Configuring Wireless Devices (Standard Requests)

For a user to view and modify wireless device settings, read/write to register WDR[SLOT] offset 19-23. These registers contain information and settings relating to communication intervals, retry, and failure recovery behaviors.

Please see Ref.6 for more details on these registers.

After changes are made to these registers, the user can use the PENDING_CFG coil @ WDC[SLOT] offset 2 to check the status of these changes. When this coil is true, the pending changes have not been communicated with the wireless device. When this coil is reset to false, the wireless device has been updated with the change. We recommend one update at a time.

4.14 Configuration Rules to Abide By

There are two important rules to obey when setting Wireless Devices, to ensure optimum stability.

$$CFG\_INTERVAL\_EXCEPTION \leq CFG\_INTERVAL\_STANDARD$$

$$CFG\_INTERVAL\_STANDARD \div CFG\_INT\_TYPE\_MEAS\_PER\_RPT \geq 1$$
$$AND$$
$$CFG\_INTERVAL\_EXCEPTION \div CFG\_INT\_TYPE\_MEAS\_PER\_RPT \geq 1$$

4.15 Wireless Device Sync Setting

All "Interval Type" wireless devices contain configuration CFG_INT_TYPE_SYNC @ offset 45 that enables them to synchronize data reporting to an external clock. Value can range from 0 – 5. If the value is 0 [default], the wireless devices do not synchronize report interval and will report data in respect to its startup time. If the value is 1 – 5, the wireless device attempts to track its report time based on the Serial Modus Gateway's time. It is important that GWTIME in the Gateway Registers is set with an appropriate time reference. For instance, GWTIME could be set to the number of seconds from January 1st, 2010, 00:00:00. Now when the Sync setting is not set to 0, the wireless device will constantly adjust its reporting interval to closely track a modulus of the gateway's time. As an example, if a wireless temperature sensor has a report interval of 30 minutes and this sync setting is enabled, this sensor will report its data near to 00:00, 00:30, 1:00, 1:30, …, etc.

The difference in the enabled values of 1 – 5 correlate to the number of "random seconds" that is included in the calculation of next report interval.   Theses setting are useful in managing networks of different sizes. If 20 sensors were all configured to synchronize and deliver data at the exact same time, the RF collisions would cripple the sensor network. Please see table below for recommend settings to be used with specific network sizes.

Sync Setting	# of Devices	Random Time
1	1-2	1 Second
2	3-7	3 Seconds
3	8-15	7 Seconds
4	16-25	15 Seconds
5	26-50	30 Seconds

5.0   Upgrading Gateway Firmware

Gateway Versions 3.0.0.0 and above are remotely upgradeable. To upgrade the SMG, you will need to already have or download the Monnit Modbus Sensor Gateway software executable and possess a Monnit Serial Modbus Gateway to USB Programming dongle. Once these are in place, obtain and the latest file upgrade from Monnit Support and save the file locally on your PC.

Put the SMG in bootloader mode by opening the enclosure and accessing the RESET Jumper. Place the jumper over the pins and remove and replace at least 5 times.

When the jumper is placed on the RESET terminals for the first time, the middle light will flash red while the other lights are off. Removing and replacing the jumper twice will then cause the all three lights to flash on and off quickly in red. Removing and replacing the jumper four more times will cause the top Gateway light to go solid red, while the other lights are off. Removing the jumper for the final time will cause all three lights to illuminate solid red. Your SMG is now in bootloader mode.

Use the Monnit Modbus Sensor Gateway software and find the menu "Gateway Commands". At the bottom, select the option "Upgrade Gateway Firmware". Select the upgrade file and click on "Open".

While the code loads, the status is displayed in the bottom left of the Monnit Modbus Sensor Gateway Software. The lights on the SMG will flash red and off during the process. Upon successful upgrade, the SMG will then reboot. Note that all registered sensors will be eliminated and the new firmware will be in a fresh from factory state.

If an error occurs during the process, factory reset the gateway using the jumper and try again.

Reference Section

Complete Gateway Features and Resource Mapping Reference

Through the Modbus interface, the following features are available for access by a Modbus master. All coils and registers are available for read or write access through the Modbus address mapping presented here.

Ref.1 - Gateway Coils

The following table represents the supported gateway specific coils. These are intended to report the status, control the state, or trigger events on the gateway.

Coil Name	Function Code	Raw Address	Description
WACTIVE	1	0	True (1) denotes that the system is configured sufficiently to communicate to the sensor. False (0) denotes that the Wireless system is not active. Causes for this include: - No Registered Sensors.
RST_DEVICE	2	1	Writing True (1) to this coil will force a device reset and cleans out all current status. Always read as False (0).
RST_WNET	3	2	Writing True (1) to this coil will force a Wireless Network Reset and reform the operating network setting based on CHANM and NETID (in Gateway Registers). Always read as False (0).
RST_COM	4	3	Writing True (1) to this coil will force the ADDRESS, COMMODE, and BAUDRATE to defaults. Always read as False (0). After setting this coil to true, a device reset command must be issued before any of the new settings will take effect.

RST_FACTORY	5	4	Writing True (1) to this coil will force all settings to Factory defaults. Always read as False (0). After setting this coil to true, the device will automatically reset so the new settings will take effect.

Example Modbus Request: Read GWC

Modbus Command: read coils 1-5 (OR RAW 0-4)
DEFAULT Modbus SETTINGS: Address: 95 (0x5F)

Modbus ASCII
Poll Gateway Coils: ":63010000000595<CR><LF>"

Modbus RTU
Poll Gateway Coils: 0x63 01 00 00 00 05 75 8A

• 63 is address
• 01 is function code (read coils)
• 00 is address high
• 00 is address low
• 00 is coil count high
• 05 is coil count low
• 758A is CRC for RTU protocols

95<CR><LF> is the check sum and end-of-line for ASCII protocols

Ref.2 - Wireless Device Coils

This section defines the location and function of all the remotely located coils available for access through the Modbus interface. Every wireless device has been allotted 4 possible coils. The table below enumerates the address allotment.

FCADDRESSFORMULA=2001+(4*WDL_SLOT)

Raw Address Formula = 2000+(4*WDL_SLOT)

Register Name	Address	Register Name	Address
WDC [0]	FC 2001 / 2000	WDC [49]	FC 2197 / 2196

The following table represents the specific Wireless Device Coils. These are intended to report the status, control the state, or trigger events on the remotely connected devices.

Coil Name	Offset	Description
ACTIVE	0	True (1) denotes that the remote wireless device is actively synchronized with the gateway. False (0) denotes that the device is considered offline by the gateway. No communications have occurred with the devices for **INACTIVITY_TIMEOUT** (in WDR) amount of time value. This is 0 if no devices are registered. **(READ ONLY)**
EXCEPTION	1	True (1) denotes that device is in an exception state (data threshold breached or sensor state) and the device's wireless report interval is governed by **INTERVAL_EXCEPTION** (in WDR). False (0) denotes that no exception state is currently noted on the wireless device. Therefore the wireless report interval is governed by **INTERVAL_STANDARD** (in WDR). **(READ ONLY)** **(READ ONLY)**

Register Name	Function Code	Raw Address	Description
PENDING_CFG	2		True (1) denotes that one or more registers have been modified from their original values (located on the remote device). False (0) denotes that the no local registers contain configurations that are different from the remote device. Writing True (1) to this coil will cause the local configuration parameters contained in the gateway to be sent to the remote device. (**FORCE OVERWRITE).** Writing False (0) to this coil will be ignored. Coil resets automatically when remote configuration changes have been confirmed.
FORCE_REMOTE_ SYNC	3		Always read as False (0). If set to True (1), then the wireless device's local registers will be cleared and the remote configurations will be retrieved.

Ref.3 - Gateway Registers

The following table represents the supported gateway settings and their corresponding properties.

Register Name	Function Code	Raw Address	Description
VERSION	40001	0	Designates the FW Version of the Gateway. **(READ-ONLY)** Example Value: 0x3000 (Read 3.0.0.0)
ID_H	40002	1	Gateway's globally-unique identifier. **(READ-ONLY)**
ID_L	40003	2	Combine an ID_H and ID_L to form UInt32 number.
WD_CNT	40004	3	Wireless Device Count – Value that can be read to discover the number of registered sensors are configured to operate on the gateway. A value **0 – 50** is permitted. **(READ-ONLY)**

			Example Value: 0 (no sensors registered, factory reset condition) Example Value: 10 (10 Registered device)
OP_CHAN	40005	4	Operating channel designator reports the wireless channel in use. Value of 0-25 is permitted **(READ-ONLY)**

BAUDRATE	40006	5	Designates the baud rate used by the Modbus interface. After modifying this register, a gateway reset must be performed before changes can take effect.
			
			Value Represented Baud Selected
			   0 2400
			   1 4800
			   2 9600
			   3 (DEFAULT) 19200
			   4 38400
			   5 57600
			   6 115200

COMMODE	40007	6	Designates the operating mode used by the Modbus interface. After modifying this register, a gateway reset must be performed before changes can take effect. **Value Meaning** 0 RTU : 8-N-2 1 (DEFAULT) RTU : 8-N-1 2 RTU : 8-E-1 3 RTU : 8-0-1 4 ASCII : 7-N-2 5 ASCII : 7-E-1 6 ASCII : 7-O-1
COMADDR	40008	7	Designates the Modbus Address used in the communications interface. Values range from 1-247. Default value is 95.

CHANM_H	40009	8	The configurable channel mask is a UInt32 bit-field that represents the allowed channels the wireless is allowed to establish a network. Default value contains a 1 for every possible channel (all channels are allowed). If the value is 0x00000011, then the network is only allowed to be established on channels 0 and 4. After these registers are modified, the RST_WNET coil must be set to true to reform the network and select new OP_NETID and OP_CHAN settings.
CHANM_L	40010	9	
GWTIME_H	40011	10	By default, this is a UInt32 value that represents the number of seconds since the gateway was last powered or reset. However, this value can be set to any value that represents the number of seconds from any point in time.
GWTIME_L	40012	11	

Example Modbus Request:

Modbus Command: read registers 40001-40010 (0-9)
DEFAULT Modbus SETTINGS: Address: 95 (0x5F)

Modbus ASCII
Poll Gateway Registers: ":63030000000983<CR><LF>"

Modbus RTU
Poll Gateway Registers: 0x63 03 00 00 00 09 0D 86
   • 63 is address
   • 03 is function code (read holding registers)
   • 00 is address high
   • 00 is address low
   • 00 is register count high
   • 09 is register count low
   • 0D86 is CRC for RTU protocols

83<CR><LF> is the check sum and end-of-line for ASCII protocols

Ref.4 - Wireless Device List Registers

The WDL register stores the serial identifier of the registered wireless devices. The serial identifiers are formatted as a UInt32, therefore two contiguous registers must be read to extract the full value.

FCADDRESSFORMULA=40101 + (2 * SLOT)
Raw Address Formula = 100 + (2 * SLOT)

List entries can be as follows:

0xFFFFFFFF: EMPTY
Otherwise, a real device is registered

Example:

Register Name	Address	Register Name	Address
WDL [0]	FC 40101, Raw 100	WD [49]	FC 40200, Raw 198

Ref.5 - Fast Read Registers

The purpose of these registers is to allow for efficient access to the remote wireless device's most current data. Any write to the first address in the FRR will zero out the latest measurement and time.

These records consist of seven (7) registers per wireless device.

FCADDRESSFORMULA=41001+(7*SLOT)
Raw Address Formula=1000+(7*SLOT)

Example:

Record Name	Address	Record Name	Address
FRR [0]	FC 41001, Raw 1000	FRR [49]	FC 41344, Raw 1343

The format of these records are:

Name	Offset	Description
AGE	0	time in seconds when the wireless device generated this data.
DATA_0, DATA_1, DATA_2, DATA_3	1, 2, 3, 4	Data is generated by wireless device. The format for this data can be found in the Monnit Serial Modbus Sensor Application Definition document
Battery	5	register value / 100 = x.xx Volts
RSSI	6	a negative number from -20 to -110 dBm

The FRR is auto zeroed when no new data comes in.

Ref.6 - Wireless Device Registers

This section defines the location and function of all the remotely located registers available for access through the Modbus interface. Every wireless device has been allotted 50 possible registers. The table below enumerates the address allotment.

FCADDRESSFORMULA=42001+(50*SLOT)
Raw Address FORMULA=2000+(50*SLOT)

Example:

Register Name	Address	Register Name	Address
WDR [0]	FC 42001, Raw 2000	WDR [49]	FC 44451, Raw 4450

The following table represents the supported Wireless Device Registers. They contain the pertinent data and configurations populated from the remote device. Through these registers, a user is capable of interpreting additional data, setting new configurations, and sending other control-related messages (CNTL) to the remote device. Unknown or unused values are defaulted to 0x0000.

Field Name	Offset	Description
ID_H	0	Wireless device's globally-unique identifier. Combine a ID_H and ID_L to form full UInt32 number. **(READ-ONLY)**
ID_L	1	
VER_MAJOR	2	Wireless device's firmware version number. Registers VER_MAJOR::VER_MINOR to be interpreted as ASCII characters with the following format: "M0"."M1"."m0"."m1". Example: VER = 0x3230::0x3136 → "Version: 2.0.1.6". **(READ-ONLY)**
VER_MINOR	3	
TYPE	4	Device Type value that is used to interpret the sensor specific portions of this record. **(READ-ONLY)**
VOLTAGE	5	Current Voltage reported from the remote device. Value formatted in millivolts. **(READ-ONLY)**. Example: 301 → 3.01 Volts
RSSI	6	Current Received Signal Strength Indicator. Formatted as Int16. Values of -20 to -106 dBm typical. The less negative the number, the more signal there was on the last communication. **(READ-ONLY)**.
STATUS	7	Current Status reported from the remote device. **(READ-ONLY)**.
DATA_0	8	The current data reported by the remote device. **(READ-ONLY)**.
DATA_1	9	
DATA_2	10	
DATA_3	11	
DATA_4	12	
DATA_5	13	
DATA_6	14	
DATA_7	15	
INACTIVITY_ TIMEOUT	16	Timeout in 5 min steps. Values of 1 to 216 (5 min to 18 hrs) permitted. If the device has communicated within the amount of time specified here, the ACTIVE coil is set to TRUE. If No communications have occurred with the devices for this specified amount of time, the ACTIVE coil is reset to FALSE.

CFG_ CHANM_H	17	Configurable Channel Mask is a UInt32 bit-field that represents the allowed channels the wireless device is permitted to use to search for gateways. If the value is written to 0x00000011, then the network is only allowed to be established on channels 1 and 4.
CFG_ CHANM_L	18	
CFG_INTERVAL_ LINK	19	Configurable Interval Link represents the device's link-state sleep time. If the device disconnects from its current network (e.g. failures, reset), it will scan permitted channels for a new link. If no gateway is found, then this specified period of time is waited before attempting to relink. This value is a UInt16 that is interpreted as follows: - CFG_LINKHB <= 18, value is in hours. (1-18 HRS) - CFG_LINKHB > 100. value is in minutes. (105 = 5 MIN) - If 0 or Otherwise, 2HR default
CFG_ INTERVAL_ STANDARD	20	Configurable Interval for Standard Reports is the regular check-in interval for the wireless device (based on timer, not events). Format: UInt16 number of seconds to wait before checking in.
CFG_ INTERVAL_ EXCEPTION	21	Configurable Interval for Exception Reports is the check-in interval used during exception cases (based on timer, not events). Format: UInt16 number of seconds to wait before checking in.
CFG_ RETRIES	22	Configurable Retry Limit represents the number of attempts made by the device to deliver its data when the primary attempt fails. Value of 0 – 10 inclusive are permitted.
CFG_ FAIL_LIM	23	Configurable Fail Limit represents the number of report attempts that can fail consecutively before the sensor drops current gateway connection, resets to link mode and re-scans for a better connection. Value of 1-10 inclusive are permitted for the relink behavior. If value is 0, then this behavior is disabled and only a power-cycle can reset the device's link settings.

CFG_PROFILE_TYPE	24	Value that selects what profile specific device type is recognized by the remote device. (**READ ONLY** – Write attempts are ignored) **INTERVAL–TYPE DEVICE = 1** -- Primarily governed by a timer. When it is time to deliver data, the wireless device transmits the data to the gateway. **TRIGGER–TYPE DEVICE = 2** -- Primarily governed by the occurrence of an event. If an event is detect OR the CFG_INTERVAL_STANDARD is reached, then the wireless device transmits the data to the gateway.
CFG_INT_TYPE_MEAS_PER_RPT	25	Device-Type Specific Parameter: **INTERVAL–TYPE DEVICE** Measurements Per Report represents the number of measurements that will be taken for every given wireless report. If an exception is noted, then the device will immediately report instead of waiting for the report interval. Value of 1 – 250 permissible. Minimum granularity of 1 sec maximum sample rate.
CFG_INT_TYPE_HYSTERESIS_H	26	Device-Type Specific Parameter: **INTERVAL–TYPE DEVICE**
CFG_INT_TYPE_HYSTERESIS_L	27	Hysteresis represents the amount of observed variance must occur to permit a device that has registered an exception to remove the exception notification.
CFG_INT_TYPE_THRESH_MIN_H	28	Device-Type Specific Parameter: **INTERVAL–TYPE DEVICE**
CFG_INT_TYPE_THRESH_MIN_L	29	Minimum Threshold represents the amount of device specific observed signal can be reduced before an exception is registered and reported.
CFG_INT_TYPE_THRESH_MAX_H	30	Device-Type Specific Parameter: **INTERVAL–TYPE DEVICE** Maximum Threshold represents the amount of device specific observed signal can be increased before an exception is registered and reported.
CFG_INT_TYPE_THRESH_MAX_L	31	

CFG_INT_TYPE_ CALVAL_1_H	32	Device-Type Specific Parameter: **INTERVAL–TYPE DEVICE**
CFG_INT_TYPE_CAL VAL_1_L	33	Calibration / Control Values.
CFG_INT_TYPE_ CALVAL_2_H	34	
CFG_INT_TYPE_ CALVAL_2_L	35	
CFG_INT_TYPE_ CALVAL_3_H	36	
CFG_INT_TYPE_ CALVAL_3_L	37	
CFG_INT_TYPE_ CALVAL_4_H	38	
CFG_INT_TYPE_ CALVAL_4_L	39	
CFG_TRG_TYPE_ DETECT_TYPE	40	Device-Type Specific Parameter: **TRIGGER–TYPE DEVICE**
CFG_TRG_TYPE_ DETECT_PERIOD	41	Mode / Control Values.
CFG_TRG_TYPE_ DETECT_COUNT	42	
CFG_TRG_TYPE_ DETECT_REARM	43	
CFG_TRG_TYPE_ DETECT_BISTABLE	44	
CFG_INT_TYPE_ SYNC	45	UInt16 value used to enable wireless device time synchronization to external time input. Value can range from 0 – 5. If the value is 0 [default], then the wireless devices do not synchronize and will report its data in respect to startup time. If the value is 1 – 5, the wireless device attempts to track its report time based on the Serial Modus Gateway's time (see GWTIME in Gateway registers).
UNUSED	46-49	

Notes:

1. See Monnit's Serial Modbus Sensor Application Definition document for more information on field definitions, enumeration, and usage for these specific registers.

2. An Interval that specifies under 10 minutes must consider the battery power usage and wireless network load the gateway may experience if the CFG_INTERVAL parameters a set too low. It is recommended to keep then network load to at most 10 device reports per minute. The maximum interval for communications is 18 hrs → 64800 seconds.

Error Reporting, Troubleshooting and Support

For technical support and troubleshooting tips please visit our support library online at http://www.monnit.com/support/. If you are unable to solve your issue using our online support, email Monnit support at support@monnit.com with your contact information and a description of the problem, and a support representative will call you within one business day.

For error reporting, please email a full description of the error to support@monnit.com.

Warranty Information

(a) Monnit warrants that Monnit-branded products will be free from defects in materials and workmanship for a period of one (1) year from the date of delivery with respect to hardware and will materially conform to their published specifications for a period of one (1) year with respect to software. Monnit may resell sensors manufactured by other entities and are subject to their individual warranties; Monnit will not enhance or extend those warranties. Monnit does not warrant that the software or any portion thereof is error free. Monnit will have no warranty obligation with respect to Products subjected to abuse, misuse, negligence or accident. If any software or firmware incorporated in any Product fails to conform to the warranty set forth in this Section, Monnit shall provide a bug fix or software patch correcting such non-conformance within a reasonable period after Monnit receives from Customer (i) notice of such non-conformance, and (ii) sufficient information regarding such non-conformance so as to permit Monnit to create such bug fix or software patch. If any hardware component of any Product fails to conform to the warranty in this Section, Monnit shall, at its option, refund the purchase price less any discounts, or repair or replace non-conforming Products with conforming Products or Products having substantially identical form, fit, and function and deliver the repaired or replacement Product to a carrier for land shipment to customer within a reasonable period after Monnit receives from Customer (i) notice of such non-conformance, and (ii) the non-conforming Product provided; however, if, in its opinion, Monnit cannot repair or replace on commercially reasonable terms it may choose to refund the purchase price. Repair parts and replacement products may be reconditioned or new. All replacement products and parts become the property of Monnit. Repaired or replacement products shall be subject to the warranty, if any remains, originally applicable to the product repaired or replaced. Customer must obtain from Monnit a Return Material Authorization Number (RMA) prior to returning any Products to Monnit. Products returned under this Warranty must be unmodified.

Customer may return all Products for repair or replacement due to defects in original materials and workmanship if Monnit is notified within ninety (90) days of customer's receipt of the product. Monnit reserves the right to repair or replace products at its own and complete discretion. Customer must obtain from Monnit a Return Material Authorization Number (RMA) prior to returning any products to Monnit. Products returned under this Warranty must be unmodified and in original packaging. Monnit reserves the right to refuse warranty repairs or replacements for any products that are damaged or not in original form. For products outside the ninety-day warranty period repair services are available at Monnit at standard labor rates for a period of one year from the Customer's original date of receipt.

(b) As a condition to Monnit's obligations under the immediately preceding paragraphs, Customer shall return Products to be examined and replaced to Monnit's facilities, in shipping cartons which clearly display a valid RMA number provided by Monnit. Customer acknowledges that replacement products may be repaired, refurbished or tested and found to be complying. Customer shall bear the risk of loss for such return shipment and shall bear all shipping costs. Monnit shall deliver replacements for Products determined by Monnit to be properly returned, shall bear the risk of loss and such costs of shipment of repaired products or replacements, and shall credit Customer's reasonable costs of shipping such returned Products against future purchases.

(c) Monnit's sole obligation under the warranty described or set forth here shall be to repair or replace non-conforming products as set forth in the immediately preceding paragraph, or to refund the documented purchase price for non-conforming Products to Customer. Monnit's warranty obligations shall run solely to Customer, and Monnit shall have no obligation to customers of Customer or other users of the Products.

Limitation of Warranty and Remedies.

THE WARRANTY SET FORTH HEREIN IS THE ONLY WARRANTY APPLICABLE TO PRODUCTS PURCHASED BY CUSTOMER. ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE ARE EXPRESSLY DISCLAIMED. MONNIT'S LIABIITY WHETHER IN CONTRACT, IN TORT, UNDER ANY WARRANTY, IN NEGLIGENCE OR OTHERWISE SHALL NOT EXCEED THE PURCHASE PRICE PAID BY CUSTOMER FOR THE PRODUCT. UNDER NO CIRCUMSTANCES SHALL MONNIT BE LIABLE FOR SPECIAL, INDIRECT OR CONSEQUENTIAL DAMAGES. THE PRICE STATED FOR THE PRODUCTS IS A CONSIDERATION IN LIMITING MONNIT'S LIABILITY. NO ACTION, REGARDLESS OF FORM, ARISING OUT OF THIS AGREEMENT MAY BE BROUGHT BY CUSTOMER MORE THAN ONE YEAR AFTER THE CAUSE OF ACTION HAS ACCRUED.

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Certifications

United States FCC

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 instruction manual, 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 more 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.*

Warning: *Changes or modifications not expressly approved by Monnit could void the user's authority to operate the equipment.*

RF Exposure

WARNING: To satisfy FCC RF exposure requirements for mobile transmitting devices, the antenna used for this transmitter must not be co-located in conjunction with any other antenna or transmitter.

FCC ID: ZTL-RFSC1

This device has been designed to operate with an approved antenna listed below, and having a maximum gain of 5.1 dBi. Antennas not included in this list or having a gain greater than 5.1 dBi are strictly prohibited for use with this device. The required antenna impedance is 50 ohms.

To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (EIRP) is not more than that required for successful communication.

Approved Antennas
The following antennas are approved for use with FCC ID: ZTL-RFSC1

- *Hyperlink HG905RD-RSP (5.1 dBi Rubber Duck)*
- *Pulse W1063 (3.0 dBi Rubber Duck)*
- *ChangHong GSM-09 (2.0 dBi Rubber Duck)*
- *Specialized Manufacturing MC-ANT-20/4.0C (4" whip)*

Canada (IC)

English

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the 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.

This radio transmitter (IC: 9794A-RFSC1) has been approved by Industry Canada to operate with the antenna types listed below with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

This device complies with Industry Canada license-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.

French

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.

Le présent émetteur radio (IC: 9794A-RFSC1) a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés ci-dessous et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur.

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, méme si le brouillage est susceptible d'en compromettre le fonctionnement.

For additional information on Monnit Wireless Sensors and Software, please visit us on the web at www.monnit.com.

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