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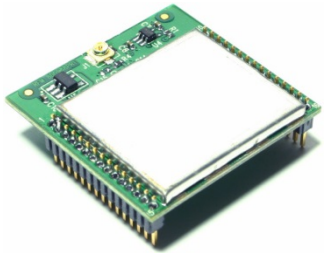
WSN802G

802.11g Wireless Sensor Network Module



Integration Guide

Revision History

Revision	Date	Author	Change Description
1	06/18/2012	F. Perkins	Initial issue
2	01/27/2015	R. Willett	Reformatted to comply with new Murata V.I.

Important Regulatory Information

RFM Product FCC ID: HSW-WSN802G
IC 4492A-WSN802G

Note: This unit 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 when the equipment is operated in a commercial environment. 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. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at their expense.

The WSN802G has been designed to operate with any dipole antenna of up to 9 dBi of gain, or any patch antenna of up to 12 dBi gain.

See Section 3.10 of this manual for regulatory notices and labeling requirements. Changes or modifications to a WSN802G not expressly approved by RFM may void the user's authority to operate the module.

Important Export Information

ECCN: 5A002.a.1 ENC
CCATS: G073573

The WSN802G products are classified under ECCN codes as 5A002.a.1 class devices and carry and ENC encryption exception. RFM has had the WSN802G products pre-screened which allows exports to countries listed in Supplement 3 to Part 740 of the Export Administration Requirements *License Exception ENC Favorable Treatment Countries*. When exporting products containing any of the WSN802G products to this list of countries, CCATS G073573 should be referenced.

Export of the WSN802G products or products containing any of the WSN802G products to other countries will require additional review and may be prohibited.

This information is provided as a guide to exporting WSN802G-based products but it is the responsibility of the entity exporting WSN802G products or devices to determine their actual requirements.

Table of Contents

1. WSN802G Introduction

The WSN802G transceiver module is a low cost, robust solution for 802.11b/g/n sensor networks. The WSN802G is unique in that it is able to sleep while still remaining a member of an 802.11b/g/n network. The WSN802G's low active current and very low sleep current makes long life battery operation practical. The WSN802G module includes analog, digital and serial I/O, providing the flexibility and versatility needed to serve a wide range of sensor network applications. The WSN802G module is easy to integrate and is compatible with standard 802.11b/g/n routers.

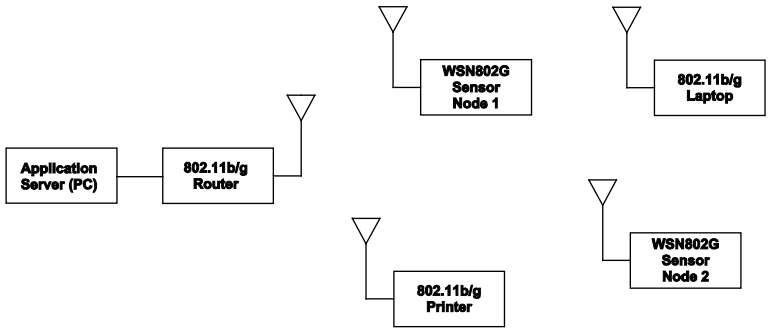


Figure 1.0.1

An example 802.11b/g/n network with WSN802G sensor nodes is shown in Figure 1.0.1. A sensor network application running on a server or PC communicates with one or more WSN802G sensor nodes through a commercial 802.11b/g/n router. WSN802G sensor nodes can be used with 802.11b/g/n routers that are also serving other applications.

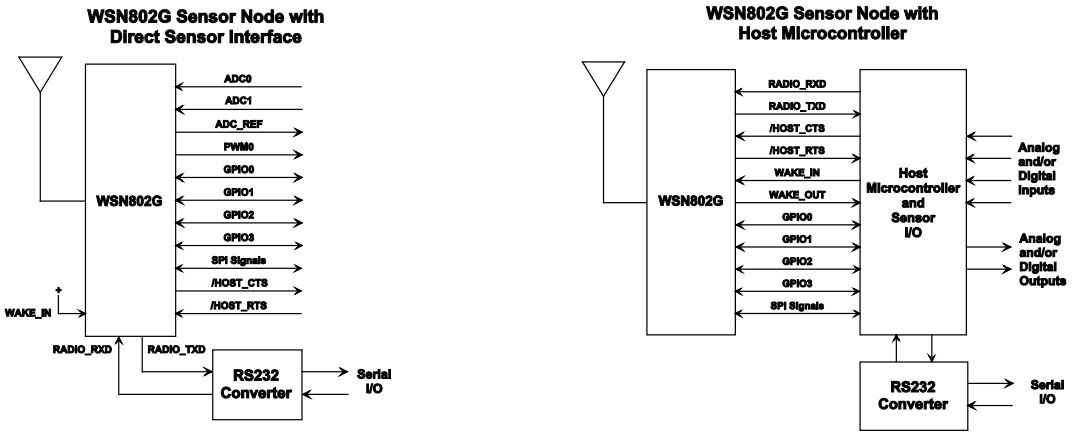


Figure 1.0.2

A WSN802G module is integrated with other components to create a complete sensor node. These components include a host circuit board, a power supply (battery), sensor I/O electronics and/or a host microcontroller, and a housing (external antenna also required on some WSN802G models). Two common configurations are show in Figure 1.0.2. Serial sensor data communication between a WSN802G module and its host microcontroller requires no protocol formatting. The WSN802G formats data received from its host into UDP packets for RF transmission, and delivers the payload data from received UDP packets to

its host. The sensor network application on the server or PC uses a simple protocol to send and receive data from WSN802G sensor nodes, as detailed in Section 4. WSN802G modules can receive configuration commands through either their serial port or over-the-air in UDP packets carrying SNMP commands.

1.1. Features

WSN802G modules provide a unique set of features for wireless sensor network applications:

- Compatibility with commercial and industrial 802.11b/g/n routers
- Low power consumption for long life battery operation including sleep mode
- Full -40 to +85 ºC industrial temperature range operation
- Analog and digital I/O, plus two serial and one SPI port
- Separate data and diagnostic ports
- System/application set up using just two Management Information Blocks (MIBs)
- Full 14 channel 802.11b/g coverage for world wide operation
- FCC, Canadian IC and European ETSI certifications
- Four module configurations:

  WSN802GC - solder reflow mounting with RF connector for external antenna connection

  WSN802GCA - solder reflow mounting with integral chip antenna

  WSN802GP - plug in connector mounting with RF connector for external antenna connection

  WSN802GPA - plug in connector mounting with integral chip antenna
- Automatic or manual I/O data reporting

1.2 Applications

WSN802G sensor networks are well suited to applications where IEEE 802.11b/g/n router compatibility, industrial temperature range operation and long battery life are important. Many applications match these criteria, including:

- Energy Monitoring and Management
- Physical Asset Management
- Cold Chain Data Logging and Food Safety
- Security and Access Control Systems
- Environmental Monitoring
- Many More

2.0 WSN802G Operation

WSN802G operation is designed to support long battery life by allowing the module to stay in sleep mode to the maximum extent possible. Compared to 802.11b/g cards used in notebook and handheld computers, the WSN802G's active current is also very low.

2.1 Active and Sleep Modes

Once the SNMP Server IP address has been set, the default state of the WSN802G is sleep mode. The WSN802G has a dedicated input to switch it from sleep to active mode, WAKE_IN (Pin 26). There are five events that will wake the WSN802G from sleep mode:

- Applying a logic high signal on the WAKE_IN pin
- Expiration of the *AutoReport* timer
- Expiration of Linkup trap timer
- Expiration of the Config trap timer
- Module's Primary SNMP Server IP address has not been set (this will not wake it, it prevents it from sleeping)

The WAKE_IN pin and *AutoReport* can be enabled/disabled. The Linkup timer sends a keep alive packet to the router every 60 seconds by default. The Config timer cannot be disabled and will generate a Config trap every 10 seconds by default. Once a module has been initially configured, the Config timer is typically set to a longer interval.

When the module wakes to an active state due to either the WAKE_IN pin or the *AutoReport* timer, it remains awake for a time period controlled by the *WakeTimeout* timer. The module returns to sleep mode when the *WakeTimeout* timer expires, subject to the conditions listed below. The *WakeTimeout* timer is held in reset and the module remains in active mode when any of the following events occur:

- A logic high signal is held on the WAKE_IN pin
- A serial byte is received
- An RF packet is sent or received
- Module's SNMP Server IP address has not been set

The *WakeTimeout* feature is used to support scenarios such as a server application parsing the I/O report and sending back a serial string or I/O output change command, or a host processor sending a serial string and waiting for a response.

As discussed in Section 5, the SNMP Server IP address can be set in a short period of time, allowing the module to switch to sleep mode for battery conservation. The SNMP server IP address only needs to be set one time.

A WSN802G module that has an SNMP Server IP Address but is not linked to an 802.11b/g/n router will cycle between sleep and active mode under the control of the scanning algorithm, even if none of the wake events discussed above are present.

Whenever the module is in active mode, a logic high is asserted on WAKE_OUT (Pin 27). WAKE_OUT can be used to signal an external processor. When the WSN802G is in sleep mode, WAKE_OUT is set to logic low.

2.2 Automatic I/O Reporting

The WSN802G sends an I/O report when one of the following events occur:

- A logic high signal is applied to the WAKE_IN pin
- The *AutoReport* timer fires (module in either active or sleep mode)

2.3 Data Serial Port

The data serial port on the WSN802G modules supports baud rates from 1.2 to 921.6 kbps. The following serial port configurations are supported:

- 5, 6, 7 and 8-bit character lengths
- 1 or 2 stop bits
- Even, odd, mark, space or no parity

The default serial port configuration is 9.6 kbps, 8, N,1. See Sections 4.14 and 7.2 for serial port configuration details. Serial port operation is full-duplex. Data is sent and received on the serial port transparently, with configuration information sent and received as UDP datagrams. The WSN802G includes an acknowledgement and retry mechanism to minimize data loss on RF transmissions. However, the UDP/IP protocol being carried by the RF transmissions does not provide guaranteed end-to-end delivery. The user must make provisions for detecting and resending data lost on an end-to-end transmission. The WSN802G data port is supported with optional /HOST_RTS and /HOST_CTS flow control signals.

2.4 Diagnostic Serial Port

The diagnostic serial port on the WSN802G modules supports baud rates from 1.2 to 115.2 kbps. The default diagnostic port configuration is 9.6 kbps, 8, N,1. Diagnostic port operation is full-duplex, three-wire, without flow control support. Diagnostic data is sent and received using a simple string protocol. Contact RFM module technical support for diagnostic port data format information.

2.5 Serial Peripheral Interface (SPI) Port

The WSN802G SPI port provides master mode functionality at data rates configurable up to 11 Mbps. SPI port operation is full duplex in the sense that a single clock signal simultaneously shifts data into and out of the SPI port.

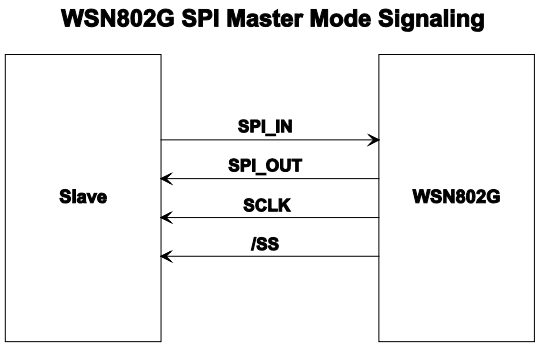


Figure 2.5.1

Figure 2.5.1 shows the signals a WSN802G uses in SPI Master mode. The AutoReport function triggers the WSN802G module to clock out a configurable command string, *SPI_MasterCmdStr*, to collect data from a Slave peripheral. The collected data is then transmitted as a data message. Alternatively, a host connected to the base can transmit an SPI command as a data message to the remote. The WSN802G will clock the command into its Slave peripheral and transmit back the Slave's response, as show in Figure 2.5.2. In either case, data strings are limited to 256 bytes.

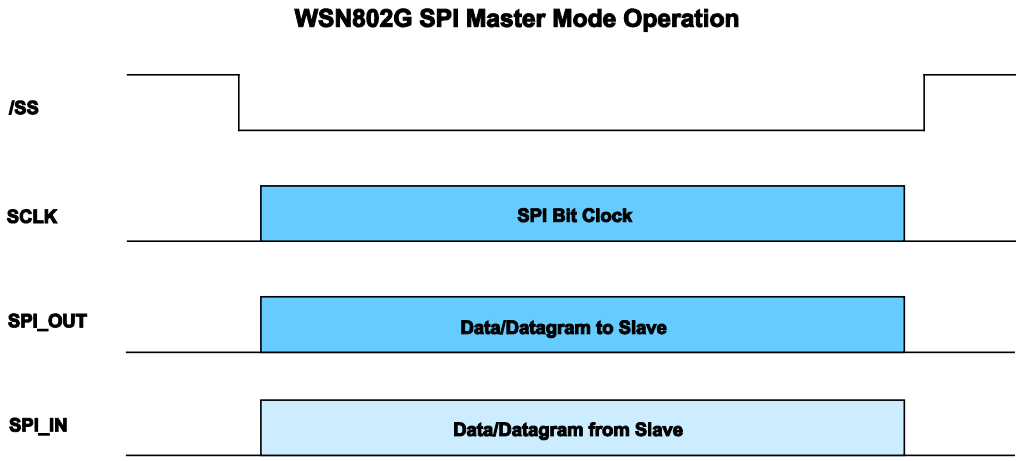


Figure 2.5.2

2.6 Analog I/O

The WSN802G includes two 10-bit ADC inputs, ADC0 (Pin 18) and ADC1 (Pin 19). Pin 25 provides a full-scale reference voltage to support ratiometric ADC measurements. ADC measurements are triggered and added to the automatic I/O report when a logic high signal is first applied to the WAKE_ IN pin or the *AutoReport* timer fires, as discussed in Section 2.2. An ADC reading is also made on the internal buss voltage of the WSN802G and included in the automatic I/O report. These readings can also be retrieved anytime the WSN802G is in active mode using the IO_REPORT application protocol command as discussed in Section 4.1.

The WSN802G also includes a 16-bit pulse width modulated output, PWM0 (Pin 9). The PWM output is low-pass filtered to provide an analog output voltage with ripple suppressed to 7 bits. External low-pass filtering can be added to further suppress ripple. The full-scale PWM output is referenced to the regulated

supply voltage (Pin 24). The PWM output is set using the IO_ WRITE_PWM application protocol command, as discussed in Section 4.4.

2.7 Digital I/O

The WSN802G includes four general purpose input/output (GPIO) ports, GPIO0 (Pin 4), GPIO1 (Pin 11), GPIO2 (Pin 10) and GPIO3 (Pin 12). When programmed as inputs, GPIO pins include an internal weak pull-up. The states of pins configured as inputs are captured as part of the automatic I/O report when a logic high signal is applied to the WAKE_IN pin or the *AutoReport* timer fires, as discussed in Section 2.2. These readings can also be retrieved anytime the WSN802G is in active mode using the IO_READ_REQUEST application protocol command as discussed in Section 4.1. The states of GPIO pins configured as outputs are set using the IO_WRITE_GPIO application protocol command as discussed in Section 4.3.

3.0 WSN802G Hardware

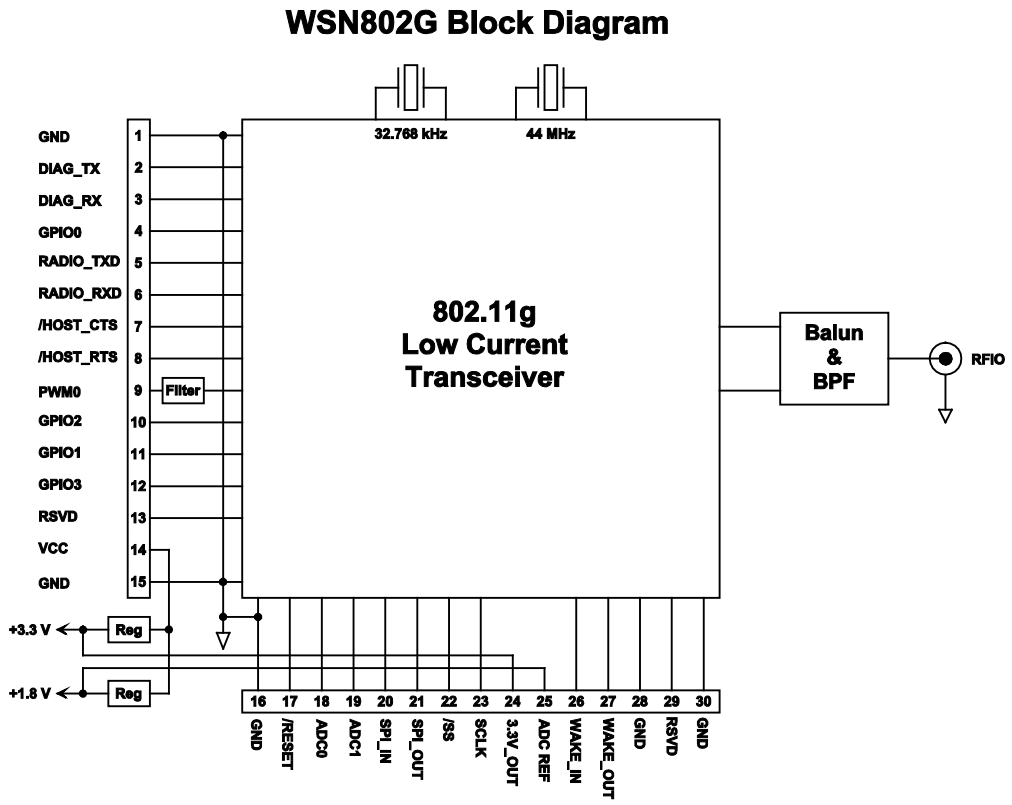


Figure 3.0.1

WSN802G modules operate in the international 2.4 GHz ISM band over the frequency range of 2401-2474 MHz, with a nominal RF output power of 10 mW. WSN802G modules support four standard 802.11g RF data rates, 1, 2, 5.5 and 11 Mbps. WSN802G modules provide a variety of hardware interfaces. There are two serial interfaces, one for data and a second for diagnostics. The data port supports standard serial baud rates from 1.2 to 921.6 kbps, and the diagnostic port supports standard serial baud rates from 1.2 to 115.2 kbps. Optional hardware flow control is provided for the data serial port. There is also a serial peripheral interface (SPI), which can operate in either master or slave mode. SPI slave mode supports data rates up to 2 Mbps, and master mode supports data rates up to 11 Mbps.

WSN802G modules includes two 10-bit ADC inputs, a 16-bit PWM (DAC) output, and four general purpose input/output (GPIO) ports. WSN802G modules are available with either RF connectors for external antennas, or with integral chip antennas (A suffix). WSN802G modules are available in two mounting configurations. The WSN802GC and WSN802GCA are designed for solder reflow mounting, and the WSN802GP and WSN802GPA are designed for plug-in connector mounting.

3.1 Absolute Maximum Ratings

Rating	Sym	Value	Units
Input/Output Pins Except ADC Inputs		-0.5 to +3.63	V
ADC Input Pins		-0.5 to 1.98	V
Non-Operating Ambient Temperature Range		-40 to +85	°C

Table 3.1.1

3.2 Specifications

Characteristic	Sym	Minimum	Typical	Maximum	Units
Operating Frequency Range		2401		2474	MHz
Spread Spectrum Method			Direct Sequence		
RF Chip Rate			11		Mcps
RF Data Rates			1, 2, 5.5, 11		Mbps
Modulation Type			BPSK at 1 Mbps, QPSK at 2 Mbps CCK at 5.5 and 11 Mbps		
Number of RF Channels			11		
RF Channel Spacing			5		MHz
Receiver Sensitivity, 8% PER:					
1 Mbps RF Data Rate			-92		dBm
2 Mbps RF Data Rate			-90		dBm
5.5 Mbps RF Data Rate			-84		
11 Mbps RF Data Rate			-81		
RF Transmit Power			10		mW
WSN802GC and WSN802GP RF Connector			U.FL Coaxial Connector		
Optimum External Antenna Impedance			50		Ω
WSN802GCA and WSN802GPA Antenna			Integral Chip		
ADC Input Range		0		1.8	V
ADC Input Resolution			10		bits
ADC Input Impedance		1			MΩ
PWM Output Resolution				16	bits
Data Serial Port Baud Rates			1.2, 2.4, 4.8, 9.6 (default), 19.2, 28.8, 38.4, 57.6, 76.8, 115.2, 230.4, 460.8, 921.6		kbps
Diagnostic Serial Port Baud Rate			1.2, 2.4, 4.8, 9.6 (default), 19.2, 28.8, 38.4, 57.6, 76.8, 115.2		kbps
Serial Peripheral Interface (SPI) Data Rate, Master Mode				11	Mbps
Serial Peripheral Interface (SPI) Data Rate, Slave Mode				2	Mbps
Digital I/O:					
Logic Low Input Level		-0.3		0.7	V
Logic High Input Level		2.24		V_{CC}	V
Input Pull-up Resistor		50		1000	KΩ
Logic Low Output Level		0		0.4	V
Logic High Output Level		2.4		V_{CC}	V
Power Supply Voltage Range	V_{CC}	+3		+3.63	Vdc
Power Supply Voltage Ripple				10	mV_{P-P}
Receive Mode Current				150	mA
Transmit Mode Current				200	mA
Sleep Mode Current			7.5		µA
WSN802GC and WSN802GCA Mounting			Reflow Soldering		
WSN802GP and WSN802GPA Mounting			Socket		
Operating Temperature Range		-40		85	°C
Operating Relative Humidity Range, Non-condensing		10		90	%

Table 3.2.1

3.3 Module Interface

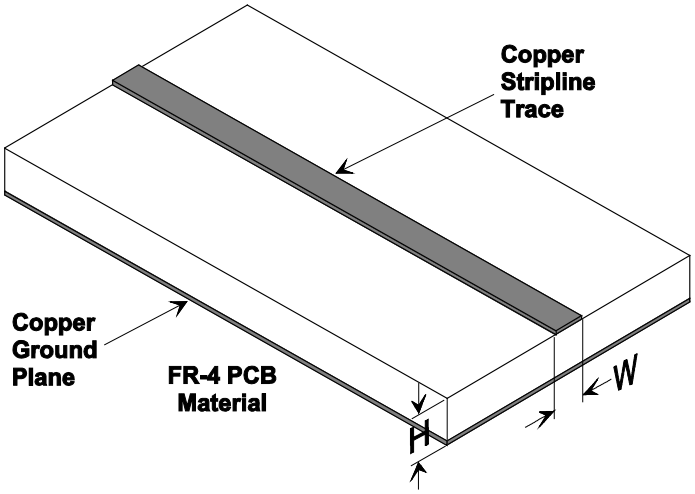
Pin	Name	I/O	Description
1	GND	-	Power supply and signal ground. Connect to the host circuit board ground.
2	DIAG_TX	O	Diagnostic serial port output.
3	DIAG_RX	I	Diagnostic serial port input.
4	GPIO0	I/O	Configurable digital I/O port 0. An internal weak pull-up is provided when configured as an input.
5	RADIO_TXD	O	Serial data output from the radio.
6	RADIO_RXD	I	Serial data input to the radio.
7	/HOST_CTS	O	UART/SPI flow control output. The module sets this line low when it is ready to accept data from the host on the RADIO_RXD or MOSI input. When the line goes high, the host must stop sending data.
8	/HOST_RTS	I	UART flow control input. The host sets this line low to allow data to flow from the module on the RADIO_TXD pin. When the host sets this line high, the module will stop sending data to the host.
9	PWM0	O	16-bit pulse-width modulated output with internal low-pass filter. Filter is first-order, with a 159 Hz 3 dB bandwidth, 10K output resistance.
10	GPIO2	I/O	Configurable digital I/O port 2. An internal weak pull-up is provided when configured as an input.
11	GPIO1	I/O	Configurable digital I/O port 1. An internal weak pull-up is provided when configured as an input.
12	GPIO3	I/O	Configurable digital I/O port 3. An internal weak pull-up is provided when configured as an input.
13	RSVD	-	Reserved pin. Leave unconnected.
14	VCC	I	Power supply input, +3.0 to +3.63 Vdc.
15	GND	-	Power supply and signal ground. Connect to the host circuit board ground.
16	GND	-	Power supply and signal ground. Connect to the host circuit board ground.
17	/RESET	I	Active low module hardware reset.
18	ADC0	I	10-bit ADC input 0. ADC full scale reading can be referenced to the module's +1.8 V regulated supply.
19	ADC1	I	10-bit ADC input 1. ADC full scale reading can be referenced to the module's +1.8 V regulated supply.
20	SPI_IN	I/O	This pin is the SPI master mode input.
21	SPI_OUT	I/O	This pin is the SPI master mode output.
22	/SS	I/O	SPI active low slave select. This pin is an output when the module is operating as a master, and an input when it is operating as a slave.
23	SCLK	I/O	SPI clock signal. This pin is an output when operating as a master, and an input when operating as a slave.
24	3.3V_OUT	O	Module's +3.3 V regulated supply, available to power external sensor circuits. Current drain on this output should be no greater than 50 mA.
25	ADC_REF	O	Module's +1.8 V regulated supply, used for ratiometric ADC readings. Current drain on this output should be no greater than 10 mA.
26	WAKE_IN	I	Active high interrupt input to wake the module from timer sleep. Can be used to wake module on event, etc.
27	WAKE_OUT	O	Active high output asserted when module wakes from timer sleep. Can be used to wake an external device.
28	GND	-	Connect to the host circuit board ground plane.
29	RSVD	-	Reserved pin. Leave unconnected.
30	GND	-	Connect to the host circuit board ground plane.

Table 3.3.1

3.4 WSN802GC and WSN802GP Antenna Connector

A U.FL miniature coaxial connector is provided on the WSN802GC and WSN802GP modules for connection to the RFIO port. A short U.FL coaxial cable can be used to connect the RFIO port directly to an antenna. In this case the antenna should be mounted firmly to avoid stressing the U.FL coaxial cable due to antenna mounting flexure. Alternately, a U.FL coaxial jumper cable can be used to connect the WSN802G module to a U.FL connector on the host circuit board. The connection between the host circuit board U.FL connector and the antenna or antenna connector on the host circuit board should be implemented as a 50 ohm stripline. Referring to Figure 3.4.1, the width of this stripline depends on the thickness of the circuit board between the stripline and the groundplane. For FR-4 type circuit board materials (dielectric constant of 4.7), the width of the stripline is equal to 1.75 times the thickness of the circuit board. Note that other circuit board traces should be spaced away from the stripline to prevent signal coupling, as shown in Table 3.4.1. The stripline trace should be kept short to minimize its insertion loss.

Circuit Board Stripline Trace Detail



For 50 ohm impedance W = 1.75 * H

Figure 3.4.1

Trace Separation from 50 ohm Microstrip	Length of Trace Run Parallel to Microstrip
100 mil	125 mill
150 mil	200 mil
200 mil	290 mil
250 mil	450 mil
300 mil	650 mil

Table 3.4.1

3.5 Input Voltage

WSN802G radio modules can operated from an unregulated DC input (Pin 14) in the range of 3.0 V (trough) to 3.63 V (peak) over the temperature range of -40 to 85° C. *Applying AC, reverse DC, or a DC voltage outside the range given above can cause damage and/or create a fire and safety hazard. Further, care must be taken so logic inputs applied to the radio stay within the voltage range of 0 to 3.3 V. Signals applied to the analog inputs must be in the range of 0 to ADC_REF (Pin 25). Applying a voltage to a logic or analog input outside of its operating range can damage the WSN802G module.*

3.6 ESD and Transient Protection

WSN802G circuit boards are electrostatic discharge (ESD) sensitive. ESD precautions must be observed when handling and installing these components. Installations must be protected from electrical transients on the power supply and I/O lines. This is especially important in outdoor installations, and/or where connections are made to sensors with long leads. *Inadequate transient protection can result in damage and/or create a fire and safety hazard.*

3.7 Interfacing to 5 V Logic System

All logic signals including the serial ports on the WSN802G are 3.3 V signals. To interface to 5 V signals, the resistor divider network shown in Figure 3.7.1 below must be placed between the 5 V signal outputs and the WSN802G signal inputs. The output voltage swing of the WSN802G 3.3 V signals is sufficient to drive 5 V logic inputs.

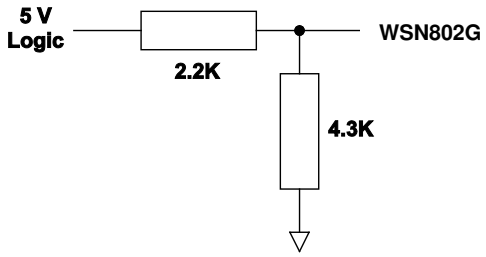


Figure 3.7.1

3.8 Power-On Reset Requirements

When applying power to the WSN802G, the /RESET pin should be held low until the power supply voltage reaches 3.3 volts for 100 milliseconds.

3.9 Mounting and Enclosures

WSN802GC radio modules are mounted by reflow soldering them to a host circuit board. WSN802GP modules are mounted by plugging their pins into a set of mating connectors on the host circuit board. Refer to Section 10.3 and/or the WSN802G Data Sheet for mounting details.

WSN802G enclosures must be made of plastics or other materials with low RF attenuation to avoid compromising antenna performance where antennas are internal to the enclosure. Metal enclosures are not suitable for use with internal antennas as they will block antenna radiation and reception. Outdoor enclosures must be water tight, such as a NEMA 4X enclosure.

3.10 Labeling and Notices

WSN802G FCC Certification - The WSN802G hardware has been certified for operation under FCC Part 15 Rules, Section 15.247. *The antenna(s) used for this transmitter must be installed to provide a separation distance of at least 20 cm from all persons and must not be co-located or operating in conjunction with any other antenna or transmitter.*

WSN802G FCC Notices and Labels - *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.*

A clearly visible label is required on the outside of the user's (OEM) enclosure stating "Contains FCC ID: HSW-WSN802G."

WARNING: This device operates under Part 15 of the FCC rules. Any modification to this device, not expressly authorized by RFM, Inc., may void the user's authority to operate this device. Canadian Department of Communications Industry Notice - IC: 4492A-WSN802G

This apparatus complies with Health Canada's Safety Code 6 / IC RSS 210.

ICES-003

This digital apparatus does not exceed the Class B limits for radio noise emissions from digital apparatus as set out in the radio interference regulations of Industry Canada.

Le present appareil numerique n'emet pas de bruits radioelectriques depassant les limites applicables aux appareils numeriques de Classe B prescrites dans le reglement sur le brouillage radioelectrique edicte par Industrie Canada.

ETSI EN 300 328

The WSN802G module has passed ETSI EN 300 328 testing conducted by an independent test laboratory.

4.0 Application Protocol

In most applications, the WSN802G auto-reporting function will be used to routinely send data from a module to the application. The WSN802G supports this type of operation through use of the auto-reporting function and the *AutoReport* and *WakeTimeout* timers.

There are three ways to read and write data and configuration parameters to and from the WSN802G module: (1) over the air using SNMP traps - configuration only; (2) over the air using UDP to send the WSN protocol; and (3) through the module's UART or SPI port using the WSN protocol. The SNMP protocol is distinct from the UDP and serial port protocol. The UDP and serial port protocol only differs in the UPD/IP packet header data.

Modules will request SNMP configuration changes using *Config Traps*. The frequency of checking for changes is configured through the Config trap timer. Details of the SNMP commands and operation is provided in Section 7 of this manual.

Modules must be in active mode (awake) to receive API commands through either over the air UDP commands or through the module's UART or SPI port. In addition to sending data, auto-report transmissions signal the application that the module is awake. Setting the *WakeTimeout* timer to 2 seconds will keep the module awake, giving the application 2 seconds to send API commands to the module. The module will remain awake past the 2 seconds if commands are being received or processed. Once the commands are completed the module will return to sleep immediately if the *WakeTimeout* time has elapsed.

The format of all of the WSN API commands and responses are given in Sections 4.1 through 4.13 below. API commands and responses sent through a wireless server (access point, etc.) are formatted as UDP/IP packets. The IPv4 UDP/IP packet format is shown in Figure 4.0.1 below. API commands and responses are carried in the UDP datagram payload area. In the text below, API commands and responses will be referred to as datagrams with the understanding they are the payload of a UDP datagram when sent through a wireless server. Automatically generated I/O reports from the WSN802G module due to timeouts or event interrupts take the form of the IO_READ - IO_REPORT datagram shown in Section 4.2. The IO_READ – IO_REPORT message is only available over the air and not through the module's serial ports.

<table>
<tr><th colspan="2">Byte 0</th><th>Byte 1</th><th colspan="2">Byte 2</th><th>Byte 3</th></tr>
<tr><td>IP Version</td><td>Header Length</td><td>Type of Service</td><td colspan="3">Total Length</td></tr>
<tr><td colspan="3">ID</td><td>Flags</td><td colspan="2">Fragment Offset</td></tr>
<tr><td colspan="2">Time to Live</td><td>Protocol</td><td colspan="3">Header Checksum</td></tr>
<tr><td colspan="6">Source IP Address</td></tr>
<tr><td colspan="6">Destination IP Address</td></tr>
<tr><td colspan="3">Source Port</td><td colspan="3">Destination Port</td></tr>
<tr><td colspan="3">UDP Length</td><td colspan="3">Checksum</td></tr>
<tr><td colspan="6">Payload (Application Command)</td></tr>
</table>

Figure 4.0.1

WSN802G modules only accept wireless application commands from and send wireless application command data/replies to the IP address of the server running their sensor application which is configured in the *SensorServerIP* parameter.

As shown in Figure 4.0.2 below, WSN802G application protocol datagrams use a standard header beginning with a protocol identifier to discriminate WSN802G protocol messages from other message types. Datagrams are in 32-bit, big-endian format. The standard header fields are:

Protocol Identifier: Unique identifier for all WSN messages, 0x52464D49

Opcode: Code indicating the type of command or response

Transaction ID: This is an incrementing transaction reference counter. Each end of the link must keep its own counter for transactions that it originates. The most significant bit of the transaction ID will be set for all transactions that the server originates.

The WSN802G application protocol messages are listed in Table 4.0.1 below. The port number that the module sends and receives wireless UDP application messages on is defined by the *SensorServerPortNum* parameter, as discussed in Section 7.2. A WSN802G module will accept wireless UDP messages specifically addressed to it, or that are broadcast (addressed to all modules). If a command is received through a wireless broadcast, the WSN802G module will reply with a broadcast.

The message format is the same for both the over the air UDP payload and the serial data communicated over either the module's UART or SPI ports. The Protocol Identifier serves as the start character for UART or SPI communicated packets with the Opcode used as a further validation of a API message instead of application data.

Byte 0	Byte 1	Byte 2	Byte 3
WSN802G Protocol Identifier = 0x52464D49			
Opcode		Transaction ID	
Data (variable length)			

Figure 4.0.2

Opcode	Direction	Description
0x0000	Server-to-Module	IO_READ_REQUEST
0x0001	Module-to-Server	IO_READ - IO_REPORT
0x0002	Server-to-Module	IO_WRITE_GPIO
0x0003	Server-to-Module	IO_WRITE_PWM
0x0004	Module-to-Server	IO_WRITE_REPLY
0x0005	Module-to-Server	IO_SERIAL_READ
0x0006	Server-to-Module	IO_SERIAL_WRITE
0x0007	Module-to-Server	IO_SPI_READ
0x0008	Server-to-Module	IO_SPI_WRITE
0x0010	Server-to-Module	CFG_READ
0x0011	Module-to-Server	CFG_READ_REPLY
0x0012	Server-to-Module	CFG_WRITE
0x0013	Module-to-Server	CFG_WRITE_REPLY

Table 4.0.1

4.1 I/O Read Request

The IO_READ_REQUEST datagram is used to request current I/O values, as shown in Figure 4.1.1.

Byte 0	Byte 1	Byte 2	Byte 3
WSN802G Protocol Identifier = 0x52464D49			
Opcode = 0x0000		Transaction ID = varies	

Figure 4.1.1

The module responds to an IO_READ_REQUEST with an IO_READ - IO_REPORT

4.2 I/O Read - I/O Report

The IO_READ - IO_REPORT datagram is used to report current I/O values, as shown in Figure 4.2.1.

Byte 0	Byte 1	Byte 2	Byte 3
WSN802G Protocol Identifier = 0x52464D49			
Opcode = 0x0001		Transaction ID = varies	
Timestamp [7..4]			
Timestamp [3..0]			
MAC Address Bytes [5..2]			
MAC Address Bytes [1..0] (sender)		ADC0	
ADC1		VOLT	
RSSI		GPIO	

Figure 4.2.1

The fields specific to this datagram are:

Timestamp: Timestamp of reading in 7.62939 µs timer ticks since startup

MAC Address: As an IO_READ - IO_REPORT can be sent unsolicited, the MAC address is provided to identify the sender, which can be helpful in situations where DHCP is used and the IP address is initially unknown or if the sender's IP address has been exchanged do to NAT.

ADC0: Current ADC0 reading, only the low 10 bits are significant

ADC1: Current ADC1 reading, only the low 10 bits are significant

VOLT: Current module voltage reading, 16-bit count in millivolts

RSSI: Current RSSI reading, only the low 10 bits are significant

GPIO: Current GPIO states, only GPIO lines defined as inputs are valid

The module generates an IO_READ - IO_REPORT datagram based on the *AutoReportInterval* and in response to an IO_READ_REQUEST.

4.3 I/O Write GPIO

The IO_WRITE_GPIO datagram is used to set module outputs, as shown in Figure 4.3.1.

Byte 0	Byte 1	Byte 2	Byte 3
WSN802G Protocol Identifier = 0x52464D49			
Opcode = 0x0002		Transaction ID = varies	
GPIO			

Figure 4.3.1

The field specific to this datagram is:

GPIO: States for GPIO lines defined as outputs. Setting a GPIO bit to 1 sets its output to 3.3 V, setting a bit to 0 sets its output to 0 V.

The module responds to an IO_WRITE_GPIO with an IO_WRITE_REPLY.

4.4 I/O Write PWM

The IO_WRITE_PWM datagram is to set the PWM0 output , as shown in Figure 4.4.1.

Byte 0	Byte 1	Byte 2	Byte 3
WSN802G Protocol Identifier = 0x52464D49			
Opcode = 0x0003		Transaction ID = varies	
PWM0		Reserved	

Figure 4.4.1

The field specific to this datagram is:

PWM0: PWM0 setting, 16-bit unsigned value

The module responds to an IO_WRITE_PWM with an IO_WRITE_REPLY.

4.5 I/O Write Reply

An IO_WRITE_REPLY datagram is sent by the WSN802G module to confirm receipt of an IO_WRITE_GPIO, or IO_WRITE_PWM datagram, as shown in Figure 4.5.1.

Byte 0	Byte 1	Byte 2	Byte 3
WSN802G Protocol Identifier = 0x52464D49			
Opcode = 0x0004		Transaction ID = varies	
Status			

Figure 4.5.1

The field specific to this datagram is:

Status: 0x0000 = successful, 0x0001 = failed

4.6 I/O Serial Read

The IO_SERIAL_READ datagram shown in Figure 4.6.1 is used by the module to transmit data received on its serial port.

Byte 0	Byte 1	Byte 2	Byte 3
WSN802G Protocol Identifier = 0x52464D49			
Opcode = 0x0005		Transaction ID = varies	
Timestamp High Bytes			
Timestamp Low Bytes			
MAC Address Bytes [5..2]			
MAC Address Bytes [1..0] (sender)		Length	
Serial Data, 0-256 bytes			

Figure 4.6.1

The fields specific to this datagram are:

Timestamp: Timestamp of reading in 7.62939 µs timer ticks since startup

MAC Address: As an IO_SERIAL_READ can be sent unsolicited, the MAC address is provided to identify the sender, which can be helpful in situations where DHCP is used and the IP address is initially unknown

Length: Length of serial data string

Serial Data: Serial data string, 0-256 bytes

When a module receives a string on its serial port, it transmits an IO_SERIAL_READ message to its server. If the module receives an IO_SERIAL_WRITE message, it will output the received data on its serial port.

4.7 I/O Serial Write

The IO_SERIAL_WRITE datagram shown in Figure 4.7.1 is used to transmit data to the module to output on its serial port.

Byte 0	Byte 1	Byte 2	Byte 3
WSN802G Protocol Identifier = 0x52464D49			
Opcode = 0x0006		Transaction ID = varies	
Length		Serial Data, 0-256 bytes	

Figure 4.7.1

The fields specific to this datagram are:

Length: Length of serial data string

Serial Data: Serial data string, 0-256 bytes

When the module receives an IO_SERIAL_WRITE message, it will output the received data on its serial port. A serial string length of zero causes no data output, but is allowed for system testing purposes.

4.8 I/O SPI Read

The IO_SPI_READ datagram shown in Figure 4.8.1 is used by the module to send out data received on its serial peripheral interface (SPI) port.

Byte 0	Byte 1	Byte 2	Byte 3
WSN802G Protocol Identifier = 0x52464D49			
Opcode = 0x0007		Transaction ID = varies	
Timestamp High Bytes			
Timestamp Low Bytes			
MAC Address Bytes [5..2]			
MAC Address Bytes [1..0] (sender)		Length	
SPI Data, 0-256 bytes			

Figure 4.8.1

The fields specific to this datagram are:

Timestamp: Timestamp of reading in 7.62939 µs timer ticks since startup

MAC Address: As an IO_SPI_READ can be sent unsolicited, the MAC address is provided to identify the sender, which can be helpful in situations where DHCP is used and the IP address is initially unknown

Length: Length of serial data string

SPI Data: Data string, 0-256 bytes

The WSN802G SPI port operates in master mode. The auto-reporting function triggers the WSN802G SPI port to clock out a stored command string, *SPI_MasterCmdStr*, to collect data from a slave peripheral. The collected data is then transmitted as an IO_SPI_READ datagram.

4.9 I/O SPI Write

The IO_SPI_WRITE datagram shown in Figure 4.9.1 is used to send data to the module to output on its serial peripheral interface (SPI) port.

Byte 0	Byte 1	Byte 2	Byte 3
WSN802G Protocol Identifier = 0x52464D49			
Opcode = 0x0008		Transaction ID = varies	
Length		SPI Data, 0-256 bytes	

Figure 4.9.1

The fields specific to this datagram are:

Length: Length of serial data string

SPI Data: Data string, 0-256 bytes

The WSN802G SPI port operates in master mode, where the WSN802G clocks out data to its slave.

4.10 CFG Read

The CFG_READ datagram is used to read a configuration register from the module through the wireless link, serial port or SPI port. Configuration registers are sorted into banks. The register location in a bank may also be referred to as the register's offset.

Byte 0	Byte 1	Byte 2	Byte 3
WSN802G Protocol Identifier = 0x52464D49			
Opcode = 0x0010		Transaction ID = varies	
Length		Bank	
Location			

Figure 4.10.1

The fields specific to this datagram are:

Length: Total length of the following Bank and Location sections, in bytes

Bank: Target register bank number

Location: Target register location

The module responds to a CFG_READ with a CFG_READ_REPLY. Note that the module must be awake in order to receive and process this command.

4.11 CFG Read Reply

In response to a CFG_READ command, the CFG_READ_REPLY datagram is sent by the module to provide the contents of a configuration register

Byte 0	Byte 1	Byte 2	Byte 3
WSN802G Protocol Identifier = 0x52464D49			
Opcode = 0x0011		Transaction ID = varies	
Length		Bank	
Location		Value	

Figure 4.11.1

The fields specific to this datagram are:

Length: Total length of the following bank, register and value sections, in bytes

Bank: Target register bank number

Location: Target register location

Value: Value in target register

IMPORTANT NOTE: The register value is returned in Little-Endian order, least significant byte first.

4.12 CFG Write

The CFG_WRITE datagram is sent through the module's wireless link, serial port or SPI port to set a configuration register in the module. Configuration registers are sorted into banks. The register location in a bank may also be referred to as the register's offset.

Byte 0	Byte 1	Byte 2	Byte 3
WSN802G Protocol Identifier = 0x52464D49			
Opcode = 0x0012		Transaction ID = varies	
Length		Bank	
Location		Value	

Figure 4.12.1

The fields specific to this datagram are:

Length: Total length of the following bank, register and value sections, in bytes

Bank: Target register bank

Location: Target register location

Value: Target register value

IMPORTANT NOTE: The register value must be entered in Little-Endian order, least significant byte first.

The module responds to a CFG_WRITE with a CFG_WRITE_REPLY. Note that the module must be awake in order to receive and process this command.

4.13 CFG Write Reply

A CFG_WRITE_REPLY datagram is sent by the module to confirm the receipt of a CFG_WRITE datagram.

Byte 0	Byte 1	Byte 2	Byte 3
WSN802G Protocol Identifier = 0x52464D49			
Opcode = 0x0013		Transaction ID = varies	
Length		Status	

Figure 4.13.1

The fields specific to this datagram are:

Length: Length of the remainder of the packet in bytes

Status: Status code: 0 = successful, 1 = failed

4.14 Configuration Parameters

The parameters that can be accessed through the CFG series API commands are detailed below, organized by bank and location. The default values in Tables 4.14.1 through 4.14.8 are shown as they would be sent using CFG_WRITE or received using CFG_READ. All numerical values in the tables are in *Little-Endian* byte order, starting with the least significant byte on the left. ASCII strings holding a representation of a numerical value, such as the *AutoReportInterval* in Bank 1, Location 2 below, use Little-Endian byte order. Strings holding text, such as the *SensorName* in Bank 1, Location 1 below, are in reading byte order, first character on the left, last character on the right.

Bank 1 - General Module Configuration

Bank	Location	Name	R/W	Size, bytes	Range	Default
1	1	SensorName	R/W	128	ASCII String	"WSN Sensor"
1	2	AutoReportInterval	R/W	8	ASCII String	"0000000A00000000" (5 s)
1	3	SensorServerIP	R/W	4	Class A,B,C	0xC803A8C0 (192.168.3.200)
1	4	SensorServerPort	R/W	4	$1..2^{16}$ -1	0x3F200000 (8255)
1	5	WakeOutPredelay	R/W	4	$0..2^{32}$ -1	0x0A000000 (10 ms)
1	6	WakeOutPostdelay	R/W	4	$0..2^{32}$ -1	0x0A000000 (10 ms)
1	7	WakeTimeout	R/W	4	$0..2^{32}$ -1	0x00000000 (0 ms)
1	8	TxPower	R/W	4	0..7	0x00000000 (8 mW)
1	9	HardwareRevision	R	N/A	ASCII String	0x312E302E30 (1.0.0)
1	10	FirmwareRevision	R	N/A	ASCII String	0x322E302E31303236 (2.0.1026)
1	11	FirmwareBuildDate	R	4	ASCII String	unique to each build date
1	12	TxRetryLimit	R/W	4	0..15	0x04000000 (4 retries)
1	13	NetworkMode	R/W	4	0..1	0x00000000 (only UDP currently supported)

Table 4.14.1

SensorName - this parameter is a user-assignable sensor module name, for example "Utility Room Temperature Sensor". The name can contain up to 128 bytes.

AutoReportInterval - this parameter sets the interval at which the sensor will send periodic reports. The parameter scaling is in microcontroller clock cycles of 0.029802322 µs. This parameter is a 64-bit number formatted as an ASCII string of the equivalent hexadecimal value.

SensorServerIP - this parameter holds the IP address of the server for the module to send sensor data reports. The IP address is formatted as a 32-bit value.

SensorServerPort - this parameter holds the port number of the server for the module to send sensor data reports. The port number is formatted as a 32-bit value, with the lower 16 bits containing the port number and the upper 16 bits set to zero.

WakeOutPredelay - this parameter sets the duration in milliseconds the WAKE_OUT pin turns on to activate an external user circuit *prior* to the rest of the module waking up.

WakeOutPostdelay - this parameter sets the duration in milliseconds the WAKE_OUT turn on to activate an external user circuit *subsequent* to the rest the module waking up.

WakeTimeout - this parameter sets the duration of inactivity in milliseconds that triggers the module to go back to sleep after being activated.

TxPower - this parameter set the transmitter output power level. Changes to this parameter require a reboot to take effect. The parameter range is 0 to 7, with 0 the highest power setting.

HardwareRevision - this parameter holds the revision code of the module hardware. This parameter is read-only.

FirmwareRevision - this parameter holds the firmware revision code. This parameter is read-only.