Radio Module User Manual

MICRO-RM2.4

MICRORIDGE

www.microridge.com

MicroRidge 2.4 GHz Radio Module

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1 Introduction

The MICRO-RM2.4 Radio Module from MicroRidge Systems is a small wireless module based on the Atmel ATmega2564RFR2 microcontroller. The ATmega2564RFR2 is a low-powered CMOS 8-bit microcontroller based on the AVR enhanced RISC architecture combined with a high data rate transceiver for the 2.4 GHz ISM (industrial, scientific and medical) band.

The MICRO-RM2.4 contains an on-board chip antenna. The module contains radio certifications for FCC, IC and EU (CE). No additional RF testing is required as long as the application of the MICRO-RM2.4 follows the approved certifications.

The small size of the MICRO-RM2.4 module allows it to be used in small and compact products. The module measures 12 x 20.75 x 3 mm (.472 x .817 x .118 inches). The module requires a power supply of 1.8 to 3.6 volts DC. This voltage range allows the module to be powered by a single 3 volt coin cell or two 1.5 volt batteries.

Radio Module Images

The photos below show the top and bottom views of the radio module. The 2 large gold pads shown in the bottom view are the ground pads discussed in the Dimensions section 7.

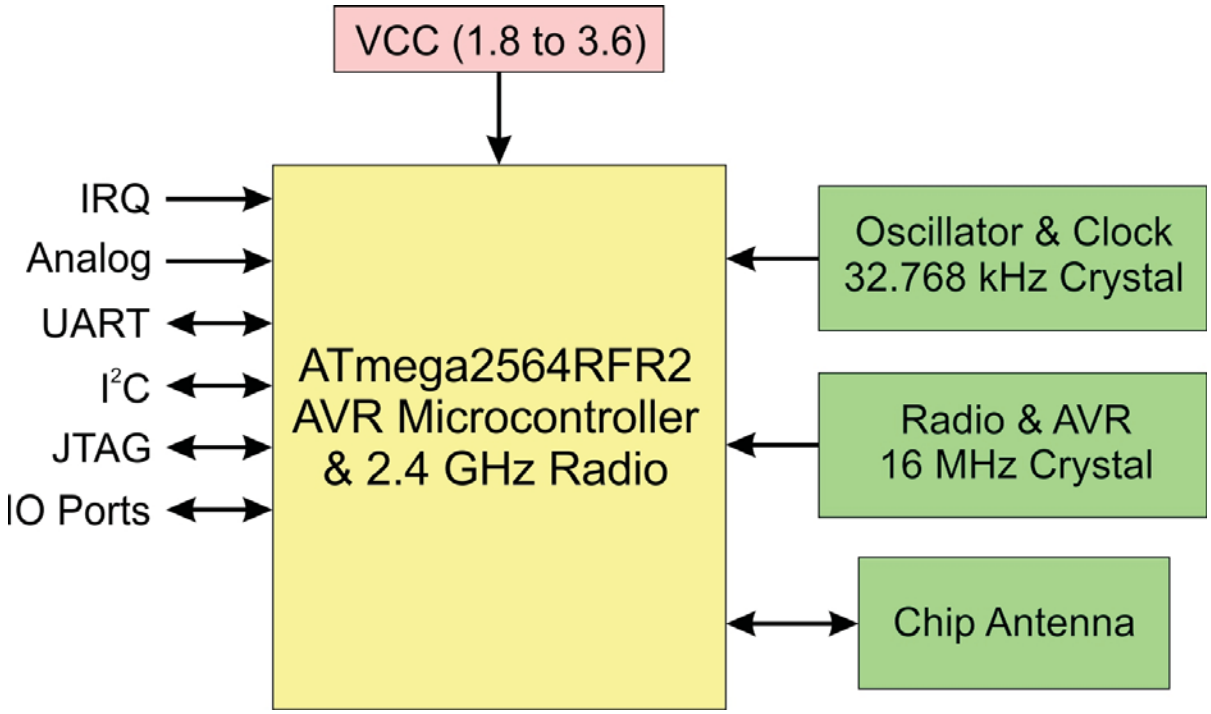
Isometric View

Top View

Bottom View

Basic Block Diagram

A basic block diagram of the MICRO-RM2.4 Radio Module is shown below. Refer to the Atmel ATmega644/1284/2564RFR2 documentation [4] for block diagrams with greater detail.



2 Features

The features of the MICRO-RM2.4 Radio Module are numerous and allow the module to be used in many low powered short range applications. The primary features of this module are as follows:

- Ultra compact size: 12 x 20.75 x 3 mm (.472 x .817 x .118 inches)
- Built-in 32.768 kHz crystal for low power and deep sleep modes
- Built-in 16 MHz crystal for 2.4 GHz transceiver and AVR microcontroller
- Power supply voltage of 1.8 to 3.6 VDC
- Typical power consumption:
  - 0.75 μA in sleep mode (transceiver in Sleep and AVR in Power Save/Down mode)
  - 14.5 ma in TX mode at 3.5 dBm
  - 12.5 ma in RX mode
- Memory resources:
  - 256K bytes In-System Self-Programmable Flash
  - 8K bytes EEPROM
  - 32K bytes SRAM
- IEEE® 802.15.4 compliant transceiver
- 2.4 GHz ISM band
- TX/RX 128 byte frame buffer
- TX output power from -17 dBm to 3.5 dBm
- Receiver sensitivity = -100 dBm
- 14 RF Channels (11 to 25, channel 14 is reserved for internal use)
- Serial bootloader
- Interface connections:
  - 30 I/O ports
  - 2 RS-232 serial ports
  - JTAG programming connection
  - I^2C
- High performance low power AVR® 8-bit microcontroller
- ROHS complainant
- Extensive documentation and software resources available on the Atmel web site

3 Releated Documents

Additional information is available about the MICRO-RM2.4 Radio Module components and supporting software from the following sources:

- A complete description of the ATmega2564RFR2 microcontroller used in the module is available on the Atmel web site (www.atmel.com). The document describing this microcontroller is ATmega644/1284/2564RFR2 42073A-MCU Wireless.
- Atmel also has additional documentation available that may be helpful in developing wireless applications for the MICRO-RM2.4 module.
- The MicroRidge Wireless Communication Library is available to assist in the development of firmware for the MICRO-RM2.4 Radio Module. A per module license is required in order to use this Communication Library. This library is only supported on the IAR Embedded Workbench Ver 6.4 or later for the AVR microcontroller. Contact MicroRidge Systems[18] for more information.

4 Specifications

The specifications sections consists of 4 areas:

Atmel Documentation	This section contains 3 of the tables from the Atmel ATmega644/1284/2564RFR2 documentation. The complete Atmel document is over 600 pages in length. In order to fully understand the radio module and how to work with it, you must become familiar with this Atmel document.
Dimensions	The dimensions for the MICRO-RM2.4 Radio Module, pad locations and bottom side ground pads are presented in this section.
Pin Configuration	The pin connections available on the MICRO-RM2.4 Radio Module are listed in this section.
Soldering	A soldering profile is shown in this section.

4.1 Atmel Documentation

For the complete specifications for the Atmel ATmega2564RFR2 radio transceiver refer to ATmega644/1284/2564RFR2 documentation[4]. The information shown below is only a few of the multiple tables from the Atmel documentation. Refer to the Atmel documentation for the test conditions and references shown in the tables.

General RF Specifications

Symbol	Parameter	Condition	Min.	Typ.	Max.	Units
f_{RF}	Frequency range	As specified in [1],[2]	2405		2480	MHz
f_{CH}	Channel spacing	As specified in [1],[2]		5		MHz
f_{HDR}	Header bit rate (SHR, PHR)	As specified in [1],[2]		250		kb/s
f_{PSDU}	PSDU bit rate	As specified in [1],[2] OQPSK_DATA_RATE = 1 OQPSK_DATA_RATE = 2 OQPSK_DATA_RATE = 3		250 500 1000 2000		kb/s kb/s kb/s kb/s
f_{CHIP}	Chip rate	As specified in [1],[2]		2000		kchip/s
f_{CLK}	Crystal oscillator frequency	Reference frequency oscillator		16		MHz
f_{CLK_ACC}	Required reference frequency accuracy	PSDU bit rate 250 kb/s 500 kb/s 1000 kb/s 2000 kb/s	-60(1) -40 -40 -30		+60(1) +40 +40 +30	ppm ppm ppm ppm
t_{XTAL}	Reference oscillator settling time	Leaving SLEEP state to crystal clock available		215	1000	µs
B_{20dB}	20 dB bandwidth			2.8		MHz

Transmitter characteristics

Symbol	Parameter	Condition	Min.	Typ.	Max.	Units
P_{TX}	TX Output power	Maximum configurable TX output power value Register bit TX_PWR = 0	0	+3.5	+6	dBm
P_{RANGE}	Output power range	16 steps, configurable in register PHY_TX_PWR		20		dB
P_{ACC}	Output power tolerance				±3	dB
	TX Return loss	100+j0 Ω differential impedance, P_{TX} = +3.5 dBm		10		dB
	EVM			8		%rms
P_{HARM}	Harmonics 2nd harmonic 3rd harmonic			 -38 -45		 dBm dBm
P_{SPUR}	Spurious Emissions 30 – ≤ 1000 MHz >1 – 12.75 GHz 1.8 – 1.9 GHz 5.15 – 5.3 GHz	Complies with EN 300 328/440, FCC-CFR-47 part 15, ARIB STD-66, RSS-210		 -36 -30 -47 -47		 dBm dBm dBm dBm

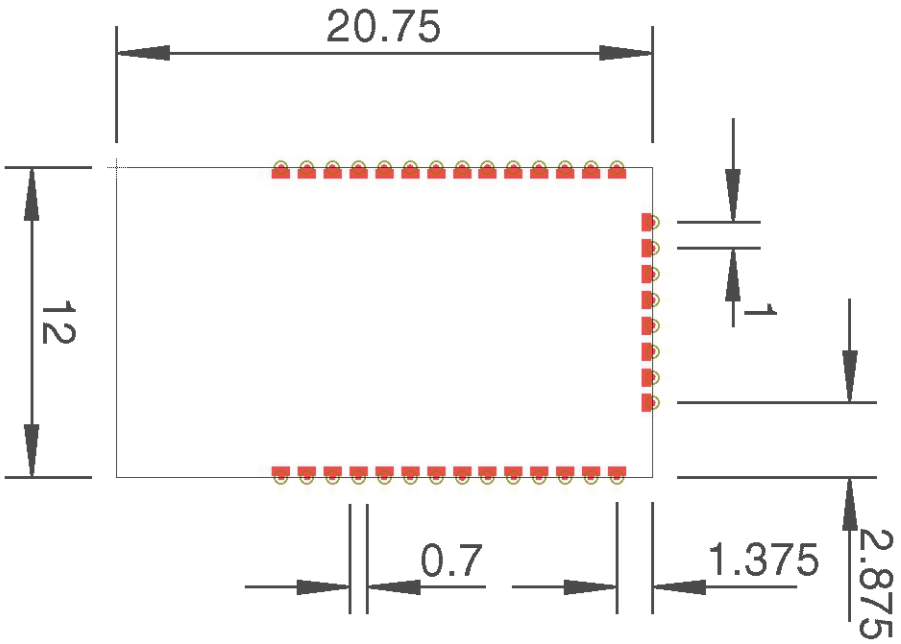
Current Consumptions Specifications

Symbol	Parameter	Condition	Min.	Typ.	Max.	Units
I_{BUSY_TX}	Supply current transmit state	P_{TX} = 3.5 dBm P_{TX} = 1.5 dBm P_{TX} = -2.5 dBm P_{TX} = -16.5 dBm (current consumption is reduced at V_{DD} = 1.8V for each output power level)		14.5 10 9 8		mA mA mA mA
$I_{RX\_ON\_RPC}$	Supply current RX_ON state RPC mode enabled(2)	RX_ON state, with register setting RX_PDT_LEVEL < 8(1)		6		mA
$I_{RX\_ON\_P\_RPC}$		RX_ON state, with register setting RX_PDT_LEVEL > 8(1)		5		mA
$I_{RX\_ON\_RPC}$	Supply current PLL_ON state RPC mode enabled(2)			0.45		mA
I_{RX_ON}	Supply current RX_ON state RPC mode disabled(2)	RX_ON state		12.5		mA
$I_{RX\_ON\_P}$		RX_ON state, with register setting RX_PDT_LEVEL > 0(1)		12.0		mA
I_{PLL_ON}	Supply current PLL_ON state RPC mode disabled(2)			5.7		mA
I_{TRX_OFF}	Supply current TRX_OFF state	TRX_OFF state		0.4		mA
I_{SLEEP}	Supply current SLEEP state	SLEEP state		0.02		µA

4.2 Dimensions

Board Dimensions

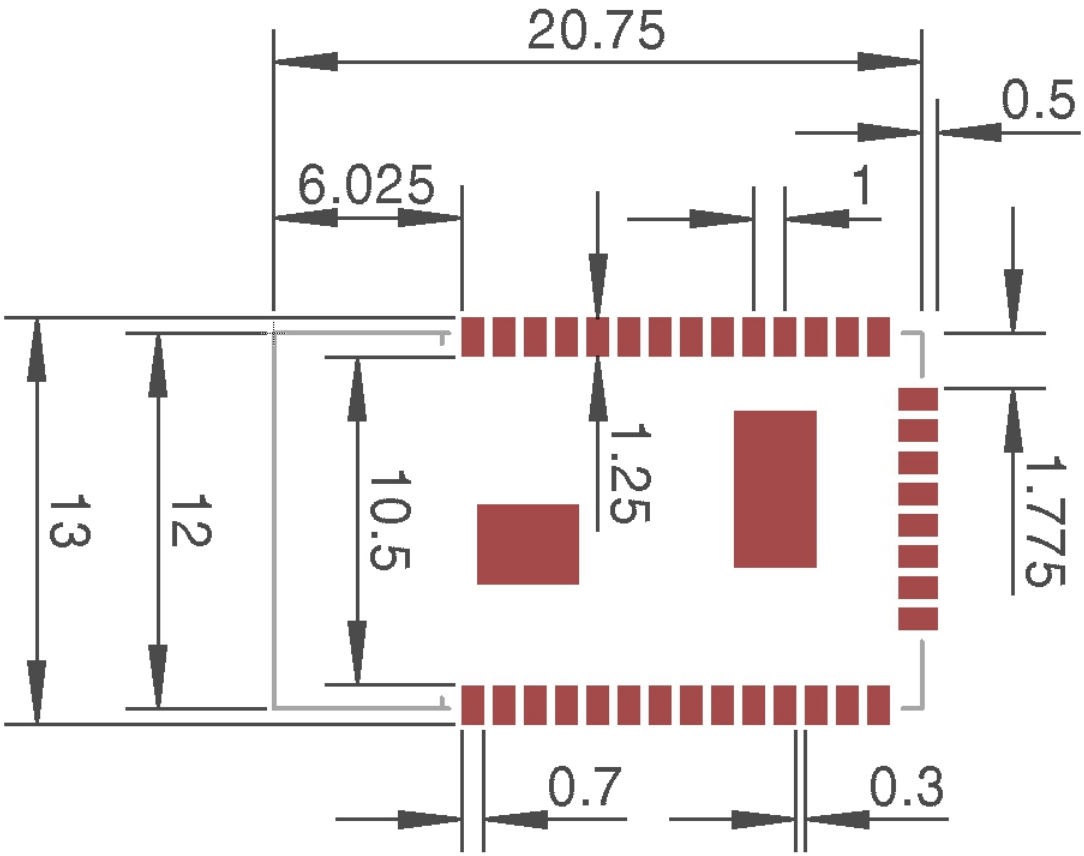
The dimensions for the MICRO-RM2.4 Radio Module are given below. All of the dimensions are in mm. The thickness of the module from the bottom of the module to the top of the RF shield is 3 mm. The pad spacing is 1 mm and the pad width is 0.7 mm.



Board Dimensions (mm) and Solder Pad Placement

Solder Pad Placement

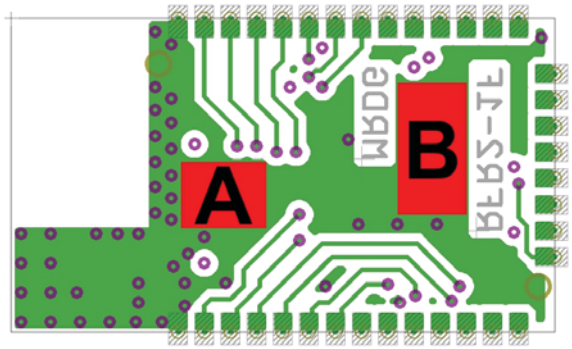
The recommended placement of the solder pads on the application board is shown below. The 2 large pads are ground pads and they are discussed in the Ground Pads. All dimensions are in mm.



Ground Pads

The bottom of the module contains 2 ground (GND) pads areas that can be used to help secure the module to the circuit board. In a rough environment, we have seen delamination problems with this type of module board. When adhesive was used to help secure the module board to the application circuit board, we no longer had any delamination problems between the module and application circuit boards. In the stuffing process, the board house can use an adhesive to help secure the wireless module to the application circuit board or solder the ground pads to the application circuit board..

The 2 ground pads are available on the bottom side of the wireless module. These ground pads are shown in red and labeled A and B. These 2 pad areas are part of the bottom ground plane.



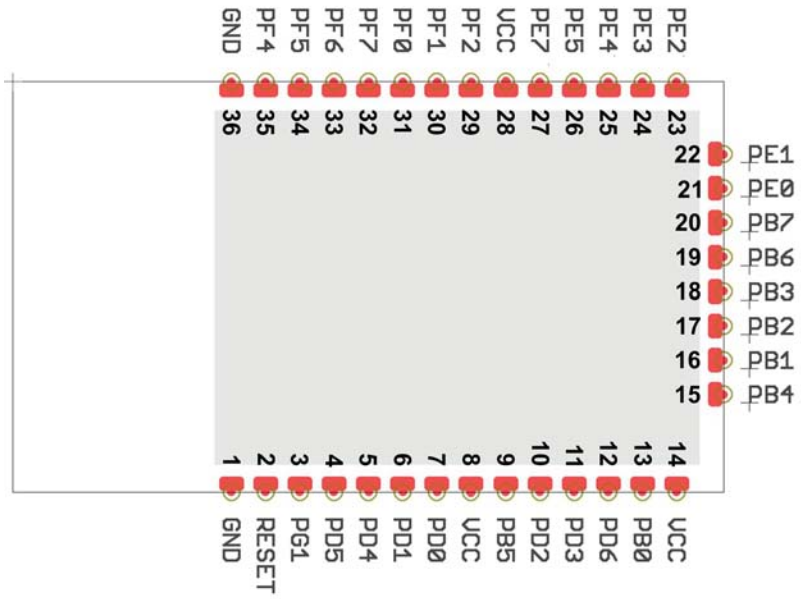
Location of the Ground Pads on the Bottom of the Wireless Module

The size and location of the ground pads is shown in the following table.

Ground Pad	Size		Distance from Upper Left Corner	
	Width, mm	Height, mm	Horizontal, mm	Vertical, mm
A	3.25	2.50	6.50	5.50
B	2.625	5.00	14.75	2.50

4.3 Pin Configuration

The pin connections for the MICRO-RM2.4 Radio Module are show below. For a complete description of each pin refer to the Atmel ATmega644/1284/2564RFR2[4] documentation.



MICRO-RM2.4 Pin Connections

Module Pin	Pin Name	Description
1	GND	Ground (connected to AVSS_RFP, AVSS_RFN, DVSS & AVSS)
2	RESET	Reset input (active low). The radio module also contains a 100K pullup resistor connected between this pin and VCC.
3	PG1	Port PG1
4	PD5	Port PD5 (alternate function XCK1)
5	PD4	Port PD4 (alternate function ICP1)
6	PD1	Port PD1 (alternate functions SDA & INT1)
7	PD0	Port PD0 (alternate functions SCL & INT0)
8	VCC	1.8 to 3.6 VDC (connected to DEVDD & EVDD)
9	PB5	Port PB5 (alternate functions OC1A & PCINT5)
10	PD2	Port PD2 (alternate functions RXD1 & INT2)

Module Pin	Pin Name	Description
11	PD3	Port PD3 (alternate functions TXD1 & INT3)
12	PD6	Port PD6 (alternate function T1)
13	PB0	Port PB0 (alternate functions SSN & PCINT0)
14	VCC	1.8 to 3.6 VDC (connected to DEVDD & EVDD)
15	PB4	Port PB4 (alternate functions OC2A & PCINT4)
16	PB1	Port PB1 (alternate functions SCK & PCINT1)
17	PB2	Port PB2 (alternate functions MOSI, PDI & PCINT2)
18	PB3	Port PB3 (alternate functions MISO, PDO & PCINT3)
19	PB6	Port PB6 (alternate functionsOC1B & PCINT6)
20	PB7	Port PB7 (alternate functions OC0A, OC1C & PCINT7)
21	PE0	Port PE0 (alternate functions RXD0 & PCINT8)
22	PE1	Port PE1 (alternate function TXD0)
23	PE2	Port PE2 (alternate functions XCK0 & AIN0)
24	PE3	Port PE3 (alternate functions OC3A & AIN1)
25	PE4	Port PE4 (alternate functions OC3B & INT4)
26	PE5	Port PE5 (alternate functions OC3C & INT5)
27	PE7	Port PE7 (alternate functions ICP3, INT7 & CLK)
28	VCC	1.8 to 3.6 VDC (connected to DEVDD & EVDD)
29	PF2	Port PF2 (alternate function ADC2)
30	PF1	Port PF1 (alternate function ADC1)
31	PF0	Port PF0 (alternate function ADC0)
32	PF7	Port PF7 (alternate functions JTAG TDI & ADC7)
33	PF6	Port PF6 (alternate functions JTAG TDO & ADC6)
34	PF5	Port PF5 (alternate functions JTAG TMS & ADC5)
35	PF4	Port PF4 (alternate functions JTAG TCK, PF3 & ADC3)
36	GND	Ground (connected to AVSS_RFP, AVSS_RFN, DVSS & AVSS)
--	PD7	Port PD7. Do not use. This ports is used internally by the wireless module.
--	TST	Connected to GND in the wireless module.
--	CLKI	Connected to GND in the wireless module.

Module Pin	Pin Name	Description
--	TOSC1	Connected to 32.768 KHz crystal in the wireless module.
--	TOSC2	Connected to 32.768 KHz crystal in the wireless module.
--	XTAL1	Connected to 16 MHz crystal in the wireless module.
--	XTAL2	Connected to 16 MHz crystal in the wireless module.

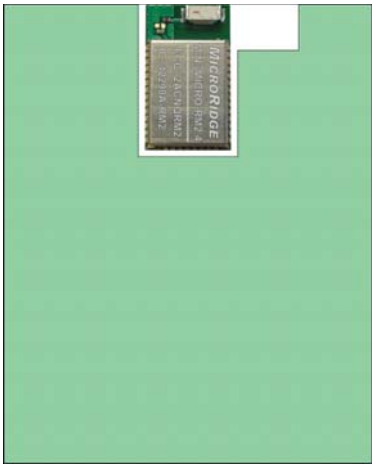
4.4 Soldering

The following J-STD-020C compliant soldering profile is recommended for the MICRO-RM2.4 Radio Module. Since the FCC and IC IDs are etched into the RF shield, there is no concern about heat form the soldering process damaging a label that contains this ID information.

Profile Feature	Values
Average ramp-up rate (217°C to peak)	3°C/s max
Preheat temperature 175°C ±25°C	180s max
Temperature maintained above 217°C	60s to 150s
Time within 5°C of actual peak temperature	20s to 40s
Peak temperature range	260°C
Ramp-down rate	6°C/s max
Time within 25°C to peak temperature	8 minutes

5 Application Board Design

Normally, chip antennas are more tolerant of the board and enclosure materials. However, the recommendations for the radio module placement on the application PCB still apply. The radio module should be placed along an edge of the application PCB as shown below.



Module placed along top edge of PCB.

Module placed along top edge of PCB.

Module placed in center portion of PCB.
Not an acceptable design.

Mounting Information

In general, via holes and traces are should not be placed on the application PCB upper layer in the area occupied by the radio module module. The exception to this is if you are soldering the ground pads[9] to the PCB board, you can use via holes and/or traces to connect the pads to the ground. Be careful that you do not place any via holes or traces adjacent to non-ground circuits.

The ground connections along the edges of the radio module should be grounded by via holes located as close as possible to the ground connections on the radio module.

Via Placement

The board design should prevent propagation of microwave fields inside the board material. Electromagnetic waves of high frequency may penetrate the board thus making the edges of the board radiate, which may distort the antenna pattern. To eliminate this effect, via holes should be placed around the board's edges. A common rule of thumb is to make the via spacing less than λ/20 at the maximum operating frequency. For the MICRO-RM2.4 Radio Module, the wavelength at 2.4 GHz is 125 mm and the maximum via spacing would be 6.25 mm.

Other Recommendations

- Metal enclosure should not be used.
- Low profile enclosures might affect antenna antenna performance.
- Avoid placing high profile components next to antenna.
- Radio module should not be placed next to other electronics which might interfere with the 2.4 GHz frequency band.

6 Ordering Information

Contact MicroRidge Systems[18] to order MICRO-RM2.4 Radio Modules. The packaging options of tray, and tape and reel are still being evaluated. There are also software options available for the radio modules.

7 Radio Certification

United States (FCC)

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. Any changes or modifications not expressly approved by manufacturer could void the user's authority to operate the equipment.

IMPORTANT! Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate this equipment.

47 CFR 15.505

For a Class B digital device or peripheral, the instructions furnished the user shall include the following or similar statement, placed in a prominent location in the text of the manual:

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or 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.

The modular transmitter must be labeled with its own FCC ID number, and, if the FCC ID is not visible when the module is installed inside another device, then the outside of the device into which the module is installed must also display a label referring to the enclosed module. This exterior label can use wording such as the following:

Contains FCC ID: 2ACNQRM2

The MICRO-RN2.4 Radio Module has a Modular approval and does not need separate approval for this module when used on an application board.

Industry Canada (IC)

This device complies with Industry Canada licence-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes: (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, meme si le brouillage est susceptible d'en compromettre le fonctionnement.

IMPORTANT! Tous les changements ou modifications pas expressément approuvés par la partie responsable de la conformité ont pu vider l'autorité de l'utilisateur pour actioner cet équipment.

This Class [B] digital apparatus complies with Canadian ICES-003.

Cet appareil numérique de la classe [B] est conforme à la norme NMB-003 du Canada

This modular transmitter must be labeled with its own IC ID. If the IC ID Certification Number is not visible while installed inside another device, then the device should display the label on it referring the enclosed module. In that case, the final end product must be labeled in a visible area with the following:

Contains IC: 12298A-RM2

The MICRO-RN2.4 Radio Module has a Modular approval and does not need separate approval for this module when used on an application board.

European Union (ETSI)

The MICRO-RN2.4 module has been certified for use in European Union countries. If this module is incorporated into a product, the manufacturer must ensure compliance of the final product to the European harmonized EMC and low voltage/safety standards. A Declaration of Conformity must be issued for each of these standards and kept on file as described in Annex II of the R&TTE Directive.

Furthermore, the manufacturer must maintain a copy of the modules' documentation and ensure the final product does not exceed the specified power ratings, antenna specifications, and/or installation requirements as specified in the user manual. If any of these specifications are exceeded in the final product, a submission must be made to a notified body for compliance testing to all required standards.

The 'CE' marking must be affixed to a visible location on the OEM product. The CE mark shall consist of the initials "CE" taking the following form:

The CE marking must have a height of at least 5 mm except where this is not possible on account of the nature of the apparatus.

The CE marking must be affixed visibly, legibly, and indelibly.

More detailed information about CE marking requirements you can find at "DIRECTIVE 1999/5/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL" on 9 March 1999 at section 12.

8 Contact MicroRidge

Email:

Support:	support@microridge.com
Sales:	sales@microridge.com
Information:	info@microridge.com

Phone:

Support:	541.593.1656
Sales:	541.593.3500
Main office:	541.593.1656
Fax:	541.593.5652

Mailing Address:

MicroRidge Systems, Inc.
PO Box 3249
Sunriver, OR 97707-0249

Shipping Address:

MicroRidge Systems, Inc.
56888 Enterprise Drive
Sunriver, OR 97707

Note: There is no mail delivery to this address. This address should only be used for package delivery services such as UPS, FedEx, etc.

Web: www.MicroRidge-RM.com

9 Revision History

Date	Version	Comments
9-3-2014	1.0.1	▪ Preliminary release of MICRO-RM2.4 User Manual
9-12-2014	1.1.2	▪ Minor revisions to preliminary manual.
10-30-2014	1.2.3	▪ Changed radio module images to reflect final FCC & IC certification numbers. ▪ Revised text for FCC and IC in Radio Certification section.
10-31-2014	1.2.4	▪ Minor word additions to Radio Certification section.