MRF24WN0MA/MB

2.4 GHz IEEE 802.11b/g/n Wireless Module

Features

- IEEE 802.11b/g/n compliant transceiver
- 2.4 GHz IEEE 802.11n Single Stream 1x1
- SPI Interface to Host Controller (4-wire including interrupt)
- Works with Microchip's MPLAB® Harmony Integrated Software Framework
- Fully integrated wireless module with voltage regulation, crystal, RF matching circuitry, PA, LNA, and PCB trace antenna
- Ultra-small W.FL connector for external antennas (MRF24WN0MB)
- Compact surface mount module: 0.700" x 1.050" x 0.085 inch (17.8 mm x 26.7 mm x 2.2 mm)
- Castellated surface mount pads for easy and reliable PCB mounting
- Environmentally friendly, RoHS compliant

Operational

- Single Operating Voltage: 3.15V to 3.45V (3.3V typical)
- Temperature Range: -40°C to +85°C Industrial
- Low Current Consumption:
  - RX mode: 60 mA (typical)
  - TX mode: 115 mA at 0 dBm; 230 mA at 18 dBm (typical)
- Power Saving Mode:
  - Hibernate: 5 µA (typical)

RF/Analog

- Frequency: 2.400 to 2.484 GHz
- Channels: 1-13
- Modulation: DSSS, CCK, BPSK, QPSK, 16QAM, 64QAM
- Sensitivity: -94 dBm

Antenna

- Integral PCB Trace Antenna (MRF24WN0MA)
- External Antenna (MRF24WN0MB)

IEEE 802.11 B/G/N WiFi® Module (Part # MRF24WN0MA)

Compliance

- Modular certified for the United States (FCC) and Canada (IC)
- European R&TTE Directive Assessed Radio Module
- Australia, New Zealand, Korea, Taiwan, Japan

Applications

- Utility and Smart Energy
- Consumer Electronics
- Industrial Controls
- Remote Device Management
- Retail
- Medical, Fitness, and Health Care

© 2015 Microchip Technology Inc.

Table of Contents

1.0 Device Overview 3
2.0 Circuit Description 11
3.0 Application Information 15
4.0 Regulatory Approval 21
5.0 Electrical Characteristics 27
Appendix A: Revision History 29
The Microchip Web Site 31
Customer Change Notification Service 31
Customer Support 31
Product Identification System 33

TO OUR VALUED CUSTOMERS

It is our intention to provide our valued customers with the best documentation possible to ensure successful use of your Microchip products. To this end, we will continue to improve our publications to better suit your needs. Our publications will be refined and enhanced as new volumes and updates are introduced.

If you have any questions or comments regarding this publication, please contact the Marketing Communications Department via E-mail at **docerrors@microchip.com**. We welcome your feedback.

Most Current Data Sheet

To obtain the most up-to-date version of this data sheet, please register at our Worldwide Web site at:

http://www.microchip.com

You can determine the version of a data sheet by examining its literature number found on the bottom outside corner of any page. The last character of the literature number is the version number, (e.g., DS30000000A is version A of document DS30000000).

Errata

An errata sheet, describing minor operational differences from the data sheet and recommended workarounds, may exist for current devices. As device/documentation issues become known to us, we will publish an errata sheet. The errata will specify the revision of silicon and revision of document to which it applies.

To determine if an errata sheet exists for a particular device, please check with one of the following:

- Microchip's Worldwide Web site; **http://www.microchip.com**
- Your local Microchip sales office (see last page)

When contacting a sales office, please specify which device, revision of silicon and data sheet (include literature number) you are using.

Customer Notification System

Register on our web site at **www.microchip.com** to receive the most current information on all of our products.

 © 2015 Microchip Technology Inc.

1.0 DEVICE OVERVIEW

The MRF24WN0MA and MRF24WN0MB are low-power, 2.4 GHz, IEEE 802.11n-compliant, surface mount modules with all associated RF components: crystal oscillator, bypass and bias passives with integrated MAC, baseband, RF and power amplifier, and built-in hardware support for encryption. See Figure 1-1.

The integrated module design frees the designer from RF and antenna design tasks and regulatory compliance testing, ultimately providing quicker time to market.

The MRF24WN0MA/MB modules are designed to be used with Microchip's MPLAB® Harmony Integrated Software Framework. The integrated framework implements the Application Programming Interface (API) that is used for command and control, for management, and data packet traffic. The MPLAB Harmony basic framework is free to download at http://www.microchip.com/harmony. For information on what is included within the basic framework and their release versions please read *"Release Notes"*.

The MRF24WN0MA module is approved for use with the integrated PCB trace antenna. The MRF24WN0MB module is approved for use with specific external antenna types that are certified with the module. An ultra-small coaxial connector (W.FL) is provided on the module for connection to the external antenna. See **Section 3.3, "External Antenna Types"** for a listing of approved antenna types.

The MRF24WN0MA/MB modules have received regulatory approvals for modular devices in the United States (FCC) and Canada (IC). Modular approval removes the need for expensive RF and antenna design, and allows the end user to place the MRF24WN0MA/MB modules inside a finished product and does not require regulatory testing for an intentional radiator (RF transmitter).

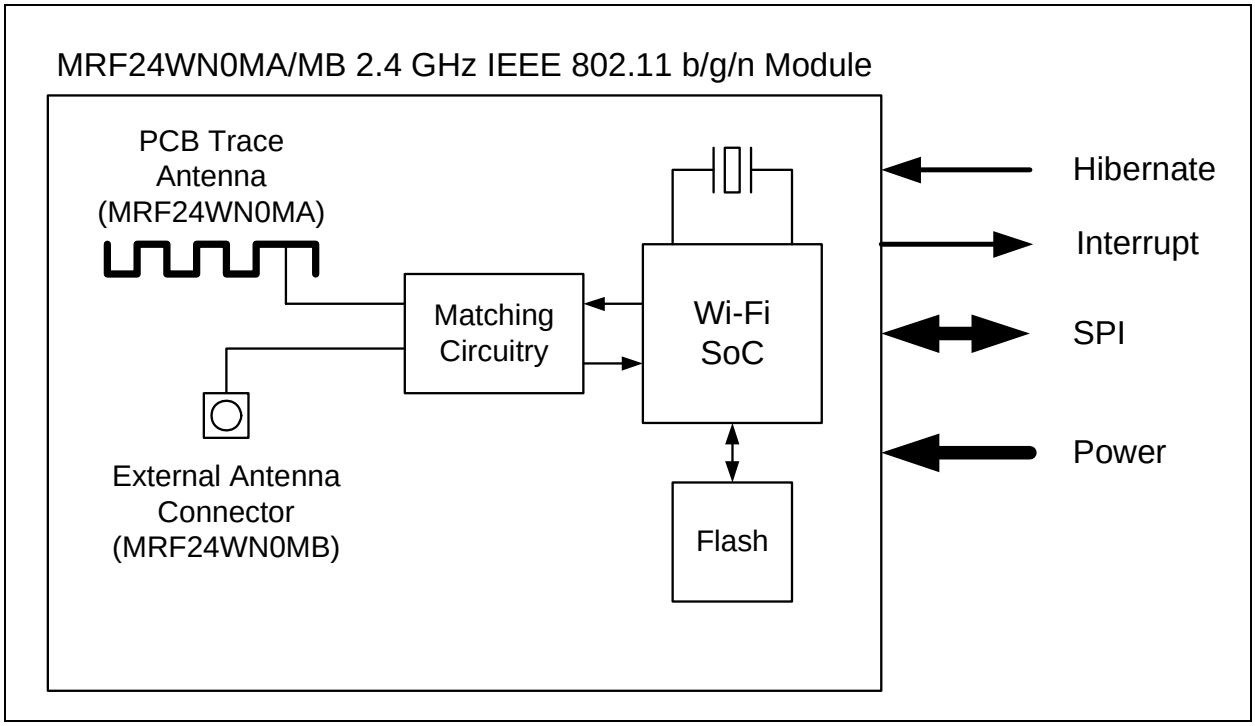
The MRF24WN0MA/MB module is an R&TTE Directive assessed radio module for operation in Europe. The module tests can be applied toward final product certification and Declaration of Conformity (DoC).

Table 1-1 lists the MFR24WN0 module family types.

TABLE 1-1: MRF24WN0 FAMILY TYPES

Device	Antenna
MRF24WN0MA	Integral
MRF24WN0MB	External

FIGURE 1-1: MRF24WN0MA/MB BLOCK DIAGRAM



1.1 Interface Description

Figure 1-2 shows the MRF24WN0MA/MB pin diagram. Table 1-2 describes the MRF24WN0MA/MB pins.

FIGURE 1-2: FIGURE 1-2: MRF24WN0MA/MB PIN DIAGRAM

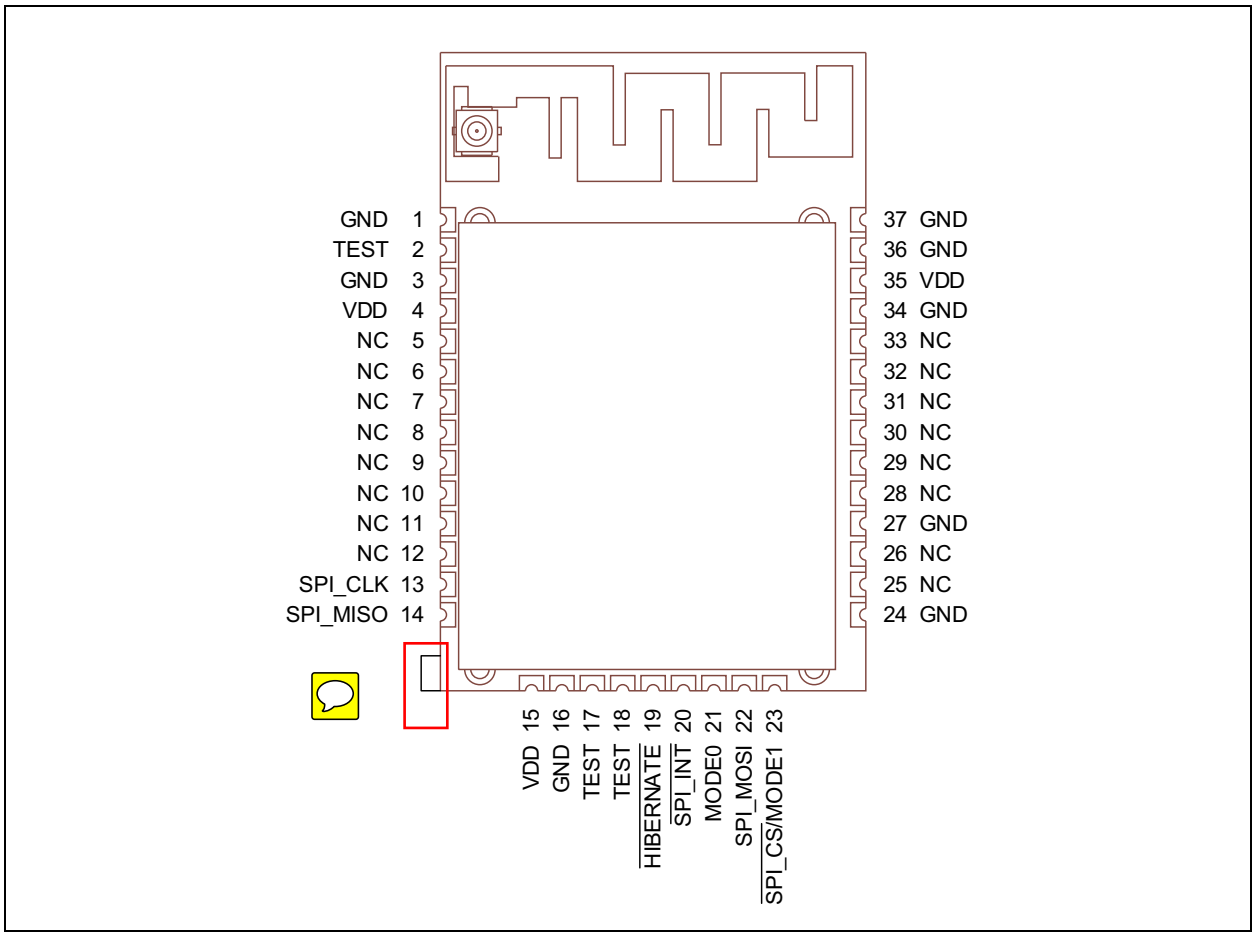


TABLE 1-2: PIN DESCRIPTIONS

Pin	Symbol	Type	Description[1]
1	GND	Power	—
2	TEST	Test	Do not connect
3	GND	Power	—
4	VDD	Power	—
5	NC	Reserved	Do not connect
6	NC	Reserved	Do not connect
7	NC	Reserved	Do not connect
8	NC	Reserved	Do not connect
9	NC	Reserved	Do not connect
10	NC	Reserved	Do not connect
11	NC	Reserved	Do not connect
12	NC	Reserved	Do not connect
13	SPI_CLK	DI	SPI clock input
14	SPI_MISO	DO	SPI data output, pull-down to GND with 10 kilo-ohm resistor.

© 2015 Microchip Technology Inc.

TABLE 1-2: PIN DESCRIPTIONS (CONTINUED)

Pin	Symbol	Type	Description[1]
15	VDD	Power	—
16	GND	Power	—
17	TEST	Test	Do not connect
18	TEST	Test	Do not connect
19	$\overline{\text{HIBERNATE}}$	DI	Lowest Power State (active-low)
20	$\overline{\text{SPI_INT}}$	DO	SPI interrupt output (active-low)
21	MODE0	DI	Mode select 0. Connect to GND[2]
22	SPI_MOSI	DI	SPI data input
23	$\overline{\text{SPI_CS}}$/MODE1	DI	SPI Chip Select/Mode select 1. Connect to VDD via 10 kilo-ohm pull-up resistor.[2][3]
24	GND	Power	—
25	NC	Reserved	Do not connect
26	NC	Reserved	Do not connect
27	GND	Power	—
28	NC	Reserved	Do not connect
29	NC	Reserved	Do not connect
30	NC	Reserved	Do not connect
31	NC	Reserved	Do not connect
32	NC	Reserved	Do not connect
33	NC	Reserved	Do not connect
34	GND	Power	—
35	VDD	Power	—
36	GND	Power	—
37	GND	Power	—

Legend: A = Analog, D = Digital, I = Input, O = Output

Note 1: For NC = No Connect pins, do not make any connection. The module is configured with internal pull-ups and downs.

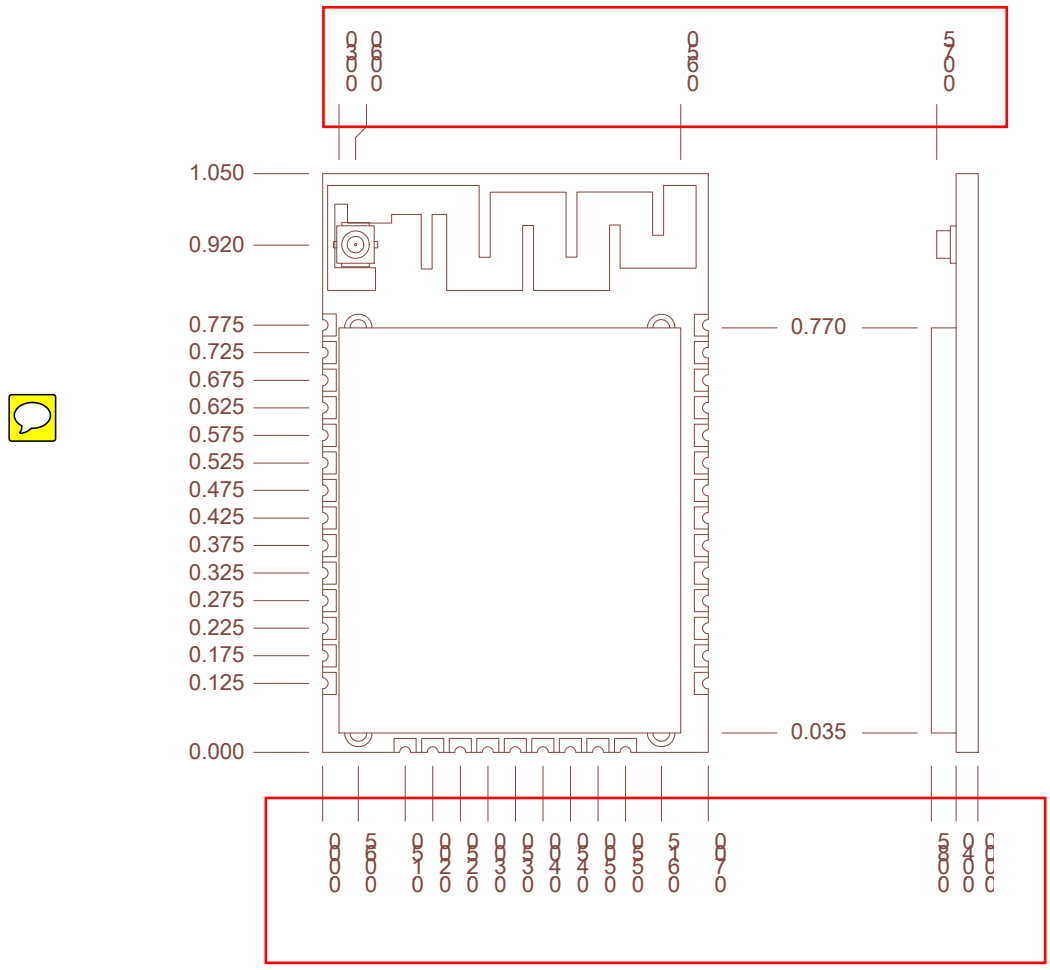
2: See **Section 2.2, "MODE0 and MODE1 Pins"**

3: See **Section 2.3, "SPI Port Pins"**

1.2 Mounting Details

Figure 1-3, Figure 1-4 and Figure 1-5 show the module's physical dimensions and the mounting details. Figure 1-6 and Figure 1-7 show the recommended host PCB footprint and layout.

FIGURE 1-3: MRF24WN0MA/MB MODULE PHYSICAL DIMENSIONS (TOP AND SIDE VIEW)



Dimensions are in inches.

Tolerances:

PCB outline: +/- 0.010"

PCB thickness: +/- 0.005"

 © 2015 Microchip Technology Inc.

FIGURE 1-4: MRF24WN0MA/MB MODULE PHYSICAL DIMENSIONS (BOTTOM VIEW)

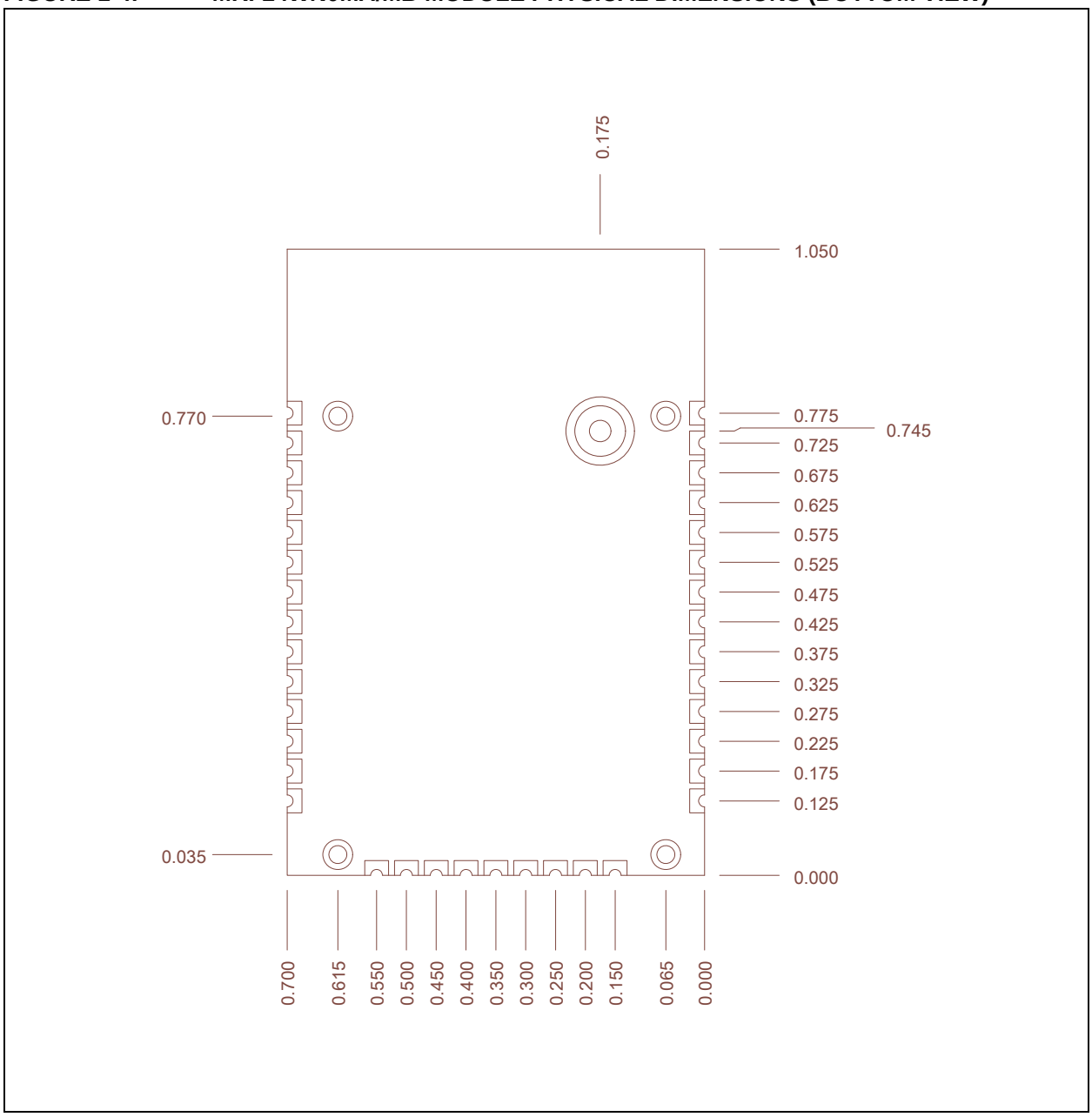
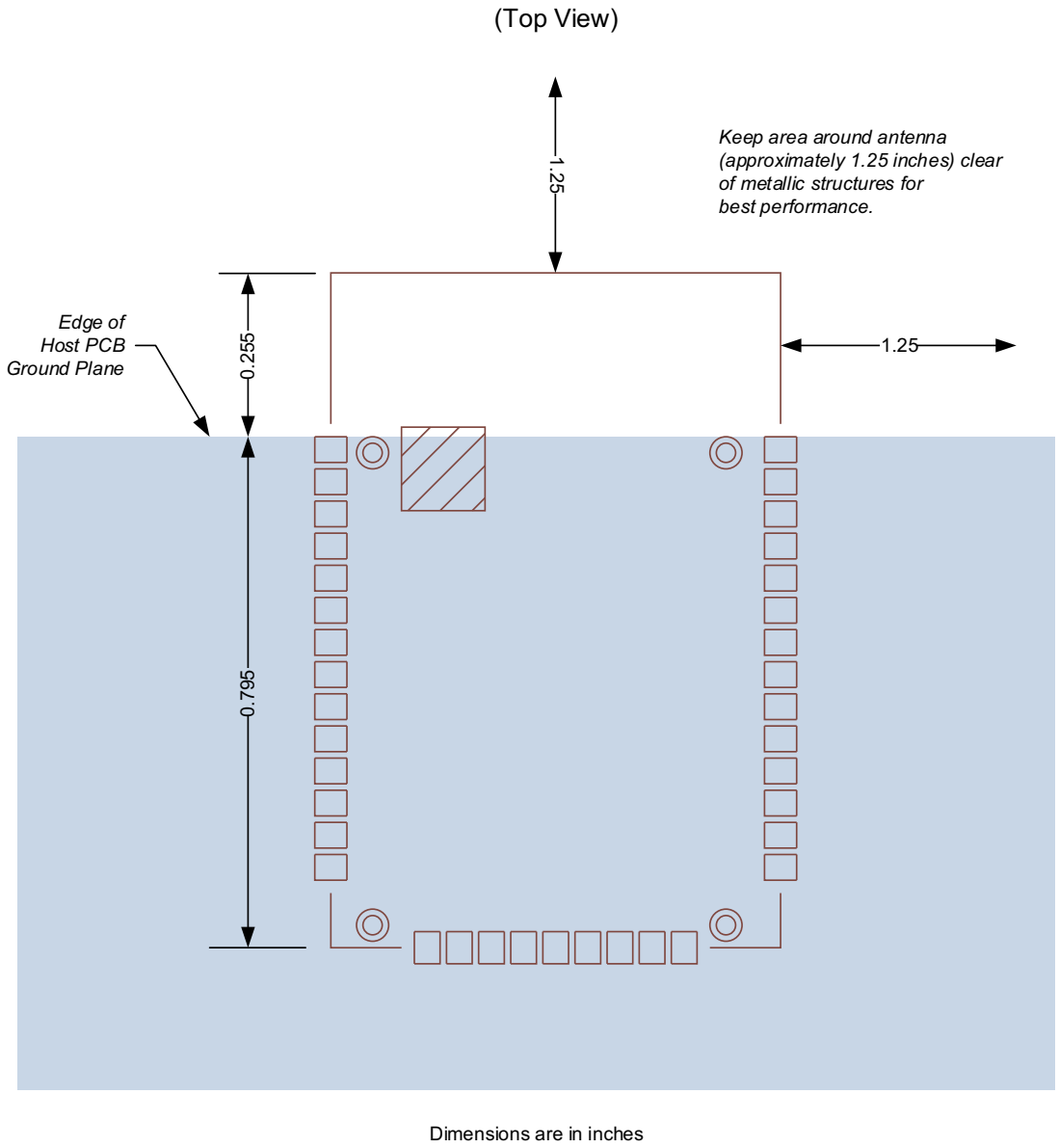


FIGURE 1-5: MRF24WN0MA/MB MODULE MOUNTING DETAILS



© 2015 Microchip Technology Inc.

FIGURE 1-6: MRF24WN0MA/MB RECOMMENDED HOST PCB FOOTPRINT

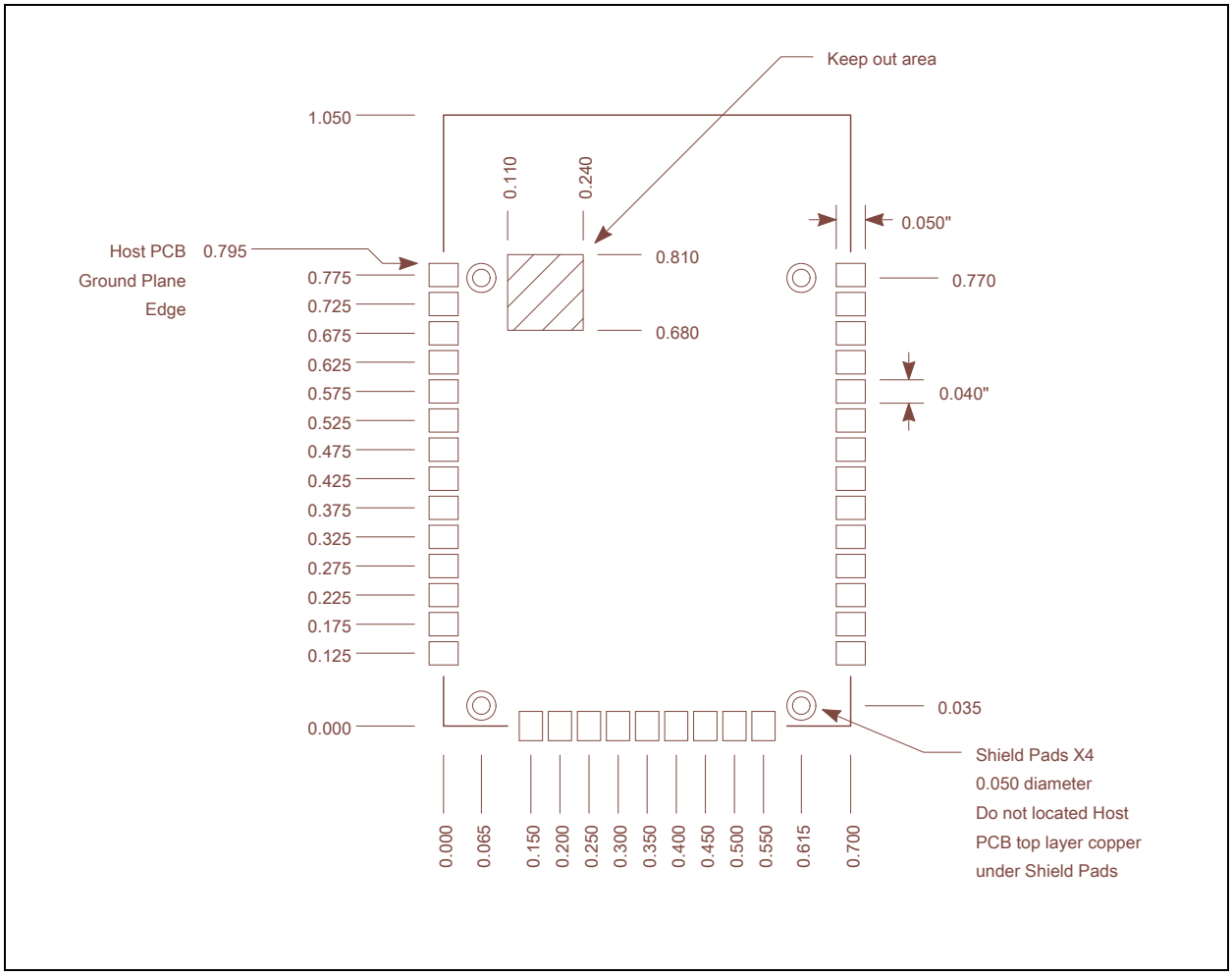
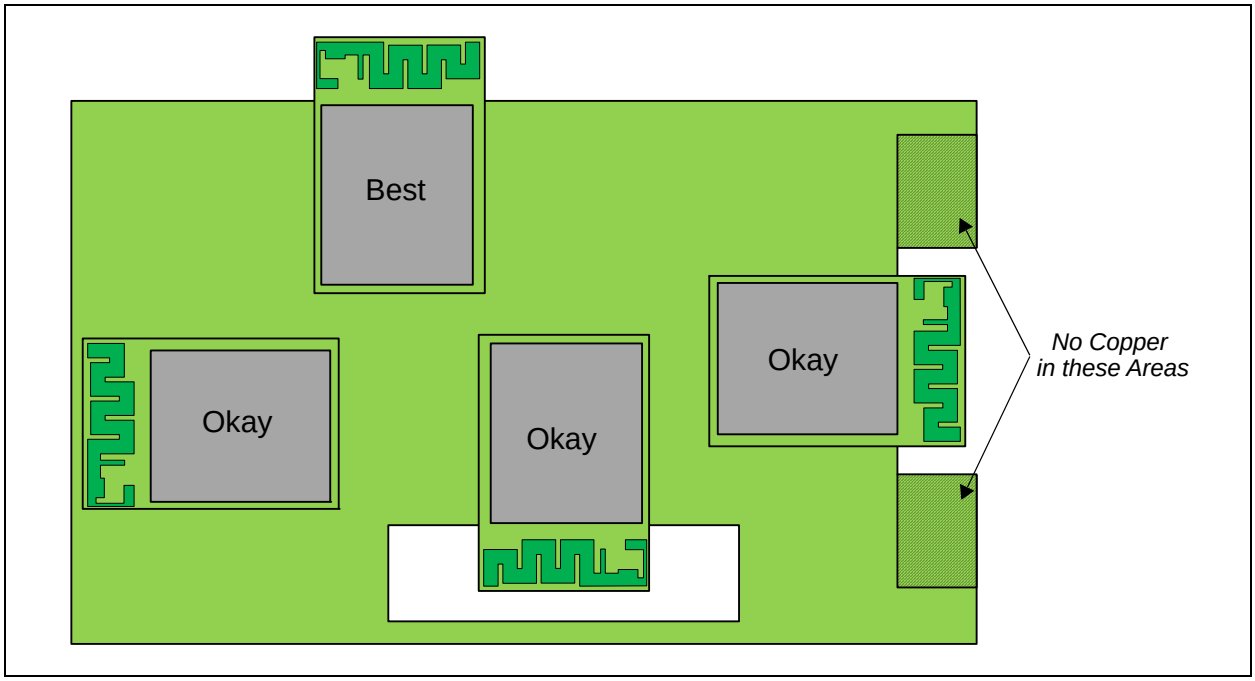


FIGURE 1-7: MRF24WN0MA/MB HOST PCB EXAMPLE LAYOUT



1.3 Soldering Recommendations

The MRF24WN0MA/MB wireless module was assembled using the IPC/JEDEC J-STD-020 Standard lead-free reflow profile. However, the MRF24WN0MA/MB module can be soldered to the host PCB using standard leaded and lead-free solder reflow profiles.

To avoid damaging the module, it is recommended to adhere to the following:

- Solder reflow recommendations are provided in the Microchip application note, *AN233 "Solder Reflow Recommendation"* (DS00233)
- Do not exceed a peak temperature (TP) of 250°C
- Refer to the vendor's solder paste data sheet for specific reflow profile recommendations
- Use no-clean flux solder paste
- Do not wash, as moisture can be trapped under the shield
- Use only one flow. If the PCB requires multiple flows, apply the module on the final flow.

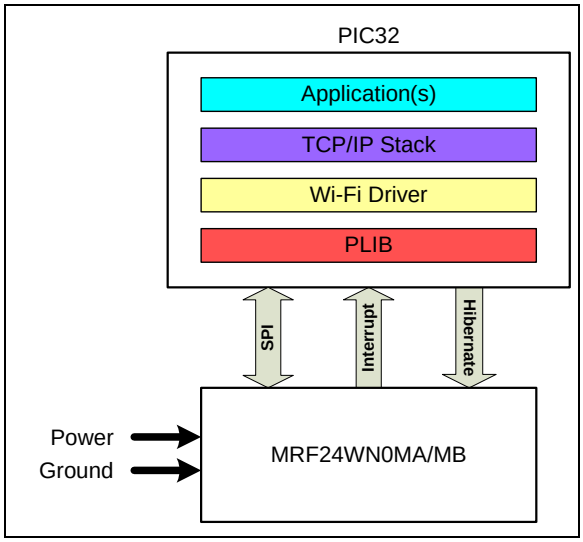
© 2015 Microchip Technology Inc.

2.0 CIRCUIT DESCRIPTION

2.1 Overview

The MRF24WN0MA/MB module interfaces to the PIC32 MCU via a 4-wire SPI port, Interrupt and Hibernate pins. This is illustrated in Figure 2-1. The MRF24WN0MA/MB modules are designed to work with Microchip's MPLAB® Harmony Integrated Software Framework. The integrated framework implements the Application Programming Interface (API) that is used for command and control, for management and data packet traffic. The MPLAB Harmony basic framework is free to download at http://www.microchip.com/harmony. For information on what is included within the basic framework and release versions please read *"Release Notes".*

FIGURE 2-1: HARMONY TO MRF24WN0MA/MB BLOCK DIAGRAM



If you are new to the Harmony Framework, please visit http://www.microchip.com/harmony and go to the *Training>Getting Started* tab.

MPLAB Harmony Help document is available in the Harmony Framework download in the `c:\microchip\harmony\<version>\doc` directory.

The PIC32 input/output ports (SPI, Interrupt and Hibernate) are configured in the Harmony Framework configuration files described in the Harmony Help document.

2.2 MODE0 and MODE1 Pins

The MODE pins must be tied to the voltage levels listed in Table 2-1 for normal operation of the module.

TABLE 2-1: MODE PIN OPERATION

Pin	Condition
MODE0	Connect to GND
$\overline{\text{SPI_CS}}$/MODE1	Connect to VDD via 10 kΩ pull-up resistor

The MODE pins are sampled at power on and wake-up (see Section 2.6, "Hibernate"). In the case of the $\overline{\text{SPI_CS}}$/MODE1, it should be pulled-up using a 10 kΩ resistor and the host MCU allows an active-high signal during power on and wake-up to ensure that the module starts up in normal operation. Once the module is operational, the pin becomes the SPI Port Chip Select pin (active-low).

2.3 SPI Port Pins

The MRF24WN0MA/MB module interfaces to the PIC32 MCU via a 4-wire SPI port. Figure 2-2 and Table 2-2 show the necessary signaling conditions.

In the case of the $\overline{\text{SPI_CS}}$/MODE1, it should be pulled-up using a 10 kΩ resistor and the host MCU allows an active-high signal during power on and wake-up to ensure that the module starts up in normal operation. Once the module is operational, the pin becomes the SPI Port Chip Select pin (active-low).

FIGURE 2-2: SPI SLAVE INTERFACE TIMING

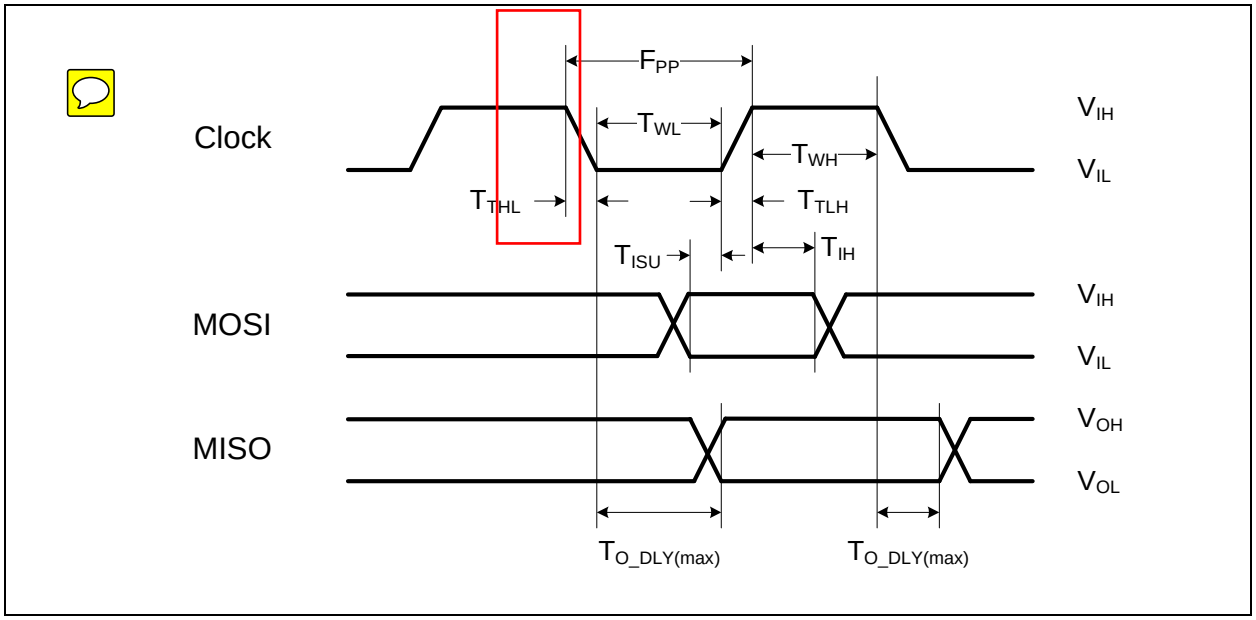


TABLE 2-2: SPI SLAVE TIMING CONSTRAINTS

Parameter	Description	Min.	Max.	Unit
f_{PP}	Clock Frequency	0	48	MHz
t_{WL}	Clock Low Time	8.3	—	ns
t_{WH}	Clock High Time	8.3	—	ns
t_{TLH}	Clock Rise Time	—	2	ns
t_{THL}	Clock Fall Time	—	2	ns
t_{ISU}	Input Setup Time	5	—	ns
t_{IH}	Input Hold Time	5	—	ns
t_{O_DLY}	Output Delay	0	5	ns

2.4 Interrupt Pin

The $\overline{\text{SPI_INT}}$ line works in conjunction with the SPI Port. It is an active low output signal to the host MCU to signal an interrupt event.

2.5 VDD and GND Pin

The MRF24WN0MA/MB wireless module has in integrated power management unit that generates all necessary voltages required by the internal circuitry. The module can be powered from a single voltage source.

Table 2-3 lists the recommended bypass capacitors. Place the capacitors as close to the module as possible.

TABLE 2-3: RECOMMENDED BYPASS CAPACITORS

Pin	Symbol	Bypass Capacitors
4	VDD	0.1 µF and 2.2 µF
15	VDD	0.1 µF and 2.2 µF
35	VDD	0.1 µF and 2.2 µF

© 2015 Microchip Technology Inc.

2.6 Hibernate

The module can enter the lowest power mode by asserting HIBERNATE pin low. No state information is preserved. Harmony framework can save state information in the host MCU and restored after wake-up (asserting HIBERNATE pin high).

The module can be woke-up by asserting HIBERNATE pin high. The module has to be initialized and any state information saved prior to hibernate restored. This process takes approximately 40 ms.

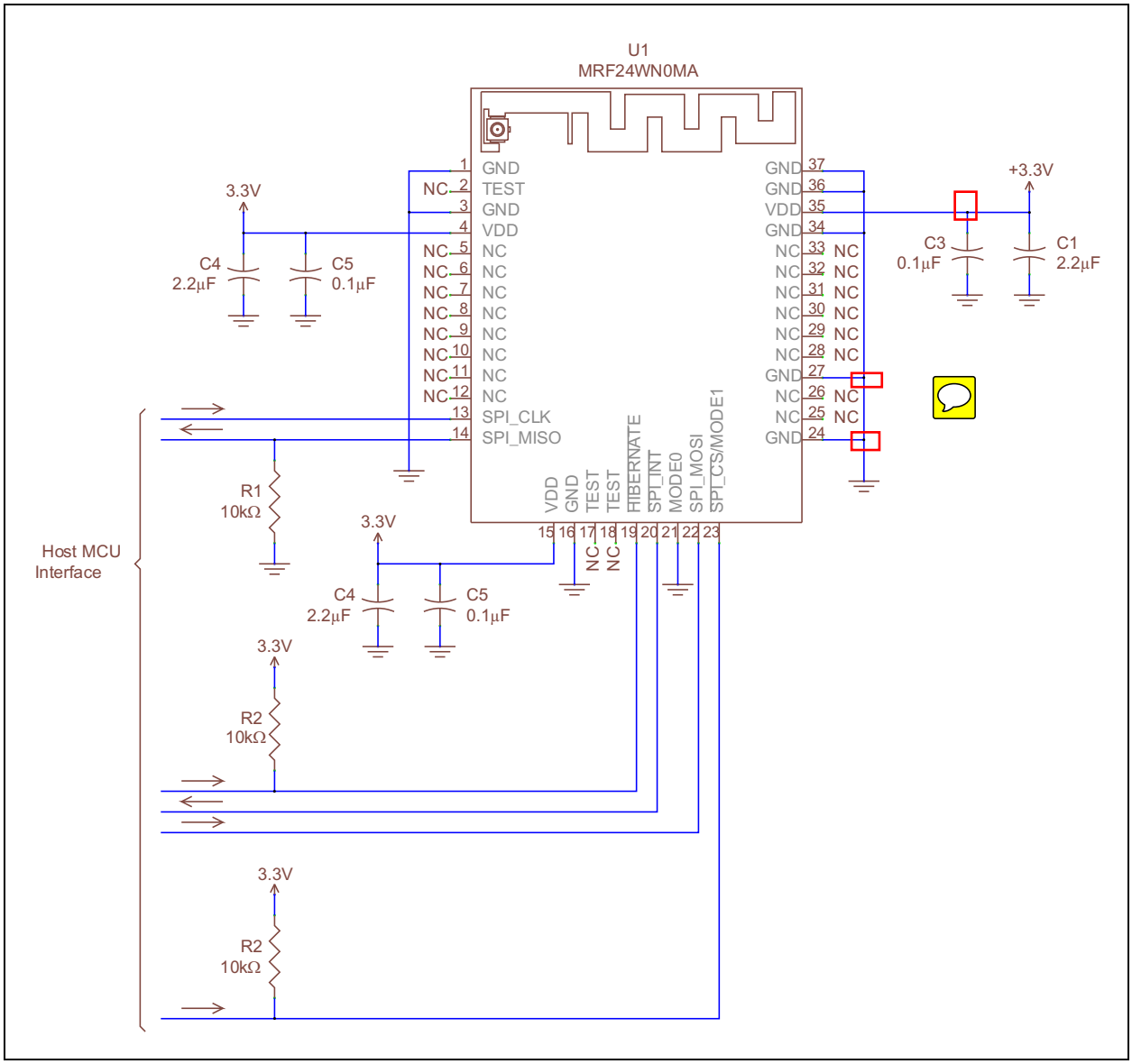
NOTES:

 © 2015 Microchip Technology Inc.

3.0 APPLICATION INFORMATION

3.1 Application Schematic

FIGURE 3-1: APPLICATION SCHEMATIC



3.2 Integral PCB Trace Antenna

For the MRF24WN0MA, the PCB antenna is fabricated on the top copper layer and covered in solder mask. The layers below the antenna have no copper trace.

It is recommended that the module be mounted on the edge of the host PCB. It is permitted for PCB material to be below the antenna structure of the module as long as no copper traces or planes are on the host PCB in that area. For best performance, place the module on the host PCB according to the details shown in Figure 1-6 in **Section 1.0, Device Overview**.

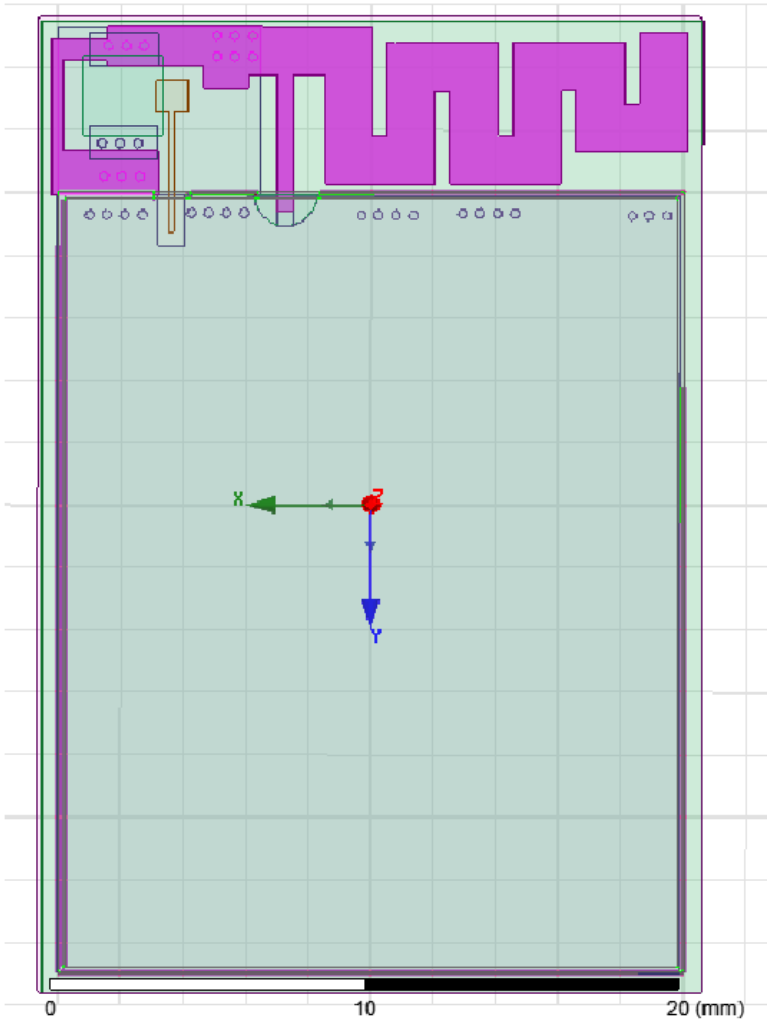
The antenna patterns shown in the following plots are simulated results of the PCB antenna. Figure 3-2 illustrates the simulation drawing; Figure 3-3 and Figure 3-4 illustrate the two-dimensional (2D) and three-dimensional (3D) radiation patterns.

The calculated average of the radiated field is shown in Figure 3-3, highlighted in yellow. The radiation pattern for the XZ plane is shown in red, and the YZ plane is shown in black. As shown, the most powerful radiation occurs in the XY plane (the red pattern).

Figure 3-4 shows the relative position of the 3D radiation "donut" with reference to the module orientation. This is a very useful guide for placement of the module to obtain the maximum range.

Figure 3-5 shows the 3D radiation pattern with the colored distribution of the radiation magnitude. The values range from -9 dB to +0.3 dB. This is very useful in interpreting the 2D radiation pattern.

FIGURE 3-2: PCB ANTENNA SIMULATION DRAWING

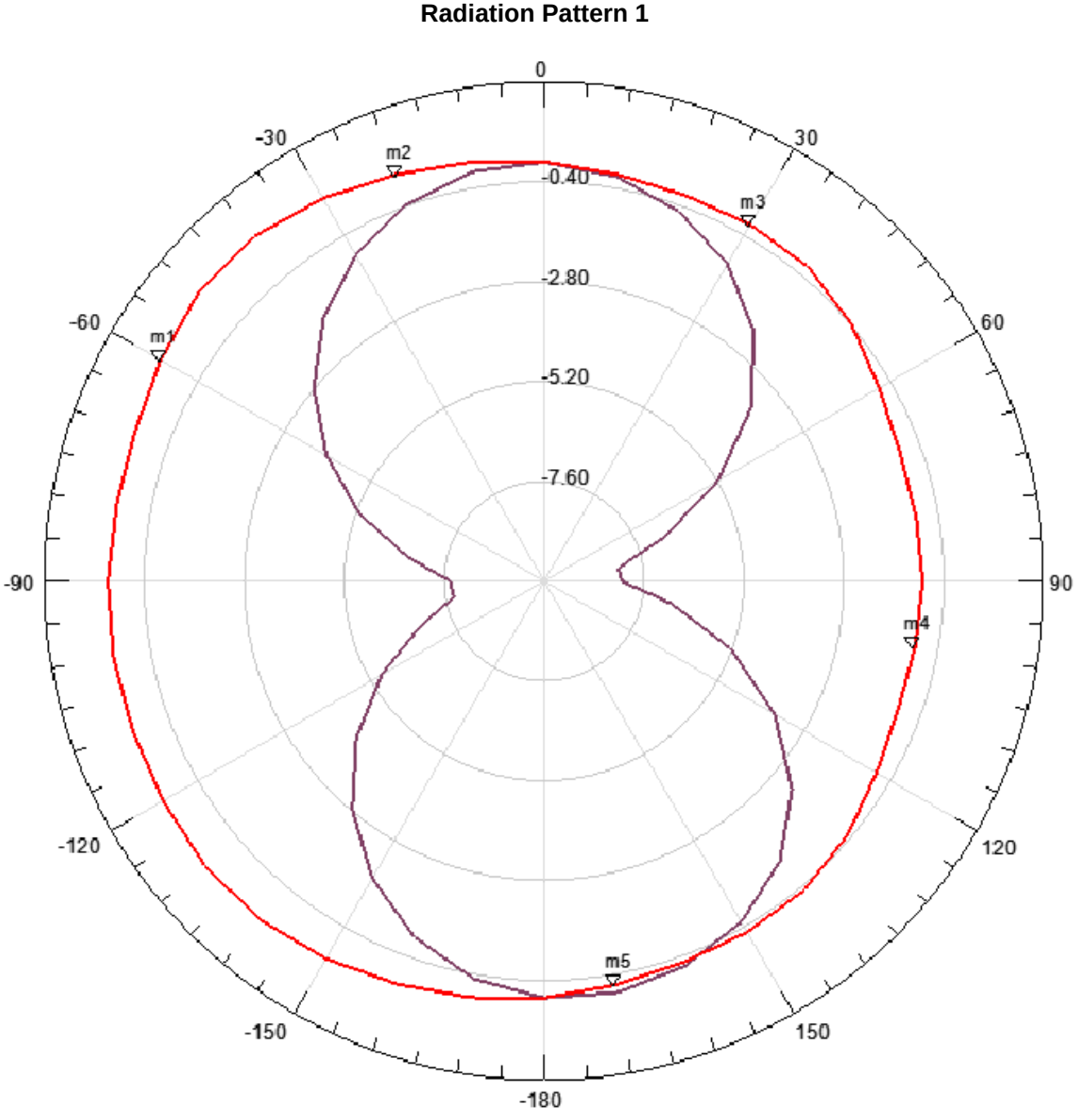


© 2015 Microchip Technology Inc.

FIGURE 3-3: SIMULATED TWO-DIMENSIONAL RADIATION PATTERN

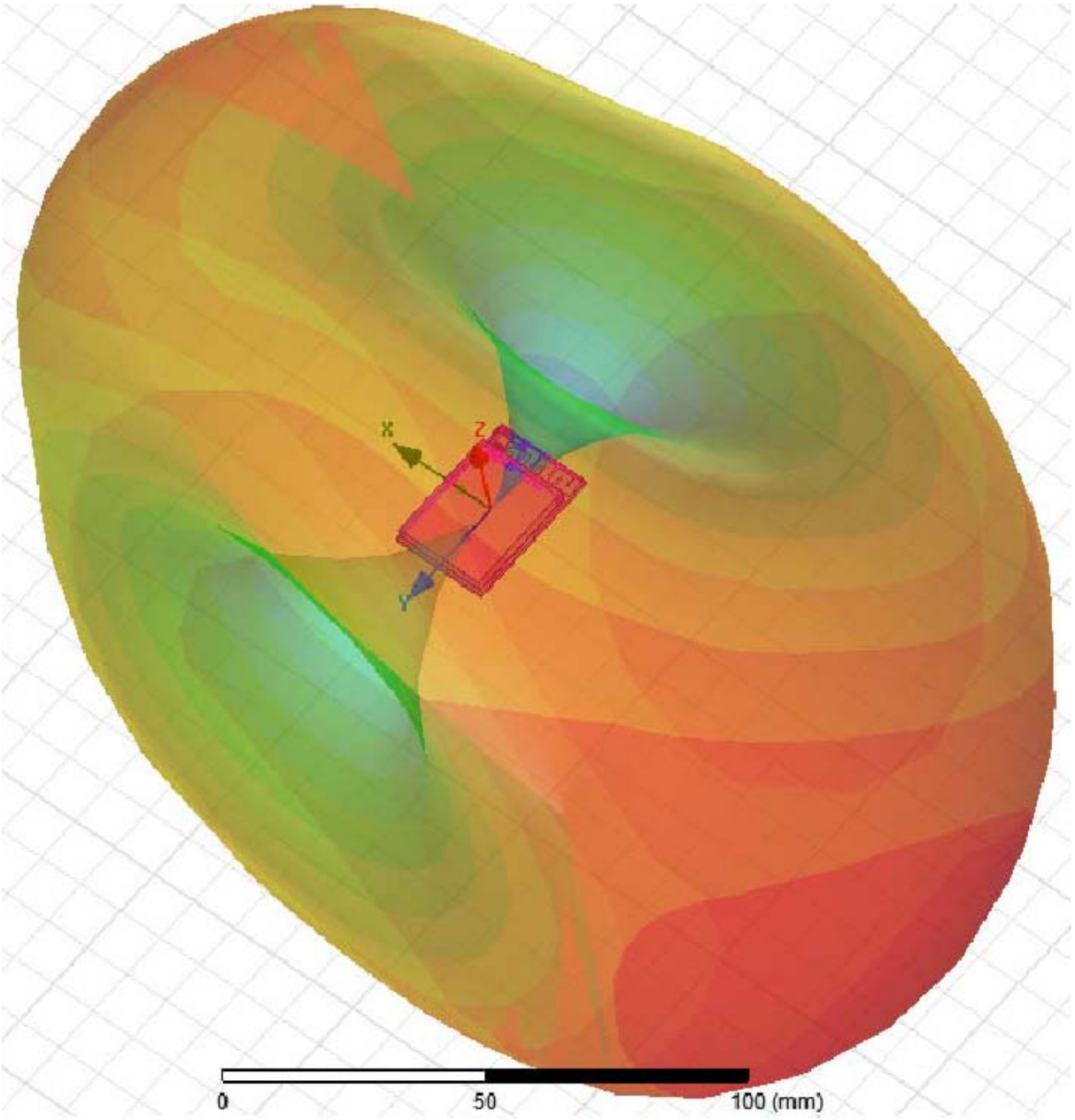
Name	Theta	Angle	Mag.
m1	-60.0000	-60.0000	0.6323
m2	-20.0000	-20.0000	0.3962
m3	30.0000	30.0000	-0.1038
m4	100.0000	100.0000	-0.9490
m5	170.0000	170.0000	-0.1414

Curve Information	Average
dB (Gain Total) Setup 1: Last Adaptive Freq. = “2.44 GHz” Phi = “0 deg”	0.0097
dB (Gain Total) Setup 2: Last Adaptive Freq. = “2.44 GHz” Phi = “0 deg”	-3.2020



Two-dimensional (2D) pattern, including the average on main radiation planes (Phi = 0 and 90 degrees).

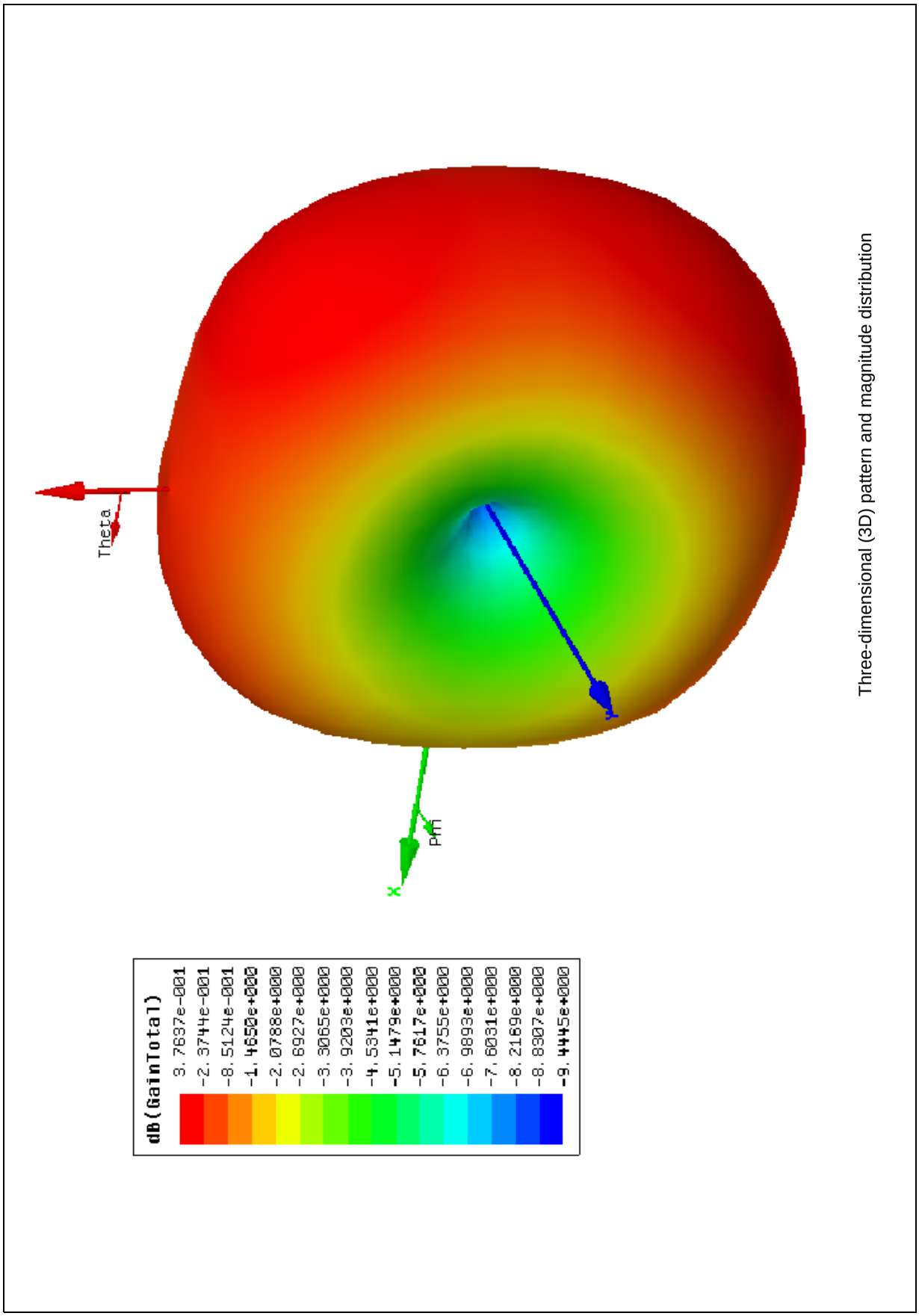
FIGURE 3-4: SIMULATED THREE-DIMENSIONAL RADIATION PATTERN



Radiation pattern against the module dimensions

 © 2015 Microchip Technology Inc.

FIGURE 3-5: SIMULATED THREE-DIMENSIONAL RADIATION PATTERN



Three-dimensional (3D) pattern and magnitude distribution

3.3 External Antenna Types

The MRF24WN0MB module has an ultra-small coaxial connector (W.FL) for connection to the external antenna.

The choice of antenna is limited to the antenna types the module has been tested with. Refer to the respective country in **Section 4.0, Regulatory Approval** for a list of tested and approved antenna types that may be used with the MRF24WN0MB module.

A list of antennas approved for use with the module is provided in Table 3-1.

TABLE 3-1: TESTED EXTERNAL ANTENNA TYPES

Type	Gain
PCB Trace	1 dBi
Dipole	2 dBi
PIFA	-3 dBi

© 2015 Microchip Technology Inc.

4.0 REGULATORY APPROVAL

This section outlines the regulatory information for the MRF24WN0MA/MB module for the following countries:

- United States
- Canada
- Europe
- Australia
- New Zealand
- Japan
- Korea
- Taiwan
- Other Regulatory Jurisdictions

4.1 United States

The MRF24WN0MA/MB module has received Federal Communications Commission (FCC) CFR47 Telecommunications, Part 15 Subpart C “Intentional Radiators” modular approval in accordance with Part 15.212 Modular Transmitter approval. Modular approval allows the end user to integrate the MRF24WN0MA/MB module into a finished product without obtaining subsequent and separate FCC approvals for intentional radiation, provided no changes or modifications are made to the module circuitry. Changes or modifications could void the user’s authority to operate the equipment. The end user must comply with all of the instructions provided by the Grantee, which indicate installation and/or operating conditions necessary for compliance.

The finished product is required to comply with all applicable FCC equipment authorizations regulations, requirements and equipment functions not associated with the transmitter module portion. For example, compliance must be demonstrated to regulations for other transmitter components within the host product; to requirements for unintentional radiators (Part 15 Subpart B “Unintentional Radiators”), such as digital devices, computer peripherals, radio receivers, etc.; and to additional authorization requirements for the non-transmitter functions on the transmitter module (i.e., Verification, or Declaration of Conformity) (e.g., transmitter modules may also contain digital logic functions) as appropriate.

4.1.1 LABELING AND USER INFORMATION REQUIREMENTS

The MRF24WN0MA/MB module has been 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 finished product into which the module is installed must also display a label referring to the enclosed module. This exterior label can use wording as follows:

> MRF24WN0MA/MB**:**
> Contains Transmitter Module FCC ID: W7O24WN0
> *or*
>
> Contains FCC ID: W7O24WN0
>
> 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 user’s manual for the product should include the following statement:

> 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.

Additional information on labeling and user information requirements for Part 15 devices can be found in KDB Publication 784748 available at the FCC Office of Engineering and Technology (OET) Laboratory Division Knowledge Database (KDB) http://apps.fcc.gov/oetcf/kdb/index.cfm.

4.1.2 RF EXPOSURE

All transmitters regulated by FCC must comply with RF exposure requirements. KDB 447498 General RF Exposure Guidance provides guidance in determining whether proposed or existing transmitting facilities, operations or devices comply with limits for human exposure to Radio Frequency (RF) fields adopted by the Federal Communications Commission (FCC).

This module is approved for installation into mobile host platforms (>20 cm antenna to user separation distance) and must not be co-located or operating in conjunction with any other antenna or transmitter except in accordance with FCC multi-transmitter guidelines. End users must be pro-vided with transmitter operating conditions for satisfy-ing RF Exposure compliance.

4.1.3 APPROVED EXTERNAL ANTENNA TYPES

To maintain modular approval in the United States, only the antenna types that have been tested shall be used. It is permissible to use different antenna manufacturers provided the same antenna type that has similar inband and out-of-band radiation patterns and antenna gain (equal to or less than) is used.

Modular approval testing of the MRF24WN0MA/MB module was performed with the antenna types listed in Table 3-1.

4.1.4 HELPFUL WEB SITES

Federal Communications Commission (FCC): http://www.fcc.gov

FCC Office of Engineering and Technology (OET) Laboratory Division Knowledge Database (KDB): http://apps.fcc.gov/oetcf/kdb/index.cfm

4.2 Canada

The MRF24WN0MA/MB module has been certified for use in Canada under Industry Canada (IC) Radio Standards Specification (RSS) RSS-210 and RSSGen. Modular approval permits the installation of a module in a host device without the need to recertify the device.

4.2.1 LABELING AND USER INFORMATION REQUIREMENTS

Labeling Requirements for the Host Device (from Section 3.2.1, RSS-Gen, Issue 3, December 2010): The host device shall be properly labeled to identify the module within the host device.

The Industry Canada certification label of a module shall be clearly visible at all times when installed in the host device, otherwise the host device must be labeled to display the Industry Canada certification number of the module, preceded by the words “Contains transmitter module”, or the word “Contains”, or similar wording expressing the same meaning, as follows:

Contains transmitter module IC: 7693A-24WN0

User Manual Notice for License-Exempt Radio Apparatus (from Section 7.1.3 RSS-Gen, Issue 3, December 2010): User manuals for license-exempt radio apparatus shall contain the following or equivalent notice in a conspicuous location in the user manual or alternatively on the device or both:

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

Transmitter Antenna (from Section 7.1.2 RSS-Gen, Issue 3, December 2010): User manuals for transmitters shall display the following notice in a conspicuous location:

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. 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.

The above notice may be affixed to the device instead of displayed in the user manual.

4.2.2 RF EXPOSURE

All transmitters regulated by IC must comply with RF exposure requirements listed in RSS-102 - Radio Frequency (RF) Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands).

 © 2015 Microchip Technology Inc.

This module is approved for installation into mobile host platforms (>20cm antenna to user separation distance)and must not be co-located or operating in conjunction with any other antenna or transmitter except in accordance with Industry Canada's multi-transmitter guidelines. End users must be provided with transmitter operating con-ditions for satisfying RF Exposure compliance.

4.2.3 APPROVED EXTERNAL ANTENNA TYPES

Transmitter Antenna (from Section 7.1.2 RSS-Gen, Issue 3, December 2010):

The MRF24WN0MA/MB module can only be sold or operated with antennas with which it was approved. Transmitter may be approved with multiple antenna types. An antenna type comprises antennas having similar in-band and out-of-band radiation patterns. Testing shall be performed using the highest gain antenna of each combination of transmitter and antenna type for which approval is being sought, with the transmitter output power set at the maximum level. Any antenna of the same type having equal or lesser gain as an antenna that had been successfully tested with the transmitter, will also be considered approved with the transmitter, and may be used and marketed with the transmitter.

When a measurement at the antenna connector is used to determine RF output power, the effective gain of the device's antenna shall be stated, based on measurement or on data from the antenna manufacturer. For transmitters of output power greater than 10 milliwatts, the total antenna gain shall be added to the measured RF output power to demonstrate compliance to the specified radiated power limits.

Modular approval testing of the MRF24WN0MA/MB module was performed with the antenna types listed in Table 3-1.

4.2.4 HELPFUL WEB SITES

Industry Canada: http://www.ic.gc.ca/

4.3 Europe

The MRF24WN0MA/MB module is an R&TTE Directive assessed radio module that is CE marked and has been manufactured and tested with the intention of being integrated into a final product.

The MRF24WN0MA/MB module has been tested to R&TTE Directive 1999/5/EC Essential Requirements for Health and Safety (Article (3.1(a)), Electromagnetic Compatibility (EMC) (Article 3.1(b)), and Radio (Article 3.2) and are summarized in Table 3-1: European Compliance Testing. A Notified Body Opinion has also been issued. All test reports are available on the MRF24WN0MA/MB product web page at http://www.microchip.com.

The R&TTE Compliance Association provides guidance on modular devices in document **Technical Guidance Note 01** available at http://www.rtteca.com/html/download_area.htm.

Note:	To maintain conformance to the testing listed in Table 4-1, the module shall be installed in accordance with the installation instructions in this data sheet and shall not be modified. When integrating a radio module into a completed product the integrator becomes the manufacturer of the final product and is therefore responsible for demonstrating compliance of the final product with the essential requirements of the R&TTE Directive.

4.3.1 LABELING AND USER INFORMATION REQUIREMENTS

The label on the final product which contains the MRF24WN0MA/MB module must follow CE marking requirements. The *"R&TTE Compliance Association Technical Guidance Note 01"* provides guidance on final product CE marking.

4.3.2 EXTERNAL ANTENNA REQUIREMENTS

From R&TTE Compliance Association document **Technical Guidance Note 01**:

> Provided the integrator installing an assessed radio module with an integral or specific antenna and installed in conformance with the radio module manufacturer's installation instructions requires no further evaluation under Article 3.2 of the R&TTE Directive and does not require further involvement of an R&TTE Directive Notified Body for the final product. [Section 2.2.4]

The European Compliance Testing listed in Table 4-1 was performed using the antenna types listed in Table 3-1.

4.3.3 HELPFUL WEB SITES

A document that can be used as a starting point in understanding the use of Short Range Devices (SRD) in Europe is the European Radio Communications Committee (ERC) Recommendation 70-03 E, which can be downloaded from the European Radio Communications Office (ERO) at: http://www.ero.dk/.

Additional helpful web sites are:

- Radio and Telecommunications Terminal Equipment (R&TTE): http://ec.europa.eu/enterprise/rtte/index_en.htm
- European Conference of Postal and Telecommunications Administrations (CEPT): http://www.cept.org/
- European Telecommunications Standards Institute (ETSI): http://www.etsi.org
- European Radio Communications Office (ERO): http://www.ero.dk/
- The Radio and Telecommunications Terminal Equipment Compliance Association (R&TTE CA): http://www.rtteca.com/

TABLE 4-1: MRF24WN0MA/MB EUROPEAN COMPLIANCE TESTING

Certification	Standards	Article	Laboratory	Report Number	Date
Safety	EN 60950-1:2006+A11:2009+A1:2010 +A12:2011	[3.1(a)]		Pending	
Health	EN 62479:2010			Pending	
EMC	EN 301 489-1 V1.9.2 (2011-09)	[3.1(b)]		Pending	
	EN 301 489-17 V2.2.1 (2012-09)				
Radio	EN 300 328 V1.8.1 (2006-06)	(3.2)		Pending	
Notified Body Opinion				Pending	

4.4 Australia

The Australia radio regulations do not provide a modular approval policy similar to the United States (FCC) and Canada (IC). However, MRF24WN0MA/MB module RF transmitter test reports can be used in part to demonstrate compliance in accordance with ACMA Radio communications “Short Range Devices” Standard 2004 (The Short Range Devices standard calls up the AS/NZS 4268:2008 industry standard). The MRF24WN0MA/MB module test reports can be used as part of the product certification and compliance folder. For more information on the RF transmitter test reports, contact Microchip Technology Australia sales office.

To meet overall Australian final product compliance, the developer must construct a compliance folder containing all relevant compliance test reports e.g. RF, EMC, electrical safety and DoC (Declaration of Conformity) etc. It is the responsibility of the integrator to know what is required in the compliance folder for ACMA compliance. All test reports are available on the MRF24WN0MA/MB product web page at http://www.microchip.com. For more information on Australia compliance, refer to the Australian Communications and Media Authority web site http://www.acma.gov.au/.

4.4.1 EXTERNAL ANTENNA REQUIREMENTS

The compliance testing listed in Table 4-1 was performed using the antenna types listed in Table 3-1.

4.4.2 HELPFUL WEB SITES

The Australian Communications and Media Authority: www.acma.gov.au/.

4.5 New Zealand

The New Zealand radio regulations do not provide a modular approval policy similar to the United States (FCC) and Canada (IC). However, MRF24WN0MA/MB module RF transmitter test reports can be used in part to demonstrate compliance against the New Zealand “General User Radio License for Short Range Devices”. New Zealand Radio communications (Radio Standards) Notice 2010 calls up the AS / NZS 4268:2008 industry standard. The MRF24WN0MA/MB module test reports can be used as part of the product certification and compliance folder. All test reports are available on the MRF24WN0MA/MB product web page at http://www.microchip.com. For more information on the RF transmitter test reports, contact Microchip Technology sales office.

Information on the New Zealand short range devices license can be found in the following web links:

http://www.rsm.govt.nz/cms/licensees/types-oflicence/general-user-licences/short-range-devices

and

http://www.rsm.govt.nz/cms/policy-and-planning/spectrum-policy-overview/legislation/gazette-notices/product-compliance

To meet overall New Zealand final product compliance, the developer must construct a compliance folder containing all relevant compliance test reports e.g. RF, EMC, electrical safety and DoC (Declaration of Conformity) etc. It is the responsibility of the developer to know what is required in the compliance folder for New Zealand Radio communications. For more information on New Zealand compliance, refer to the web site http://www.rsm.govt.nz/.

© 2015 Microchip Technology Inc.

4.5.1 EXTERNAL ANTENNA REQUIREMENTS

The compliance testing listed in Table 4-1 was performed using the antenna types listed in Table 3-1.

4.6 Japan

The MRF24WN0MA/MB module has received type certification and is labeled with its own technical conformity mark and certification number as required to conform to the technical standards regulated by the Ministry of Internal Affairs and Communications (MIC) of Japan pursuant to the Radio Act of Japan.

Integration of this module into a final product does not require additional radio certification provided installation instructions are followed and no modifications of the module are allowed. Additional testing may be required:

- If the host product is subject to electrical appliance safety (for example, powered from an AC mains), the host product may require Product Safety Electrical Appliance and Material (PSE) testing. The integrator should contact their conformance laboratory to determine if this testing is required.
- There is an voluntary Electromagnetic Compatibility (EMC) test for the host product administered by VCCI: http://www.vcci.jp/vcci_e/index.html

4.6.1 LABELING AND USER INFORMATION REQUIREMENTS

The label on the final product which contains the MRF24WN0MA/MB module must follow Japan marking requirements. The integrator of the module should refer to the labeling requirements for Japan available at the Ministry of Internal Affairs and Communications (MIC) website.

The MRF24WN0MA/MB module is labeled with its own technical conformity mark and certification number. The final product in which this module is being used must have a label referring to the type certified module inside:

Contains transmitter module with certificate number:

Pending

4.6.2 EXTERNAL ANTENNA REQUIREMENTS

The compliance testing was performed using the antenna types listed in Table 3-1.

4.6.3 4.6.2 HELPFUL WEB SITES

Ministry of Internal Affairs and Communications (MIC): http://www.tele.soumu.go.jp/e/index.htm

Association of Radio Industries and Businesses (ARIB): http://www.arib.or.jp/english/

4.7 Korea

The MRF24WN0MA/MB module has received certification of conformity in accordance with the Radio Waves Act. Integration of this module into a final product does not require additional radio certification provided installation instructions are followed and no modifications of the module are allowed.

4.7.1 LABELING AND USER INFORMATION REQUIREMENTS

The label on the final product which contains the MRF24WN0MA/MB module must follow KC marking requirements. The integrator of the module should refer to the labeling requirements for Korea available on the Korea Communications Commission (KCC) website.

The MRF24WN0MA/MB module is labeled with its own KC mark. The final product requires the KC mark and certificate number of the module:

Pending

4.7.2 EXTERNAL ANTENNA REQUIREMENTS

The Korea compliance testing was performed using the antenna types listed in Table 3-1.

4.7.3 HELPFUL WEB SITES

Korea Communications Commission (KCC): http://www.kcc.go.kr

National Radio Research Agency (RRA): http://rra.go.kr

4.8 Taiwan

The MRF24WN0MA/MB module has received compliance approval in accordance with the Telecommunications Act. Customers seeking to use the compliance approval in their product should contact Microchip Technology sales or distribution partners to obtain a Letter of Authority.

Integration of this module into a final product does not require additional radio certification provided installation instructions are followed and no modifications of the module are allowed.

4.8.1 LABELING AND USER INFORMATION REQUIREMENTS

The MRF24WN0MA/MB module is labeled with its own NCC mark and certificate number as below:

The user's manual should contain below warning (for RF device) in traditional Chinese:

注意！

依據 低功率電波輻射性電機管理辦法

第十二條 經型式認證合格之低功率射頻電機，非經許可，

公司、商號或使用者均不得擅自變更頻率、加大功率或變更原設計

之特性及功能。

第十四條 低功率射頻電機之使用不得影響飛航安全及干擾合法通信；

經發現有干擾現象時，應立即停用，並改善至無干擾時方得繼續使用。

前項合法通信，指依電信規定作業之無線電信。

低功率射頻電機須忍受合法通信或工業、科學及醫療用電波輻射性

電機設備之干擾。

© 2015 Microchip Technology Inc.

5.0 ELECTRICAL CHARACTERISTICS

Table 5-1, Table 5-2 and Table 5-3 provide the module's absolute maximum ratings, the recommended operating conditions and the DC characteristics for digital IO pins.

TABLE 5-1: ABSOLUTE MAXIMUM RATINGS(1)

Symbol	Description	Max Rating	Units
VDD	Voltage on VDD with respect to GND	-0.3 to 4.0	V
V_{DI} Min.	Minimum digital input voltage	-0.3	V
V_{DO} Max.	Maximum digital input voltage	VDD+0.3	V
RF_{IN}	Maximum RF input (referenced to 50 ohms)	+10	dBm

Note 1: Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at those or any other conditions above those indicated in the operation listings of this specification is not implied. Exposure above maximum rating conditions for extended periods may affect device reliability.

TABLE 5-2: RECOMMENDED OPERATING CONDITIONS

Symbol		Min.	Typ.	Max.	Units
VDD	Supply voltage	3.15	3.3	3.45	V
TAMB	Ambient temperature under bias	-40	--	85	°C

TABLE 5-3: DC CHARACTERISTICS FOR DIGITAL IO PINS

DC CHARACTERISTICS		Operating Conditions(1)			
Symbol	**Parameter**	**Min.**	**Typ.**	**Max.**	**Units**
VIH	High Level Input Voltage	1.8	—	3.6	V
VIL	Low Level Input Voltage	-0.3	—	0.3	V
VOH	High Level Output Voltage	2.2	—	3.3	V
VOL	Low Level Output Voltage	0	—	0.4	V
IIH	High Level Input Current	—	—	0.1	µA
IIL	Low Level Input Current	—	—	0.1	µA
IOH	High Level Output	—	—	20	mA
IOL	Low Level Output Current	—	—	20	mA
CIN	Input Capacitance	—	3		pF

Note: Operating temperature: 25°C; Operating voltage: VDD = 3.3V

Table 5-4, Table 5-5 and Table 5-6 show the radio receive and transmit characteristics and the synthesizer characteristics.

TABLE 5-4: RADIO RECEIVE CHARACTERISTICS

Symbol	Parameter	Conditions	Min	Typ(1)	Max	Unit
fRX	RX input frequency range	—	2.400	—	2.484	GHz
SRF	Sensitivity					
	CCK	1 Mbps	—	-95.7	—	dBm
		11 Mbps	—	-87.7	—	
	OFDM	6 Mbps	—	-92.7	—	
		54 Mbps	—	-75.7	—	
	HT20	MCS0	—	-92.7	—	
		MCS7	—	-72.7	—	
	HT40	MCS0	—	-90.7	—	
		MCS7	—	-69.7	—	

Note 1: Performance measured at J1.

TABLE 5-5: RADIO TRANSMIT CHARACTERISTICS

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
fRX	TX output frequency range	—	2.400	—	2.484	GHz
pOUT	Output power(1)					
	802.11b mask compliant	1 Mbps	—	12	—	dBm
	802.11g mask compliant	6 Mbps	—	17	—	
	802.11g EVM compliant	54 Mbps	—	17	—	
	802.11n HT20 mask compliant	MCS0	—	16	—	
	802.11n HT40 mask compliant	MCS0	—	13	—	
	802.11n HT20 EVM compliant	MCS7	—	16	—	
	802.11n HT40 EVM compliant	MCS7	—	13	—	
aPC	Accuracy of power control	—	—	+/- 0.5	—	dB

Note 1: Performance measured at J1.

TABLE 5-6: SYNTHESIZER CHARACTERISTICS

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
fC	Center channel frequency	Center frequency at 5 MHz spacing	2.412	—	2.472	GHz
fREF	Reference oscillator frequency	+/-20 ppm	—	40	—	MHz
fSTEP	Frequency step size (at RF)	—	—	5	—	MHz

© 2015 Microchip Technology Inc.

APPENDIX A: REVISION HISTORY

Revision A (July, 2015)

This is the initial release of this document.

NOTES:

 © 2015 Microchip Technology Inc.

THE MICROCHIP WEB SITE

Microchip provides online support via our WWW site at www.microchip.com. This web site is used as a means to make files and information easily available to customers. Accessible by using your favorite Internet browser, the web site contains the following information:

- **Product Support** – Data sheets and errata, application notes and sample programs, design resources, user's guides and hardware support documents, latest software releases and archived software
- **General Technical Support** – Frequently Asked Questions (FAQ), technical support requests, online discussion groups, Microchip consultant program member listing
- **Business of Microchip** – Product selector and ordering guides, latest Microchip press releases, listing of seminars and events, listings of Microchip sales offices, distributors and factory representatives

CUSTOMER CHANGE NOTIFICATION SERVICE

Microchip's customer notification service helps keep customers current on Microchip products. Subscribers will receive e-mail notification whenever there are changes, updates, revisions or errata related to a specified product family or development tool of interest.

To register, access the Microchip web site at www.microchip.com. Under "Support", click on "Customer Change Notification" and follow the registration instructions.

CUSTOMER SUPPORT

Users of Microchip products can receive assistance through several channels:

- Distributor or Representative
- Local Sales Office
- Field Application Engineer (FAE)
- Technical Support

Customers should contact their distributor, representative or Field Application Engineer (FAE) for support. Local sales offices are also available to help customers. A listing of sales offices and locations is included in the back of this document.

Technical support is available through the web site at: http://microchip.com/support.

NOTES:

© 2015 Microchip Technology Inc.

PRODUCT IDENTIFICATION SYSTEM

To order or obtain information, e.g., on pricing or delivery, refer to the factory or the listed sales office.

PART NO.	I	RM	XXX
Device	Temperature Range	Package	Firmware Revision Number

Device:	MRF24WN0MA: MRF24WN0MB:	Integral Antenna External Antenna Connection
Temperature Range:	I =	-40°C to +85°C (Industrial)
Package:	RM =	Radio Module

Examples:

MRF24WN0MA-I/RM

NOTES:

 © 2015 Microchip Technology Inc.

Note the following details of the code protection feature on Microchip devices:

- Microchip products meet the specification contained in their particular Microchip Data Sheet.
- Microchip believes that its family of products is one of the most secure families of its kind on the market today, when used in the intended manner and under normal conditions.
- There are dishonest and possibly illegal methods used to breach the code protection feature. All of these methods, to our knowledge, require using the Microchip products in a manner outside the operating specifications contained in Microchip's Data Sheets. Most likely, the person doing so is engaged in theft of intellectual property.
- Microchip is willing to work with the customer who is concerned about the integrity of their code.
- Neither Microchip nor any other semiconductor manufacturer can guarantee the security of their code. Code protection does not mean that we are guaranteeing the product as "unbreakable."

Code protection is constantly evolving. We at Microchip are committed to continuously improving the code protection features of our products. Attempts to break Microchip's code protection feature may be a violation of the Digital Millennium Copyright Act. If such acts allow unauthorized access to your software or other copyrighted work, you may have a right to sue for relief under that Act.

Information contained in this publication regarding device applications and the like is provided only for your convenience and may be superseded by updates. It is your responsibility to ensure that your application meets with your specifications. MICROCHIP MAKES NO REPRESENTATIONS OR WARRANTIES OF ANY KIND WHETHER EXPRESS OR IMPLIED, WRITTEN OR ORAL, STATUTORY OR OTHERWISE, RELATED TO THE INFORMATION, INCLUDING BUT NOT LIMITED TO ITS CONDITION, QUALITY, PERFORMANCE, MERCHANTABILITY OR FITNESS FOR PURPOSE**.** Microchip disclaims all liability arising from this information and its use. Use of Microchip devices in life support and/or safety applications is entirely at the buyer's risk, and the buyer agrees to defend, indemnify and hold harmless Microchip from any and all damages, claims, suits, or expenses resulting from such use. No licenses are conveyed, implicitly or otherwise, under any Microchip intellectual property rights unless otherwise stated.

Trademarks

The Microchip name and logo, the Microchip logo, dsPIC, FlashFlex, flexPWR, JukeBlox, KEELOQ, KEELOQ logo, Kleer, LANCheck, MediaLB, MOST, MOST logo, MPLAB, OptoLyzer, PIC, PICSTART, PIC^{32} logo, RightTouch, SpyNIC, SST, SST Logo, SuperFlash and UNI/O are registered trademarks of Microchip Technology Incorporated in the U.S.A. and other countries.

The Embedded Control Solutions Company and mTouch are registered trademarks of Microchip Technology Incorporated in the U.S.A.

Analog-for-the-Digital Age, BodyCom, chipKIT, chipKIT logo, CodeGuard, dsPICDEM, dsPICDEM.net, ECAN, In-Circuit Serial Programming, ICSP, Inter-Chip Connectivity, KleerNet, KleerNet logo, MiWi, MPASM, MPF, MPLAB Certified logo, MPLIB, MPLINK, MultiTRAK, NetDetach, Omniscient Code Generation, PICDEM, PICDEM.net, PICkit, PICtail, RightTouch logo, REAL ICE, SQI, Serial Quad I/O, Total Endurance, TSHARC, USBCheck, VariSense, ViewSpan, WiperLock, Wireless DNA, and ZENA are trademarks of Microchip Technology Incorporated in the U.S.A. and other countries.

SQTP is a service mark of Microchip Technology Incorporated in the U.S.A.

Silicon Storage Technology is a registered trademark of Microchip Technology Inc. in other countries.

GestIC is a registered trademark of Microchip Technology Germany II GmbH & Co. KG, a subsidiary of Microchip Technology Inc., in other countries.

All other trademarks mentioned herein are property of their respective companies.

© 2015, Microchip Technology Incorporated, Printed in the U.S.A., All Rights Reserved.

ISBN:

QUALITY MANAGEMENT SYSTEM
CERTIFIED BY DNV
═ ISO/TS 16949 ═

Microchip received ISO/TS-16949:2009 certification for its worldwide headquarters, design and wafer fabrication facilities in Chandler and Tempe, Arizona; Gresham, Oregon and design centers in California and India. The Company's quality system processes and procedures are for its PIC® MCUs and dsPIC® DSCs, KEELOQ® code hopping devices, Serial EEPROMs, microperipherals, nonvolatile memory and analog products. In addition, Microchip's quality system for the design and manufacture of development systems is ISO 9001:2000 certified.

Worldwide Sales and Service

AMERICAS

Corporate Office
2355 West Chandler Blvd.
Chandler, AZ 85224-6199
Tel: 480-792-7200
Fax: 480-792-7277
Technical Support:
http://www.microchip.com/support
Web Address:
www.microchip.com

Atlanta
Duluth, GA
Tel: 678-957-9614
Fax: 678-957-1455

Austin, TX
Tel: 512-257-3370

Boston
Westborough, MA
Tel: 774-760-0087
Fax: 774-760-0088

Chicago
Itasca, IL
Tel: 630-285-0071
Fax: 630-285-0075

Cleveland
Independence, OH
Tel: 216-447-0464
Fax: 216-447-0643

Dallas
Addison, TX
Tel: 972-818-7423
Fax: 972-818-2924

Detroit
Novi, MI
Tel: 248-848-4000

Houston, TX
Tel: 281-894-5983

Indianapolis
Noblesville, IN
Tel: 317-773-8323
Fax: 317-773-5453

Los Angeles
Mission Viejo, CA
Tel: 949-462-9523
Fax: 949-462-9608

New York, NY
Tel: 631-435-6000

San Jose, CA
Tel: 408-735-9110

Canada - Toronto
Tel: 905-673-0699
Fax: 905-673-6509

ASIA/PACIFIC

Asia Pacific Office
Suites 3707-14, 37th Floor
Tower 6, The Gateway
Harbour City, Kowloon

Hong Kong
Tel: 852-2943-5100
Fax: 852-2401-3431

Australia - Sydney
Tel: 61-2-9868-6733
Fax: 61-2-9868-6755

China - Beijing
Tel: 86-10-8569-7000
Fax: 86-10-8528-2104

China - Chengdu
Tel: 86-28-8665-5511
Fax: 86-28-8665-7889

China - Chongqing
Tel: 86-23-8980-9588
Fax: 86-23-8980-9500

China - Dongguan
Tel: 86-769-8702-9880

China - Hangzhou
Tel: 86-571-8792-8115
Fax: 86-571-8792-8116

China - Hong Kong SAR
Tel: 852-2943-5100
Fax: 852-2401-3431

China - Nanjing
Tel: 86-25-8473-2460
Fax: 86-25-8473-2470

China - Qingdao
Tel: 86-532-8502-7355
Fax: 86-532-8502-7205

China - Shanghai
Tel: 86-21-5407-5533
Fax: 86-21-5407-5066

China - Shenyang
Tel: 86-24-2334-2829
Fax: 86-24-2334-2393

China - Shenzhen
Tel: 86-755-8864-2200
Fax: 86-755-8203-1760

China - Wuhan
Tel: 86-27-5980-5300
Fax: 86-27-5980-5118

China - Xian
Tel: 86-29-8833-7252
Fax: 86-29-8833-7256

ASIA/PACIFIC

China - Xiamen
Tel: 86-592-2388138
Fax: 86-592-2388130

China - Zhuhai
Tel: 86-756-3210040
Fax: 86-756-3210049

India - Bangalore
Tel: 91-80-3090-4444
Fax: 91-80-3090-4123

India - New Delhi
Tel: 91-11-4160-8631
Fax: 91-11-4160-8632

India - Pune
Tel: 91-20-3019-1500

Japan - Osaka
Tel: 81-6-6152-7160
Fax: 81-6-6152-9310

Japan - Tokyo
Tel: 81-3-6880- 3770
Fax: 81-3-6880-3771

Korea - Daegu
Tel: 82-53-744-4301
Fax: 82-53-744-4302

Korea - Seoul
Tel: 82-2-554-7200
Fax: 82-2-558-5932 or
82-2-558-5934

Malaysia - Kuala Lumpur
Tel: 60-3-6201-9857
Fax: 60-3-6201-9859

Malaysia - Penang
Tel: 60-4-227-8870
Fax: 60-4-227-4068

Philippines - Manila
Tel: 63-2-634-9065
Fax: 63-2-634-9069

Singapore
Tel: 65-6334-8870
Fax: 65-6334-8850

Taiwan - Hsin Chu
Tel: 886-3-5778-366
Fax: 886-3-5770-955

Taiwan - Kaohsiung
Tel: 886-7-213-7828

Taiwan - Taipei
Tel: 886-2-2508-8600
Fax: 886-2-2508-0102

Thailand - Bangkok
Tel: 66-2-694-1351
Fax: 66-2-694-1350

EUROPE

Austria - Wels
Tel: 43-7242-2244-39
Fax: 43-7242-2244-393

Denmark - Copenhagen
Tel: 45-4450-2828
Fax: 45-4485-2829

France - Paris
Tel: 33-1-69-53-63-20
Fax: 33-1-69-30-90-79

Germany - Dusseldorf
Tel: 49-2129-3766400

Germany - Karlsruhe
Tel: 49-721-625370

Germany - Munich
Tel: 49-89-627-144-0
Fax: 49-89-627-144-44

Italy - Milan
Tel: 39-0331-742611
Fax: 39-0331-466781

Italy - Venice
Tel: 39-049-7625286

Netherlands - Drunen
Tel: 31-416-690399
Fax: 31-416-690340

Poland - Warsaw
Tel: 48-22-3325737

Spain - Madrid
Tel: 34-91-708-08-90
Fax: 34-91-708-08-91

Sweden - Stockholm
Tel: 46-8-5090-4654

UK - Wokingham
Tel: 44-118-921-5800
Fax: 44-118-921-5820

07/14/15

© 2015 Microchip Technology Inc.