



MRF24WB0MA/MRF24WB0MB

Data Sheet

2.4 GHz, IEEE Std. 802.11b™
RF Transceiver Module

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MICROCHIP

MRF24WB0MA/MRF24WB0MB

MRF24WB0MA/MRF24WB0MB Data Sheet
2.4 GHz IEEE Std. 802.11b™

Features:

- IEEE Std. 802.11-compliant RF Transceiver
- Serialized unique MAC address
- Data Rate: 1 and 2 Mbps
- IEEE Std. 802.11b/g/n compatible
- Small size: 21mm x 31mm 36-pin Surface Mount Module
- Integrated PCB antenna (MRF24WB0MA)
- External antenna option (MRF24WB0MB) with ultra miniature coaxial (U.FL) connector
- Range: up to 400m (1300 ft.)
- Easy integration into final product – accelerates product development, provides quicker time to market
- Radio regulation certification for United States (FCC), Canada (IC), Europe (ETSI) and Japan (ARIB)
- Wi-Fi® certified (WFA ID: WFA7150)
- Designed for use with Microchip microcontroller families (PIC18, PIC24, dsPIC33, and PIC32) with downloadable Microchip TCP/IP Stack

Operational:

- Single operating voltage: 2.7V-3.6V (3.3V typical)
- Temperature Range: 0° C to +70° C Commercial
- Simple, four-wire SPI interface with interrupt
- Low-current consumption:
 - RX mode – 85 mA (typical)
 - TX mode – 154 mA (+10 dBm typical)
 - Sleep – 250 µA (typical)
 - Hibernate – <0.1 µA (typical)

RF/Analog Features:

- ISM Band 2.400-2.483.5 GHz operation
- 14 Channels selectable individually or domain-restricted
- DSSS Modulation
- Data Rate – 1000 kbps
- -91 dBm Typical sensitivity at 1 Mbps
- +10 dBm Typical output power with control
- Integrated low phase noise VCO, RF frequency synthesizer, PLL loop filter and PA
- Digital VCO and filter calibration

- Integrated RSSI ADC and I/Q DACs, RSSI readings available to host
- Balanced receiver and transmitter characteristics for low power consumption

MAC/Baseband Features:

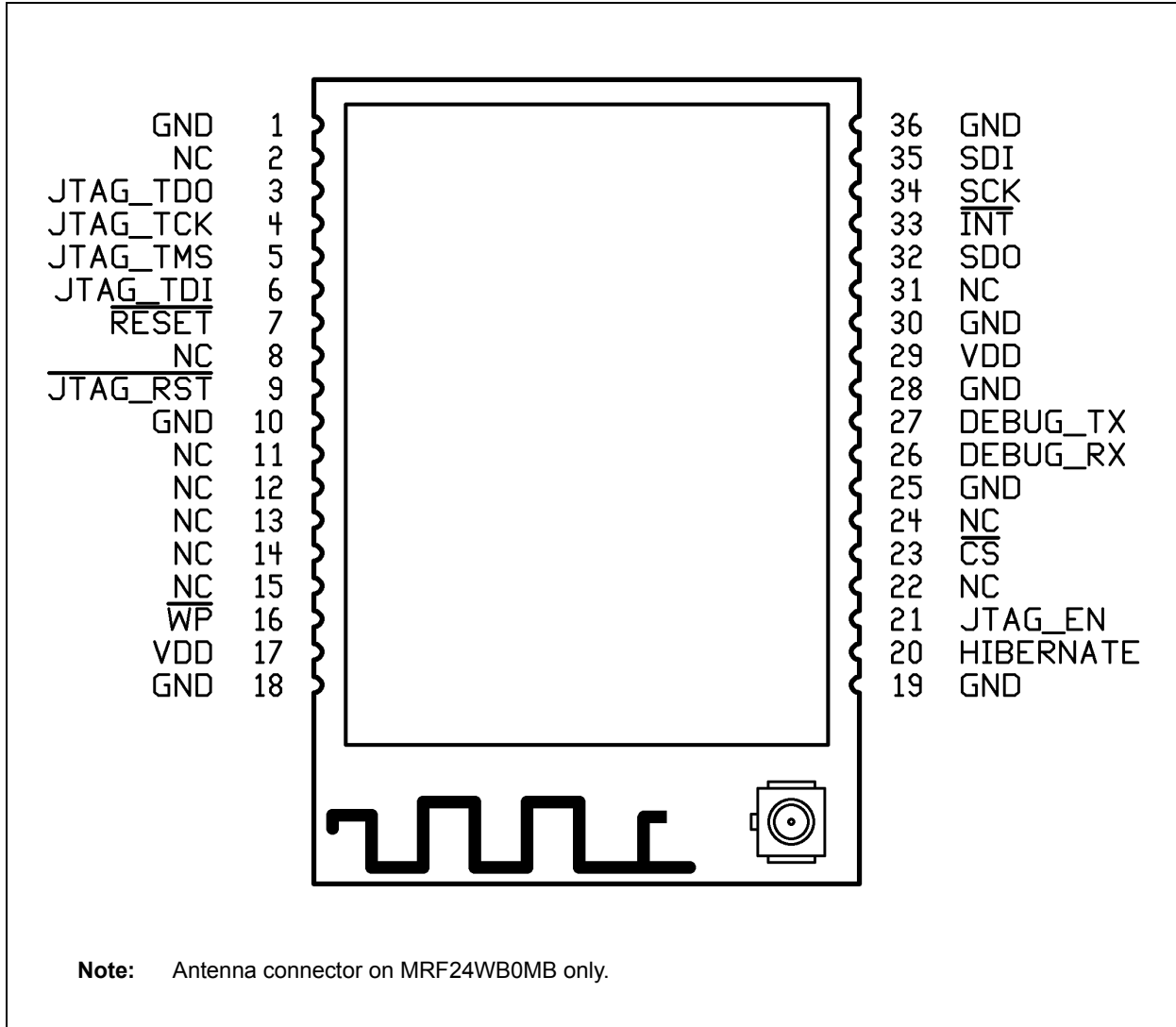
- Hardware CSMA/CA access control, automatic ACK, and FCS creation and checking
- Automatic MAC packet retransmit
- Hardware Security Engine for AES and RC4-based ciphers
- Supports 802.1x, 802.1i security: WEP, WPA-PSK, and WPA-2-PSK.

Applications:

- Utility and Smart Energy
 - Thermostats
 - Smart Meters
 - White Goods
 - HVAC
- Consumer Electronics
 - Remote Control
 - Internet Radio
 - Home Security
 - Toys
- Industrial Controls
 - Chemical Sensors
 - HVAC
 - Security Systems
 - M2M Communication
- Remote Device Management
 - Location and Asset Tracking
 - Automotive
 - Code Update
- Retail
 - POS Terminals
 - Wireless Price Tags
 - Digital Remote
- Medical, Fitness, and Healthcare
 - Glucose Meters
 - Fitness Equipment
 - Patient Asset Tracking

MRF24WB0MA/MRF24WB0MB

Pin Diagram



MRF24WB0MA/MRF24WB0MB

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MRF24WB0MA/MRF24WB0MB

NOTES:

MRF24WB0MA/MRF24WB0MB

1.0 DEVICES OVERVIEW

The MRF24WB0MA and MRF24WB0MB are low-power, 2.4 GHz, IEEE Std. 802.11-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 AES, and TKIP (WEP, WPA, WPA2 security). The integrated module design frees the designer from RF and antenna design tasks and regulatory compliance testing, ultimately providing quicker time to market.

The MRF24WB0MA module is approved for use with the integrated PCB meander antenna.

The MRF24WB0MB comes with an ultra miniature coaxial connector (U.FL) and is approved for use with a list of pre-certified antennas. See **Section 2.8 “External Antenna”**, for specific recommendations.

The MRF24WB0MA/MRF24WB0MB modules are designed to be used with Microchip’s TCP/IP software stack. The software stack has an integrated driver that implements the API that is used in the modules for command and control, and for management and data packet traffic.

The Microchip TCP/IP software stack is available in the free *Microchip Application Libraries* download (including example applications and source code) from the Microchip web site, <http://www.microchip.com/wireless>

The combination of the module and a PIC running the TCP/IP stack results in support for IEEE Standard 802.11 and IP services. This allows, for example, the immediate implementation of a wireless web server.

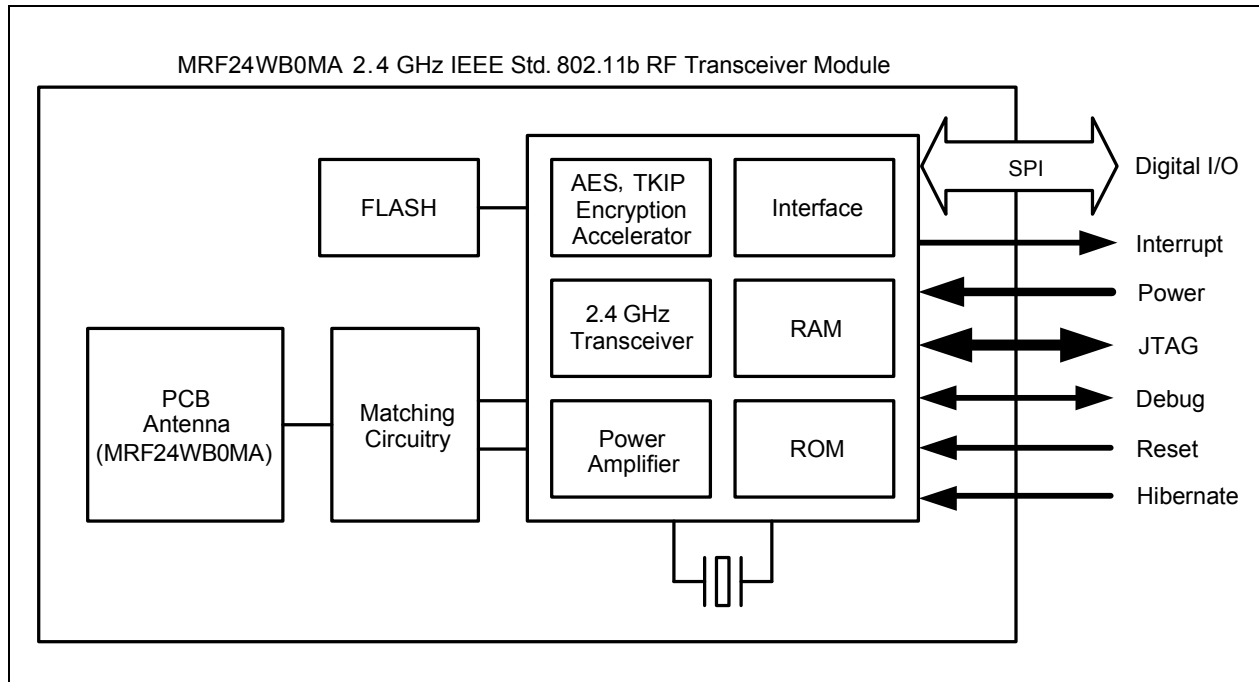
The MRF24WB0MA/MRF24WB0MB modules have received regulatory approvals for modular devices in the United States (FCC), Canada (IC), and Europe (ETSI). The modular approval removes the need for expensive RF and antenna design, and allows the end user to place the modules inside a finished product and not require regulatory testing for an intentional radiator (RF transmitter). They also have Radio Type Approval Certification for Japan. See **Section 3.0 “Regulatory Approval”**, for the specific requirements that should be adhered to by the integrator.

1.1 Interface Description

The block diagram in Figure 1-1 represents a MRF24WB0MA/MRF24WB0MB module. It interfaces to a Microchip PIC18, PIC24, dsPIC33, or PIC32 micro-controllers via a four-wire serial slave SPI interface – interrupt, hibernate, Reset, power and ground signals. The module runs on a single supply voltage of nominally 3.3v. It also supports optional JTAG and serial debug for testability. The debug port operates at 3.3v and requires a level shifter for operation with RS-232 devices. Figure 1-2 shows a simplified example connection between a Microchip PIC MCU and the module. Table 1-1 lists the pin descriptions.

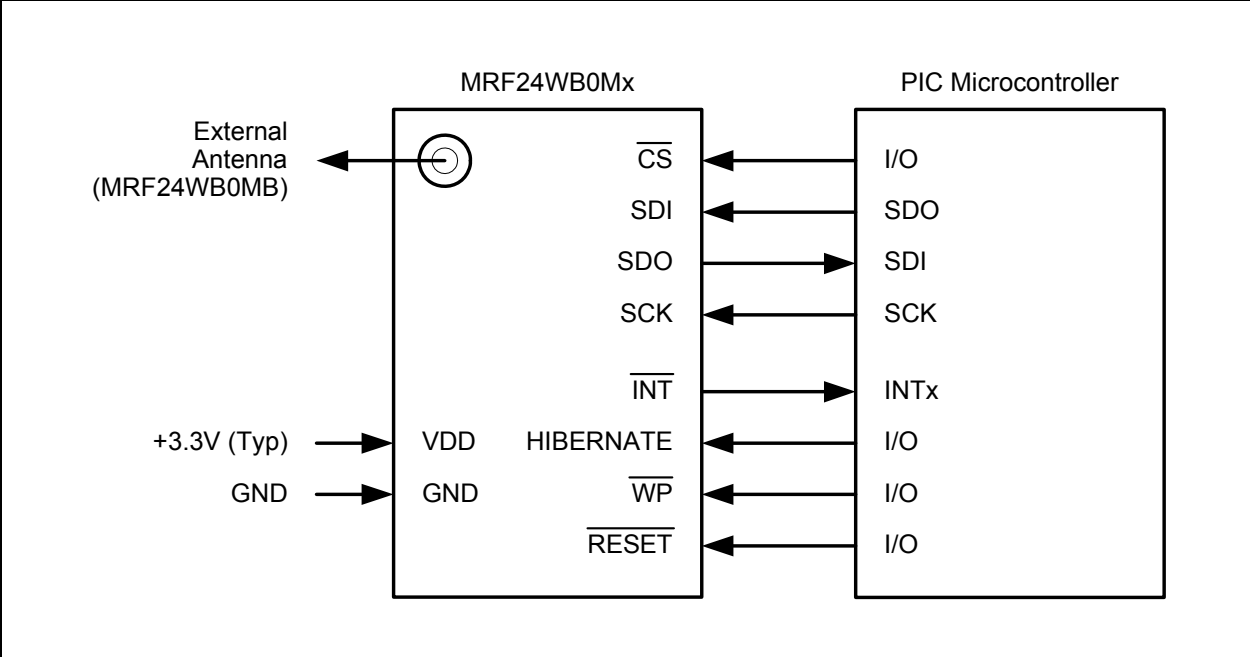
Data communications with the MRF24WB0MA/MRF24WB0MB are through the SPI interface that is detailed in **Section 2.0 “Circuit Description”**. The Microchip PIC microcontroller communicates with the module via a command API from within the Microchip TCP/IP stack. The command API is detailed in the Microchip TCP/IP Stack online help that is included in the free *Microchip Application Libraries* download.

FIGURE 1-1: MRF24WB0MA/MRF24WB0MB BLOCK DIAGRAM



MRF24WB0MA/MRF24WB0MB

FIGURE 1-2: MICROCONTROLLER TO MRF24WB0MA/MRF24WB0MB INTERFACE



MRF24WB0MA/MRF24WB0MB

TABLE 1-1: Pin Description

Pin	Symbol	Type	Description
1	GND	P	Ground
2	NC	NC	Do not connect
3	JTAGTDO	O	JTAG test data output
4	JTAGTCK	I: Constant ⁽¹⁾	JTAG clock input
5	JTAGTMS	I	JTAG mode input
6	JTAGTDI	I	JTAG test data input
7	$\overline{\text{RESET}}$	I: Constant ⁽¹⁾	Module Reset input
8	NC	NC	Do not connect
9	$\overline{\text{JTAGRST}}$	I	JTAG Reset input (optional; see Section 2.0)
10	GND	P	Ground
11	NC	NC	Do not connect
12	NC	NC	Do not connect
13	NC	NC	Do not connect
14	NC	NC	Do not connect
15	NC	NC	Do not connect
16	$\overline{\text{WP}}^{(2)}$	I	Write protect (this pin is used to enable FLASH update)
17	VDD	P	Power
18	GND	P	Ground
19	GND	P	Ground
20	HIBERNATE	I	Hibernate mode enable (high input will disable the module)
21	JTAGEN	I	JTAG test enable
22	NC	NC	Do not connect
23	$\overline{\text{CS}}$	I	SPI Chip Select input
24	NC	NC	Do not connect
25	GND	P	Ground
26	DEBUGRX	I	Serial debug port input (see Section 2.0)
27	DEBUTX	O	Serial debug port output (see Section 2.0)
28	GND	P	Ground
29	VDD	P	Power
30	GND	P	Ground
31	NC	NC	Do not connect
32	SDO	O	SPI data out
33	$\overline{\text{INT}}$	O	Interrupt output (open drain – requires a pull-up)
34	SCK	I	SPI clock input
35	SDI	I	SPI data in
36	GND	P	Ground

Legend: Pin type abbreviation: P = Power input, I = Input, O = Output, NC = Do Not Connect

Note 1: Signals of Type “I: Constant” must either be constantly driven by the host or have a pull-up or pull-down (in case the host is likely to tri-state the signal during power down modes). The constant drive is used to ensure defined operation of the part and to minimize leakage current during low power modes.

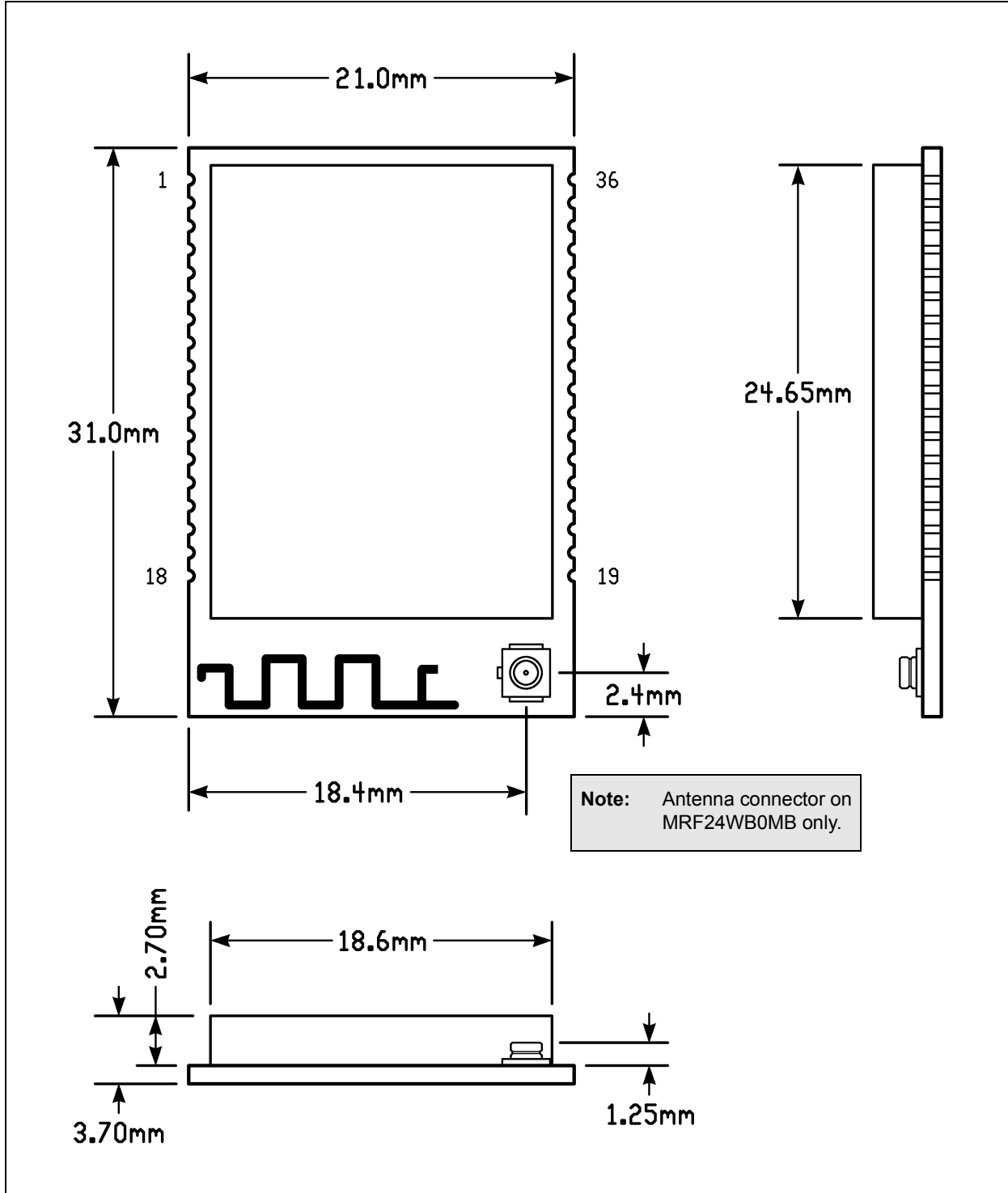
2: $\overline{\text{WP}}$ is used as write-protect for the internal module SPI Flash. For production use, this pin should be pulled low. For end application, this pin can be controlled by the host microcontroller to enable in field Flash updates.

MRF24WB0MA/MRF24WB0MB

1.2 Mounting Details

The MRF24WB0MA/MRF24WB0MB is a surface mountable module. Module dimensions are shown in Figure 1-3. The module Printed Circuit Board (PCB) is 1 mm thick with castellated mounting points on two sides.

FIGURE 1-3: MRF24WB0MA/MRF24WB0MB MODULE PHYSICAL DIMENSIONS



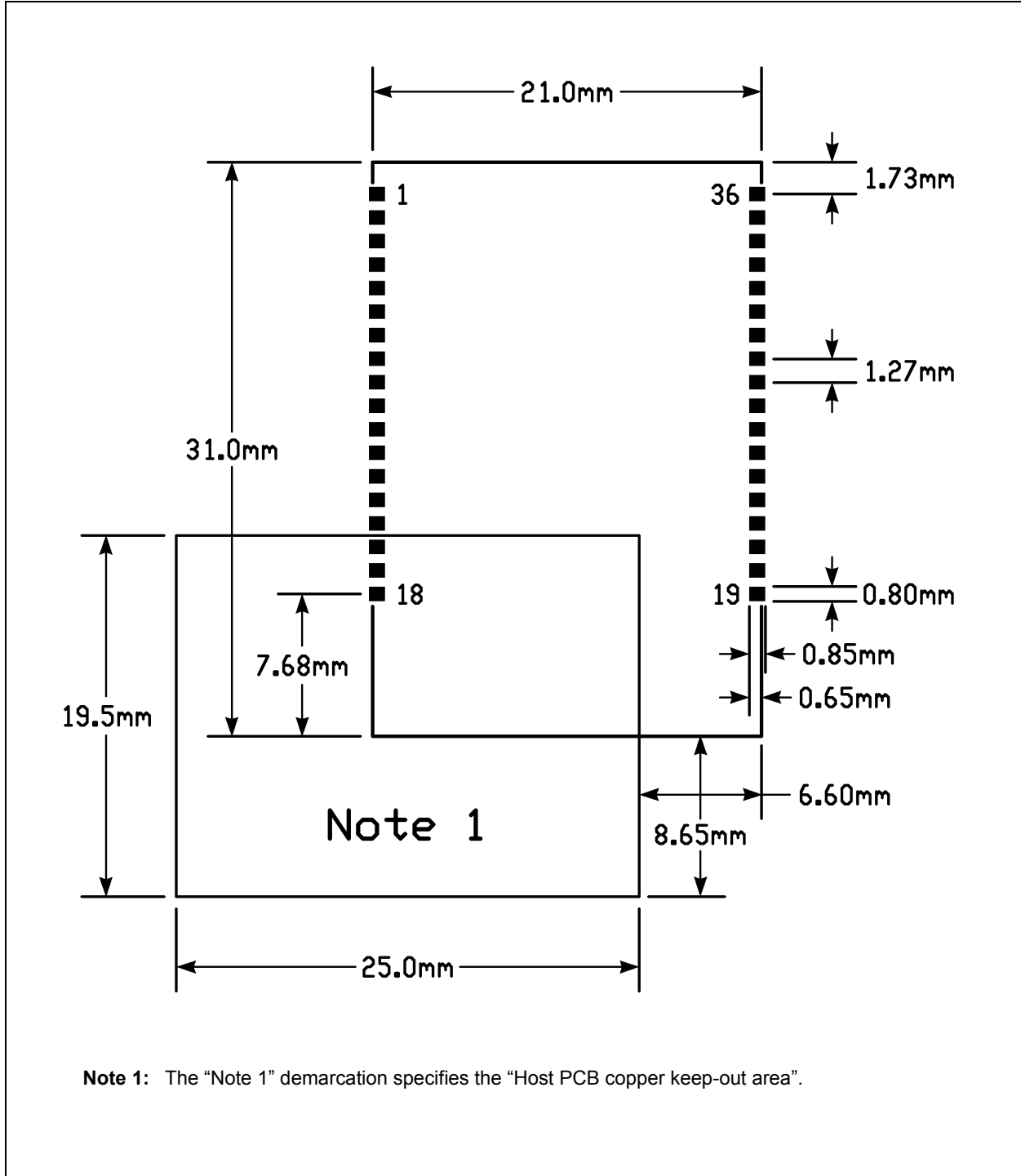
MRF24WB0MA/MRF24WB0MB

Figure 1-4 shows the recommended host PCB footprint for the module.

The MRF24WB0MA has an integrated PCB antenna. For best performance, follow the mounting details shown in Figure 1-4.

For best performance, mount the module on the edge of the host PCB with the antenna pattern facing outward.

FIGURE 1-4: RECOMMENDED PCB FOOTPRINT



MRF24WB0MA/MRF24WB0MB

Figure 1-5 illustrates the module reflow profile that is recommended for mounting the device onto the host PCB.

FIGURE 1-5: RECOMMENDED MODULE REFLOW PROFILE AND SETPOINTS

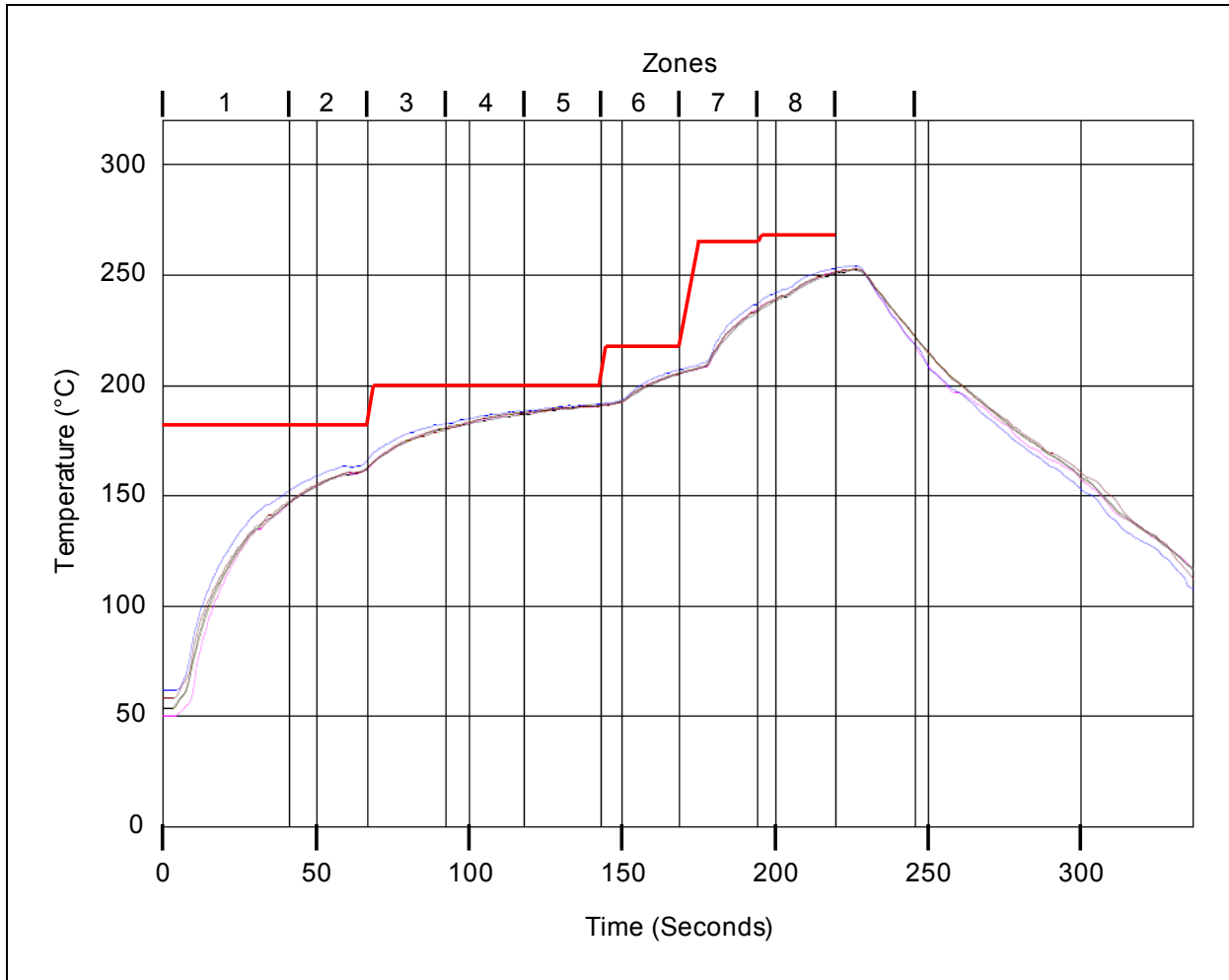


TABLE 1-2: MODULE REFLOW PROFILE⁽¹⁾

Zone	1	2	3	4	5	6	7	8
Temperature (°C)	180°	180°	200°	200°	200°	220°	265°	270°

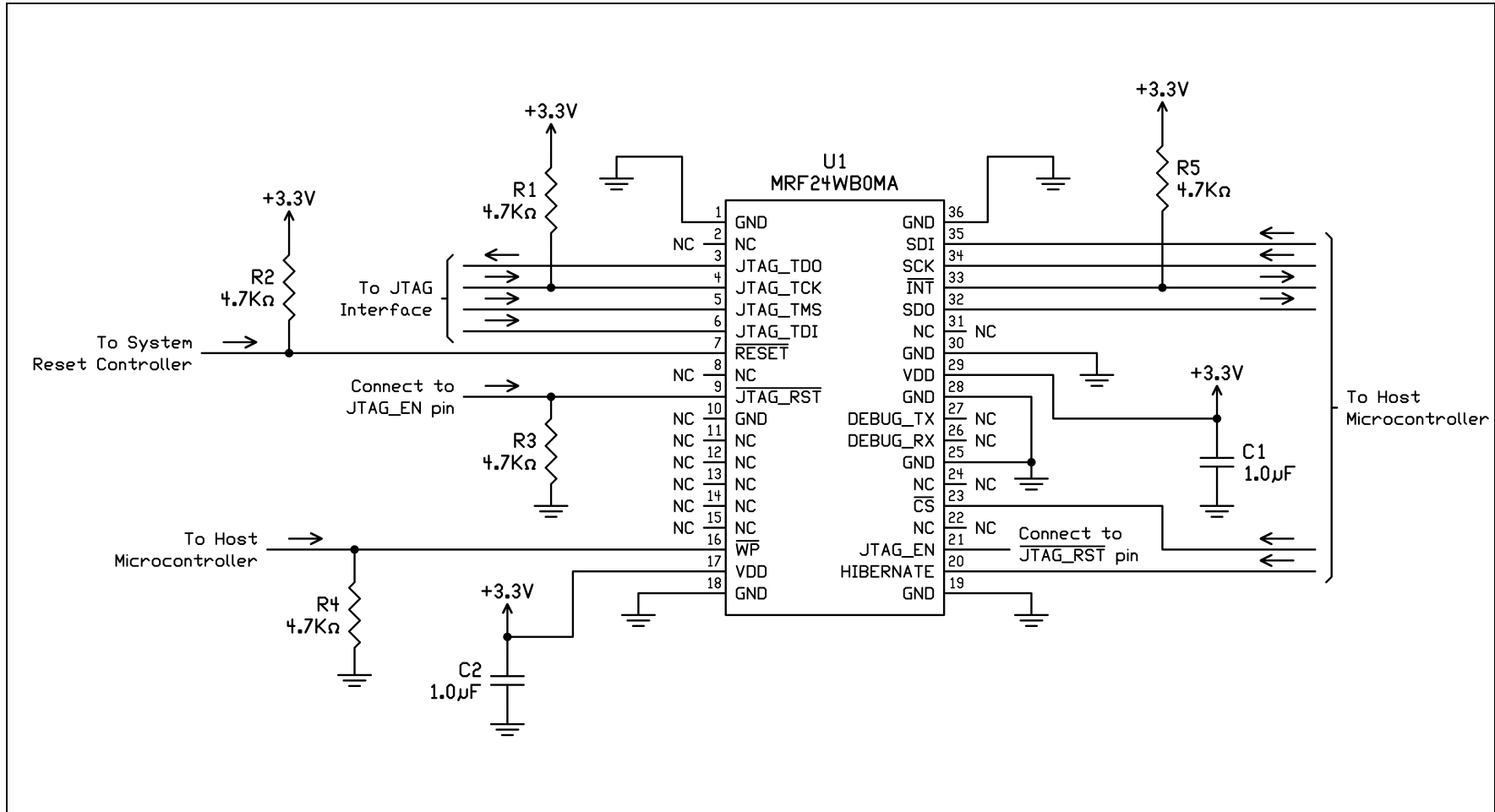
Note 1: Conveyor Speed: 90 cm/min

2.0 CIRCUIT DESCRIPTION

The MRF24WB0MA/MRF24WB0MB interfaces to Microchip PIC18, PIC24, dsPIC33, and PIC32 microprocessors with a minimal of external components through digital-only connections. This section details use of the module, starting with an example host connection as shown in Figure 2-1.

2.1 Schematic

FIGURE 2-1: MRF24WB0MA/MRF24WB0MB EXAMPLE APPLICATION SCHEMATIC



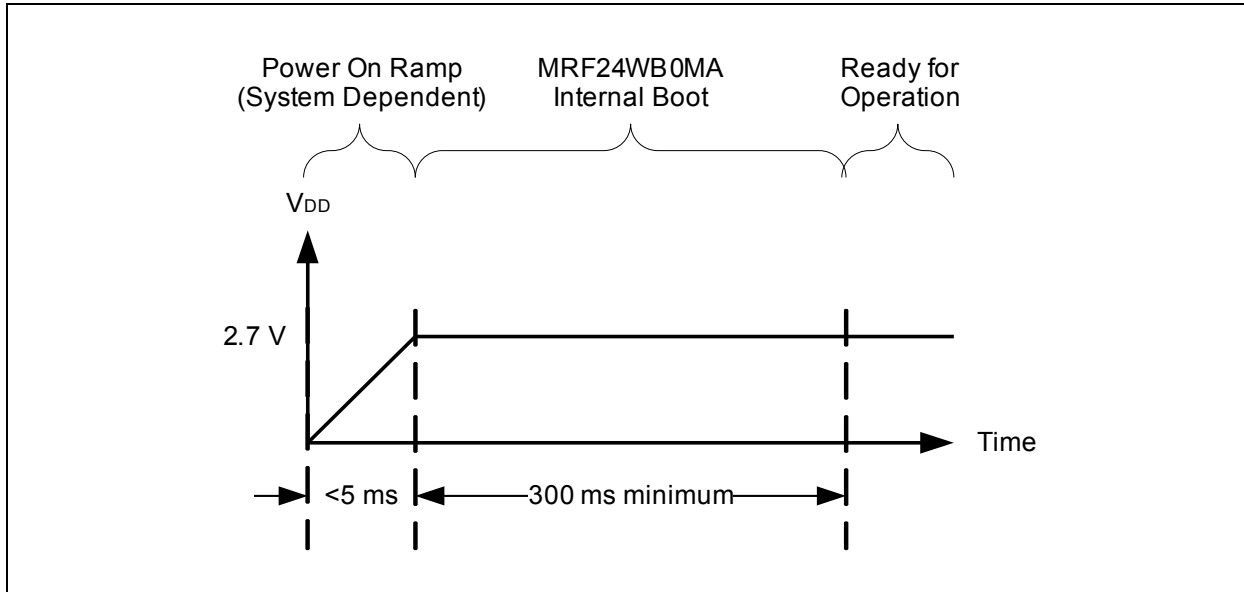
MRF24WB0MA/MRF24WB0MB

2.2 Power-On Sequence

The internal regulators for the digital and analog core power supplies are enabled by driving the HIBERNATE pin high. Figure 2-2 shows the waveforms for the core supplies when powering up the MRF24WB0MA/MRF24WB0MB with a nominal 3.3V applied to VDD.

There is an internal Power-on-Reset (POR) detect which starts the boot sequence from the internal ROM when the core is powered. After approximately 300 ms from when the VDD supply is within specification, the MRF24WB0MA/MRF24WB0MB is ready for operation.

FIGURE 2-2: MRF24WB0MA/MRF24WB0MB POWER-ON SEQUENCE TIMING



2.3 Power States

The MRF24WB0MA/MRF24WB0MB has several power states. These are Hibernate, Sleep and Active (two sub-states), as shown in Figure 2-3. The selection of power state directly affects system behavior, as well as overall power consumption or battery life. There is also a “Standby” state that is not user-controlled.

2.3.1 HIBERNATE STATE

An “Off” state is defined as no power applied to the device. The Hibernate mode is the closest to controlled off that the module can approach. It is controlled via the HIBERNATE pin (high input puts the module into Hibernate). When in Hibernate, the module only consumes leakage current, but does not maintain state. Hibernate has to be fully controlled by the PIC MCU and requires the TCP/IP stack to restart on an awake. This state provides the best battery life for embedded products. Note that entering Hibernate for intervals of less than 30 seconds is not likely to save power. Battery life expectation can be more than a year for devices operating on AA cells that would be in Hibernate except to wake up every hour for a small data transfer (<math>< 500\text{ Bytes}</math>).

2.3.2 SLEEP STATE

The Sleep state is a low power dynamic state that automatically implements the 802.11 Power Save feature. In this mode, if enabled, the module will enter power save mode when all activity is complete.

The module will wake autonomously to any PIC intervention so it can check DTIM beacons from the Access Point. If any traffic is listed as queued for the module, then it will awaken and get the data from the Access Point on the next possible opportunity. When data is acquired, the module will interrupt the PIC microcontroller on a normal “data available” indication. If no data is available on a DTIM check, the module reenters the Power Save state until the next DTIM. The DTIM interval is programmed at the Access Point. This state can provide “as if on” behavior of the radio with a significant power savings versus “always on”. The battery life expectation of this mode is several days to several weeks. This mode is characterized by a very low latency (as low as 200 mS) to transfer data from the low power state.

2.3.3 ACTIVE STATE

The Active state is identified as one of two states where the radio circuitry is fully on. There is the Receive state (RX ON) and the Transmit state (TX ON).

MRF24WB0MA/MRF24WB0MB

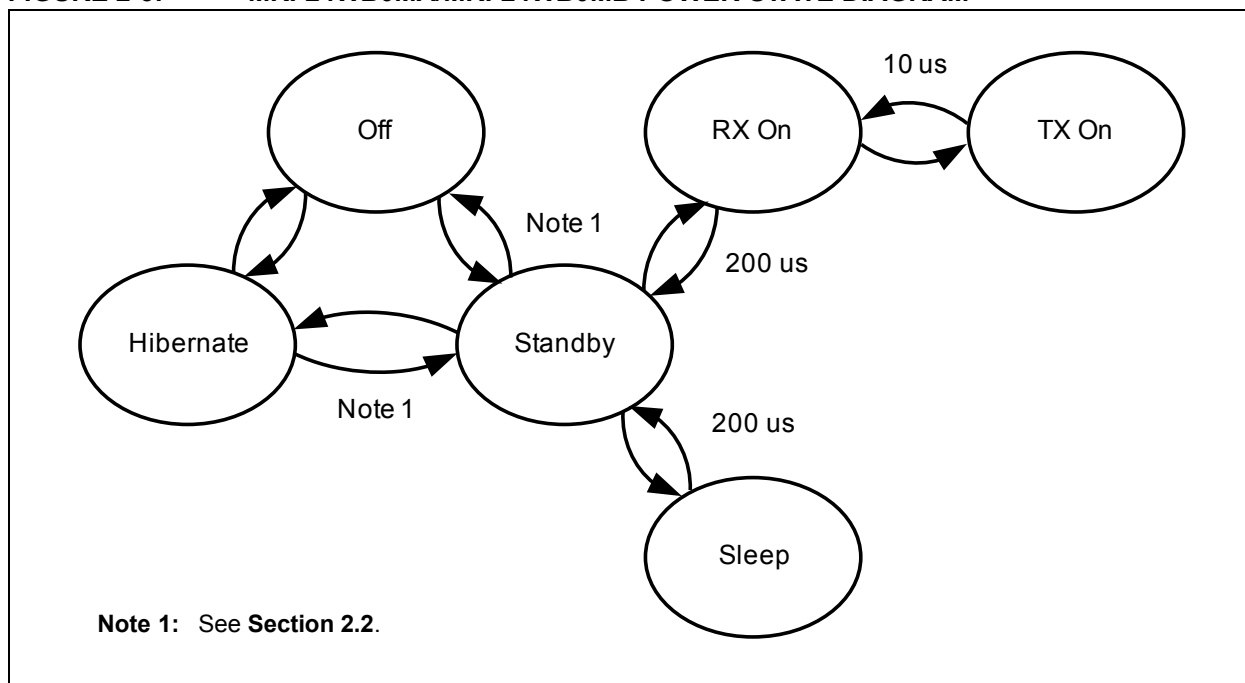
2.3.4 STANDBY STATE

The Standby state is not user-controlled but is noted as it helps identify and track certain operations of the module during power tracing.

TABLE 2-1: MRF24WB0MA/MRF24WB0MB POWER STATE DEFINITIONS

State	VDD	$\overline{\text{CS}}$	Description
Off	0V	0V	Power is completely disconnected
Hibernate	3.3V	3.3V	All internal power regulators are OFF – enabled by HIBERNATE pin
Sleep	3.3V	0V	Enabled by TCPIP driver
RX ON	3.3V	0V	Receive circuits are on and receiving
TX ON	3.3V	0V	Transmit circuits are on and transmitting
Standby	3.3V	0V	State machine transition state only – not user controlled

FIGURE 2-3: MRF24WB0MA/MRF24WB0MB POWER-STATE DIAGRAM



2.4 JTAG Interface

Joint Test Action Group (JTAG) is the common name used for the IEEE 1149.1 standard entitled *Standard Test Access Port and Boundary-Scan Architecture* for test access ports that are used for testing printed circuit boards using boundary scan. The MRF24WB0MA/MRF24WB0MB supports JTAG boundary scan. The JTAG port provides the optional hardware JTAG Reset input, JTAGRST. JTAG_EN and JTAGRST need to be driven high to enable JTAG mode. JTAG should not be enabled during normal functional operation. This function affects power state current.

2.5 Debug Serial Interface

The MRF24WB0MA/MRF24WB0MB incorporates a Transmitted Data pin (DEBUGTX) and a Received Data pin (DEBUGRX) for serial debugging purposes. These pins can be connected to commercially available RS-232 line drivers/receivers with appropriate external level shifters. The serial interface is fully tested at 115200 bits/seconds with RS-232/UART interface applications.

MRF24WB0MA/MRF24WB0MB

2.6 SPI Interface

The slave Serial Peripheral Interface (SPI) is used to interface with the host PIC microcontroller. The slave SPI interface works with the Interrupt line ($\overline{\text{INT}}$). When data is available for the PIC microcontroller during operation, the $\overline{\text{INT}}$ line is asserted low by the MRF24WB0MA/MRF24WB0MB module. The $\overline{\text{INT}}$ line is de-asserted high by the MRF24WB0MA/MRF24WB0MB after the data is transferred to the host PIC microcontroller. The SPI SCK speed can be up to 25 MHz.

The slave SPI interface implements the [CPOL=0; CPHA=0] and [CPOL=0; CPHA=1] modes (0 and 3) of operation. That is, data is clocked in on the first rising edge of the clock after Chip Select ($\overline{\text{CS}}$) is asserted.

Data is placed on the bus with most significant bit (MSb) first and least significant bit (LSb) last.

Figure 4-1 in **Section 4.0 “Electrical Characteristics”** shows the SPI timing diagram. Table 4-7 details the SPI timing AC characteristics.

2.7 PCB Antenna

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 1-4.

The antenna patterns shown in the following plots, designated as Figure 2-4, Figure 2-5 and Figure 2-6, refer to three separate axis of measurement that correspond to the orientation of the module (drawn in the center of each plot).

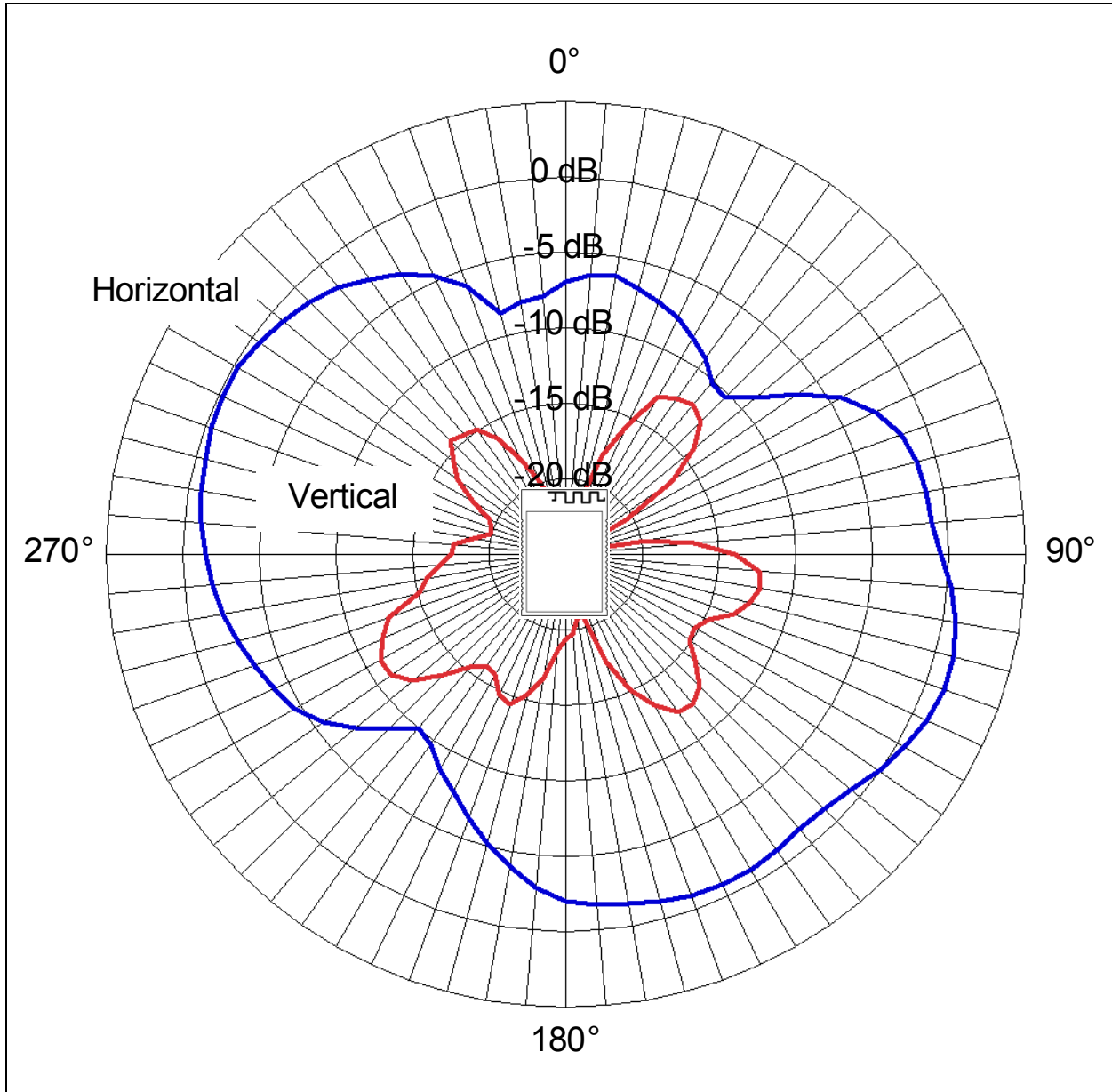
The horizontal and vertical data, blue and red respectively, in each plot correspond to the orientation (polarization) of the measurement antenna rotated 360 degrees around the module.

The horizontal measurement was done with the receive antenna parallel with the module PCB. The vertical measurement was done perpendicular to the module PCB.

These patterns allow the designer to understand the performance of the module with respect to the position of the receive/transmit antenna at the other end of the link. Figure 2-4, Figure 2-5 and Figure 2-6 show the simulated radiation patterns expected from the PCB antenna.

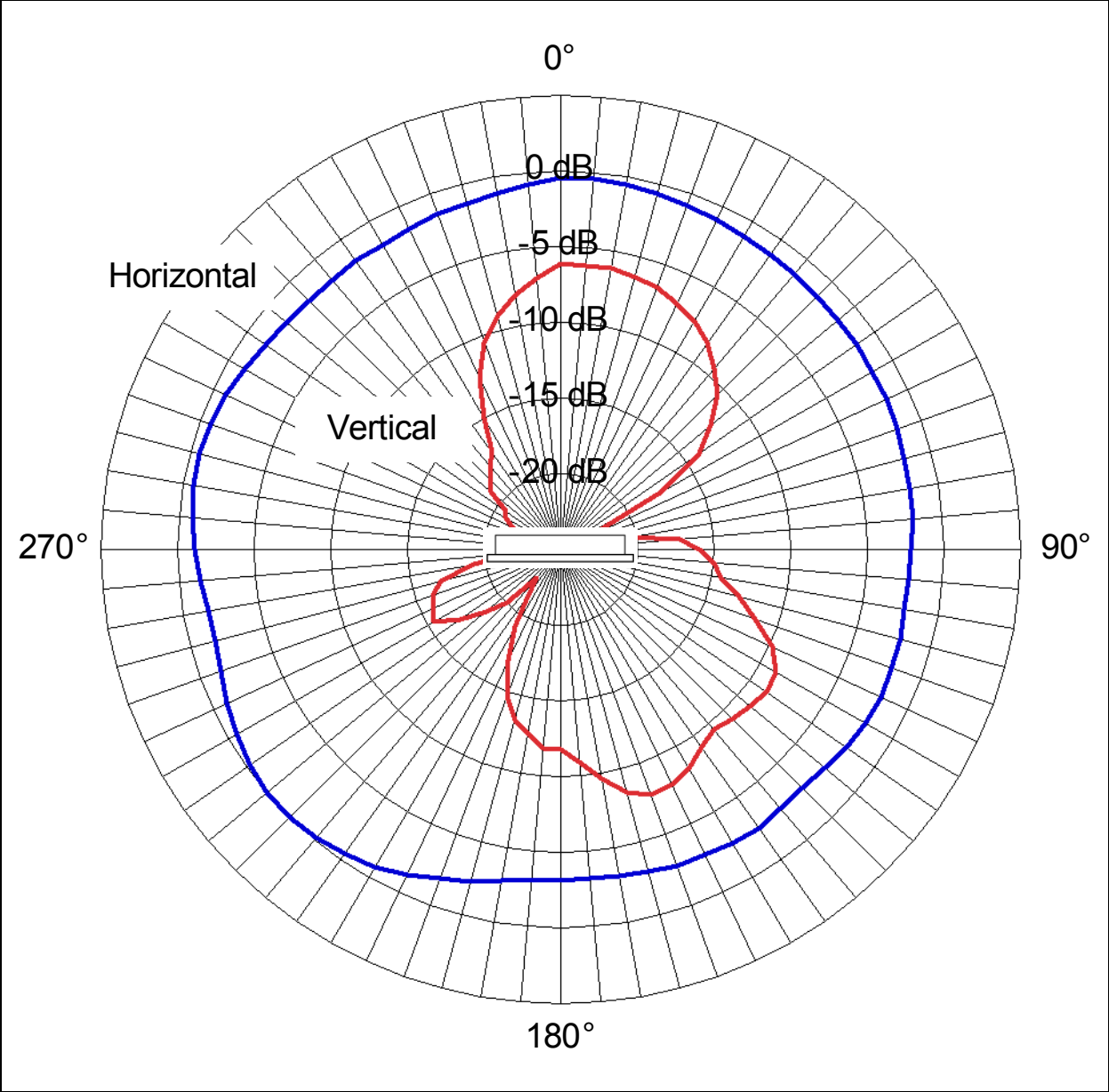
MRF24WB0MA/MRF24WB0MB

FIGURE 2-4: AZIMUTH RADIATION PATTERN, 2.44GHZ



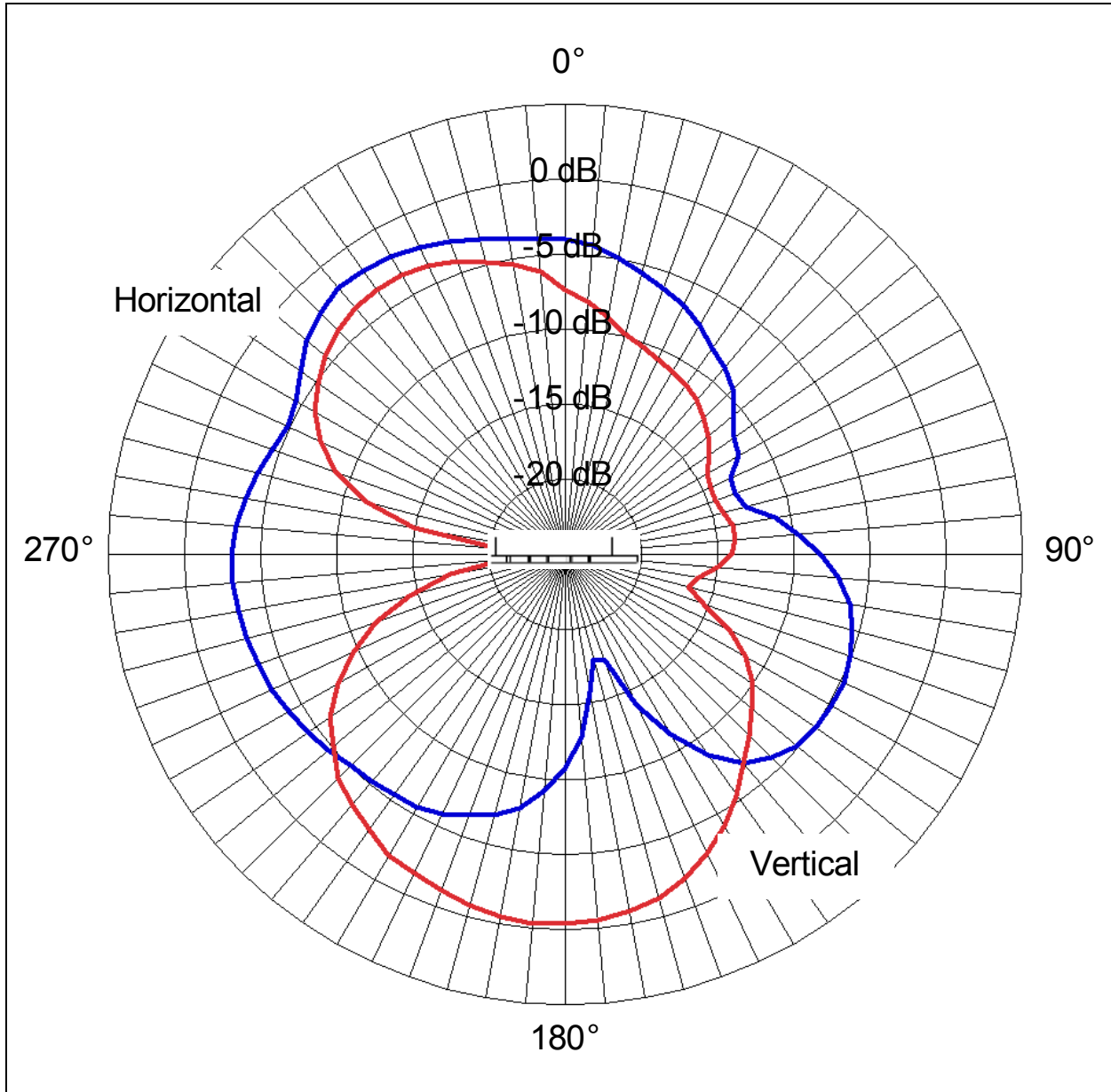
MRF24WB0MA/MRF24WB0MB

FIGURE 2-5: RADIATION PATTERN ON SIDE WITH PCB ANTENNA, 2.44GHZ



MRF24WB0MA/MRF24WB0MB

FIGURE 2-6: RADIATION PATTERN ALONG PIN EDGE, 2.44GHZ



MRF24WB0MA/MRF24WB0MB

2.8 External Antenna

The MRF24WB0MB has been regulatory certified for use with a number of antennas. The modular certifications hold only if the following antennas, or antennas that are materially and functionally equivalent, are used. All antennas connect to the module via an ultra miniature coaxial (U.FL or IPEX) connector.

A list of antennas for use with the module is provided in Table 2-2.

TABLE 2-2: LIST OF CERTIFIED EXTERNAL ANTENNAS

Part Number	Type	Gain (dBi)	VSWR Max.	Connector	Vendor
RFA-02-P05	PCB	2	2.0	IPEX	Aristotle
RFA-02-L6H1-70-35	Dipole	2	2.0	IPEX	Aristotle
RFA-02-D3	Dipole	1.5	2.0	IPEX	Aristotle
RFA-02-L2H1	Dipole	2	2.0	IPEX	Aristotle
RFA-02-3-C5H1	Dipole	3	2.0	IPEX	Aristotle
RFA-02-5-C7H1	Dipole	5	2.0	IPEX	Aristotle
RFA-02-5-F7H1	Dipole	5	2.0	IPEX	Aristotle
WF2400-15001A	Dipole	5	2.0	IPEX	Saytec
WF2400-15001AR	Dipole	5	2.0	RF-IPEX	Saytec
WF2400-10001I	Dipole	2	2.0	IPEX	Saytec
WF2400-10001R	Dipole	2	2.0	RF-IPEX	Saytec
AN2400-5901RS, used with connector SMASFR8-3152H-00X00I	Omni	9	2.0	IPEX	Saytec
AN2400-5901RS, used with connector SMASFR8-3152H-00X00IR	Omni	9	2.0	RF-IPEX	Saytec

MRF24WB0MA/MRF24WB0MB

3.0 REGULATORY APPROVAL

The MRF24WB0MA/MRF24WB0MB module has received regulatory approvals for modular devices in the United States, Canada and European countries. Modular approval allows the end user to place the MRF24WB0MA/MRF24WB0MB module inside a finished product and not require regulatory testing for an intentional radiator (RF transmitter), 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 integrator may still be responsible for testing the end product for any additional compliance requirements that become necessary with this module installed (for example: digital device emission, PC peripheral requirements, etc.) in the specific country that the end device will be marketed.

Refer to the specific country radio regulations for details on regulatory compliance.

3.1 United States

The MRF24WB0MA/MRF24WB0MB has received Federal Communications Commission (FCC) CFR47 Telecommunications, Part 15 Subpart C "Intentional Radiators" 15.247 and modular approval in accordance with FCC Public Notice DA 00-1407 Released: June 26, 2000, Part 15 Unlicensed Modular Transmitter Approval. The MRF24WB0MA/MRF24WB0MB module can be integrated into a finished product without obtaining subsequent and separate FCC approvals.

The MRF24WB0MA/MRF24WB0MB 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. The following examples present terminology that could be used:

Contains Transmitter Module FCC ID:
W7OZG2100-ZG2101

or

Contains FCC ID: W7OZG2100-ZG2101

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.

MRF24WB0MA/MRF24WB0MB

3.1.1 RF EXPOSURE

All transmitters regulated by FCC must comply with RF exposure requirements. OET Bulletin 65, *Evaluating Compliance with FCC Guidelines for Human Exposure to Radio Frequency Electromagnetic Fields*, provides assistance 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). The bulletin offers guidelines and suggestions for evaluating compliance.

If appropriate, compliance with exposure guidelines for mobile and unlicensed devices can be accomplished by the use of warning labels and by providing users with information concerning minimum separation distances from transmitting structures and proper installation of antennas.

The following statement must be included as a CAUTION statement in manuals and OEM products to alert users of FCC RF exposure compliance:

To satisfy FCC RF Exposure requirements for mobile and base station transmission devices, a separation distance of 20 cm or more should be maintained between the antenna of this device and persons during operation. To ensure compliance, operation at closer than this distance is not recommended.

The antenna(s) used for this transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

If the MRF24WB0MA/MRF24WB0MB module is used in a portable application (i.e., the antenna is less than 20 cm from persons during operation), the integrator is responsible for performing Specific Absorption Rate (SAR) testing in accordance with FCC rules 2.1091.

3.1.2 HELPFUL WEB SITES

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

3.2 Canada

The MRF24WB0MA/MRF24WB0MB module has been certified for use in Canada under Industry Canada (IC) Radio Standards Specification (RSS) "RSS-210" and "RSS-Gen".

From "Section 7.1.1, RSS-Gen", Issue 2, June 2007, *Modular Transmitter Approval*:

"Host devices which contain separately certified modules do not need to be recertified, provided that they meet the following conditions:

- The host device, as a stand-alone unit without any separately certified modules, complies with all applicable Radio Standards Specifications.
- The host device and all the separately certified modules it contains jointly meet the RF exposure compliance requirements of "RSS-102", if applicable.
- The host device complies with the certification labeling requirements of each of the modules it contains."

The following example demonstrates labeling compliance.

NOTE: Compliance of a module in its final configuration is the responsibility of the applicant. A host device will not be considered certified if the instructions regarding antenna configuration provided in the original description, of one or more separately certified modules it contains, were not followed.

From "Section 5.2, RSS-Gen", Issue 2, June 2007, *Equipment Labels*:

"All Category I radio equipment intended for use in Canada shall permanently display on each transmitter, receiver or inseparable combination thereof, the applicant's name (i.e., manufacturer's name, trade name or brand name), model number and certification number. This information shall be affixed in such a manner as to not be removable except by destruction or defacement. The size of the lettering shall be legible without the aid of magnification, but is not required to be larger than 8-point font size. If the device is too small to meet this condition, the information can be included in the user manual upon agreement with Industry Canada."

The label is shown in the following example:

Contains IC: 8248A-G21ZEROG

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From "Section 7.1.6, RSS-Gen", Issue 2, June 2007, *Digital Circuits*:

"If the device contains digital circuitry that is not directly associated with the radio transmitter, the device shall also have to comply with ICES-003, Class A or B as appropriate, except for ICES-003 labeling requirements. The test data obtained (for the ICES-003 tests) shall be kept by the manufacturer or importer whose name appears on the equipment label, and made available to Industry Canada on request, for as long as the model is being marketed in Canada."

3.2.1 HELPFUL WEB SITES:

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

3.3 Europe

The MRF24WB0MA/MRF24WB0MB module has been certified for use in European countries. The following testing has been completed:

Test standard ETSI EN 300 328 V1.7.1 (2006-10):

- Maximum Transmit Power
- Maximum EIRP Spectral Density
- Frequency Range
- Radiated Emissions

Test standards ETSI EN 301 489-1:2008 and ETSI EN 301 489-17:2008:

- Radiated Emissions
- Electro-Static Discharge
- Radiated RF Susceptibility

The modules are fully compliant with

- Radiated Emissions EN 55022
- Electrostatic Discharge EN 61000-4-2
- Radiated Immunity EN 61000-4-3
- EN 60950-1
- CE-Mark
- RoHS

ETSI does not provide a modular approval similar to the USA (FCC) and Canada (IC). However, the testing completed above can be used as part of the customer's application for certification. The test report data can be included in their test plan and can significantly reduce the lower customer's certification burden.

A helpful 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", downloadable from the European Radio Communications Office (ERO): <http://www.ero.dk>

The end user is responsible for ensuring compliance with harmonized frequencies and labeling requirements for each country in which the end device is marketed and sold.

3.3.1 HELPFUL WEB SITES:

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/>

3.4 Wi-Fi® Alliance

Wi-Fi Alliance Certification focuses on interoperability testing of devices based on 802.11 standards.

Historically, when the certification process and programs were developed by Wi-Fi Alliance members, the vast majority of the 802.11 clients were PC-centric, and certification testing adequately addressed those types of devices. In subsequent years, the number of Wi-Fi devices that are not PC-centric has grown significantly.

These non-standard devices, as a class of products, have been dubbed Application Specific Devices (ASDs) by the Wi-Fi Alliance. ASDs are 802.11 devices, e.g., clients or access points (APs), which cannot be tested under a standard Alliance test plan because they do not comply with the standard test configuration and/or because they are designed to perform a specific application. Examples include, but are not limited to: bar code scanners, pagers, recording devices, monitoring equipment, and cable modems.

The APs or clients that are used to validate ASD compliance (from the standard test bed) will meet all of the requirements specified in the applicable System Interoperability Test Plans (referred to as the "standard test plan"), unless specifically exempted. The MRF24WB0MA and MRF24WB0MB modules are in the ASD category.

The modules are certified under Wi-Fi 802.11 with WPA2, WPA, and WEP System Interoperability ASD Model Test Plan with Test Engine For IEEE 802.11a, b, and g Devices (Version 1.0).

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Per the Wi-Fi Alliance approved ASD test plan, the definition of the Microchip MRF24WB0MA and MRF24WB0MB modular solutions is expressed in the following statements:

“Member Wireless solution is a single-chip 802.11b module including MAC, baseband, RF and power amplifier personal STA. It utilizes a simple to use API for embedded markets, and an OS is not a requirement for operation. It supports 1 and 2 Mbps (TX and RX). It also supports WEP, WPA Personal, and WPA2 Personal security. Ciphers supported are AES and TKIP. The Member Wireless solution interfaces with the HOST through SPI Bus. Some applications for the Member Wireless solution are as following:

- Sensors/Controls such as Industrial & Factory sensors, HVAC, & Lighting
- Consumer Electronic such as remote controls, toys, and internet radio

This certification ensures that the MRF24WB0MA and MRF24WB0MB modules have passed rigorous testing for interoperability across existing consumer and business Wi-Fi equipments, and their certifications are completed (WFA ID: WFA7150). The certification effort undertaken will save customers time and money. For modular policy, please refer to WFA Module Policy (Version 2.2; MARCH 2006).”

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4.0 ELECTRICAL CHARACTERISTICS

TABLE 4-1: DIGITAL ELECTRICAL CHARACTERISTICS (NOMINAL CONDITIONS: 25C, VDD = 3.3V)

Parameters	Min	Typ	Max	Units
V _{IL} (Input low voltage)	-0.3		0.8	V
V _{IH} (Input high voltage)	2		5.5	V
V _{OL} (Output low voltage)			0.4	V
V _{OH} (Output high voltage)	2.4			V
I _{OL} (Output low level current at V _{OL} Max)		8.5		mA
I _{OH} (Output high level current at V _{OH} Min)		15.4		mA

TABLE 4-2: ABSOLUTE MAXIMUM RATINGS⁽¹⁾

Parameters	Min	Max	Notes
Storage Temperature	-40C	+125C	
V _{DD}	0V	4.2V for 0.5mSec	V _{DD} above this level and duration will disable Radio
V _{IN} on SDI, $\overline{\text{CS}}$, SCK	-0.3V	5.5V	

Note 1: Listed Absolute Maximum Ratings are not meant for functional operation. Operation at these levels is not guaranteed, and may reduce the operating life of the component.

TABLE 4-3: RECOMMENDED OPERATING CONDITIONS

Parameters	Min	Typ	Max	Units
Ambient Temperature	0		+70	Degrees Celsius
V _{DD} – for FCC and IC	2.70	3.3	3.63 ⁽²⁾	Volts
V _{DD} – for ETSI ⁽¹⁾	2.80	3.3	3.63 ⁽²⁾	Volts
V _{DD} – for Japan ⁽¹⁾	2.97	3.3	3.63 ⁽²⁾	Volts

Note 1: Operation in EU and/or Japan over extended voltage range of 2.7V to 3.6V will require additional certification testing by customer. The module is capable of this operation.

2: While 3.63V is the maximum operating voltage, the module will detect an overvoltage condition at 4.2V and disable the RF Transmit function in 0.5 ms. This is an RF certification behavior pertaining to disabling transmission in unforeseen overvoltage conditions.

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TABLE 4-4: CURRENT CONSUMPTION⁽³⁾ (NOMINAL CONDITIONS: 25C, VDD = 3.3V)

Parameters	Min	Typ	Max	Units
IDD, Hibernate = 3.3V		0.1		μA
IDD, Sleep (software enabled)		250 ⁽¹⁾		μA
IDD, Standby (transitional state)		10		mA
IDD core ⁽²⁾ , RX on, Receive @-83dBm with 2Mbps modulated signal at antenna port		85		mA
IDD core, TX on, +0 dBm		115		mA
IDD core, TX on, +10 dBm		154		mA

Note 1: Sleep current is current consumed during periods of “standby” between DTIM beacons. The module will awake 2 mS before a DTIM and turn on its receiver, and possibly its transmitter (if data is available for it).

2: IDD core is current consumed by the part not including the I/O consumption of the SPI port.

3: Current Consumption values represent Typical Peak currents, and the measured current conditions were done with 85% duty cycle modulated signal. Wi-Fi applications typically operate at less than 85% TX duty cycle. TX current is dependent on such criteria as transmit power setting, and transmit data rate and bandwidth being used. RX current is affected by connection distance.

TABLE 4-5: RECEIVER AC CHARACTERISTICS⁽¹⁾

Parameters	Min	Typ	Max	Units
Flo	2412		2484	MHz
RX Min Input Level Sensitivity, 1Mbps, 8% PER		-91		dBm
RX Min Input Level Sensitivity, 2Mbps, 8% PER		-88		dBm
RX Max Input Level (Power), 1Mbps, 8% PER		-4		dBm
RX Max Input Level (Power), 2Mbps, 8% PER		-4		dBm

Note 1: Nominal conditions: 25C, VDD = 3.3V, Flo = 2437 MHz, measurements at antenna port.

TABLE 4-6: TRANSMITTER AC CHARACTERISTICS⁽¹⁾

Parameters	Min	Typ	Max	Units
Flo	2412		2484	MHz
Average Pout (transmit spectrum mask compliant)		+10		dBm
Average Pout gain step resolution from +5 to +10dBm		0.5		dB
Average Pout gain step resolution from -5 to +5dbm		1.0		dB
Average Pout settled variation	-0.5		0.5	dB

Note 1: Nominal conditions: 25C, VDD = 3.3V, Flo = 2437 MHz, 2 Mbps. modulated signal measured at antenna port.

MRF24WB0MA/MRF24WB0MB

FIGURE 4-1: SPI INPUT TIMING

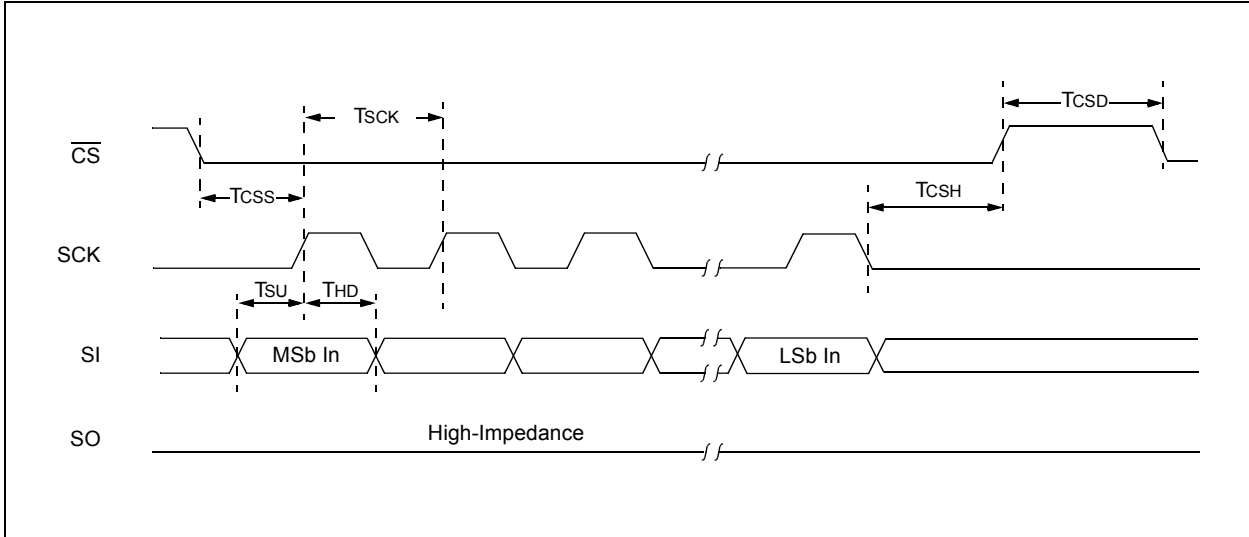


FIGURE 4-2: SPI OUTPUT TIMING

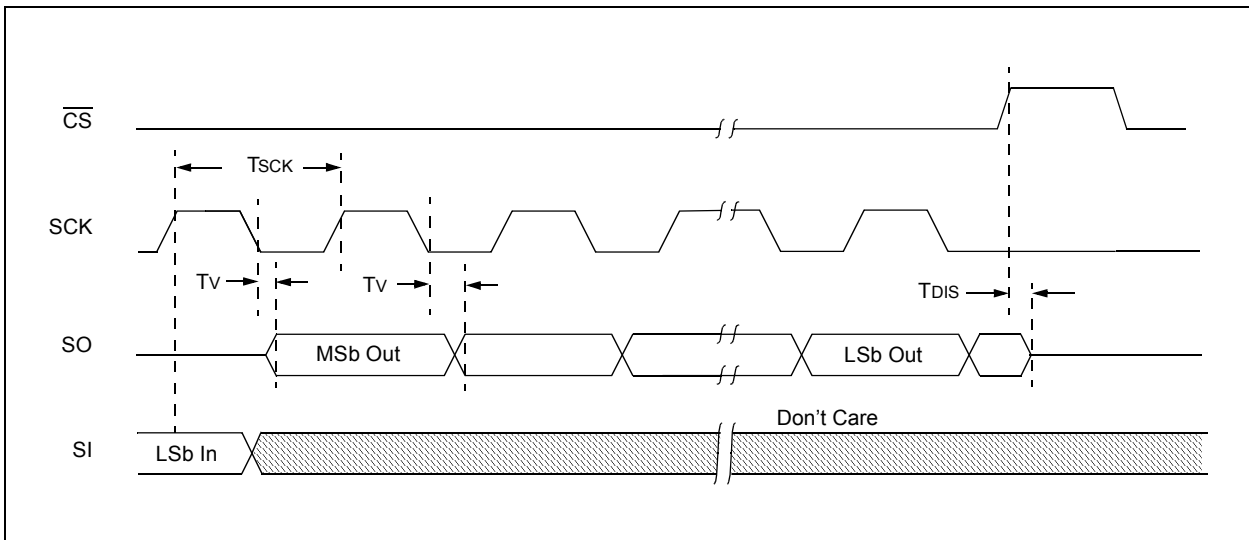


TABLE 4-7: SPI INTERFACE AC CHARACTERISTICS

Symbol	Parameters	Min	Max	Units
T_{SCK}	SCK Period	40		nS
T_{CSD}	CS High time	50		nS
T_{CSS}	CS Setup time	50		nS
T_{CSH}	CS Hold time	50		nS
T_{SU}	SDI Setup time	10		nS
T_{HD}	SDI Hold time	10		nS
T_{V}	SDO Valid time		15	nS

MRF24WB0MA/MRF24WB0MB

NOTES:

APPENDIX A: REVISION HISTORY

Revision A (April 2010)

Initial release of this document.

MRF24WB0MA/MRF24WB0MB

NOTES:

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MRF24WB0MA/MRF24WB0MB

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5. What deletions from the document could be made without affecting the overall usefulness?

6. Is there any incorrect or misleading information (what and where)?

7. How would you improve this document?

MRF24WB0MA/MRF24WB0MB

PRODUCT IDENTIFICATION SYSTEM

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

<u>PART NO.</u>	M	X	T	X
Device	Module	Module Type	Tape and Reel	Temperature Range
Device	MR24WB0MA/MRF24WB0MB; VDD range 2.7V to 3.6V			
Temperature Range	C	=	0°C to	+70°C (Commercial)

Examples:

- a) MRF24WB0MA/RM = Commercial temp. tray
- b) MRF24WB0MB/RM = Commercial temp. tray



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