



MRF24J40MB

Data Sheet

2.4 GHz IEEE Std. 802.15.4™
20 dBm RF Transceiver Module

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2.4 GHz IEEE Std. 802.15.4™ 20 dBm RF Transceiver Module

Features:

- IEEE Std. 802.15.4™ Compliant RF Transceiver
- Supports ZigBee®, MiWi™, MiWi P2P and Proprietary Wireless Networking Protocols
- Small Size: 0.9" x 1.3" (22.9 mm x 33.0 mm), Surface Mountable
- Integrated Crystal, Internal Voltage Regulator, Matching Circuitry, Power Amplifier, Low Noise Amplifier and PCB Antenna
- Easy Integration into Final Product – Minimize Product Development, Quicker Time to Market
- Radio Regulation Certified for United States (FCC), Canada (IC) and Europe (ETSI)
- Compatible with Microchip Microcontroller Families (PIC16F, PIC18F, PIC24F/H, dsPIC33 and PIC32)
- Up to 4000 ft. Range

Operational:

- Operating Voltage: 2.4-3.6V (3.3V typical)
- Temperature Range: -40°C to +85°C Industrial
- Simple, Four-Wire SPI Interface
- Low-Current Consumption:
 - RX mode: 25 mA (typical)
 - TX mode: 130 mA (typical)
 - Sleep: 5 µA (typical)

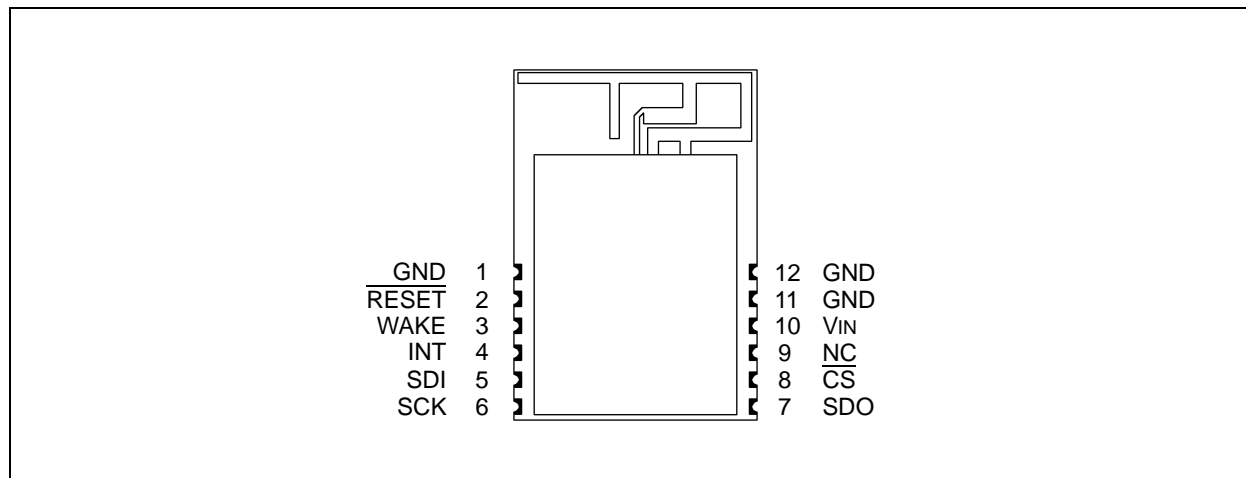
RF/Analog Features:

- ISM Band 2.405-2.475 GHz Operation
- Data Rate: 250 kbps
- -102 dBm Typical Sensitivity with -23 dBm Maximum Input Level
- +20 dBm Typical Output Power with 56 dB TX Power Control Range
- Integrated Low Phase Noise VCO, Frequency Synthesizer and PLL Loop Filter
- Digital VCO and Filter Calibration
- Integrated RSSI ADC and I/Q DACs
- Integrated LDO
- High Receiver and RSSI Dynamic Range

MAC/Baseband Features:

- Hardware CSMA-CA Mechanism, Automatic ACK Response and FCS Check
- Independent Beacon, Transmit and GTS FIFO
- Supports all CCA modes and RSS/LQI
- Automatic Packet Retransmit Capable
- Hardware Security Engine (AES-128) with CTR, CCM and CBC-MAC modes
- Supports Encryption and Decryption for MAC Sublayer and Upper Layer

FIGURE 1: PIN DIAGRAM



MRF24J40MB

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1.0 DEVICE OVERVIEW

The MRF24J40MB is a 2.4 GHz IEEE Std. 802.15.4™ compliant, surface mount module with integrated crystal, internal voltage regulator, matching circuitry, Power Amplifier, Low Noise Amplifier and PCB antenna. The MRF24J40MB module operates in the non-licensed 2.4 GHz frequency band. The integrated module design frees the integrator from extensive RF and antenna design, and regulatory compliance testing, allowing quicker time to market.

The MRF24J40MB module is compatible with Microchip's ZigBee®, MiWi™ and MiWi P2P software stacks. Each software stack is available as a free download, including source code, from the Microchip web site: <http://www.microchip.com/wireless>.

The MRF24J40MB module has received regulatory approvals for modular devices in the United States (FCC), Canada (IC) and Europe (ETSI). Modular approval removes the need for expensive RF and antenna design, and allows the end user to place the MRF24J40MB module inside a finished product and not require regulatory testing for an intentional radiator (RF transmitter).

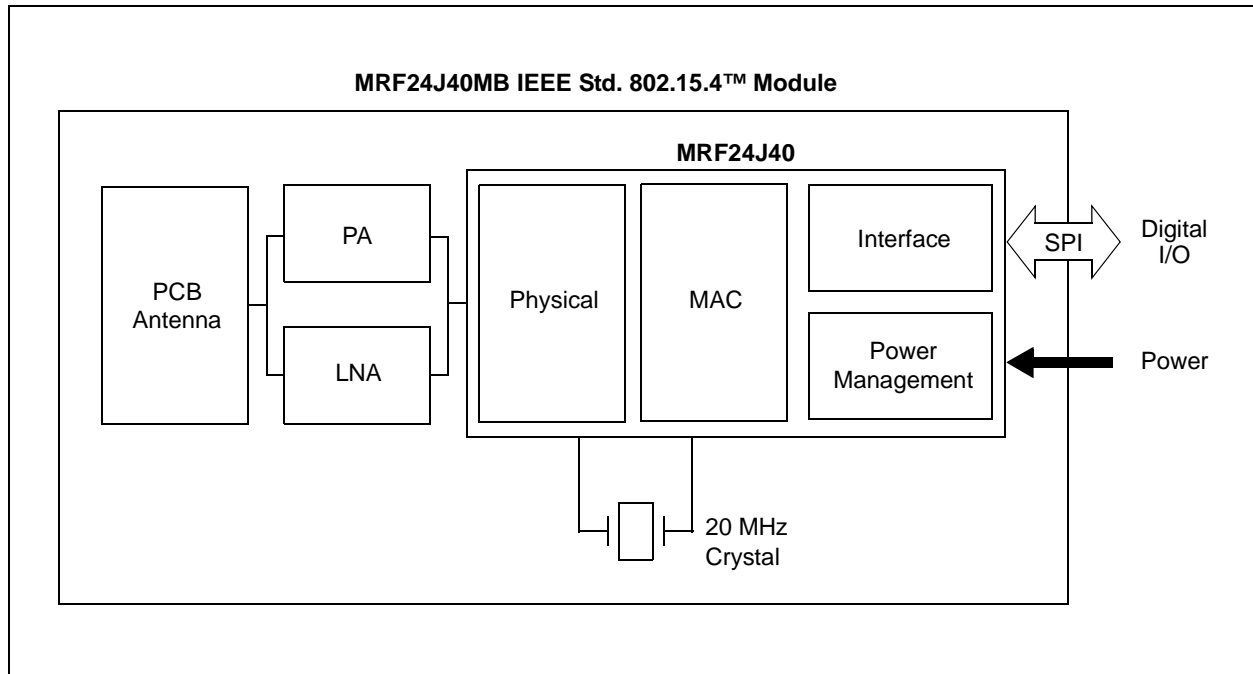
Note: See Section 3.0 "Regulatory Approval" for specific requirements to be followed by the integrator.

1.1 Interface Description

Figure 1-1 shows a simplified block diagram of the MRF24J40MB module. The module is based on the Microchip Technology MRF24J40 IEEE 802.15.4™ 2.4 GHz RF Transceiver IC. The module interfaces to many popular Microchip PIC® microcontrollers via a 4-wire serial SPI interface, interrupt, wake, Reset, power and ground, as shown in Figure 1-2. Table 1-1 provides the pin descriptions.

Data communications with the MRF24J40MB module are documented in the "MRF24J40 IEEE 802.15.4™ 2.4 GHz RF Transceiver Data Sheet" (DS39776). Refer to the MRF24J40 Data Sheet for specific serial interface protocol and register definitions.

FIGURE 1-1: MRF24J40MB BLOCK DIAGRAM



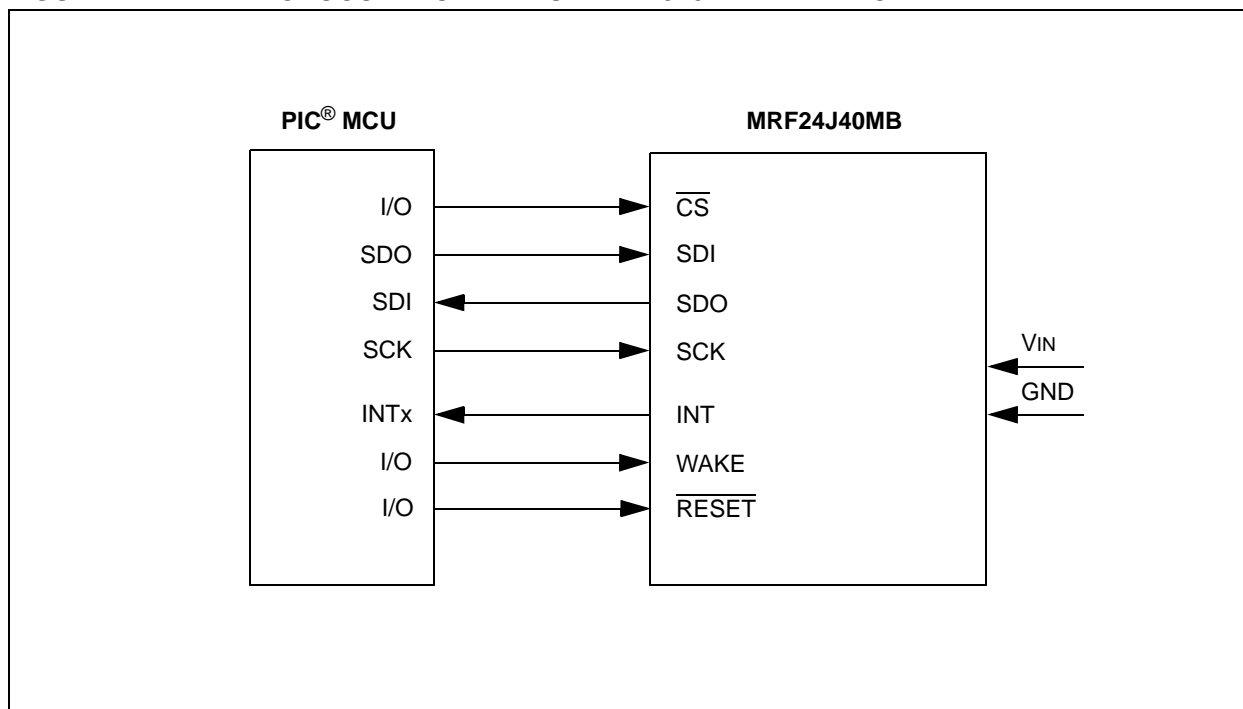
MRF24J40MB

TABLE 1-1: PIN DESCRIPTION

Pin	Symbol	Type	Description
1	GND	Power	Ground
2	$\overline{\text{RESET}}$	DI	Global hardware Reset pin
3	WAKE	DI	External wake-up trigger
4	INT	DO	Interrupt pin to microcontroller
5	SDI	DI	Serial interface data input
6	SCK	DI	Serial interface clock
7	SDO	DO	Serial interface data output from MRF24J40
8	$\overline{\text{CS}}$	DI	Serial interface enable
9	NC	—	No connection
10	VIN	Power	Power supply
11	GND	Ground	Ground
12	GND	Ground	Ground

Legend: Pin type abbreviation: D = Digital, I = Input, O = Output

FIGURE 1-2: MICROCONTROLLER TO MRF24J40MB INTERFACE



1.2 Mounting Details

The MRF24J40MB is a surface mountable module. Module dimensions are shown in Figure 1-3. The module Printed Circuit Board (PCB) is 0.032" thick with castellated mounting points on the edge. Figure 1-4 is a recommended host PCB footprint for the MRF24J40MB.

The MRF24J40MB has an integrated PCB antenna. For the best performance, follow the mounting details shown in Figure 1-5. It is recommended that the module be mounted on the edge of the host PCB, and an area around the antenna, approximately 1.2", be kept clear of metal objects. A host PCB ground plane around the MRF24J40MB acts as a counterpoise to the PCB antenna. It is recommended to extend the ground plane at least 0.4" around the module.

FIGURE 1-3: MODULE DETAILS

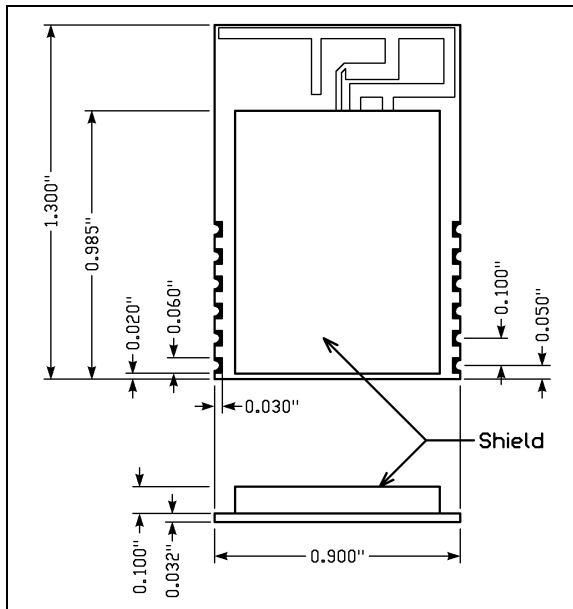
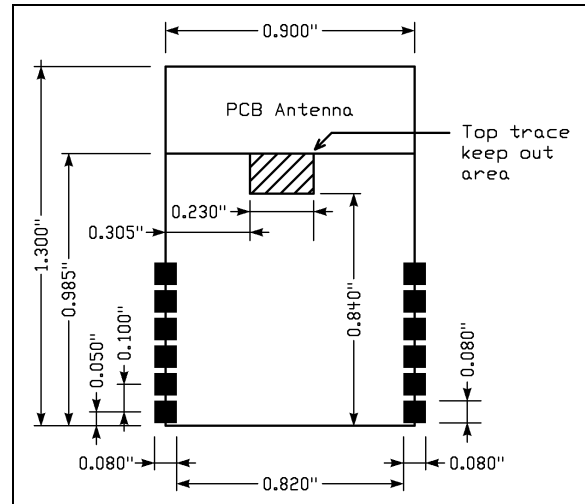
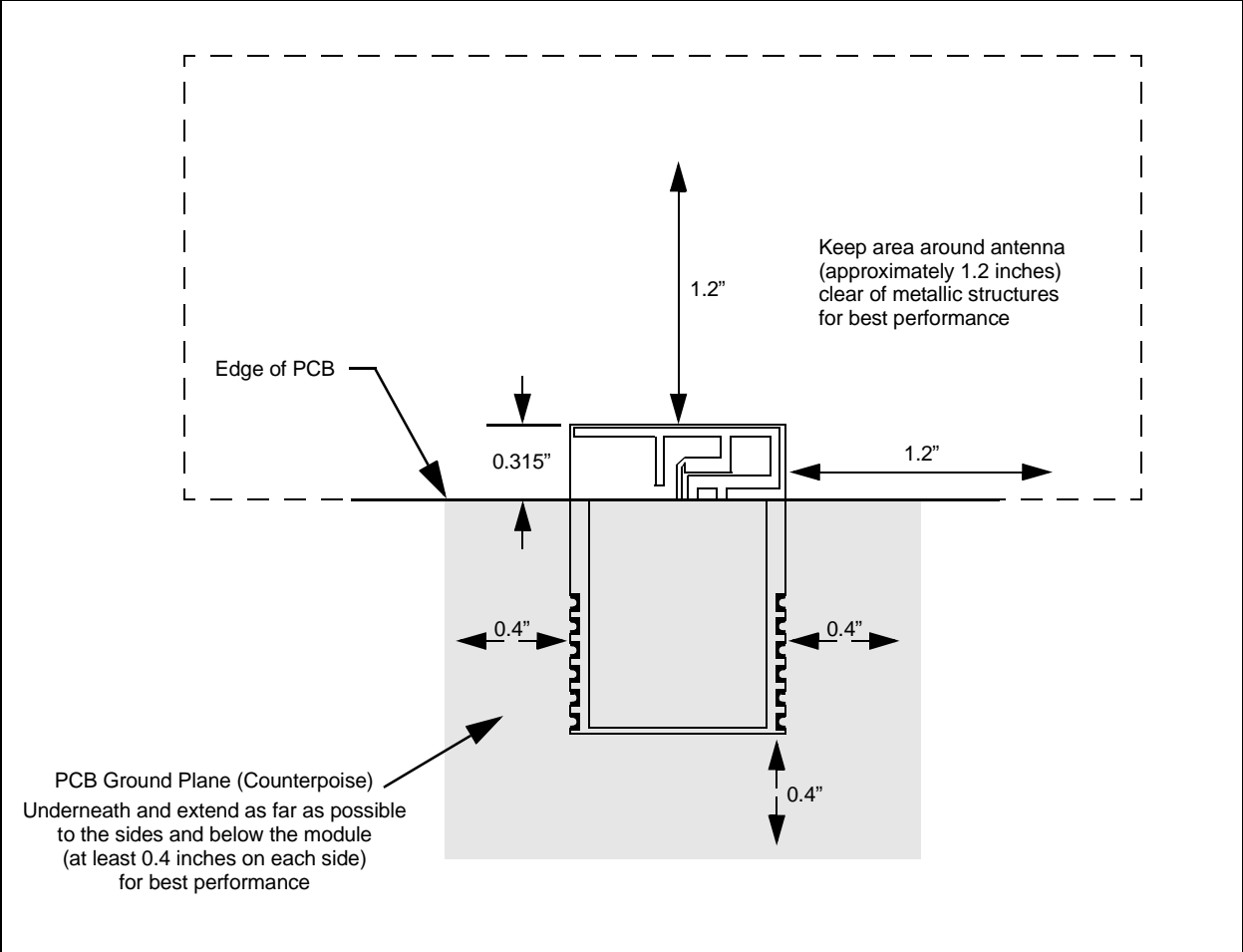


FIGURE 1-4: RECOMMENDED PCB FOOTPRINT



MRF24J40MB

FIGURE 1-5: MOUNTING DETAILS



1.3 Operation

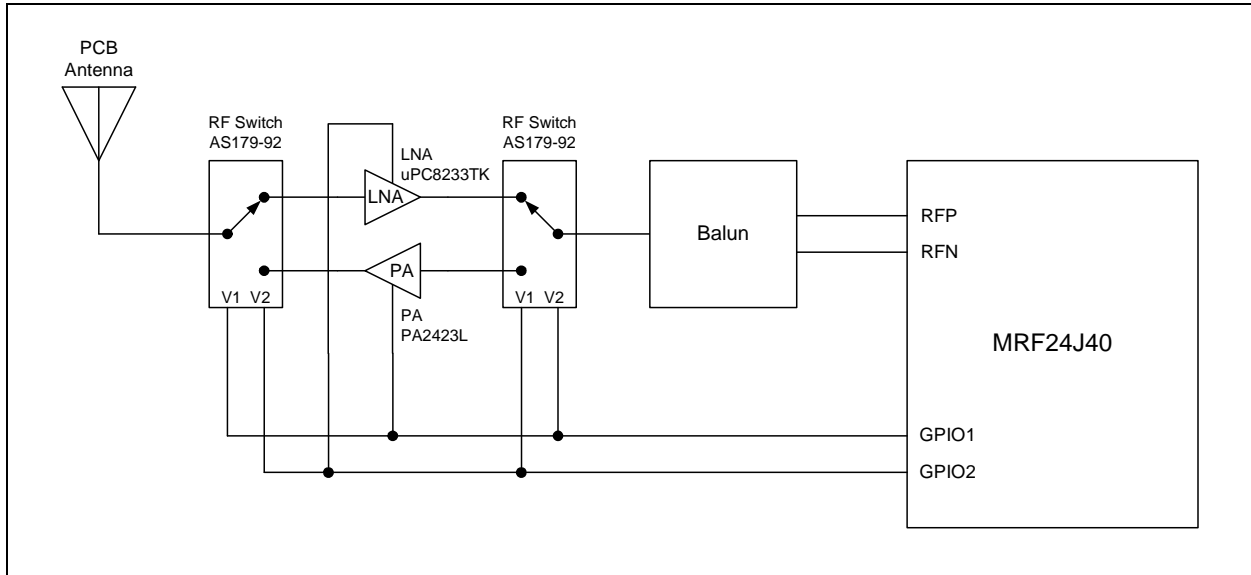
1.3.1 PA/LNA CONTROL

Operation of the Power Amplifier (PA) IC3 and Low Noise Amplifier (LNA) IC5 is controlled by the MRF24J40 internal RF state machine via RF switches, IC2 and IC4, and the GPIO1 and GPIO2 pins on the MRF24J40. Figure 1-6 shows the PA/LNA block diagram. Figure 2-1 is the schematic diagram for the module.

The internal RF state machine is configured for the PA/LNA mode by setting TESTMODE (0x22F<2:0>) = 111. Pins, GPIO1 and GPIO2, then control the RF switches, PA and LNA automatically when the MRF24J40 receives and transmits data.

Note: A complete explanation of the operation of the PA/LNA control is documented in the “MRF24J40 Data Sheet” (DS39776), Section 4.2 “External PA/LNA Control”.

FIGURE 1-6: PA/LNA BLOCK DIAGRAM



1.3.2 ENERGY DETECTION (ED)

Before performing an energy detection (see Section 3.6.1 “RSSI Firmware Request (RSSI Mode 1)” in the “MRF24J40 Data Sheet” (DS39776)), perform the following steps:

1. Configure the internal RF state machine to normal operation (TESTMODE (0x22F<2:0>) = 000).
2. Configure GPIO2 and GPIO1 direction for the output (TRISGP2 (0x34<2>) = 1 and TRISGP1 (0x34<1>) = 1).
3. Set GPIO2 (0x33<2>) = 1 and GPIO1 (0x32<1>) = 0. This enables the LNA and disables the PA.
4. Perform the energy detection following the steps in Section 3.6.1 “RSSI Firmware Request (RSSI Mode 1)” in the “MRF24J40 Data Sheet” (DS39776).

Note: The LNA will amplify the received signal. The RSSI value will include the receive signal strength plus the LNA amplification.

1.3.3 SLEEP

To get the lowest power consumption from the MRF24J40MB module during Sleep, it is necessary to disable both the PA and LNA. To do this, perform the following steps:

1. Configure the internal RF state machine to normal operation (TESTMODE (0x22F<2:0>) = 000).
2. Configure the GPIO2 and GPIO1 direction for output (TRISGP2 (0x34<2>) = 1 and TRISGP1 (0x34<1>) = 1).
3. Set GPIO2 (0x33<2>) = 0 and GPIO1 (0x32<1>) = 0. This disables the LNA and the PA.
4. Put the MRF24J40 to Sleep following the steps in the “MRF24J40 Data Sheet” (DS39776).

When waking the module, re-enable the PA/LNA mode.

MRF24J40MB

NOTES:

2.0 CIRCUIT DESCRIPTION

The MRF24J40MB is a complete 2.4 GHz IEEE Std. 802.15.4™ compliant surface mount module with integrated crystal, internal voltage regulator, matching circuitry, Power Amplifier, Low Noise Amplifier and PCB antenna. The MRF24J40MB module interfaces to many popular Microchip PIC microcontrollers via a 4-wire serial SPI interface, interrupt, wake, Reset, power and ground. Data communications with the MRF24J40MB module are documented in the "*MRF24J40 IEEE 802.15.4™ 2.4 GHz RF Transceiver Data Sheet*" (DS39776). Refer to the MRF24J40 Data Sheet for specific serial interface protocol and register definitions.

2.1 Schematic

A schematic diagram of the module is shown in Figure 2-1 and the Bill of Materials (BOM) is shown in Table 2-1.

The MRF24J40MB module is based on the Microchip Technology MRF24J40 IEEE 802.15.4™ 2.4 GHz RF Transceiver IC (U1). The serial I/O (SCK, SDI, SDO and CS), RESET, WAKE and INT pins are brought out to the module pins. The SDO signal is tri-state buffered by IC7 to solve a silicon errata, where the SDO signal does not release to a high-impedance state, after the CS pin returns to its inactive state.

Crystal, X1, is a 20 MHz crystal with a frequency tolerance of ± 10 ppm @ 25°C to meet the IEEE Std. 802.15.4 symbol rate tolerance of ± 40 ppm.

A balun is formed by components: L1, L2, L3, C2, C3 and C4. L2 is also a pull-up for the RFP and RFN pins on the MRF24J40. C4 also acts as a DC block capacitor. RF switches, IC2 and IC4, switch between the power amplifier, IC3, when transmitting and low noise amplifier, IC5, when receiving. A low-pass filter is formed by components: L10, L11, C31, C32 and C36. The remaining passive components provide bias and decoupling.

MRF24J40MB

FIGURE 2-1: MRF24J40MB SCHEMATIC

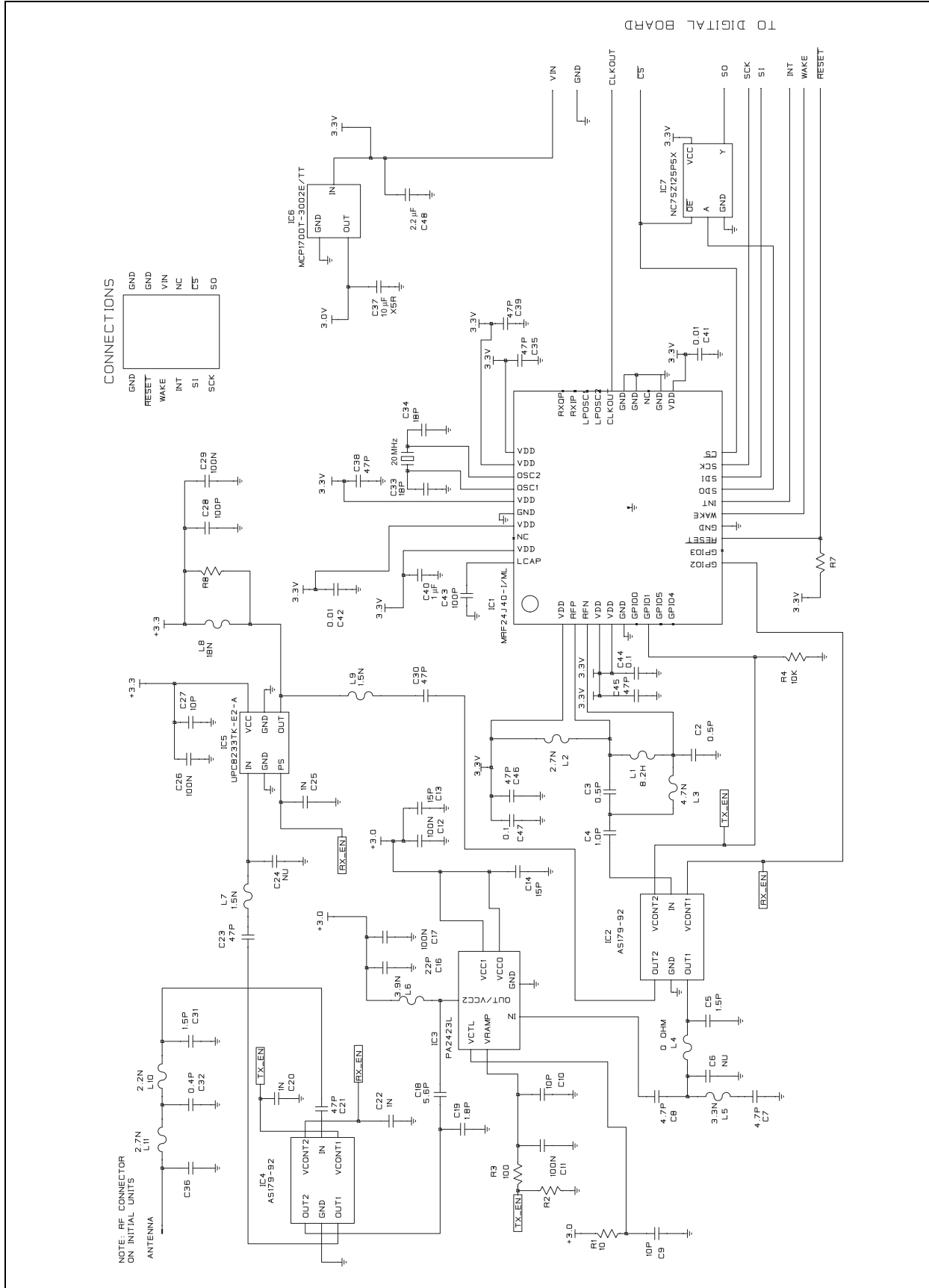


TABLE 2-1: MRF24J40MB BILL OF MATERIALS

Designator	Description	Manufacturer	Part Number
C2	Chip Capacitor 0402 COG 0.5P	Johanson Technology	500R07S0R5AV4T
C3	Chip Capacitor 0402 COG 0.5P	Johanson Technology	500R07S0R5AV4T
C4	Chip Capacitor 0402 COG 1.0P	Johanson Technology	500R07S1R0BV4T
C5	Chip Capacitor 0402 COG 1.5P	Murata	GRM1555C1H1R5CZ01D
C6	Not Used		
C7	Chip Capacitor 0402 COG 4.7P	Murata	GRM1555C1H4R7CZ01D
C8	Chip Capacitor 0402 COG 4.7P	Murata	GRM1555C1H4R7CZ01D
C9	Chip Capacitor 0402 COG 10P	Murata	GRM1555C1H100JZ01D
C10	Chip Capacitor 0402 COG 10P	Murata	GRM1555C1H100JZ01D
C11	Chip Capacitor 0402 X5R 100N	Murata	GRM155R61A104KA01D
C12	Chip Capacitor 0402 X5R 100N	Murata	GRM155R61A104KA01D
C13	Chip Capacitor 0402 COG 15P	Murata	GRM1555C1H150JZ01D
C14	Chip Capacitor 0402 COG 15P	Murata	GRM1555C1H150JZ01D
C16	Chip Capacitor 0402 COG 22P	Murata	GRM1555C1H220JZ01D
C17	Chip Capacitor 0402 X5R 100N	Murata	GRM155R61A104KA01D
C18	Chip Capacitor 0402 COG 5.6P	Murata	GRM1555C1H5R6CZ01D
C19	Chip Capacitor 0402 COG 1.8P	Murata	GRM1555C1H1R8CZ01D
C20	Chip Capacitor 0402 X7R 1N	Murata	GRM155R71H102KA01D
C21	Chip Capacitor 0402 COG 47P	Murata	GRM1555C1H470JZ01D
C22	Chip Capacitor 0402 X7R 1N	Murata	GRM155R71H102KA01D
C23	Chip Capacitor 0402 COG 47P	Murata	GRM1555C1H470JZ01D
C24	Not Used		
C25	Chip Capacitor 0402 X7R 1N	Murata	GRM155R71H102KA01D
C26	Chip Capacitor 0402 X5R 100N	Murata	GRM155R61A104KA01D
C27	Chip Capacitor 0402 COG 10P	Murata	GRM1555C1H100JZ01D
C28	Chip Capacitor 0402 COG 100P	Murata	GRM1555C1H101JZ01D
C29	Chip Capacitor 0402 X5R 100N	Murata	GRM155R61A104KA01D
C30	Chip Capacitor 0402 COG 47P	Murata	GRM1555C1H470JZ01D
C31	Chip Capacitor 0402 COG 1.5P	Johanson Technology	500R07S1R5BV4T
C32	Chip Capacitor 0402 COG 0.4P	Johanson Technology	500R07S0R4AV4T
C33	Chip Capacitor 0402 COG 18P	Murata	GRM1555C1H180JZ01D
C34	Chip Capacitor 0402 COG 18P	Murata	GRM1555C1H180JZ01D
C35	Chip Capacitor 0402 COG 47P	Murata	GRM1555C1H470JZ01D
C36	Not Used		
C37	Chip Capacitor 0805 X5R 10U	Murata	GRM21BR60J106ME19L
C38	Chip Capacitor 0402 COG 47P	Murata	GRM1555C1H470JZ01D
C39	Chip Capacitor 0402 COG 47P	Murata	GRM1555C1H470JZ01D
C40	Chip Capacitor 0402 X5R 1U	Murata	GRM155R60J105ME19D
C41	Chip Capacitor 0402 X7R 10N	Murata	GRM155R71E103KA01D
C42	Chip Capacitor 0402 X7R 10N	Murata	GRM155R71E103KA01D
C43	Chip Capacitor 0402 COG 100P	Murata	GRM1555C1H101JZ01D
C44	Chip Capacitor 0402 X5R 100N	Murata	GRM155R61A104KA01D
C45	Chip Capacitor 0402 COG 47P	Murata	GRM1555C1H470JZ01D

Note: Capacitors and inductors cannot be substituted.

MRF24J40MB

TABLE 2-1: MRF24J40MB BILL OF MATERIALS (CONTINUED)

Designator	Description	Manufacturer	Part Number
C46	Chip Capacitor 0402 X5R 100N	Murata	GRM155R61A104KA01D
C47	Chip Capacitor 0402 COG 47P	Murata	GRM1555C1H470JZ01D
C48	Chip Capacitor 0603 X5R 2.2U	Murata	GRM188R60J225ME01D
IC1	802.15.4 Radio	Microchip	MRF24J40-I/ML
IC2	Switch SPDT	Skyworks	AS179-92
IC3	Power Amplifier	SiGe	PA2423L-R
IC4	Switch SPDT	Skyworks	AS179-92
IC5	Low Noise Amplifier	NEC	UPC8233TK-E2-A
IC6	Voltage Regulator	Microchip	MCP1700T-3302E/TT
IC7	Buffer-SC70 Package	Fairchild	NC7SZ125P5X
L1	Chip Inductor 0402 8.2N	Panasonic	ELJ-RF8N2JFB
L2	Chip Inductor 0402 2.7N	Panasonic	ELJ-RF2N7DFB
L3	Chip Inductor 0402 4.7N	Panasonic	ELJ-RF4N7DFB
L4	Chip Resistor 0402 00hms	Dale	CRCW04020000Z0ED
L5	Chip Inductor 0402 3.3N	Panasonic	ELJ-RF3N3DFB
L6	Chip Inductor 0402 3.9N	Panasonic	ELJ-RF3N9DFB
L7	Chip Inductor 0402 1.5N	Panasonic	ELJ-RF1N5DFB
L8	Chip Inductor 0402 18N	Panasonic	ELJ-RF18NJFB
L9	Chip Inductor 0402 1.5N	Panasonic	ELJ-RF1N5DFB
L10	Chip Inductor 0402 2.2N	Panasonic	ELJ-RF2N2DFB
L11	Chip Inductor 0402 2.7N	Panasonic	ELJ-RF2N7DFB
R1	Chip Resistor 0402 10Ohms 5%	Dale	CRCW040210R0JNED
R2	Not Used		
R3	Chip Resistor 0402 2.2Ohms 5%	Dale	CRCW04022R20JNED
R4	Chip Resistor 0402 10K 5%	Dale	CRCW040210K0JNED
R7	Not Used		
R8	Not Used		
S	Shield-Custom	TBD	
X1	20 MHz Crystal	Abracon	ABM8-156-20.0000MHZ-T

Note: Capacitors and inductors cannot be substituted.

2.2 Printed Circuit Board

The MRF24J40MB module printed circuit board is constructed with FR4 material, four layers and 0.032 inches thick. The layers are shown in Figure 2-2 through Figure 2-6. The stack up of the PCB is shown in Figure 2-7.

FIGURE 2-2: TOP SILK SCREEN

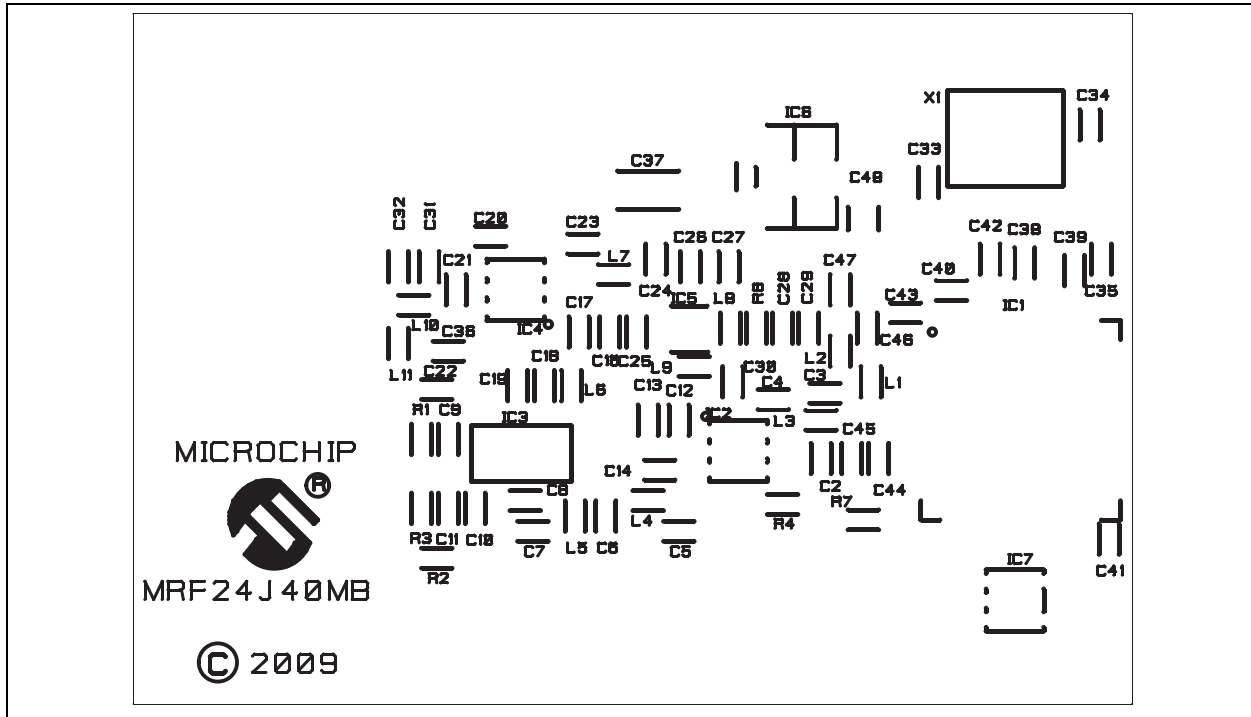


FIGURE 2-3: TOP COPPER

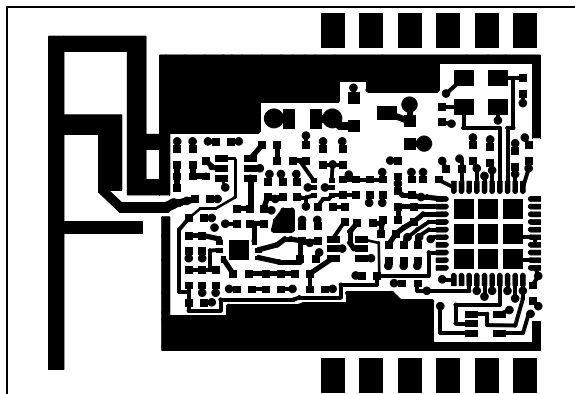
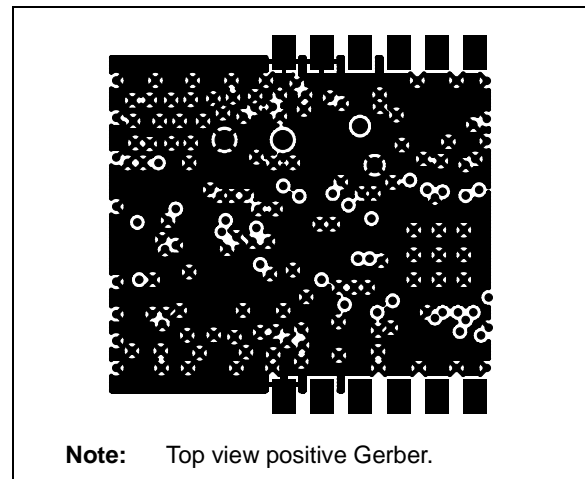


FIGURE 2-4: LAYER 2 – GROUND PLANE



MRF24J40MB

FIGURE 2-5: LAYER 3 – POWER PLANE

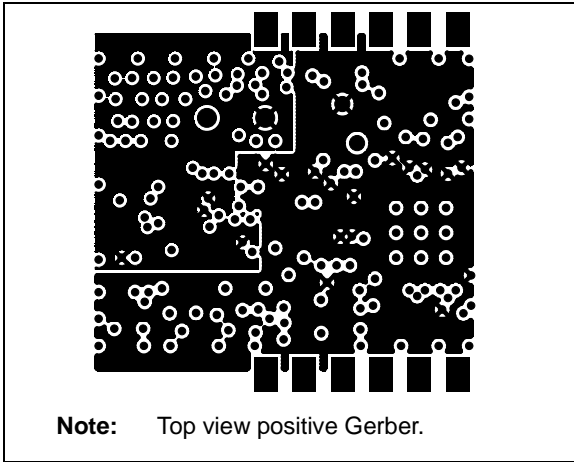


FIGURE 2-6: BOTTOM COPPER

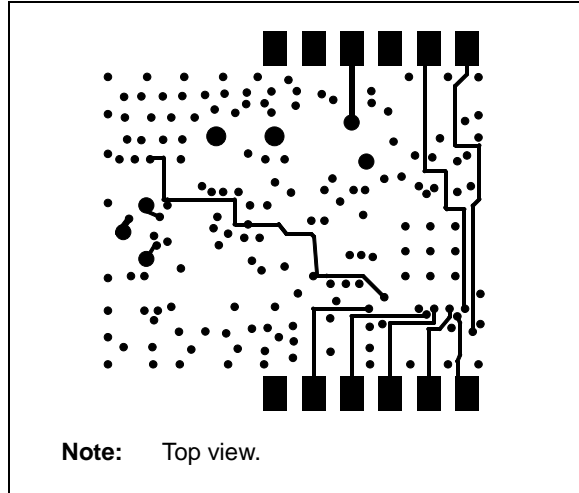
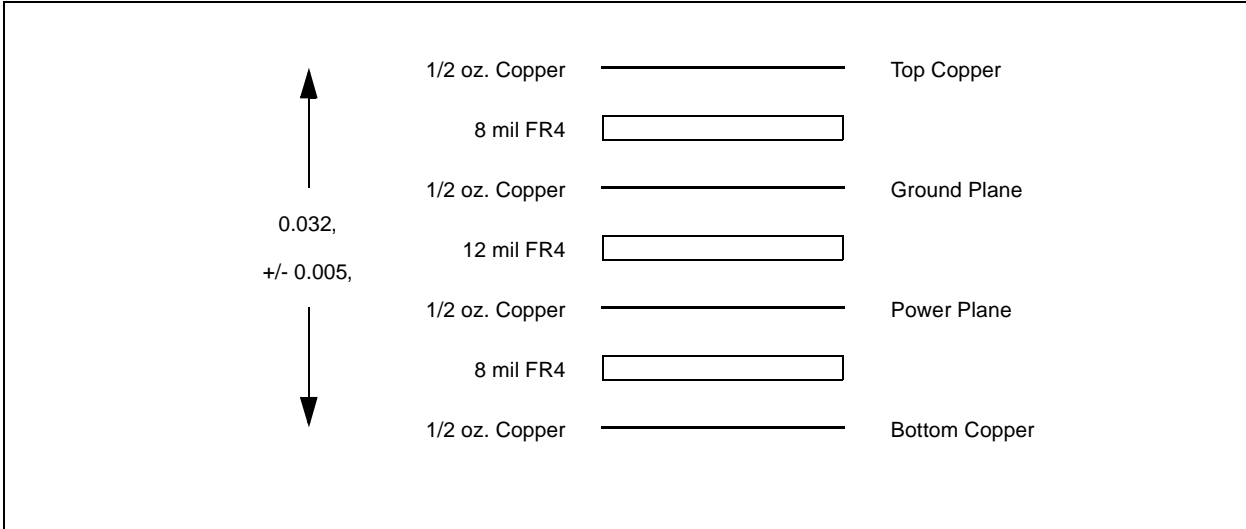


FIGURE 2-7: PCB LAYER STACK UP



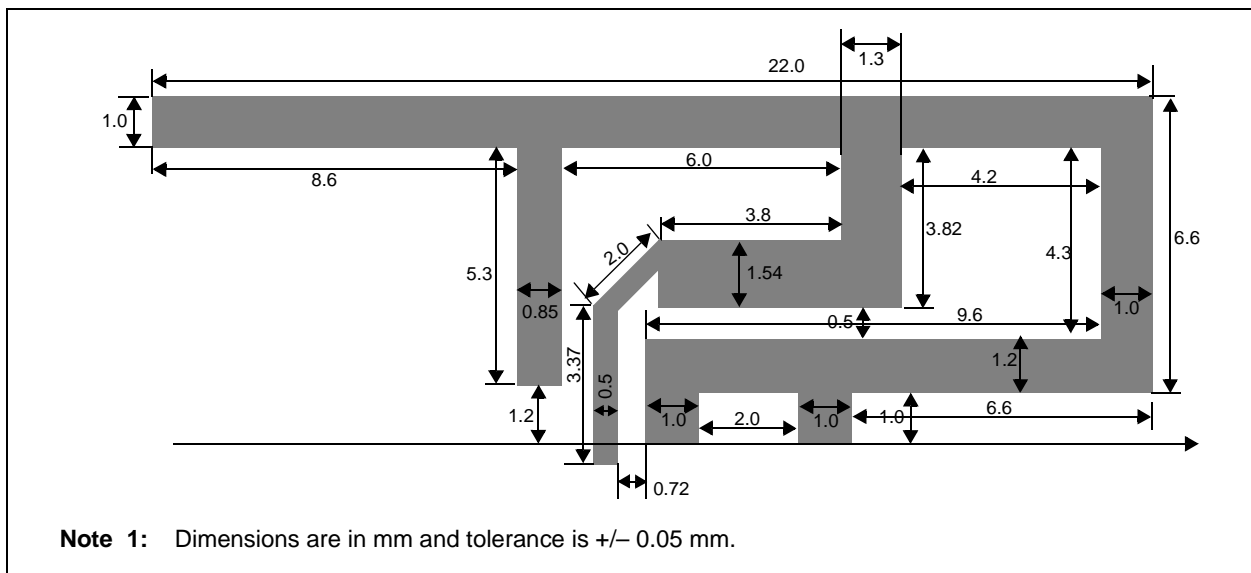
2.3 PCB Antenna

The PCB antenna is fabricated on the top copper trace. Figure 2-8 shows the trace dimensions. The layers below the antenna have no copper traces. The ground and power planes under the components serve as a counterpoise to the PCB antenna. Additional ground plane on the host PCB will substantially enhance the performance of the module. For best performance, place the module on the host PCB following the recommendations in **Section 1.2 “Mounting Details”**.

The Printed Circuit Board (PCB) antenna was designed and simulated using Ansoft Designer[®] and HFSS[™] 3D full-wave solver software by Ansoft Corporation

(www.ansoft.com) and tested in an anechoic room. The design goal was to create a compact, low-cost antenna with the best radiation pattern. Figure 2-9 shows the simulation drawing and Figure 2-10 and Figure 2-11 show the 2D and 3D radiation patterns, respectively. As shown by the radiation patterns, the performance of the antenna is dependant upon the orientation of the module. Figure 2-12 shows the impedance simulation and Figure 2-13 shows the SWR simulation. The discrete matching circuitry matches the impedance of the antenna with the MRF24J40 transceiver IC.

FIGURE 2-8: PCB ANTENNA DIMENSIONS



MRF24J40MB

FIGURE 2-9: PCB ANTENNA SIMULATION DRAWING

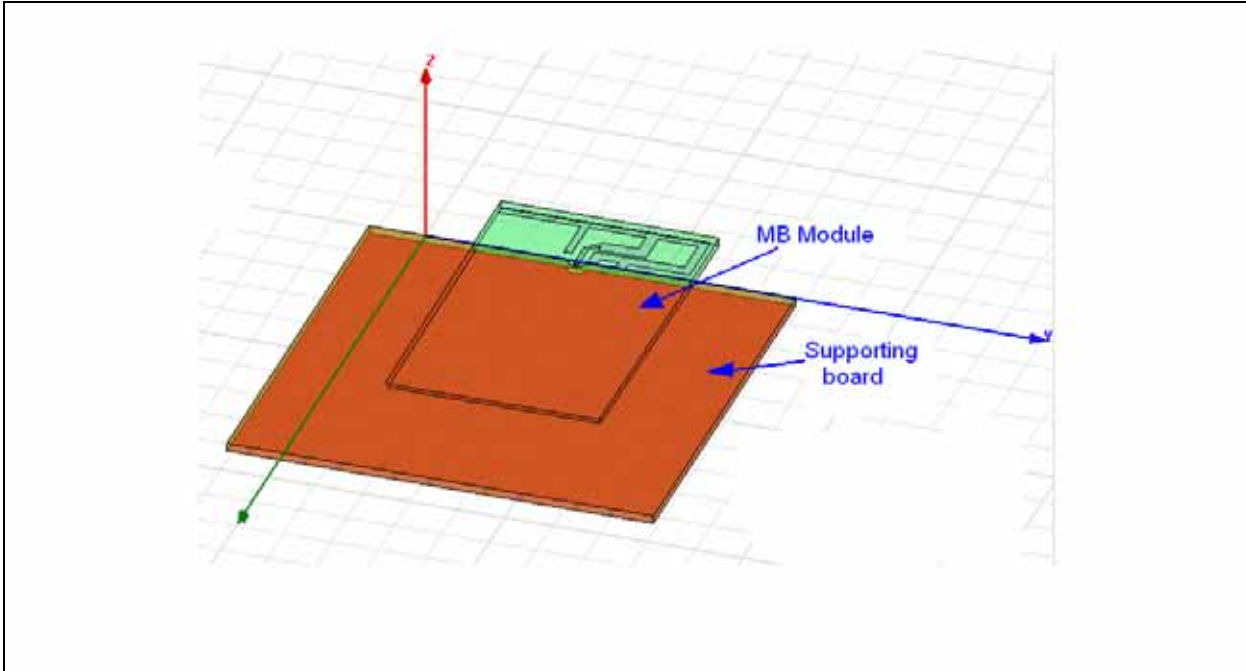


FIGURE 2-10: SIMULATED 2D RADIATION PATTERN

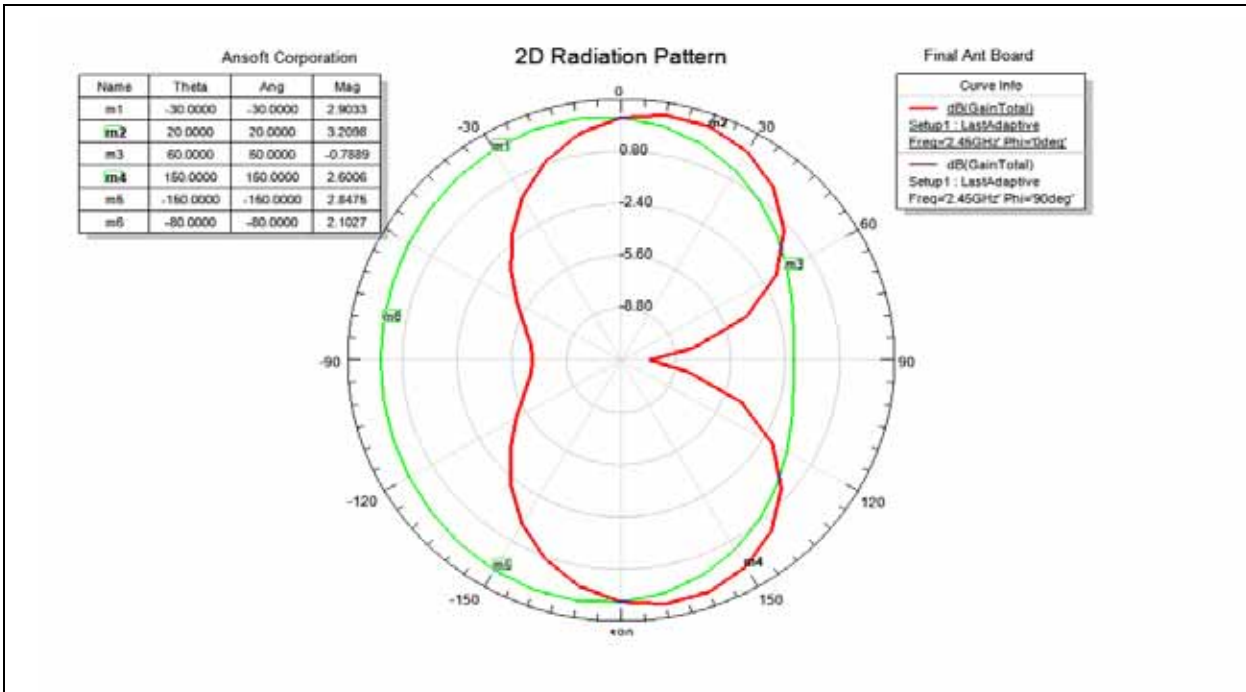


FIGURE 2-11: SIMULATED 3D RADIATION PATTERN

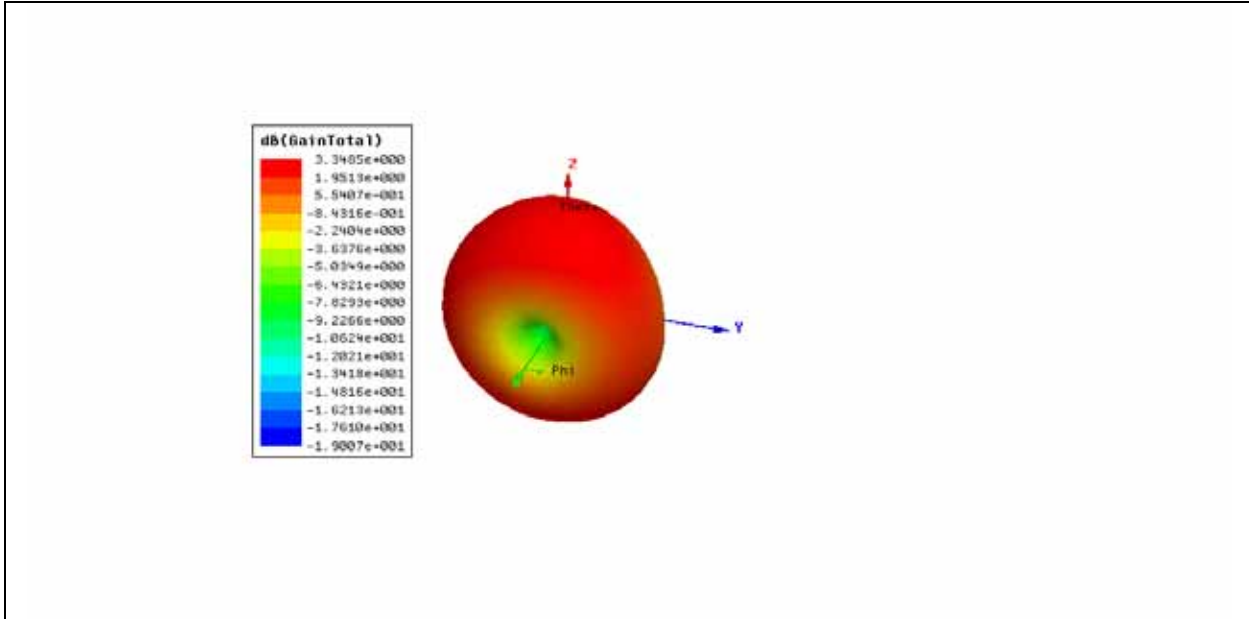
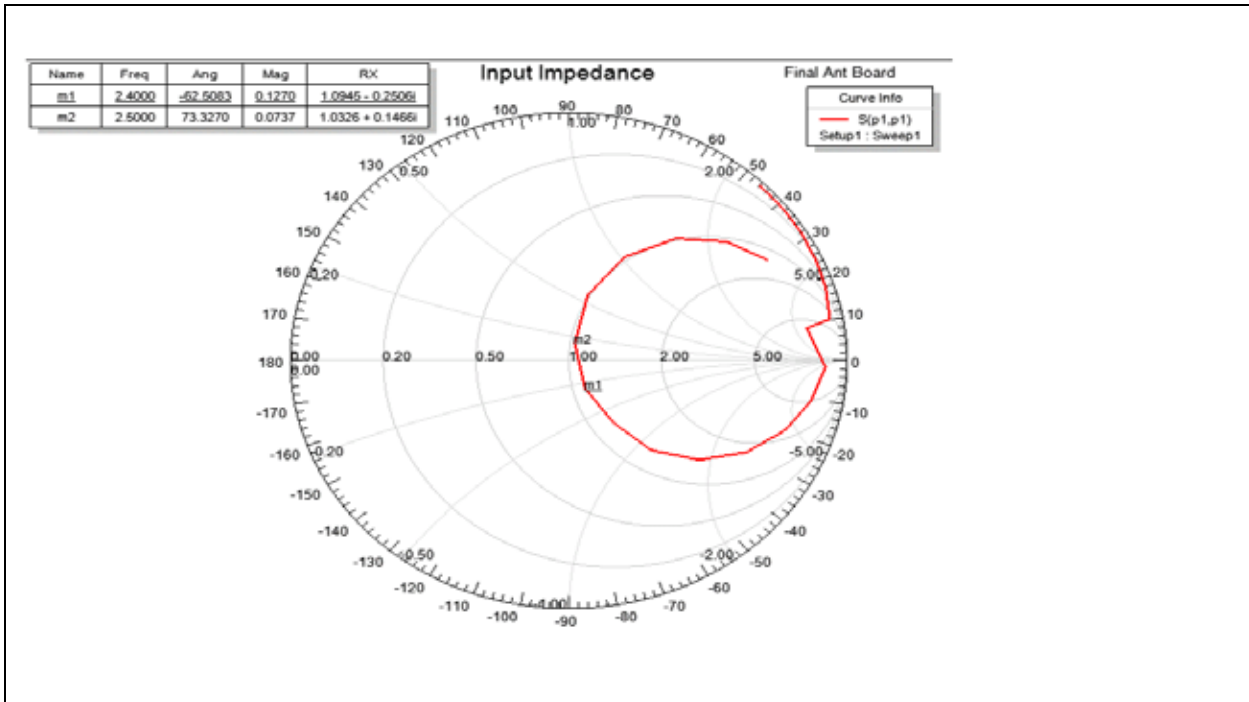
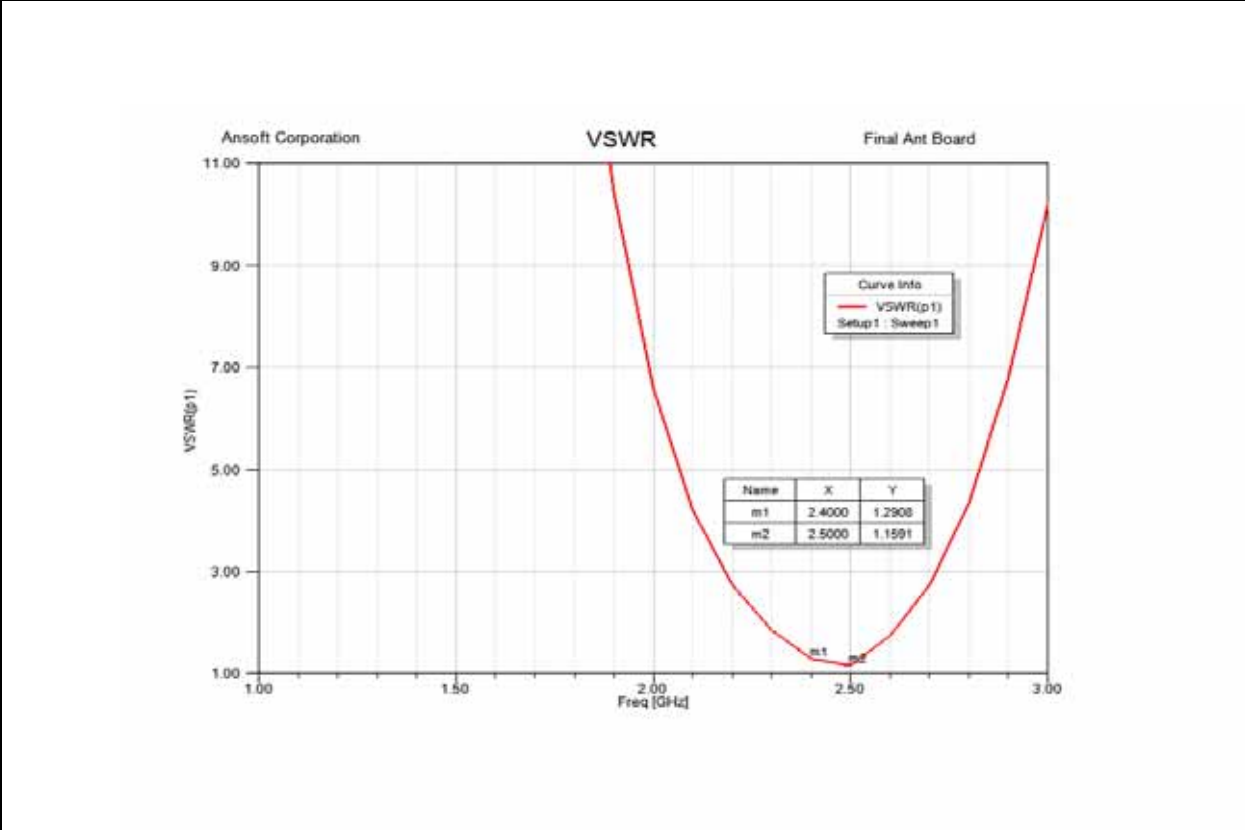


FIGURE 2-12: SIMULATED PCB ANTENNA IMPEDANCE



MRF24J40MB

FIGURE 2-13: SIMULATED PCB ANTENNA SWR



3.0 REGULATORY APPROVAL

The MRF24J40MB 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 MRF24J40MB 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 required with this module, installed (for example: digital device emission, PC peripheral requirements, etc.) in the specific country that the end device will be marketed.

Annex F of the IEEE Std. 802.15.4 document has a good summary of regulatory requirements in various countries concerning IEEE Std. 802.15.4 devices. The standard can be downloaded from the IEEE Standards web page: <http://standards.ieee.org/getieee802/802.15.html>.

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

3.1 United States

The MRF24J40MB 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 MRF24J40MB module can be integrated into a finished product without obtaining subsequent and separate FCC approvals.

The MRF24J40MB 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 such as the following:

Contains Transmitter Module FCC ID:
OA3MRF24J40MB
-or-
Contains FCC ID: OA3MRF24J40MB
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.

The user's manual 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.

3.1.1 MRF24J40MB SETTINGS

To meet the FCC requirements, the following settings must be observed by the integrator:

- The MRF24J40MB transmit power setting (RFFCON3 0x203) cannot exceed -1.9 dB.
- Only channels 11 through 25 may be selected (RFFCON0 0x200).

3.1.2 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.

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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 MRF24J40MB module is used in a portable application (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.

3.1.3 HELPFUL WEB SITES

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

3.2 Canada

The MRF24J40MB 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:

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

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 an 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.

Label:

Contains IC: 7693A-24J40MB

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 MRF24J40MB SETTINGS

To meet Industry Canada (IC) requirements, the following settings must be observed by the integrator:

- The MRF24J40MB transmit power setting (RFCON3 0x203) cannot exceed -1.9 dB.
- Only channels 11 through 25 may be selected (RFCON0 0x200).

3.2.2 HELPFUL WEB SITES

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

3.3 Europe

The MRF24J40MB 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
- Electrostatic Discharge
- Radiated RF Susceptibility

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 the end device is marketed and sold.

3.3.1 MRF24J40MB SETTINGS

To meet ETSI requirements, the following settings must be observed by the integrator:

- The MRF24J40MB transmit power setting (RFCON3 0x203) cannot exceed -14.9 dB. This is to meet the requirements of ETSI EN 300 328 v1.7.1 (2006-05), Maximum e.i.r.p. spectral density limit, Section 4.3.2.2, "For wideband modulations other than FHSS (e.g., DSSS, OFDM, etc.), the maximum e.i.r.p. spectral density is limited to 10 mW per MHz". The output power of the MRF24J40MB module, at this setting with the PA enabled, is 9 dBm.
- Only channels 11 through 25 may be selected (RFCON0 0x200).

3.3.2 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/>

MRF24J40MB

NOTES:

4.0 ELECTRICAL CHARACTERISTICS

TABLE 4-1: RECOMMENDED OPERATING CONDITIONS

Parameters	Min	Typ	Max	Units
Ambient Operating Temperature	-40	—	+85	°C
Supply Voltage for RF, Analog and Digital Circuits	2.4	—	3.6	V
Supply Voltage for Digital I/O	2.4	3.3	3.6	V
Input High Voltage (V _{IH})	0.5 x V _{DD}	—	V _{DD} + 0.3	V
Input Low Voltage (V _{IL})	-0.3	—	0.2 x V _{DD}	V

TABLE 4-2: CURRENT CONSUMPTION

(T_A = 25°C, V_{DD} = 3.3V)

Chip Mode	Condition	Min	Typ	Max	Units
Sleep	Sleep Clock Disabled	—	5 μA	—	μA
TX	At Maximum Output Power	—	130 mA	—	mA
RX		—	25 mA	—	mA

TABLE 4-3: RECEIVER AC CHARACTERISTICS

Typical values are at T_A = 25°C, V_{DD} = 3.3V, LO Frequency = 2.445 GHz

Parameters	Condition	Min	Typ	Max	Units
RF Input Frequency	Compatible to IEEE Std. 802.15.4™, 2003	2.405	—	2.480	GHz
RF Sensitivity		—	-102	—	dBm
Maximum RF Input		-23	—	—	dBm
LO Leakage	Measured at Balun Matching Network Input at Frequency, 2.405-2.48 GHz	—	-60	—	dBm
Input Return Loss		-8	-12	—	dB
Noise Figure (including matching)		—	1.9	—	dB
Adjacent Channel Rejection	@ +/-5 MHz	30	—	—	dB
Alternate Channel Rejection	@ +/-10 MHz	40	—	—	dB
RSSI Range		—	50	—	dB
RSSI Error		-5	—	5	dB

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TABLE 4-4: TRANSMITTER AC CHARACTERISTICS

Typical values are at $T_A = 25^\circ\text{C}$, $V_{DD} = 3.3\text{V}$, LO Frequency = 2.445 GHz

Parameters	Condition	Min	Typ	Max	Units
RF Carrier Frequency		2.405	—	2.475	GHz
Maximum RF Output Power		—	20	—	dBm
RF Output Power Control Range		—	56	—	dB
TX Gain Control Resolution	Programmed by Register	—	1.25	—	dB
Carrier Suppression		—	-30	—	dBc
TX Spectrum Mask for O-QPSK Signal	Offset Frequency > 3.5 MHz, at 0 dBm Output Power	-33	—	—	dBm
TX EVM		—	15	—	%

APPENDIX A: REVISION HISTORY

Revision A (June 2009)

Original release of this document.

Revision B (August 2009)

Added **Section 3.0 “Regulatory Approval”**.

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NOTES:

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Device: MRF24J40MB Literature Number: DS70599B

Questions:

1. What are the best features of this document?

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4. What additions to the document do you think would enhance the structure and subject?

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?

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	I	-X
Device	Module	Module Type	Tape and Reel	Temperature Range
Device	MRF24J40MB;			
	VDD range 2.4V to 3.6V			
Temperature Range	I			
	= -40°C to +85°C			(Industrial)

Examples:

- a) MRF24J40MB-I = Industrial temp. tray
- b) MRF24J40MBT-I = Industrial temp., tape and reel.



WORLDWIDE SALES AND SERVICE

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