RNWF11 Wi-Fi® Module Family Data Sheet

RNWF11

Introduction

The RNWF11 Module is a low-power 2.4 GHz IEEE® 802.11b/g/n compliant, fully RF certified wireless module designed for Internet of Things (IoT) applications. This module is interfaced via a Two-Wire UART interface with Microchip's simple ASCII-based AT commands for easy integration into most of the applications. The host microcontroller can dynamically configure the RNWF11 Module with a few simple ASCII commands.

The RNWF11 Module operates at a single supply voltage VDD (3.3V typical).

The RNWF11 Module is available with an on-board Printed Circuit Board (PCB) antenna with an integrated Microchip Trust&Go secure device.

Features

Wireless Interfaces

- PHY:
  - IEEE 802.11 b/g/n WLAN link
  - Single spatial stream of 20 MHz channel bandwidth
  - 2.4 GHz (2400~2483.5 MHz) ISM band
- MAC:
  - Infrastructure BSS STA mode
  - Soft-AP mode functionality
  - Active and passive scanning
  - Transmit power control support over temperature and voltage
- Security:
  - WPA3 personal (SAE and PMF-802.11w)
  - WPA2 personal, with options for WPA compatibility and PMF
- Supports Host Assisted Over-the-Air (OTA) Firmware Update
- UART Host Interface
- On-Chip Network Stack to Offload MCU:
  - Network features – TCP, UDP, DHCP, ARP, HTTP, TLS and DNS
  - Hardware accelerators for Wi-Fi® and TLS security to improve connection time
  - TLS v1.2 with symmetric/asymmetric crypto acceleration
- Cloud Connectivity:
  - Enables quick cloud connectivity via MQTT to different cloud vendors like Azure, AWS and more
- I/O Manager:
  - Enables host MCU to control different peripherals connected via GPIO, ADC or PWM pins on the RNWF11 Module

Power Management and System Recovery

- Low-Power Modes (Extreme Deep Sleep)
- Integrated Power-on Reset (POR) and Brown-out Reset (BOR)
- Secondary Oscillator

Security

- Hardware Accelerated Security Modes (with Built-in DMA Support)
- Crypto Engine with True Random Number Generator (TRNG) for Data Encryption/Decryption and Authentication (AES, 3DES, SHA, MD5 and HMAC)
- AES Modes:
  - Electronic Code Book (ECB)
  - Cypher Block Chaining (CBC)
  - Counter Mode (CTR)
  - Cypher Feedback Mode (CFB)
  - Output Feedback Mode (OFB)
  - Galois/Counter Mode (GCM)
- Hardware Accelerated Public Key Cryptography with Support for:
  - 16-DSP multipliers configuration
  - 256-bit ECC/ECDH/ECDSA/Curve25519
  - 256-bit Ed25519
  - 512-bit ECC/ECDH/ECDSA generation

Antenna Options

- PCB Antenna Variants:
  - RNWF11PC

Wireless Feature

- On-board Front-End Module (FEM)/Power Amplifier (PA) to Meet the TX Power Requirements

Security

- Integrated Trust&GO

Clock Management

- Integrated 40 MHz POSC

Advanced Analog

- 8 Analog Channels

Input/Output

- 30 GPIO Pins

Output Compare

- 4 Output Compare Modules

Package and Operating Conditions

- Package:
  - 54-pin SMD package with Shield CAN
  - Size: 24.5 mm x 20.5 mm x 2.5 mm
- Operating conditions:
  - 3.0-3.6V, -40°C to +85°C and 200 MHz

Certifications

- RNWF11 Module Certified to FCC, ISED, UKCA, MIC, KCC, NCC and CE Radio Regulations
- RoHS and REACH Compliant

Note: For more details on the latest supported features, refer to the *RNWF11 Application Developer's Guide*.

Acronyms and Abbreviations

For complete list of acronyms and abbreviations, refer to the 6. Appendix B: Acronyms and Abbreviations

Table of Contents

1. Ordering Information

This chapter provides the ordering information of the RNWF11 Module.

1.1 RNWF11 Module Ordering Information

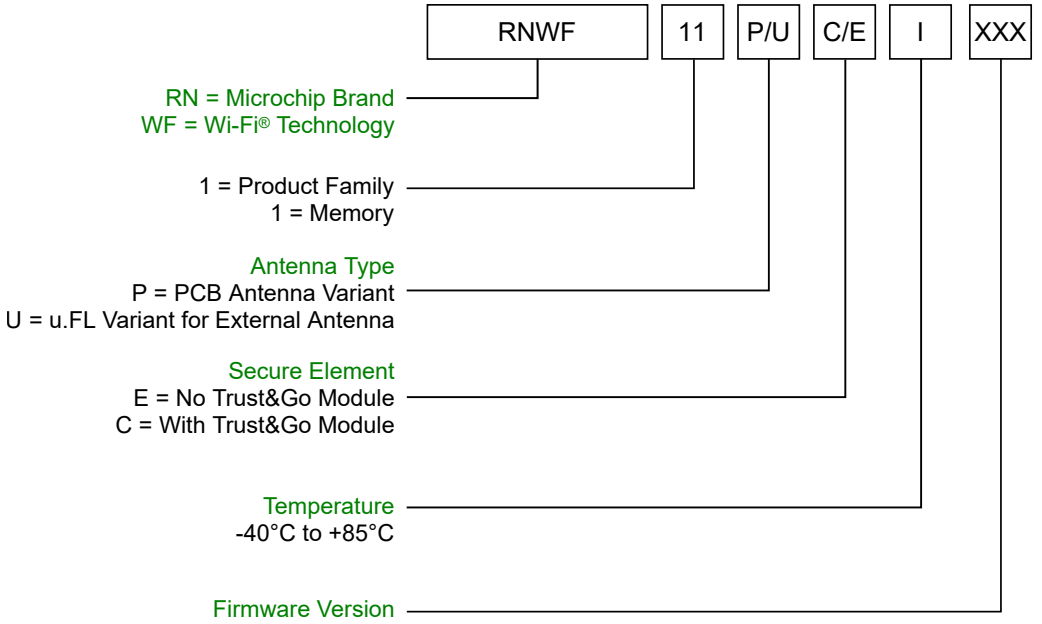
The following table describes the ordering information of the RNWF11 Module.

Table 1-1. RNWF11 Module Ordering Details

Model Number	Description	Regulatory Certification	Ordering Code
RNWF11PC	RNWF11 Module with PCB antenna and Trust&GO	FCC, ISED, CE, UKCA, KCC, MIC, NCC	RNWF11PC-I100

The following figure illustrates the details of the RNWF11 Module ordering information.

Figure 1-1. RNWF11 Module Ordering Information



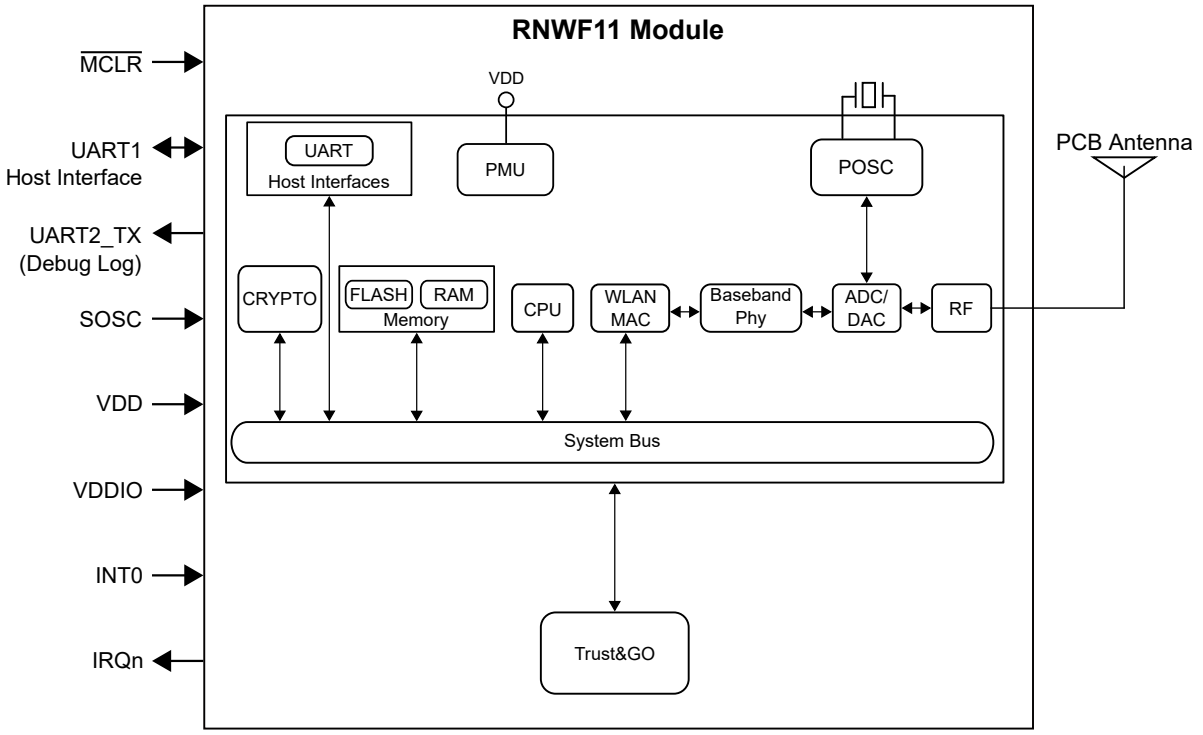
2. RNWF11 Module Description

The RNWF11 Module is a fully-certified module that contains an integrated FEM and Trust&GO with the following antenna options:

- PCB antenna (RNWF11PC)

The Trust&GO is a pre-configured and pre-provisioned secure element of Microchip's family of security-focused devices. The Trust&Go is connected using I2C2 in the module. The following figure illustrates the RNWF11 Module block diagram.

Figure 2-1. RNWF11 Module Block Diagram



2.1 Pin Details of RNWF11 Module

This section provides details on pin diagrams and pinout table of the RNWF11 Module.

Figure 2-2. RNWF11 Module Pin Diagram

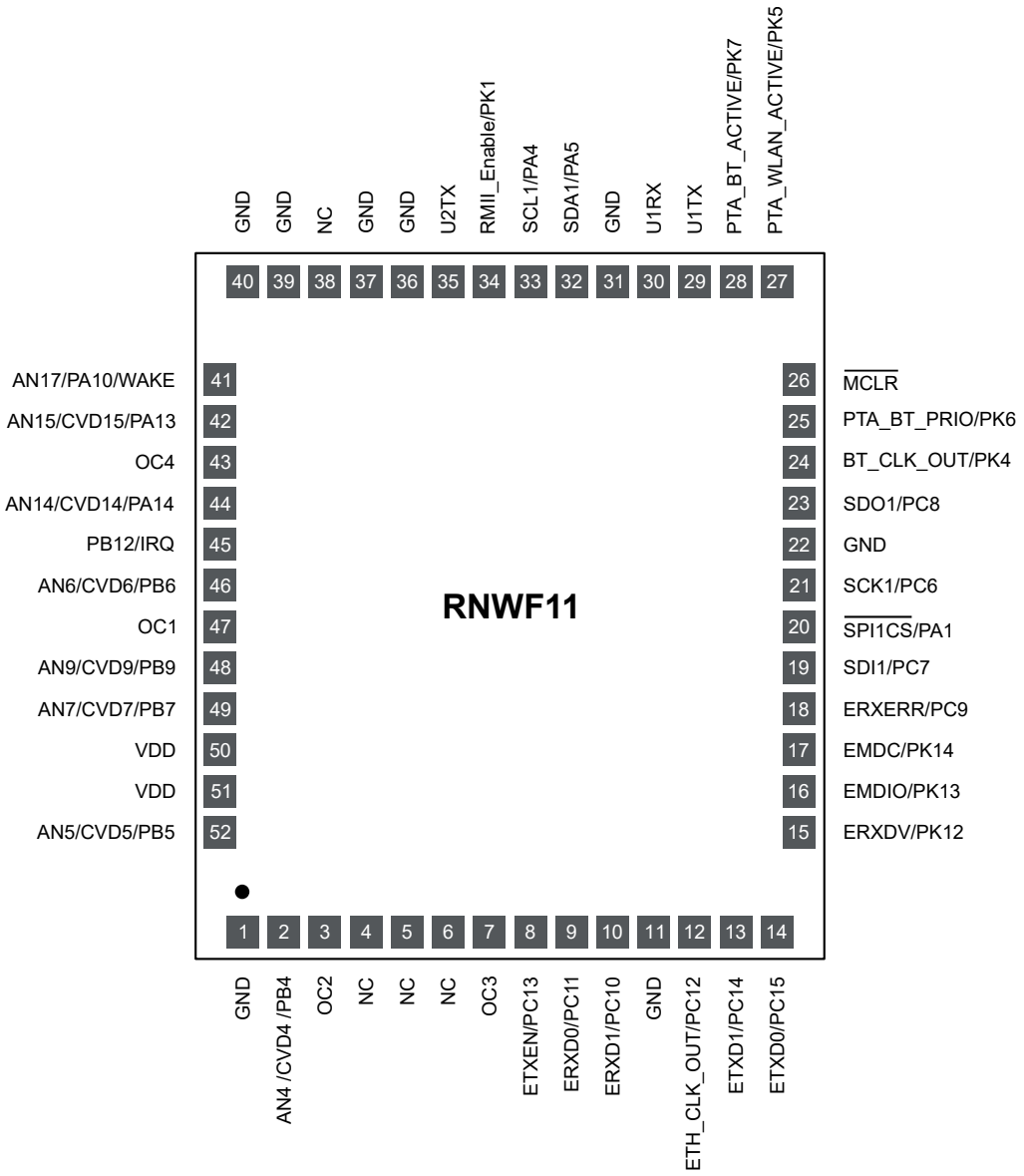


Table 2-1. RNWF11 Module Pinout Table

Pin Number	Pin Name	Pin Type	Pin Description
1	GND	P	Ground
2	AN4	I	Analog input 4
	CVD4	O	Touch 4
	PB4	I/O	Port B digital I/O 4
3	OC2	O	Output compare 2
4	Reserved	—	Reserved, Do not connect
5	Reserved	—	Reserved, Do not connect
6	Reserved	—	Reserved, Do not connect
7	OC3	O	Output compare 3
8	ETXEN	O	Ethernet transmit enable output
	PC13	I/O	Port C digital I/O 13

.....continued

Pin Number	Pin Name	Pin Type	Pin Description
9	ERXD0	I	Ethernet RMII receive data bit 0
	PC11	I/O	Port C digital I/O 11
10	ERXD1	I	Ethernet RMII receive data bit 1
	PC10	I/O	Port C digital I/O 10
11	GND	P	Ground
12	ETH_CLK_OUT	O	Ethernet RMII reference clock out (50 MHz), requires an external 33Ω series termination resistor
	PC12	I/O	Port C digital I/O 12
13	ETXD1	O	Ethernet RMII transmit data bit 1
	PC14	I/O	Port C digital I/O 14
14	ETXD0	I	Ethernet RMII transmit data bit 0
	PC15	I/O	Port C digital I/O 15
15	ERXDV	I	Ethernet RMII receive data valid
	PK12	I/O	Port K digital I/O 12
16	EMDIO	I/O	Ethernet management data I/O
	PK13	I/O	Port K digital I/O 13
17	EMDC	O	Ethernet management data clock
	PK14	I/O	Port K digital I/O 14
18	ERXERR	I	Ethernet RMII receive error
	PC9	I/O	Port C digital I/O 9
19	SDI1	I	SPI data in
	PC7	I/O	Port C digital I/O 7
20	SPI1CS	O	SPI clock select (active-low)
	PA1	I/O	Port A digital I/O 1
21	SCK1	O	SPI clock
	PC6	I/O	Port C digital I/O 6
22	GND	P	Ground
23	SDO1	O	SPI data out
	PC8	I/O	Port C digital I/O 8
24	BT_CLK_OUT	O	Bluetooth® reference clock out (26 MHz)
	PK4	I/O	Port K Digital I/O 4
25	PTA_BT_PRIO	I/O	Packet Traffic Arbitration (PTA) Bluetooth priority signal for Bluetooth and Wi-Fi® coexistence
	PK6	I/O	Port K digital I/O 6
26	$\overline{\text{MCLR}}$	I	Master Clear (Reset, Active low, Requires external RC circuit)
27	PTA_WLAN_ACTIVE	I/O	PTA Wi-Fi active signal for Bluetooth and Wi-Fi coexistence
	PK5	I/O	Port K digital I/O 5
28	PTA_BT_ACTIVE	I/O	PTA Wi-Fi active signal for Bluetooth and Wi-Fi coexistence
	PK7	I/O	Port K digital I/O 7
29	U1TX	O	UART 1 transmit for host interface
30	U1RX	I	UART 1 receive for host interface
31	GND	P	Ground
32	SDA1	I/O	I^2C data to ATECC608B TrustFlex
	PA5	I/O	Port A digital I/O 5
33	SCL1	I/O	I^2C clock to ATECC608B TrustFlex
	PA4	I/O	Port A digital I/O 4

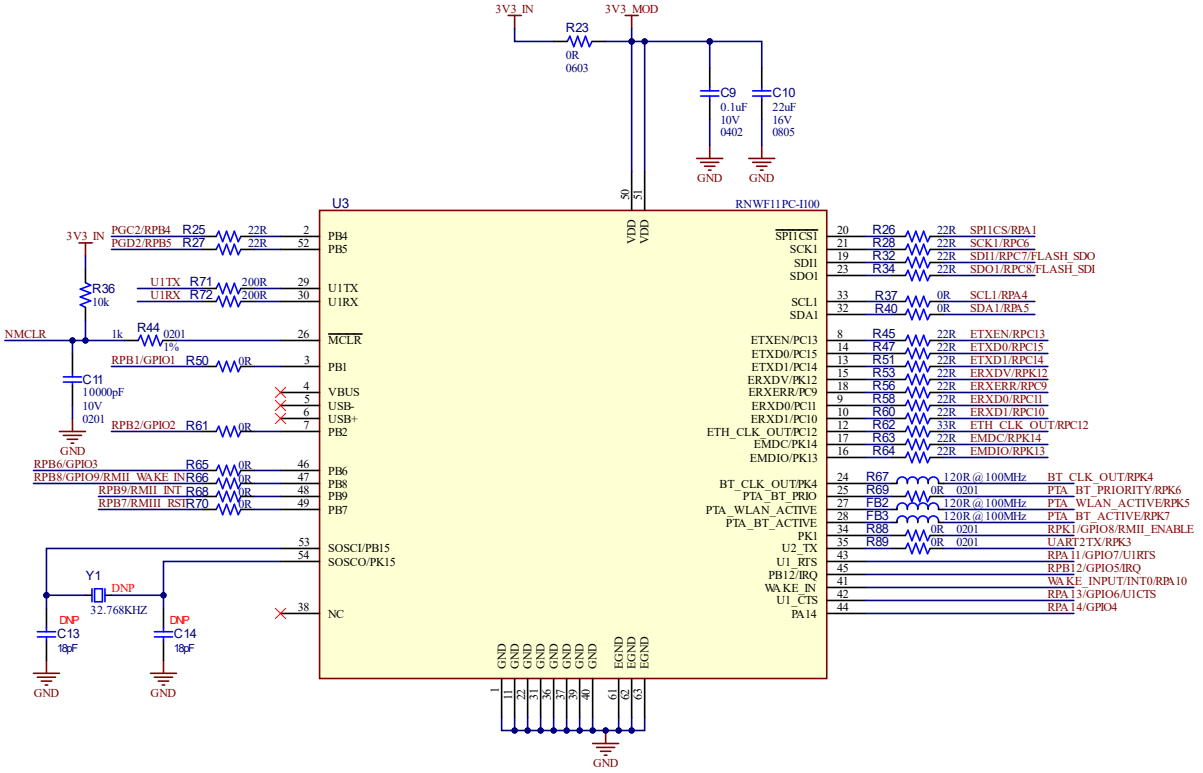
.....continued

Pin Number	Pin Name	Pin Type	Pin Description
34	RMII_Enable	O	Ethernet RMII enable
	PK1	I/O	Port K digital I/O 1
35	U2TX	O	UART 2 TX used as debug UART TX
36	GND	P	Ground
37	GND	P	Ground
38	NC	—	Do not connect
39	GND	P	Ground
40	GND	P	Ground
41	AN17	I	Analog input 17
	PA10	I/O	Port A digital I/O 10
	WAKE	I	Wake input
42	AN15	I	Analog input 15
	CVD15	O	Touch 15
	PA13	I/O	Port A digital I/O 13
43	OC4	O	Output compare 4
44	AN14	I	Analog input 14
	PA14	I/O	Port A digital I/O 14
	CVD14	O	Touch 4
45	PB12	I/O	Port B digital I/O 12
	IRQ	O	IRQ
46	AN6	I	Analog input 6
	CVD6	O	Touch 6
	PB6	I/O	Port B digital I/O 6
47	OC1	O	Output compare 1
48	AN9	I	Analog input 9
	CVD9	O	Touch 9
	PB9	I/O	Port B digital I/O 9
49	AN7	I	Analog input 7
	PB7	I/O	Port B digital I/O 7
	CVD7	O	Touch 7
50	VDD	P	Input supply voltage (3.3V)
51	VDD	P	Input supply voltage (3.3V)
52	AN5	I	Analog input 5
	CVD5	O	Touch 5
	PB5	I/O	Port B digital I/O 5

2.2 Basic Connection Requirement

The RNWF11PC Module requires attention to a minimal set of device pin connections before proceeding with development. The following figure illustrates the RNWF11 Module basic connection and interface diagram.

Figure 2-3. RNWF11PC Basic Connections

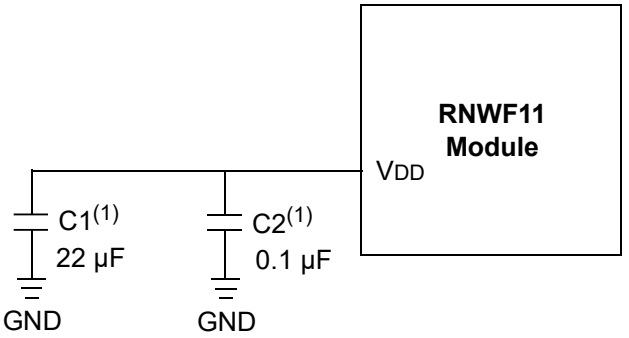


Note: The Y1 (32 kHz) connection is optional. For more details, refer to the firmware release notes at RNWF11PC.

2.2.1 Power Pins

The recommendation is to add a bulk and a decoupling capacitor at the input supply pin (VDD and GND pins) of the RNWF11 Module.

Figure 2-4. Recommended Module Power Supply Connections



Notes:

1. The value of the C1 and C2 capacitors can vary based on the application requirement.
2. Place the C1 and C2 capacitors close to the module pin.

2.2.2 Master Clear ($\overline{\text{MCLR}}$) Pin

The MCLR pin provides for two specific device functions:

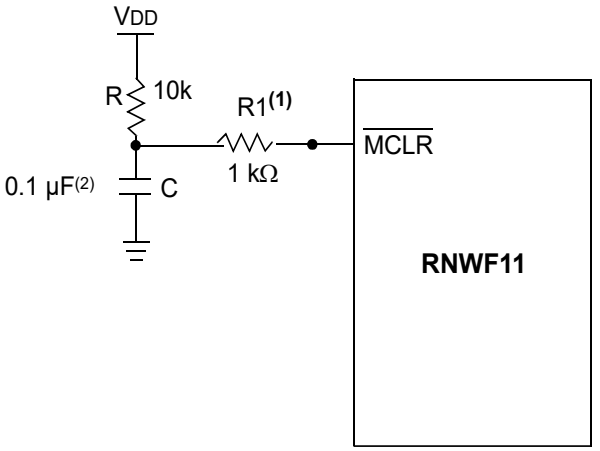
- Device Reset
- Device programming and debugging

Pulling the $\overline{MCLR}$ pin low generates a device Reset. The following figure illustrates a typical $\overline{MCLR}$ circuit. When programming and debugging the device, consider the resistance and capacitance that can be added to the pin. Device programmers and debuggers drive the $\overline{MCLR}$ pin. As a result, specific voltage levels (VIH and VIL) and fast signal transitions must not be adversely affected. Therefore, specific values of R and C need to be adjusted based on the application and PCB requirements.

For example, the recommendation is to isolate capacitor C from the $\overline{MCLR}$ pin during programming and debugging operations.

Place the components within one-quarter inch (6 mm) from the $\overline{MCLR}$ pin.

Figure 2-5. Example of $\overline{MCLR}$ Pin Connections



Notes:

1. 470Ω ≤ R1 ≤ 1 kΩ limits any current flowing into $\overline{MCLR}$ from the external capacitor C, in the event of $\overline{MCLR}$ pin breakdown, due to Electrostatic Discharge (ESD) or Electrical Overstress (EOS). The user must meet the $\overline{MCLR}$ pin VIH and VIL specifications without interfering with the debug/programmer tools.
2. Size the capacitor to prevent unintentional resets from brief glitches or to extend the device Reset period during POR.

2.2.3 Unused I/O Pins

In case of Low-power modes, do not allow the unused I/O pins to float as inputs. They can be configured as outputs and driven to a Logic-low state. Alternatively, reserve the inputs by connecting the pin to VSS through a 1-10k resistor and configuring the pin as an input.

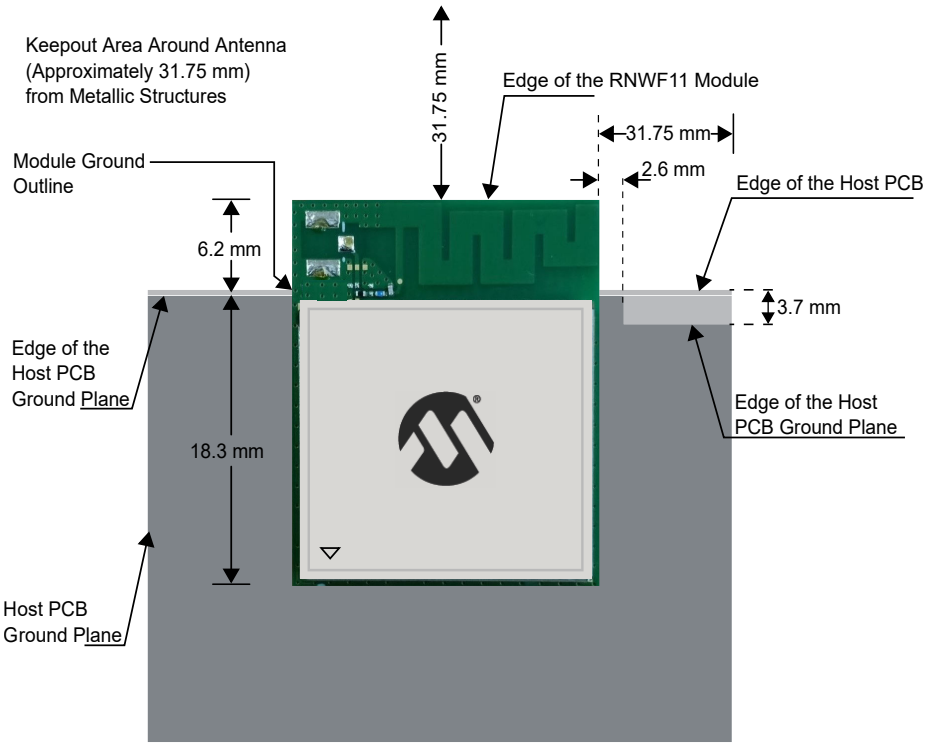
In general, the I/O pins need to be driven based on the application use-case. The user must know how a particular pin is wired before driving it to a particular state. For example, do not drive a pin to low if it is wired to sink current or drive high if it is going to source current.

2.3 RNWF11 Module Placement Guidelines

- For any Wi-Fi product, the antenna placement affects the performance of the whole system. The antenna requires free space to radiate RF signals, and it must not be surrounded by the ground plane. Thus, for best PCB antenna performance, the RNWF11PC module must be placed at the edge of the host board.
- The RNWF11PC Module ground outline edge must be aligned with the edge of the host board ground plane (see the following figure).

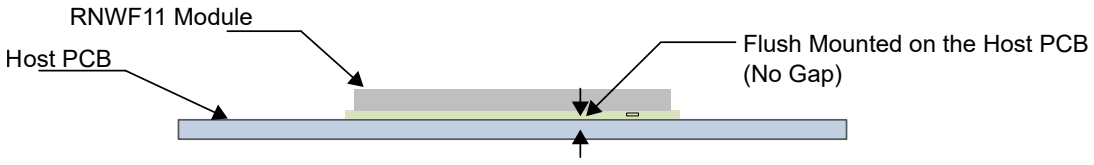
- A low-impedance ground plane for the RNWF11 Module ensures the best radio performance (best range and lowest noise). The ground plane can be extended beyond the minimum recommendation as required for the host board Electromagnetic Compatibility (EMC) and noise reduction.
- For best performance, keep metal structures and components (such as mechanical spacers, bump on and so on) at least 31.75 mm away from the PCB trace antenna (see the following figure).
- The antenna on the RNWF11 Module must not be placed in direct contact with or close proximity to plastic casing or objects. Keep a minimum clearance of 10 mm in all directions around the PCB antenna. The following figure illustrates the module placement.

Figure 2-6. RNWF11PC Module Placement (Top View)



- The module must be flush mounted to the host board. The following figure illustrates the mounting guidelines recommendation.

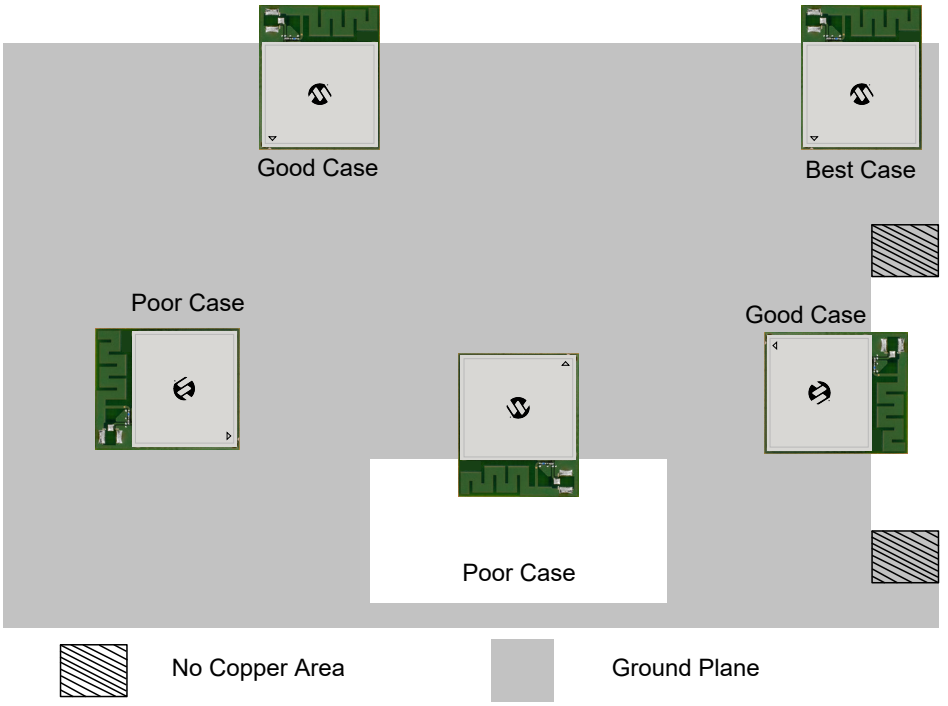
Figure 2-7. RNWF11 Mounting Guidelines Recommendation (Side View)



- Three exposed GND pads (61-63) on the bottom of the RNWF11 Module must be soldered to the host board (see 54-Lead RF Module With Shield (6YX) - 20.5x24.5 mm [MODULE]).
- A PCB cutout is required under the RF test point (see 54-Lead RF Module With Shield (6YX) - 20.5x24.5 mm [MODULE]).
- Copper keep-out areas are required on the top layer under voltage test points (55-60) (see 54-Lead RF Module With Shield (6YX) - 20.5x24.5 mm [MODULE]).

The following figure illustrates examples of the RNWF11PC Module placement on a host board with a ground plane. For placement-specific guidance, see Figure 2-6.

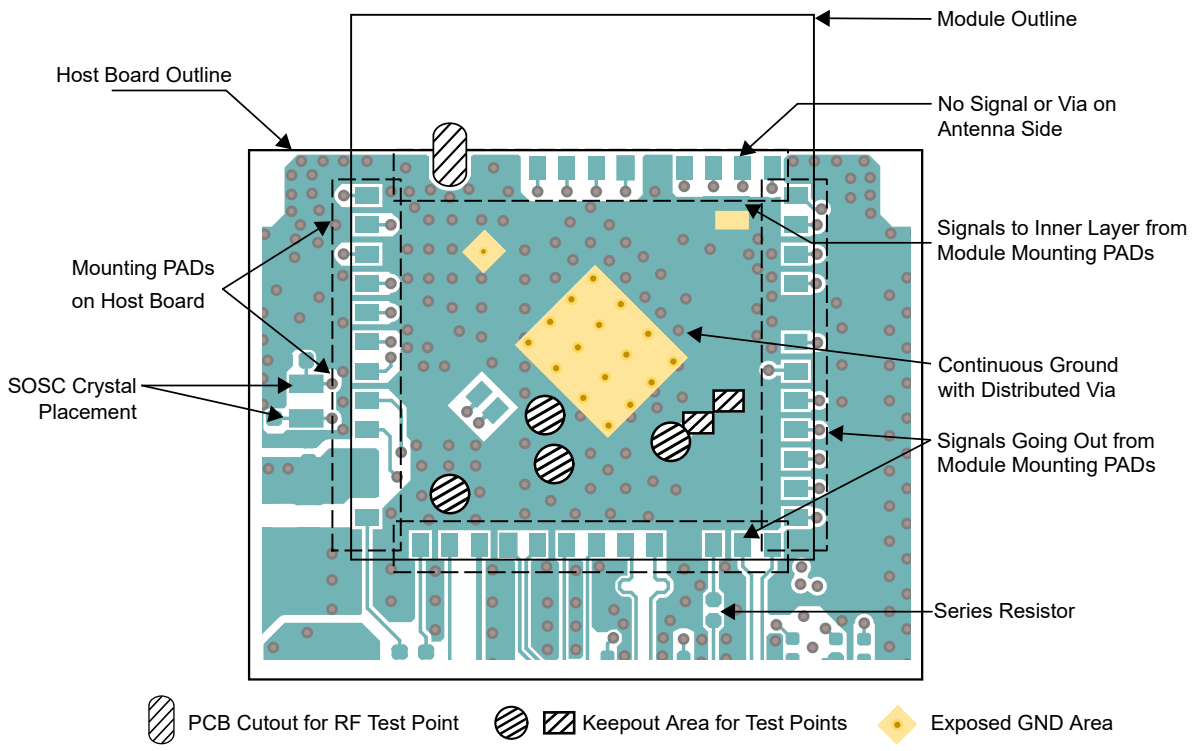
Figure 2-8. Examples of the RNWF11PC Module Placements on the Host Board



2.4 RNWF11 Module Routing Guidelines

- Use the multi-layer host board for routing signals on the inner layer and the bottom layer.
- The top layer (underneath the module) of the host board must be ground with as many GND vias as possible (see Figure 2-9 and 54-Lead RF Module With Shield (6YX) - 20.5x24.5 mm [MODULE]).
- Avoid fan-out of the signals under the module or antenna area. Use a via to fan-out signals to the edge of the RNWF11 Module.
- For better GND connection to the RNWF11 Module, solder the exposed GND pads of the RNWF11 Module on the host board.
- For the module GND pad, use a GND via of a minimum 10 mil (hole diameter) for good ground to all the layers and thermal conduction path.
- It is recommended to have a series resistor on the host board for all GPIOs. These resistors must be placed close to the RNWF11 Module. For the placement of the series resistor, see Figure 2-9. Pin 26 through pin 30 on the RNWF11 Module are critical pins to have series resistors. For more details on these pins, see Table 2-1.
- All Ethernet TX and RX signals trace lengths (RMII interface) are matched on the RNWF11 Module PCB.
- USB differential pair signals are 90Ω impedance matched on the RNWF11 Module PCB and the same must be followed on the host board.
- SOSC crystal (32.768 kHz) on the host board must be placed close to the RNWF11 Module and follow the shortest trace routing length with the minimum number of vias (see Figure 2-9 and Figure 2-10).

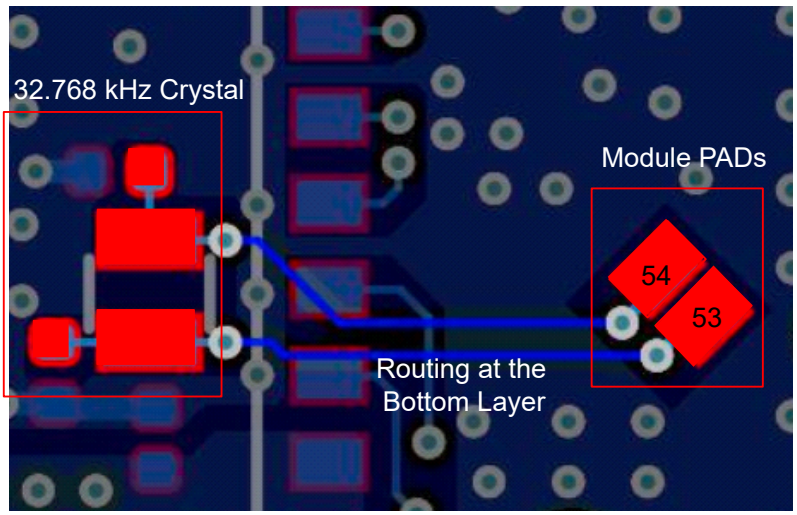
Figure 2-9. Example Host Board Top Layer



Note:

1. For the recommended RNWF11 Module footprint, see 54-Lead RF Module With Shield (6YX) - 20.5x24.5 mm [MODULE].

Figure 2-10. Placement and Routing of SOSC Crystal



2.5 RNWF11 Module RF Considerations

The overall performance of the system, RF and Wi-Fi are significantly affected by the product design, environment and application. The product designer must ensure system-level shielding (if required) and verify the performance of the product features and applications.

The user must consider the following guidelines for optimal Wi-Fi performance:

- Position the RNWF11 Module in a noise-free RF environment and keep it far away from high-frequency clock signals and any other sources of RF energy.
- Do not shield the antenna by any metal objects.
- The power supply must be clean and noise-free.
- Ensure that the width of the traces routed to GND, VDD rails are sufficiently large for handling peak TX current consumption.

Note: The RNWF11 Module includes RF shielding on top of the board as a standard feature.

2.6 RNWF11 Module Antenna Considerations

2.6.1 PCB Antenna

For the RNWF11PC Module, the PCB antenna is fabricated on the top copper layer and covered in solder mask. The layers below the antenna do not have copper trace. The recommendation is to mount the module on the edge of the host board, and ensure there is no PCB material beneath the antenna structure of the module, as well as avoid any copper traces or planes in that specific area of the host board. Also, verify the maintenance of antenna tuning when integrating the module onto a host board or end-product.

The following table provides details about the technical specification of the PCB antenna, which is tested with the RNWF11 Module mounted on a carrier/evaluation board of 0.8 mm PCB thickness.

Table 2-2. PCB Antenna Specifications

Parameter	Specification
Operating frequency	Approximately 2400-2500 MHz
Peak gain	2.51 dBi at 2450 MHz
Efficiency (average)	71%

2.6.1.1 PCB Antenna Radiation Pattern

The following figures illustrate the module orientation and PCB antenna radiation pattern.

Figure 2-11. Module Orientation for Radiation Pattern Measurement

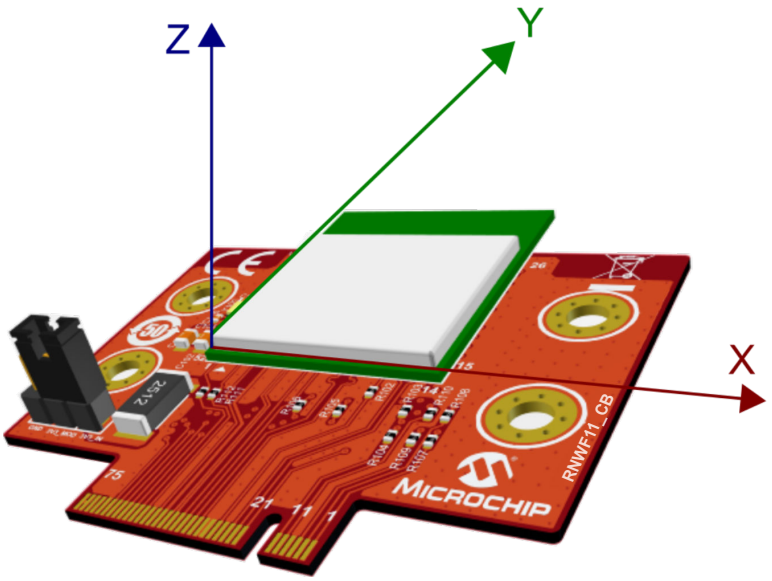


Figure 2-12. Phi = 0 Degree Antenna Radiation Pattern

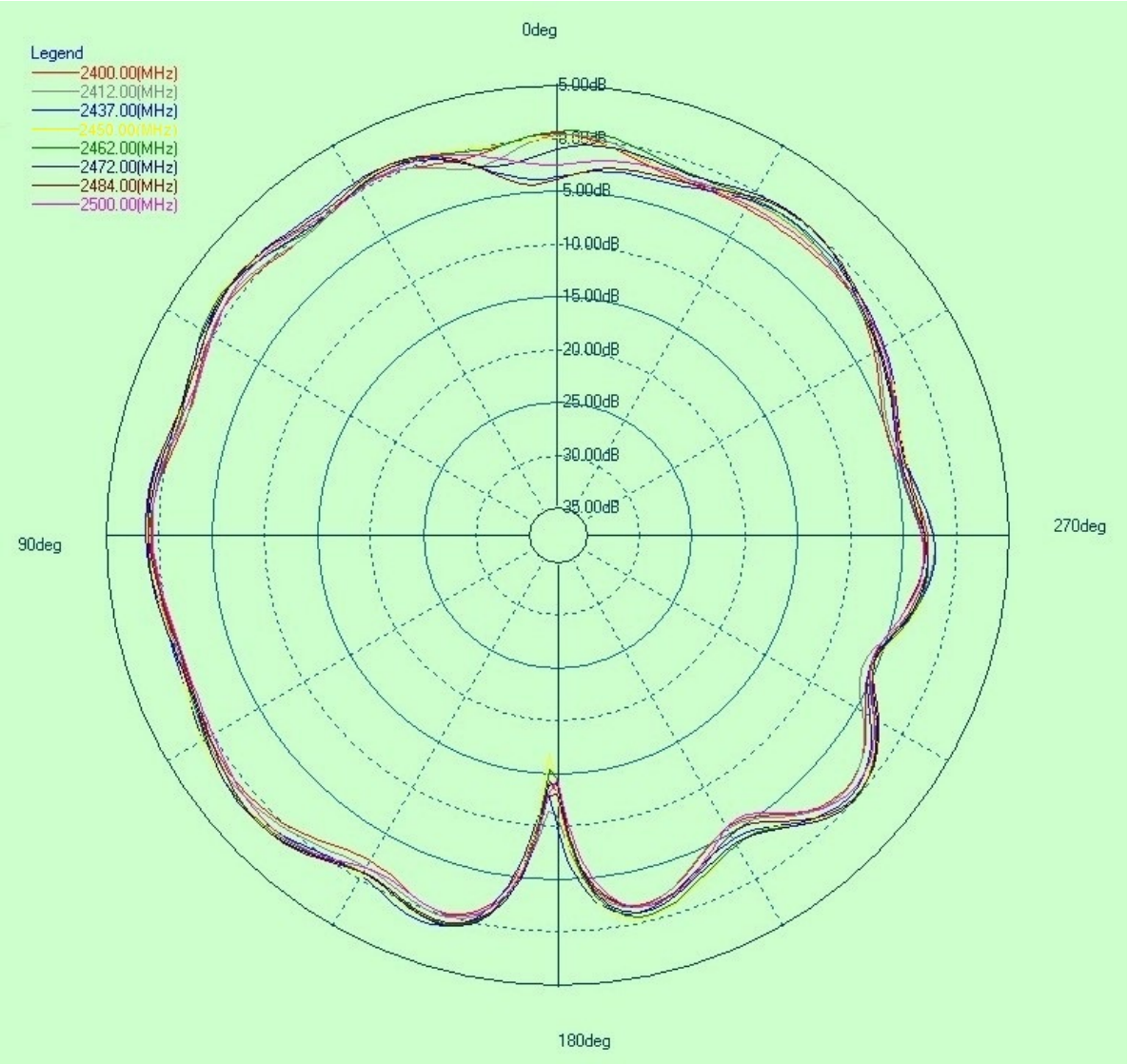


Figure 2-13. Phi = 90 Degree Antenna Radiation Pattern

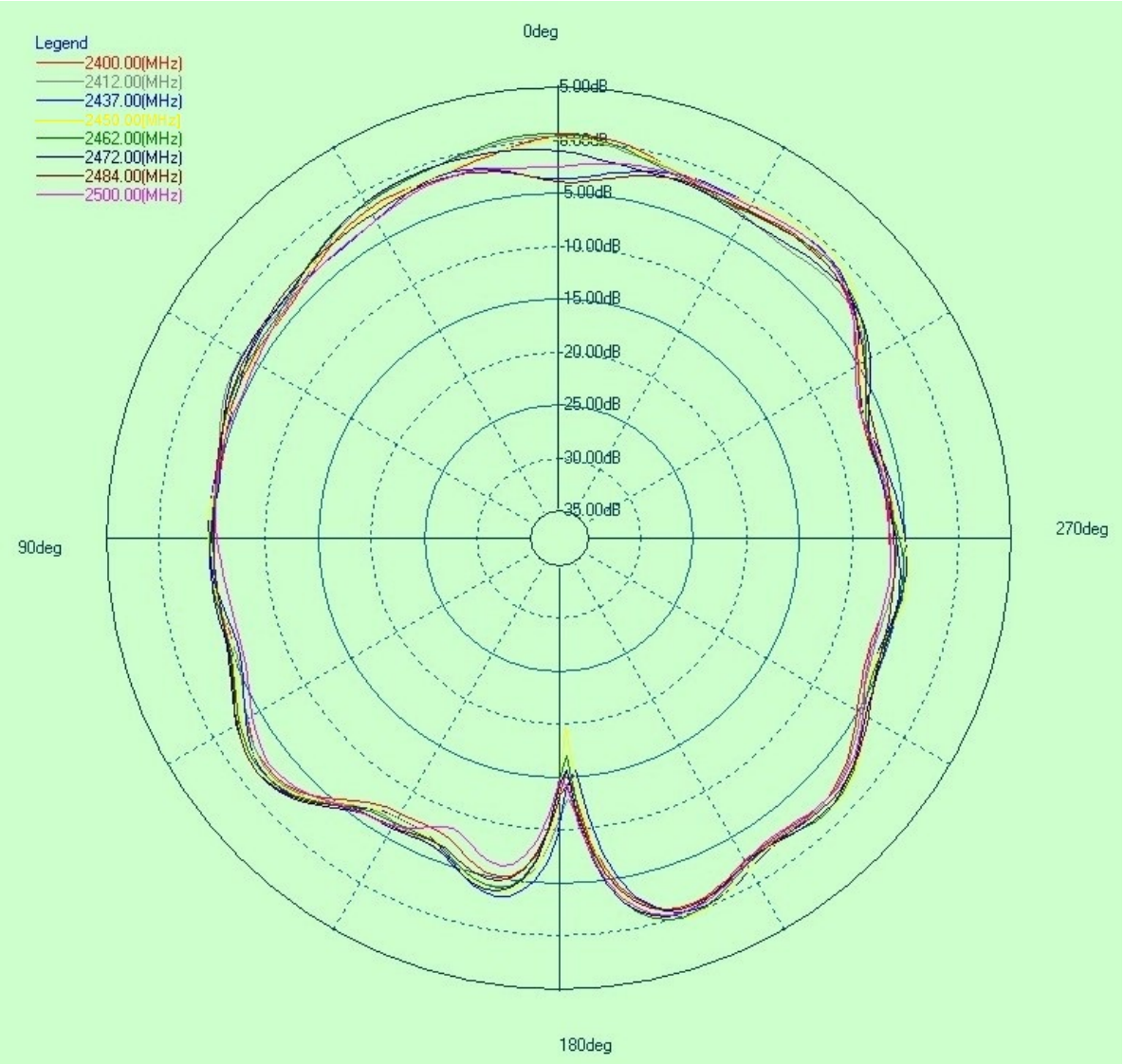
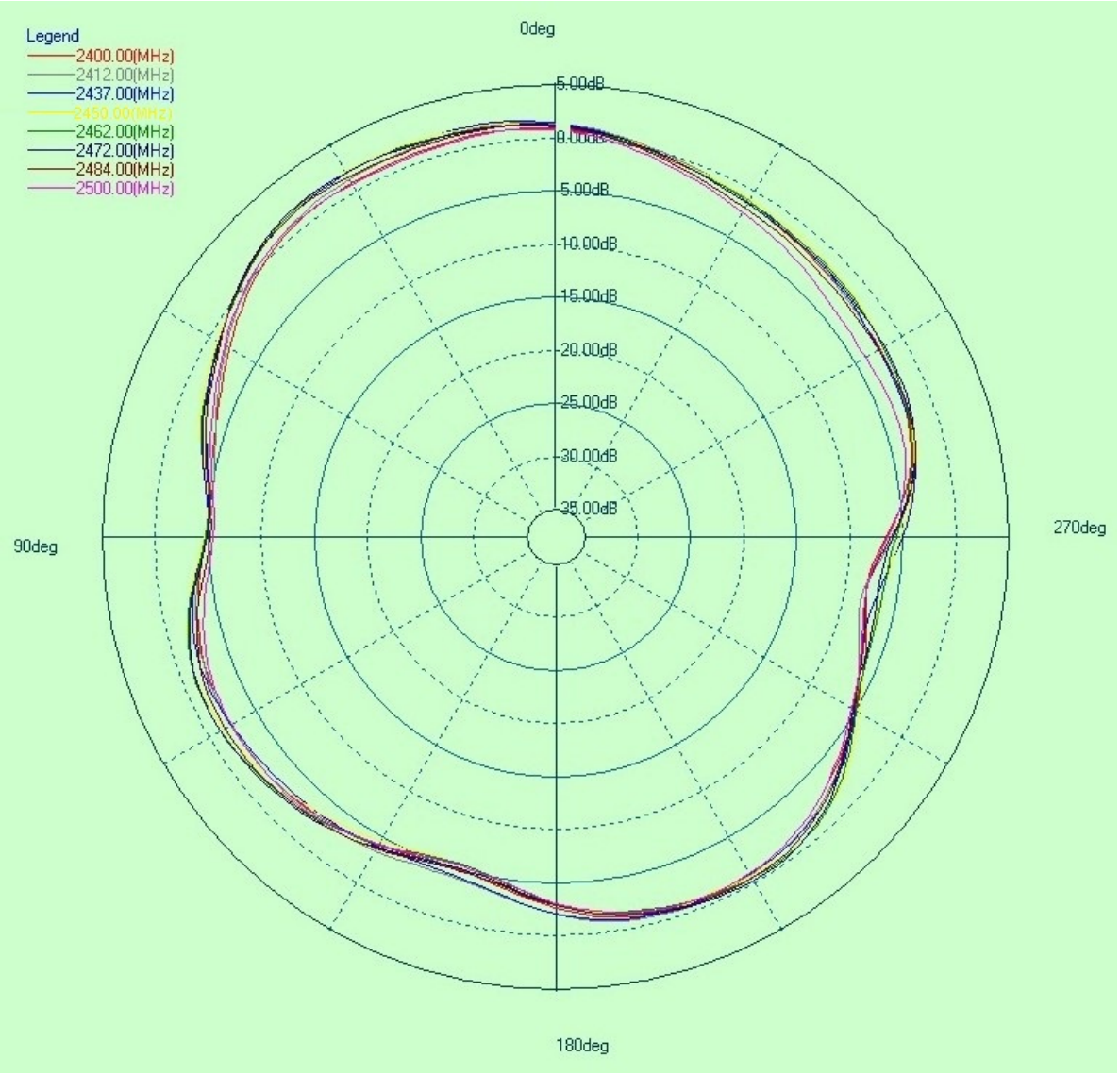


Figure 2-14. Theta=90 Degree Antenna Radiation Pattern



2.7 RNWF11 Module Reflow Profile Information

The assembly of the RNWF11 Module utilized the IPC/JEDEC J-STD-020 Standard lead-free reflow profile. The user can solder the RNWF11 Module to the host board using standard leaded or lead-free solder reflow profiles. To avoid damaging the RNWF11 Module, adhere to the following recommendations:

- For solder reflow recommendations, refer to the *AN233 Solder Reflow Recommendation* (DS00000233).
- Do not exceed a Peak Temperature (TP) of 250°C.
- For more details on specific reflow profile recommendations from the vendor, refer to the *Solder Paste Data Sheet*.
- 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.

2.7.1 Cleaning

The exposed GND pad helps to self-align the RNWF11 Module, avoiding pad misalignment. The recommendation is to use no-clean solder pastes. Ensure that the reflow process fully dries the no-clean paste fluxes. This can require longer reflow profiles and/or peak temperatures toward the high end of the process window as per the recommendation of the solder paste vendor. The uncured flux residues can lead to corrosion and/or shorting in accelerated testing and possibly the field.

2.8 RNWF11 Module Assembly Considerations

The RNWF11 Module is assembled with an EMI shield to ensure compliance with EMI emission and immunity rules. The EMI shield is made of a tin-plated steel (SPTE) and is not hermetically sealed. Solutions, such as IPA and similar solvents, can be used to clean this module. Cleaning solutions containing acid must never be used on the module.

2.8.1 Conformal Coating

The modules are not intended for use with a conformal coating and the customer assumes all risks (such as the module reliability, performance degradation and so on) if a conformal coating is applied to the modules.

3. Electrical Characteristics

This chapter provides the electrical characteristics of the RNWF11 Module across the operating temperature range of the device.

3.1 RNWF11 Module Electrical Characteristics

This chapter provides the electrical characteristics of the RNWF11 Module.

3.1.1 Absolute Maximum Ratings

Exposure to these maximum rating conditions for extended periods may affect device reliability. Functional operation of the device at these or any other conditions, above the parameters indicated in the operation listings of this specification, is not implied. The following table details about the absolute maximum ratings of the RNWF11 Module.

Table 3-1. Absolute Maximum Ratings

Parameter	Value
Ambient temperature under bias	-40°C to +85°C
Storage temperature	-40°C to +125°C
Voltage on V_{DD} with respect to GND	0.3V to (V_{DD} + 0.3V)
Voltage on V_{BUS} with respect to GND	0.3V to (V_{DD} + 0.3V)
Maximum current out of GND pin(s)	500 mA
Maximum current into V_{DD} pin(s)(2)	500 mA
Maximum current sunk/sourced by any 4x I/O pin(3)	15 mA
Maximum current sunk/sourced by any 8x I/O pin(3)	25 mA
Maximum current sunk by all ports	150 mA
Maximum current sourced by all ports(2)	150 mA
ESD Qualification	
Human Body Model (HBM) per JEDEC JS-001-2017	±2000V
Charged Device Model (CDM) (JEDEC JS-002-2018)	±500V

Notes:

1. The stresses mentioned in this table can 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 to maximum rating conditions for extended periods can affect device reliability.
2. The maximum allowable current is a function of the device's maximum power dissipation.
3. Characterized, but not tested. For the 4x and 8x I/O pin lists, refer to the parameters DO10 and DO20.

Table 3-2. Recommended Operating Conditions

Symbol	Parameter	Min.	Typ.	Max.	Unit
V_{DD}	Power supply input voltage	3.0	3.3	3.6	V

3.1.2 DC Characteristics

Table 3-3. POR Electrical Characteristics

DC CHARACTERISTICS			Standard Operating Conditions: 2.97V to 3.63V (Unless Otherwise Stated) Operating Temperature: -40°C ≤ T_A ≤ +85°C				
Parameter No.	Symbol	Characteristics	Min.	Typ.	Max.	Units	Conditions
DC16	V_{POR}	VDD start voltage to ensure internal POR signal	1.5	—	—	V	—
DC17	SV_{DD}	V_{DD} rise rate to ensure internal POR signal	0.03	—	0.115	V/ms	110-28.7 ms at 3.3V

Table 3-4. BOR Electrical Characteristics

DC CHARACTERISTICS			Standard Operating Conditions: 2.97V to 3.63V (Unless Otherwise Stated) Operating Temperature: -40°C ≤ T_A ≤ +85°C				
Parameter No.	Symbol	Characteristics	Min.(1)	Typ.	Max.	Units	Conditions
BO10	V_{BOR}	BOR event on V_{DD} transition high-to-low(2)	2.6	—	2.8	V	—

Notes:

1. Parameters are for design guidance only and are not tested in manufacturing.
2. Overall functional device operation at $V_{BORMIN} < V_{DD} < V_{DDMIN}$ is tested but not characterized. All device Analog modules, such as ADC and more, are going to function but with degraded performance below V_{DDMIN}.

Table 3-5. Operating Current (I_{DD}, RF = OFF)(1)(2)

DC CHARACTERISTICS			Standard Operating Conditions: 2.97V to 3.63V (Unless Otherwise Stated) Operating Temperature: -40°C ≤ T_A ≤ +85°C	
Parameter No.	Typ.(1)	Max.	Units	Conditions
I/O Operating Current (IDD): Peripheral Enabled (PMDx = 0)				
DC26	23.6	—	mA	200 MHz

Note:

1. Data in the Typical column is at 3.3V, 25°C unless otherwise stated.

Table 3-6. Power-Down Current (I_{PD})

DC CHARACTERISTICS(3)			Standard Operating Conditions:2.97V to 3.63V (Unless Otherwise Stated) Operating Temperature: -40°C ≤ T_A ≤ +85°C		
Parameter No.	Typ.(1)	Max.	Units	Conditions	
Power-Down Current (I_{PD})					
DC40s	1.7	—	µA	-40°C	Extreme Sleep mode(2)
DC40t	0.71	—	µA	25°C	
DC40u	2.12	—	µA	85°C	
Module Differential Current					
DC42e	70	—	µA	3.3V	• RTCC+ Timer1 with 32 kHz • Crystal: ΔI_{RTCC}
DC43d	120	—	µA	3.3V	ADC: ΔI_{ADC}

.....continued				
DC CHARACTERISTICS(3)			**Standard Operating Conditions:2.97V to 3.63V (Unless Otherwise Stated)** **Operating Temperature: -40°C ≤ T_A ≤ +85°C**	
Parameter No.	**Typ.(1)**	**Max.**	**Units**	**Conditions**
Power-Down Current (I_{PD})				

Notes:

1. Data in the Typical column is at 3.3V, Ta = 25°C unless otherwise stated.
2. All subsystems disabled except WAKE pin.
3. This parameter is characterized but not tested in manufacturing.

Table 3-7. I/O Pin Input Specifications

DC CHARACTERISTICS			**Standard Operating Conditions: 2.97V to 3.63V (Unless Otherwise Stated)** **Operating Temperature: -40°C ≤ T_A ≤ +85°C**				
Parameter No.	**Symbol**	**Characteristics**	**Min.**	**Typ.(1)**	**Max.**	**Units**	**Conditions**
—	V_{IL}	Input low voltage	—	—	—	—	—
DI10		I/O pins	V_{SS}	—	0.2* V_{DD}	V	—
DI18		SDAx, SCLx	V_{SS}	—	0.3* V_{DD}	V	SMBus disabled(4)
DI19		SDAx, SCLx	V_{SS}	—	0.8	V	SMBus enabled(4)
DI20	V_{IH}	Input high voltage	—	—	—	—	(4)
		I/O pins	0.80* V_{DD}	—	V_{DD}	V	
DI30	I_{CNPU}	Change notification pull-up current	—	—	-40	µA	• V_{DD} = 3.3V • V_{PIN} = V_{SS}(3)
DI50	I_{IL}	Input leakage current(3)	—	—	—	—	—
		I/O ports	—		±1	µA	V_{SS} ≤ V_{PIN} ≤ V_{DD}, Pin at high-impedance
DI51		Analog input pins	—		±1	µA	V_{SS} ≤ V_{PIN} ≤ V_{DD}, Pin at high-impedance
DI55		$\overline{MCLR}$(2)	—		±1	µA	V_{SS} ≤ V_{PIN} ≤ V_{DD}
DI56		XTAL_IN	—		±1	µA	V_{SS} ≤ V_{PIN} ≤ V_{DD}, HS mode

Notes:

1. Data in the Typ. column is at 3.3V, +25°C unless otherwise stated.
2. The leakage current on the $\overline{MCLR}$ pin is strongly dependent on the applied voltage level. The specified levels represent normal operating conditions. Higher leakage current may be measured at different input voltages.
3. Negative current is defined as current sourced by the pin.
4. This parameter is characterized but not tested in manufacturing.

Table 3-8. I/O Pin Output Specifications

DC CHARACTERISTICS			Standard Operating Conditions: 2.97V to 3.63V (Unless Otherwise Stated) Operating Temperature: -40°C ≤ T_A ≤ +85°C				
Parameter No.	Symbol	Characteristic	Min.	Typ.	Max.	Units	Conditions[1]
DO10	V_{OL}	Output low voltage I/O pins: 4xsink driver pins - RA4, RA5, RA10, RA13, RA14, RB4-RB7, RB9, RB12, RC9-RC12, RK1, RK4-RK7, RK12	—	—	0.4	V	I_{OL} ≤ 10 mA, V_{DD} = 3.3V
		Output low voltage I/O pins: 8x sink driver pins - RA0, RA1, RA11, RC0, RC8, RC9, RC13-RC15, RK13, RK14	—	—	0.4	V	I_{OL} ≤ 15 mA, V_{DD} = 3.3V
DO20	V_{OH}	Output high voltage I/O pins: 4xsource driver pins - RA4, RA5, RA10, RA13, RA14, RB4-RB7, RB9, RB12, RC9-RC12, RK1, RK4-RK7, RK12	2.4	—	—	V	I_{OH} ≥ -10 mA, V_{DD} = 3.3V
		Output high voltage I/O pins: 8x source driver pins - RA1, RC8, RC9, RC13, RC14, RC15, RK13, RK14	2.4	—	—	V	I_{OH} ≥ -15 mA, V_{DD} = 3.3V
DO20a	V_{OH1}	Output high voltage I/O pins: 4xsource driver pins - RA4, RA5, RA10, RA13, RA14, RB4-RB7, RB9, RB12, RC9-RC12, RK1, RK4-RK7, RK12	1.5	—	—	V	I_{OH} ≥-14 mA, V_{DD} = 3.3V
			2.0	—	—	V	I_{OH} ≥ -12 mA, V_{DD} = 3.3V
			3.0	—	—	V	I_{OH} ≥ -7 mA, V_{DD} = 3.3V
		Output high voltage I/O pins: 8x source driver pins - RA1, RC8, RC9, RC13, RC14, RC15, RK13, RK14	1.5	—	—	V	I_{OH} ≥ -22 mA, V_{DD} = 3.3V
			2.0	—	—	V	I_{OH} ≥ -18 mA, V_{DD} = 3.3V
			3.0	—	—	V	I_{OH} ≥ -10 mA, V_{DD} = 3.3V

Note: These parameters are characterized but not tested in manufacturing.

Table 3-9. Wi-Fi® Current

DC Characteristics		Standard Operating Conditions: 3.0-3.6V (Unless Otherwise Stated) Operating Temperature: -40°C ≤ T_A ≤ +85°C	
Device States	Code Rate[6]	Output Power (Typ.) (dBm)	Current (Typ.) (mA)[3]
On_Transmit[4]	802.11b 1 Mbps[5]	20.5	293
	802.11b 1 Mbps	14.5	212
	802.11b 11 Mbps[5]	20.5	293
	802.11g 6 Mbps	19.5	272
	802.11g 54 Mbps[5]	18.5	241
	802.11n MCS0	18.5	258
	802.11n MCS7[5]	17.0	223
	802.11n MCS7	11.0	179
On_Receive	802.11b 1 Mbps	—	75
	802.11n MCS7[5]	—	89.5

.....continued			
DC Characteristics		**Standard Operating Conditions: 3.0-3.6V (Unless Otherwise Stated)** **Operating Temperature: -40°C ≤ T_A ≤ +85°C**	
Device States	**Code Rate(6)**	**Output Power (Typ.) (dBm)**	**Current (Typ.) (mA)(3)**

Notes:

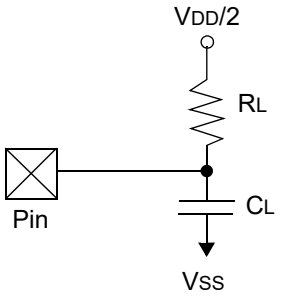
1. Measured along with the RF matching network and FEM circuit (assume 50W impedance).
2. The test conditions for I_{DD} measurements are as follows:
   - CPU, Flash Panel and SRAM data memory are operational
   - CPU is operating at 50 MHz
   - CPU is in Wi-Fi® RF Test mode
   - All peripheral modules are disabled (ON bit = 0) but the associated PMD bit is cleared
   - Watchdog and fail safe clock monitor disabled
   - All I/O pins are configured as inputs and pulled to V_{DD}
   - VBUS3V3 connected to V_{DD}
   - $\overline{MCLR}$ = V_{DD}
3. Data in the Typ. column is at 3.3V, 25°C unless otherwise stated.
4. Tested at channel 7 in Fixed Mode Gain.
5. This parameter is characterized and tested in manufacturing.
6. This parameter is characterized but not tested in manufacturing.

3.1.3 AC Characteristics and Timing Parameters

The information contained in this section defines the RNWF11 Module AC characteristics and timing parameters.

Figure 3-1. Load Conditions for Device Timing Specifications

Load Condition 1 – for all pins except XTAL_OUT



- R_L = 464Ω
- C_L = 50 pF for all pins except XTAL_OUT
- C_L = 12 pF for XTAL_OUT output

Table 3-10. Capacitive Loading Requirements on Output Pins

AC CHARACTERISTICS			**Standard Operating Conditions: 2.97V to 3.63V (Unless Otherwise Stated)** **Operating Temperature: -40°C ≤ T_A ≤ +85°C**				
Parameter No.	**Symbol**	**Characteristics**	**Min.**	**Typ.(1)**	**Max.**	**Units**	**Conditions**
DO56	CI	All I/O pins (except pins used as CxOUT)	—	—	50	pF	—
DO58	Cb	SCLx, SDAx	—	—	400	pF	I^2C mode

Note:

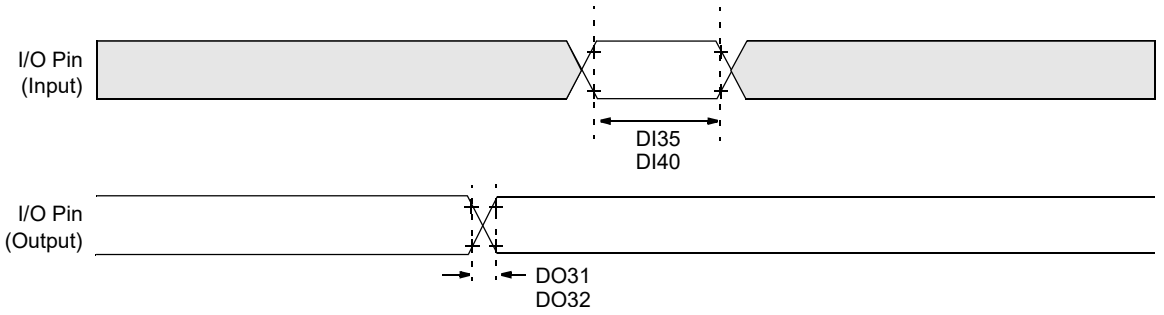
1. Data in the Typ. column is at 3.3V, +25°C unless otherwise stated.

Table 3-11. I/O Timing Requirements

AC CHARACTERISTICS		Standard Operating Conditions: 2.97V to 3.63V (Unless Otherwise Stated) Operating Temperature: -40°C ≤ T_A ≤ +85°C					
Parameter No.	Symbol	Characteristics[2]	Min.	Typ.[1]	Max.	Units	Conditions
DO31	T_{IOR}	**Port output rise time**	—	—	9.5	ns	C_{LOAD} = 50 pF
		I/O pins:	—	—	6	ns	C_{LOAD} = 20 pF
		4x source driver pins -					
		RA4, RA5, RA10, RA13, RA14, RB4-RB7, RC9-RC12, RK1, RK4-RK7, RK12					
		Port output rise time	—	—	8	ns	C_{LOAD} = 50 pF
		I/O pins:	—	—	6	ns	C_{LOAD} = 20 pF
		8x source driver pins -					
		RA1, RC8, RC9, RC13, RC14, RC15, RK13, RK14					
DO32	T_{IOF}	**Port output fall time**	—	—	9.5	ns	C_{LOAD} = 50 pF
		I/O pins:	—	—	6	ns	C_{LOAD} = 20 pF
		4x source driver pins -					
		RA10, RB4-RB7, RB9, RB12, RC9-RC12, RK12					
		Port output fall time	—	—	8	ns	C_{LOAD} = 50 pF
		I/O pins:	—	—	6	ns	C_{LOAD} = 20 pF
		8x source driver pins -					
		RA1, RC8, RC9, RC13-RC15, RK13, RK14					
DI35	T_{INP}	INTx pin high or low time	5	—	—	ns	—
DI40	T_{RBP}	CNx high or low time (input)	5	—	—	ns	—

Notes:
1. Data in the Typ. column is at 3.3V, +25°C unless otherwise stated.
2. This parameter is characterized but not tested in manufacturing.

Figure 3-2. I/O Timing Characteristics



Note: For more details on load conditions, see Figure 3-1.

Table 3-12. ADC Module Specifications[1, 2]

AC CHARACTERISTICS			Standard Operating Conditions: 2.97V to 3.63V (Unless Otherwise Stated) Operating Temperature: -40°C ≤ T_A ≤ +85°C				
Parameter No.	Symbol	Characteristics	Min.	Typ.	Max.	Units	Conditions
Device Supply							
AD01	AV_{DD}	Module V_{DD} supply	V_{DD}–0.3	—	V_{DD} + 0.3	V	—

.....continued

AC CHARACTERISTICS			Standard Operating Conditions: 2.97V to 3.63V (Unless Otherwise Stated) Operating Temperature: -40°C ≤ T_A ≤ +85°C				
Parameter No.	**Symbol**	**Characteristics**	**Min.**	**Typ.**	**Max.**	**Units**	**Conditions**
Device Supply							
AD02	AV_{SS}	Module V_{SS} supply	V_{SS}	—	V_{SS} + 0.3	V	—
Reference Inputs							
AD05	V_{REFH}	Reference voltage high	—	—	AV_{DD}	V	(1)
AD06	V_{REFL}	Reference voltage low	AV_{SS}	—	—	V	(1)
AD07	V_{REF}	Absolute reference voltage (V_{REFH}– V_{REFL})	AV_{DD}–0.3	—	AV_{DD} + 0.3	V	(2)
AD08	I_{REF}	Current drain	—	102	—	µA	Per ADCx (‘x’ = 0-4, 7)
Analog Input							
AD12	V_{INH}- V_{INL}	Full-Scale input span	V_{REFL}	—	V_{REFH}	V	—
AD13	V_{INL}	Absolute V_{INL} input voltage	AV_{SS}	—	V_{REFL}	V	—
AD14	V_{INH}	Absolute V_{INH} input voltage	AV_{SS}	—	V_{REFH}	V	—
ADC Accuracy							
AD20c	N_R	Resolution	6	—	12	bits	Selectable 6, 8, 10, 12 resolution ranges
AD21c	INL	Integral nonlinearity	—	±3	—	LSb	V_{INL} = AVSS = V_{REFL} = 0V, AV_{DD} = V_{REFH} = 3.3V
AD22c	DNL	Differential nonlinearity	—	±1	—	LSb	V_{INL} = AV_{SS} = V_{REFL} = 0V, AV_{DD} = V_{REFH} = 3.3V
AD23c	G_{ERR}	Gain error	—	±8	—	LSb	V_{INL} = AV_{SS} = V_{REFL} = 0V, AV_{DD} = V_{REFH} = 3.3V
AD24c	E_{OFF}	Offset error	—	±4	—	LSb	V_{INL} = AV_{SS} = 0V, AV_{DD} = 3.3V
Dynamic Performance							
AD31b	SINAD	Signal to noise and distortion	—	67	—	dB	Single-ended(4)(5)
AD34b	ENOB	Effective number of bits	—	10.5	—	bits	(4)(5)

Notes:

1. The ADC module is functional at V_{BORMIN} < V_{DD} < V_{DDMIN} but with degraded performance. Unless otherwise stated, module functionality is guaranteed but not characterized.
2. ADC performance is measured in the MCU mode only.
3. These parameters are not characterized or tested in manufacturing.
4. These parameters are characterized but not tested in manufacturing.
5. Characterized with a 1 kHz sine wave.

3.1.4 Radio Performance of the RNWF11 Module

This section describes the Wi-Fi radio specifications and performance characteristics of the RNWF11 Module.

Table 3-13. Radio Specifications

Feature	Description
WLAN standards	IEEE® 802.11b/g/n
Frequency range	Approximately 2.412-2.472 GHz (approximately 2400-2483.5 MHz ISM band)
Number of channels	11 for North America and 13 for Europe and Japan

3.1.4.1 Receiver Performance

The following table provides the receiver performance characteristics of the RNWF11 Module.

Table 3-14. RNWF11 Module Receiver Performance Characteristics(1)

RF Characteristics		Standard Operating Conditions: 3.0-3.6V (Unless Otherwise Stated) Operating Temperature: -40°C ≤ T_A ≤ +85°C Measured at 25°C, 3.3V			
Parameter	**Description(5)**	**Min.**	**Typ.**	**Max.**	**Unit**
Frequency	—	2412	—	2472	MHz
Sensitivity 802.11b	1 Mbps DSSS	—	-99.5	—	dBm
	2 Mbps DSSS	—	-96.5	—	
	5.5 Mbps DSSS	—	-94.5	—	
	11 Mbps DSSS(6)	—	-91.5	—	
Sensitivity 802.11g	6 Mbps OFDM	—	-93.5	—	dBm
	9 Mbps OFDM	—	-93	—	
	12 Mbps OFDM	—	-91	—	
	18 Mbps OFDM	—	-89	—	
	24 Mbps OFDM	—	-86	—	
	36 Mbps OFDM	—	-82.5	—	
	48 Mbps OFDM	—	-78.5	—	
	54 Mbps OFDM(6)	—	-76.5	—	
Sensitivity 802.11n (Bandwidth at 20 MHz) (both long GI and short GI)	MCS 0	—	-92.5	—	dBm
	MCS 1	—	-89.5	—	
	MCS 2	—	-87.5	—	
	MCS 3	—	-84.5	—	
	MCS 4	—	-80.5	—	
	MCS 5	—	-76.5	—	
	MCS 6	—	-74.5	—	
	MCS 7(6)	—	-73	—	
Maximum receive signal level	1, 2 Mbps DSSS	-2	—	—	dBm
	5.5, 11Mbps DSSS	-2	—	—	
	6 Mbps OFDM	-2	—	—	
	54 Mbps OFDM	-7	—	—	
	MCS 0	-2	—	—	
	MCS 7	-8	—	—	

.....continued

RF Characteristics		Standard Operating Conditions: 3.0-3.6V (Unless Otherwise Stated) Operating Temperature: -40°C ≤ T_A ≤ +85°C Measured at 25°C, 3.3V			
Parameter	**Description(5)**	**Min.**	**Typ.**	**Max.**	**Unit**
Adjacent channel rejection	1 Mbps DSSS (30 MHz offset)	44.5	—	—	dB
	11 Mbps DSSS (25 MHz offset)	39.5	—	—	
	6 Mbps OFDM (25 MHz offset)	41.5	—	—	
	54 Mbps OFDM (25 MHz offset)	24.5	—	—	
	MCS 0 – 20 MHz Bandwidth (25 MHz offset)	40.5	—	—	
	MCS 7 – 20 MHz Bandwidth (25 MHz offset)	21.5	—	—	
RSSI accuracy	—	-5	—	+5	dB

Notes:

1. Measured after the RF matching network and FEM output (assume 50 impedance).
2. RF performance is ensured at 3.3V, 25°C, with a 2-3 dB change at boundary conditions.
3. The availability of some specific channels and/or operational frequency bands are country-dependent and must be programmed in the host product at the factory to match the intended destination. Regulatory bodies prohibit exposing the settings to the end user. This requirement needs to be taken care of via host implementation.
4. The host product manufacturer must ensure that the RF behavior adheres to the certification (for example, FCC, ISED) requirements when the module is installed in the final host product.
5. This parameter is characterized but not tested in manufacturing.
6. This parameter is characterized and tested in manufacturing.

3.1.4.2 Transmitter Performance

The following table provides the transmitter performance characteristics of the RNWF11 Module.

Table 3-15. RNWF11 Module Transmitter Performance Characteristics

RF Characteristics		Standard Operating Conditions: 3.0V to 3.6V (Unless Otherwise Stated) Operating Temperature: -40°C ≤ T_A ≤ +85°C Measured at 25°C, 3.3V			
Parameter	**Description(8)**	**Min.**	**Typ.(3)**	**Max.**	**Unit**
Frequency	—	2412	—	2472	MHz
Output power(1)(2) 802.11b	1 Mbps DSSS(9)	—	20.5	—	dBm
	2 Mbps DSSS	—	20.5	—	
	5.5 Mbps DSSS	—	20.5	—	
	11 Mbps DSSS	—	20.5	—	

.....continued

RF Characteristics		Standard Operating Conditions: 3.0V to 3.6V (Unless Otherwise Stated) Operating Temperature: -40°C ≤ T_A ≤ +85°C Measured at 25°C, 3.3V			
Parameter	**Description[8]**	**Min.**	**Typ.[3]**	**Max.**	**Unit**
Output power[1][2] 802.11g	6 Mbps OFDM	—	19.5	—	dBm
	9 Mbps OFDM	—	19.5	—	
	12 Mbps OFDM	—	19.5	—	
	18 Mbps OFDM	—	19.5	—	
	24 Mbps OFDM	—	19.5	—	
	36 Mbps OFDM	—	19.5	—	
	48 Mbps OFDM	—	19.5	—	
	54 Mbps OFDM[9]	—	18.5	—	
Output power[1][2] 802.11n (Bandwidth at 20 MHz)	MCS 0	—	18.5	—	dBm
	MCS 1	—	18.5	—	
	MCS 2	—	18.5	—	
	MCS 3	—	18.5	—	
	MCS 4	—	18.5	—	
	MCS 5	—	18.5	—	
	MCS 6	—	18	—	
	MCS 7[9]	—	17	—	
Transmit Power Control (TPC) Accuracy	—	—	±1.5[2]	—	dB
Harmonic output power (Radiated, Regulatory mode)	2nd	—	42	74[7]	dBuV/m
	3rd	—	Below noise floor	74[7]	

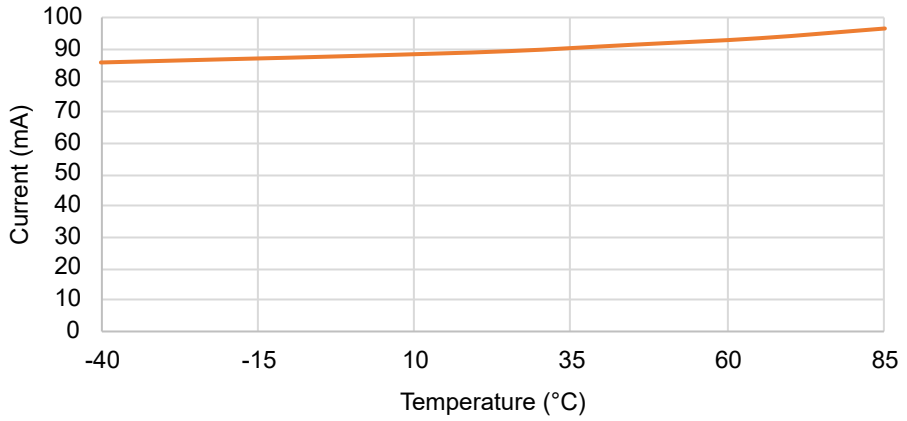
Notes:

1. Measured at IEEE® 802.11 specification-compliant EVM/Spectral mask.
2. Measured after the RF matching network and FEM output (assume 50Ω impedance).
3. RF performance is ensured at 3.3V, 25°C, with a 2-3 dB change at boundary conditions.
4. With respect to TX power, different (higher/lower) RF output power settings may be used for specific antennas and/or enclosures, in which case, re-certification may be required. Program the custom gain table to control the transmit power using the MCHPRT3 tool. For more details, refer to the *Testing PIC32MZ-W1 SoC with MCHPRT3 Tool (DS50003203)*.
5. The availability of some specific channels and/or operational frequency bands are country-dependent and must be programmed in the host product at the factory to match the intended destination. Regulatory bodies prohibit exposing the settings to the end user. This requirement needs to be taken care of via host implementation.
6. The host product manufacturer must ensure that the RF behavior adheres to the certification (for example, FCC, ISED) requirements when the module is installed in the final host product.
7. FCC-radiated emission limits (restricted band)
8. This parameter is characterized but not tested in manufacturing.
9. This parameter is characterized and tested in manufacturing.

3.1.5 RNWF11 Module Characteristics Graph

3.1.5.1 Receiver and Transmitter Current Characteristics Graphs

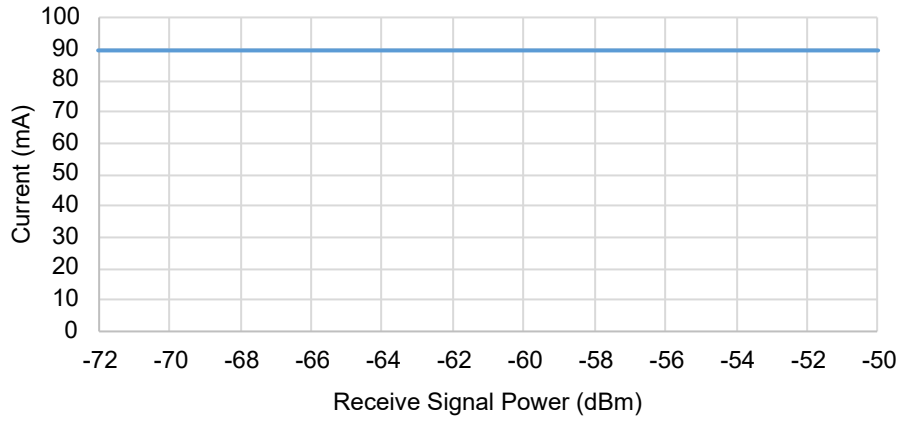
Figure 3-3. Receive Current vs. Temperature MCS7, Channel 7, 3.3V



Notes:

1. At all the data rates, the performance remains the same except the values. This graph is only for reference.
2. The current measurement includes the SoC and FEM current.
3. This current includes processor current.

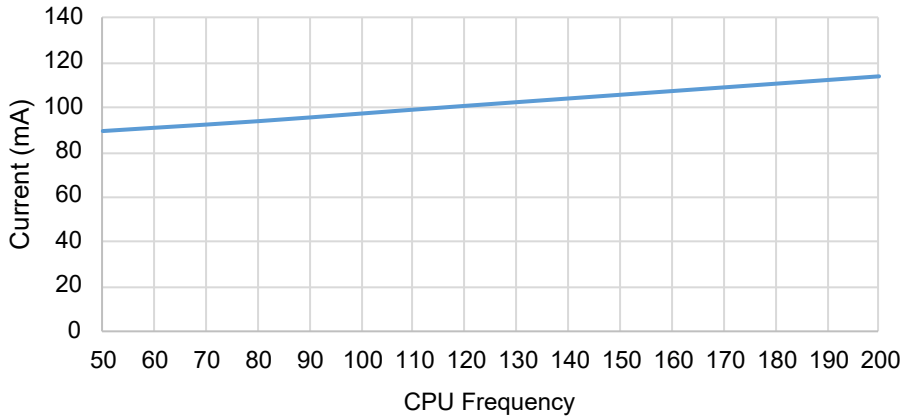
Figure 3-4. Receive Current vs. Receive Signal Power MCS7, Channel 7, 3.3V, 25°C



Notes:

1. At all the data rates, the performance remains the same except the values. This graph is only for reference.
2. The current measurement includes the SoC and FEM current.
3. This current includes processor current.

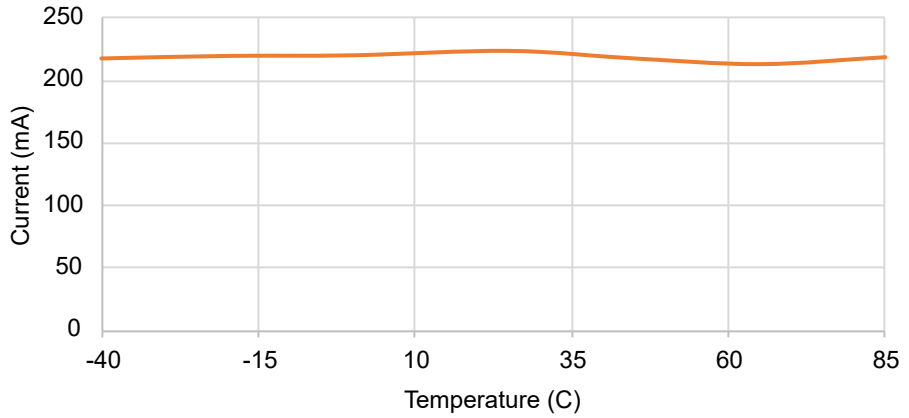
Figure 3-5. Receive Current vs. CPU Frequency MCS7, Channel 7, 3.3V, 25°C



Notes:

1. At all the data rates, the performance remains the same except the values. This graph is only for reference.
2. The current measurement includes the SoC and FEM current.
3. This current includes processor current.

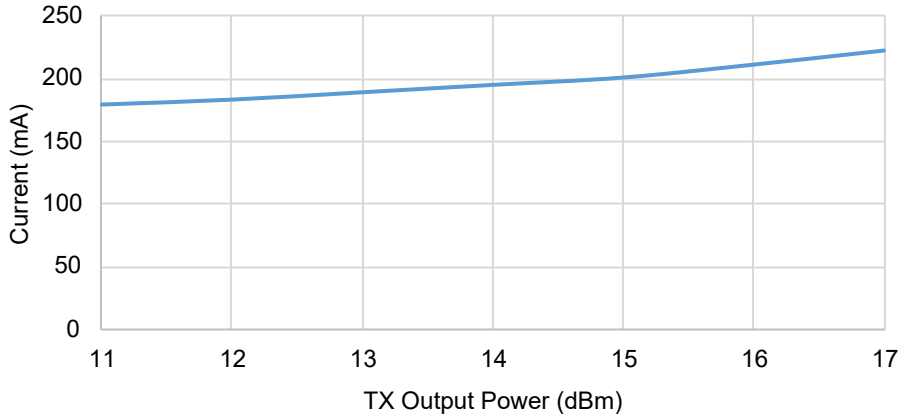
Figure 3-6. Transmit Current vs. Temperature MCS7, Channel 7, 3.3V



Notes:

1. At all the data rates, the performance remains the same except the values. This graph is only for reference.
2. The current measurement includes the SoC and FEM current.
3. This current includes processor current.

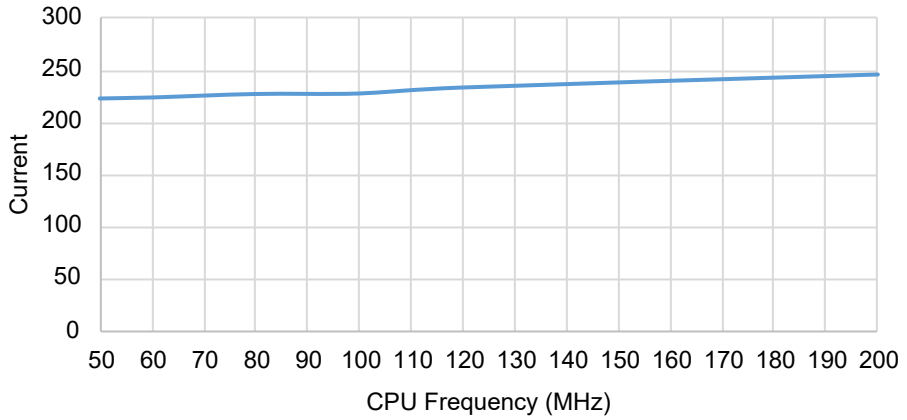
Figure 3-7. Transmit Current vs. Output Power MCS7, Channel 7, 3.3V, 25°C



Notes:

1. At all the data rates, the performance remains the same except the values. This graph is only for reference.
2. The current measurement includes the SoC and FEM current.
3. This current includes processor current.

Figure 3-8. Transmit Current vs. CPU Frequency MCS7, Channel 7, 3.3V, 25°C

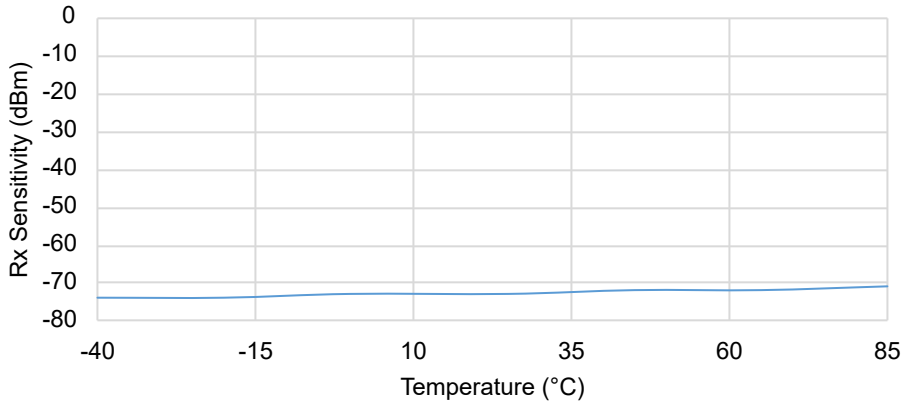


Notes:

1. At all the data rates, the performance remains the same except the values. This graph is only for reference.
2. The current measurement includes the SoC and FEM current.
3. This current includes processor current.

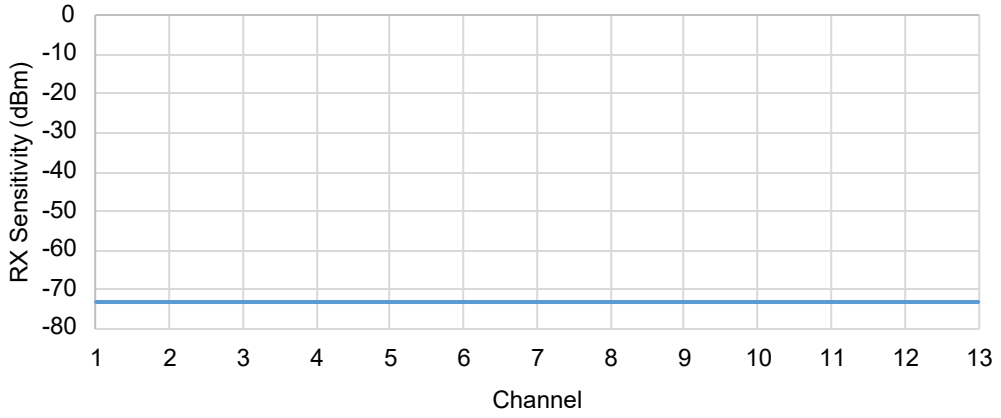
3.1.5.2 Receiver and Transmitter Performance Characteristics Graphs

Figure 3-9. RX Sensitivity vs. Temperature MCS7, Channel 7, 3.3V



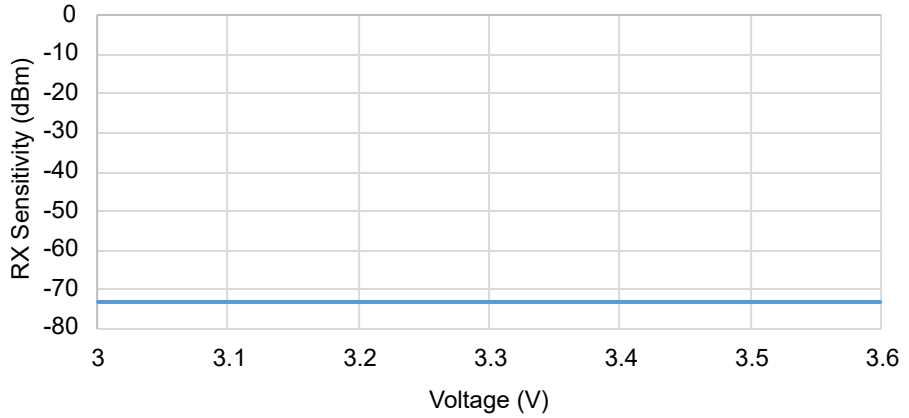
Note: At all the data rates, the performance remains the same except the values. This graph is only for reference.

Figure 3-10. RX Sensitivity vs. Channel MCS7, 25°C, 3.3V



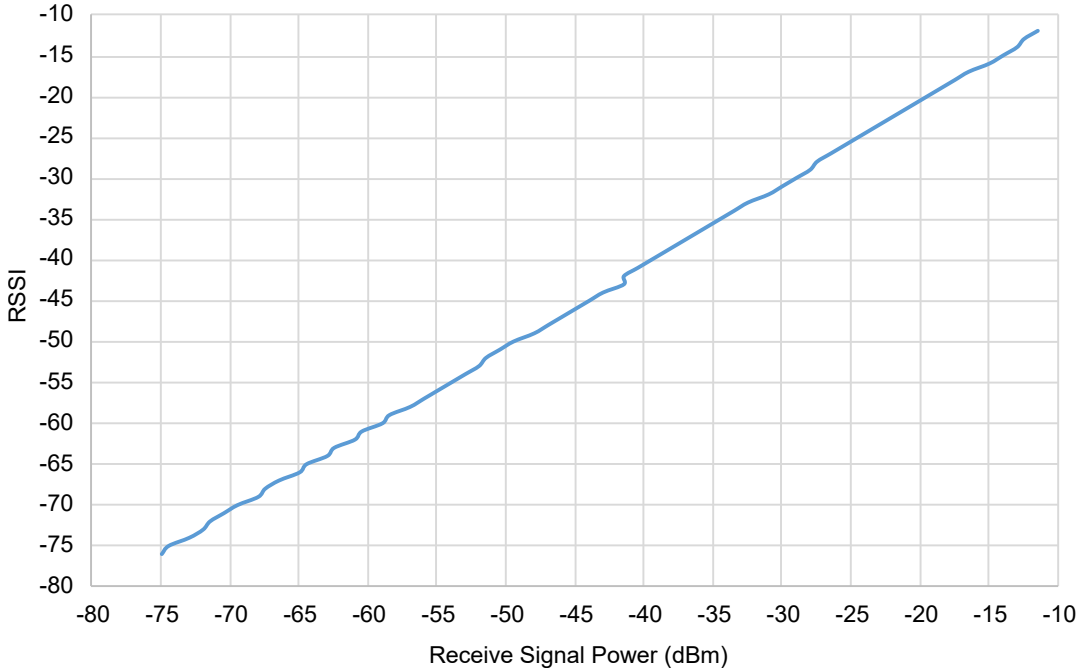
Note: At all the data rates, the performance remains the same except the values. This graph is only for reference.

Figure 3-11. RX Sensitivity vs. Voltage MCS7, Channel 7, 25°C



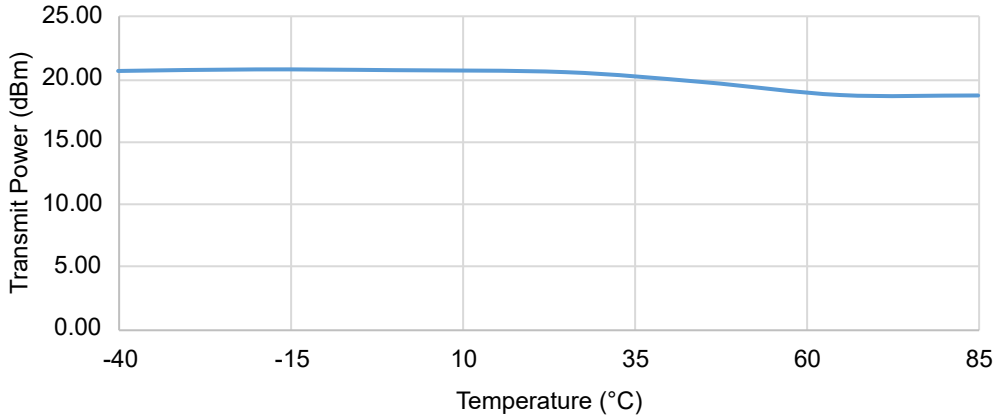
Note: At all the data rates, the performance remains the same except the values. This graph is only for reference.

Figure 3-12. RSSI MCS7, Channel 7, 25°C



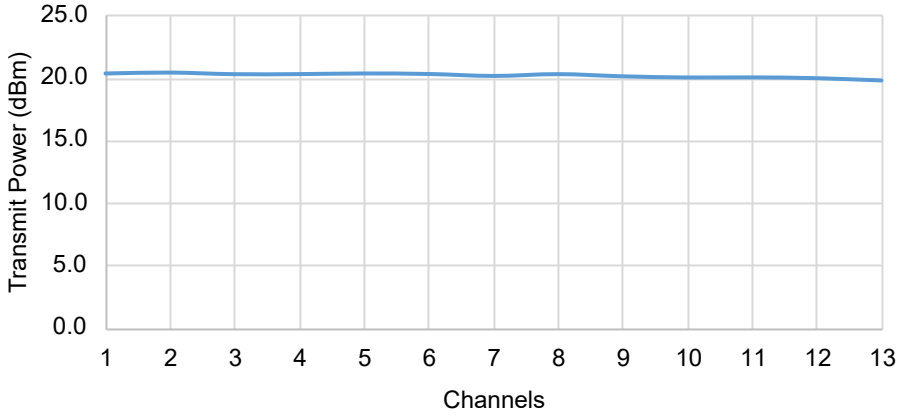
Note: At all the data rates, the performance remains the same except the values. This graph is only for reference.

Figure 3-13. Transmit Power vs. Temperature 1 Mbps, Channel 7, 3 .3V



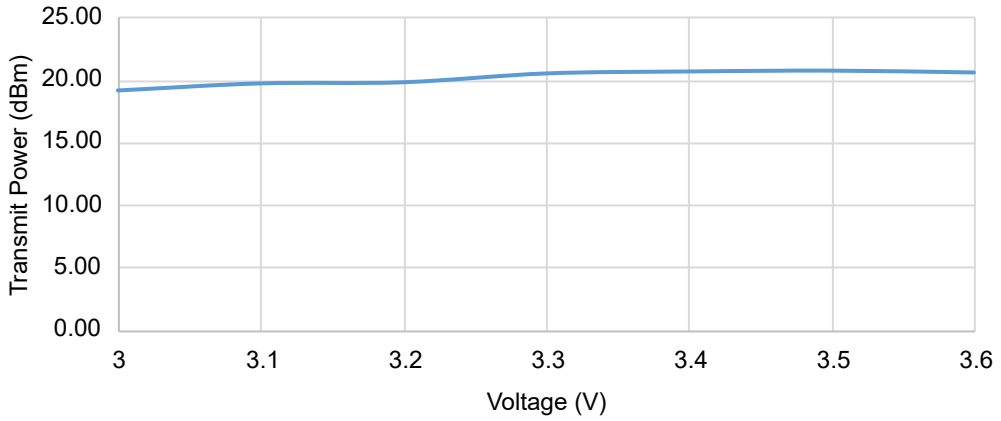
Note: At all the data rates, the performance remains the same except the values. This graph is only for reference.

Figure 3-14. Transmit Power vs. Channels 1 Mbps, 25°C, 3.3V



Note: At all the data rates, the performance remains the same except the values. This graph is only for reference.

Figure 3-15. Transmit Power vs. Voltages 1 Mbps, Channel 7, 25°C



Note: At all the data rates, the performance remains the same except the values. This graph is only for reference.

4. Packaging Information

This chapter provides the information on package markings, dimension and footprint of the RNWF11 Module.

4.1 RNWF11 Module Packaging Information

For the most current package drawings, see the Microchip Packaging Specification available at www.microchip.com/en us/support/package-drawings.

4.1.1 RNWF11 Module Packaging Marking

Figure 4-1. RNWF11 Module Packaging Marking

Legend:

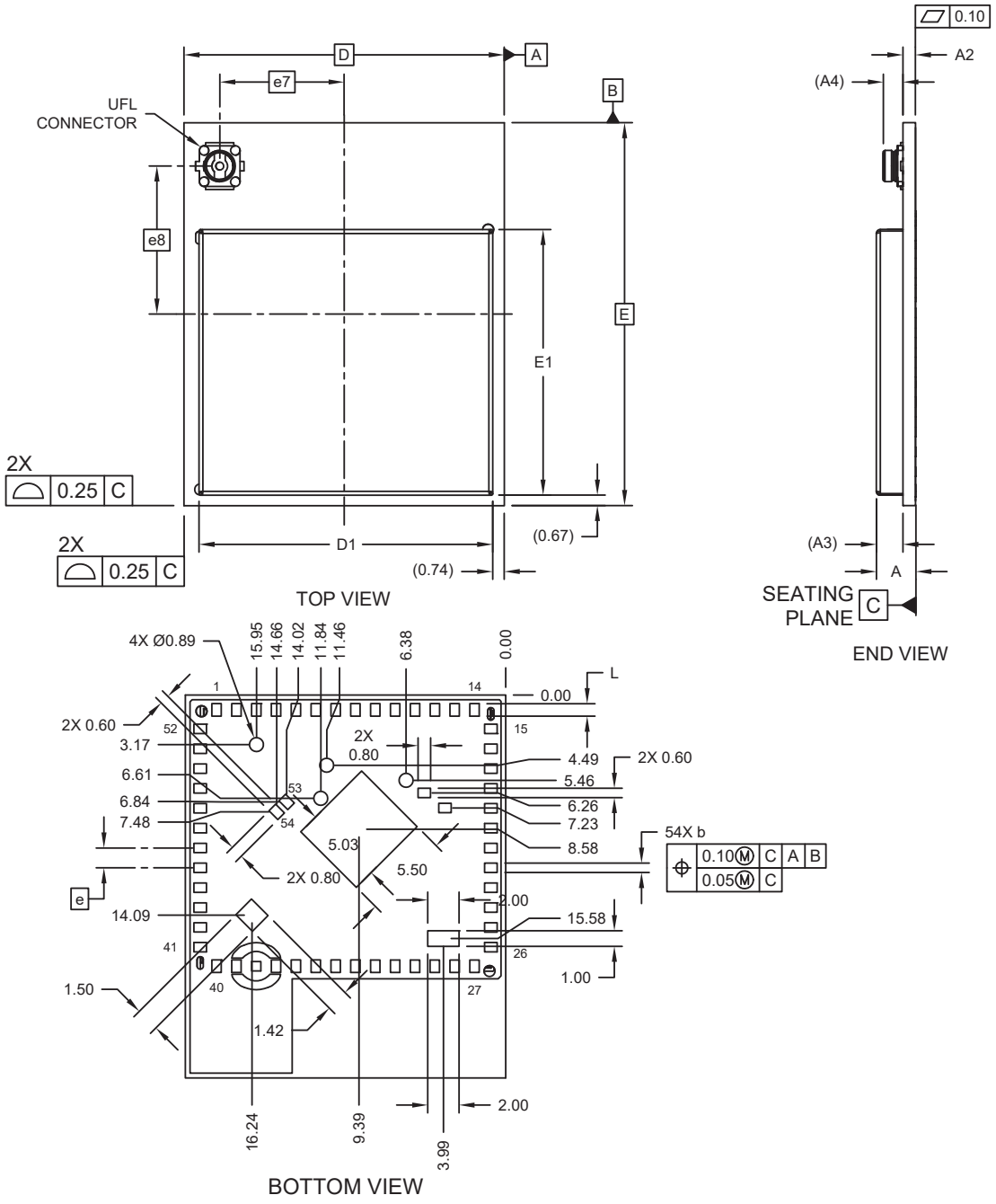
YY:	Year code (last 2 digits of calendar year)
WW	Week code (week of January 1 is week "01")
NNN	Alphanumeric traceability code

4.1.2 RNWF11 Module Package Dimension

This section provides the package dimension details of the RNWF11 Module.

54-Lead RF Module With Shield (6YX) - 20.5x24.5 mm [MODULE]

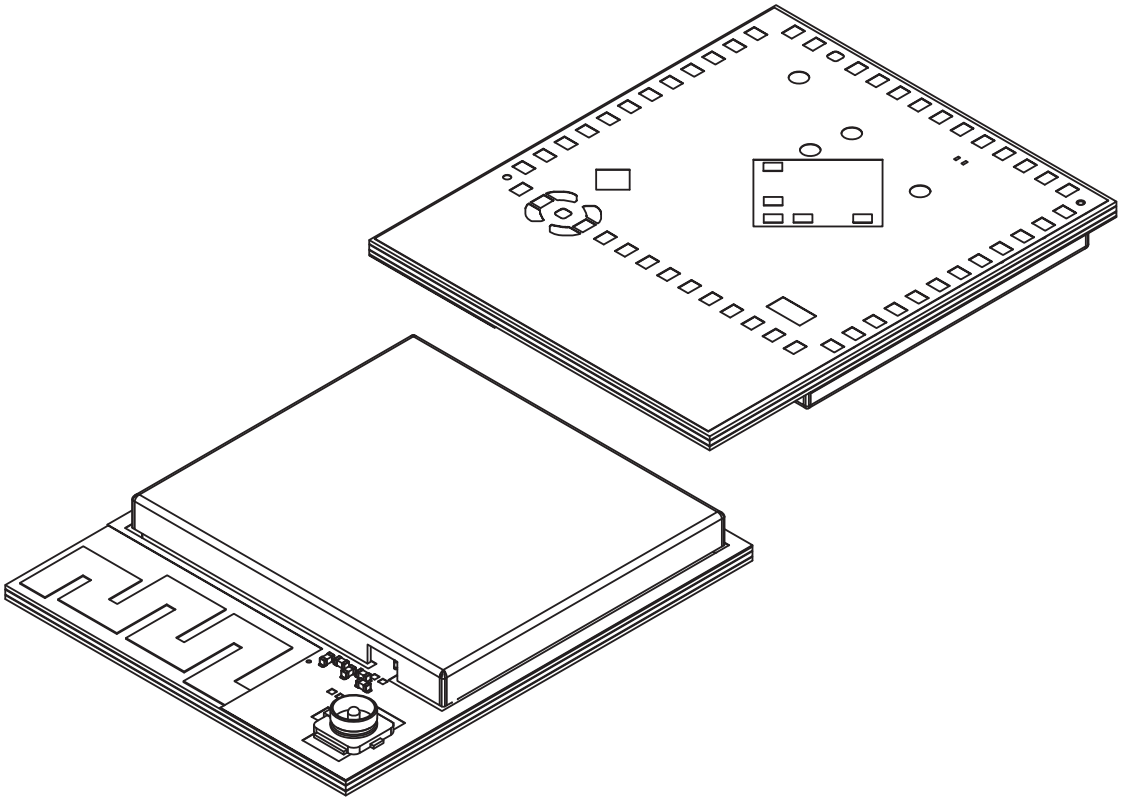
Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



Microchip Technology Drawing C04-10050 Rev D Sheet 1 of 2

54-Lead RF Module With Shield (6YX) - 20.5x24.5 mm [MODULE]

Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



Units		MILLIMETERS		
Dimension Limits		MIN	NOM	MAX
Number of Terminals	N		54	
Overall Height	A	2.40	2.50	2.60
PCB Thickness	A2	0.70	0.80	0.90
Shield Height	A3		1.70 REF	
UFL Connector Height	A4		1.25 REF	
Overall Length	D		20.50 BSC	
Overall Width	E		24.50 BSC	
Shield Length	D1	18.70	18.80	18.90
Shield Width	E1	16.90	17.00	17.10
Terminal Width	b	0.50	0.60	0.70
Terminal Length	L	0.70	0.80	0.90

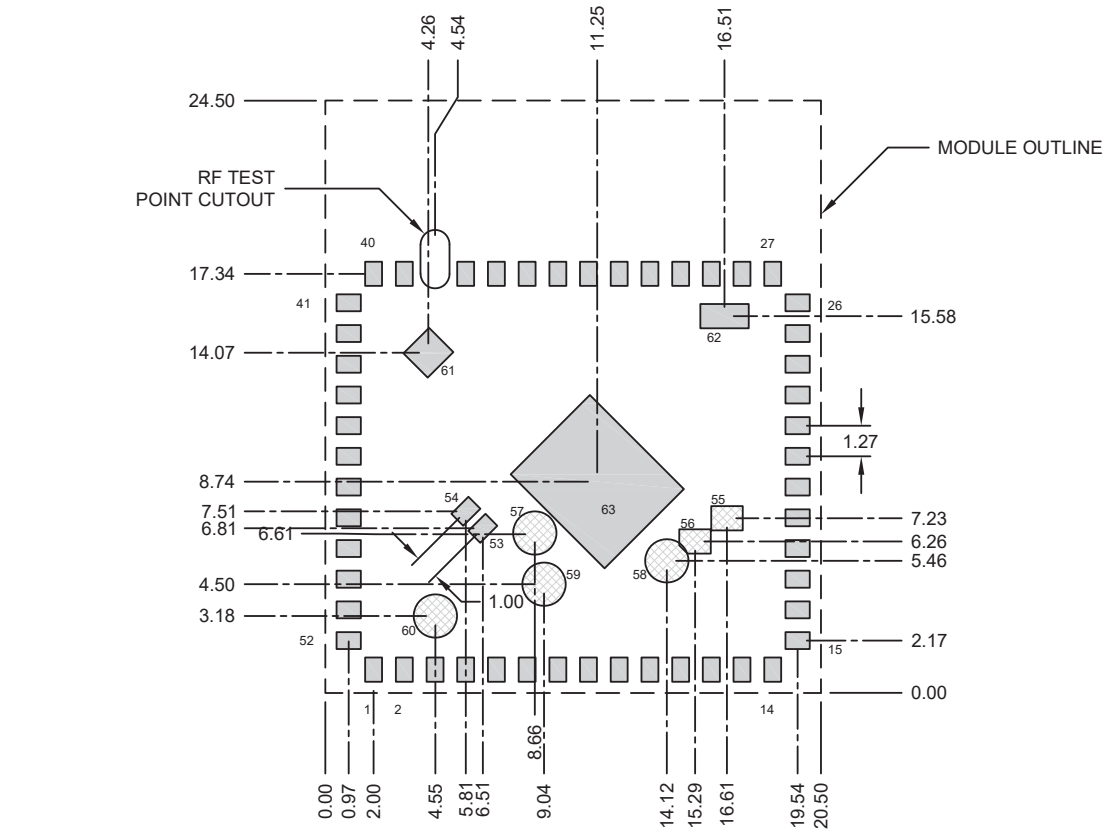
Microchip Technology Drawing C04-10050 Rev D Sheet 2 of 2

4.1.3 RNWF11 Module Recommended Footprint

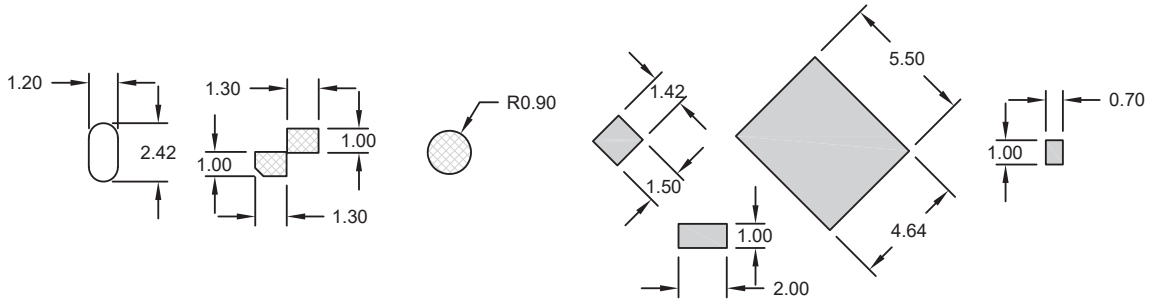
This section provides the recommended footprint details of the RNWF11 Module.

54-Lead RF Module With Shield (6YX) - 20.5x24.5 mm [MODULE]

Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



RECOMMENDED LAND PATTERN
NOTE: Place pins 53, 54, 61, and 63 with 45° angle



RF TEST POINT CUTOUT | COPPER KEEPOUT | COPPER KEEPOUT | EXPOSED GROUND PADS (SOLDER MASK DIMENSION) | TERMINAL PAD

Notes:

1. All dimensions are in millimeters.

Microchip Technology Drawing C04-12050 Rev D

5. Appendix A: Regulatory Approval

The RNWF11 module has received regulatory approval for the following countries:

- United States/FCC ID: 2ADHKWFI32E01
- Canada/ISED:
  - IC: 20266-WFI32E01
  - HVIN: RNWF11PC
  - PMN: WFI32E01 Module
- Europe/CE
- Japan/MIC: 005-102870
- Korea/KCC: R-R-mcp-WFI32E01
- Taiwan/NCC: CCAN21Y11038T2
- Great Britain/UKCA

5.1 United States

The RNWF11PC module has received Federal Communications Commission (FCC) CFR47 Telecommunications, Part 15 Subpart C “Intentional Radiators” single-modular approval in accordance with Part 15.212 Modular Transmitter approval. Single-modular transmitter approval is defined as a complete RF transmission sub-assembly, designed to be incorporated into another device, that must demonstrate compliance with FCC rules and policies independent of any host. A transmitter with a modular grant can be installed in different end-use products (referred to as a host, host product or host device) by the grantee or other equipment manufacturer, then the host product may not require additional testing or equipment authorization for the transmitter function provided by that specific module or limited module device.

The user must comply with all of the instructions provided by the Grantee, which indicate installation and/or operating conditions necessary for compliance.

A host product itself is required to comply with all other applicable FCC equipment authorization regulations, requirements, and equipment functions that are not associated with the transmitter module portion. For example, compliance must be demonstrated: to regulations for other transmitter components within a host product; to requirements for unintentional radiators (Part 15 Subpart B), 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., Suppliers Declaration of Conformity (SDoC) or certification) as appropriate (e.g., Bluetooth and Wi-Fi transmitter modules may also contain digital logic functions).

5.1.1 Labeling and User Information Requirements

The RNWF11PC 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 display a label referring to the enclosed module. This exterior label must use the following wording:

> Contains Transmitter Module FCC ID: 2ADHKWFI32E01
>
> or
>
> Contains FCC ID: 2ADHKWFI32E01
>
> **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 for the finished product must 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, which is available at the FCC Office of Engineering and Technology (OET) Laboratory Division Knowledge Database (KDB) apps.fcc.gov/oetcf/kdb/index.cfm.

5.1.2 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).

From the FCC Grant: Output power listed is conducted. This grant is valid only when the module is sold to OEM integrators and must be installed by the OEM or OEM integrators. This transmitter is restricted for use with the specific antenna(s) tested in this application for Certification and must not be co-located or operating in conjunction with any other antenna or transmitters within a host device, except in accordance with FCC multi-transmitter product procedures.

RNWF11PC: This module is approved for installation into mobile or/and portable host platforms at least 20 cm away from the human body.

5.1.3 Approved Antennas

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, provided the same antenna type, antenna gain (equal to or less than), with similar in-band and out-of band characteristics (refer to specification sheet for cutoff frequencies).

For RNWF11PC, the approval is received using the integral PCB antenna.

5.1.4 Helpful Web Sites

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

5.2 Canada

The RNWF11PC module has been certified for use in Canada under Innovation, Science and Economic Development Canada (ISED, formerly Industry Canada) Radio Standards Procedure (RSP) RSP-100, Radio Standards Specification (RSS) RSS-Gen and RSS-247. Modular approval permits the installation of a module in a host device without the need to recertify the device.

5.2.1 Labeling and User Information Requirements

Labeling Requirements (from RSP-100 - Issue 12, Section 5): The host product shall be properly labeled to identify the module within the host device.

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

Contains IC: 20266-WFI32E01

User Manual Notice for License-Exempt Radio Apparatus (from Section 8.4 RSS-Gen, Issue 5, February 2021): 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 contains license-exempt transmitter(s)/receiver(s) that comply with Innovation, Science and Economic Development Canada's license-exempt RSS(s). Operation is subject to the following two conditions:

(1) This device may not cause interference;

(2) This device must accept any interference, including interference that may cause undesired operation of the device.

L'émetteur/récepteur exempt de licence contenu dans le présent appareil est conforme aux CNR d'Innovation, Sciences et Développement économique 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;

2. L'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Transmitter Antenna (From Section 6.8 RSS-GEN, Issue 5, February 2021): User manuals, for transmitters shall display the following notice in a conspicuous location:

This radio transmitter [IC: 20266-WFI32E01] has been approved by Innovation, Science and Economic Development Canada to operate with the antenna types listed below, with the maximum permissible gain indicated. Antenna types not included in this list that have a gain greater than the maximum gain indicated for any type listed are strictly prohibited for use with this device.

Le présent émetteur radio [IC: 20266-WFI32E01] a été approuvé par Innovation, Sciences et Développement économique Canada pour fonctionner avec les types d'antenne énumérés cidessous et ayant un gain admissible maximal. Les types d'antenne non inclus dans cette liste, et dont le gain est supérieur au gain maximal indiqué pour tout type figurant sur la liste, sont strictement interdits pour l'exploitation de l'émetteur.

Immediately following the above notice, the manufacturer shall provide a list of all antenna types approved for use with the transmitter, indicating the maximum permissible antenna gain (in dBi) and required impedance for each.

5.2.2 RF Exposure

All transmitters regulated by Innovation, Science and Economic Development Canada (ISED) must comply with RF exposure requirements listed in RSS-102 - Radio Frequency (RF) Exposure Compliance of Radio communication Apparatus (All Frequency Bands).

This transmitter is restricted for use with a specific antenna tested in this application for certification, and must not be co-located or operating in conjunction with any other antenna or transmitters within a host device, except in accordance with Canada multi-transmitter product procedures.

RNWF11: The device operates at an output power level which is within the ISED SAR test exemption limits at any user distance greater than 20 cm.

5.2.3 Approved Antennas

For RNWF11PC, the approval is received using the integral PCB antenna.

5.2.4 Helpful Web Sites

Innovation, Science and Economic Development Canada (ISED): www.ic.gc.ca/.

5.3 Europe

The RNWF11PC module is a Radio Equipment Directive (RED) assessed radio module that is CE marked and has been manufactured and tested with the intention of being integrated into a final product.

The RNWF11PC module has been tested to RED 2014/53/EU Essential Requirements mentioned in the following European Compliance table.

Table 5-1. European Compliance Information

Certification	Standard	Article
Safety	EN 62368	3.1a
Health	EN 62311	
EMC	EN 301 489-1	3.1b
	EN 301 489-17	
Radio	EN 300 328	3.2

The ETSI provides guidance on modular devices in the "*Guide to the application of harmonised standards covering articles 3.1b and 3.2 of the RED 2014/53/EU (RED) to multi-radio and combined radio and non-radio equipment*" document available at http://www.etsi.org/deliver/etsi_eg/203300_203399/20 3367/01.01.01_60/eg_203367v010101p.pdf.

Note: To maintain conformance to the standards listed in the preceding European Compliance table, 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 against the RED.

5.3.1 Labeling and User Information Requirements

The label on the final product that contains the RNWF11PC module has must follow CE marking requirements.

5.3.2 Conformity Assessment

From ETSI Guidance Note EG 203367, section 6.1, when non-radio products are combined with a radio product:

If the manufacturer of the combined equipment installs the radio product in a host non-radio product in equivalent assessment conditions (i.e. host equivalent to the one used for the assessment of the radio product) and according to the installation instructions for the radio product, then no additional assessment of the combined equipment against article 3.2 of the RED is required.

5.3.2.1 Simplified EU Declaration of Conformity

Hereby, Microchip Technology Inc. declares that the radio equipment type RNWF11PC is in compliance with Directive 2014/53/EU.

The full text of the EU declaration of conformity, for this product, is available at *RNWF11* (available under *Documents* > *Certifications*).

5.3.3 Approved Antennas

For RNWF11PC, the approval is received using the integral PCB antenna.

5.3.4 Helpful Websites

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 Communications Committee (ECC) at: http://www.ecodocdb.dk/.

Additional helpful web sites are:

- Radio Equipment Directive (2014/53/EU): https://ec.europa.eu/growth/single-market/european-standards/harmonised-standards/red_en

- European Conference of Postal and Telecommunications Administrations (CEPT): http://www.cept.org
- European Telecommunications Standards Institute (ETSI): http://www.etsi.org
- The Radio Equipment Directive Compliance Association (REDCA): http://www.redca.eu/

5.4 Japan

The RNWF11PC module has received type certification and is required to be 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: www.vcci.jp/vcci_e/index.html

5.4.1 Labeling and User Information Requirements

The label on the final product which contains the RNWF11PC module(s) 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.

For the RNWF11PC module, due to a limited module size, the technical conformity logo and ID is displayed in the data sheet and/or packaging and cannot be displayed on the module label. The final product in which this module is being used must have a label referring to the type certified module inside:

5.4.2 Helpful Web Sites

- Ministry of Internal Affairs and Communications (MIC): www.tele.soumu.go.jp/e/index.htm.
- Association of Radio Industries and Businesses (ARIB): www.arib.or.jp/english/.

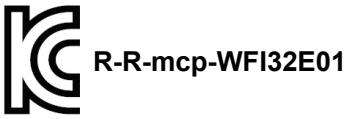
5.5 Korea

The RNWF11PC 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.

5.5.1 Labeling and User Information Requirements

The label on the final product which contains the RNWF11PC module(s) 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 RNWF11PC module is labeled with its own KC mark. The final product requires the KC mark and certificate number of the module:



5.5.2 Helpful Websites

- Korea Communications Commission (KCC): www.kcc.go.kr.
- National Radio Research Agency (RRA): rra.go.kr.

5.6 Taiwan

The RNWF11PC 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.

5.6.1 Labeling and User Information Requirements

For the RNWF11PC module, due to the limited module size, the NCC mark and ID are displayed in the data sheet only and cannot be displayed on the module label:

此模組於取得認證後將依規定於模組規格書或外包裝標示審驗合格標籤，並要求平台廠商於平台上標示本產品內含發射器模組。

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

根據 NCC LP0002 低功率射頻器材技術規範_章節 3.8.2：

取得審驗證明之低功率射頻器材，非經核准，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。

低功率射頻器材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。

前述合法通信，指依電信管理法規定作業之無線電通信。

低功率射頻器材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。

5.6.2 Helpful Web Sites

National Communications Commission (NCC): www.ncc.gov.tw

5.7 UKCA (UK Conformity Assessed)

The RNWF11PC module is a UK conformity assessed radio module that meets all the essential requirements according to CE RED requirements.

5.7.1 Labeling Requirements for Module and User’s Requirements

The label on the final product that contains the RNWF11PC module must follow UKCA marking requirements.

The UKCA mark above is printed on the module itself or on the packing label.

Additional details for the label requirement are available at:

https://www.gov.uk/guidance/using-the-ukca-marking#check-whether-you-need-to-use-the-new-ukca-marking.

5.7.2 UKCA Declaration of Conformity

Hereby, Microchip Technology Inc. declares that the radio equipment type the RNWF11PC module is in compliance with the Radio Equipment Regulations 2017. The full text of the UKCA declaration of conformity for this product is available (under *Documents* > *Certifications*) at: www.microchip.com/RNWF11.

5.7.3 Helpful Websites

For more information on the UKCA regulatory approvals, refer to the www.gov.uk/guidance/placing-manufactured-goods-on-the-market-in-great-britain.

5.8 Other Regulatory Information

- For information about other countries' jurisdictions not covered here, refer to the specific product listed in the www.microchip.com/design-centers/wireless-connectivity/certifications (available under *Documents* > *Certifications*).
- If the customer needs another regulatory jurisdiction certification or to recertify the module for other reasons, contact Microchip for the required utilities and documentation.

6. Appendix B: Acronyms and Abbreviations

Table 6-1. Acronyms and Abbreviations

Acronyms	Abbreviations
BOR	Brown-out Reset
CBC	Cypher Block Chaining
CFB	Cypher Feedback Mode
DMT	Deadman Timer
CTR	Counter Mode
ECB	Electronic Code Book
EOS	Electrical Overstress
EMC	Electromagnetic Compatibility
ESD	Electrostatic Discharge
FEM	Front-end Module
FRC	Fast RC
FSCN	Fail-Safe Clock Monitor
GCM	Galois/Counter Mode
GND	Ground
IoT	Internet of Things
LNA	Low Noise Amplifier
LPC	Low-Power RC
MCU	Microcontroller
OFB	Output Feedback Mode
OST	Oscillator Start-up Timer
OTA	Over-the-Air
PA	Power Amplifier
PCB	Printed Circuit Board
POSC	Primary Oscillator
PLVD	Programmable Low nVoltage Detect
PMU	Power Management Unit
POR	Power-on Reset
PWRT	Power-up Timer
SOSC	Secondary Oscillator
TP	Peak Temperature
RX	Receiver
TRNG	True Random Number Generator
TX	Transmitter
WSM	Wireless Sleep Mode
WDS	Wireless Deep Sleep mode
WDT	Watchdog Timer
ZPBOR	Zero-power BOR

7. Document Revision History

The revision history describes the changes that were implemented in the document. The changes are listed by revision, starting with the most current publication.

Table 7-1. Document Revision History

Revision	Date	Section	Description
A	02/2024	Document	Initial Revision

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