WIUBS02 Wi-Fi Module Data Sheet

WIUBS02

Introduction

The Wi-Fi Link Controller Module WIUBS02 is a low power 2.4 GHz IEEE® 802.11b/g/n compliant, fully RF certified wireless module designed for IoT (Internet of Things) applications. These modules are interfaced to a host microcontroller though SPI/SDIO/USB interface.

- WILCS02 Module supports Host Interface via SPI/SDIO
- WIUBS02 Module supports Host Interface via USB

The Module operates at a single supply voltage V_{DD} (3.3V typical), certain Input Output (IOs) pins supports a voltage range of 1.8-3.6V by supplying the V_{DDIO} pin separately.

The WILCS02 module is available with an on-board Printed Circuit Board (PCB) antenna or U.FL connector for an external antenna.

Features

- Compliant with IEEE 802.11 b/g/n Single Spatial Stream of 20 MHz Channel Bandwidth
- Transmission Control Protocol/Internet Protocol (TCP/IP)-Based Connectivity Protocols Along with SSL and MQTT Capabilities.
- Supports STA Mode and Soft AP Functionality in IEEE 802.11 Infrastructure and IBSS Networks
- Protected Management Frame (PMF) Handled in Hardware, WPA3 Support
- Integrated Power Amplifier (PA) and TX/RX Switch and Power Management
- Internal Flash Memory to Store Firmware
- Immutable Secure Boot with Hardware Root of Trust
- Supports Host Assisted Over-the-Air (OTA) Firmware Update
- On-Chip Network Stack to Offload MCU
  - Network features – TCP, UDP, DHCP, ARP, HTTP, MQTT, IPv6 TLS 1.2/1.3 and DNS
  - Hardware accelerators for Wi-Fi® and TLS security to improve connection time
- Hardware Based Low-Power Modes with Support for Magic Packet-Based Snooze Mode
  - Low Power modes – Connected Sleep and Extreme Deep Sleep (XDS)
    - Extreme Deep Sleep (XDS) current < 1 µA
  - Fast host wake-up from Sleep mode by a pin or the host I/O transaction
  - Optional low-power secondary oscillator (RTCC oscillator) 32.768 KHz for real-time clock and calendar applications(2)
- Hardware-Based IEEE 802.15.2 Compliant Three-Wire Packet Traffic Arbitration (PTA) Interface for Wi-Fi/ Bluetooth® Coexistence(2)
- SDIO/SPI/USB Host Interface
- Secure Device Firmware Upgrade (DFU)

Security

- Hardware Accelerated Security Modes (CryptoMaster) with Built-in DMA Support

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  - Encryption engines (AES and TDES with different NIST modes of operation):
    - Modes – Electronic Code Book (ECB), Cypher Block Chaining (CBC), Counter Mode (CTR), Cypher Feedback Mode (CFB) and Output Feedback Mode (OFB)
    - AES key sizes: 128b, 192b and 256b
  - Authentication engines:
    - SHA-1 and SHA-2
    - AES GCM (Galois/Counter mode)
    - HMAC and AES CMAC
  - On-chip oscillator for NDRNG generation
- Multi-Purpose Public Key Crypto Engine Supporting the Following Algorithms:
  - ECC/ECDH/ECDSA with standard NIST prime curves up to 521-bit, Curve25519 and Ed25519
  - RSA up to 2048-bit keys

Operating Conditions

- Operating Voltage (V_{DD}): 3.0-3.6V (3.3V Typical), (V_{DDIO}): 1.8-3.6V
- Operating Temperature: -40°C to 85°C

Module Variants

- PCB Antenna:
  - WIUBS02PE
- U.FL Connector for External Antenna:
  - WIUBS02UE

Package

- 28-Pin SMD Package with Shield CAN on Top
- Size: 21.7 mm x 14.7 mm x 2.1 mm

Applications

- Smart Factories/Control Devices
- Security Systems, CCTV
- Smart Homes/Lighting, Smart Locks
- Computing, Wi-Fi Dongles, Protocol Bridging
- Internet of Things (IoT) Sensor Tag
- Remote Control
- Wearable Smart Devices
- Industrial Control

Certifications

- WILCS02 Module is Planned to be Certified to FCC, ISED, UKCA and CE Radio Regulations
- RoHS and REACH Compliant

Notes:

1. Refer to the *WILCS02 Application Developer's Guide (TBA)* for the latest supported features.
2. The WILCS02 module does not support the PTA interface and the RTCC oscillator function together. Refer to 2.1. Pin Details of WILCS02 Module for more details.

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1. Module Ordering Information

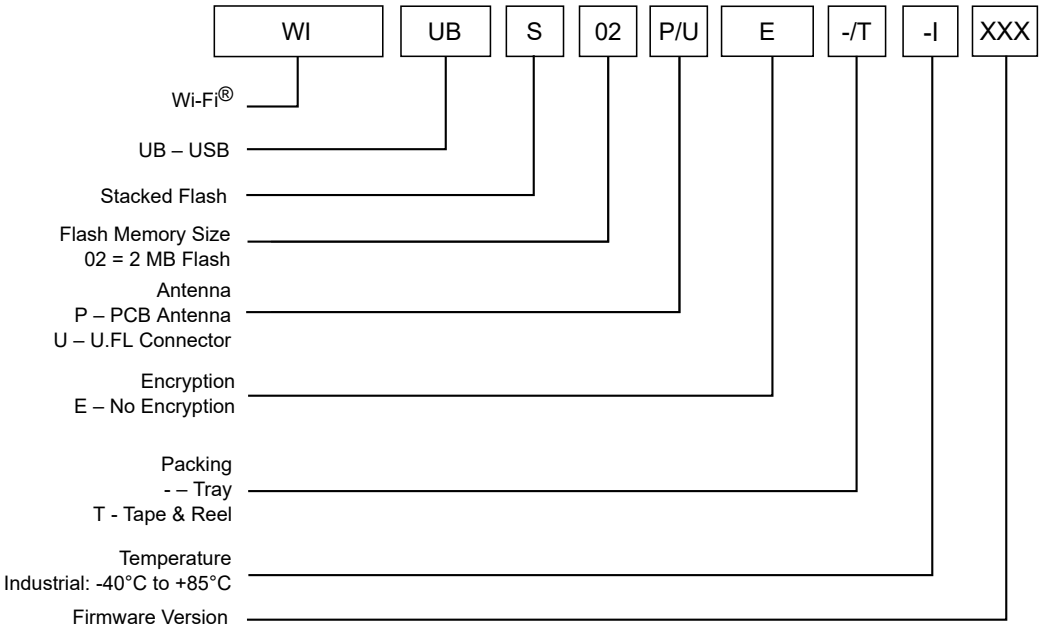
This chapter provides the ordering information of the WILCS02 and WIUBS02 module.

Table 1-1. WILCS02 and WIUBS02 Module Ordering Details

Module Name	Description	Ordering Code
WIUBS02PE	Wi-Fi Link Controller Module with PCB Antenna and USB Interface	WIUBS02PE-I
WIUBS02UE	Wi-Fi Link Controller Module with U.FL connector for external Antenna and USB Interface	WIUBS02UE-I

The following figure illustrates the details of the WIUBS02 module ordering information.

Figure 1-1. WILCS02 and WIUBS02 Module Ordering Information



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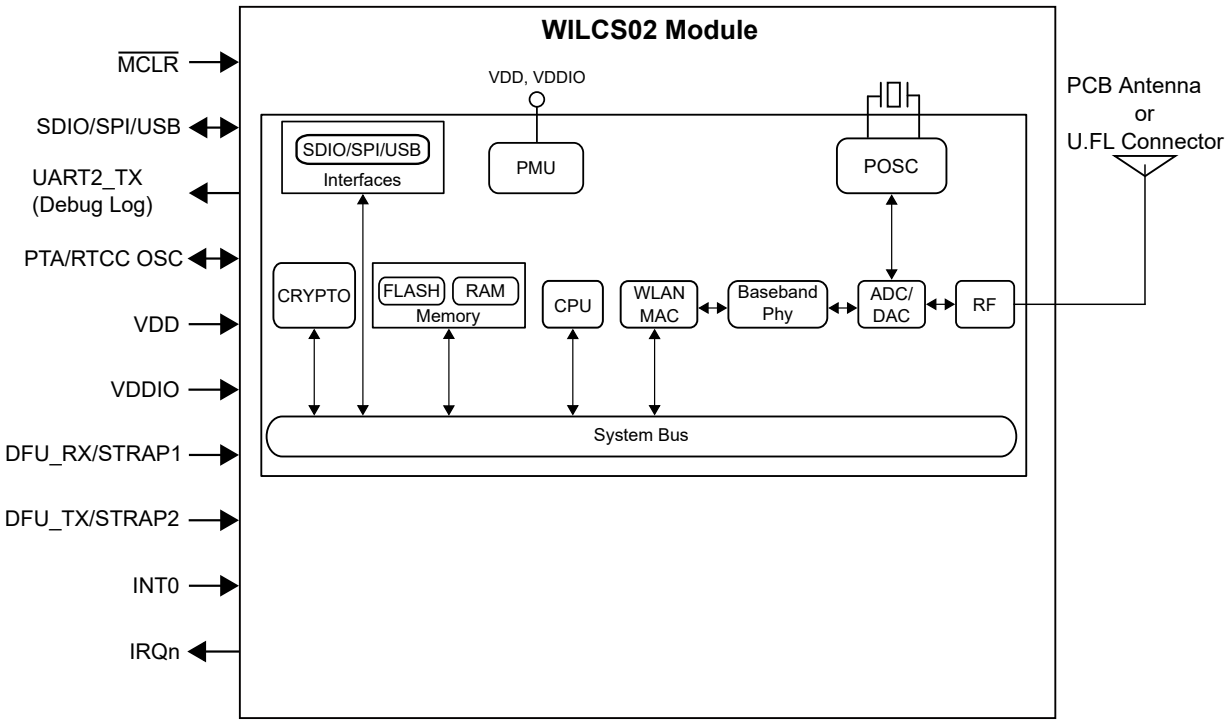
2. Device Overview

The WILCS02 module is a fully RF certified wireless module. The WILCS02 module is available with the following antenna variants:

- PCB antenna (WIUBS02PE)
- U.FL connector (WIUBS02UE) for external antenna

The following figure illustrates the WILCS02 module block diagram and various peripherals supported by the module.

Figure 2-1. WILCS02 Module Block Diagram



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2.1 Pin Details of WILCS02 Module

This section provides details on pin diagrams and pinout table of WILCS02 module.

Figure 2-2. WILCS02 Module Pin Diagram (Bottom View)

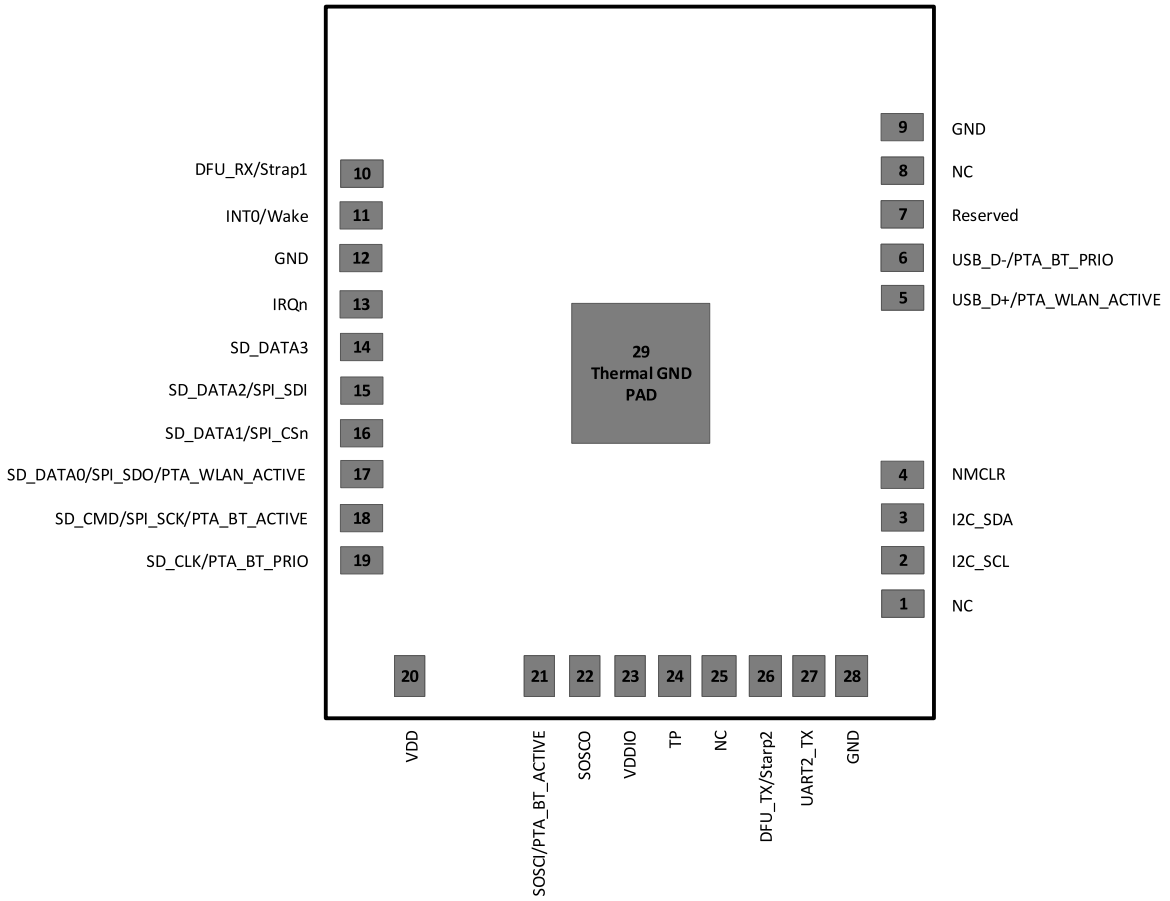

Table 2-1. WILCS02 Module Pinout Table

Pin Number	Pin Name	Pin Type	Pin Description
1	NC	—	No connection
2	I2C_SCL	I	I^2C clock. Recommended to connect external pull-up resistor
3	I2C_SDA	I/O	I^2C data. Recommended to connect external pull-up resistor
4	$\overline{MCLR}$	I	Master clear reset, active-low
5	USB_D+/PTA_WLAN_ACTIVE	O	USB Data+/ PTA interface, WLAN Active
6	USB_D- / PTA_BT_PRIO	I/O	USB Data-/ PTA interface, BT Priority
7	—	I/O	Reserved
8	NC	—	No connection
9	GND	P	Ground
10	DFU_RX/Strap1	I	For device firmware update receive pin. Recommended to connect to a pull-down resistor of 100K.
11	INT0/Wake	I	To wake-up the Wi-Fi® module from its Extreme Deep Sleep (XDS) mode by the host

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.....continued

Pin Number	Pin Name	Pin Type	Pin Description
12	GND	P	Ground
13	IRQn(2)	O	Interrupt request (active-low) from the Wi-Fi module to wake-up the host from its Sleep state
14	SD_DATA3(2)	O	SDIO interface, SD DATA 3
15	SD_DATA2/SPI_SDI	O	SDIO interface, SD DATA 2/Serial interface, Serial Data In
16	SD_DATA1/SPI_CSn	I	SDIO interface, SD DATA 1/Serial interface Chip Select (Active low)
17	SD_DATA0/SPI_SDO/ PTA_WLAN_ACTIVE	I/O	SDIO interface, SD Data 0/SPI interface, Serial Data Out/PTA Interface, WLAN Active
18	SD_CMD/SPI_SCK/PTA_BT_ACTIVE	I/O	SDIO interface, SD Command signal PTA Interface, BT Active
19	SD_CLK/PTA_BT_PRIO(2)	I/O	SDIO interface, SD Clock Signal PTA Interface, BT Priority
20	VDD	P	VDD power supply (3.0-3.6V)
21	SOSCI/PTA_BT_ACTIVE (1)	I	RTCC oscillator input for 32.768 KHz external crystal/ PTA Interface BT_ACTIVE
22	SOSCO	O	RTCC oscillator output
23	VDDIO	P	I/O power supply (1.8-3.6V)
24	TP	P	Test point: 1.5V(3)
25	NC	—	No connection
26	DFU_TX/Strap2	I	For device firmware update receive pin. Recommended to connect to a pull-down resistor of 100K.
27	UART2_TX(2)	I/O	UART2 transmit signal for the debug log
28	GND	P	Ground
29	GND Paddle	P	Thermal ground pad

Notes:

1. This pin can be configured either as an oscillator input pin or as PTA BT_ACTIVE. The WILCS02 module does not support both the functionality together.
2. These pins support lower voltage by supplying the V_{DDIO} pin separately (1.8V - 3.6V).
3. Do not connect any signal to source the voltage.

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2.2 Basic Connection Requirement

The WILCS02 module requires attention to a minimal set of device pin connections before proceeding with development.

Figure 2-3. WILCS02 Module Basic Connection and Interface Diagram

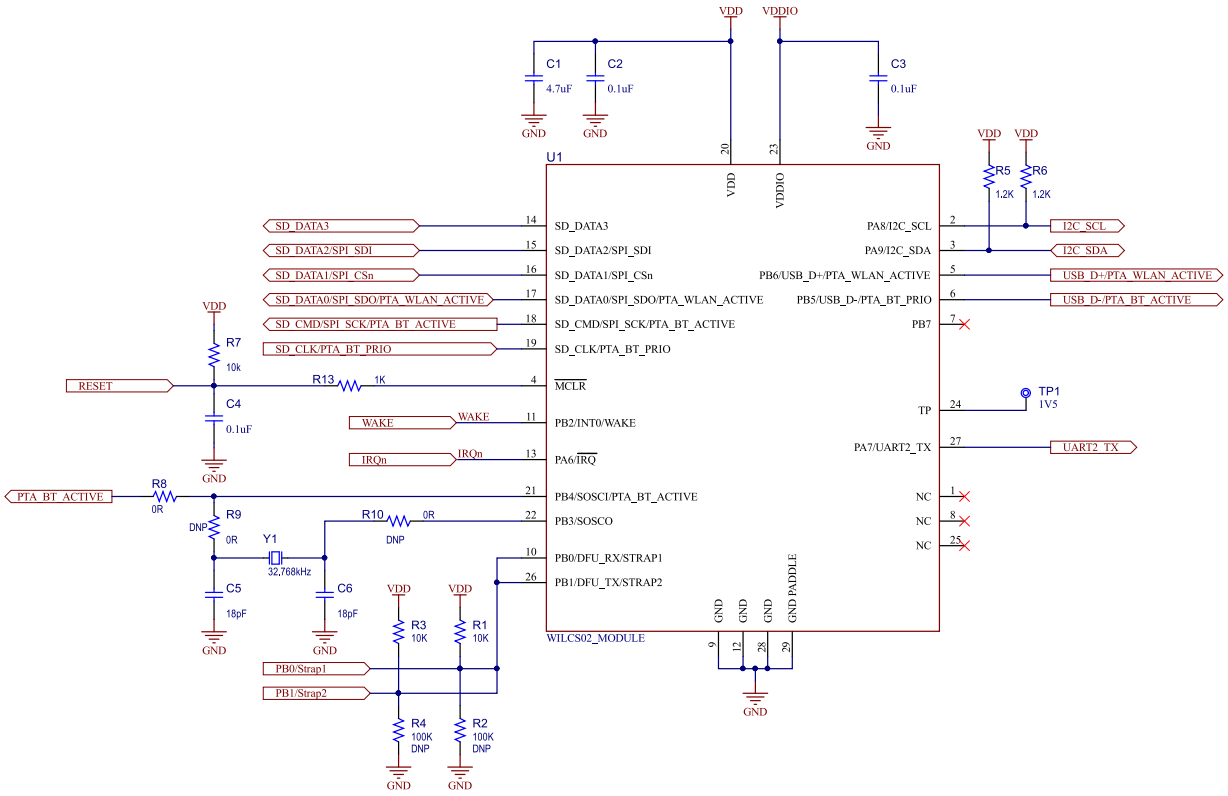


Table 2-2. Configuration Details

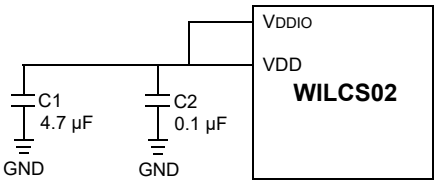
Configuration Details			
Module Pin10/Strap1	**Module Pin26/Strap2**	**Host Interface Selection**	**Description**
0	0	UART1	WILCS02 module with UART1
Note: The mentioned resistance values are only guidelines. For details on the application schematics, refer to the *WILCS02 Wi-Fi Link Controller SD Board* (TBA).			

2.2.1 Power Supply Pin

It is recommended to add a bulk and a decoupling capacitor at the input supply Pin 20 (V_{DD}), Pin 23 (V_{DDIO}) and GND of the WILCS02 module.

V_{DD} and V_{DDIO} can be connected to the same supply for the typical 3.3V operation. For I/Os to operate at a lower voltage, typically 1.8V, V_{DDIO} can be connected separately along with a decoupling capacitor.

Figure 2-4. Recommended Module Power Supply Connections



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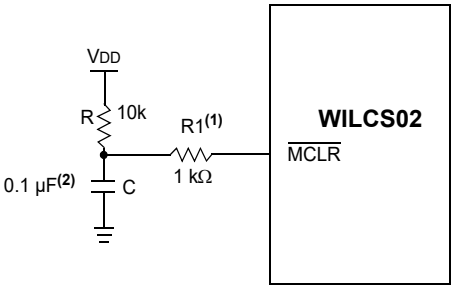
The value of the C1 and C2 capacitors may vary based on the application requirements and source of supply voltage. The C1 and C2 capacitors must be placed close to the pin.

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

The $\overline{MCLR}$ pin works as a device Reset.

Pulling the $\overline{MCLR}$ pin low generates a device Reset. The basic connection and interface diagram of the module illustrates a typical $\overline{MCLR}$ circuit. See the *Module Basic Connection and Interface Diagram* in the *Basic Connection Requirement* from Related Links.

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). Ensure that the $\overline{MCLR}$ pin V_{IH} and V_{IL} specifications are met without interfering with the Debug/ Programmer tools.
2. The capacitor can be sized to prevent unintentional Resets from brief glitches or to extend the device Reset period during POR.

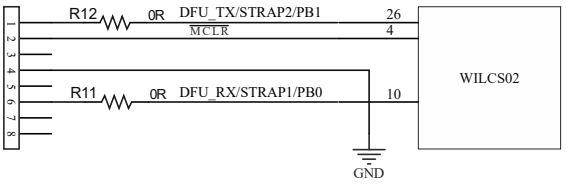
2.2.3 Device Firmware Update

The WILCS02 module is available for purchase with pre-programmed firmware. Microchip periodically releases the firmware to fix reported issues or to implement the latest feature support. There are two ways to perform a regular firmware update:

1. Serial DFU command-based update over UART
2. Host-assisted Over-the-Air (OTA) update

Note: For the serial DFU and OTA programming guidance, refer to the *WILCS02 Module Application Developer's Guide*.

Figure 2-6. Basic Connection Diagram of DFU



2.2.4 Interface with Host Microcontroller

The WILCS02 module can be interfaced with the host microcontroller through the UART_TX and UART_RX data line and optional UART flow control signals UART_RTS and UART_CTS.

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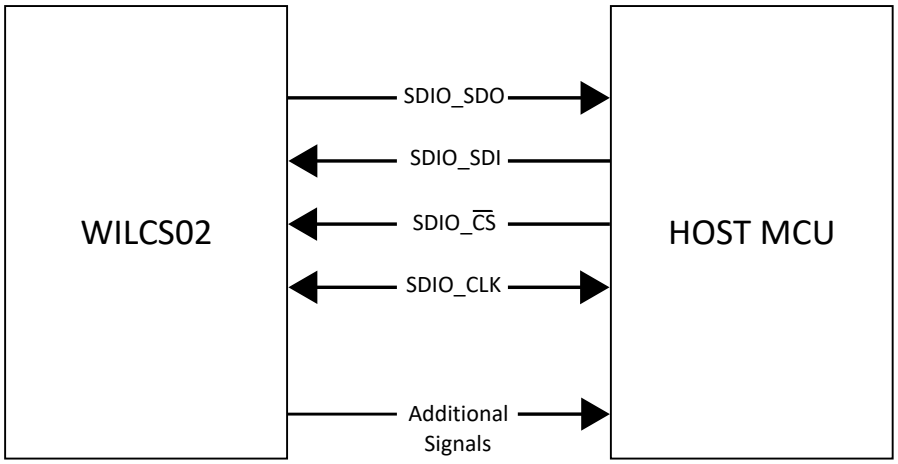
Figure 2-7. WILCS02 Module Host Interface Diagram



2.3 WILCS02 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 the best PCB antenna performance, it is recommended that the WILCS02PE/ WIUBS02PE module is placed at the edge of the host board.
- The WILCS02PE/WIUBS02PE module ground outline edge must be aligned with the edge of the host board ground plane as shown in the following figure.
- A low-impedance ground plane for the WILCS02 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 EMC and noise reduction.
- For the 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 as illustrated in the following figure.
- The antenna on the WILCS02 module must not be placed in direct contact with or in close proximity to plastic casing or objects. Keep a minimum clearance of 10 mm in all directions around the PCB antenna as shown in the following figure. Keeping metallic and plastic objects close to the antenna can detune the antenna and reduce the performance of the device.
- Exposed GND pads on the bottom of the WILCS02 module must be soldered to the host board (see the *Example of Host Board on Top Layer* figure in the *WILCS02 Module Routing Guidelines* from Related Links).
- A PCB cutout or a copper keepout is required under the RF test point (see *WILCS02 Module Packaging Information* from Related Links).
- Copper keepout areas are required on the top layer under voltage test points (see *WILCS02 Module Packaging Information* from Related Links).
- Alternatively, the entire region, except the exposed ground paddle, can be solder-masked.

The following figure illustrates the examples of WILCS02 Module placement on a host board with a ground plane. Refer to the following figure for placement-specific guidance.

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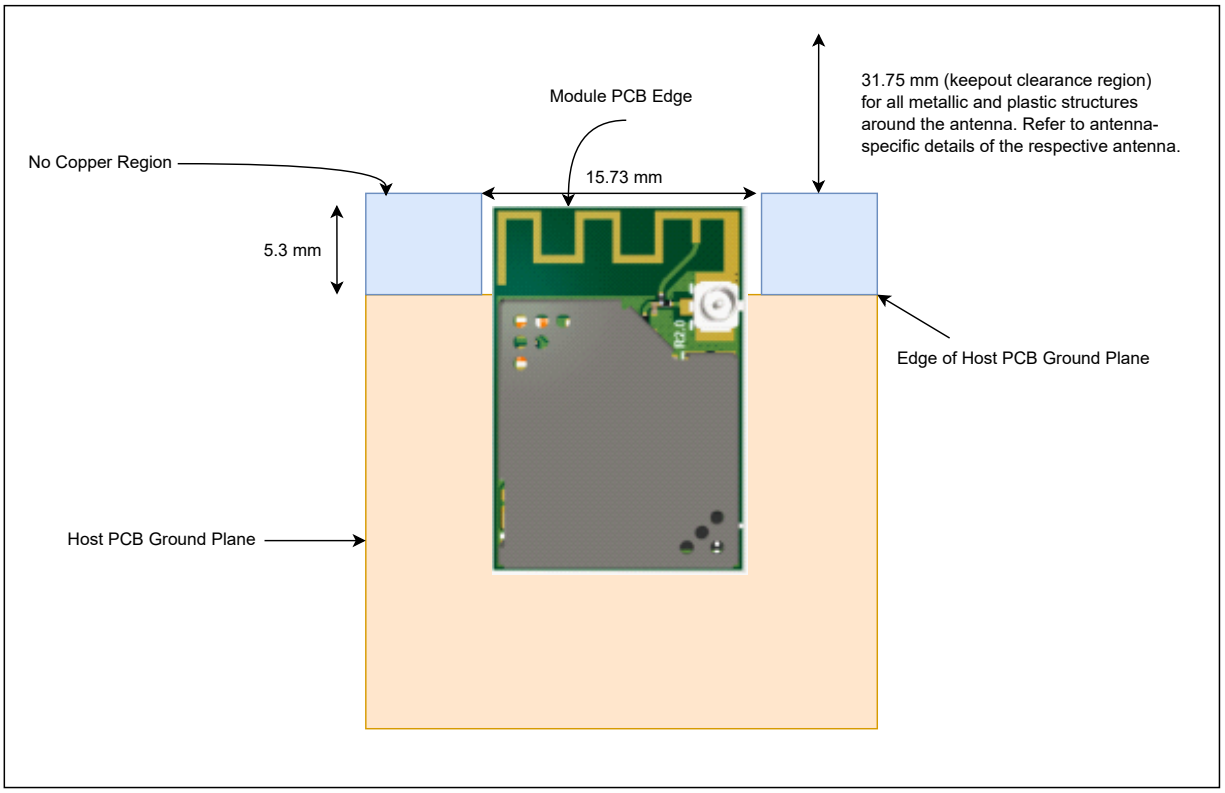
Figure 2-8. Module Placement Guidelines



The following figure illustrates the examples of the WILCS02 module placement on a host board with a ground plane. Refer to Figure 2-8 for placement-specific guidance.

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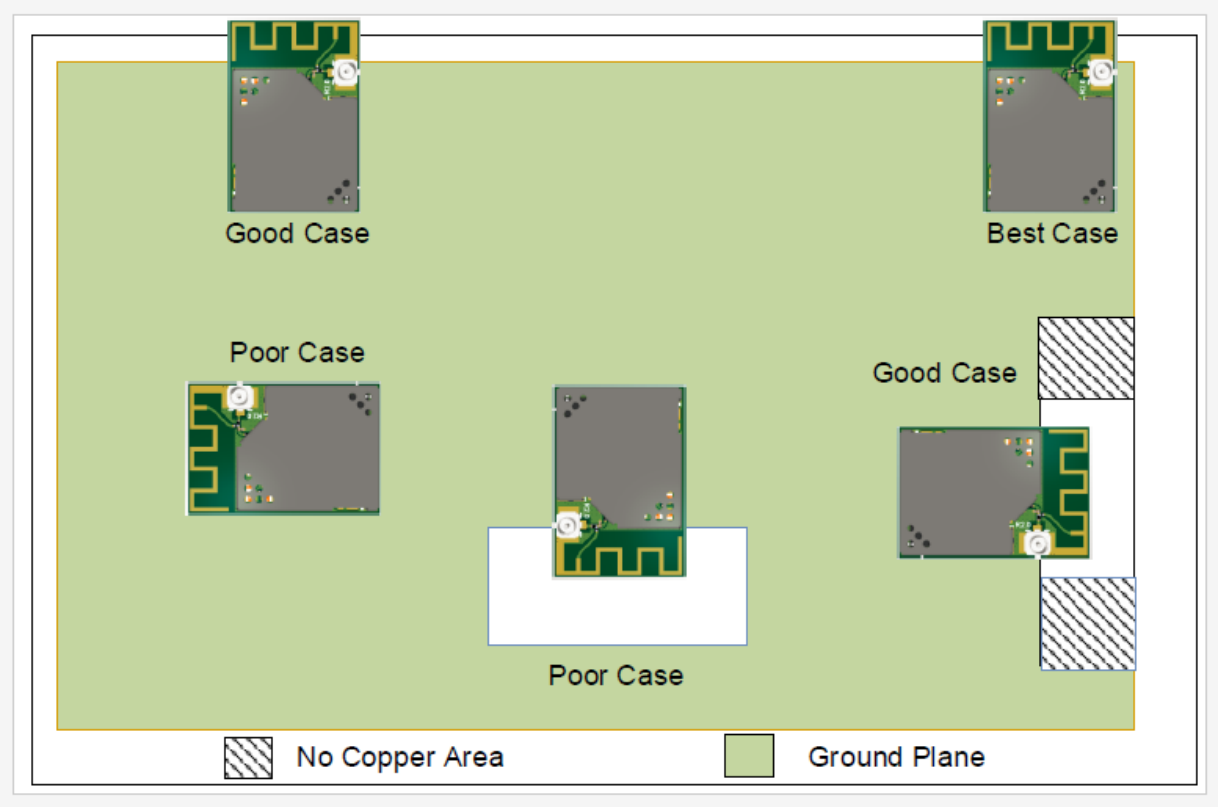
Figure 2-9. WILCS02 Module Placement



2.4 WILCS02 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, shown in the following figure.
- Avoid fan-out of the signals under the module or antenna area. Use a via to fan-out signals to the edge of the WILCS02 module.
- For a better GND connection to the WILCS02 module, solder the exposed GND pads of the WILCS02 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.
- Having a series resistor on the host board for all GPIOs is recommended. These resistors must be placed close to the WILCS02 module. The following figure illustrates the placement of the series resistor.
- The SOSC crystal (32.768 kHz) on the host board must be placed close to the WILCS02 module and follow the shortest trace routing length with no vias (see the following figure).

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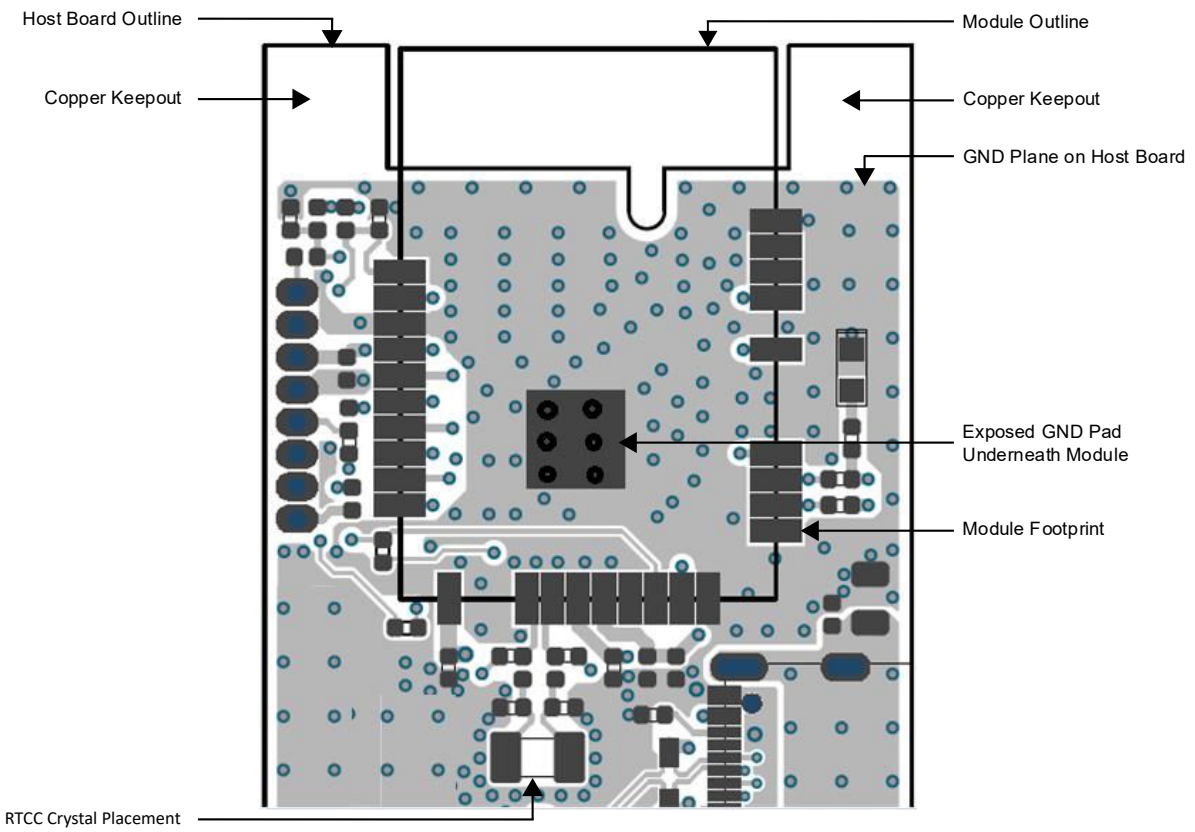
Figure 2-10. Example of Host Board on Top Layer



2.5 WILCS02 Module RF Considerations

The overall performance of the system is 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.

Consider the following guidelines for optimal RF performance:

- The WILCS02 module must be positioned in a noise-free RF environment and must be kept far away from high-frequency clock signals and any other sources of RF energy.
- The antenna must not be shielded by any metal objects.
- The power supply must be clean and noise-free.
- Make sure that the width of the traces routed to GND, VDD rails are sufficiently large for handling peak TX current consumption.
  Note: The WILCS02 module includes RF shielding on top of the board as a standard feature.

2.6 WILCS02 Module Antenna Considerations

2.6.1 PCB Antenna

For the WILCS02PE/WIUBS02PE module, the PCB antenna is fabricated on the top copper layer and covered with a solder mask. The layers below the antenna do not have copper trace. It is recommended that the module be mounted on the edge of the host board and to have no PCB material below the antenna structure of the module and no copper traces or planes on the host board in that area.

The following table lists the technical specification of the PCB antenna when tested with the WILCS02 module mounted on the WILCS02 Wi-Fi Link Controller SD Board.

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Table 2-3. PCB Antenna Specification for WILCS02 Module

Parameter	Specification
Operating frequency	2400-2485 MHz
Peak gain	1.18 dBi at 2445 MHz
Efficiency (average)	68.83%[1]

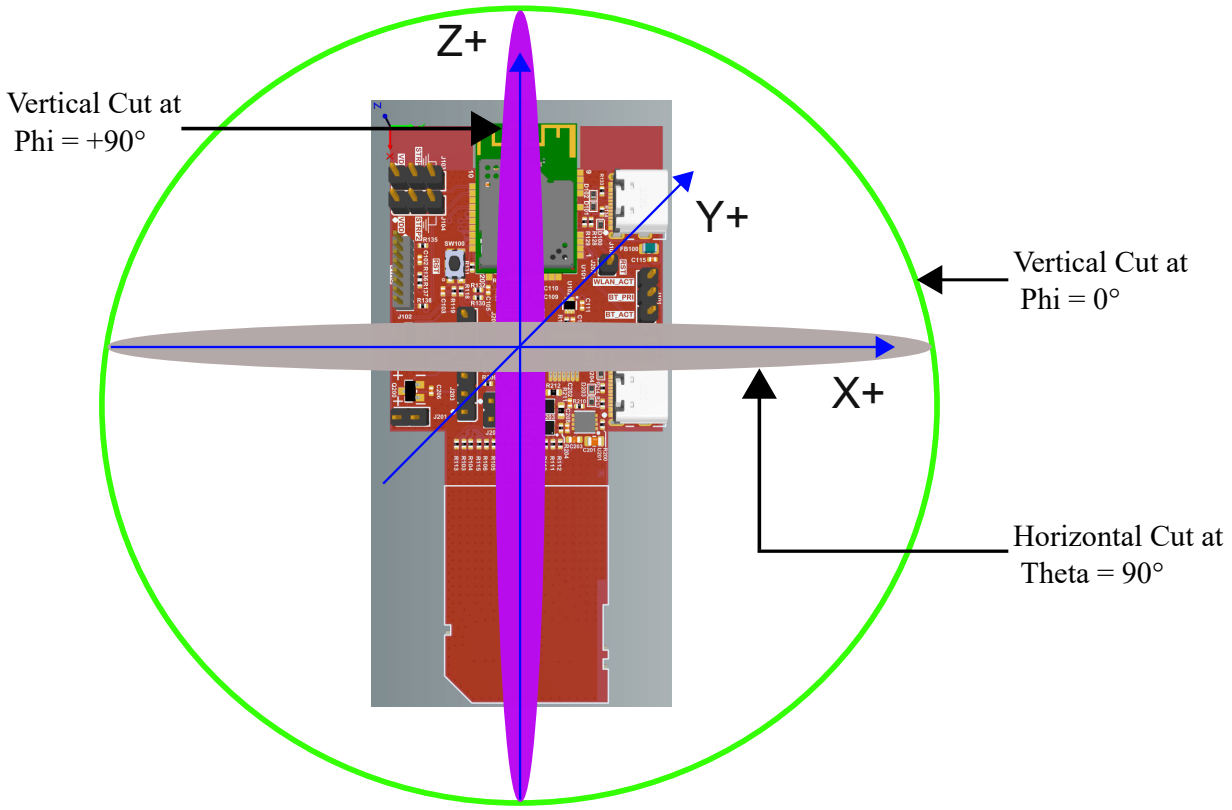
Note:

1. The size of the WILCS02 Wi-Fi Link Controller SD Board is 85 mm x 40 mm. The antenna efficiency will improve with larger ground plane base boards. If the best case routing guidelines are followed on a larger ground plane application board, the efficiency will be better.

PCB Antenna Radiation Pattern

The following figure illustrates the module orientation in the measurement system for the PCB antenna radiation pattern.

Figure 2-11. Module Orientation for Radiation Pattern Measurement



3D Antenna Radiation Pattern

The following figures illustrate the 3D cross section of the antenna radiation pattern.

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Figure 2-12. 3D Antenna Radiation Pattern (Slant view)

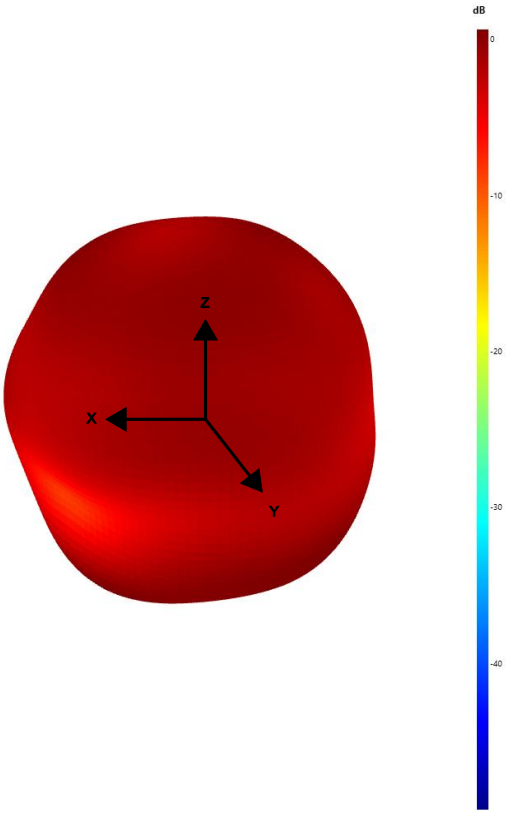

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Figure 2-13. 3D Antenna Radiation Pattern (XY view)

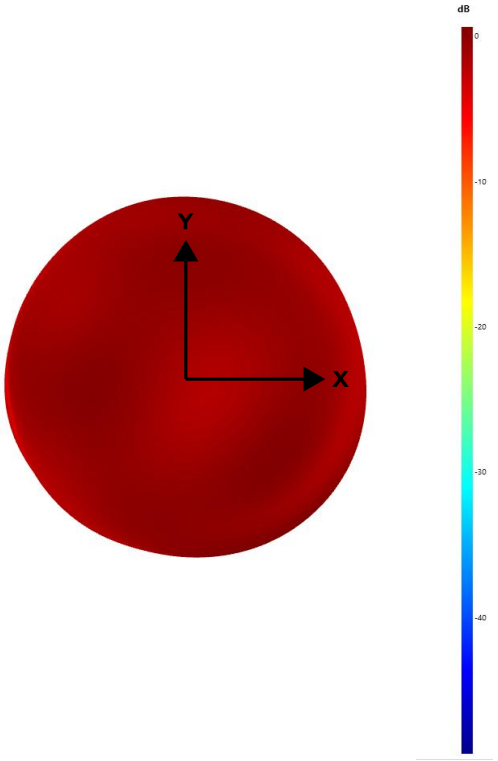

Figure 2-14. 3D Antenna Radiation Pattern (XZ view)

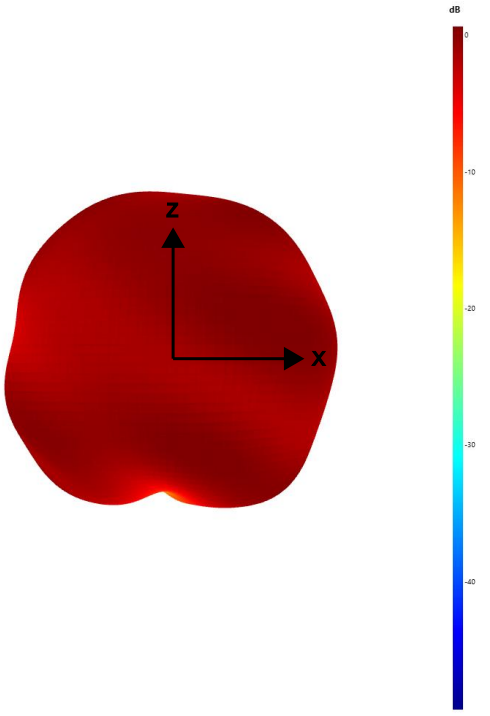

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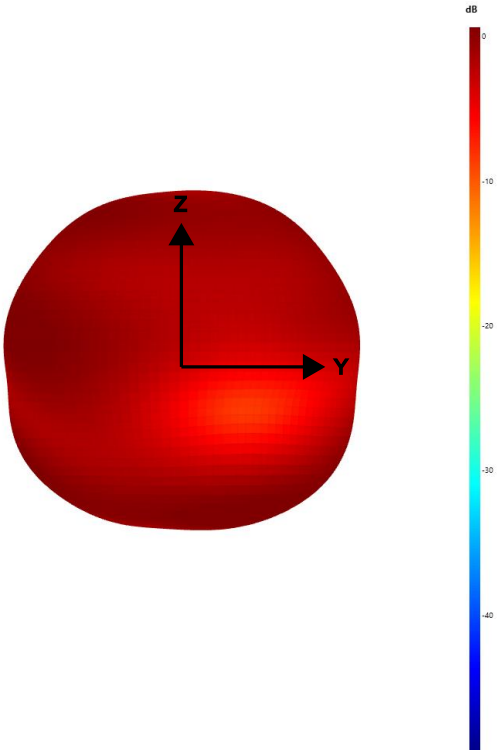
Figure 2-15. 3D Antenna Radiation Pattern (YZ view)



2D Antenna Radiation Pattern

The following figures illustrate the 2D cross section of the antenna radiation pattern.

Figure 2-16. Antenna Radiation Azimuth Plane Pattern @ Theta = 90°

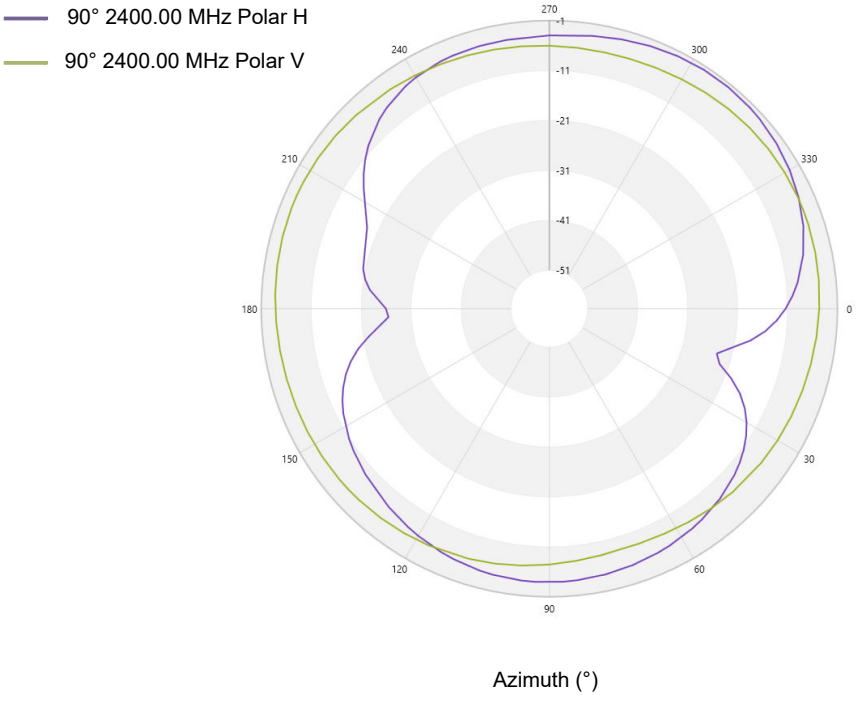


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Figure 2-17. Antenna Radiation Elevated Plane Pattern @ Phi = 0°

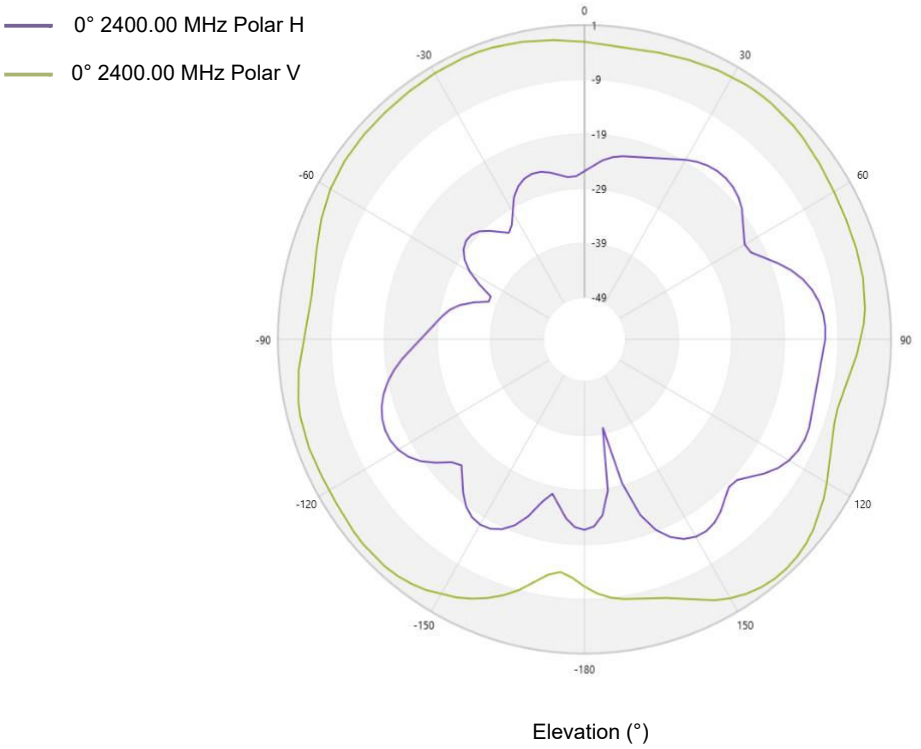
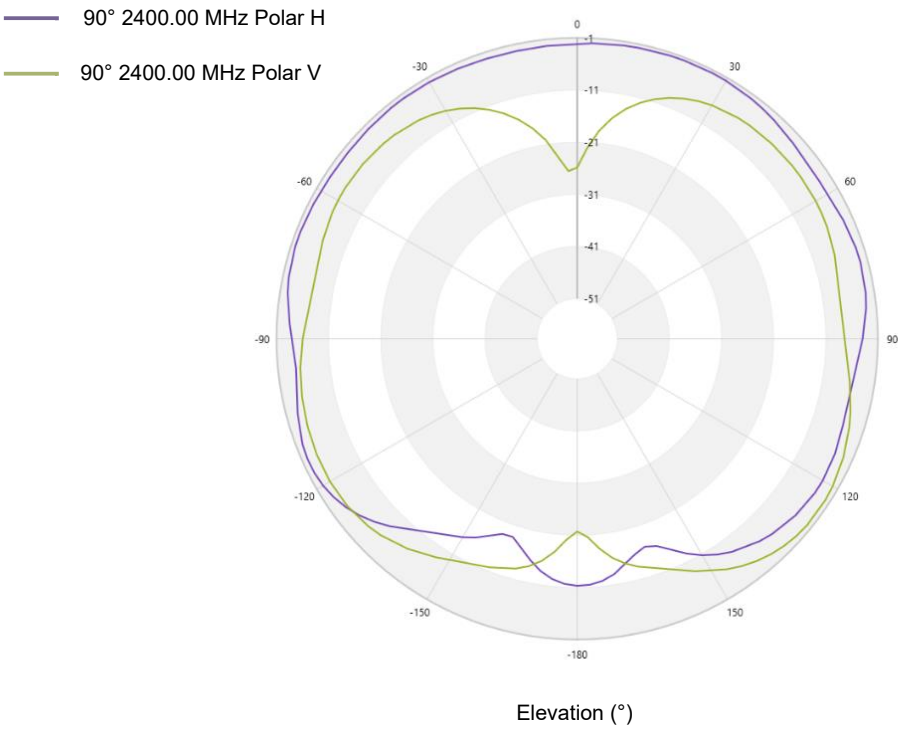


Figure 2-18. Antenna Radiation Elevated Plane Pattern @ Phi = 90°



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2.6.2 External Antenna Placement Recommendations

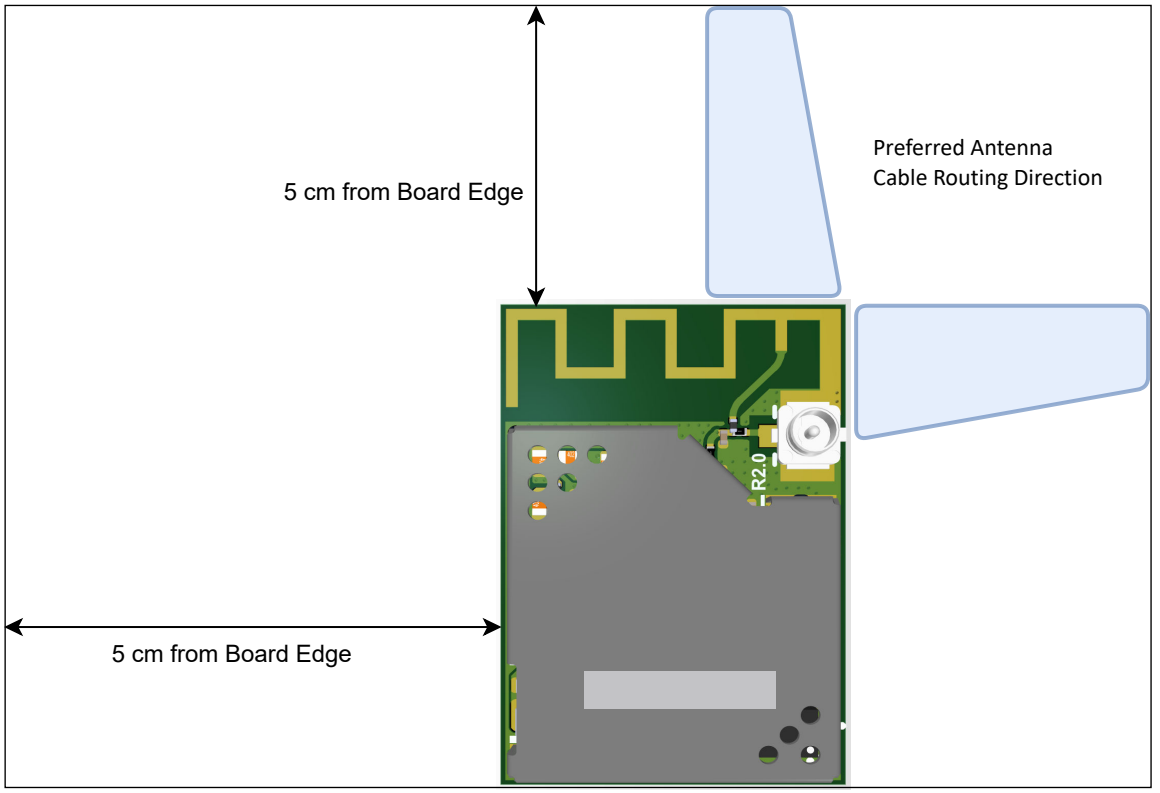
The user must ensure the following for the placement of the antenna and its cable:

- Do not route the antenna cable over circuits generating electrical noise on the host board or alongside or underneath the module. The recommendation is to route the cable straight out of the module.
- Do not place the antenna in direct contact or in close proximity of the plastic casing/objects.
- Do not enclose the antenna within a metal shield.
- The user must keep any components capable of radiating noise, signals or harmonics in the 2.4-2.5 GHz frequency range away from the antenna and, if feasible, provide shielding for such components. Any noise radiated from the host board in this frequency band degrades the sensitivity of the module.
- Place the antenna at a distance greater than 5 cm away from the module. The following figure illustrates the antenna keepout area (do not place the antenna in this area). This recommendation is based on an open-air measurement and does not take into account any metal shielding of the customer end product. When a metal enclosure is used, the antenna can be located closer to the WILCS02 module.

These recommendations are based on an open-air measurement and do not take into account any metal shielding of the customer end product. When a metal enclosure is used, the antenna can be located closer to the WILCS02 module.

The following figure illustrates how the antenna cable must be routed depending on the location of the antenna with respect to the WILCS02 PCB. There are two possible options for the optimum routing of the cable.

Figure 2-19. WILCS02 Module Antenna Placement Guidelines



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Note: These are generic guidelines and the recommendation is that customers can check and fine-tune the antenna positioning in the final host product based on RF performance.

2.6.2.1 External Antennas

The WILCS02UE/WIUBS02UE modules have an ultra-small surface mount U.FL connector for an external antenna connection. The choice of antenna is limited to the antenna types that the module is tested and approved for.

The WILCS02UE/WIUBS02UE modules are approved to use with the antennas listed in the following table. It is permissible to use a different antenna, provided it is the same antenna type, has the same antenna gain (equal or less than) and similar in-band and out-of-band characteristics are present (refer to antenna specification sheet for cutoff frequencies).

If other antenna types are used, the OEM installer must conduct the necessary assessments and authorize the antenna with the respective regulatory agencies and ensure compliance.

Table 2-4. WILCS02 Module Approved External Antenna List with Antenna Gain

Antenna No.	Part Number	Manufacturer	Antenna Gain (dBi)	Antenna Type	Regulatory Certification	
					FCC/ISED(2) (3)	CE
1	WXE2400	TE Connectivity/Laird External Antennas	3	Dipole	x	x
2	ANT-2.4-CW-RCL-RPS	TE Connectivity/Linx Technologies	2.3	Dipole	x	x
3	RFA-02-C2M2-D034	Alead	2	Dipole	x	x
4	RFA-02-L2H1(6)	Aristotle	2	Dipole	x	x
5	RFA-02-C2H1-D034(6)	Alead	2	Dipole	x	x
6	RFA-02-D3(6)	Aristotle	2	Dipole	x	x
7	RFDPA870920IMLB301(6)	Walsin	1.84	Dipole	x	x
8	RFDPA870920IMAB302(6)	Walsin	1.82	Dipole	x	x
9	RFDPA870920IMAB305(6)	Walsin	1.82	Dipole	x	x
10	RFDPA870910IMAB308(6)	Walsin	2	Dipole	x	x
11	RFA-02-C2M2(6)	Aristotle	2	Dipole	x	x
12	RN-SMA-S-RP(6)	Microchip	0.56	Dipole	x	x
13	W1049B030(6)	Pulse	2	Dipole	x	x
14	RN-SMA4-RP(6)	Microchip	2.2	Dipole	x	x

Notes:

1. ‘x’ denotes the antennas covered under the certification.
2. If the end product using the module is designed to have an antenna port that is accessible to the end user, a unique (non-standard) antenna connector (as permissible by FCC) must be used (for example, RP (Reverse Polarity)-SMA socket).
3. If an RF coaxial cable is used between the module RF output and the enclosure, a unique (non-standard) antenna connector must be used in the enclosure wall to interface with the antenna.
4. Contact the antenna vendor for detailed antenna specifications to review the suitability to the end product operating environment and to identify alternatives.
5. If any external antenna is used other than the recommended antennas in the list, it may need an extra step of post-calibration on the customer's application board.
6. These antennas need post calibration, refer to the application note for post calibration process.

2.7 WILCS02 Module Reflow Profile Information

The WILCS02 module was assembled using the IPC/JEDEC J-STD-020 standard lead-free reflow profile. The WILCS02 module can be soldered to the host board using standard leaded or lead-free solder reflow profiles. To avoid damaging the module, adhere to the following recommendations:

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- For solder reflow recommendations, refer to the *AN233 Solder Reflow Recommendation Application Note* (DS00233).
- Do not exceed a peak temperature (TP) of 250°C.
- For 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 module, avoiding pad misalignment. The recommendation is to use the no clean solder pastes. Ensure full drying of no-clean paste fluxes as a result of the reflow process. As per the recommendation by the solder paste vendor, this requires longer reflow profiles and/or peak temperatures toward the high end of the process window. The uncured flux residues can lead to corrosion and/or shorting in accelerated testing and possibly the field.

2.8 WILCS02 Module Assembly Considerations

The WILCS02 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 like IPA and similar solvents can be used to clean the WILCS02 module. However, do not use the cleaning solutions that contain acid 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.

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3. Electrical Specifications

This chapter provides the electrical specifications and the characteristics of the WILCS02 Module across the operating temperature range of the product.

3.1 WILCS02 Module Absolute Maximum Ratings

The following table provides details about the list of absolute maximum ratings for the WILCS02 module. Exposure to these maximum rating conditions for extended periods can affect the device's 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.

Table 3-1. Absolute Maximum Ratings

Parameter	Value
Ambient temperature under bias(1)	-40°C to +85°C
Storage temperature	-65°C to +150°C
Voltage on V_{DD} with respect to GND	-0.3V to +4.0V
Voltage on any pin(s) with respect to GND	-0.3V to (V_{DD}+0.3V)
Voltage on (Pin 13-19 and 27) with respect to GND	-0.3V to (V_{DDIO}+0.3V)
Maximum current out of GND pins(2)	500 mA
Maximum current into V_{DD} pins(2)	500 mA
ESD Qualification	
Human Body Model (HBM) per JESD22-A114	2000V
Charged Device Model (CDM) (ANSI/ESD STM 5.3.1)	±500V

Notes:

1. The preceding table provides the list of stresses that 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.
2. Maximum allowable current is a function of the device's maximum power dissipation.

3.2 Thermal Specifications

Table 3-2. Thermal Operating Conditions

Rating	Symbol	Min.	Typ	Max.	Unit
Industrial Temperature Devices:					
Operating ambient temperature range	T_A	-40	—	+85	°C
Operating junction temperature range	T_J	-40	—	+125	°C

Table 3-3. Recommended Operating Voltages

Param. No.	Symbol	Characteristics	Min.	Typ.	Max.	Unit	Conditions
DC_1	V_{DD}	V_{DD} voltage range	3	3.3	3.6	V	—
DC_4	V_{DDIO}	V_{DDIO} voltage range	1.8	3.3	3.6	V	Module pins (13-19 and 27) only. All other I/Os are at V_{DD}.
DC_7	GNDDB	Common EDP ground reference	V_{SS}	V_{SS}	V_{SS}	V	—

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3.3 WILCS02 Module DC Characteristics

3.3.1 I/O Pin DC Electrical Specifications

Table 3-4. I/O Pin DC Electrical Specifications

DC Characteristics			Standard Operating Conditions: V_{DD} = V_{DDIO} = 3.0V to 3.6V (unless otherwise stated) Operating Temperature: -40°C ≤ T_A ≤ +85°C for Industrial				
Param. No.	Symbol	Characteristics	Min.	Typ.(1)	Max.	Units	Conditions
DI_1	V_{IL}	Input low voltage I/O pins	GND	—	0.2*V_{DDIO}	V	—
DI_3	V_{IH}	Input high voltage	0.8*V_{DDIO}	—	V_{DDIO}	V	—
DI_5	V_{OL}	Output low voltage	—	—	0.4	V	—
DI_9	V_{OH}	Output high voltage	2.4	—	—	V	—
		Output high voltage	1	—	—	V	V_{DDIO} = 1.8V
DI_13	I_{IL}	Input pin leakage current	-1	—	+1	µA	—

3.3.2 Wi-Fi Current Consumption

Table 3-5. Wi-Fi Current Consumption DC Electrical Specifications

DC Characteristics(1)(2)				Standard Operating Conditions: V_{DD}=V_{DDIO}= 3.0V to 3.6V (unless otherwise stated) Operating Temperature: -40°C ≤ T_A ≤ +85°C for Industrial				
Param. No.	Symbol	Device States	Code Rate	Output Power (Typ.) (dBm)	Current (Typ.) (mA)(3)	Max.	Units	Conditions
IWF_TX	I_{DD}	On_Transmit(5)	802.11b 1 Mbps	19	266	—	mA	V_{DD} = V_{DDIO} = 3.3V
			802.11b 1 Mbps	14	243	—		
			802.11b 11 Mbps	20	268	—		
			802.11g 6 Mbps	19	269	—		
			802.11g 54 Mbps	16	236	—		
			802.11n MCS0	17	239	—		
			802.11n MCS7	17	238	—		
			802.11n MCS7	15.5	233	—		
			802.11n MCS7	10.5	224	—		
IWF_RX	I_{DD}	On_Receive	802.11b 1 Mbps	—	80	—		
			802.11n MCS7	—	86			

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.....continued

DC Characteristics[1][2]				Standard Operating Conditions: V_{DD}=V_{DDIO}= 3.0V to 3.6V (unless otherwise stated) Operating Temperature: -40°C ≤ T_A ≤ +85°C for Industrial				
Param. No.	Symbol	Device States	Code Rate	Output Power (Typ.) (dBm)	Current (Typ.) (mA)[3]	Max.	Units	Conditions

Notes:

1. Measured along with the RF matching network (assume 50Ω impedance)
2. The test conditions for I_{DD} current 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
   - WDT and FSCM are disabled
   - All I/O pins are configured as inputs and pulled to V_{DD}
   - $\overline{MCLR}$ = V_{DD}
3. Data in the "Typ." column is at 3.3V, 25°C unless otherwise stated.
4. This parameter is characterized, but not tested in manufacturing.
5. Tested at channel 7 in Fixed mode gain.

3.3.3 Extreme Deep Sleep (XDS) Current Consumption

Table 3-6. Extreme Deep Sleep (XDS) Current Consumption

DC Characteristics						Standard Operating Conditions: V_{DD} = V_{DDIO} = 3.0V to 3.6V (unless otherwise stated) Operating Temperature: -40°C ≤ T_A ≤ +85°C for Industrial
Param. No.	Symbol	Characteristics	Typ[1]	Max.	Units	Conditions
XDSPWR_1	I_{DD_XDS}[2]	I_{DD} in XDS mode	0.7	—	µA	V_{DD} = V_{DDIO} = 3.3V

Notes:

1. Typical values at 25°C only
2. Conditions:
   - All peripherals inactive
   - All IO configured as input and pulled down internally

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3.4 WILCS02 Module AC Characteristics

3.4.1 SDIO Controller AC Timing Specifications

Figure 3-1. SDIO Controller AC Timing Diagram

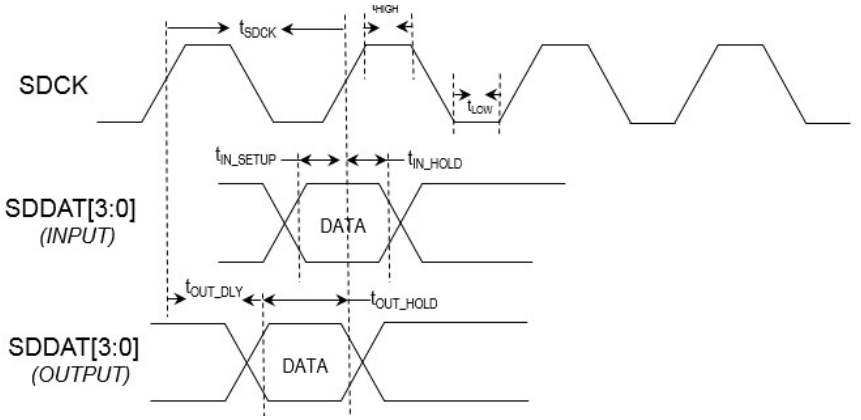

Table 3-7. SDIO Controller AC Timing Specifications

AC Characteristics			Standard Operating Conditions: V_{DD} = V_{DDIO} = 3.0V to 3.6V (unless otherwise stated) Operating Temperature: -40°C ≤ T_A ≤ +85°C for Industrial -40°C ≤ T_A ≤ +105°C for V-temp				
Param. No.	**Symbol**	**Characteristics**	**Min.**	**Typ**	**Max.**	**Units**	**Conditions(1)**
SD/SDIO Default Speed Mode							
SD_5	tSDCK	Clock frequency	0	25	50	MHz	
SD_7	tDUTY	Duty cycle	—	50	—	%	—
SD_9	tHIGH	Clock high time	4.5	—	—	ns	—
SD_11	tLOW	Clock low time	9	—	—	ns	—
SD_13	tRISE	Clock rise time	See I/O pin specification parameter DI25				
SD_15	tFALL	Clock fall time	See I/O pin specification parameter DI27				
SD_17	tIN_SETUP	Input setup time	6	—	—	ns	—
SD_19	tIN_HOLD	Input hold time	4	—	—	ns	—
SD_21	tOUT_DLY	Output delay time	3	—	11	ns	VDDIO = 3.3V, C_{LOAD} = 15 pF ($_{Max}$)
SD_23	tOUT_SETUP	Output hold time	—	—	—	ns	

Notes:

1. All output pins with 15 pF load.
2. Maximum clock frequency specified is limited by the SDIO Host interface internal design; actual maximum clock frequency can be lower and depends on the specific PCB layout.

3.4.2 SPI Electrical Specifications

Note: Traditional Serial Communication Interface documentation uses the terminology “Master” and “Slave”. The equivalent Microchip terminology used in this document is “Host” and “Client”, respectively.

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Figure 3-2. SPI Client CPHA=0 Timing Diagram

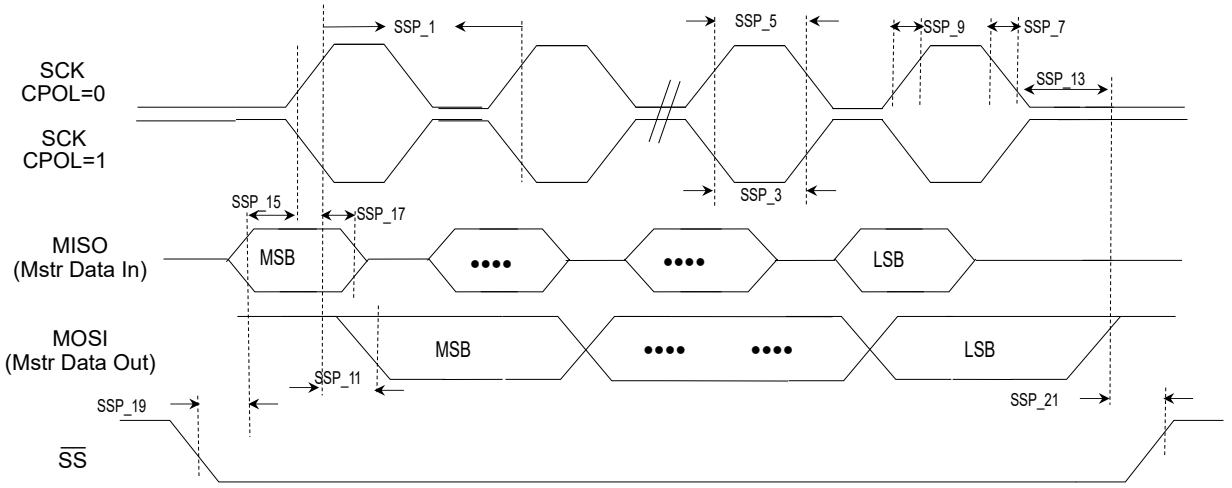

Figure 3-3. SPI Client CPHA=1 Timing Diagram

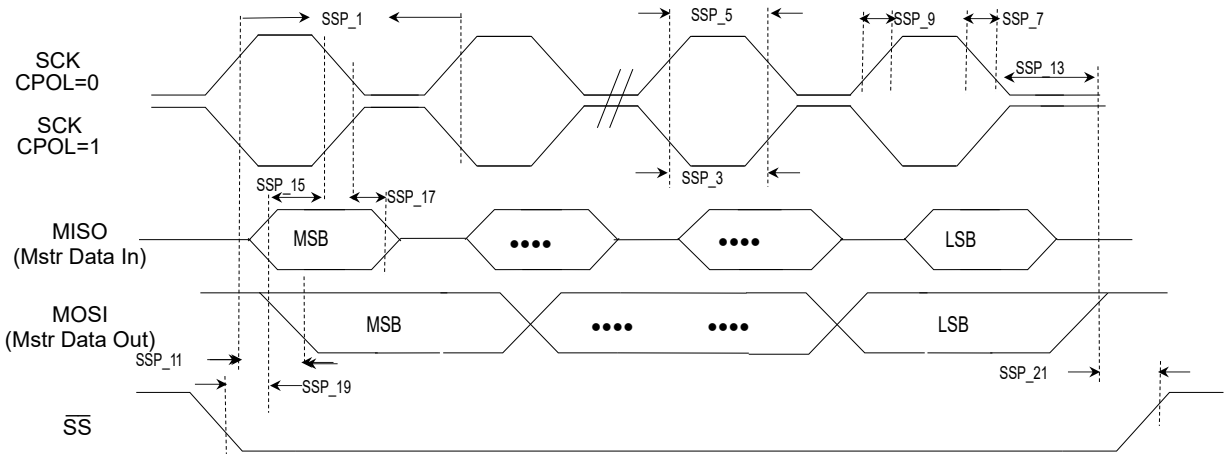

Table 3-8. SPI Client Mode Electrical Specifications

AC Characteristics			Standard Operating Conditions: V_{DD} = V_{DDIO} = 3.0V to 3.6V (unless otherwise stated) Operating Temperature: -40°C ≤ T_A ≤ +85°C for Industrial -40°C ≤ T_A ≤ +105°C for V-temp				
Param. No.	**Symbol**	**Characteristics**	**Min.**	**Typ**	**Max.**	**Units**	**Conditions**
SSP_1	FSCK	SCK frequency	—	—	20	MHz	SPI2 CLOCK on PA6
			—	—	40		SPI1 CLOCK on PA0
SSP_3	TSCL	SCK output low time	1/(2*FSCK)	—	—	ns	—
SSP_5	TSCH	SCK output high time	1/(2*FSCK)	—	—	ns	—
SSP_7	TSCF	SCK and MOSI output fall time	—	—	DI27	ns	See parameter DI27 I/O spec
SSP_9	TSCR	SCK and MOSI output rise time	—	—	DI25	ns	See parameter DI25 I/O spec

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AC Characteristics			Standard Operating Conditions: V_{DD} = V_{DDIO} = 3.0V to 3.6V (unless otherwise stated) Operating Temperature: -40°C ≤ T_A ≤ +85°C for Industrial -40°C ≤ T_A ≤ +105°C for V-temp				
Param. No.	Symbol	Characteristics	Min.	Typ	Max.	Units	Conditions
SSP_11	TSOV	MOSI data output valid after SCK	—	—	7	ns	—
SSP_15	TSIS	MISO setup time of data input to SCK	5	—	—	ns	
SSP_17	TSIH	MISO hold time of data input to SCK	5	—	—	ns	

Notes:

1. Assumes VDDIOx (min) and 10 pF external load on all SPIx pins unless otherwise noted.
2. CPHA=0.
3. CPHA=1.
4. These parameters are characterized, but not tested in manufacturing.

3.4.3 USB OTG AC Electrical Specifications

Table 3-9. USB OTG AC Electrical Specifications

AC Characteristics			Standard Operating Conditions: V_{DD} = V_{DDIO} = 3.0V to 3.6V (unless otherwise stated) Operating Temperature: -40°C ≤ T_A ≤ +85°C for Industrial -40°C ≤ T_A ≤ +105°C for V-temp				
Param. No.	Symbol	Characteristics	Min.	Typ	Max.	Units	Conditions[1]
USB_1	VDDUSB	USB Transceiver Voltage	3	—	3.6	V	Voltage on VDDIOx must be in this range for proper USB operation
VBUS Supply							
USB_3	VBUS	High-power Port	4.75	—	5.25	V	500 mA load
USB_5		Low-power Port	4.4	—	5.25	V	100 mA Load
USB_7	VILUSB	Input Low Voltage for USB Buffer	—	—	0.8	V	—
USB_9	VIHUSB	Input High Voltage for USB Buffer	2	—	—	V	—
USB_11	VDIFS	Differential Input Sensitivity	—	—	0.2	V	The difference between D+ and D- must exceed this value while VCM is met
USB_13	VCM	Differential Common Mode Range	0.8	—	2.5	V	VUSB = 3.0V to 3.6V
USB_15	ZOUT	Driver Output Impedance	36	—	55	W	—
USB_17	VOLUSB	Voltage Output Low	—	—	0.3	V	1.425 kW load connected to VUSB = 3.6V

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.....continued

AC Characteristics			Standard Operating Conditions: V_{DD} = V_{DDIO} = 3.0V to 3.6V (unless otherwise stated) Operating Temperature: -40°C ≤ T_A ≤ +85°C for Industrial -40°C ≤ T_A ≤ +105°C for V-temp				
Param. No.	Symbol	Characteristics	Min.	Typ	Max.	Units	Conditions(1)
USB_19	VOHUSB	Voltage Output High	2.8	—	3.6	V	14.25 kW load connected to ground w/VUSB = 3.0V
USB_21	VBUS	USB VBUS Input range	—	—	5.5	V	—

Note:

1. These parameters are characterized, but not tested in manufacturing.

3.4.4 XOSC32 RTCC Oscillator AC Electrical Specifications

Table 3-10. XOSC32 RTCC Oscillator AC Electrical Specifications

AC Characteristics			Standard Operating Conditions: V_{DD} = V_{DDIO} = 3.0V to 3.6V (unless otherwise stated) Operating Temperature: -40°C ≤ T_A ≤ +85°C for Industrial				
Param. No.	Symbol	Characteristics	Min.	Typ.	Max.	Units	Conditions(1)
XOSC32_1	FOSC_XOSC32	XOSC32 oscillator crystal frequency	—	32.768	—	kHz	SOSCI, SOSCO RTCC oscillator
XOSC32_15	TOSC32	TOSC32 = 1/FOSC_XOSC32	—	—	—	µs	See parameter XOSC32_1 for FOSC_XOSC32 value
XOSC32_21	XCLK32_DC	Ext clock oscillator duty cycle	—	50	—	%	—

Notes:

1. Crystal oscillator requirements:
   - Crystal load capacitance = 12 pF
   - Maximum Drive level = 200 µW
2. This parameter is characterized but not tested in manufacturing.

3.4.5 Power on Reset AC Electrical Specifications

Table 3-11. Power on Reset AC Electrical Specifications

AC Characteristics			Standard Operating Conditions: V_{DD} = V_{DDIO} = 3.0V to 3.6V (unless otherwise stated) Operating Temperature: -40°C ≤ T_A ≤ +85°C for Industrial				
Param. No.	Symbol	Characteristics	Min.	Typ.	Max.	Units	Conditions
DC_11	VPOR	V_{DD} start voltage to ensure internal POR signal	1.45	—	1.65	V	—
DC_12	SVDD	V_{DD} rise rate to ensure internal POR signal	0.03	—	0.115	V/ms	0-3.0V in 0.1s
DC_13	TRST	External Reset valid active pulse width	2	—	—	us	—

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3.5 WILCS02 Module Radio Specifications

Table 3-12. WILCS02 Module Radio Specifications

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

3.5.1 WILCS02 Module Receiver Performance

Table 3-13. WILCS02 Module Receiver Performance Characteristics(1)

RF Characteristics			Standard Operating Conditions: V_{DD}=V_{DDIO}= 3.0V to 3.6V (unless otherwise stated) Operating Temperature: -40°C ≤ T_A ≤ +85°C for Industrial			
Param. No.	Characteristics	Description(5)	Min.	Typ	Max.	Units
WF_RX_1	Frequency	—	2412	—	2472	MHz
WF_RX_2	Sensitivity 802.11b	1 Mbps DSSS	—	-97	—	dBm
		2 Mbps DSSS	—	-93	—	
		5.5 Mbps DSSS	—	-92	—	
		11 Mbps DSSS(6)	—	-88	—	
WF_RX_3	Sensitivity 802.11g	6 Mbps OFDM	—	-91	—	dBm
		9 Mbps OFDM	—	-90	—	
		12 Mbps OFDM	—	-88	—	
		18 Mbps OFDM	—	-86	—	
		24 Mbps OFDM	—	-83	—	
		36 Mbps OFDM	—	-80	—	
		48 Mbps OFDM	—	-75	—	
		54 Mbps OFDM(6)	—	-74	—	
WF_RX_4	Sensitivity 802.11n (Bandwidth at 20 MHz) (Both long GI and short GI)	MCS 0	—	-89	—	dBm
		MCS 1	—	-86	—	
		MCS 2	—	-84	—	
		MCS 3	—	-81	—	
		MCS 4	—	-78	—	
		MCS 5	—	-74	—	
		MCS 6	—	-72	—	
		MCS 7(6)	—	-70	—	
WF_RX_5	Maximum receive signal level	1, 2 Mbps DSSS	8	—	—	dBm
		5.5, 11 Mbps DSSS	8	—	—	
		6 Mbps OFDM	-1.5	—	—	
		54 Mbps OFDM	-8.5	—	—	
		MCS 0	-0.5	—	—	
		MCS 7	-8.5	—	—	

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.....continued

RF Characteristics			Standard Operating Conditions: V_{DD}=V_{DDIO}= 3.0V to 3.6V (unless otherwise stated) Operating Temperature: -40°C ≤ T_A ≤ +85°C for Industrial			
Param. No.	Characteristics	Description[5]	Min.	Typ	Max.	Units
WF_RX_6	Adjacent channel rejection	1 Mbps DSSS (30 MHz offset)	43.5	—	—	dB
		11 Mbps DSSS (25 MHz offset)	38.5	—	—	
		6 Mbps OFDM (25 MHz offset)	46.5	—	—	
		54 Mbps OFDM (25 MHz offset)	28.5	—	—	
		MCS 0 – 20 MHz Bandwidth (25 MHz offset)	45.5	—	—	
		MCS 7 – 20 MHz Bandwidth (25 MHz offset)	25.5	—	—	
WF_RX_7	RSSI accuracy	—	-5	—	5	dB

Notes:

1. Measured after RF matching network (assume 50Ω 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.

3.5.2 WILCS02 Module Transmitter Performance

Table 3-14. WILCS02 Module Transmitter Performance Characteristics

RF Characteristics			Standard Operating Conditions: V_{DD}=V_{DDIO}= 3.0V to 3.6V (unless otherwise stated) Operating Temperature: -40°C ≤ T_A ≤ +85°C for Industrial			
Param. No.	Characteristics	Description[8]	Min.	Typ[3]	Max.	Units
WF_TX_1	Frequency	—	2412	—	2472	MHz
WF_TX_2	Output power[1][2] 802.11b	1 Mbps DSSS[9]	—	19	—	dBm
		2 Mbps DSSS	—	19	—	
		5.5 Mbps DSSS	—	20	—	
		11 Mbps DSSS	—	20	—	

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RF Characteristics			Standard Operating Conditions: V_{DD}=V_{DDIO}= 3.0V to 3.6V (unless otherwise stated) Operating Temperature: -40°C ≤ T_A ≤ +85°C for Industrial			
Param. No.	Characteristics	Description[8]	Min.	Typ[3]	Max.	Units
WF_TX_3	Output power[1][2] 802.11g	6 Mbps OFDM	—	19	—	dBm
		9 Mbps OFDM	—	19	—	
		12 Mbps OFDM	—	19	—	
		18 Mbps OFDM	—	19	—	
		24 Mbps OFDM	—	19	—	
		36 Mbps OFDM	—	18	—	
		48 Mbps OFDM	—	17.5	—	
		54 Mbps OFDM[9]	—	17	—	
WF_TX_4	Output power[1][2] 802.11n (Bandwidth at 20 MHz)	MCS 0	—	18	—	dBm
		MCS 1	—	18	—	
		MCS 2	—	18	—	
		MCS 3	—	17.5	—	
		MCS 4	—	17.5	—	
		MCS 5	—	17	—	
		MCS 6	—	17	—	
		MCS 7[9]	—	17	—	
WF_TX_5	Transmit Power Control (TPC) accuracy	—	—	±2[2]	—	dB
WF_TX_6	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 RF matching network (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 can be used for specific antennas and/or enclosures, in which case, re-certification can be required. Program the custom gain table to control the transmit power using the MCHPRT3 tool.
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.

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3.5.3 WILCS02 Module Receiver and Transmitter Characteristics Graphs

Figure 3-4. Receive Current vs Temperature, MCS7, Channel 7, 3.3V

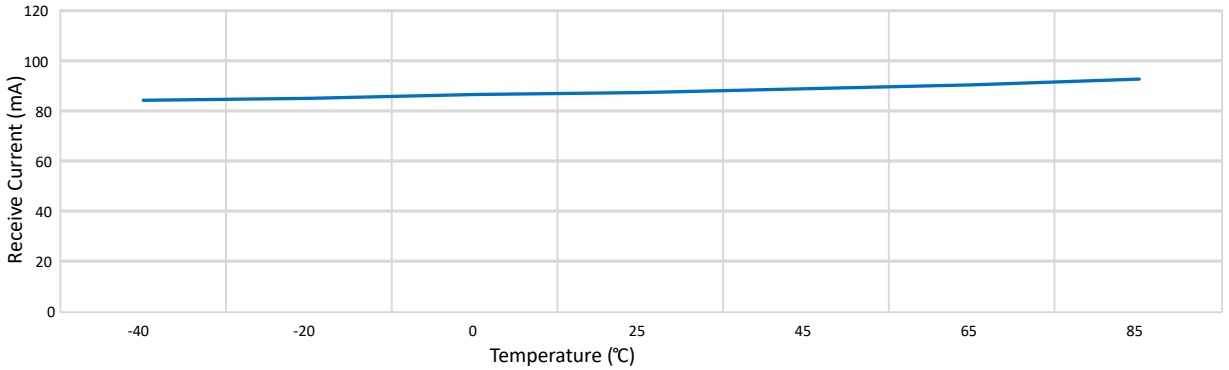

Figure 3-5. Receive Current vs Receive Signal Power, MCS7, Channel 7, 3.3V, 25℃

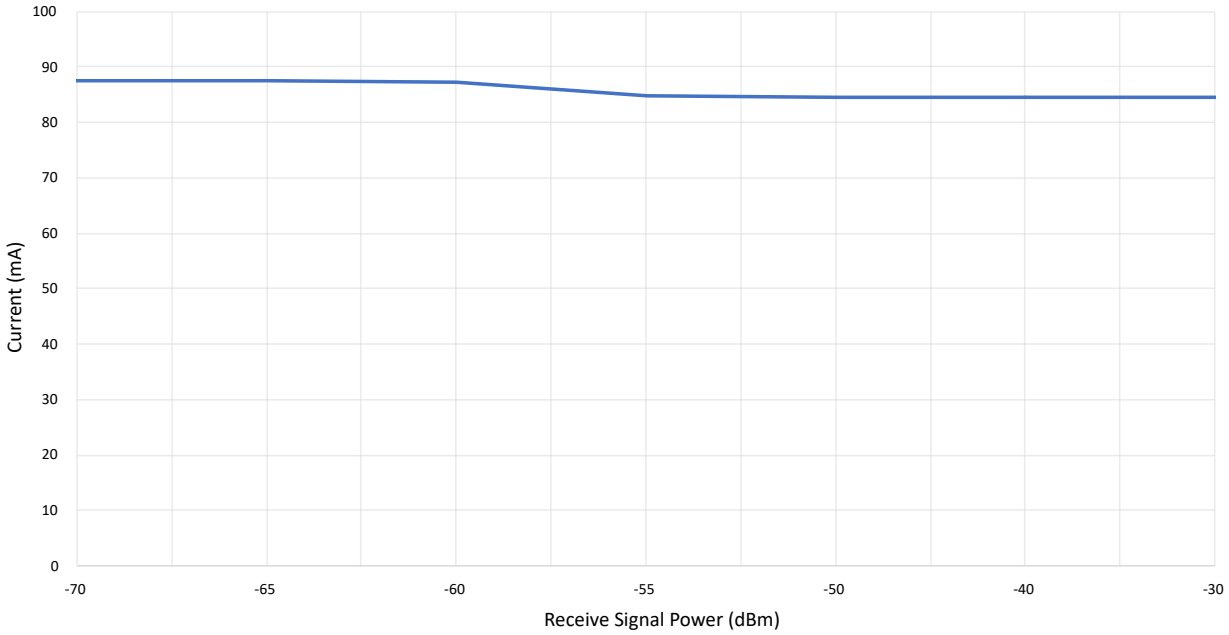

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Figure 3-6. Transmit Current vs Temperature, MCS7, Channel 7, 3.3V

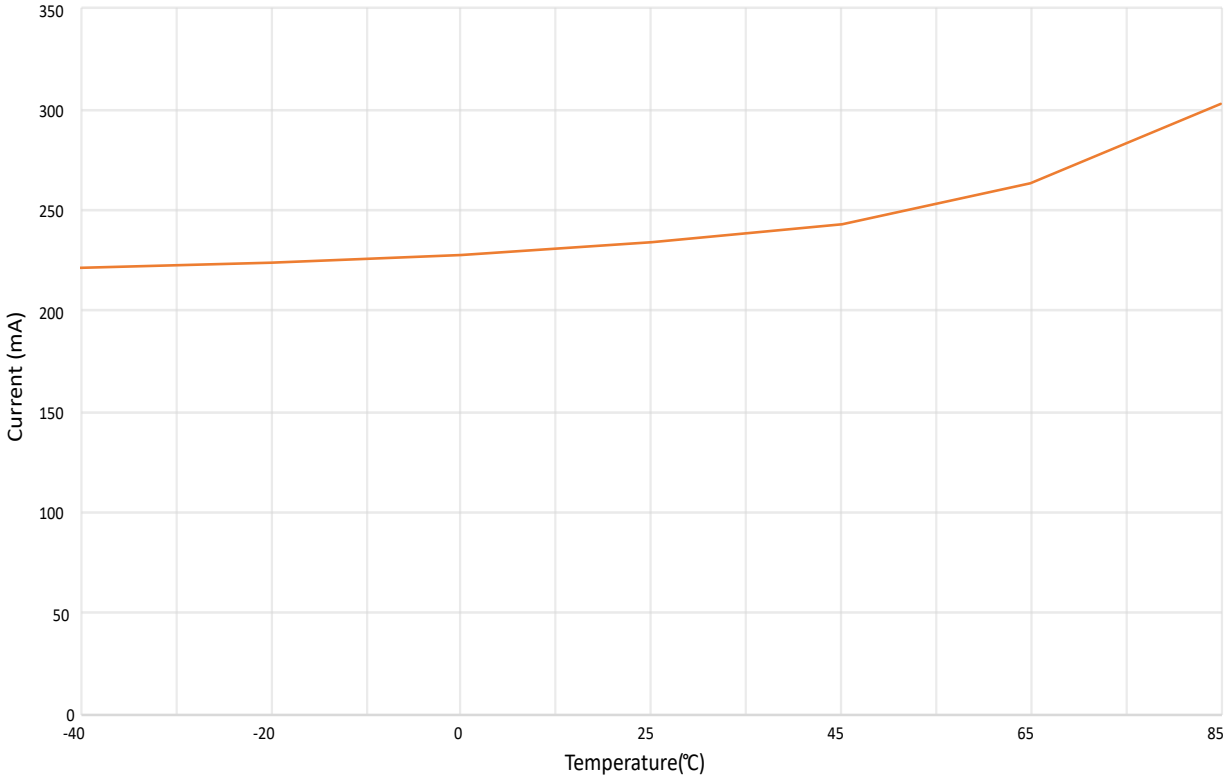

Figure 3-7. Transmit Current vs Transmit Output Power, MCS7, Channel 7, 3.3V, 25℃

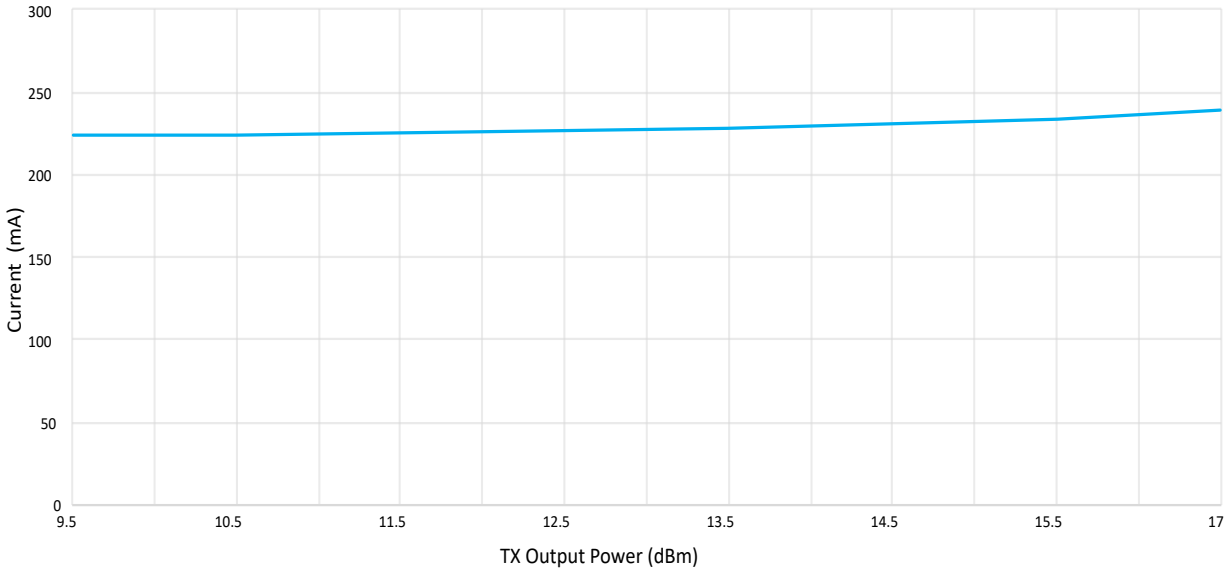

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Figure 3-8. Transmit Power vs Voltage, 1M, Channel 7, 3.3V, 25℃

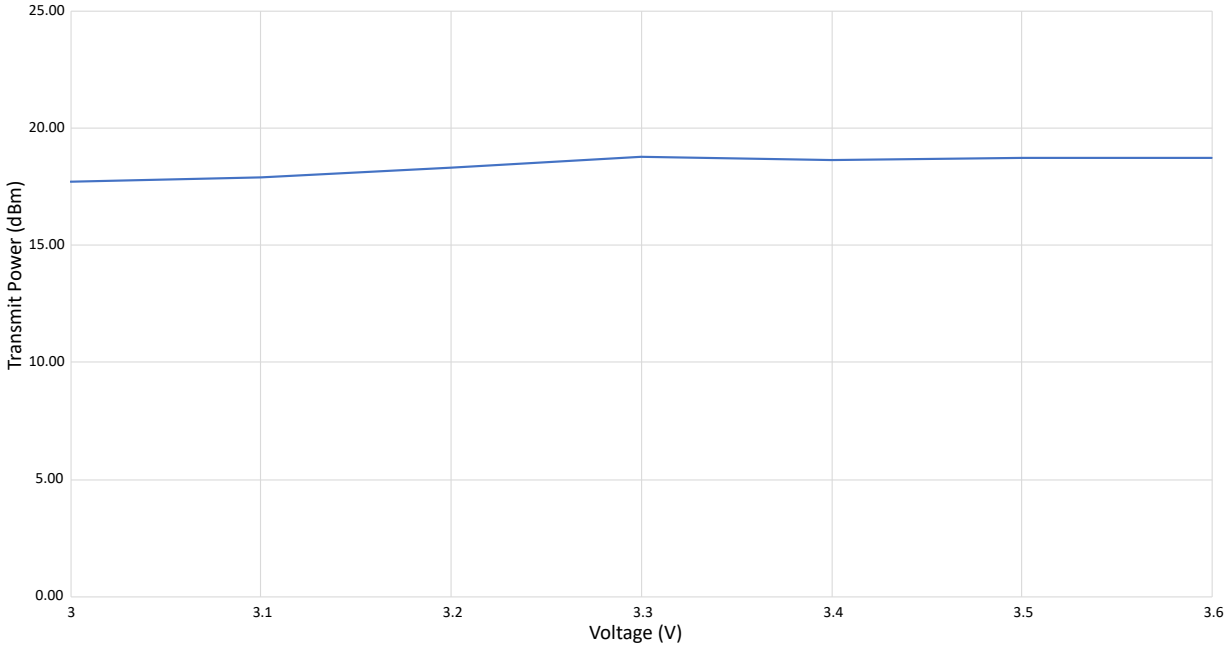

Figure 3-9. Transmit Power vs Temperature, 1M, Channel 7, 3.3V

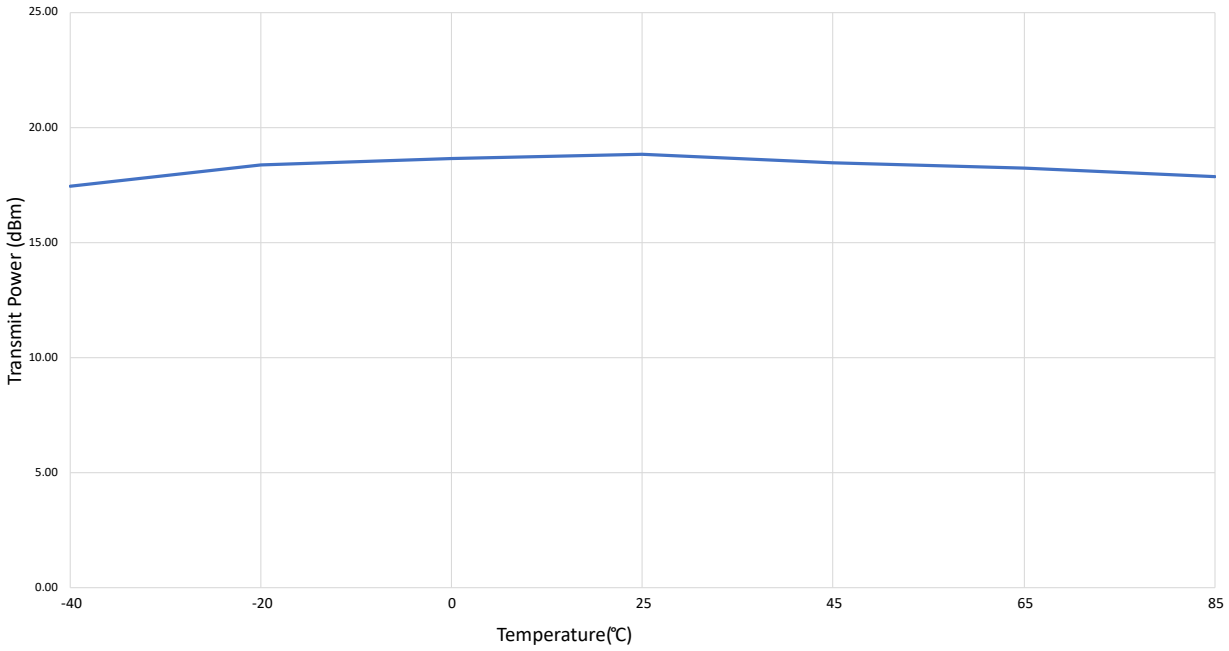

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Figure 3-10. Transmit Power vs Channel, 1M, Channel 7, 3.3V, 25℃

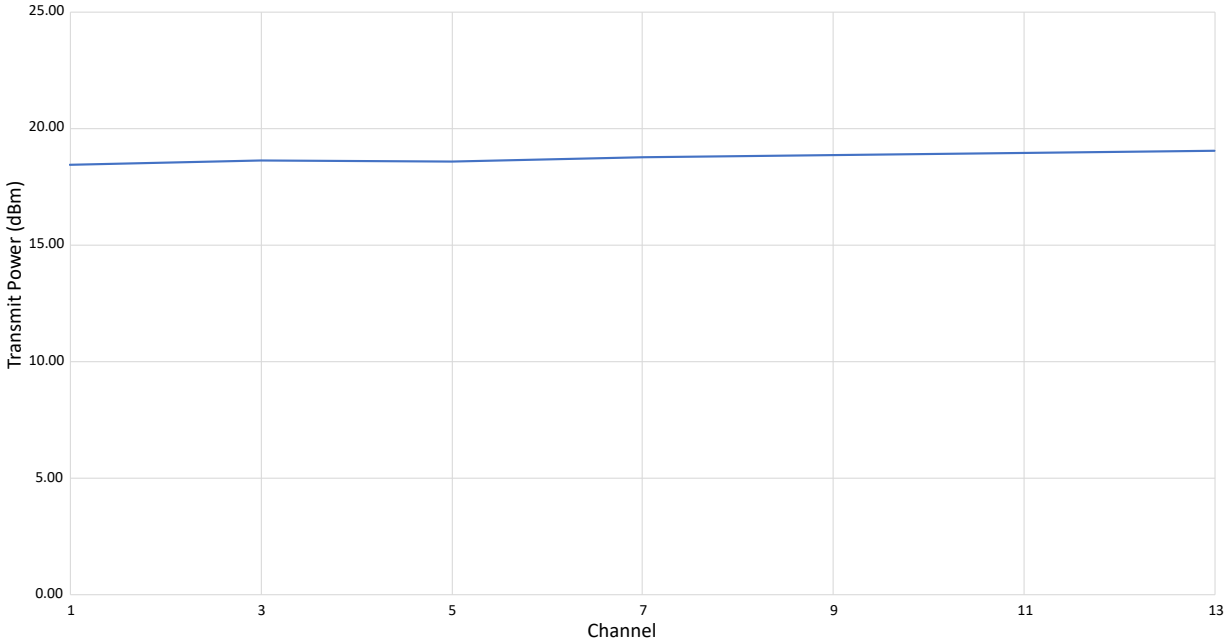

Figure 3-11. RX RSSI vs RX Input Power, MCS7, 3.3V, 25℃

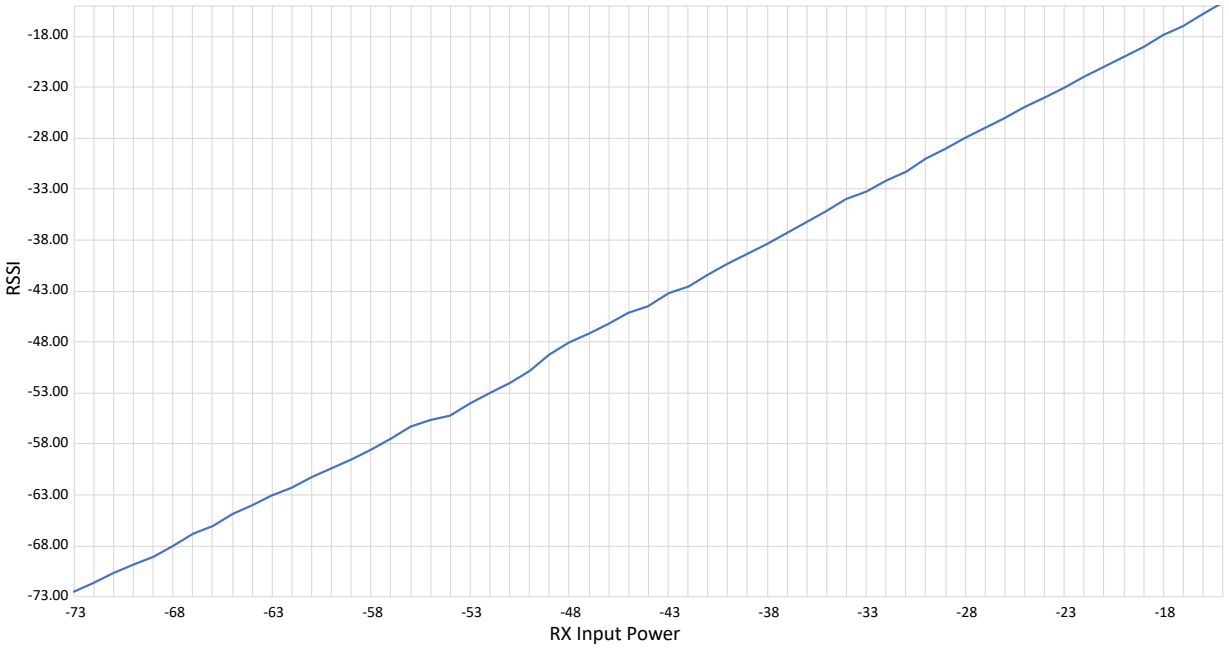

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Figure 3-12. RX Sensitivity vs Channel, MCS7, 3.3V, 25℃

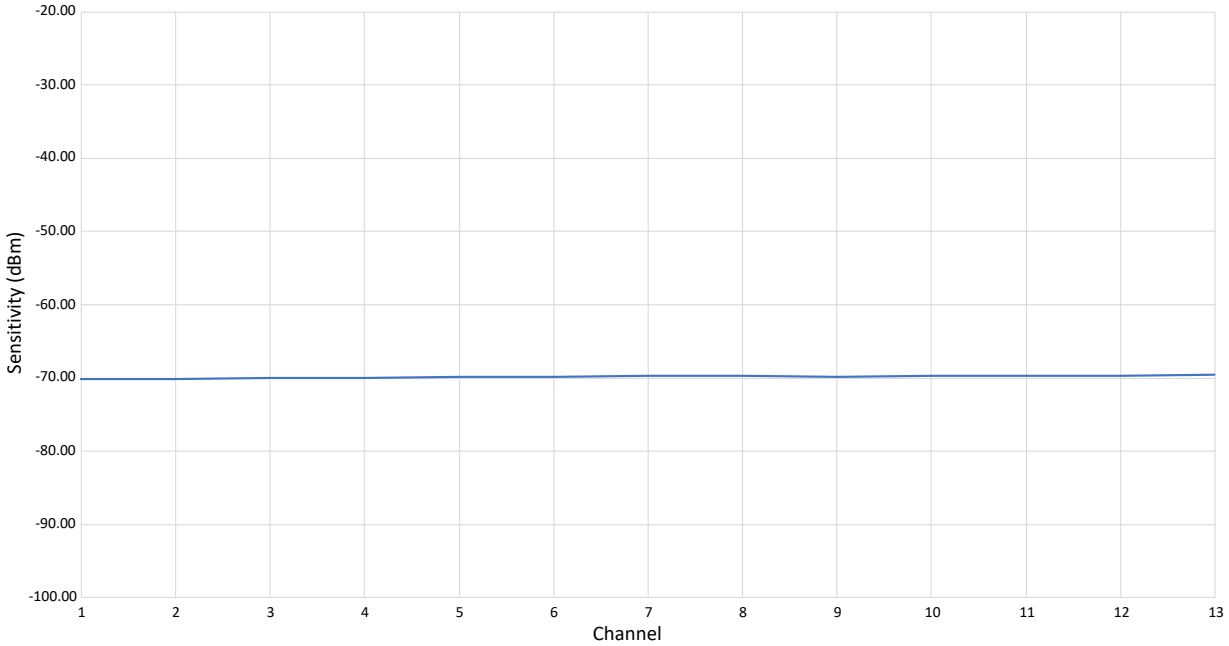

Figure 3-13. Receive Sensitivity vs Voltage, MCS7, Channel 7, 3.3V, 25℃

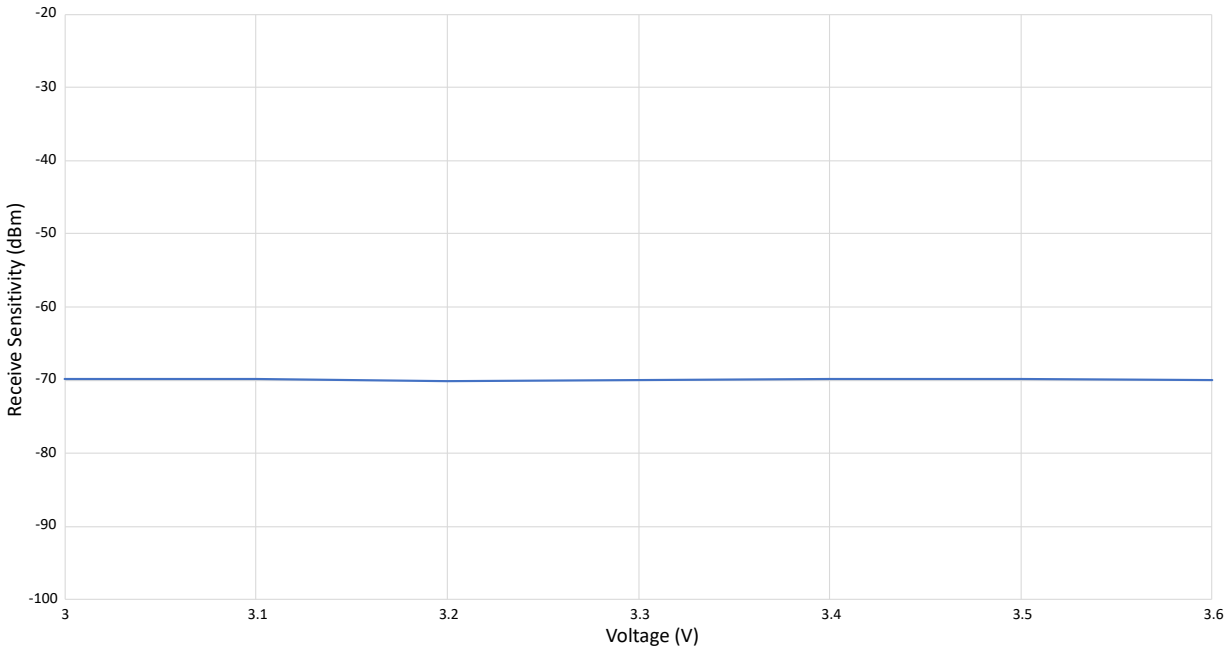

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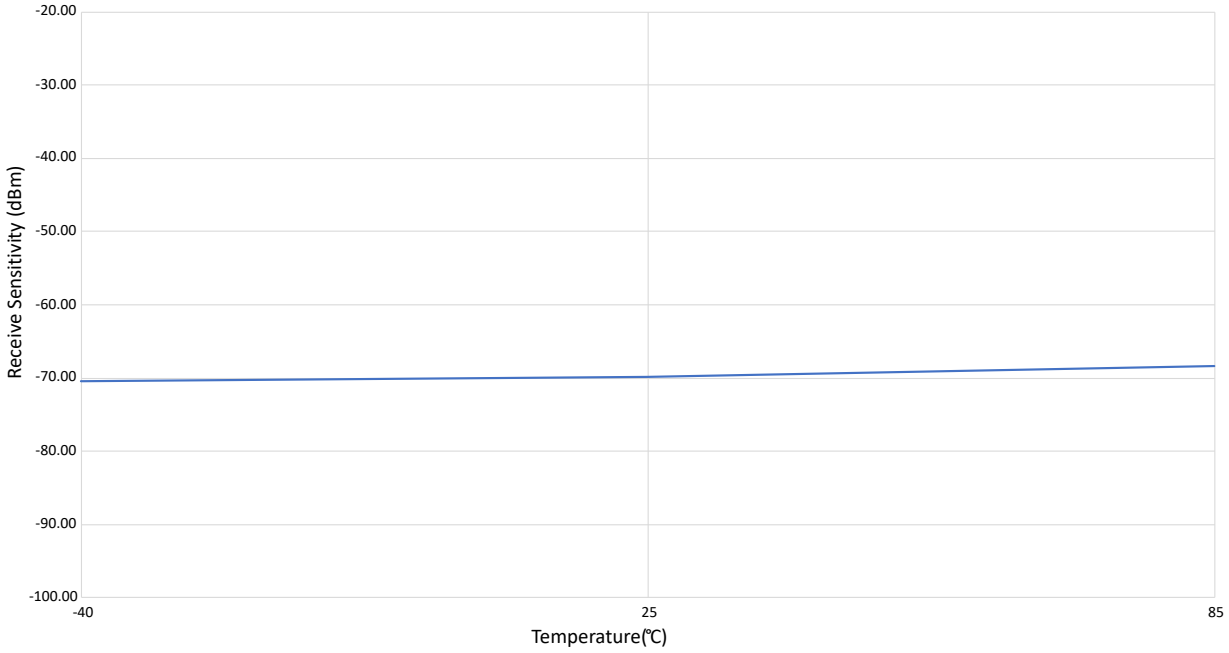
Figure 3-14. Receive Sensitivity vs Temperature, MCS7, Channel 7, 3.3V



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4. WILCS02 Module Packaging Information

4.1 WILCS02 Module Packaging Marking

Figure 4-1. WILCS02 Module Packaging Marking

Legend:

XX....X	Module part number and version and regulatory designator
YY:	Year code (last 2 digits of calendar year)
WW	Week code (week of January 1 is week "01")
NNN	Alphanumeric traceability code

4.2 WILCS02 Module Packaging Dimension

This section provides the package dimension details of the WILCS02 module.

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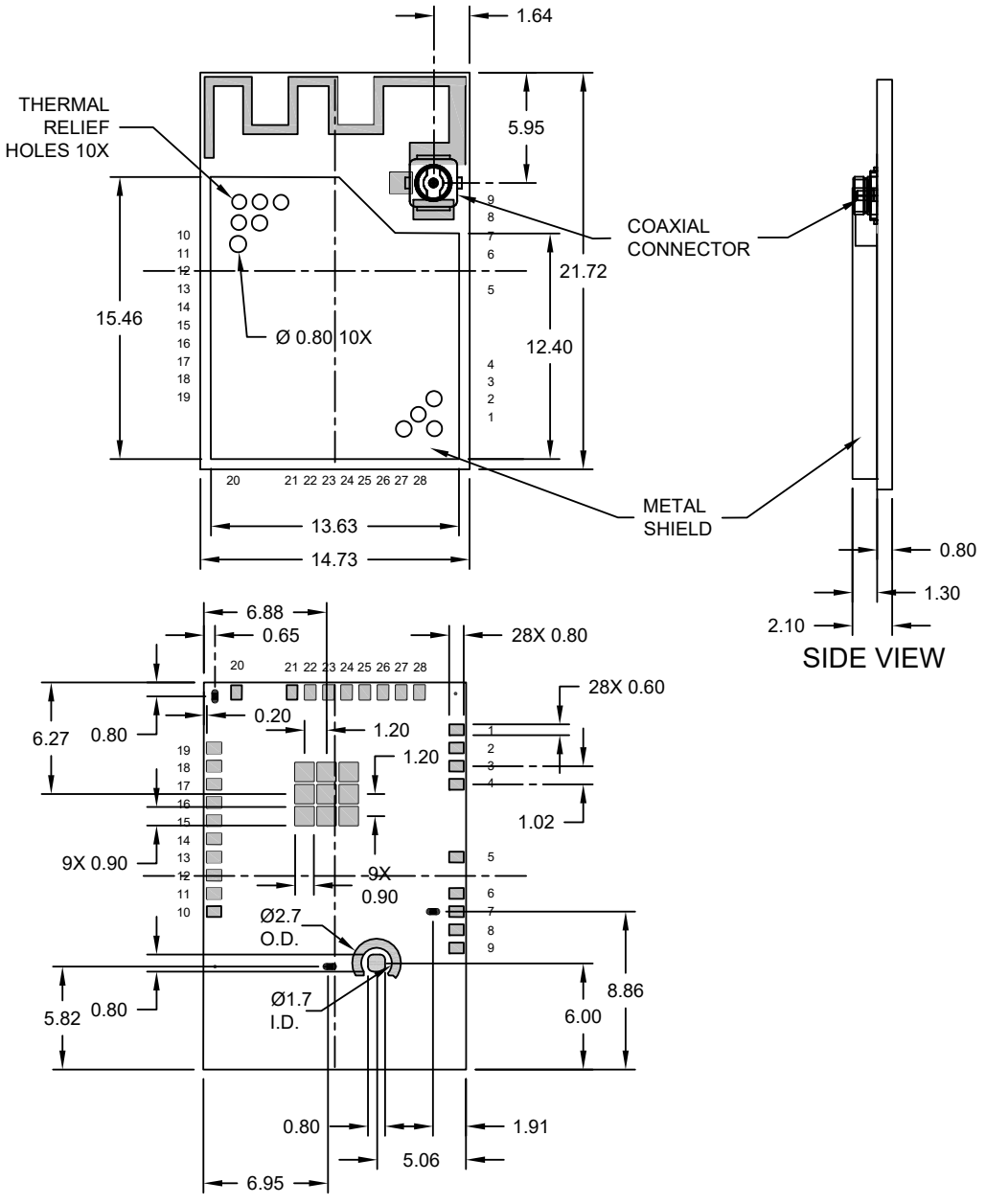
28-Lead PCB Module (TEC) - 14.73x21.72x2.1 mm Body [MODULE] With Metal Shield and Coaxial Connector

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



Microchip Technology Drawing C04-21567 Rev B Sheet 1 of 2

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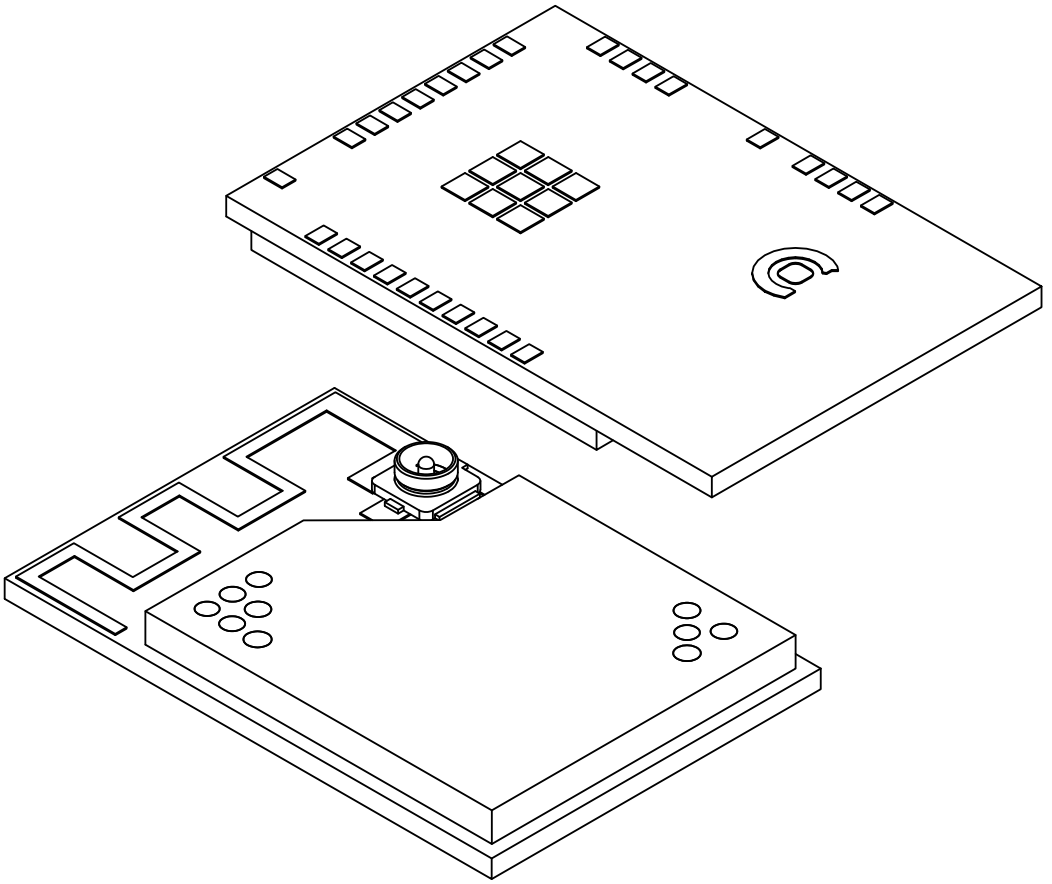
28-Lead PCB Module (TEC) - 14.73x21.72x2.1 mm Body [MODULE] With Metal Shield and Coaxial Connector

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



Notes:

1. All dimensions are in Millimeters.

Microchip Technology Drawing C04-21567 Rev B Sheet 2 of 2

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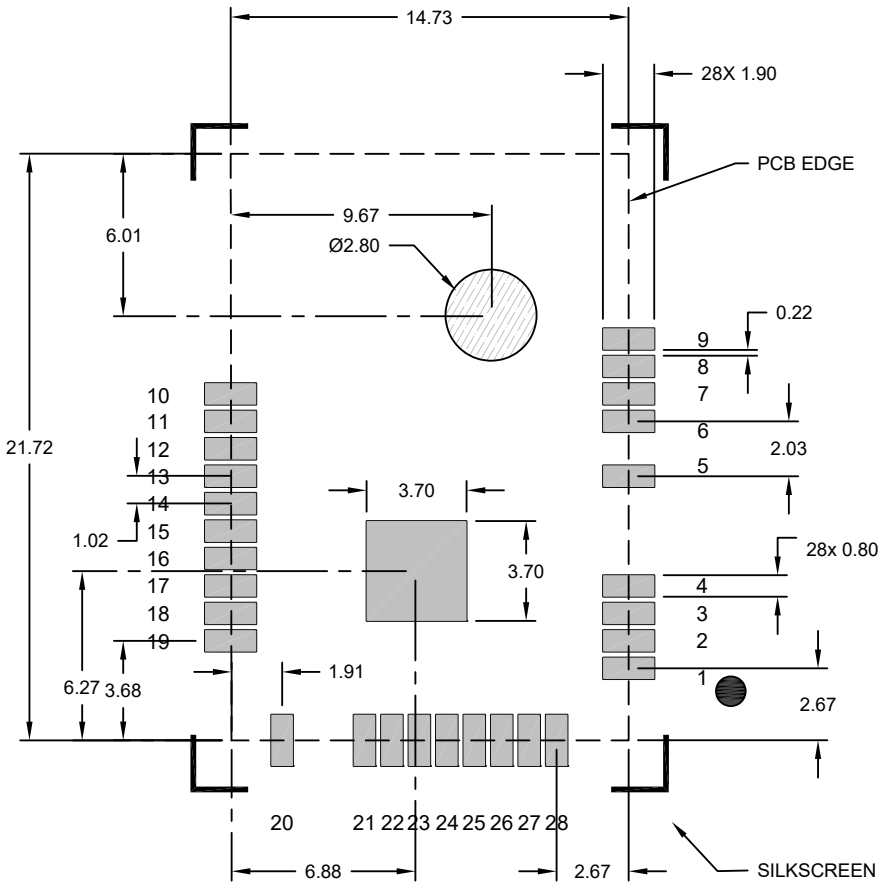
28-Lead PCB Module (TEC) - 14.73x21.72x2.1 mm Body [MODULE] With Metal Shield and Coaxial Connector

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



COPPER KEEPOUT ZONE

RECOMMENDED LAND PATTERN

Notes:

1. All dimensions are in millimeters.
2. Keep these areas free from routes and exposed copper. Ground fill with solder mask may be placed here.

Microchip Technology Drawing C04-23567 Rev B

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5. Appendix A: Regulatory Approval

The WIUBS02PE module has received regulatory approval for the following countries:

- United States/FCC ID: 2ADHKWIXCS02
- Canada/ISED:
  - IC: 20266-WIXCS02
  - HVIN: WIUBS02PE
  - PMN:Wireless MCU Module with IEEE®802.11 b/g/n
- Europe/CE

The WIUBS02UE module has received regulatory approval for the following countries:

- United States/FCC ID: 2ADHKWIXCS02U
- Canada/ISED:
  - IC: 20266-WIXCS02U
  - HVIN: WIUBS02UE
  - PMN:Wireless MCU Module with IEEE®802.11 b/g/n
- Europe/CE

5.1 United States

The WIUBS02PE/WIUBS02UE modules have 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 WIUBS02PE/WIUBS02UE modules have 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:

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For the WIUBS02PE module	Contains Transmitter Module FCC ID: 2ADHKWIXCS02 or Contains FCC ID: 2ADHKWIXCS02 **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**.
For the WIUBS02UE module	Contains Transmitter Module FCC ID: 2ADHKWIXCS02U or Contains FCC ID: 2ADHKWIXCS02U **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.

WIUBS02PE/WIUBS02UE: These modules are approved for installation into mobile or/and host platforms at least 20 cm away from the human body.

5.1.3 Approved Antenna Types

To maintain modular approval in the United States, only the antenna types that have been tested shall be used. It is permissible to use different antenna, 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 the WIUBS02PE, the approval is received using the integral PCB antenna.

For the WIUBS02UE, approved antennas are listed in the WIUBS02 Module Approved External Antenna.

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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 WIUBS02PE/WIUBS02UE modules have 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:

For the WIUBS02PE module	**Contains IC: 20266-WIXCS02**
For the WIUBS02UE module	**Contains IC: 20266-WIXCS02U**

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-WIXCS02 and IC: 20266-WIXCS02U have 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-WIXCS02 and IC: 20266-WIXCS02U 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.

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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.

WIUBS02PE/WIUBS02UE: The devices operate 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 Exposition aux RF

Tous les émetteurs réglementés par Innovation, Sciences et Développement économique Canada (ISDE) doivent se conformer à l'exposition aux RF. exigences énumérées dans RSS-102 - Conformité à l'exposition aux radiofréquences (RF) des appareils de radiocommunication (toutes les bandes de fréquences).

Cet émetteur est limité à une utilisation avec une antenne spécifique testée dans cette application pour la certification, et ne doit pas être colocalisé ou fonctionner conjointement avec une autre antenne ou émetteur au sein d'un appareil hôte, sauf conformément avec les procédures canadiennes relatives aux produits multi-transmetteurs.

Les appareils fonctionnent à un niveau de puissance de sortie qui se situe dans les limites du DAS ISED. tester les limites d'exemption à toute distance d'utilisateur supérieure à 20 cm.

5.2.4 Approved Antenna Types

For the WIUBS02PE, the approval is received using the integral PCB antenna.

For the WIUBS02UE, approved antennas are listed in the WIUBS02 Module Approved External Antenna.

5.2.5 Helpful Web Sites

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

5.3 Europe

The WIUBS02PE/WIUBS02UE modules are 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 WIUBS02PE/WIUBS02UE modules have 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.

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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 WIUBS02PE/WIUBS02UE modules 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 WIUBS02PE/WIUBS02UE modules are in compliance with Directive 2014/53/EU.

The full text of the EU declaration of conformity, for this product, is available at www.microchip.com/design-centers/wireless-connectivity/.

5.3.3 Approved Antenna Types

For the WIUBS02PE, the approval is received using the integral PCB antenna.

For the WIUBS02UE, approved antennas are listed in the WIUBS02 Module Approved External 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 UKCA (UK Conformity Assessed)

The WIUBS02PE/WIUBS02UE module is a UK conformity assessed radio module that meets all the essential requirements according to CE RED requirements.

5.4.1 Labeling Requirements for Module and User's Requirements

The label on the final product that contains the WIUBS02PE/WIUBS02UE module must follow UKCA marking requirements.

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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.

5.4.2 UKCA Declaration of Conformity

Hereby, Microchip Technology Inc. declares that the radio equipment type the WIUBS02PE/WIUBS02UE modules are 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/en-us/product/WIUBS02.

5.4.3 Approved Antennas

The testing of the WIUBS02PE/WIUBS02UE module was performed with the antennas listed in WIUBS02 Module Approved External Antenna.

5.4.4 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.

5.5 Other Regulatory Information

- For information about other countries' jurisdictions not covered here, refer to the www.microchip.com/design-centers/wireless-connectivity/certifications.
- Should other regulatory jurisdiction certification be required by the customer, or the customer needs to recertify the module for other reasons, contact Microchip for the required utilities and documentation.

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6. Appendix B: Acronyms and Abbreviations

Table 6-1. Acronyms and Abbreviations

Acronyms	Abbreviations
ADC	Analog-to-Digital Converter
AES	Advanced Encryption Standard
ASCII	American Standard Code for Information Interchange
CBC	Cypher Block Chaining
CDM	Charged Device Model
CFB	Cypher Feedback Mode
CLK	Clock
CMD	Command
CPU	Central Processing Unit
CTR	Counter Mode
CTS	Clear-to-Send
DAC	Digital-to-Analog Converter
DC	Direct Current
DES	Data Encryption Standard
DFU	Device Firmware Update
DNP	Do Not Populate
ECB	Electronic Code Book
ECC	Elliptic-Curve Cryptography
EMC	Electro-Magnetic Compatibility
EMI	Electro-Magnetic Interference
ESD	Electrostatic Discharge
ESR	Effective Series Resistance
EVM	Error Vector Magnitude
FCC	Federal Communications Commission
GND	Ground
GPIO	General Purpose I/O
HBM	Human Body Model
HPA	High Power Amplifiers
HTTP	Hypertext Transfer Protocol
I2C	Inter-Integrated Circuit
IP	Internet Protocol
I/O	Input Output
IPWR	Idle Current
IRQn	Interrupt Request (active-low)
ISED	Innovation, Science and Economic Development
ISM	International Safety Management Certification
LNA	Low Noise Amplifier
LPRC	Low Power RC Oscillator
$\overline{\text{MCLR}}$	Master Clear Input Active Low
MSB	Most Significant Bit
NC	No Connection
NDRNG	Non Deterministic Random Number Generator

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.....continued

Acronyms	Abbreviations
NIST	National Institute of Standards and Technology
OEM	Original Equipment Manufacturer
OFB	Output Feedback Mode
OFDM	Orthogonal Frequency Division Multiplexing
OTA	Over-the-Air
OTP	One Time Programmable
PA	Power Amplifier
PCB	Printed Circuit Board
PMF	Protected Management Frame
PMU	Power Management Unit
POR	Power-on Reset
POSC	Primary Oscillator
PRIO	Priority
PSM	Pulse Skipping Mode
PTA	Packet Traffic Arbitration
PWM	Pulse Width Modulation
RF	Radio Frequency
ROM	Read Only Memory
RP	Reverse Polarity
RSSI	Receive Signal Strength Indication
RTC	Real Time Counter
RTCC	Real Time Clock Calendar
RTS	Request-to-Send
RX	Receive
SMA	SubMiniature Connector
SMD	Surface Mount Device
SOSC	Secondary Oscillator
SOSCO	Secondary Oscillator Output
SRAM	Static Random Access Memory
SSL	Secure Sockets Layer
STM	Standard Test Method
TCP	Transmission Control Protocol
TLS	Transport Layer Security
TP	Test Point
TPC	Transmit Power Control
TX	Transmit
UART	Universal Asynchronous Receiver/Transmitter
UDP	Unified Data Packet
VQFN	Very Thin Quad Flat No-lead
WCM	Wi-Fi® Context Memory
WLAN	Wireless Local Area Network
WPA	Wi-Fi Protected Access
XDS	Extended Deep Sleep
XLP	Extreme Low-Power
XOSC	Crystal Oscillator

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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	06/2024	Document	Initial Revision

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Microchip Information

The Microchip Website

Microchip provides online support via our website at www.microchip.com/. This website is used to make files and information easily available to customers. Some of the content available includes:

- **Product Support** – Data sheets and errata, application notes and sample programs, design resources, user's guides and hardware support documents, latest software releases and archived software
- **General Technical Support** – Frequently Asked Questions (FAQs), technical support requests, online discussion groups, Microchip design partner program member listing
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