WINCS02 Family Data Sheet

WINCS02IC and WINCS02 Family

www.microchip.com Product Pages: WINCS02IC, WINCS02PC, WINCS02PE, WINCS02UC, WINCS02UE

Introduction

The WINCS02IC is a low power consuming IC containing a 2.4 GHz IEEE 802.11b/g/n-compliant radio with integrated High Power Amplifier (HPA), Low Noise Amplifier (LNA), Radio Frequency (RF) switches for TX/RX control and hardware-based security accelerator. The WINCS02IC is designed to execute Microchip-provided Wi-Fi® and Networking stack components accessible through a Serial Peripheral Interface (SPI).

The WINCS02 is a fully-integrated module based on WINCS02IC. It contains all necessary external components and antenna to simplify a new board design. The module is interoperable with various vendors' 802.11 b/g/n access points. The module has a compact form factor of 21.7 mm x 14.7 mm x 2.1 mm.

The WINCS02IC and WINCS02 Module operates at a single supply voltage V_{DD}, V_{DDIO} (3.3V typical).

The WINCS02 Module is available with an on-board Printed Circuit Board (PCB) antenna or U.FL connector for an external antenna and with or without integrated Microchip Trust&Go CryptoAuthentication™ device.

Note: The WINCS02IC must be programmed with the appropriate Network Controller firmware version to meet the specification described in the data sheet.

WINCS02IC and WINCS02 Module Features

- IEEE 802.11 b/g/n, Single Stream (1x1) 20 MHz Bandwidth WLAN Link
  - Compatible with Wi-Fi® 6/7 2.4 GHz band
- 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), TX/RX Switch and Power Management
- Internal Flash Memory (Up to 2 MB) to Store Firmware
- Immutable Secure Boot with Hardware Root of Trust
- Supports Host Assisted Over-the-Air (OTA) Firmware Update
- Supports Extreme Deep Sleep (XDS) Mode(1)
- On-Chip Network Stack to Offload MCU(3)
  - Network features – TCP, UDP, DHCP, ARP, HTTP, MQTT, IPv6, TLS 1.2 and DNS
  - Hardware accelerators for Wi-Fi and TLS security to improve connection time
- Hardware-Based IEEE 802.15.2 Compliant Three-Wire Packet Traffic Arbitration (PTA) Interface for Wi-Fi/Bluetooth® Coexistence(2)
- SPI (SDIO based SPI; SDIO-SPI) Host Interface
- Secure Device Firmware Upgrade (DFU)

- WINCS02 Module with Integrated Microchip Trust&Go Secure Device (Optional)

Security

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

- **WINCS02IC**
  - Operating Voltage V_{DD} and V_{DDIO}: 3.0-3.6V (3.3V Typical)
  - Operating Temperature: -40°C to 105°C
    - AEC-Q100 Grade 2 qualified
- **WINCS02 Module**
  - Operating Voltage V_{DD} and V_{DDIO}: 3.0-3.6V (3.3V Typical)
  - Operating Temperature: -40°C to 85°C

Module Variants

- PCB Antenna:
  - WINCS02PE
  - WINCS02PC
- U.FL Connector for External Antenna:
  - WINCS02UE
  - WINCS02UC

Package

- **WINCS02IC**
  - 48-pin VQFN
  - Size: 7 mm x 7 mm x 0.9 mm
- **WINCS02 Module**
  - 28-pin SMD Package with RF Shield Can on Top
  - Size: 21.7 mm x 14.7 mm x 2.1 mm

Applications

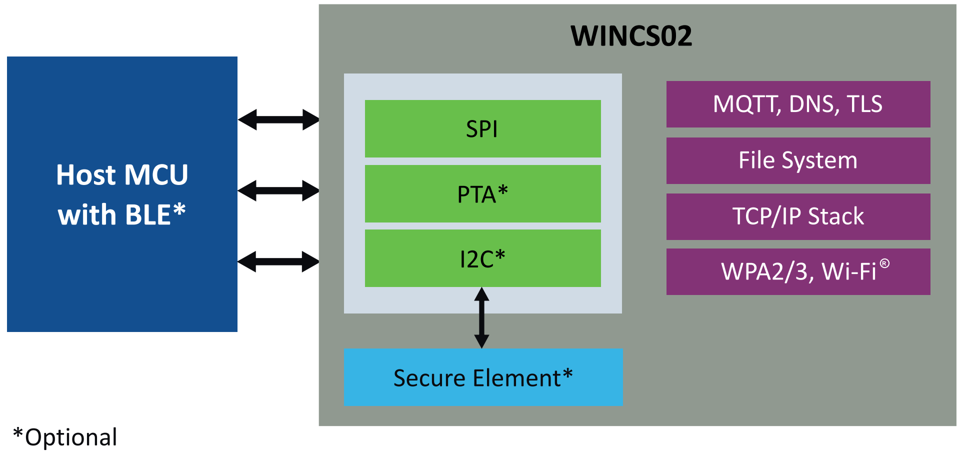
- Smart Factories/Control Devices
- Security Systems, CCTV
- Smart Homes/Lighting, Smart Locks

- Computing, Wi-Fi Dongles, Protocol Bridging
- Internet of Things (IoT) Sensor Tag
- Remote Control
- Wearable Smart Devices
- Industrial Control

Certifications

- WINCS02 Module Certified to FCC, ISED, CE, UKCA, MIC, KCC and NCC Radio Regulations
- RoHS and REACH Compliant

Example Block Diagram



Notes:

1. For more details on the Extreme Deep Sleep (XDS) mode, refer to Extreme Deep Sleep (XDS) Current Consumption and MPLAB® Harmony WINCS02 WLAN Library.
2. Either the PTA functionality or the RTCC oscillator can be used. For more details, refer to Pin Details of WINCS02 Module.
3. For more details about the latest supported features, refer to the MPLAB® Harmony WINCS02 WLAN Library and WINCS02 Application Developer's Guide.

Table of Contents

1. Ordering Information

This chapter provides the ordering information of the WINCS02IC and the WINCS02 Module.

1.1 WINCS02IC Ordering Information

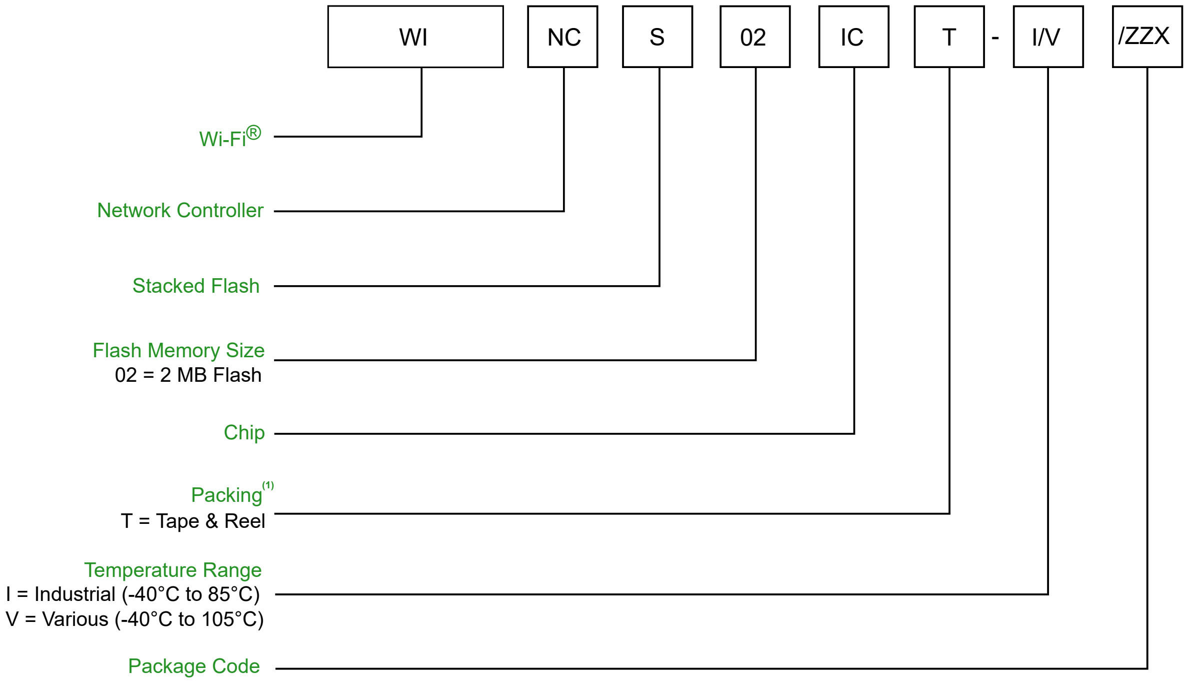
This section provides the ordering information of the WINCS02IC.

Table 1-1. WINCS02IC Ordering Details

SoC Name	Pin and Package	Description	Ordering Code
WINCS02IC	48-pin VQFN (7 mm x 7 mm x 0.9 mm)	32-bit Network Controller IC with WLAN connectivity and hardware-based security accelerator with 2 MB stacked Flash	WINCS02IC-I/ZZX
			WINCS02ICT-I/ZZX WINCS02IC-V/ZZX WINCS02ICT-V/ZZX

The following figure illustrates the details of the WINCS02IC ordering information.

Figure 1-1. WINCS02IC Ordering Information



Notes:

1. By default, the WINCS02IC comes with Tray packing.
2. The WINCS02IC must be programmed with the appropriate Network Controller firmware version to meet the specification described in the data sheet.

1.2 Module Ordering Information

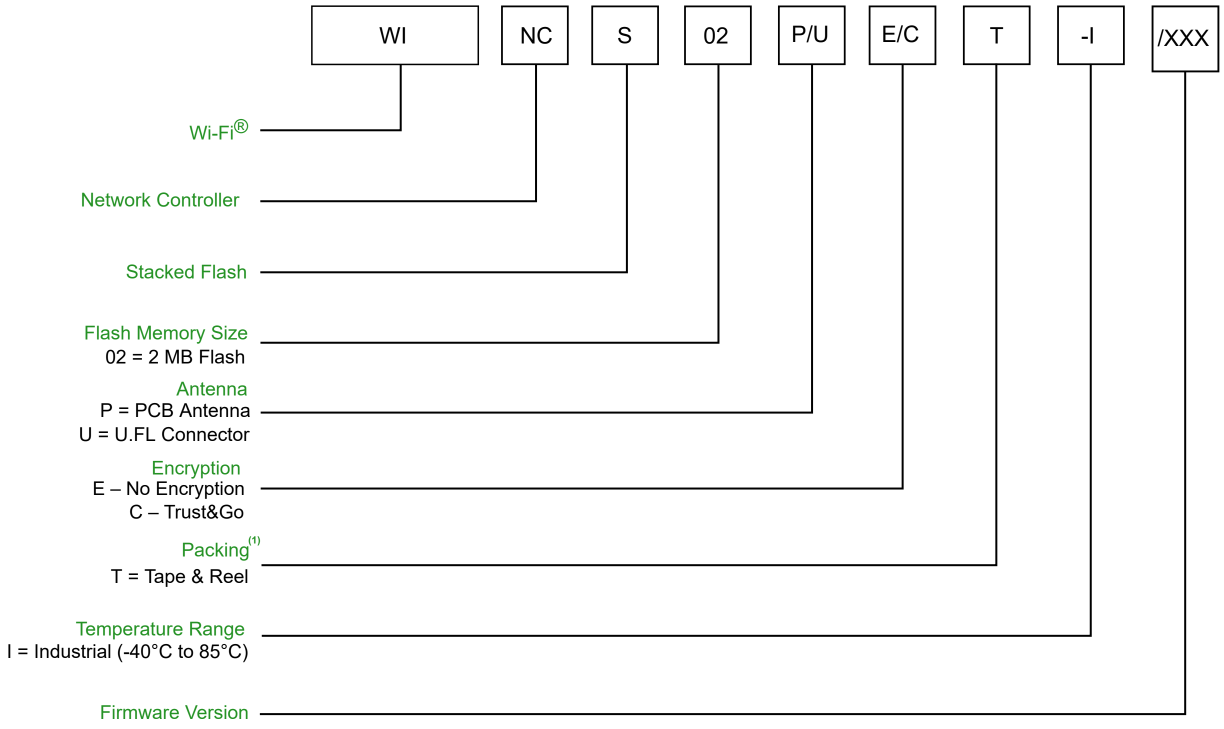
This chapter provides the ordering information of the WINCS02 Module.

Table 1-2. WINCS02 Module Ordering Details

Module Name	Description	Ordering Code
WINCS02PE	Wi-Fi® Network Controller Module with PCB Antenna	WINCS02PE-I/XXX
WINCS02PC	Wi-Fi Network Controller Module with PCB Antenna and Trust&Go	WINCS02PC-I/XXX
WINCS02UE	Wi-Fi Network Controller Module with U.FL connector for external Antenna	WINCS02UE-I/XXX
WINCS02UC	Wi-Fi Network Controller Module with U.FL connector for external Antenna and Trust&Go	WINCS02UC-I/XXX

The following figure illustrates the details of the WINCS02 Module ordering information.

Figure 1-2. WINCS02 Module Ordering Information



Note:

1. By default, the WINCS02 Module comes with Tray packing.

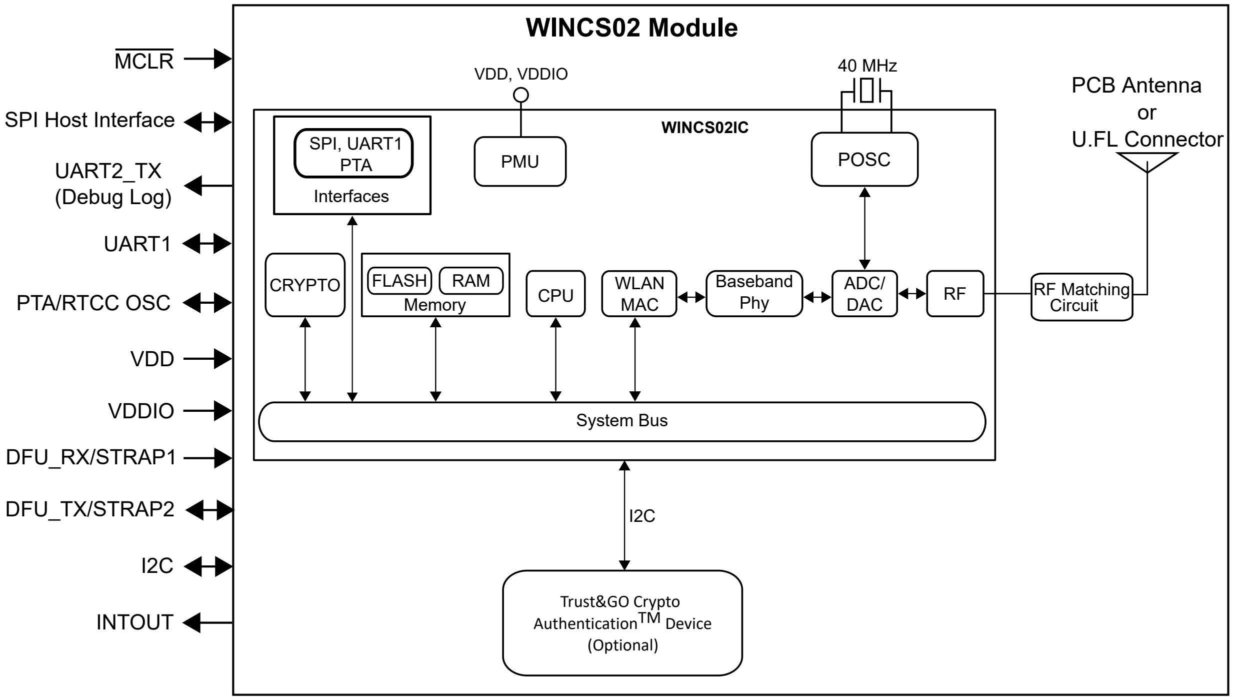
2. Device Overview

The WINCS02IC is a single chip 2.4 GHz and IEEE® 802.11b/g/n-compliant solution with integrated HPA, LNA and RF switches for TX/RX control. The WINCS02 is a fully RF-certified module based on WINCS02IC available with the following antenna variants:

- PCB antenna (WINCS02PE/WINCS02PC)
- U.FL connector (WINCS02UE/WINCS02UC) for external antenna

The following figure illustrates the WINCS02IC and the WINCS02 Module block diagram and various peripherals supported by these devices.

Figure 2-1. WINCS02 Module Block Diagram



2.1 Pin Details of WINCS02IC

This section provides details on pin diagrams and the pinout table of WINCS02IC.

Figure 2-2. WINCS02IC Pin Diagram

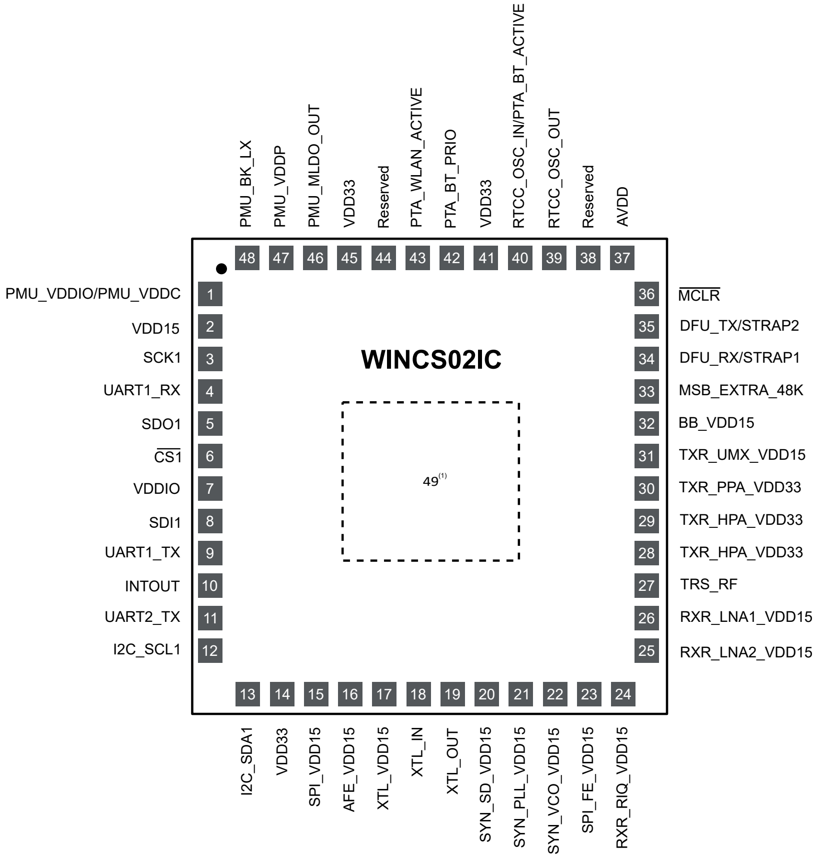


Table 2-1. WINCS02IC Pinout Table

Pin Number	Pin Name	Pin Type	Description
1	PMU_VDDIO/ PMU_VDDC	P	Input power supply to the on-chip PMU I/O and PMU Core section (3.0V-3.6V, 3.3V typical)
2	VDD15	P	1.5V input supply voltage Connect to 1.5V on-chip PMU output
3	SCK1	I	SPI1, Serial Clock Connect to the Serial Clock of the host device
4	UART1_RX(6)	I	Used for external antenna calibration Connect this signal to a test point or a pin header
5	SDO1	O	SPI1, Serial Data Out Connect to the Serial Data In of the host device
6	$\overline{\text{CS1}}$	I	SPI1, Chip Select (Active low) Connect to the Chip Select of the host device
7	VDDIO	P	Input supply voltage to I/O Port (3.0-3.6V, 3.3V typical)
8	SDI1	I	SPI1, Serial Data In Connect to Serial Data Out of the host device

Table 2-1. WINCS02IC Pinout Table (continued)

Pin Number	Pin Name	Pin Type	Description
9	UART1_TX(6)	O	Used for external antenna calibration Connect this signal to a test point or a pin header
10	INTOUT	O	Interrupt request (Active-low) from the Wi-Fi® module
11	UART2_TX	O	UART2 Transmit signal to print the firmware debug log
12	I2C_SCL1	I	I2C Clock to connect Trust&Go Authentication Secure device. Connect an external Pull up resistor, if used
13	I2C_SDA1	I/O	I^{2}C Data to connect Trust&Go Authentication Secure device Connect an external Pull up resistor, if used
14	VDD33	P	Input supply voltage for the Main Power Domain (3.0-3.6V, 3.3V typical)
15	SPI_VDD15	P	1.5V input supply voltage to internal SPI Block Connect to 1.5V on-chip PMU output
16	AFE_VDD15	P	1.5V input supply voltage to RF Analog Front-End Connect to 1.5V on-chip PMU output
17	XTL_VDD15	P	1.5V input supply voltage to primary oscillator section Connect to 1.5V on-chip PMU output
18	XTL_IN	I	40 MHz primary oscillator crystal input
19	XTL_OUT	O	40 MHz primary oscillator crystal output
20	SYN_SD_VDD15	P	1.5V input supply voltage to RF Synthesizer/SD Connect to 1.5V on-chip PMU output
21	SYN_PLL_VDD15	P	1.5V Input supply voltage to Synthesizer/PLL Connect to 1.5V on-chip PMU output
22	SYN_VCO_VDD15	P	1.5V input supply voltage to RF Synthesizer/VCO Connect to 1.5V on-chip PMU output
23	SPI_FE_VDD15	P	1.5V input supply voltage to RF Front-End/SPI Connect to 1.5V on-chip PMU output
24	RXR_RIQ_VDD15	P	1.5V input supply voltage to RF IQ Mixer/RXR Connect to 1.5V on-chip PMU output
25	RXR_LNA2_VDD15	P	1.5V input supply voltage to LNA stage-2 Connect to 1.5V on-chip PMU output
26	RXR_LNA1_VDD15	P	1.5V input supply voltage to LNA stage-1 Connect to 1.5V on-chip PMU output
27	TRS_RF	I/O	RF transmit/receive
28	TXR_HPA_VDD33	P	Input power supply to High-Power Amplifier (HPA) on the Transmitter (3.0-3.6V, 3.3V typical)
29	TXR_HPA_VDD33	P	
30	TXR_PPA_VDD33	P	Input power supply to Pre-Power Amplifier (PPA) on the Transmitter (3.0-3.6V, 3.3V typical)
31	TXR_UMX_VDD15	P	1.5V input supply voltage to RF Upconvertor Mixer/TXR Connect to 1.5V on-chip PMU output
32	BB_VDD15	P	1.5V input supply voltage to RF Base Band section Connect to 1.5V on-chip PMU output
33	MSB_EXTRA_48K	O	Connect a pull-down resistor of 48.7K with 1% tolerance to create a constant current reference for internal analog/RF blocks.

Table 2-1. WINCS02IC Pinout Table (continued)

Pin Number	Pin Name	Pin Type	Description
34	DFU_RX/STRAP1	I	Device Firmware Update, receive signal
			Host interface configuration strapping1 pin. Connecting to a pull-up resistor of 10K is recommended.
35	DFU_TX/STRAP2	O	Device Firmware Update, transmit signal
		I	Host interface configuration strapping2 pin. Connecting to a pull-up resistor of 10K is recommended.
36	$\overline{\text{MCLR}}$	I	Master Clear Reset Input (Active low)
37	AVDD	P	Input power supply to Analog Block (3.0-3.6V, 3.3V typical)
38	Reserved(7)	I/O	Reserved pin Connect to an I/O pin (tri-stated) of a host device or to an external switch for future use
39	RTCC_OSC_OUT(5)	O	32.768 KHz RTCC oscillator output
40	RTCC_OSC_IN/ PTA_BT_ACTIVE(4)(5)	I	32.768 KHz RTCC Oscillator input
			PTA interface, Bluetooth® Coexistence device active indication input to WINCS02IC
41	VDD33	P	Input supply voltage for the Main Power Domain (3.0-3.6V, 3.3V typical)
42	PTA_BT_PRIO	I	PTA interface, Bluetooth Coexistence device priority indication input to WINCS02IC.
43	PTA_WLAN_ACTIVE	O	PTA interface, WINCS02IC WLAN active indication output to Bluetooth Coexistence device
44	Reserved	I/O	Reserved pin Do not connect.
45	VDD33	P	Input supply voltage for the Main Power Domain (3.0-3.6V, 3.3V typical)
46	PMU_MLDO_OUT(3)	P	1.5V output of on-chip PMU MLDO
47	PMU_VDDP	P	Input power supply to the on-chip PMU (3.0-3.6V, 3.3V typical)
48	PMU_BK_LX	P	1.5V output of on-chip PMU Buck Regulator Connect to an external LC filter (L = 4.7 uH and C = 10 uF)
49	GND	P	Thermal ground paddle

Notes:

1. Refer to the reference design package for exact pin mapping and signal connection.
2. WINCS02IC does not support GPIO functionality. All the pins are reserved.
3. Do not connect any external 1.5V supply.
4. This pin can be used either as an oscillator input pin or as PTA BT_ACTIVE. Both functionalities cannot be supported simultaneously.
5. Current firmware does not support the RTCC oscillator function; it is recommended to have an option to mount the RTCC oscillator in the design to upgrade with the future version of firmware releases.
6. For more details, refer to the WINCS02 Module External Antenna Calibration Guide (DS50003753).
7. Do not leave this pin unconnected. Follow the directions in the Pin Description column for future upgrades.

2.2 Pin Details of WINCS02 Module

This section provides details on pin diagrams and pinout table of WINCS02 Module.

Figure 2-3. WINCS02 Module Pin Diagram

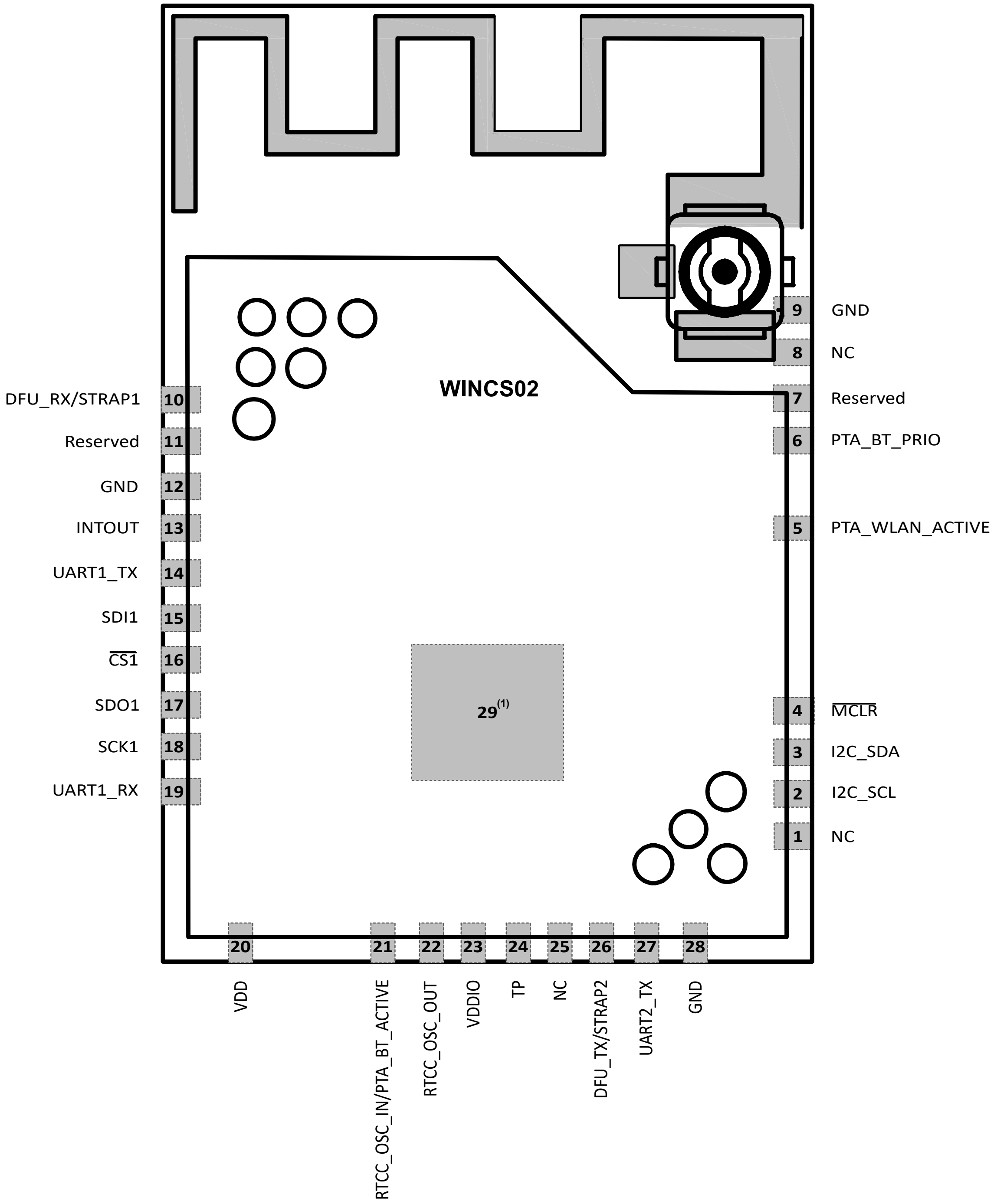


Table 2-2. WINCS02 Module Pinout Table

Pin Number	Pin Name	Pin Type	Pin Description
1	NC	—	No connection

Table 2-2. WINCS02 Module Pinout Table (continued)

Pin Number	Pin Name	Pin Type	Pin Description
2	I2C_SCL	I	I^{2}C clock connected to Trust&GO device. Recommended to connect external pull-up resistor of 1.2K on the host board for WINCS02PC and WINCS02UC devices.
3	I2C_SDA	I/O	I^{2}C data connected to Trust&GO device. Recommended to connect external pull-up resistor of 1.2K on the host board for WINCS02PC and WINCS02UC devices.
4	$\overline{\text{MCLR}}$	I	Master Clear Reset Input (Active low)
5	PTA_WLAN_ACTIVE	O	PTA interface, WLAN Active indication output to Bluetooth® Coexistence device
6	PTA_BT_PRIO	I	PTA interface, Bluetooth Coexistence device priority indication input to WINCS02
7	Reserved	I/O	Reserved pin Do not connect.
8	NC	—	No connection
9	GND	P	Ground
10	DFU_RX/STRAP1	I	Device Firmware Update, receive signal Host interface configuration, Strapping1 pin. For more details on exact configuration, refer to Table 2-3.
11	Reserved[(5)]	—	Reserved pin Connect to an I/O pin (tri-stated) of a host device or to an external switch for future use.
12	GND	P	Ground
13	INTOUT	O	Interrupt request (Active low) from the Wi-Fi® module
14	UART1_TX[(4)]	O	Used for external antenna calibration Connect this signal to a test point or a pin header.
15	SDI1	I	SPI1, Serial Data In Connect to Serial Data Out of the host device
16	$\overline{\text{CS1}}$	I	SPI1, Chip Select (Active low) Connect to the Chip Select of host device
17	SDO1	O	SPI1, Serial Data Out Connect to the Serial Data In of the host device
18	SCK1	I	SPI1, Serial Clock Connect to the Serial Clock of the host device
19	UART1_RX[(4)]	I	Used for external antenna calibration Connect this signal to a test point or a pin header.
20	VDD	P	VDD power supply (3.0-3.6V)
21	RTCC_OSC_IN/ PTA_BT_ACTIVE[(1)(3)]	I	32.768 KHz RTCC Oscillator input PTA interface, Bluetooth Coexistence device active indication input to WINCS02
22	RTCC_OSC_OUT[(3)]	O	32.768 KHz RTCC Oscillator output
23	VDDIO	P	I/O power supply (3.0-3.3V)
24	TP	P	PMU Output Test point: 1.5V[(2)]
25	NC	—	No connection
26	DFU_TX/STRAP2	O	Device Firmware Update, transmit signal
		I	Host interface configuration, Strapping2 pin. For more details on exact configuration, refer to the Table 2-3.

Table 2-2. WINCS02 Module Pinout Table (continued)

Pin Number	Pin Name	Pin Type	Pin Description
27	UART2_TX	O	UART2 transmit signal for the firmware log. UART setting: 460,800 baud, 8N1 and no flow control
28	GND	P	Ground
29	GND Paddle	P	Thermal ground paddle

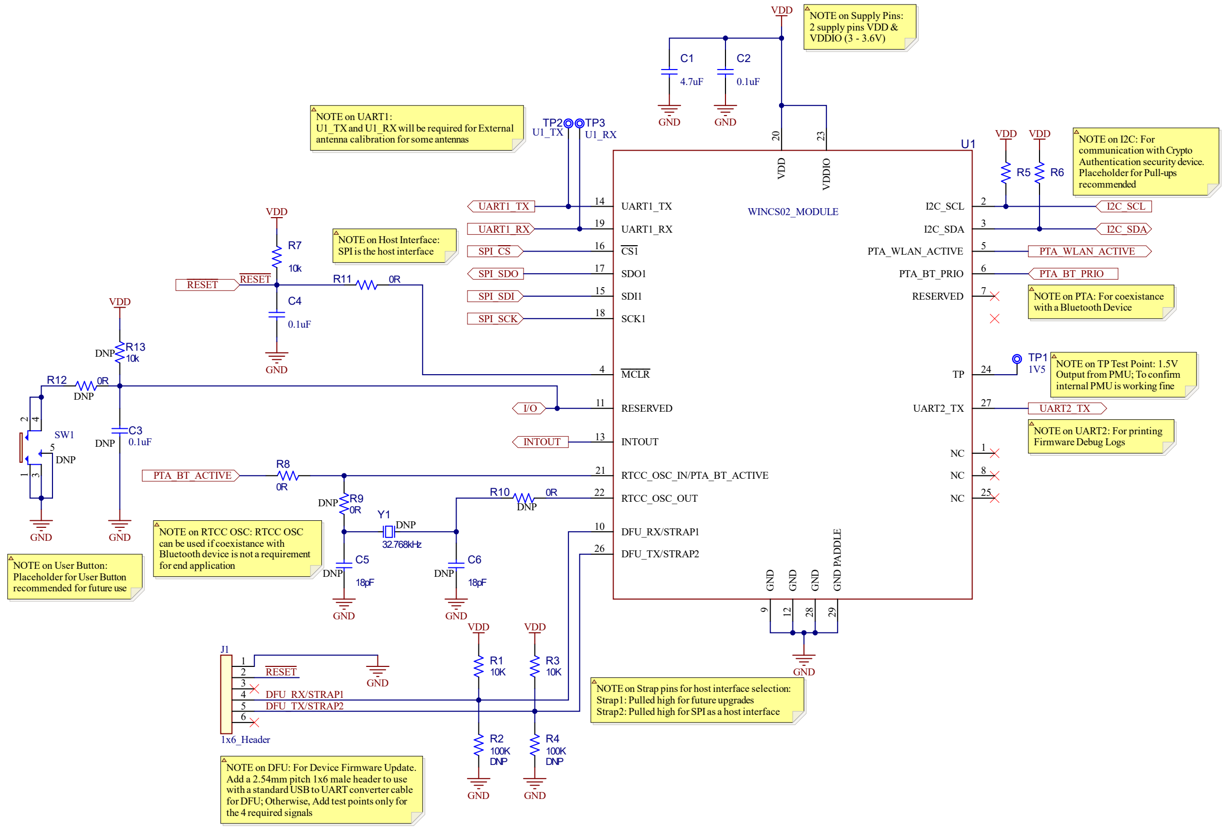
Notes:

1. This pin can be used either as an oscillator input pin or as PTA BT_ACTIVE. The WINCS02 Module does not support both the functionality together.
2. Do not connect any external 1.5V supply.
3. Current firmware does not support RTCC Oscillator function; it is recommended to have an option to mount RTCC Oscillator in the design to upgrade with the future version of firmware releases.
4. For more details, refer to the WINCS02 Module External Antenna Calibration Guide (DS50003753).
5. Do not leave this pin unconnected. Follow the directions in the Pin Description column for future upgrades.

2.3 Basic Connection Requirement

The WINCS02 Module requires attention to a minimal set of device pin connections before proceeding with development.

Figure 2-4. WINCS02 Module Basic Connection and Interface Diagram



NOTE on Supply Pins:
2 supply pins VDD & VDDIO (3 - 3.6V)

NOTE on UART1:
U1_TX and U1_RX will be required for External antenna calibration for some antennas

NOTE on Host Interface:
SPI is the host interface

NOTE on I2C: For communication with Crypto Authentication security device. Placeholder for Pull-ups recommended

NOTE on PTA: For coexistance with a Bluetooth Device

NOTE on TP Test Point: 1.5V Output from PMU; To confirm internal PMU is working fine

NOTE on UART2: For printing Firmware Debug Logs

NOTE on User Button: Placeholder for User Button recommended for future use

NOTE on RTCC OSC: RTCC OSC can be used if coexistance with Bluetooth device is not a requirement for end application

NOTE on Strap pins for host interface selection:
Strap1: Pulled high for future upgrades
Strap2: Pulled high for SPI as a host interface

NOTE on DFU: For Device Firmware Update. Add a 2.54mm pitch 1x6 male header to use with a standard USB to UART converter cable for DFU; Otherwise, Add test points only for the 4 required signals

Table 2-3. Configuration Details

Configuration Details			
Module Pin10/Strap1	**Module Pin26/Strap2**[1]	**Host Interface Selection**	**Description**
1	X (Pulled High)	SPI	WINCS02 Module with SPI

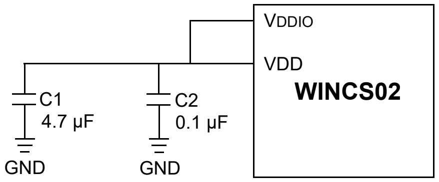
Notes:

1. The recommendation is to provide an option to mount the pulled-high resistor in the host board design for future upgrades.
2. The mentioned resistance values are only guidelines. For details on the application schematics, refer to the WINCS02 Add On Board User's Guide (DS50003721).

2.3.1 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 WINCS02 Module.

Figure 2-5. Recommended Module Power Supply Connections



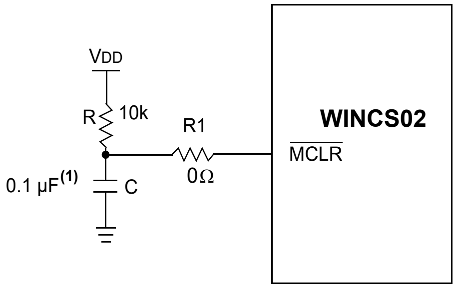
The value of the C1 and C2 capacitors may vary based on the application requirements and source of supply voltage. The C1 and C2 capacitors must be placed close to the pin.

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

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

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

Figure 2-6. Example of $\overline{\text{MCLR}}$ Pin Connections



Note:

1. The capacitor can be sized to prevent unintentional Resets from brief glitches or to extend the device Reset period during POR.

Related Links

Basic Connection Requirement

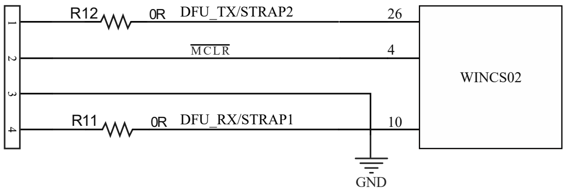
2.3.3 Device Firmware Update

The WINCS02 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 *WINCS02 Application Developer's Guide*.

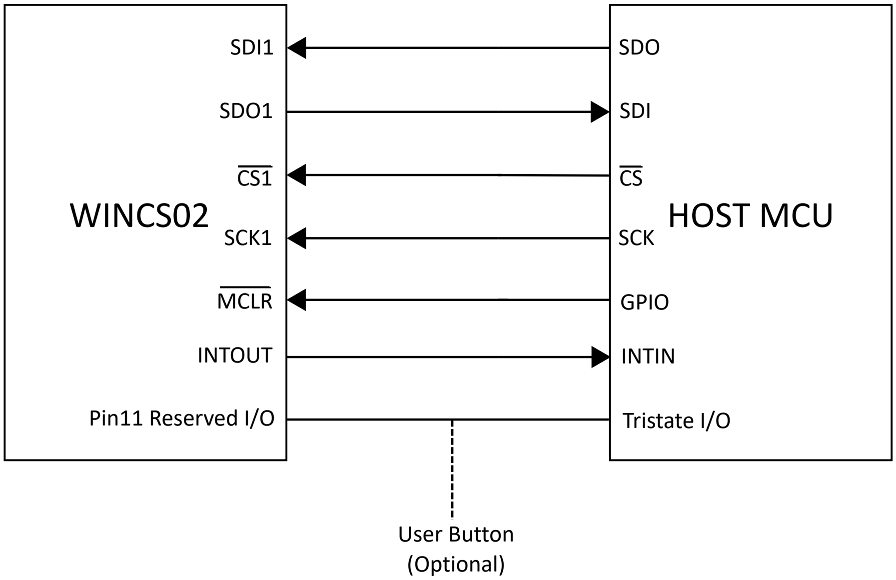
Figure 2-7. Basic Connection Diagram of DFU



2.3.4 Interface with Host Microcontroller

The WINCS02 Module can be interfaced with the host microcontroller through the SPI.

Figure 2-8. WINCS02 Module Host Interface Diagram



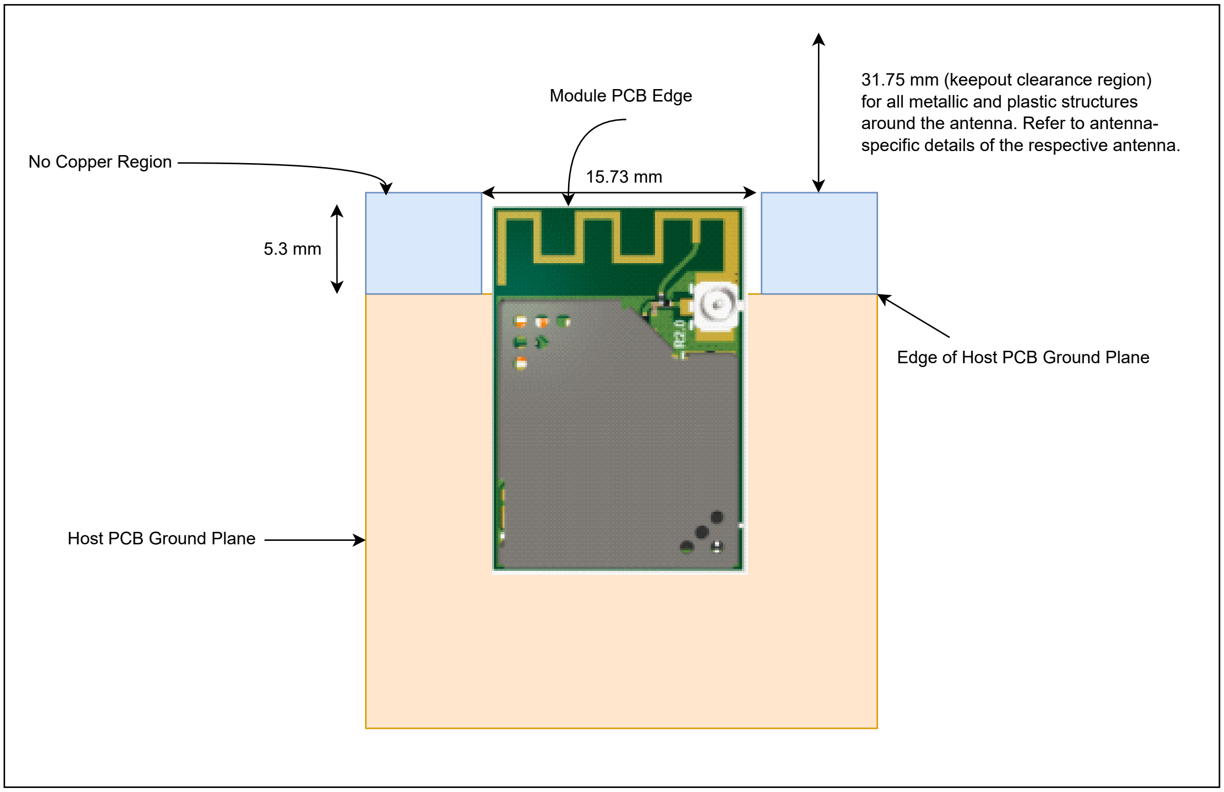
2.4 WINCS02 Module Placement Guidelines

- 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 WINCS02PC/E Module is placed at the edge of the host board.
- The WINCS02PC/WINCS02PE 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 WINCS02 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 WINCS02 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 WINCS02 Module must be soldered to the host board (see the *Example of Host Board on Top Layer* figure in the *WINCS02 Module Routing Guidelines* from Related Links).
- A PCB cutout or a copper keepout is required under the RF test point (see *WINCS02 Module Packaging Information* from Related Links).
- Copper keepout areas are required on the top layer under voltage test points (see *WINCS02 Module Packaging Information* from Related Links).
- Alternatively, the entire region, except the exposed ground paddle, can be solder-masked.

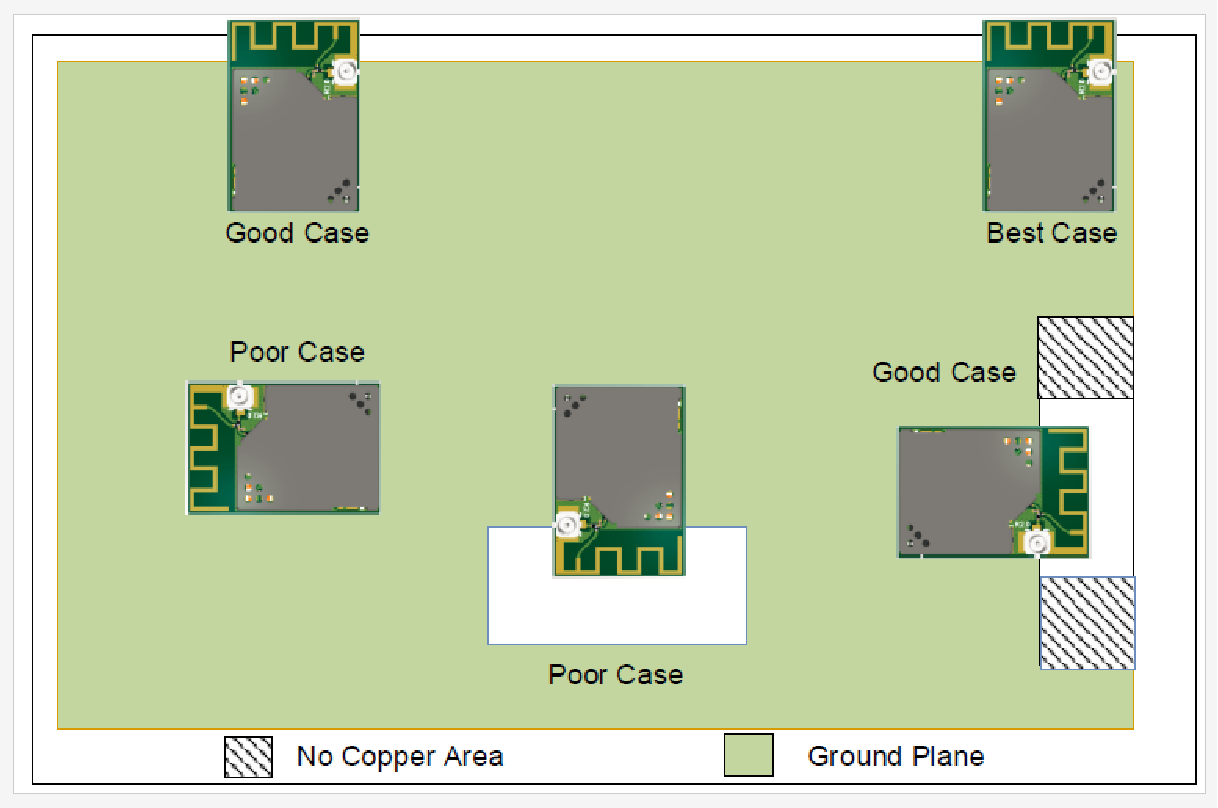
The following figure illustrates the examples of WINCS02 Module placement on a host board with a ground plane. Refer to the following figure for placement-specific guidance.

Figure 2-9. Module Placement Guidelines



The following figure illustrates the examples of the WINCS02 Module placement on a host board with a ground plane. Refer to Figure 2-9 for placement-specific guidance.

Figure 2-10. WINCS02 Module Placement



Related Links

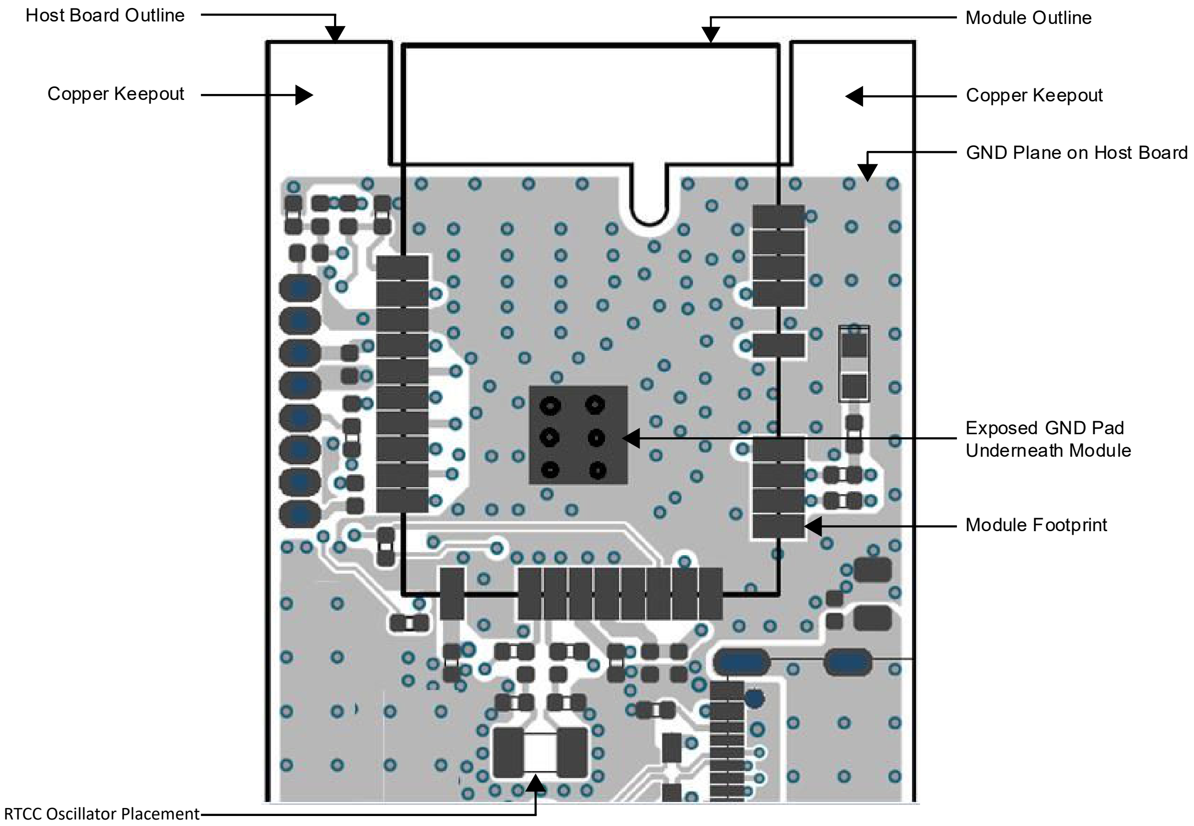
WINCS02 Module Routing Guidelines

WINCS02 Module Packaging Information

2.5 WINCS02 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 as 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 WINCS02 Module.
- For a better GND connection to the WINCS02 Module, solder the exposed GND pads of the WINCS02 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 reserved pins and digital interface pins is recommended. These resistors must be placed close to the WINCS02 Module.
- The RTCC Oscillator (32.768 kHz) on the host board must be placed close to the WINCS02 Module and follow the shortest trace routing length with no vias (see the following figure).

Figure 2-11. Example of WINCS02 Module Placement on Host Board (Top Layer)



2.6 WINCS02 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 WINCS02 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 WINCS02 Module includes RF shielding on top of the board as a standard feature.

2.7 WINCS02 Module Antenna Considerations

2.7.1 PCB Antenna

For the WINCS02PE/PC Module, the PCB antenna is fabricated on the top copper layer. The layers below the antenna do not have copper trace. It is recommended that the module to 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 WINCS02 Module mounted on the WINCS02 Add-On Board.

Table 2-4. PCB Antenna Specification for WINCS02 Module

Parameter	Specification
Operating frequency	2400-2485 MHz
Peak gain	1.18 dBi at 2410 MHz
Efficiency (average)	45%(1)

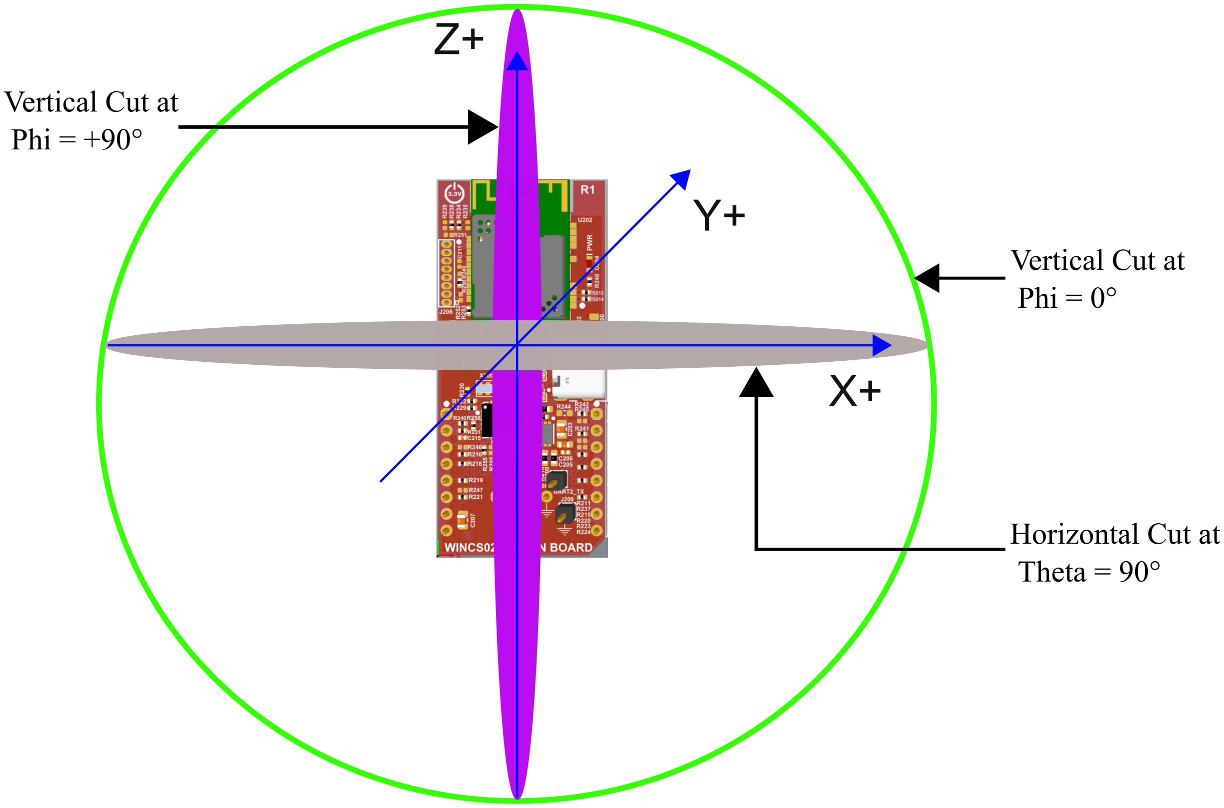
Note:

1. The size of the WINCS02 Add-On Board is 25.4 mm x 57.2 mm. The antenna efficiency will improve with larger ground plane base boards. The same antenna achieved an average efficiency of 69% with a base board size of 85 mm x 40 mm. 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.

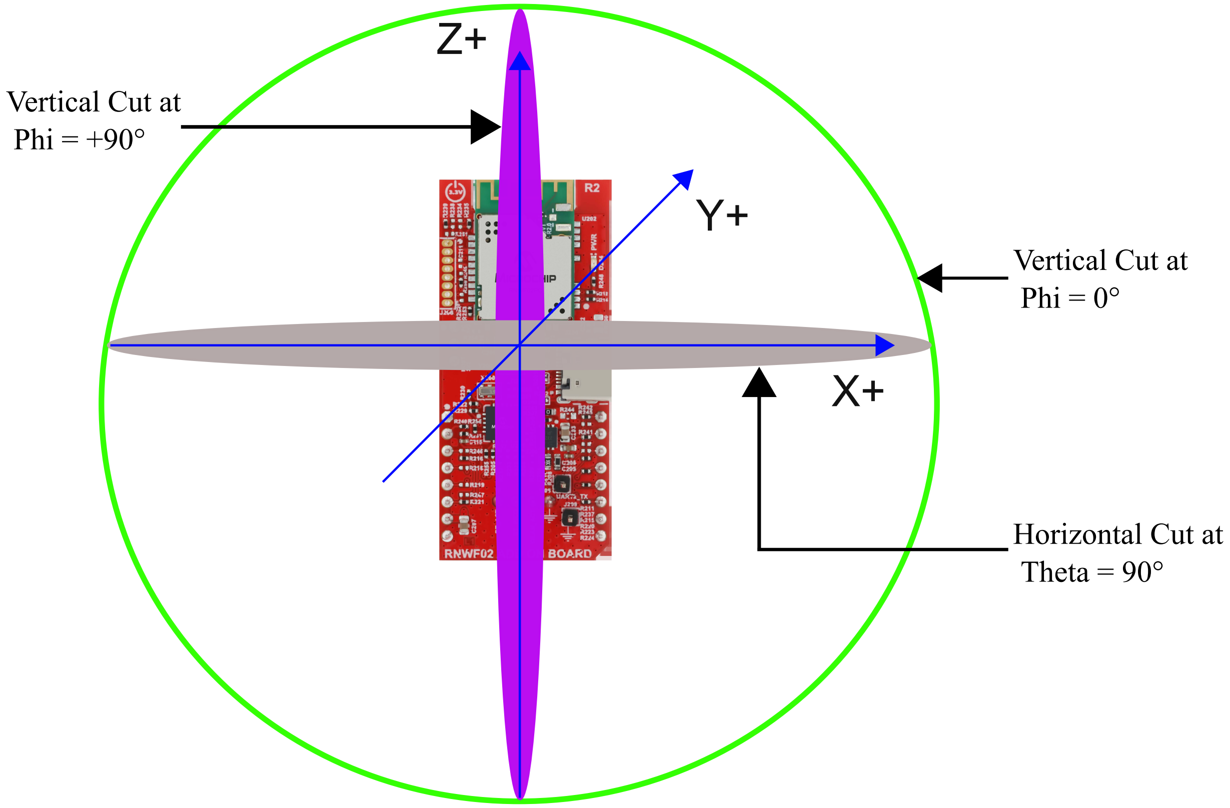
Figure 2-12. Module Orientation for Radiation Pattern Measurement



PCB Antenna Radiation Pattern

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

Figure 2-13. Module Orientation for Radiation Pattern Measurement



3D Antenna Radiation Pattern

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

Figure 2-14. 3D Antenna Radiation Pattern (Slant View)

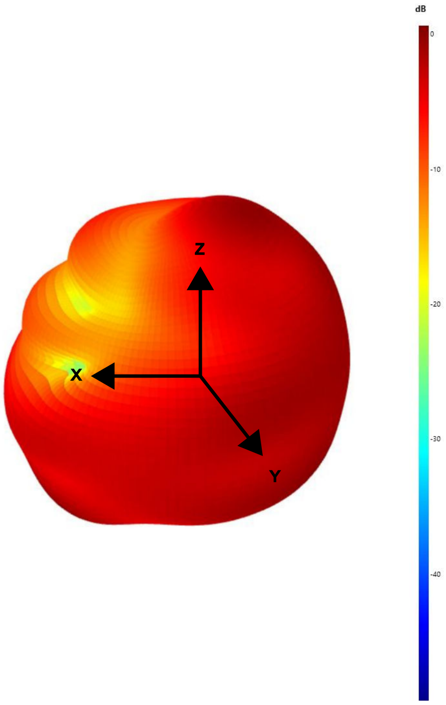


Figure 2-15. 3D Antenna Radiation Pattern (XY View)

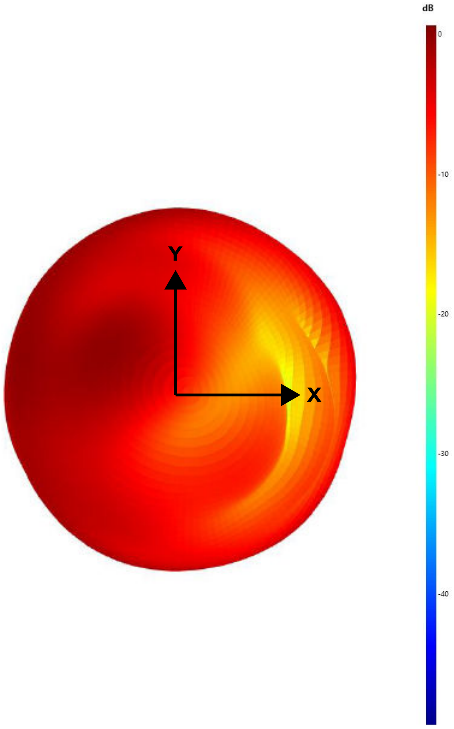


Figure 2-16. 3D Antenna Radiation Pattern (XZ View)

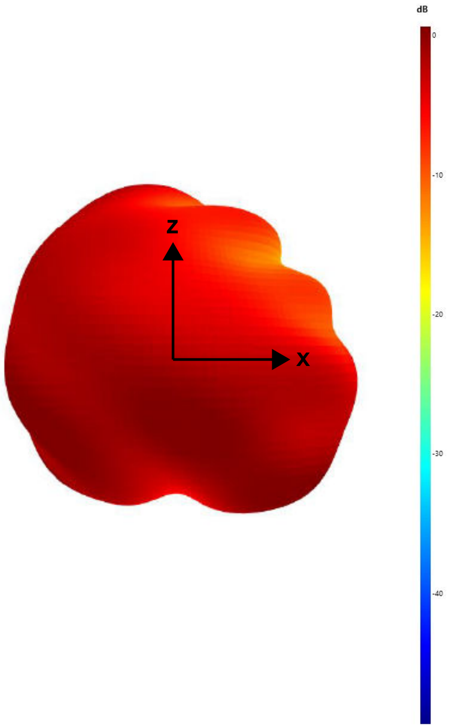
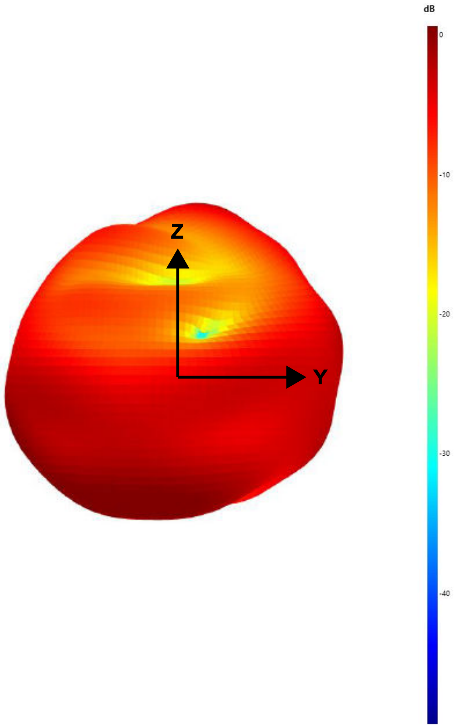


Figure 2-17. 3D Antenna Radiation Pattern (YZ View)



2D Antenna Radiation Pattern

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

Figure 2-18. Antenna Radiation Azimuth Plane Pattern when Theta = 90°

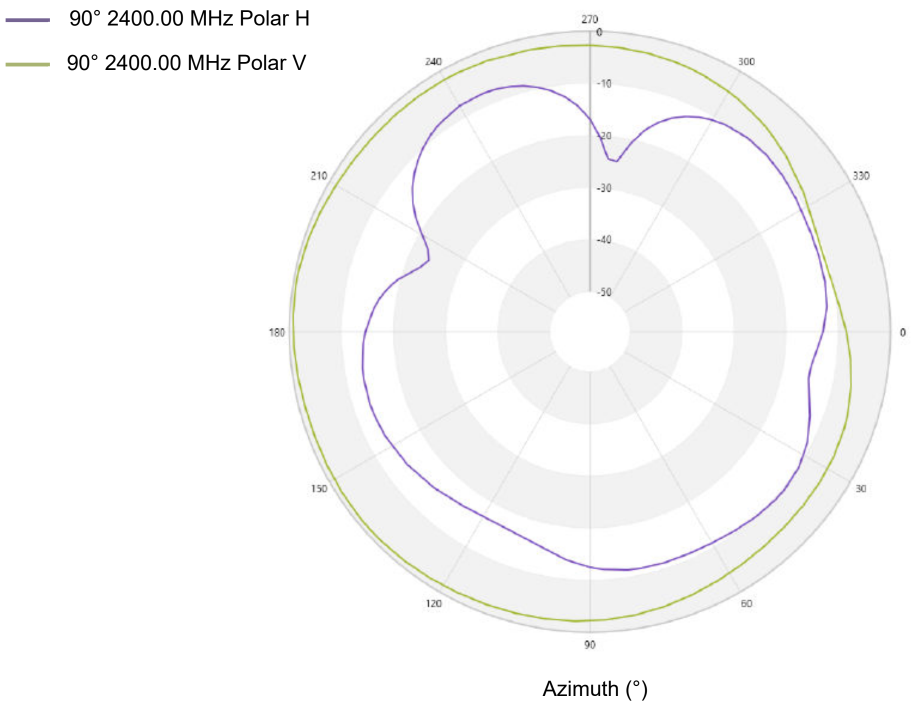


Figure 2-19. Antenna Radiation Elevated Plane Pattern when Phi = 0°

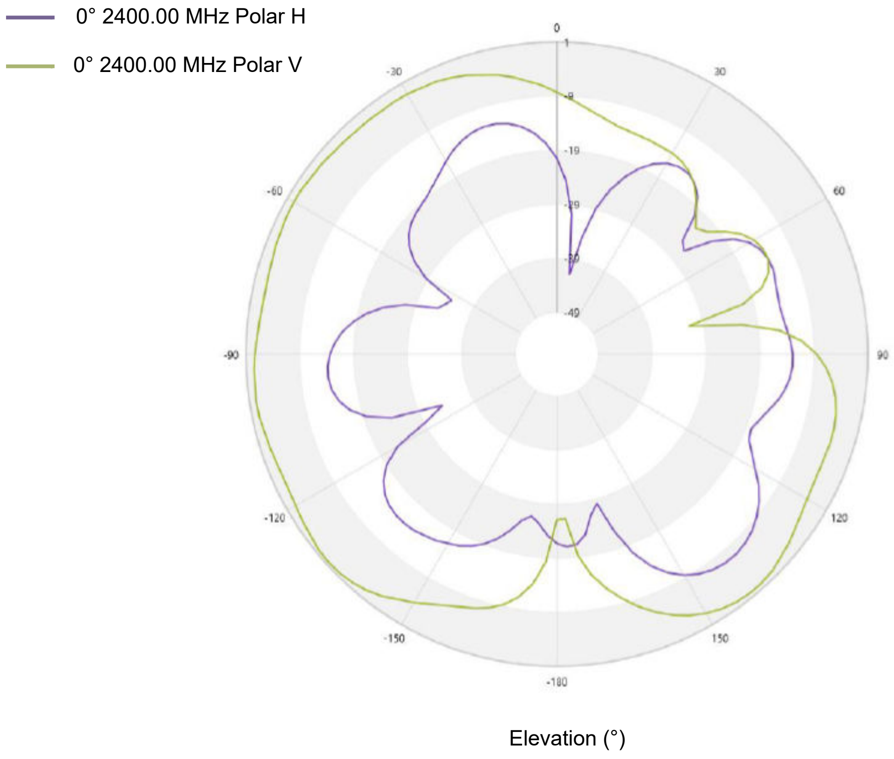
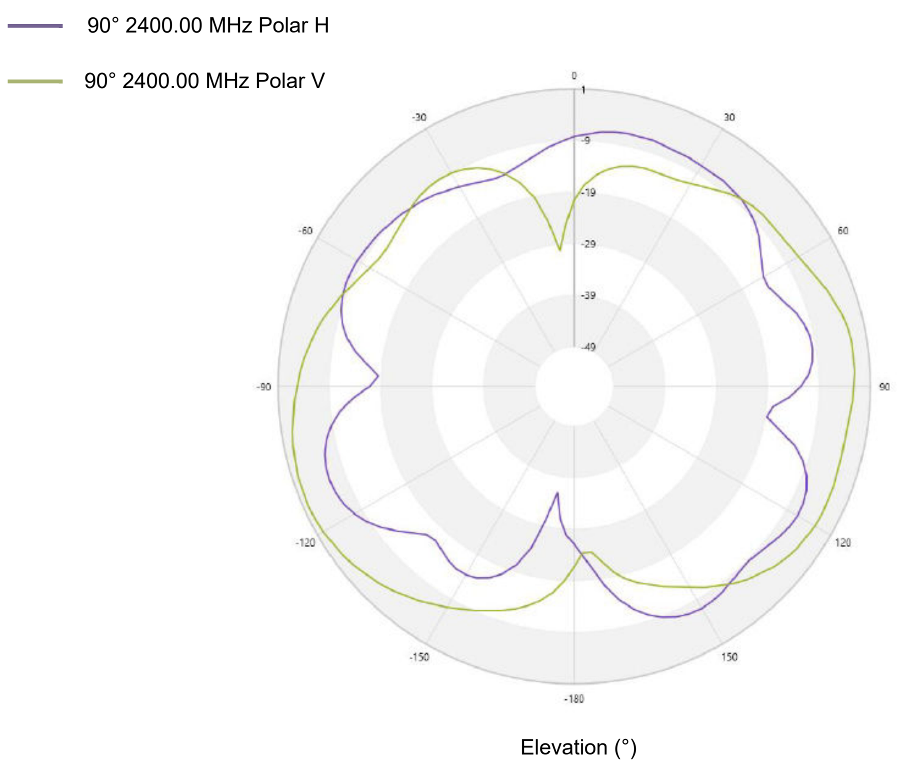


Figure 2-20. Antenna Radiation Elevated Plane Pattern when Phi = 90°



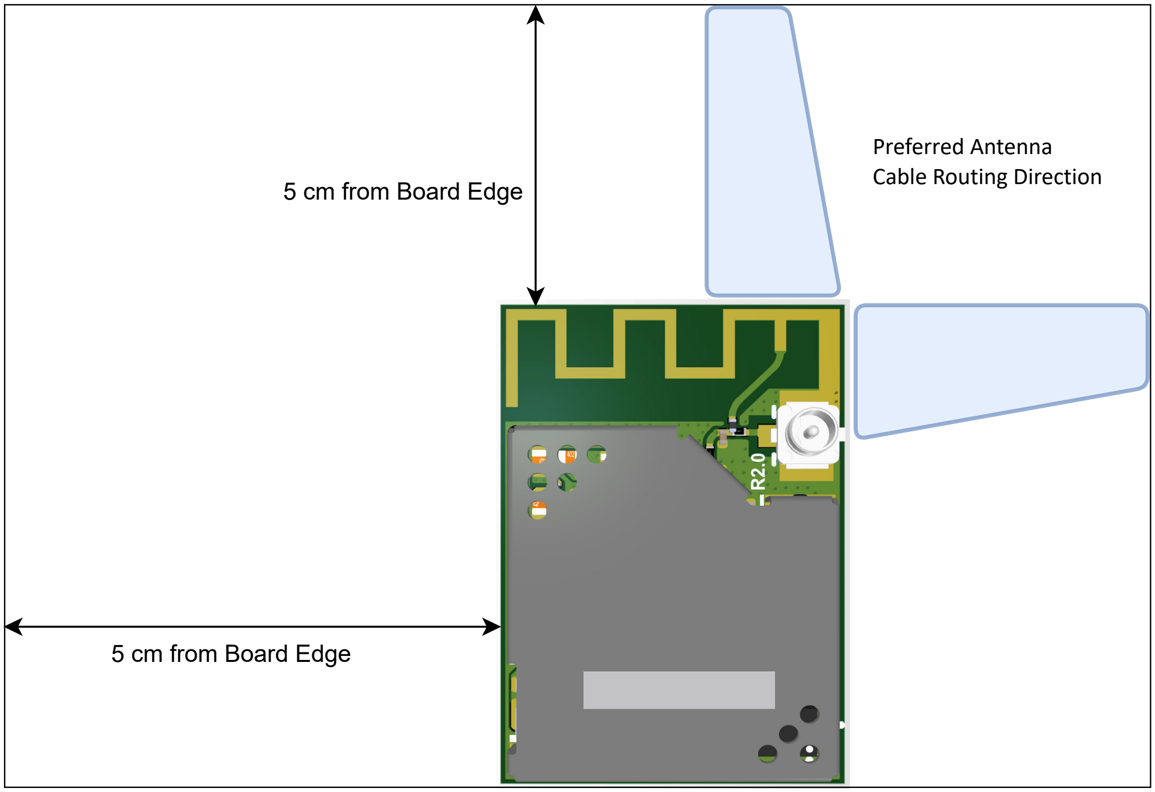
2.7.2 External Antenna Placement Recommendations

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 WINCS02 Module.

The following figure illustrates how the antenna cable must be routed depending on the location of the antenna with respect to the WINCS02 PCB. There are two possible options for the optimum routing of the cable.

Figure 2-21. WINCS02 Module Antenna Placement Guidelines



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.

2.7.2.1 External Antennas

The WINCS02/UE/UC Modules have a 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 regulatory certification.

The WINCS02/UE/UC 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 2-5. Approved External Antenna List with Antenna Gain for WINCS02 Module

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	Aristotle	2	Dipole	x	x

Table 2-5. Approved External Antenna List with Antenna Gain for WINCS02 Module (continued)

Antenna No.	Part Number	Manufacturer	Antenna Gain (dBi)	Antenna Type	Regulatory Certification	
					FCC/ISED[2] [3]	CE
5	RFA-02-C2H1-D034	Alead	2	Dipole	x	x
6	RFA-02-D3	Aristotle	2	Dipole	x	x
7	RFDPA870920IMLB301	Walsin	1.84	Dipole	x	x
8	RFDPA870920IMAB302[5]	Walsin	1.82	Dipole	x	x
9	RFDPA870920IMAB305	Walsin	1.82	Dipole	x	x
10	RFDPA870910IMAB308[5]	Walsin	2	Dipole	x	x
11	RFA-02-C2M2	Aristotle	2	Dipole	x	x
12	RN-SMA-S-RP[5]	Microchip	0.56	Dipole	x	x
13	W1049B030[5]	Pulse	2	Dipole	x	x
14	RN-SMA4-RP	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 of these antennas are used, an additional post-calibration step is required on the customer's application board. For more details, refer to the *WINCS02 Module External Antenna Calibration Guide* (DS50003753).

2.8 WINCS02 Module Reflow Profile Information

The WINCS02 Module was assembled using the IPC/JEDEC J-STD-020 standard lead-free reflow profile. The WINCS02 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:

- 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.

2.8.1 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.

2.9 WINCS02 Module Assembly Considerations

The WINCS02 Module is assembled with an Electro-Magnetic Interference (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 WINCS02 Module. However, do not use the cleaning solutions that contain acid on the module.

2.9.1 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 Specifications

This chapter provides the electrical specifications and the characteristics of the WINCS02IC and the WINCS02 Module across the operating temperature range of the product.

3.1 WINCS02IC Electrical Specifications

This chapter provides the electrical specifications and the characteristics of the WINCS02IC.

3.1.1 WINCS02IC Absolute Maximum Ratings

The following table provides details about the list of absolute maximum ratings for the WINCS02IC device. Exposure to these maximum rating conditions for extended periods can 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.

Table 3-1. Absolute Maximum Ratings

Parameter	Value
Ambient temperature under bias[1,2]	-40°C to +105°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[3]	-0.3V to (V_{DD}+0.3V)
Voltage on any pin, with respect to GND	-0.3V to (V_{DDIO}+0.3V)
Maximum current out of GND pins	300 mA
Maximum current into V_{DD} pins[2]	300 mA
Maximum output current sourced/sunk by any I/O pin	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 JESD22-A114	±2000V
Charged Device Model (CDM) (ANSI/ESD STM 5.3.1) (All pins / Corner pins)	±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.

3.1.2 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
V-Temp Temperature Devices:					
Operating ambient temperature range	T_A	-40	—	+105	°C
Operating junction temperature range[1]	T_J	-40	—	+125	°C
Power Dissipation:					
Internal chip power dissipation: P_{INT} = (VDDIOx x (IDD –∑ IOH)) + (VDD x IDD)	P_D	$P_{INT} + P_{I/O}$			W
Maximum allowed power dissipation	P_{DMAX}	$(T_J – T_A)/θ_{JA}$			W

Table 3-2. Thermal Operating Conditions (continued)

Rating	Symbol	Min.	Typ	Max.	Unit
Note: 1. Junction temperature can exceed 125°C under these ambient conditions.					

Table 3-3. Thermal Packaging Characteristics

Characteristics	Symbol	Typ	Max.	Unit
Thermal resistance, 48-pin VQFN (7 mm x 7 mm x 0.9 mm) package	θ_{JA}	21	—	°C/W
Note: Junction-to-ambient thermal resistance, θ_{JA} numbers are based on JEDEC 2S2P achieved by package simulations.				

Table 3-4. 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	3	3.3	3.6	V	—
DC_7	GNDDB	Common EDP ground reference	V_{SS}	V_{SS}	V_{SS}	V	—

3.1.3 Maximum Clock Frequencies AC Electrical Specifications

Table 3-5. Maximum Clock Frequencies 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	Max.	Units
FCLK_1	F_{CY}	Frequency of system clock	80	MHz
Note: By default, the device runs at its maximum clock frequency.				

3.1.4 WINCS02IC DC Characteristics

3.1.4.1 I/O Pin DC Electrical Specifications

Table 3-6. 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** **-40°C ≤ T_A ≤ +105°C for V-temp**				
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 non-5V tolerant I/O pins	0.8*V_{DDIO}	—	V_{DDIO}	V	—
DI_5	V_{OL}	Output low voltage	—	—	0.4	V	V_{DDIO} = 3.3V at I_{OL} ≦ 10 mA
DI_9	V_{OH}	Output high voltage	2.4	—	—	V	V_{DDIO} = 3.3V at I_{OH} ≦ 10 mA

Table 3-6. I/O Pin DC Electrical Specifications (continued)

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** **-40°C ≤ T_A ≤ +105°C for V-temp**				
Param. No.	Symbol	Characteristics	Min.	Typ.[1]	Max.	Units	Conditions
DI_13	I_{IL}	Input pin leakage current	-1	—	+1	µA	—

Note:
1. This parameter is characterized but not tested in manufacturing.

3.1.4.2 WINCS02IC Wi-Fi® Current Consumption

Table 3-7. 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** **-40°C ≤ T_A ≤ +105°C for V-temp**				
Param. No.	Symbol	Device States	Code Rate	Output Power (Typ.) (dBm)	Current (Typ.) (mA)	Max.	Units	Conditions
IWF_TX	I_{DD}	On_Transmit	802.11b 1 Mbps	19	288	—	mA	V_{DD} = V_{DDIO} = 3.3V
			802.11b 1 Mbps	13	263	—		
			802.11b 11 Mbps	20	289	—		
			802.11g 6 Mbps	19	287	—		
			802.11g 54 Mbps	17	263	—		
			802.11n MCS0	18	279	—		
			802.11n MCS7	17	262	—		
			802.11n MCS7	11	249	—		
IWF_RX	I_{DD}	On_Receive	802.11b 1 Mbps	—	88	—		
			802.11n MCS7	—	94			

Notes:
1. Tested on channel 7 using an internal test firmware that provides manual control of the data rate. In the Application mode firmware, the data rate is selected automatically based on the RSSI and other variables.
2. Data in the "Typ." column is at 3.3V, 25°C unless otherwise stated.
3. These parameters are characterized but not tested in manufacturing.

3.1.4.3 Extreme Deep Sleep (XDS) Current Consumption

The WINCS02 Module supports Extreme Deep Sleep (XDS) mode, which can be enabled using the appropriate API. For details, refer to MPLAB® Harmony WINCS02 WLAN Library. To exit XDS mode, asset the MCLR pin and complete the full driver initialization.

Table 3-8. 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** **-40°C ≤ T_A ≤ +105°C for V-temp**			
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

3.1.5 WINCS02IC AC Characteristics

3.1.5.1 External XTAL POSC 40 MHz AC Electrical Specifications

Table 3-9. External XTAL POSC 40 MHz 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$^{(2)}$	Characteristics	Min.	Typ	Max.	Units	Conditions$^{(1)}$
XOSC_1	FOSC_XOSC	XOSC crystal frequency	—	40	—	MHz	XIN, XOUT primary oscillator
XOSC_1A	TOSC	TOSC = 1/FOSC_XOSC	—	—	—	ns	See parameter XOSC_1 for FOSC_XOSC value
XOSC_34	g_m	XOSC transconductance GAIN = 0	—	16	—	mA/V	XOSC auto gain control disabled
XOSC_39	XCLK_FST	Primary XIN clock fail safe time-out period	—	2	—	ms	—

Notes:
1. Crystal oscillator requirements:
   - ESR = 50Ω
   - Maximum drive level = 200 µW
2. This parameter is characterized but not tested in manufacturing.

3.1.5.2 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** **-40°C ≤ T_A ≤ +105°C for V-temp**				
Param. No.	Symbol	Characteristics	Min.	Typ.	Max.	Units	Conditions
XOSC32_1	FOSC_XOSC32	XOSC32 oscillator crystal frequency	—	32.768	—	kHz	RTCC oscillator

Table 3-10. XOSC32 RTCC Oscillator AC Electrical Specifications (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**
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	—	%	—

Note:
1. This parameter is characterized but not tested in manufacturing.

3.1.5.3 SDIO-SPI AC Timing Specifications

Figure 3-1. SDIO-SPI AC Timing Diagram

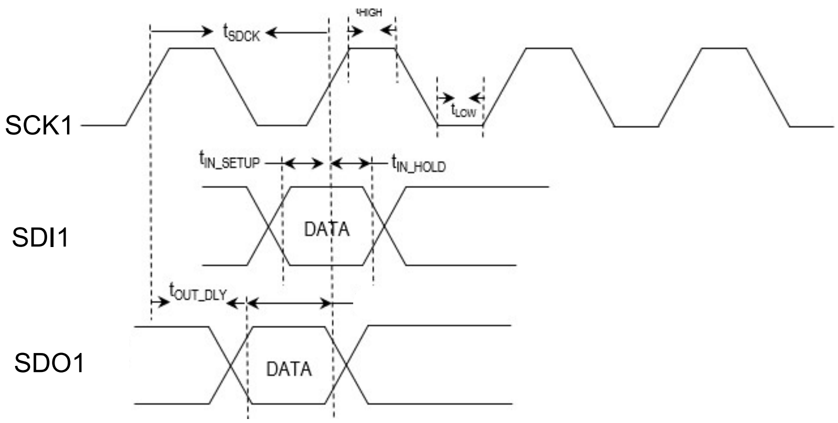


Table 3-11. SDIO Controller AC Timing Specifications

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_5	t_{SDCK}	Clock frequency	0	—	50	MHz	—
SD_7	t_{DUTY}	Duty cycle	—	50	—	%	—
SD_9	t_{HIGH}	Clock high time	8.5	—	—	ns	—
SD_11	t_{LOW}	Clock low time	8.5	—	—	ns	—
SD_13	t_{RISE}	Clock rise time	—	—	5	—	—
SD_15	t_{FALL}	Clock fall time	—	—	5	—	—
SD_17	t_{IN_SETUP}	Input setup time	6	—	—	ns	—
SD_19	t_{IN_HOLD}	Input hold time	1	—	—	ns	—
SD_21	t_{OUT_DLY}	Output delay time	3	—	13	ns	VDDIO = 3.3V, C_{LOAD} = 15 pF ($_{Max}$)

Table 3-11. SDIO Controller AC Timing Specifications (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]

Notes:

1. All output pins with 15 pF load
2. The 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.

3.1.5.4 Power-on Reset AC Electrical Specifications

Table 3-12. 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** **-40°C ≤ T_A ≤ +105°C for V-temp**				
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	T(nRST)	External Reset valid active pulse width	3	—	—	us	—

3.1.6 WINCS02IC Radio Specifications

Table 3-13. WINCS02IC 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

3.1.6.1 WINCS02IC Receiver Performance

Table 3-14. WINCS02IC 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** **-40°C ≤ T_A ≤ +105°C for V-temp Temp**			
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	—	-94	—	
		5.5 Mbps CCK	—	-93	—	
		11 Mbps CCK(6)	—	-89	—	

Table 3-14. WINCS02IC Receiver Performance Characteristics(1) (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** **-40°C ≤ T_A ≤ +105°C for V-temp Temp**			
Param. No.	**Characteristics**	**Description(5)**	**Min.**	**Typ**	**Max.**	**Units**
WF_RX_3	Sensitivity 802.11g	6 Mbps OFDM	—	-92	—	dBm
		9 Mbps OFDM	—	-91	—	
		12 Mbps OFDM	—	-89	—	
		18 Mbps OFDM	—	-87	—	
		24 Mbps OFDM	—	-84	—	
		36 Mbps OFDM	—	-81	—	
		48 Mbps OFDM	—	-76	—	
		54 Mbps OFDM(6)	—	-75	—	
WF_RX_4	Sensitivity 802.11n (Bandwidth at 20 MHz) (Both long GI and short GI)	MCS 0	—	-90	—	dBm
		MCS 1	—	-87	—	
		MCS 2	—	-85	—	
		MCS 3	—	-82	—	
		MCS 4	—	-79	—	
		MCS 5	—	-74	—	
		MCS 6	—	-73	—	
		MCS 7(6)	—	-71	—	
WF_RX_5	Maximum receive signal level	1, 2 Mbps DSSS	-3	—	—	dBm
		5.5, 11 Mbps CCK	-3	—	—	
		6 Mbps OFDM	-3	—	—	
		54 Mbps OFDM	-7.2	—	—	
		MCS 0	-3	—	—	
		MCS 7	-7	—	—	
WF_RX_6	Adjacent channel rejection	1 Mbps DSSS (30 MHz offset)	43.5	—	—	dB
		11 Mbps CCK (25 MHz offset)	39.5	—	—	
		6 Mbps OFDM (25 MHz offset)	39.5	—	—	
		54 Mbps OFDM (25 MHz offset)	21.5	—	—	
		MCS 0 – 20 MHz Bandwidth (25 MHz offset)	38.5	—	—	
		MCS 7 – 20 MHz Bandwidth (25 MHz offset)	19.5	—	—	
WF_RX_7	RSSI accuracy	—	-5	—	5	dB

Table 3-14. WINCS02IC Receiver Performance Characteristics(1) (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** **-40°C ≤ T_A ≤ +105°C for V-temp Temp**			
Param. No.	Characteristics	Description(5)	Min.	Typ	Max.	Units

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.

3.1.6.2 WINCS02IC Transmitter Performance

Table 3-15. WINCS02IC 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** **-40°C ≤ T_A ≤ +105°C for V-temp**			
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 CCK	—	20	—	
		11 Mbps CCK	—	20	—	
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	—	

Table 3-15. WINCS02IC Transmitter Performance Characteristics (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** **-40°C ≤ T_A ≤ +105°C for V-temp**			
Param. No.	Characteristics	Description[8]	Min.	Typ[3]	Max.	Units
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.

3.1.6.3 WINCS02IC Receiver and Transmitter Characteristics Graphs

Figure 3-2. Receive Current vs Temperature, MCS7, Channel 7, 3.3V

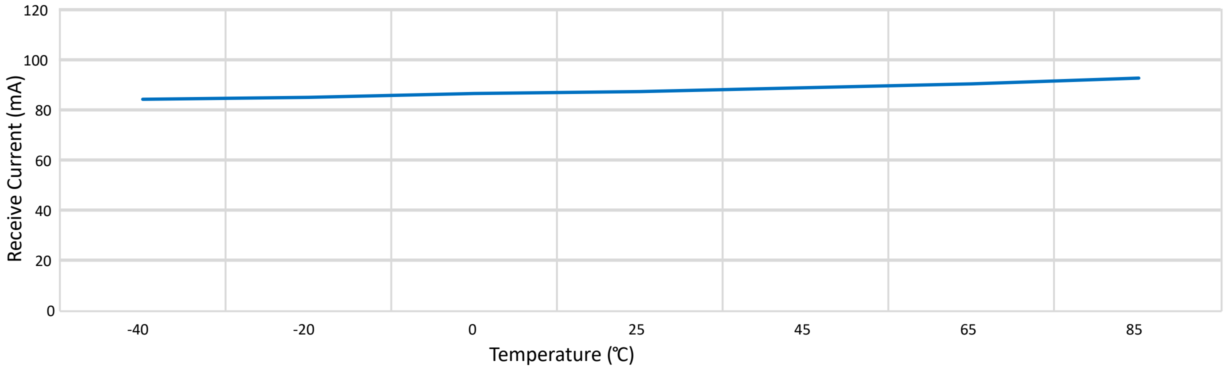


Figure 3-3. Receive Current vs Receive Signal Power, MCS7, Channel 7, 3.3V, 25℃

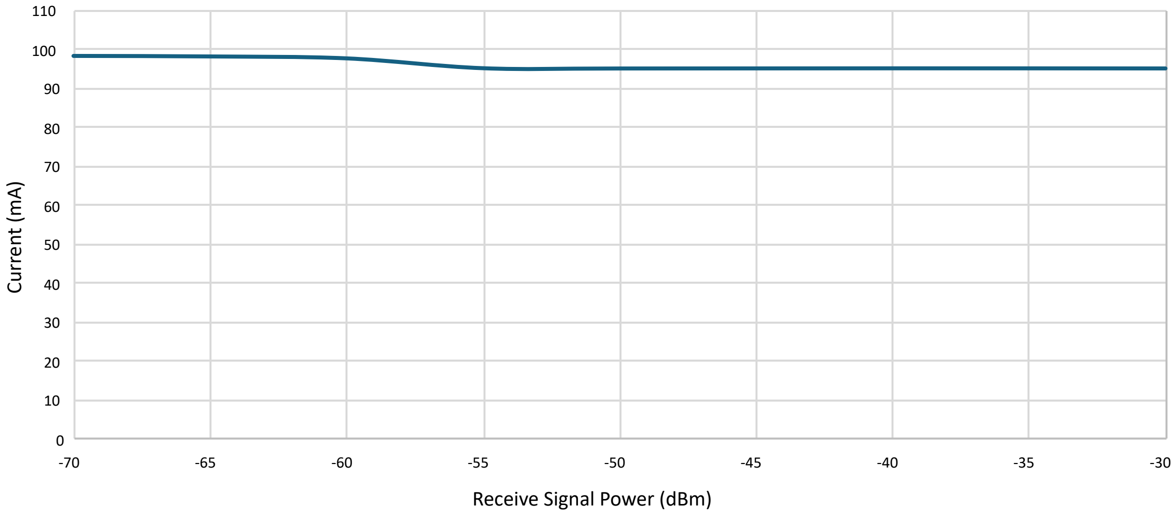


Figure 3-4. Transmit Current vs Temperature, MCS7, Channel 7, 3.3V

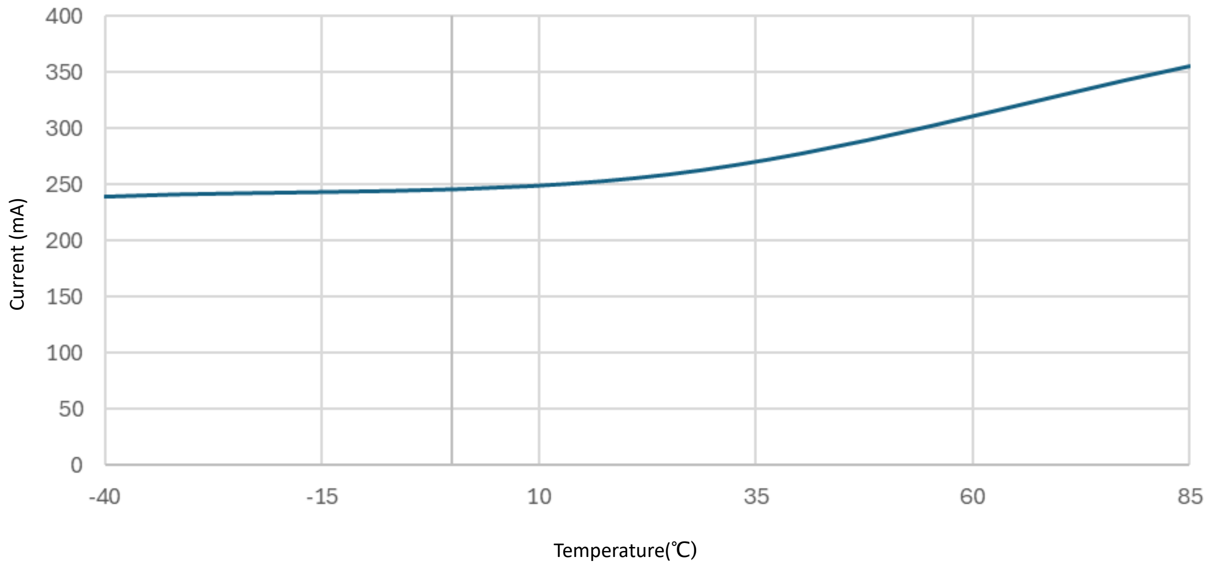


Figure 3-5. Transmit Current vs Transmit Output Power, MCS7, Channel 7, 3.3V, 25℃

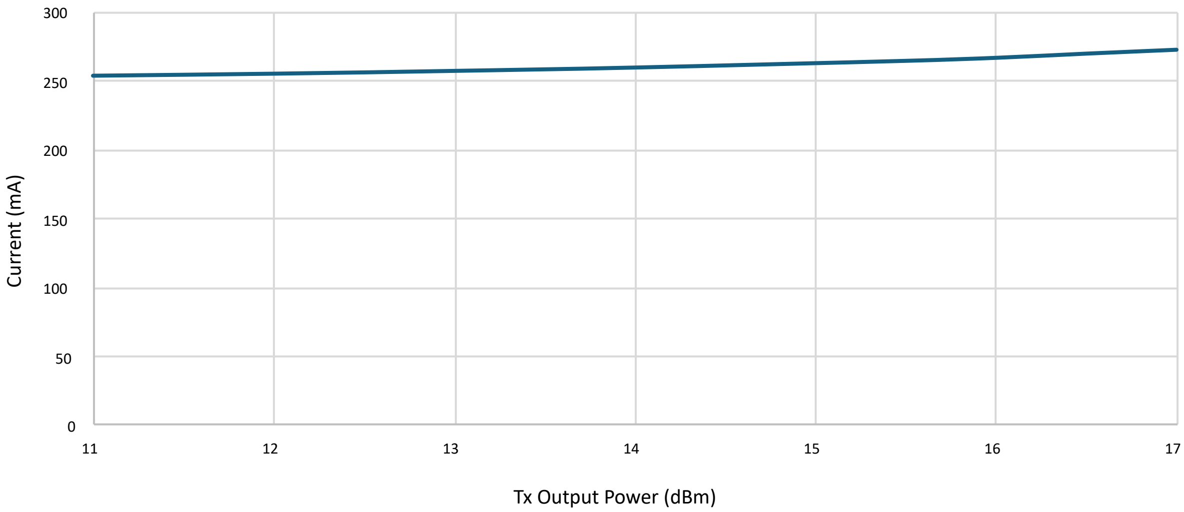


Figure 3-6. Transmit Power vs Voltage, 11b, 1Mbps, Channel 7, 25℃

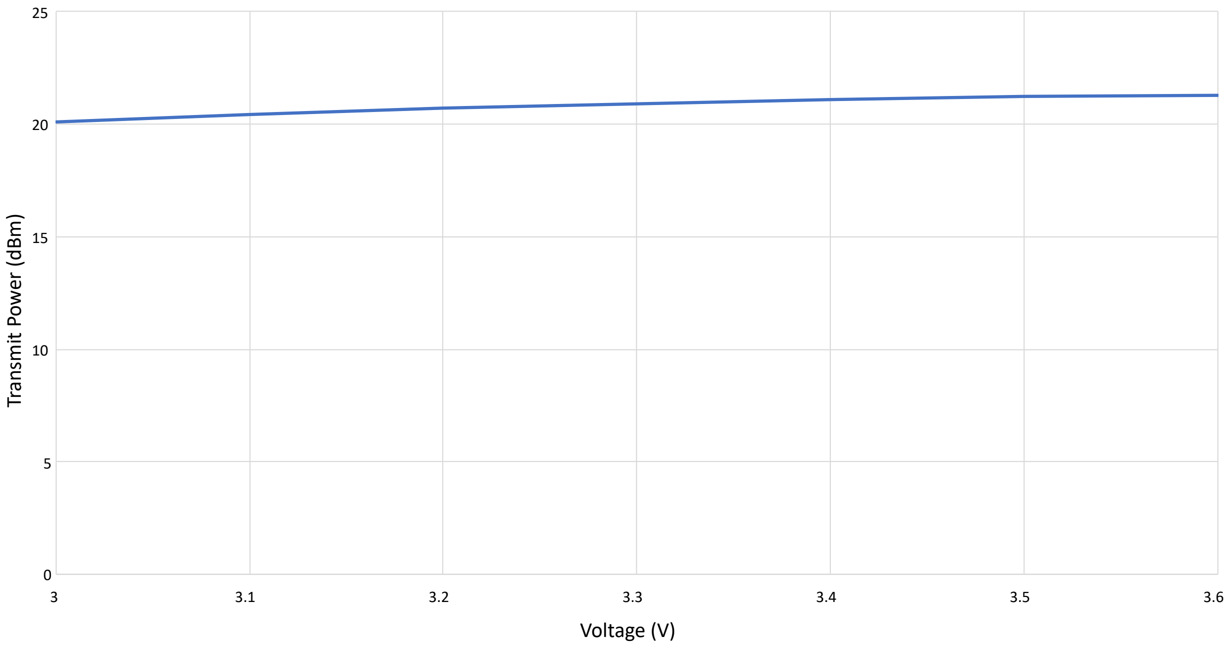


Figure 3-7. Transmit Power vs Temperature, 11b, 1Mbps, Channel 7, 3.3V, 25℃

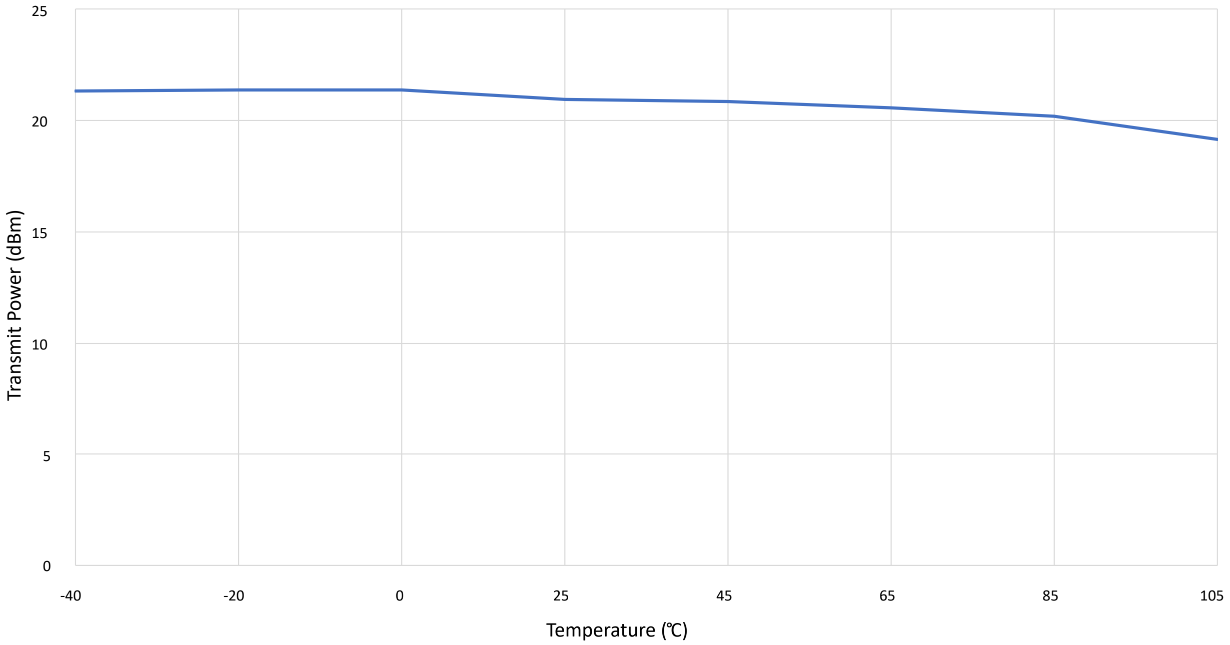


Figure 3-8. Transmit Power vs Channel, 1Mbps, 3.3V, 25℃

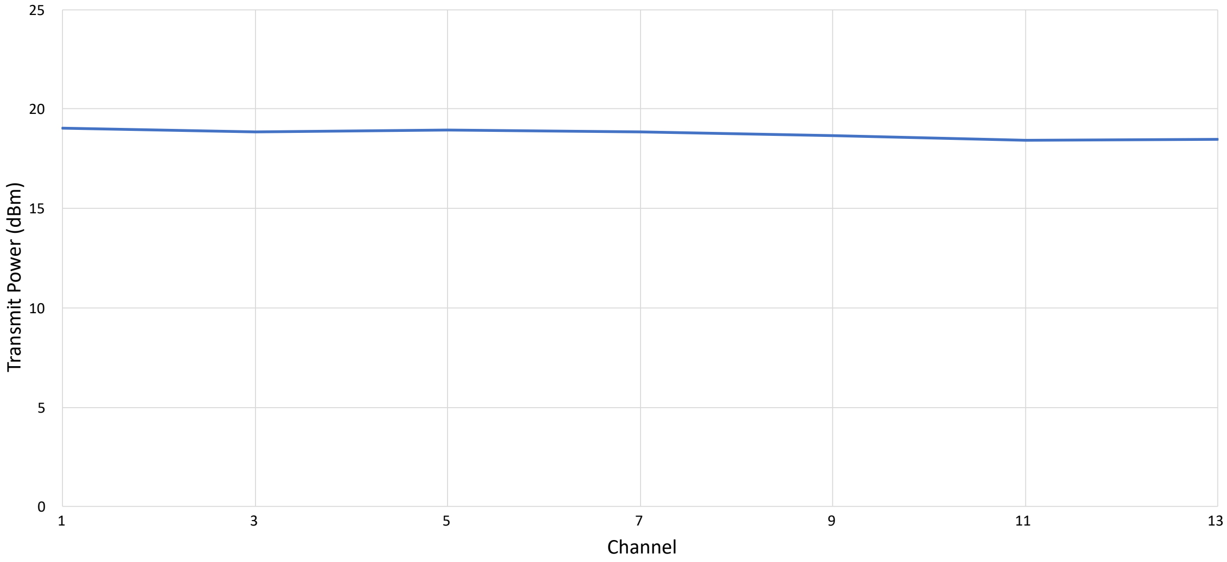


Figure 3-9. RSSI vs Received Signal Power, MCS7, Channel7, 3.3V, 25℃

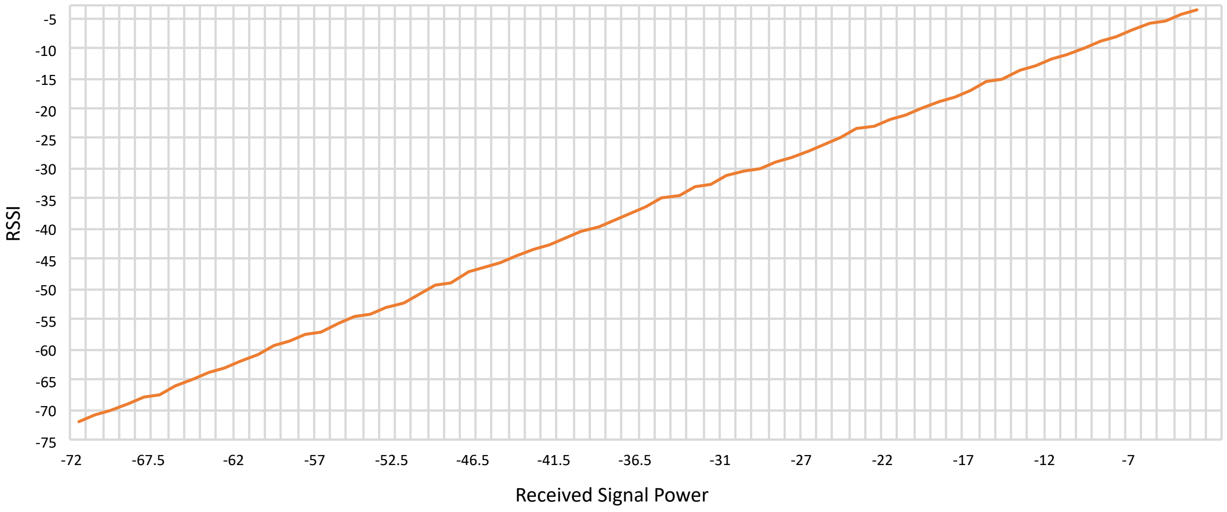


Figure 3-10. RX Sensitivity vs Channel, MCS7, 3.3V, 25℃

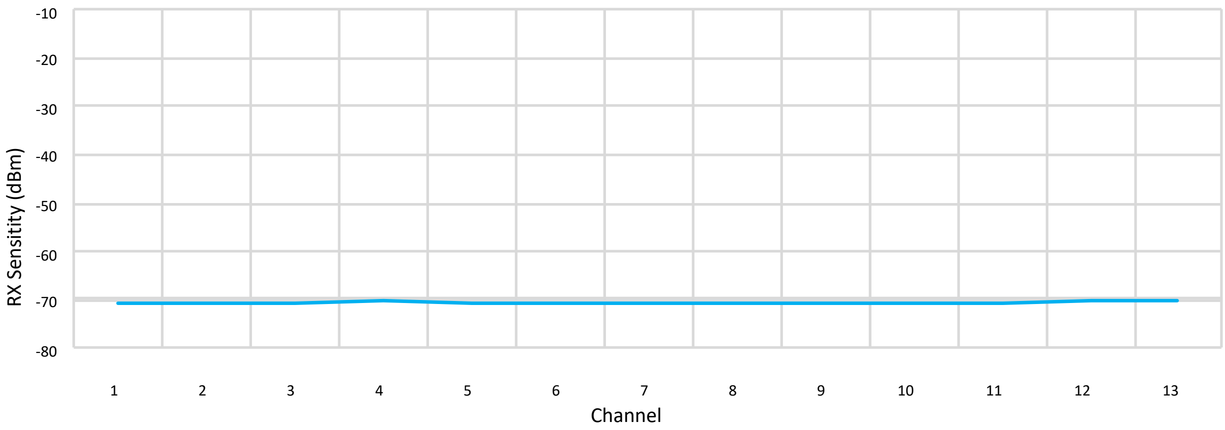
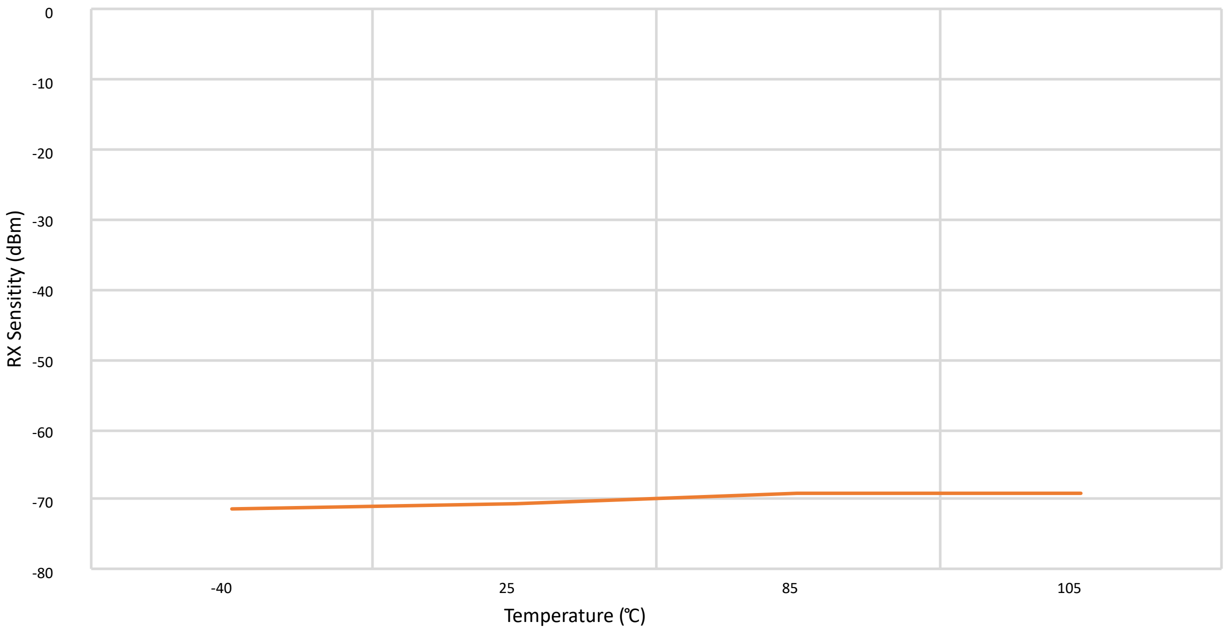


Figure 3-11. RX Sensitivity vs Temperature, MCS7, Channel 7, 3.3V



3.2 WINCS02 Module Electrical Specifications

This chapter provides the electrical specifications and the characteristics of the WINCS02 Module across the operating temperature range of the product.

3.2.1 WINCS02 Module Absolute Maximum Ratings

The following table provides details about the list of absolute maximum ratings for the WINCS02 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 3-16. 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 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.

3.2.2 Thermal Specifications

Table 3-17. 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 3-18. 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	3	3.3	3.6	V	—
DC_7	GND	Common EDP ground reference	V_{SS}	V_{SS}	V_{SS}	V	—

3.2.3 WINCS02 Module AC and DC Characteristics

For WINCS02 Module AC and DC Electrical Characteristics, refer to WINCS02IC Electrical Specifications.

3.2.3.1 Wi-Fi® Current Consumption

Table 3-19. 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)(2)	Max.	Units	Conditions
IWF_TX	I_{DD}	On_Transmit	802.11b 1 Mbps(4)	19	304	—	mA	V_{DD} = V_{DDIO} = 3.3V
			802.11b 1 Mbps(4)	13	270	—		
			802.11b 11 Mbps(3)	20	311	—		
			802.11g 6 Mbps(4)	19	310	—		
			802.11g 54 Mbps(3)	17	274	—		
			802.11n MCS0(4)	18	300	—		
			802.11n MCS7(3)	17	273	—		
			802.11n MCS7(4)	11	252	—		
IWF_RX	I_{DD}	On_Receive	802.11b 1 Mbps(4)	—	92	—		
			802.11n MCS7(3)	—	98			

Notes:
1. Tested on channel 7 using an internal test firmware that provides manual control of data rate. In the Application mode firmware, the data rate is selected automatically based on the RSSI and other variables.
2. Data in the “Typ.” column is at 3.3V, 25°C unless otherwise stated.
3. These parameters are tested in manufacturing.
4. These parameters are characterized but not tested in manufacturing.

3.2.4 WINCS02 Module Radio Specifications

Table 3-20. WINCS02 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

3.2.4.1 WINCS02 Module Receiver Performance

Table 3-21. WINCS02 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	—	

Table 3-21. WINCS02 Module Receiver Performance Characteristics(1) (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_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	-3	—	—	dBm
		5.5, 11 Mbps CCK	-3	—	—	
		6 Mbps OFDM	-3	—	—	
		54 Mbps OFDM	-8.5	—	—	
		MCS 0	-3	—	—	
		MCS 7	-8.5	—	—	
WF_RX_6	Adjacent channel rejection	1 Mbps DSSS	43.5	—	—	dB
		(30 MHz offset)				
		11 Mbps CCK	38.5	—	—	
		(25 MHz offset)				
		6 Mbps OFDM	46.5	—	—	
		(25 MHz offset)				
		54 Mbps OFDM	28.5	—	—	
		(25 MHz offset)				
		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

Table 3-21. WINCS02 Module Receiver Performance Characteristics(1) (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

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.

3.2.4.2 WINCS02 Module Transmitter Performance

Table 3-22. WINCS02 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 CCK	—	20	—	
		11 Mbps CCK	—	20	—	
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

Table 3-22. WINCS02 Module Transmitter Performance Characteristics (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[8]	Min.	Typ[3]	Max.	Units
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.

3.2.4.3 WINCS02 Module Receiver and Transmitter Characteristics Graphs

Figure 3-12. Receive Current vs Temperature, MCS7, Channel 7, 3.3V

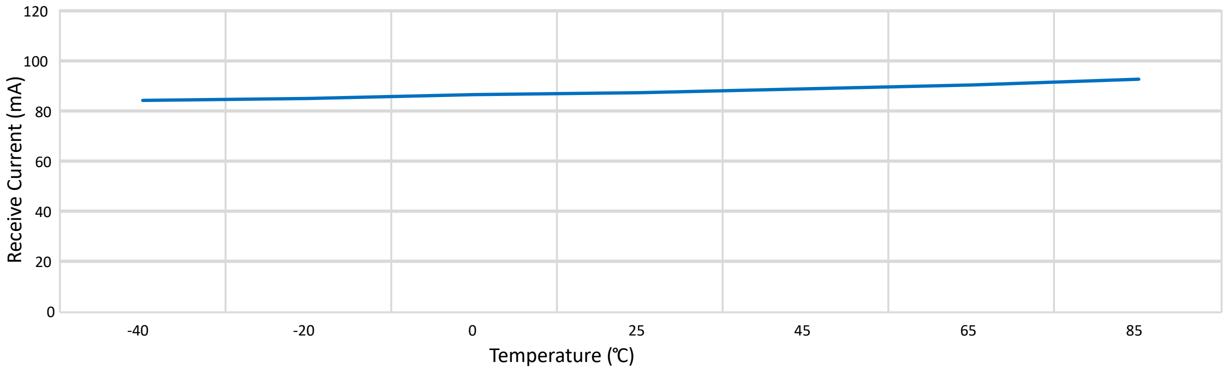


Figure 3-13. Receive Current vs Receive Signal Power, MCS7, Channel 7, 3.3V, 25℃

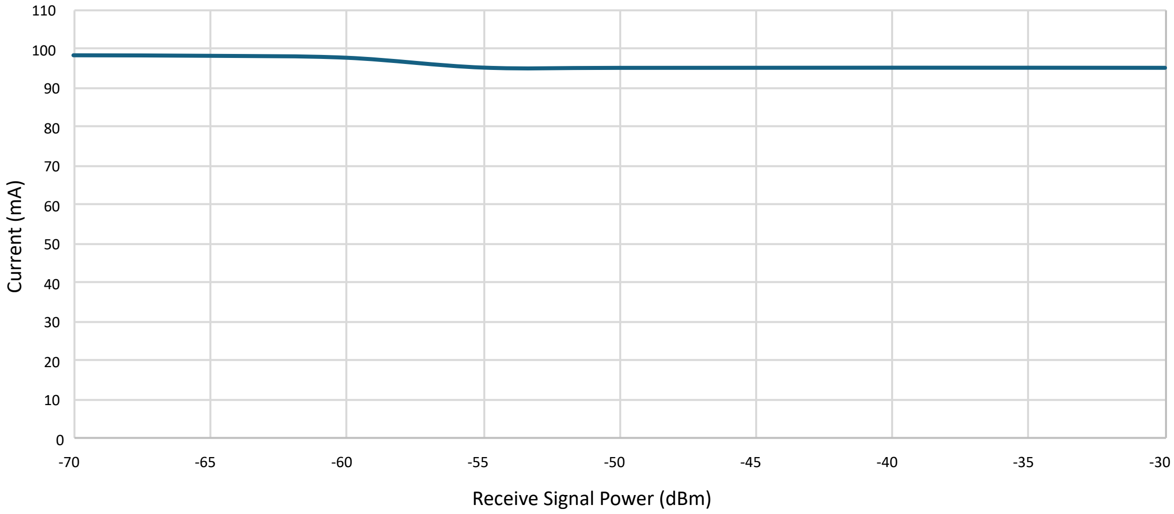


Figure 3-14. Transmit Current vs Temperature, MCS7, Channel 7, 3.3V

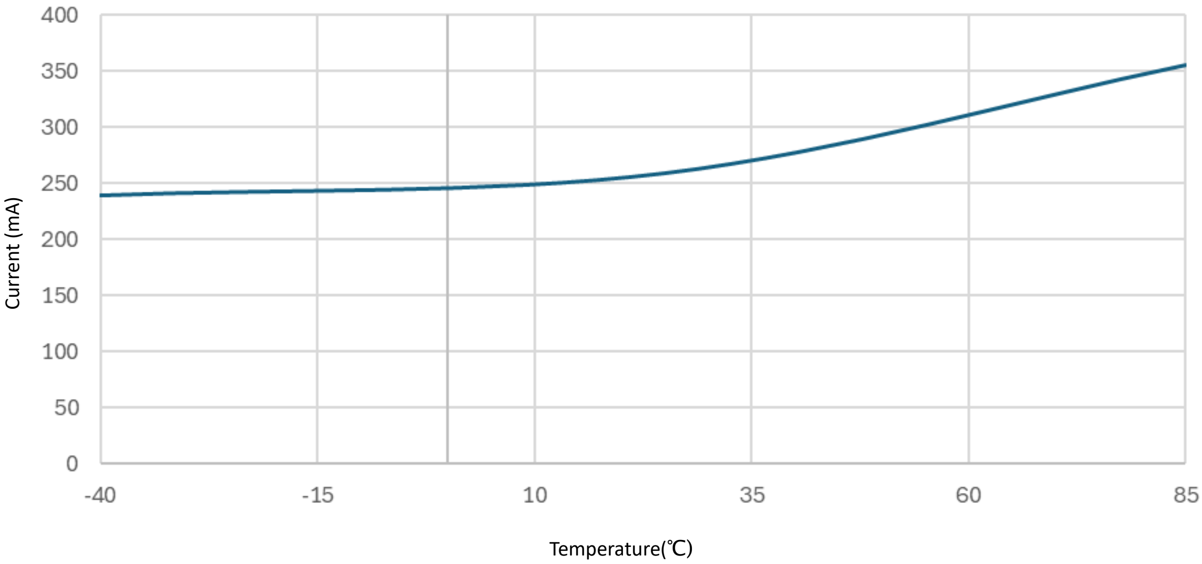


Figure 3-15. Transmit Current vs Transmit Output Power, MCS7, Channel 7, 3.3V, 25℃

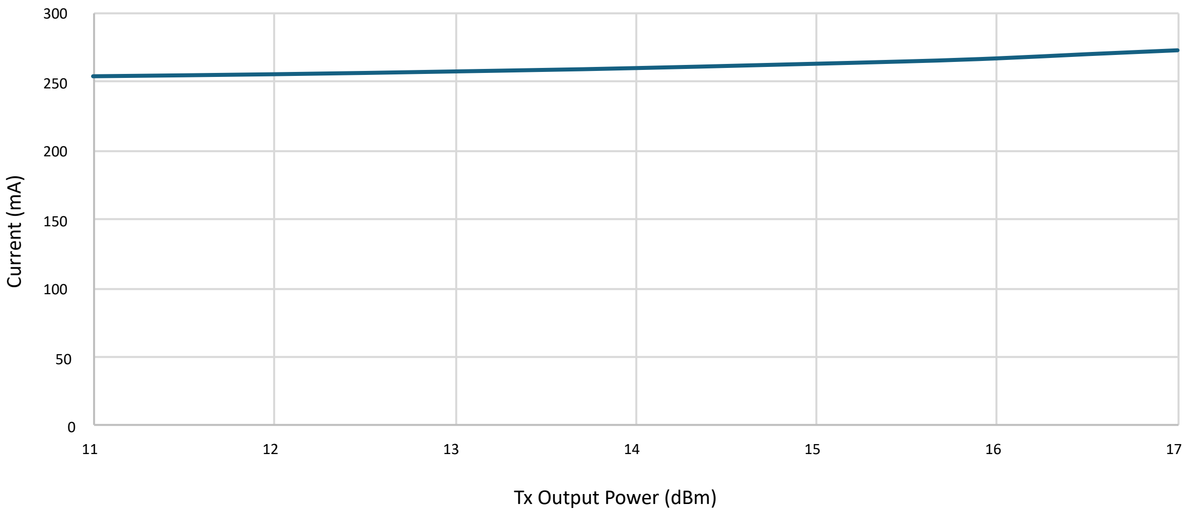


Figure 3-16. Transmit Power vs Voltage, 1M, Channel 7, 3.3V, 25℃

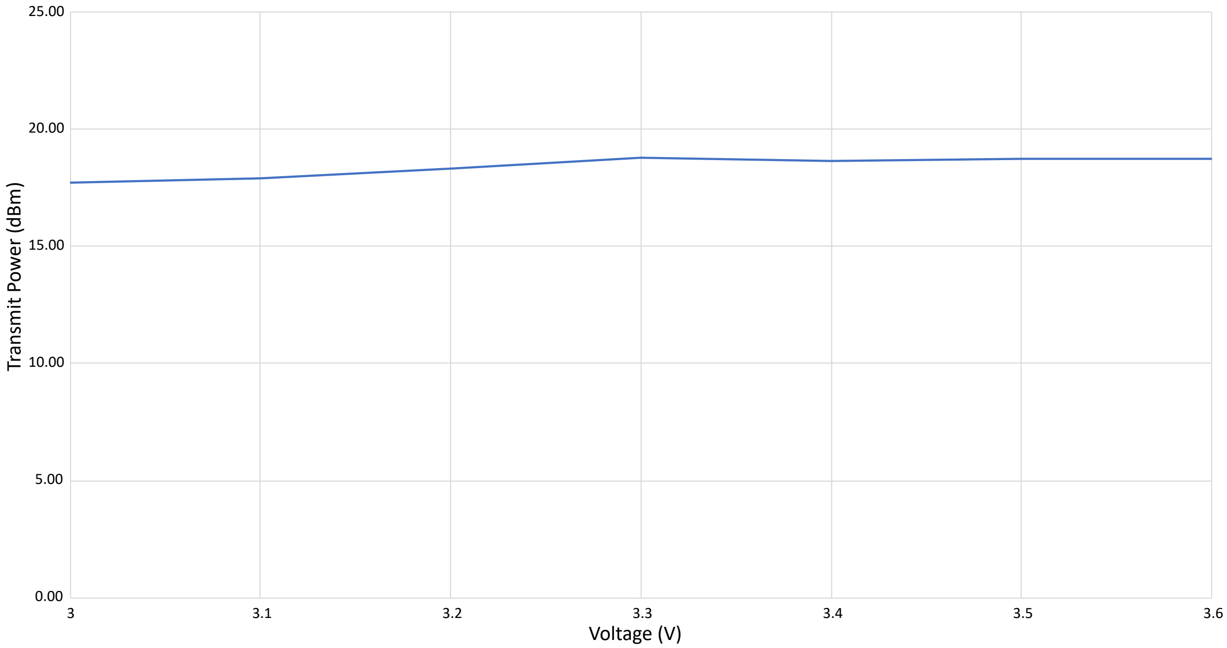


Figure 3-17. Transmit Power vs Temperature, 1M, Channel 7, 3.3V

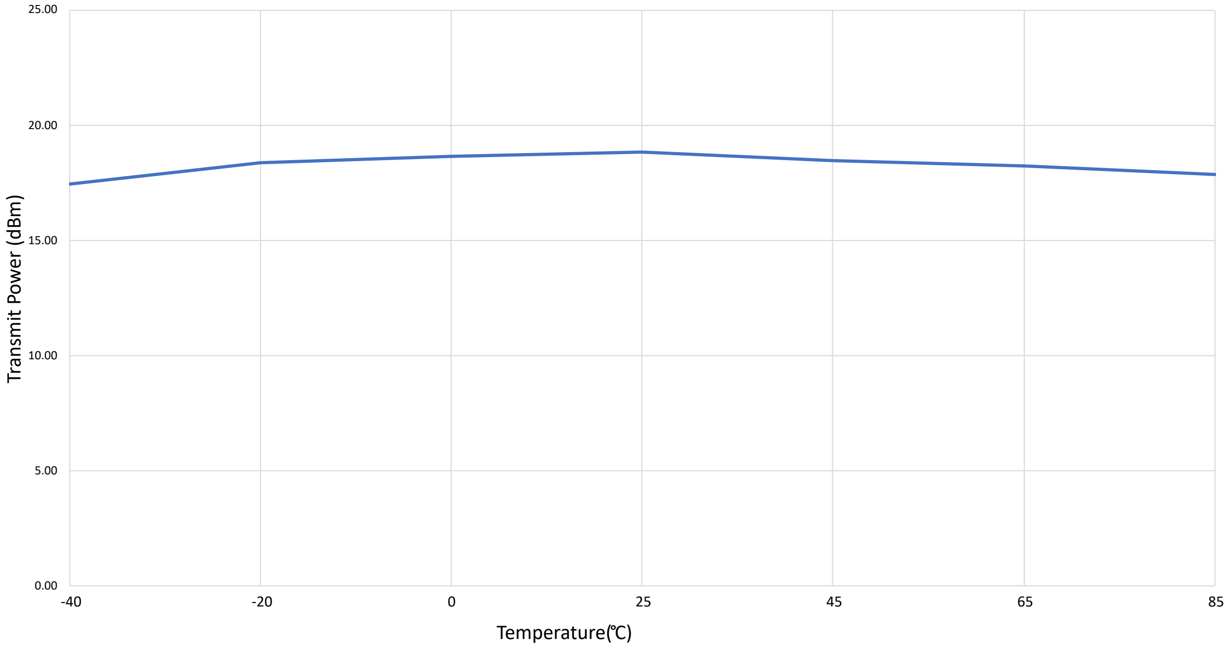


Figure 3-18. Transmit Power vs Channel, 1M, Channel 7, 3.3V, 25℃

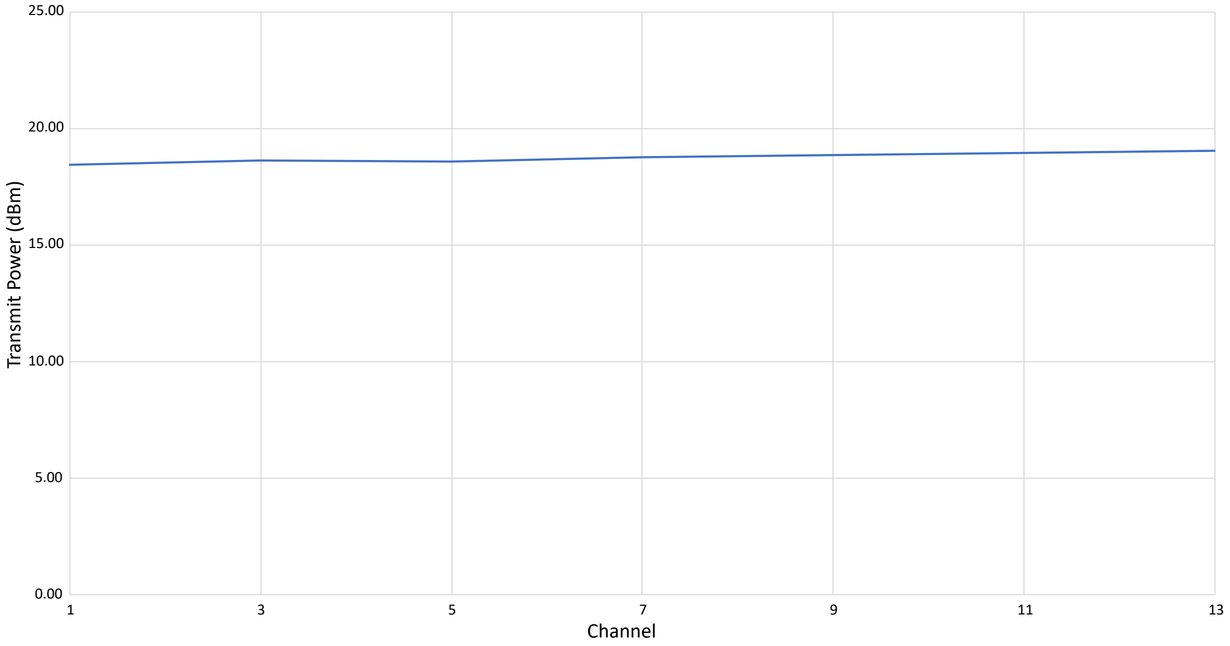


Figure 3-19. RX RSSI vs RX Input Power, MCS7, 3.3V, 25℃

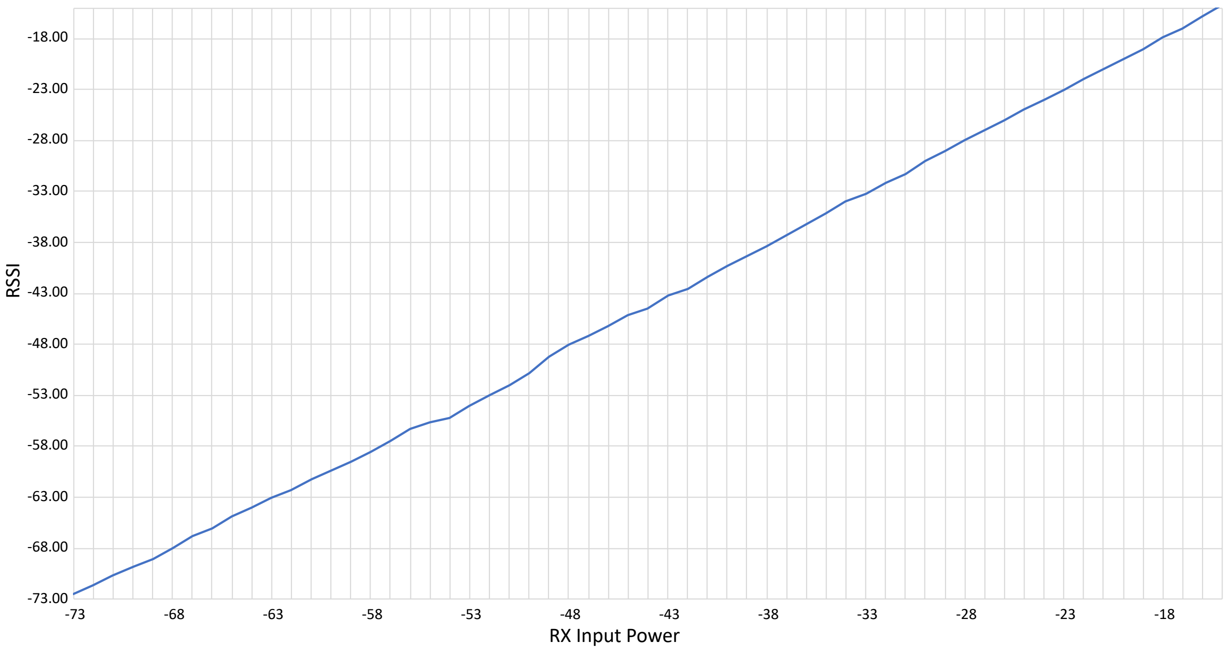


Figure 3-20. RX Sensitivity vs Channel, MCS7, 3.3V, 25℃

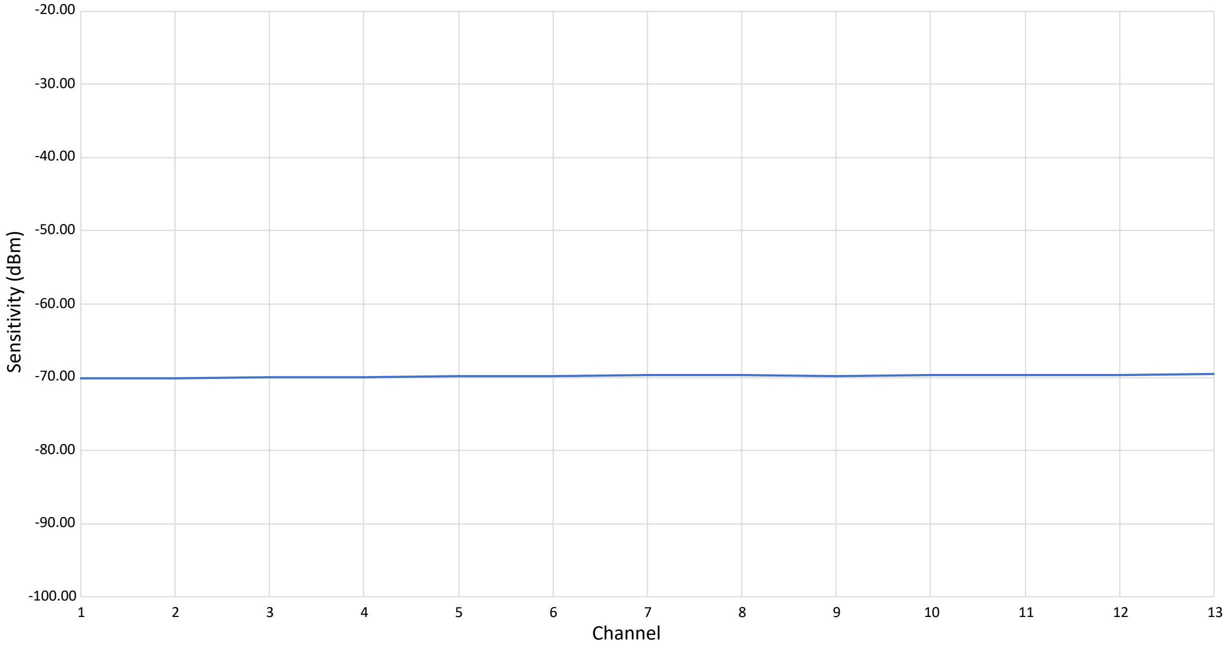


Figure 3-21. Receive Sensitivity vs Voltage, MCS7, Channel 7, 3.3V, 25℃

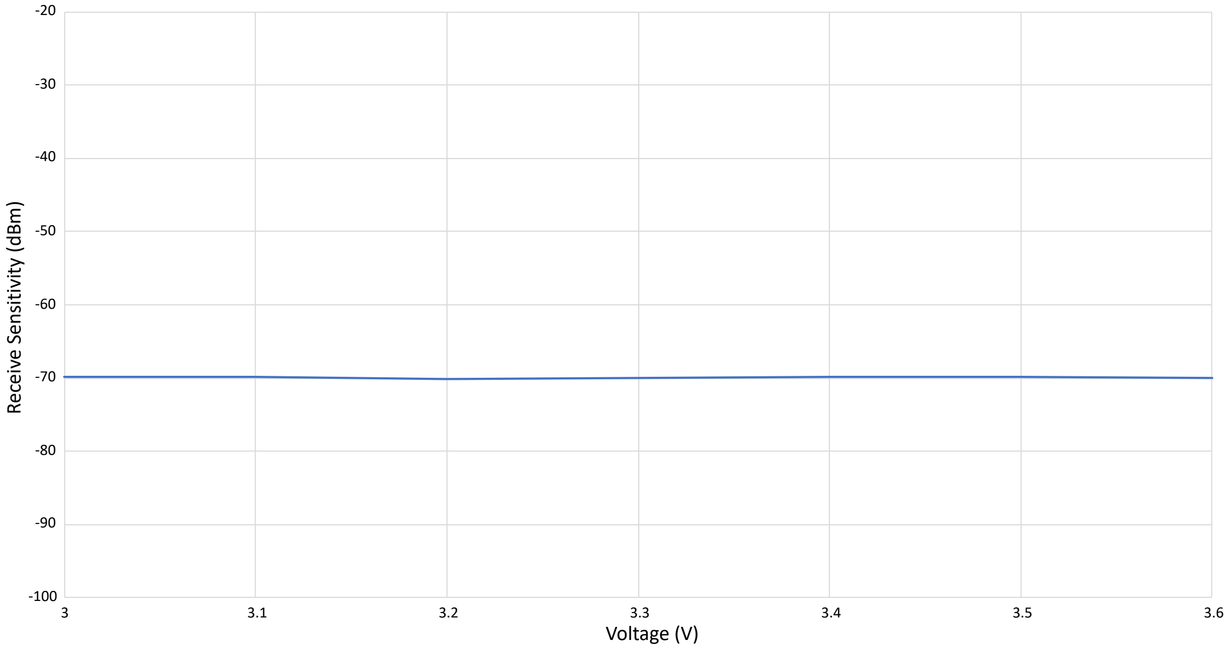
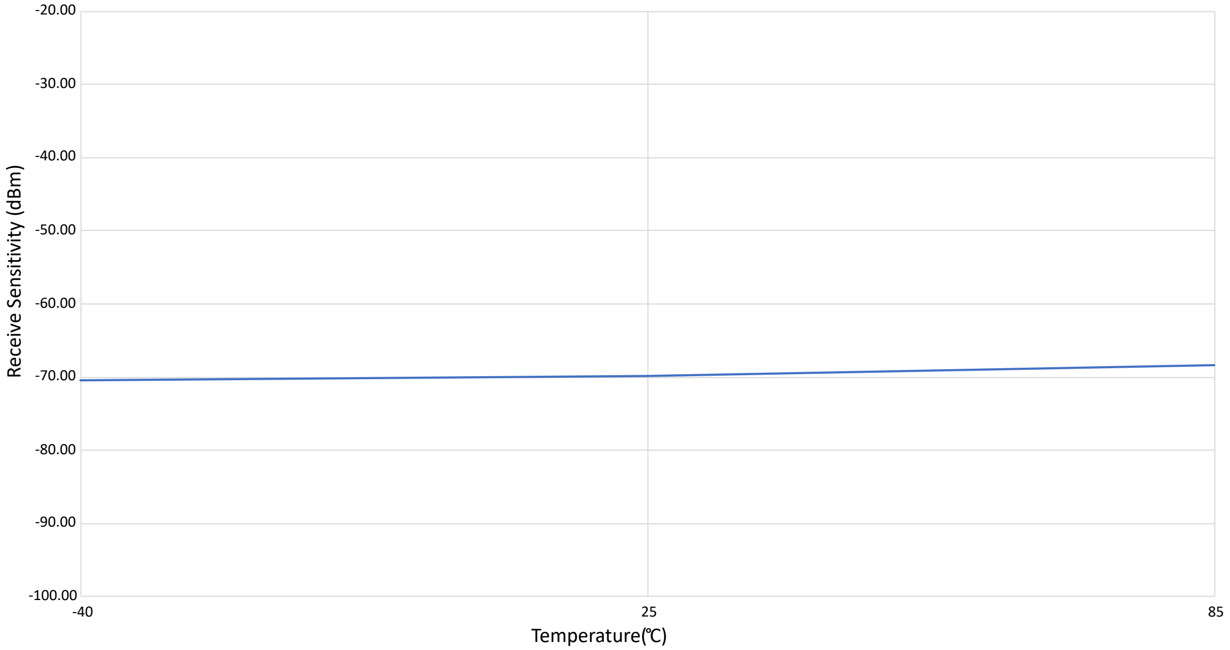


Figure 3-22. Receive Sensitivity vs Temperature, MCS7, Channel 7, 3.3V



4. Packaging Information

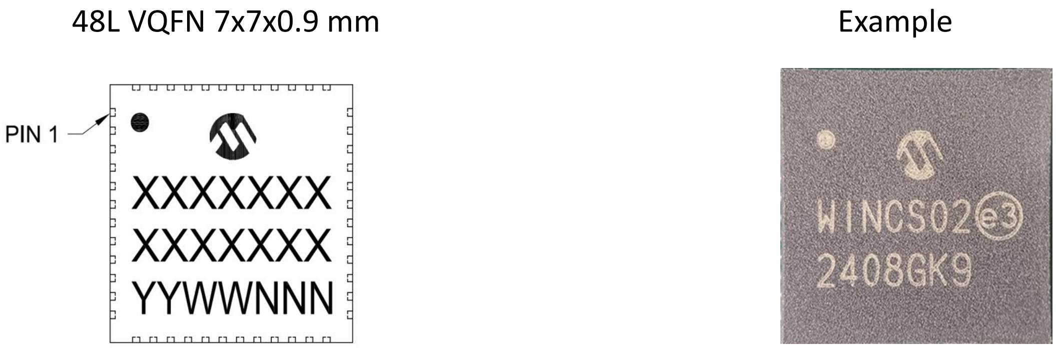
This chapter provides information on package markings, dimension and footprint of the WINCS02IC and the WINCS02 Module.

4.1 WINCS02IC 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 WINCS02IC Package Marking

Figure 4-1. WINCS02IC Package Marking



48L VQFN 7x7x0.9 mm

Example

Legend: XX...X Customer-specific information
Year code (last digit of calendar year)
YY Year code (last 2 digits of calendar year)
WW Week code (week of January 1 is week '01')
NNN Alphanumeric traceability code
Pb-free JEDEC designator for Matte Tin (Sn)
This package is Pb-free. The Pb-free JEDEC designator (e3)
can be found on the outer packaging for this package.

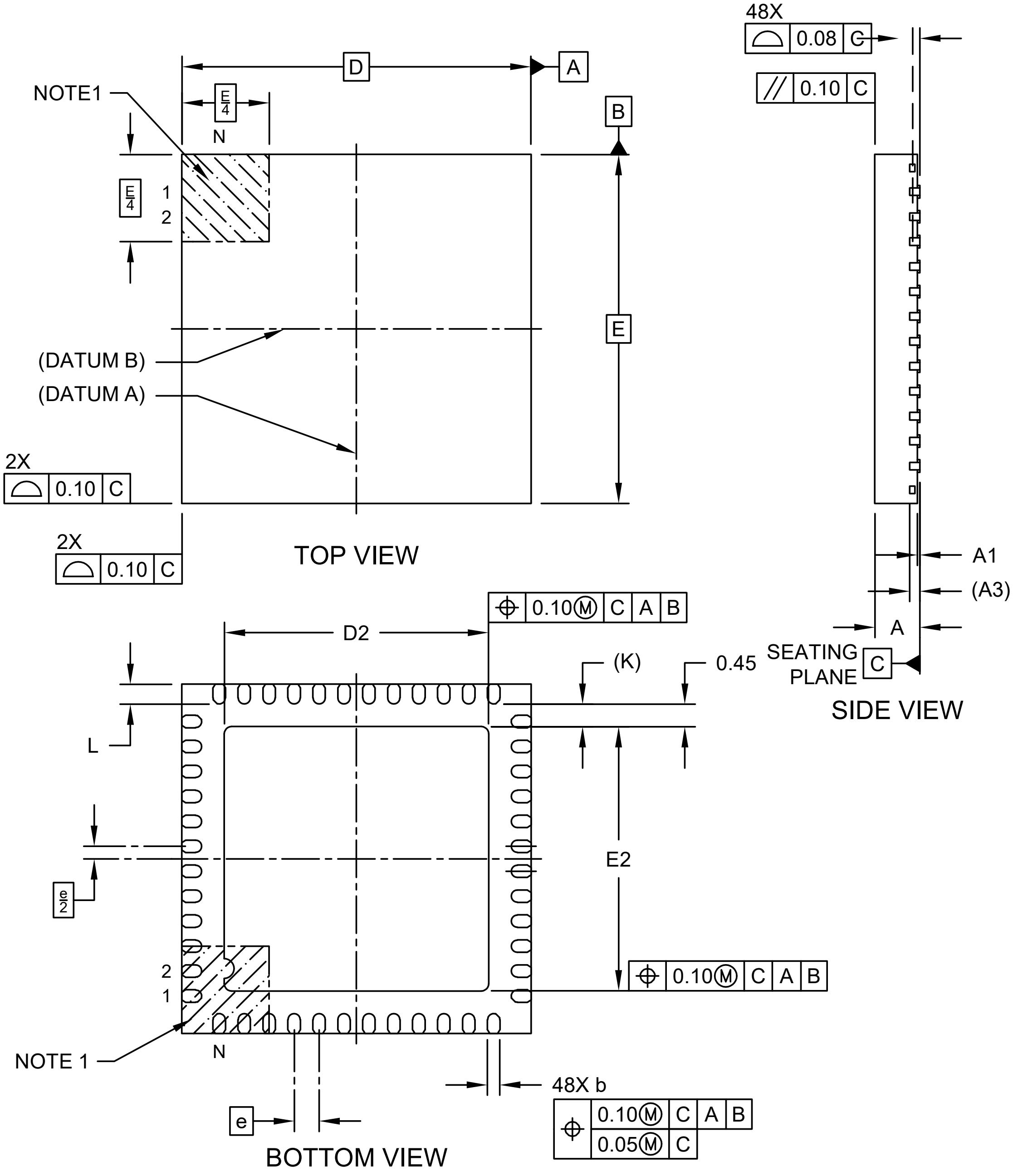
Note:
In the event the full Microchip part number cannot be marked on one line, it will be carried over to the next line, thus limiting the number of available characters for customer-specific information.

4.1.2 WINCS02IC Packaging Dimension

This section provides the package dimension details of WINCS02IC.

48-Lead Very Thin Plastic Quad Flat, No Lead Package (ZZX) - 7x7 mm Body [VQFN] With 5.3 mm Exposed Pad

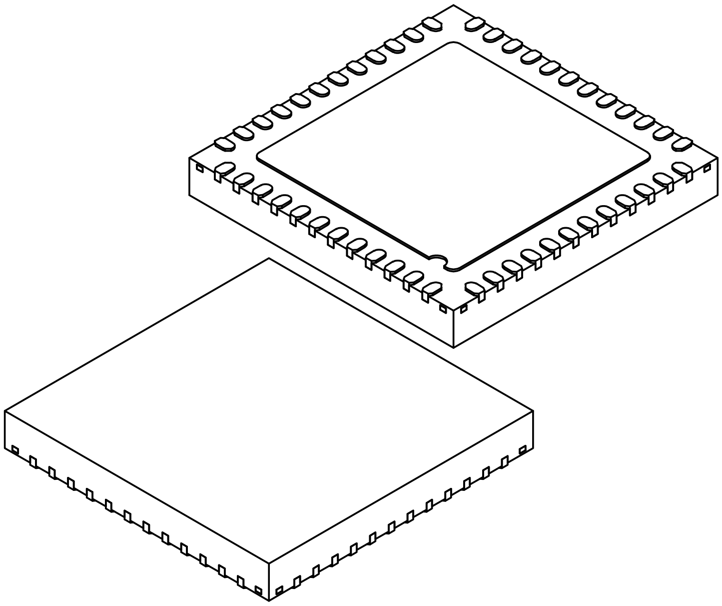
Note:	For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



Microchip Technology Drawing C04-535 Rev A Sheet 1 of 2

48-Lead Very Thin Plastic Quad Flat, No Lead Package (ZZX) - 7x7 mm Body [VQFN] With 5.3 mm Exposed Pad

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		48	
Pitch	e		0.50 BSC	
Overall Height	A	0.80	0.85	0.90
Standoff	A1	0.00	0.035	0.05
Terminal Thickness	A3		0.203 REF	
Overall Length	D		7.00 BSC	
Exposed Pad Length	D2	5.20	5.30	5.40
Overall Width	E		7.00 BSC	
Exposed Pad Width	E2	5.20	5.30	5.40
Terminal Width	b	0.20	0.25	0.30
Terminal Length	L	0.30	0.40	0.50
Terminal-to-Exposed-Pad	K		0.45 REF	

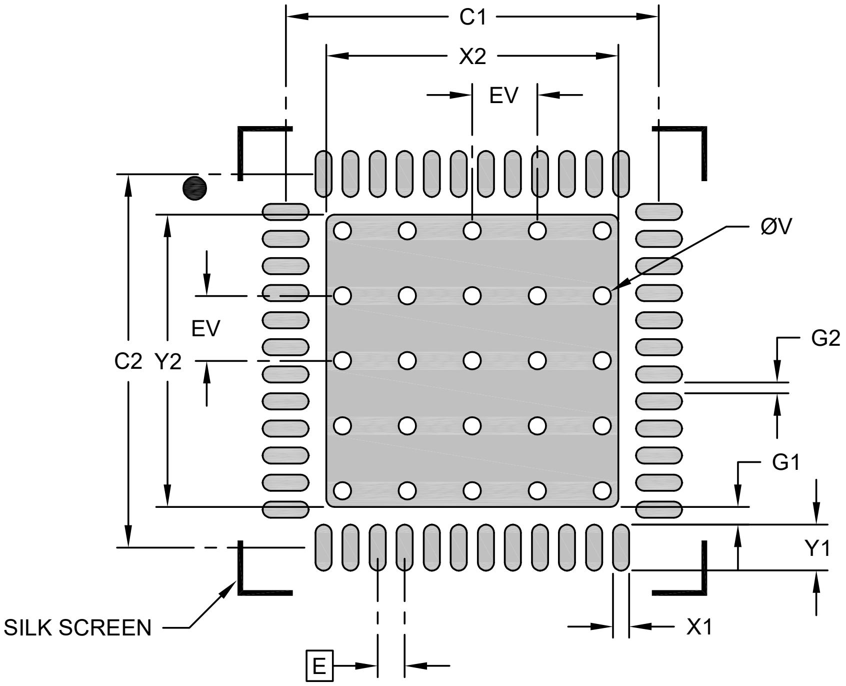
Notes:

1. Pin 1 visual index feature may vary, but must be located within the hatched area.
2. Package is saw singulated
3. Dimensioning and tolerancing per ASME Y14.5M
   BSC: Basic Dimension. Theoretically exact value shown without tolerances.
   REF: Reference Dimension, usually without tolerance, for information purposes only.

Microchip Technology Drawing C04-535 Rev A Sheet 2 of 2

48-Lead Very Thin Plastic Quad Flat, No Lead Package (ZZX) - 7x7 mm Body [VQFN] With 5.3 mm Exposed Pad

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



RECOMMENDED LAND PATTERN

	Units	MILLIMETERS		
	Dimension Limits	MIN	NOM	MAX
Contact Pitch	E	0.50 BSC		
Center Pad Width	X2			5.40
Center Pad Length	Y2			5.40
Contact Pad Spacing	C1		6.90	
Contact Pad Spacing	C2		6.90	
Contact Pad Width (X48)	X1			0.30
Contact Pad Length (X48)	Y1			0.85
Contact Pad to Center Pad (X48)	G1	0.33		
Contact Pad to Contact Pad (X44)	G2	0.20		
Thermal Via Diameter	V		0.33	
Thermal Via Pitch	EV		1.20	

Notes:

1. Dimensioning and tolerancing per ASME Y14.5M

   BSC: Basic Dimension. Theoretically exact value shown without tolerances.

2. For best soldering results, thermal vias, if used, should be filled or tented to avoid solder loss during reflow process

Microchip Technology Drawing C04-2535 Rev A

4.2 WINCS02 Module Packaging Information

4.2.1 WINCS02 Module Packaging Marking

Figure 4-2. WINCS02 Module Packaging Marking

Legend:

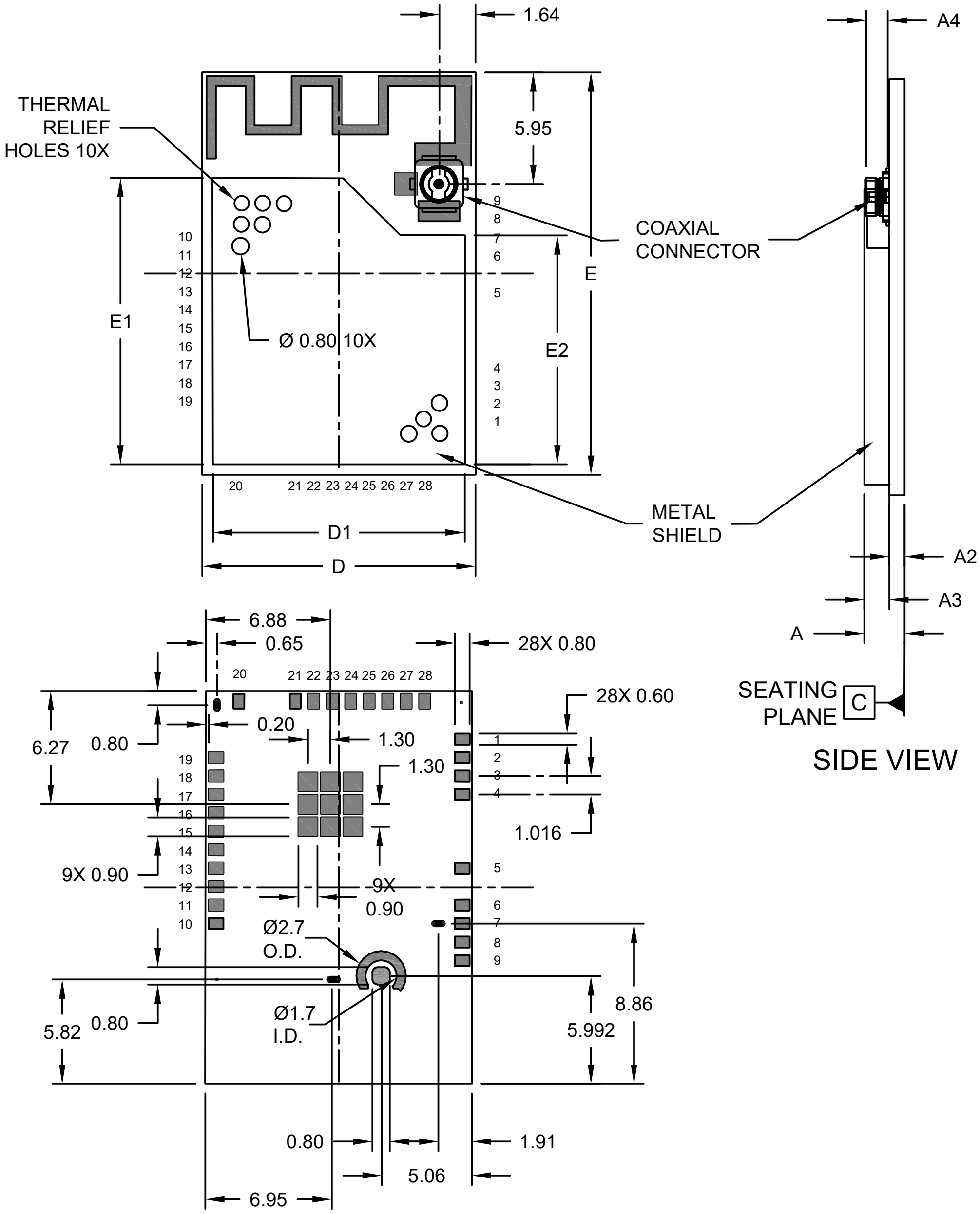
XX....X	Module part number and version and regulatory designator
YY:	Year code (last 2 digits of calendar year)
WW	Week code (week of January 1 is week "01")
NNN	Alphanumeric traceability code

4.2.2 WINCS02 Module Packaging Dimension

This section provides the package dimension details of the WINCS02 Module.

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

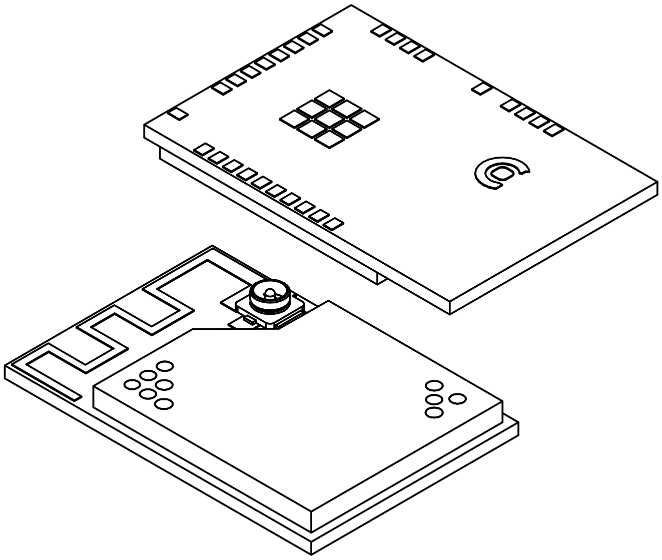
Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



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

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



Units		MILLIMETERS		
Dimension Limits		MIN	NOM	MAX
Number of Terminals	N	28		
Overall Height	A	1.90	2.10	2.30
PCB Thickness	A2	0.70	0.80	0.90
Shield Height	A3	1.30 REF		
UFL Connector Height	A4	1.25 REF		
Overall Length	D	14.73 BSC		
Overall Width	E	21.72 BSC		
Shield Length	D1	13.53	13.63	13.73
Shield Width	E1	15.36	15.46	15.56
Terminal Width	b	0.50	0.60	0.70
Terminal Length	L	0.70	0.80	0.90
Shield Width 2	E2	12.30	12.40	12.50

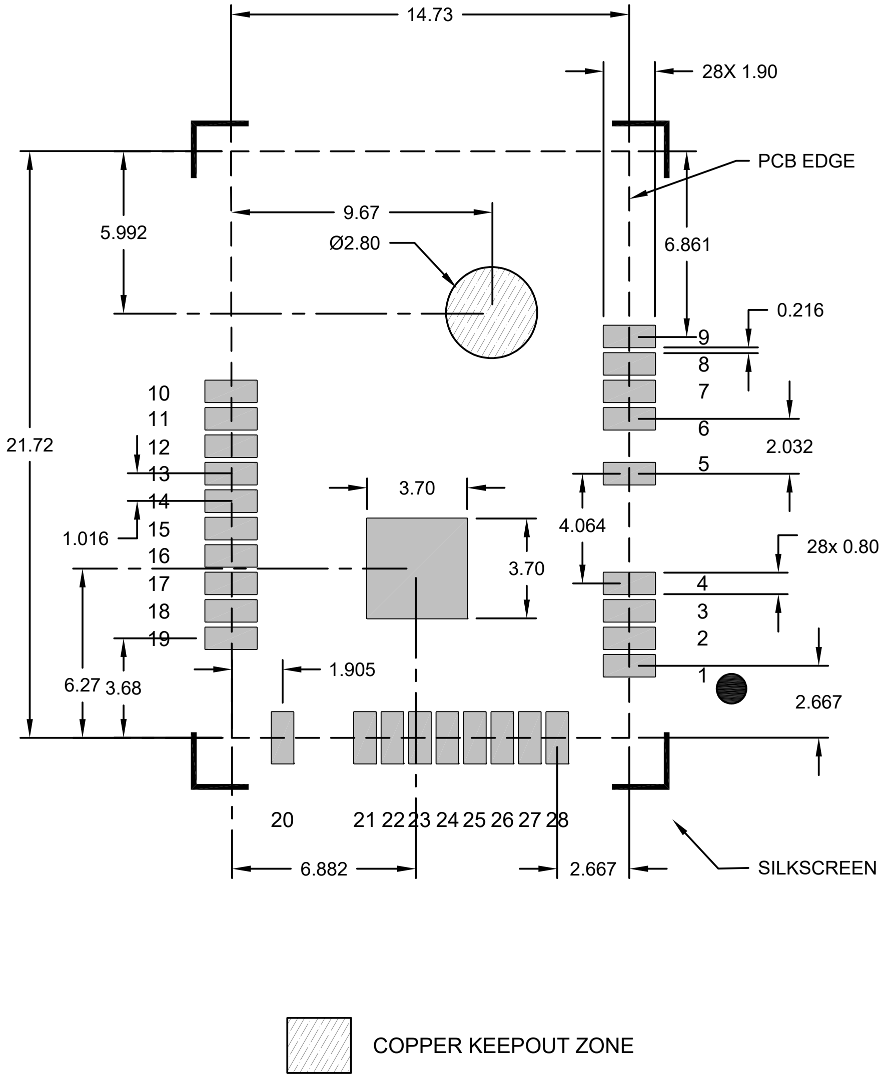
Notes:

1. All dimensions are in millimeters.

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

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



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 C

5. Appendix A: Regulatory Approval

The WINCS02PC Module has received regulatory approval for the following countries:

- United States/FCC ID: 2ADHKWIXCS02
- Canada/ISED:
  - IC: 20266-WIXCS02
  - HVIN: WINCS02PC
  - PMN:Wireless MCU Module with IEEE®802.11 b/g/n
- Europe/CE
- Great Britain/UKCA
- Japan/MIC: 020-240380
- Korea/KCC: R-R-mcp-WIXCS02
- Taiwan/NCC: CCAN24Y11100T5

The WINCS02PE Module has received regulatory approval for the following countries:

- United States/FCC ID: 2ADHKWIXCS02
- Canada/ISED:
  - IC: 20266-WIXCS02
  - HVIN: WINCS02PE
  - PMN:Wireless MCU Module with IEEE®802.11 b/g/n
- Europe/CE
- Great Britain/UKCA
- Japan/MIC: 020-240380
- Korea/KCC: R-R-mcp-WIXCS02
- Taiwan/NCC: CCAN24Y11101T7

The WINCS02UC Module has received regulatory approval for the following countries:

- United States/FCC ID: 2ADHKWIXCS02U
- Canada/ISED:
  - IC: 20266-WIXCS02U
  - HVIN: WINCS02UC
  - PMN:Wireless MCU Module with IEEE®802.11 b/g/n
- Europe/CE
- Great Britain/UKCA
- Japan/MIC: 020-240380
- Korea/KCC: R-R-mcp-WIXCS02
- Taiwan/NCC: CCAN24Y11110T8

The WINCS02UE Module has received regulatory approval for the following countries:

- United States/FCC ID: 2ADHKWIXCS02U
- Canada/ISED:
  - IC: 20266-WIXCS02U
  - HVIN: WINCS02UE

  - PMN:Wireless MCU Module with IEEE®802.11 b/g/n
- Europe/CE
- Great Britain/UKCA
- Japan/MIC: 020-240380
- Korea/KCC: R-R-mcp-WIXCS02
- Taiwan/NCC: CCAN24Y11111T0

5.1 United States

The WINCS02PC/WINCS02PE/WINCS02UC/WINCS02UE 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 WINCS02PC/WINCS02PE/WINCS02UC/WINCS02UE 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:

For the WINCS02PC/PE 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 WINCS02UC/UE 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.

WINCS02PC/WINCS02PE/WINCS02UC/WINCS02UE: These modules are approved for installation into mobile or/and portable host platforms.

5.1.3 Approved Antenna Types

To maintain modular approval in the United States, only the tested antenna types are 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 WINCS02PC/PE, the approval is received using the integral PCB antenna.

For the WINCS02UC/UE, approved antennas are listed in the WINCS02 Module Approved External 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 WINCS02PC/WINCS02PE/WINCS02UC/WINCS02UE 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 WINCS02PC/WINCS02PE Module	**Contains IC: 20266-WIXCS02**
For the WINCS02UC/WINCS02UE 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: 20266-20266-WIXCS02 and IC: 20266-20266-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: 20266-20266-WIXCS02 and IC: 20266-20266-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.

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 Radiocommunication 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.

WINCS02PC/WINCS02PE/WINCS02UC/WINCS02UE: The device operates at an output power level which is within the ISED SAR test exemption limits at any user distance.

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.

5.2.3 Approved Antenna Types

For the WINCS02PC/PE, approval was received using the integral PCB antenna.

For the WINCS02UC/UE, approved antennas are listed in the WINCS02 Module Approved External Antenna.

5.2.4 Helpful Web Sites

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

5.3 Europe

The WINCS02PC/WINCS02PE/WINCS02UC/WINCS02UE 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 WINCS02PC/WINCS02PE/WINCS02UC/WINCS02UE 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.

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 WINCS02PC/WINCS02PE/WINCS02UC/WINCS02UE 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 WINCS02PC/WINCS02PE/WINCS02UC/WINCS02UE 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 WINCS02PC/PE, approval was received using the integral PCB antenna.

For the WINCS02UC/UE, approved antennas are listed in the WINCS02 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: docdb.cept.org/.

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 WINCS02PC/WINCS02PE/WINCS02UC/WINCS02UE Modules have 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 WINCS02PC/WINCS02PE/WINCS02UC/WINCS02UE 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 WINCS02PC/WINCS02PE/WINCS02UC/WINCS02UE Modules, 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:	
WINCS02PC/WINCS02PE/WINCS02UC/WINCS02UE Module	R 020-240380

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 WINCS02PC/WINCS02PE/WINCS02UC/WINCS02UE Modules have 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 WINCS02PC/WINCS02PE/WINCS02UC/WINCS02UE 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 WINCS02PC/WINCS02PE/WINCS02UC/WINCS02UE Modules are labeled with its own KC mark. The final product requires the KC mark and certificate number of the Module:	
WINCS02PC/WINCS02PE/WINCS02UC/WINCS02UE Module	**R-R-mcp-WIXCS02**

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 WINCS02PC/WINCS02PE/WINCS02UC/WINCS02UE Modules have 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 WINCS02PC/WINCS02PE/WINCS02UC/WINCS02UE Modules, 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:	
WINCS02PC Module	CCAN24Y11100T5
WINCS02PE Module	CCAN24Y11101T7
WINCS02UC Module	CCAN24Y11110T8
WINCS02UE Module	CCAN24Y11111T0

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。

此模組於取得認證後將依規定於模組本體標示審驗合格標籤，並要求平台廠商於平台上標示本產品內含發射器模組

5.6.2 Helpful Web Sites

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

5.7 UKCA (UK Conformity Assessed)

The WINCS02PC/WINCS02PE/WINCS02UC/WINCS02UE 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 WINCS02PC/WINCS02PE/WINCS02UC/WINCS02UE 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 WINCS02PC/WINCS02PE/WINCS02UC/WINCS02UE 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/WINCS02.

5.7.3 Approved Antennas

The testing of the WINCS02PC/WINCS02PE/WINCS02UC/WINCS02UE Module was performed with the antennas listed in WINCS02 Module Approved External Antenna.

5.7.4 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.

5.8 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.

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 Amplifier
HTTP	Hypertext Transfer Protocol
I^2C	Inter-Integrated Circuit
IP	Internet Protocol
I/O	Input Output
IPWR	Idle Current
ISED	Innovation, Science and Economic Development
ISM	International Safety Management Certification
LNA	Low Noise Amplifier
$\overline{\text{MCLR}}$	Master Clear Reset Active Low
MSB	Most Significant Bit
NC	No Connection
NDRNG	Non Deterministic Random Number Generator
NIST	National Institute of Standards and Technology
OEM	Original Equipment Manufacturer

Table 6-1. Acronyms and Abbreviations (continued)

Acronyms	Abbreviations
OFB	Output Feedback Mode
OFDM	Orthogonal Frequency Division Multiplexing
OSC	Oscillator
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
PTA	Packet Traffic Arbitration
PWM	Pulse Width Modulation
RF	Radio Frequency
ROM	Read Only Memory
RP	Reverse Polarity
RSSI	Receive Signal Strength Indication
RTCC	Real Time Clock Calendar
RTS	Request-to-Send
RX	Receive
SMA	SubMiniature Connector
SMD	Surface Mount Device
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
WLAN	Wireless Local Area Network
WPA	Wi-Fi® Protected Access
XOSC	Crystal Oscillator

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
B	03/2025	WINCS02IC and WINCS02 Module Features	• Added compatibility for Wi-Fi® 6/7 2.4 GHz band • Added support for Extreme Deep Sleep (XDS) mode • Added "Example Block Diagram"
		Device Overview	Updated "WINCS02 Module Block Diagram"
		Pin Details of WINCS02IC	Updated "WINCS02IC Pinout Table"
		Pin Details of WINCS02 Module	Updated "WINCS02 Module Pinout Table"
		Basic Connection Requirement	Updated "WINCS02 Module Basic Connection and Interface Diagram"
		Interface with Host Microcontroller	Updated "WINCS02 Module Host Interface Diagram"
		PCB Antenna	Added "3D Antenna Radiation Patterns" and updated "2D Antenna Radiation Patterns"
		External Antennas	Updated "Approved External Antenna List with Antenna Gain for WINCS02 Module" table
		Extreme Deep Sleep (XDS) Current Consumption	Added this section
		SDIO-SPI AC Timing Specifications	"SPI Electrical Specifications" section was replaced with "SDIO-SPI AC Timing Specifications"
		Appendix A: Regulatory Approval, Japan, Korea, Taiwan	Added regulatory approval details for Japan, Korea and Taiwan
A	09/2024	Document	Initial Revision

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