ESP32-C3-WROOM-02

Datasheet

Module with 4 MB flash and on-board PCB antenna
Built around RISC-V single-core SoC
Supporting 2.4 GHz Wi-Fi and Bluetooth 5

Pre-release v0.5
Espressif Systems

About This Document

This document provides specifications for the ESP32-C3-WROOM-02 module.

Document Updates

Please always refer to the latest version on https://www.espressif.com/en/support/download/documents.

Revision History

For revision history of this document, please refer to the last page.

Documentation Change Notification

Espressif provides email notifications to keep you updated on changes to technical documentation. Please subscribe at www.espressif.com/en/subscribe.

Certification

Download certificates for Espressif products from www.espressif.com/en/certificates.

1 Module Overview

1.1 Features

MCU

- ESP32-C3 embedded, 32-bit RISC-V single-core processor, up to 160 MHz
- 384 KB ROM
- 400 KB SRAM (16 KB for cache)
- 8 KB SRAM in RTC

Wi-Fi

- IEEE 802.11 b/g/n-compliant
- Center frequency range of operating channel: 2412 ~ 2484 MHz
- Supports 20 MHz, 40 MHz bandwidth in 2.4 GHz band
- 1T1R mode with data rate up to 150 Mbps
- Wi-Fi Multimedia (WMM)
- TX/RX A-MPDU, TX/RX A-MSDU
- Immediate Block ACK
- Fragmentation and defragmentation
- Transmit opportunity (TXOP)
- Automatic Beacon monitoring (hardware TSF)
- 4 × virtual Wi-Fi interfaces
- Simultaneous support for Infrastructure BSS in Station mode, SoftAP mode, Station + SoftAP mode, and promiscuous mode
  Note that when ESP32-C3 family scans in Station mode, the SoftAP channel will change along with the Station channel
- Antenna diversity
- 802.11mc FTM

Bluetooth®

- Bluetooth LE: Bluetooth 5, Bluetooth mesh
- Speed: 125 Kbps, 500 Kbps, 1 Mbps, 2 Mbps
- Advertising extensions
- Multiple advertisement sets
- Channel selection algorithm #2

Hardware

- Interfaces: GPIO, SPI, UART, I2C, I2S, remote control peripheral, LED PWM controller, general DMA controller, TWAI® controller (compatible with ISO 11898-1), temperature sensor, SAR ADC
- 40 MHz crystal oscillator
- 4 MB SPI flash
- Operating voltage/Power supply: 3.0 ~ 3.6 V
- Operating ambient temperature:
  - 85 °C version module: –40 ~ 85 °C
  - 105 °C version module: –40 ~ 105 °C
- Dimensions: (18.0 × 20.0 × 3.2) mm

Test

- HTOL/HTSL/uHAST/TCT/ESD/Latch-up

1.2 Description

ESP32-C3-WROOM-02 is a general-purpose Wi-Fi and Bluetooth LE module. This module features a rich set of peripherals and high performance, which makes it an ideal choice for smart home, industrial automation, health care, consumer electronics, etc.

The module comes in two versions:

- 85 °C version
- 105 °C version

The two versions both come with an on-board PCB antenna and a 4 MB external SPI flash. The information in this datasheet is applicable to both versions.

The ordering information ESP32-C3-WROOM-02 is as follows:

Table 1: ESP32-C3-WROOM-02 Ordering Information

Module	Chip embedded	Flash	Module dimensions (mm)
ESP32-C3-WROOM-02 (85 °C version)	ESP32-C3	4 MB	18.0 × 20.0 × 3.2
ESP32-C3-WROOM-02 (105 °C version)			

At the core of this module is ESP32-C3*, which has a 32-bit RISC-V single-core processor.

ESP32-C3 integrates a rich set of peripherals, ranging from UART, I2C, I2S, remote control peripheral, LED PWM controller, general DMA controller, TWAI® controller, temperature sensor, ADC, and up to 22 GPIOs. It also includes SPI, Dual SPI and Quad SPI interfaces.

Note:
* For more information on ESP32-C3, please refer to *ESP32-C3 Family Datasheet*.

1.3 Applications

- Smart Home
  - Light control
  - Smart button
  - Smart plug
  - Indoor positioning
- Industrial Automation
  - Industrial robot
  - Mesh network
  - Human machine interface (HMI)
  - Industrial field bus
- Health Care
  - Health monitor
  - Baby monitor
- Consumer Electronics
  - Smart watch and bracelet
  - Over-the-top (OTT) devices
  - Wi-Fi and bluetooth speaker
  - Logger toys and proximity sensing toys
- Smart Agriculture
  - Smart greenhouse
  - Smart irrigation
  - Agriculture robot
- Retail and Catering
  - POS machines
  - Service robot
- Audio Device
  - Internet music players
  - Live streaming devices
  - Internet radio players
- Generic Low-power IoT Sensor Hubs
- Generic Low-power IoT Data Loggers

Contents

List of Tables

List of Figures

2 Block Diagram

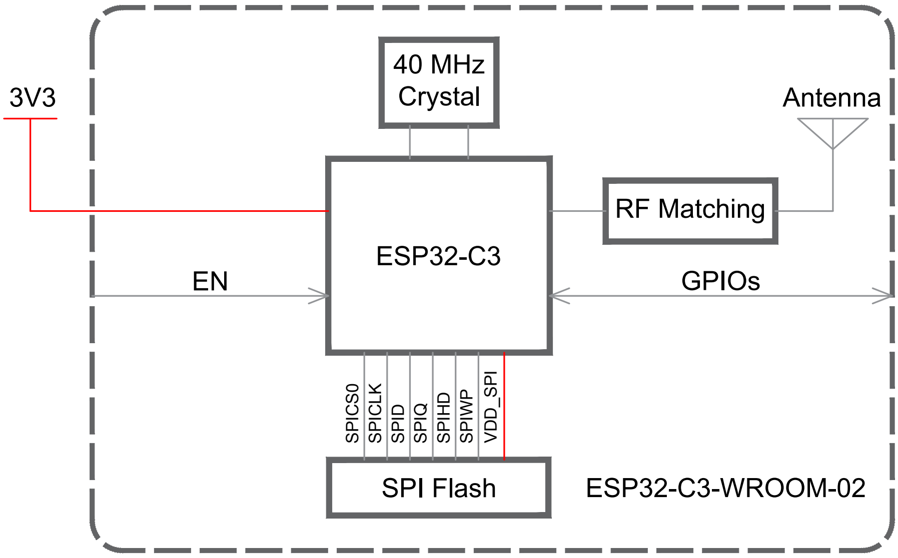


Figure 1: ESP32-C3-WROOM-02 Block Diagram

3 Pin Definitions

3.1 Pin Layout

The pin diagram below shows the approximate location of pins on the module. For the actual diagram drawn to scale, please refer to Figure 7.1 *Physical Dimensions*.

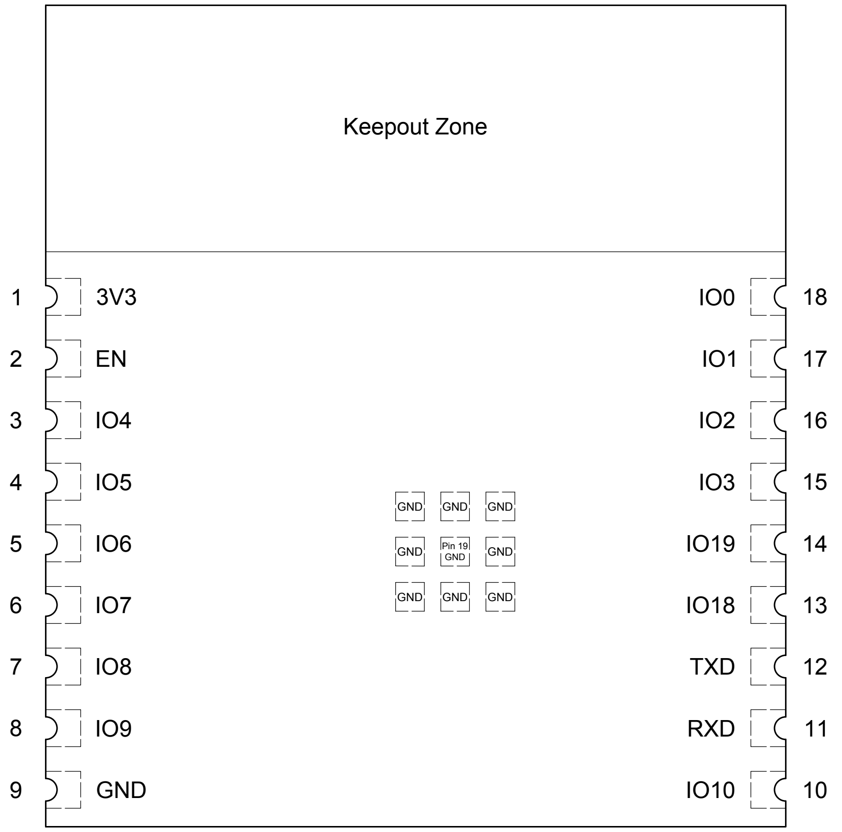


Figure 2: Pin Layout (Top View)

3.2 Pin Description

The module has 19 pins. See pin definitions in Table 2.

For peripheral pin configurations, please refer to *ESP32-C3 Family Datasheet*.

Table 2: Pin Definitions

Name	No.	Type	Function
3V3	1	P	Power supply
EN	2	I	High: on, enables the chip. Low: off, the chip powers off. Note: Do not leave the EN pin floating.
IO4	3	I/O/T	GPIO4, ADC1_CH4, FSPIHD, MTMS
IO5	4	I/O/T	GPIO5, ADC2_CH0, FSPIWP, MTDI
IO6	5	I/O/T	GPIO6, FSPICLK, MTCK

Cont'd on next page

Table 2 – cont'd from previous page

Name	No.	Type	Function
IO7	6	I/O/T	GPIO7, FSPID, MTDO
IO8	7	I/O/T	GPIO8
IO9	8	I/O/T	GPIO9
GND	9,19	P	Ground
IO10	10	I/O/T	GPIO10, FSPICS0
RXD0	11	I/O/T	GPIO20, U0RXD
TXD0	12	I/O/T	GPIO21, U0TXD
IO18	13	—	GPIO18
IO19	14	I/O/T	GPIO19
IO3	15	I/O/T	GPIO3, ADC1_CH3
IO2	16	I/O/T	GPIO2, ADC1_CH2, FSPIQ
IO1	17	I/O/T	GPIO1, ADC1_CH1, XTAL_32K_N
IO0	18	I/O/T	GPIO0, ADC1_CH0, XTAL_32K_P

3.3 Strapping Pins

ESP32-C3 chip family has three strapping pins: GPIO8, GPIO9, GPIO10. The pin mapping between ESP32-C3 chip family and the module is listed below. For more information, see Chapter 5 *Module Schematics*.

- GPIO8 = IO8
- GPIO9 = IO9
- GPIO10 = IO10

Software can read the values of corresponding bits from the register GPIO_STRAPPING.

During the chip's system reset, the latches of the strapping pins sample the voltage level as strapping bits of "0" or "1" and hold these bits until the chip is powered down or shut down.

Types of system reset include:

- Power-on-reset
- RTC watchdog reset
- Brownout reset
- Analog super watchdog reset
- Crystal clock glitch detection reset

By default, the pin IO9 is connected to the internal pull-up and pull-down resistors. If IO9 is not connected or connected to an external high-impedance circuit, the internal weak pull-up/pull-down will determine the default input level of these strapping pins.

To change the strapping bit values, you can apply the external pull-down/pull-up resistances, or use the host MCU's GPIOs to control the voltage level of these pins when powering on ESP32-C3 chip family.

After reset, the strapping pins work as normal-function pins.

Refer to Table 3 for a detailed boot-mode configuration of the strapping pins.

Table 3: Strapping Pins

<table>
<tr><th colspan="4">Booting Mode [1]</th></tr>
<tr><td>Pin</td><td>Default</td><td>SPI Boot</td><td>Download Boot</td></tr>
<tr><td>IO8</td><td>N/A</td><td>Any value</td><td>1</td></tr>
<tr><td>IO9</td><td>Pull-up</td><td>1</td><td>0</td></tr>
<tr><th colspan="4">Enabling/Disabling ROM Code Print During Booting</th></tr>
<tr><td>Pin</td><td>Default</td><td colspan="2">Functionality</td></tr>
<tr><td>IO8</td><td>N/A</td><td colspan="2">When the value of eFuse bit UART_PRINT_CONTROL is
0, print is enabled and not controlled by IO8.
1, if IO8 is 0, print is enabled; if IO8 is 1, it is disabled.
2, if IO8 is 0, print is disabled; if IO8 is 1, it is enabled.
3, print is disabled and not controlled by IO8.</td></tr>
<tr><th colspan="4">Controlling JTAG Signal Source During Booting</th></tr>
<tr><td>Pin</td><td>Default</td><td colspan="2">Functionality</td></tr>
<tr><td>IO10</td><td>N/A</td><td colspan="2">When the value of eFuse bit EFUSE_JTAG_SEL_ENABLE is
0, JTAG signals cannot be used.
1, if IO10 is 0, JTAG signals come from chip pins;
if IO10 is 1, JTAG signals cannot be used.</td></tr>
</table>

[1] The strapping combination of IO8 = 0 and IO9 = 0 is invalid and will trigger unexpected behavior.

4 Electrical Characteristics

4.1 Absolute Maximum Ratings

Stresses above those listed in *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions* is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

Table 4: Absolute Maximum Ratings

Symbol	Parameter	Min	Max	Unit
VDD33	Power supply voltage	–0.3	3.6	V
T_{STORE}	Storage temperature	–40	150	°C

4.2 Recommended Operating Conditions

Table 5: Recommended Operating Conditions

Symbol	Parameter	Min	Typ	Max	Unit
VDD33	Power supply voltage	3.0	3.3	3.6	V
I_{VDD}	Current delivered by external power supply	0.5	—	—	A
T	Ambient temperature	–40	—	105	°C
Humidity	Humidity condition	—	—	85	%RH

4.3 DC Characteristics (3.3 V, 25 °C)

Table 6: DC Characteristics (3.3 V, 25 °C)

Symbol	Parameter	Min	Typ	Max	Unit
C_{IN}	Pin capacitance	—	2	—	pF
V_{IH}	High-level input voltage	0.75 × VDD[1]	—	VDD[1]+ 0.3	V
V_{IL}	Low-level input voltage	–0.3	—	0.25 × VDD[1]	V
I_{IH}	High-level input current	—	—	50	nA
I_{IL}	Low-level input current	—	—	50	nA
V_{OH}[2]	High-level output voltage	0.8 × VDD[1]	—	—	V
V_{OL}[2]	Low-level output voltage	—	—	0.1 × VDD[1]	V
I_{OH}	High-level source current (VDD[1]= 3.3 V, V_{OH} >= 2.64 V, PAD_DRIVER = 3)	—	40	—	mA
I_{OL}	Low-level sink current (VDD[1]= 3.3 V, V_{OL} = 0.495 V, PAD_DRIVER = 3)	—	28	—	mA
R_{PU}	Pull-up resistor	—	45	—	kΩ
R_{PD}	Pull-down resistor	—	45	—	kΩ
V_{IH_nRST}	Chip reset release voltage	0.75 × VDD[1]	—	VDD[1]+ 0.3	V

Cont'd on next page

Table 6 – cont'd from previous page

Symbol	Parameter	Min	Typ	Max	Unit
V_{IL_nRST}	Chip reset voltage	–0.3	—	0.25 × VDD[1]	V

[1] VDD is the I/O voltage for a particular power domain of pins.

[2] V_{OH} and V_{OL} are measured using high-impedance load.

4.4 Current Consumption Characteristics

With the use of advanced power-management technologies, the module can switch between different power modes. For details on different power modes, please refer to Section *Low Power Management* in *ESP32-C3 Family Datasheet*.

Table 7: Current Consumption Depending on RF Modes

Work mode	Description		Peak (mA)
Active (RF working)	TX	802.11b, 1 Mbps, @20.5 dBm	345
		802.11g, 54 Mbps, @18 dBm	285
		802.11n, HT20, MCS 7, @17.5 dBm	280
		802.11n, HT40, MCS 7, @17 dBm	280
	RX	802.11b/g/n, HT20	82
		802.11n, HT40	84

[1] The current consumption measurements are taken with a 3.3 V supply at 25 °C of ambient temperature at the RF port. All transmitters' measurements are based on a 100% duty cycle.

[2] The current consumption figures for in RX mode are for cases when the peripherals are disabled and the CPU idle.

Table 8: Current Consumption Depending on Work Modes

Work mode	Description		Typ	Unit
Modem-sleep[1, 2]	The CPU is powered on[3]	160 MHz	20	mA
		80 MHz	15	mA
Light-sleep	—		130	μA
Deep-sleep	RTC timer + RTC memory		5	μA
Power off	CHIP_PU is set to low level, the chip is powered off		1	μA

[1] The current consumption figures in Modem-sleep mode are for cases where the CPU is powered on and the cache idle.

[2] When Wi-Fi is enabled, the chip may switch between Active and Modem-sleep modes. Therefore, current consumption changes accordingly.

[3] In practice, software can adjust CPU's frequency according to CPU load to reduce current consumption.

4.5 Wi-Fi Radio

4.5.1 Wi-Fi RF Standards

Table 9: Wi-Fi RF Standards

Name		Description
Center frequency range of operating channel [1]		2412 ~ 2484 MHz
Wi-Fi wireless standard		IEEE 802.11b/g/n
Data rate	20 MHz	11b: 1, 2, 5.5 and 11 Mbps 11g: 6, 9, 12, 18, 24, 36, 48, 54 Mbps 11n: MCS0-7, 72.2 Mbps (Max)
	40 MHz	11n: MCS0-7, 150 Mbps (Max)
Antenna type		PCB antenna

[1] Device should operate in the center frequency range allocated by regional regulatory authorities. Target center frequency range is configurable by software.

4.5.2 Wi-Fi RF Transmitter (TX) Specifications

Target TX power is configurable based on device or certification requirements. The default characteristics are provided in Table 10.

Table 10: TX Power with Spectral Mask and EVM Meeting 802.11 Standards

Rate	Min (dBm)	Typ (dBm)	Max (dBm)
802.11b, 1 Mbps	—	20.5	—
802.11b, 11 Mbps	—	20.5	—
802.11g, 6 Mbps	—	20.0	—
802.11g, 54 Mbps	—	18.0	—
802.11n, HT20, MCS 0	—	19.0	—
802.11n, HT20, MCS 7	—	17.5	—
802.11n, HT40, MCS 0	—	18.5	—
802.11n, HT40, MCS 7	—	17.0	—

Table 11: TX EVM Test

Rate	Min (dB)	Typ (dB)	SL[1] (dB)
802.11b, 1 Mbps, @20.5 dBm	—	–24.5	–10
802.11b, 11 Mbps, @20.5 dBm	—	–25.0	–10
802.11g, 6 Mbps, @20 dBm	—	–23.0	–5
802.11g, 54 Mbps, @18 dBm	—	–28.0	–25
802.11n, HT20, MCS 0, @19 dBm	—	–23.5	–5
802.11n, HT20, MCS 7, @17.5 dBm	—	–30.5	–27

Cont'd on next page

Table 11 – cont'd from previous page

Rate	Min (dB)	Typ (dB)	SL[1] (dB)
802.11n, HT40, MCS 0, @18.5 dBm	—	–26.5	–5
802.11n, HT40, MCS 7, @17 dBm	—	–30.5	–27

[1] SL stands for standard limit value.

4.5.3 Wi-Fi RF Receiver (RX) Specifications

Table 12: RX Sensitivity

Rate	Min (dBm)	Typ (dBm)	Max (dBm)
802.11b, 1 Mbps	—	–98.0	—
802.11b, 2 Mbps	—	–96.0	—
802.11b, 5.5 Mbps	—	–93.0	—
802.11b, 11 Mbps	—	–88.6	—
802.11g, 6 Mbps	—	–93.0	—
802.11g, 9 Mbps	—	–92.0	—
802.11g, 12 Mbps	—	–90.8	—
802.11g, 18 Mbps	—	–88.4	—
802.11g, 24 Mbps	—	–85.4	—
802.11g, 36 Mbps	—	–82.0	—
802.11g, 48 Mbps	—	–78.0	—
802.11g, 54 Mbps	—	–76.4	—
802.11n, HT20, MCS 0	—	–93.0	—
802.11n, HT20, MCS 1	—	–90.8	—
802.11n, HT20, MCS 2	—	–88.2	—
802.11n, HT20, MCS 3	—	–84.6	—
802.11n, HT20, MCS 4	—	–81.4	—
802.11n, HT20, MCS 5	—	–77.4	—
802.11n, HT20, MCS 6	—	–75.4	—
802.11n, HT20, MCS 7	—	–74.4	—
802.11n, HT40, MCS 0	—	–90.0	—
802.11n, HT40, MCS 1	—	–87.6	—
802.11n, HT40, MCS 2	—	–84.8	—
802.11n, HT40, MCS 3	—	–81.8	—
802.11n, HT40, MCS 4	—	–78.4	—
802.11n, HT40, MCS 5	—	–74.4	—
802.11n, HT40, MCS 6	—	–72.6	—
802.11n, HT40, MCS 7	—	–71.2	—

Table 13: Maximum RX Level

Rate	Min (dBm)	Typ (dBm)	Max (dBm)
802.11b, 1 Mbps	—	5	—
802.11b, 11 Mbps	—	5	—
802.11g, 6 Mbps	—	5	—
802.11g, 54 Mbps	—	0	—
802.11n, HT20, MCS 0	—	5	—
802.11n, HT20, MCS 7	—	0	—
802.11n, HT40, MCS 0	—	5	—
802.11n, HT40, MCS 7	—	0	—

Table 14: RX Adjacent Channel Rejection

Rate	Min (dB)	Typ (dB)	Max (dB)
802.11b, 1 Mbps	—	35	—
802.11b, 11 Mbps	—	35	—
802.11g, 6 Mbps	—	31	—
802.11g, 54 Mbps	—	14	—
802.11n, HT20, MCS 0	—	31	—
802.11n, HT20, MCS 7	—	13	—
802.11n, HT40, MCS 0	—	19	—
802.11n, HT40, MCS 7	—	8	—

4.6 Bluetooth LE Radio

4.6.1 Bluetooth LE RF Transmitter (TX) Specifications

Table 15: Transmitter General Characteristics

Parameter	Min	Typ	Max	Unit
RF transmit power	—	0	—	dBm
Gain control step	—	3	—	dB
RF power control range	–27	—	18	dBm

Table 16: Transmitter Characteristics - Bluetooth LE 1M

Parameter	Description	Min	Typ	Max	Unit
In-band emissions	F = F0 ± 2 MHz	—	–37.62	—	dBm
	F = F0 ± 3 MHz	—	–41.95	—	dBm
	F = F0 ± > 3 MHz	—	–44.48	—	dBm
Modulation characteristics	$\Delta\ f1_{\text{avg}}$	—	245.00	—	kHz
	$\Delta\ f2_{\text{max}}$	—	208.00	—	kHz
	$\Delta\ f2_{\text{avg}}/\Delta\ f1_{\text{avg}}$	—	0.93	—	—
Carrier frequency offset	—	—	–9.00	—	kHz
Carrier frequency drift	$\|f_0 - f_n\|_{n=2,\ 3,\ 4,\ ..k}$	—	1.17	—	kHz
	$\|f_1 - f_0\|$	—	0.30	—	kHz
	$\|f_n - f_{n-5}\|_{n=6,\ 7,\ 8,\ ..k}$	—	4.90	—	kHz

Table 17: Transmitter Characteristics - Bluetooth LE 2M

Parameter	Description	Min	Typ	Max	Unit
In-band emissions	F = F0 ± 4 MHz	—	–43.55	—	dBm
	F = F0 ± 5 MHz	—	–45.26	—	dBm
	F = F0 ± > 5 MHz	—	–47.00	—	dBm
Modulation characteristics	$\Delta\ f1_{\text{avg}}$	—	497.00	—	kHz
	$\Delta\ f2_{\text{max}}$	—	398.00	—	kHz
	$\Delta\ f2_{\text{avg}}/\Delta\ f1_{\text{avg}}$	—	0.95	—	—
Carrier frequency offset	—	—	–9.00	—	kHz
Carrier frequency drift	$\|f_0 - f_n\|_{n=2,\ 3,\ 4,\ ..k}$	—	0.46	—	kHz
	$\|f_1 - f_0\|$	—	0.70	—	kHz
	$\|f_n - f_{n-5}\|_{n=6,\ 7,\ 8,\ ..k}$	—	6.80	—	kHz

Table 18: Transmitter Characteristics - Bluetooth LE 125K

Parameter	Description	Min	Typ	Max	Unit
In-band emissions	F = F0 ± 2 MHz	—	–37.90	—	dBm
	F = F0 ± 3 MHz	—	–41.00	—	dBm
	F = F0 ± > 3 MHz	—	–42.50	—	dBm
Modulation characteristics	$\Delta\ f1_{\text{avg}}$	—	252.00	—	kHz
	$\Delta\ f1_{\text{max}}$	—	200.00	—	kHz
Carrier frequency offset	—	—	–13.70	—	kHz
Carrier frequency drift	$\|f_0 - f_n\|_{n=1,\ 2,\ 3,\ ..k}$	—	1.52	—	kHz
	$\|f_0 - f_3\|$	—	0.65	—	kHz
	$\|f_n - f_{n-3}\|_{n=7,\ 8,\ 9,\ ..k}$	—	0.70	—	kHz

Table 19: Transmitter Characteristics - Bluetooth LE 500K

Parameter	Description	Min	Typ	Max	Unit
In-band emissions	F = F0 ± 2 MHz	—	–37.90	—	dBm
	F = F0 ± 3 MHz	—	–41.30	—	dBm
	F = F0 ± > 3 MHz	—	–42.80	—	dBm
Modulation characteristics	$\Delta\ f2_{\text{avg}}$	—	220.00	—	kHz
	$\Delta\ f2_{\text{max}}$	—	205.00	—	kHz
Carrier frequency offset	—	—	–11.90	—	kHz
Carrier frequency drift	$\|f_0 - f_n\|_{n=1,\ 2,\ 3,\ ..k}$	—	1.37	—	kHz
	$\|f_0 - f_3\|$	—	1.09	—	kHz
	$\|f_n - f_{n-3}\|_{n=7,\ 8,\ 9,\ ..k}$	—	0.51	—	kHz

4.6.2 Bluetooth LE RF Receiver (RX) Specifications

Table 20: Receiver Characteristics - Bluetooth LE 1M

Parameter	Description	Min	Typ	Max	Unit
Sensitivity @30.8% PER	—	—	–97	—	dBm
Maximum received signal @30.8% PER	—	—	10	—	dBm
Co-channel C/I	—	—	7	—	dB
Adjacent channel selectivity C/I	F = F0 + 1 MHz	—	–4	—	dB
	F = F0 – 1 MHz	—	–4	—	dB
	F = F0 + 2 MHz	—	–29	—	dB
	F = F0 – 2 MHz	—	–31	—	dB
	F $\geq$ F0 + 3 MHz	—	–33	—	dB
	F $\leq$ F0 – 3 MHz	—	–35	—	dB
	F $\geq$ F0 + 4 MHz	—	–35	—	dB
	F $\leq$ F0 – 4 MHz	—	–37	—	dB
Image frequency	—	—	–35	—	dB
Adjacent channel to image frequency	F = F_{image} + 1 MHz	—	–40	—	dB
	F = F_{image} – 1 MHz	—	–33	—	dB
Out-of-band blocking performance	30 MHz ~ 2000 MHz	—	–6	—	dBm
	2003 MHz ~ 2399 MHz	—	–26	—	dBm
	2484 MHz ~ 2997 MHz	—	–25	—	dBm
	3000 MHz ~ 12.75 GHz	—	–5	—	dBm
Intermodulation	—	—	–30	—	dBm

Table 21: Receiver Characteristics - Bluetooth LE 2M

Parameter	Description	Min	Typ	Max	Unit
Sensitivity @30.8% PER	—	—	–93	—	dBm
Maximum received signal @30.8% PER	—	—	5	—	dBm
Co-channel C/I	—	—	10	—	dB
Adjacent channel selectivity C/I	F = F0 + 2 MHz	—	–8	—	dB
	F = F0 – 2 MHz	—	–7	—	dB
	F = F0 + 4 MHz	—	–32	—	dB
	F = F0 – 4 MHz	—	–34	—	dB
	F $\geq$ F0 + 6 MHz	—	–39	—	dB
	F $\leq$ F0 – 6 MHz	—	–39	—	dB
Image frequency	—	—	–32	—	dB
Adjacent channel to image frequency	F = F_{image} + 2 MHz	—	–39	—	dB
	F = F_{image} – 2 MHz$^{(2)}$	—	–8	—	dB
Out-of-band blocking performance	30 MHz ~ 2000 MHz	—	–12	—	dBm
	2003 MHz ~ 2399 MHz	—	–30	—	dBm
	2484 MHz ~ 2997 MHz	—	–28	—	dBm
	3000 MHz ~ 12.75 GHz	—	–6	—	dBm
Intermodulation	—	—	–29	—	dBm

Table 22: Receiver Characteristics - Bluetooth LE 125K

Parameter	Description	Min	Typ	Max	Unit
Sensitivity @30.8% PER	—	—	–105	—	dBm
Maximum received signal @30.8% PER	—	—	10	—	dBm
Co-channel C/I	—	—	2	—	dB
Adjacent channel selectivity C/I	F = F0 + 1 MHz	—	–6	—	dB
	F = F0 – 1 MHz	—	–4	—	dB
	F = F0 + 2 MHz	—	–33	—	dB
	F = F0 – 2 MHz	—	–41	—	dB
	F $\geq$ F0 + 3 MHz	—	–37	—	dB
	F $\leq$ F0 – 3 MHz	—	–46	—	dB
	F $\geq$ F0 + 4 MHz	—	–40	—	dB
	F $\leq$ F0 – 4 MHz	—	–49	—	dB
Image frequency	—	—	–40	—	dB
Adjacent channel to image frequency	F = F_{image} + 1 MHz	—	–46	—	dB
	F = F_{image} – 1 MHz	—	–37	—	dB

Table 23: Receiver Characteristics - Bluetooth LE 500K

Parameter	Description	Min	Typ	Max	Unit
Sensitivity @30.8% PER	—	—	–101	—	dBm
Maximum received signal @30.8% PER	—	—	10	—	dBm
Co-channel C/I	—	—	3	—	dB

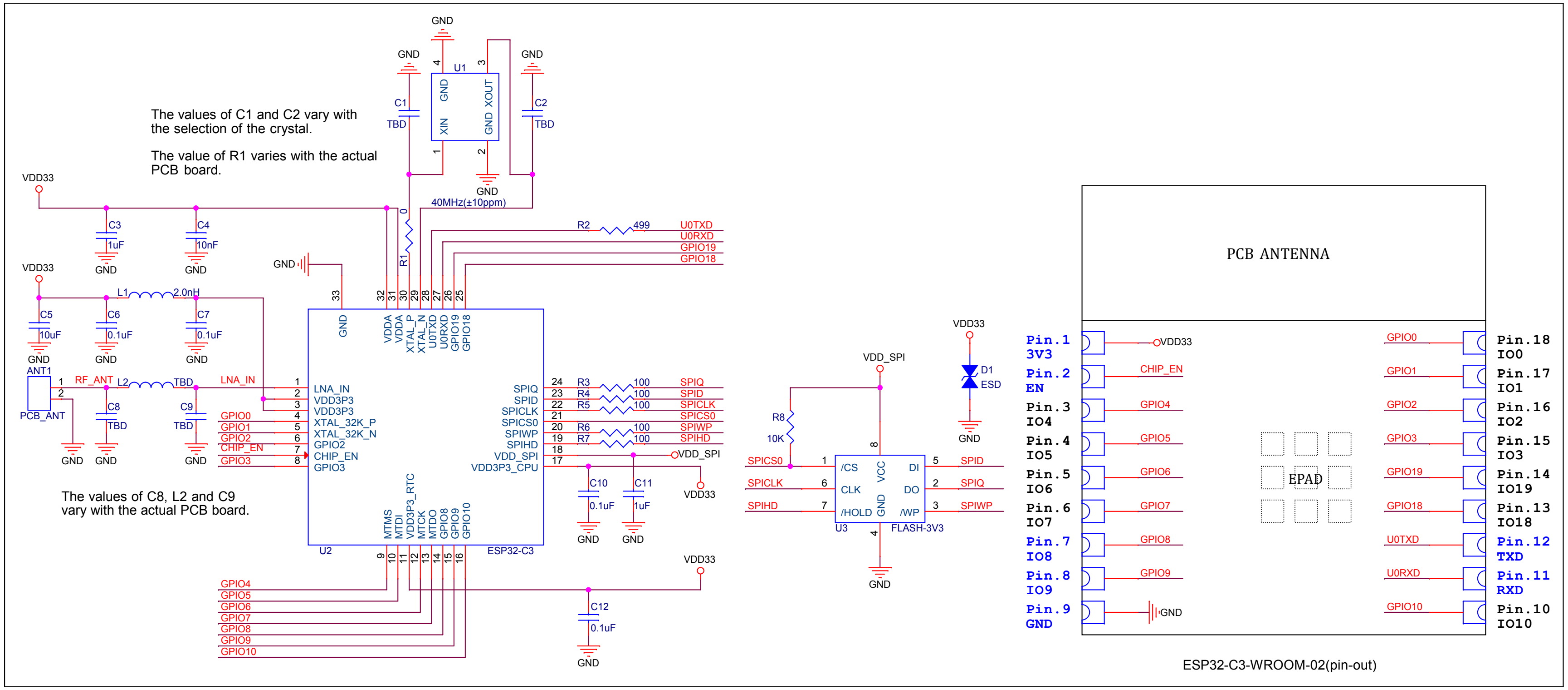
Cont'd on next page

Table 23 – cont'd from previous page

Parameter	Description	Min	Typ	Max	Unit
Adjacent channel selectivity C/I	F = F0 + 1 MHz	—	–6	—	dB
	F = F0 – 1 MHz	—	–7	—	dB
	F = F0 + 2 MHz	—	–34	—	dB
	F = F0 – 2 MHz	—	–37	—	dB
	F $\geq$ F0 + 3 MHz	—	–38	—	dB
	F $\leq$ F0 – 3 MHz	—	–40	—	dB
	F $\geq$ F0 + 4 MHz	—	–40	—	dB
	F $\leq$ F0 – 4 MHz	—	–42	—	dB
Image frequency	—	—	–40	—	dB
Adjacent channel to image frequency	F = F_{image} + 1 MHz	—	–45	—	dB
	F = F_{image} – 1 MHz	—	–38	—	dB

5 Module Schematics

This is the reference design of the module.



The values of C1 and C2 vary with the selection of the crystal.

The value of R1 varies with the actual PCB board.

The values of C8, L2 and C9 vary with the actual PCB board.

Figure 3: ESP32-C3-WROOM-02 Schematics

6 Peripheral Schematics

This is the typical application circuit of the module connected with peripheral components (for example, power supply, antenna, reset button, JTAG interface, and UART interface).

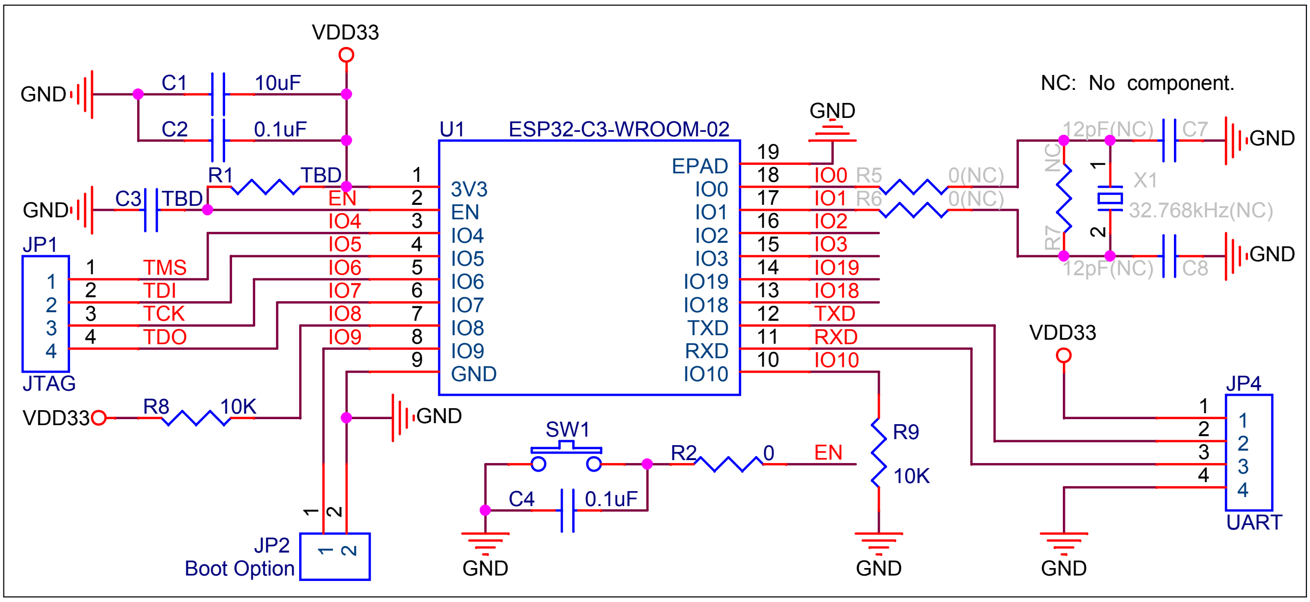


Figure 4: Peripheral Schematics

- Soldering the EPAD to the ground of the base board is not a must, though doing so can get optimized thermal performance. If you do want to solder it, please ensure that you apply the correct amount of soldering paste.
- To ensure the power supply to the ESP32-C3 family chip is stable during power-up, it is advised to add an RC delay circuit at the EN pin. The recommended setting for the RC delay circuit is usually R = 10 kΩ and C = 1 μF. However, specific parameters should be adjusted based on the power-up timing of the module and the power-up and reset sequence timing of the chip. For power-up and reset sequence timing diagram of the ESP32-C3 family chip, please refer to Section *Power Scheme* in *ESP32-C3 Family Datasheet* .

7 Physical Dimensions and PCB Land Pattern

7.1 Physical Dimensions

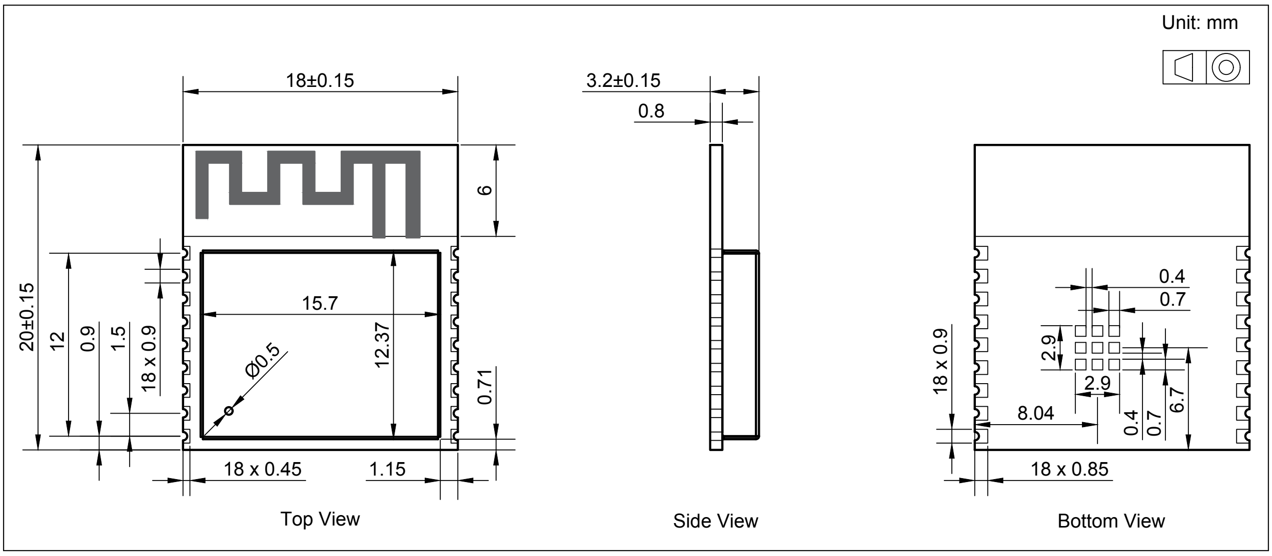


Figure 5: Physical Dimensions

7.2 Recommended PCB Land Pattern

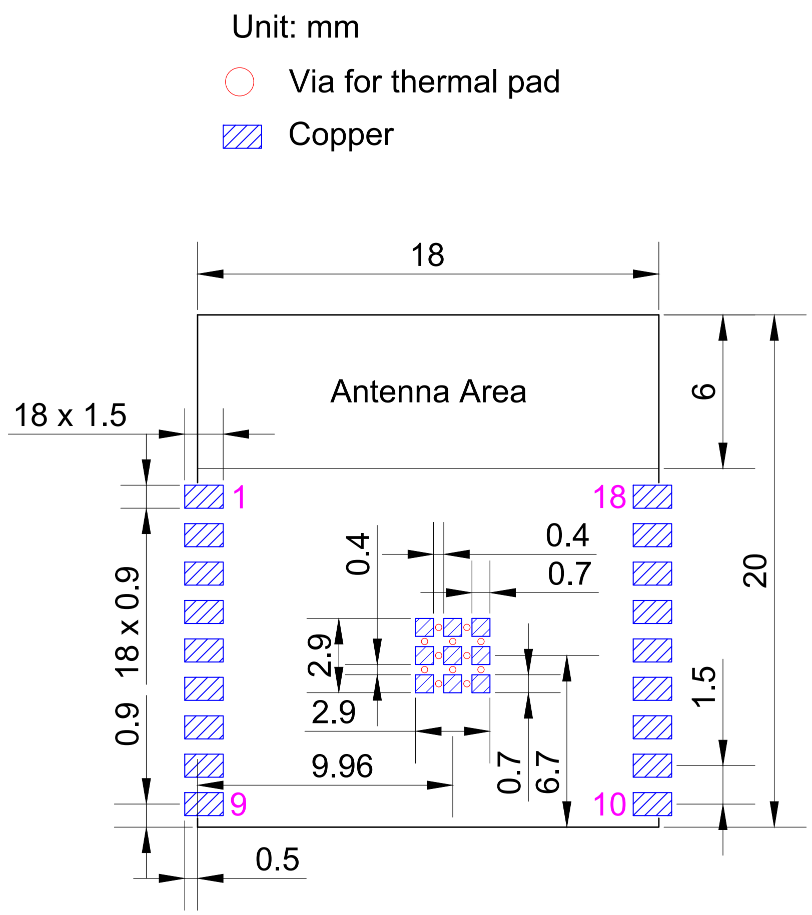


Figure 6: Recommended PCB Land Pattern

8 Product Handling

8.1 Storage Conditions

The products sealed in moisture barrier bags (MBB) should be stored in a non-condensing atmospheric environment of < 40 °C and /90%RH. The module is rated at the moisture sensitivity level (MSL) of 3.

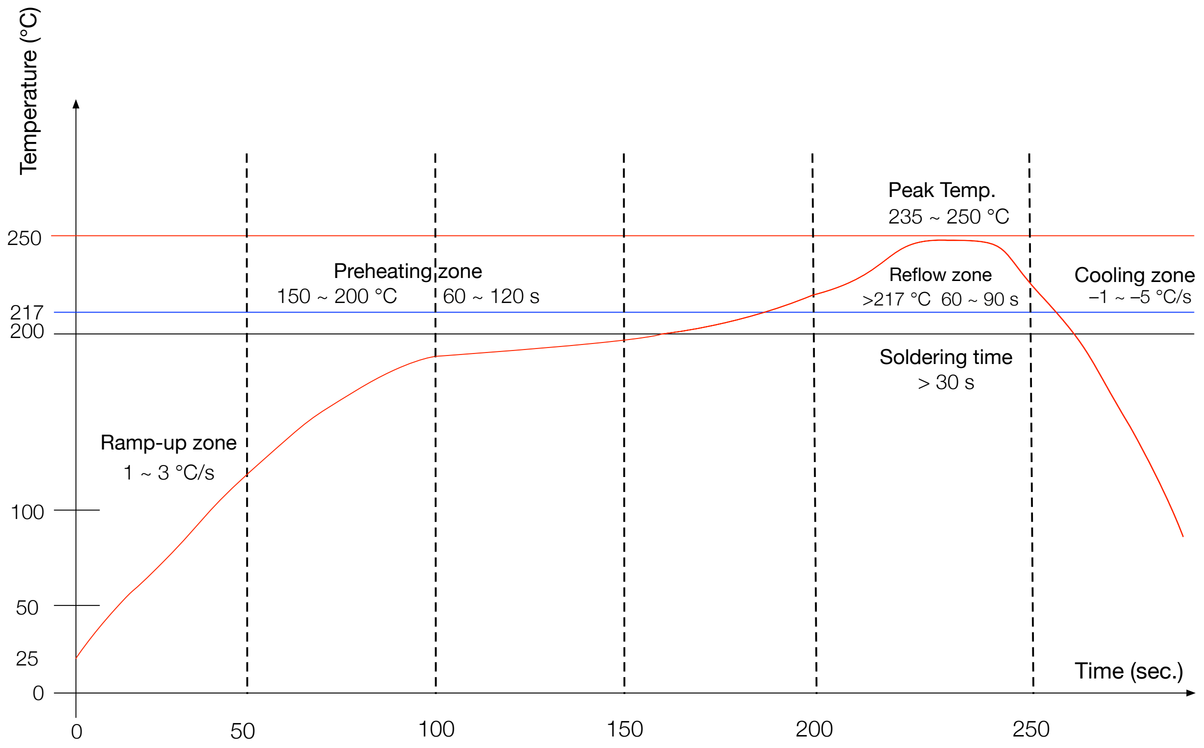
After unpacking, the module must be soldered within 168 hours with the factory conditions 25±5 °C and /60%RH. If the above conditions are not met, the module needs to be baked.

8.2 Electrostatic Discharge (ESD)

- Human body model (HBM): 2000 V
- Charged-device model (CDM): 500 V

8.3 Reflow Profile

Solder the module in a single reflow.



Ramp-up zone — Temp.: 25 ~ 150 °C Time: 60 ~ 90 s Ramp-up rate: 1 ~ 3 °C/s
Preheating zone — Temp.: 150 ~ 200 °C Time: 60 ~ 120 s
Reflow zone — Temp.: >217 °C Time: 60 ~ 90 s; Peak Temp.: 235 ~ 250 °C Time: 30 ~ 70 s
Cooling zone — Peak Temp. ~ 180 °C Ramp-down rate: –1 ~ –5 °C/s
Solder — Sn-Ag-Cu (SAC305) lead-free solder alloy

Figure 7: Reflow Profile

9 Learning Resources

9.1 Must-Read Documents

Please familiarize yourself with the following documents:

- *ESP32-C3 Family Datasheet*

  This is an introduction to the specifications of ESP32-C3 family's hardware, including overview, pin definitions, functional description, peripheral interface, electrical characteristics, etc.

- *ESP-IDF Programming Guide*

  Extensive documentation for the ESP-IDF development framework, ranging from hardware guides to API reference.

- *Espressif Products Ordering Information*

9.2 Important Resources

Here are the important ESP32-C3-related resources.

- ESP32 BBS

  Engineer-to-Engineer (E2E) Community for Espressif products where you can post questions, share knowledge, explore ideas, and help solve problems with fellow engineers.

Revision History

Date	Version	Release notes
2021-03-05	V0.5	Preliminary release

www.espressif.com

Disclaimer and Copyright Notice