

ESP32-C3-WIZ2012

Datasheet



Pre-release v0.6
Espressif Systems
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About This Document

This document provides specifications for the ESP32-C3-WIZ2012 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](#).

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1 Module Overview

1.1 Features

MCU

- ESP32-C3FH4 embedded, 32-bit RISC-V single-core processor, up to 160 MHz
- 384 KB ROM
- 400 KB SRAM
- 8 KB SRAM in RTC

- Speed: 1 Mbps, 2 Mbps
- Advertising extensions
- Multiple advertisement sets
- Channel selection algorithm #2

Hardware

Wi-Fi

- IEEE 802.11 b/g/n-compliant
- 1T1R mode with data rate up to 150 Mbps
- A-MPDU and A-MSDU aggregation
- 0.4 μ s guard interval
- Center frequency range of operating channel: 2412 ~ 2484 MHz

- 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
- Operating voltage/Power supply: 3.0 ~ 3.6 V
- Ambient temperature: -40 ~ 105 °C
- Dimensions: (12.0 × 20.0 × 3.4) mm

Bluetooth[®]

- Bluetooth LE: Bluetooth 5, Bluetooth mesh

Test

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

1.2 Description

ESP32-C3-WIZ2012 is a general-purpose Wi-Fi and Bluetooth LE module.

The ordering information ESP32-C3-WIZ2012 is as follows:

Table 1: ESP32-C3-WIZ2012 Ordering Information

Module	Chip embedded	Module dimensions (mm)
ESP32-C3-WIZ2012	ESP32-C3FH4	12.0 × 20.0 × 3.4

At the core of this module is ESP32-C3FH4*, which has a 32-bit RISC-V single-core processor and 4 MB high-temperature flash.

Note:

* For more information on ESP32-C3FH4, 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

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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 6.1 *Physical Dimensions*.

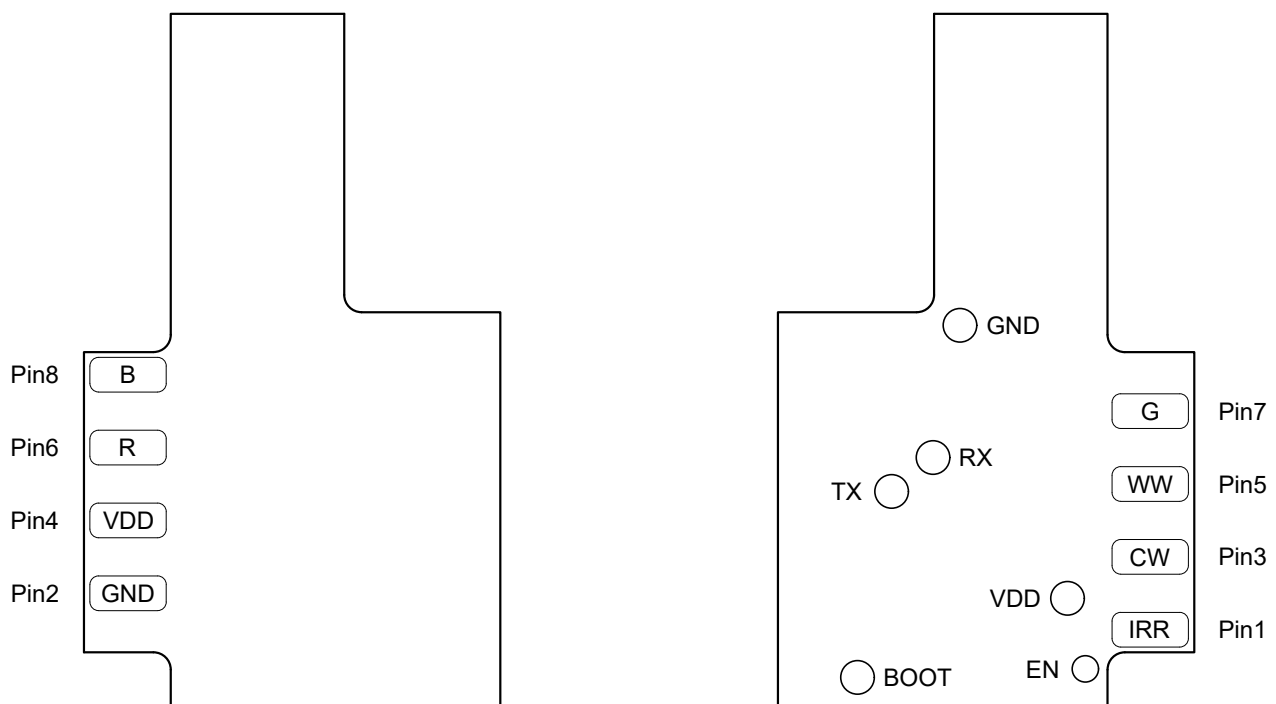


Figure 2: Pin Layout (Top View)

3.2 Pin Description

The module has 8 pins and 6 test points. Please find details in Table 2 and Table 3.

For peripheral pin configurations, please refer to [ESP32-C3 Family Datasheet](#).

By default, most GPIOs of the ESP32-C3FH4 chip do not have internal pull-up or pull-down resistors. You can add them yourself.

Table 2: Pin Definitions

Name	No.	IO No.	Function
IRR	1	IO18	GPIO or IRR
GND	2	—	Ground
CW	3	IO10	PWM output
VDD	4	—	3.3 V power input
WW	5	IO7	PWM output

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Table 2 – cont'd from previous page

Name	No.	IO No.	Function
R	6	IO6	PWM output
G	7	IO4	PWM output
B	8	IO5	PWM output

Table 3: Test Point Definitions

Name	IO No.	Function
GND	—	Ground
RX	IO20	Debug UART data reception
TX	IO21	Debug UART data transmission
VDD	—	3.3 V power input
EN	—	Module enable signal (internal pull-up by default). Active high
BOOT	IO9	0: Download boot mode; 1: SPI boot mode (default)

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 4 for a detailed boot-mode configuration of the strapping pins.

Table 4: Strapping Pins

Booting Mode ¹			
Pin	Default	SPI Boot	Download Boot
IO8	N/A	Any value	1
IO9	Pull-up	1	0
Enabling/Disabling ROM Code Print During Booting			
Pin	Default	Functionality	
IO8	N/A	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.	
Controlling JTAG Signal Source During Booting			
Pin	Default	Functionality	
IO10	N/A	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.	

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 5: 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 6: 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 7: 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

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Table 7 – cont'd from previous page

Symbol	Parameter	Min	Typ	Max	Unit
V_{IH_nRST}	Chip reset release voltage	$0.75 \times VDD^1$	—	$VDD^1 + 0.3$	V
V_{IL_nRST}	Chip reset voltage	-0.3	—	$0.25 \times VDD^1$	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 8: Current Consumption Depending on RF Modes

Work mode	Description		Peak (mA)
Active (RF working)	TX	802.11b, 1 Mbps, @20.5 dBm	335
		802.11g, 54 Mbps, @18 dBm	275
		802.11n, HT20, MCS 7, @17.5 dBm	270
		802.11n, HT40, MCS 7, @17 dBm	270
	RX	802.11b/g/n, HT20	84
		802.11n, HT40	87

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 9: 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
		Normal speed: 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 switches between Active and Modem-sleep modes. Therefore, current consumption changes accordingly.

³ In Modem-sleep mode, the CPU frequency changes automatically. The frequency depends on the CPU load and the peripherals used.

4.5 Wi-Fi Radio

4.5.1 Wi-Fi RF Standards

Table 10: Wi-Fi RF Standards

Name		Description
Center frequency range of operating channel ¹		2412 ~ 2462 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		Ceramic 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 11.

Table 11: 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 12: 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

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Table 12 – 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 13: 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	—	–88.5	—
802.11g, 6 Mbps	—	–92.8	—
802.11g, 9 Mbps	—	–91.8	—
802.11g, 12 Mbps	—	–90.8	—
802.11g, 18 Mbps	—	–88.5	—
802.11g, 24 Mbps	—	–85.5	—
802.11g, 36 Mbps	—	–82.0	—
802.11g, 48 Mbps	—	–77.8	—
802.11g, 54 Mbps	—	–76.2	—
802.11n, HT20, MCS 0	—	–92.6	—
802.11n, HT20, MCS 1	—	–90.6	—
802.11n, HT20, MCS 2	—	–88.0	—
802.11n, HT20, MCS 3	—	–84.8	—
802.11n, HT20, MCS 4	—	–81.6	—
802.11n, HT20, MCS 5	—	–77.4	—
802.11n, HT20, MCS 6	—	–75.6	—
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	—	–74.2	—
802.11n, HT40, MCS 6	—	–72.6	—
802.11n, HT40, MCS 7	—	–71.2	—

Table 14: 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 15: 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 16: 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 17: Transmitter Characteristics - Bluetooth LE 1M

Parameter	Description	Min	Typ	Max	Unit
In-band emissions	$F = F_0 \pm 2 \text{ MHz}$	—	-37.62	—	dBm
	$F = F_0 \pm 3 \text{ MHz}$	—	-41.95	—	dBm
	$F = F_0 \pm > 3 \text{ MHz}$	—	-44.48	—	dBm
Modulation characteristics	$\Delta f_{1\text{avg}}$	—	245.00	—	kHz
	$\Delta f_{2\text{max}}$	—	208.00	—	kHz
	$\Delta f_{2\text{avg}}/\Delta f_{1\text{avg}}$	—	0.93	—	—
Carrier frequency offset	—	—	-9.00	—	kHz
Carrier frequency drift	$ f_0 - f_n _{n=2, 3, 4, \dots, k}$	—	1.17	—	kHz
	$ f_1 - f_0 $	—	0.30	—	kHz
	$ f_n - f_{n-5} _{n=6, 7, 8, \dots, k}$	—	4.90	—	kHz

Table 18: Transmitter Characteristics - Bluetooth LE 2M

Parameter	Description	Min	Typ	Max	Unit
In-band emissions	$F = F_0 \pm 4 \text{ MHz}$	—	-43.55	—	dBm
	$F = F_0 \pm 5 \text{ MHz}$	—	-45.26	—	dBm
	$F = F_0 \pm > 5 \text{ MHz}$	—	-47.00	—	dBm
Modulation characteristics	$\Delta f_{1\text{avg}}$	—	497.00	—	kHz
	$\Delta f_{2\text{max}}$	—	398.00	—	kHz
	$\Delta f_{2\text{avg}}/\Delta f_{1\text{avg}}$	—	0.95	—	—
Carrier frequency offset	—	—	-9.00	—	kHz
Carrier frequency drift	$ f_0 - f_n _{n=2, 3, 4, \dots, k}$	—	0.46	—	kHz
	$ f_1 - f_0 $	—	0.70	—	kHz
	$ f_n - f_{n-5} _{n=6, 7, 8, \dots, k}$	—	6.80	—	kHz

4.6.2 Bluetooth LE RF Receiver (RX) Specifications

Table 21: Receiver Characteristics - Bluetooth LE 1M

Parameter	Description	Min	Typ	Max	Unit
Sensitivity @30.8% PER	—	—	−96	—	dBm
Maximum received signal @30.8% PER	—	—	10	—	dBm
Co-channel C/I	—	—	8	—	dB
Adjacent channel selectivity C/I	$F = F_0 + 1 \text{ MHz}$	—	−4	—	dB
	$F = F_0 - 1 \text{ MHz}$	—	−3	—	dB
	$F = F_0 + 2 \text{ MHz}$	—	−32	—	dB
	$F = F_0 - 2 \text{ MHz}$	—	−36	—	dB
	$F \geq F_0 + 3 \text{ MHz}^{(1)}$	—	—	—	dB
	$F \leq F_0 - 3 \text{ MHz}$	—	−39	—	dB
Image frequency	—	—	−29	—	dB
Adjacent channel to image frequency	$F = F_{image} + 1 \text{ MHz}$	—	−38	—	dB
	$F = F_{image} - 1 \text{ MHz}$	—	−34	—	dB
Out-of-band blocking performance	30 MHz ~ 2000 MHz	—	−9	—	dBm
	2003 MHz ~ 2399 MHz	—	−18	—	dBm
	2484 MHz ~ 2997 MHz	—	−16	—	dBm
	3000 MHz ~ 12.75 GHz	—	−6	—	dBm
Intermodulation	—	—	−44	—	dBm

¹ Refer to the value of Adjacent channel to image frequency when $F = F_{image} - 1 \text{ MHz}$.

Table 22: Receiver Characteristics - Bluetooth LE 2M

Parameter	Description	Min	Typ	Max	Unit
Sensitivity @30.8% PER	—	—	-93	—	dBm
Maximum received signal @30.8% PER	—	—	0	—	dBm
Co-channel C/I	—	—	10	—	dB
Adjacent channel selectivity C/I	$F = F_0 + 2 \text{ MHz}$	—	-7	—	dB
	$F = F_0 - 2 \text{ MHz}$	—	-7	—	dB
	$F = F_0 + 4 \text{ MHz}^{(1)}$	—	—	—	dB
	$F = F_0 - 4 \text{ MHz}$	—	-34	—	dB
	$F \geq F_0 + 6 \text{ MHz}$	—	-39	—	dB
	$F \leq F_0 - 6 \text{ MHz}$	—	-39	—	dB
Image frequency	—	—	-27	—	dB
Adjacent channel to image frequency	$F = F_{image} + 2 \text{ MHz}$	—	-39	—	dB
	$F = F_{image} - 2 \text{ MHz}^{(2)}$	—	—	—	dB
Out-of-band blocking performance	30 MHz ~ 2000 MHz	—	-17	—	dBm
	2003 MHz ~ 2399 MHz	—	-19	—	dBm
	2484 MHz ~ 2997 MHz	—	-16	—	dBm
	3000 MHz ~ 12.75 GHz	—	-22	—	dBm
Intermodulation	—	—	-40	—	dBm

¹ Refer to the value of Image frequency.

² Refer to the value of Adjacent channel selectivity C/I when $F = F_0 + 2 \text{ MHz}$.

6 Physical Dimensions

6.1 Physical Dimensions

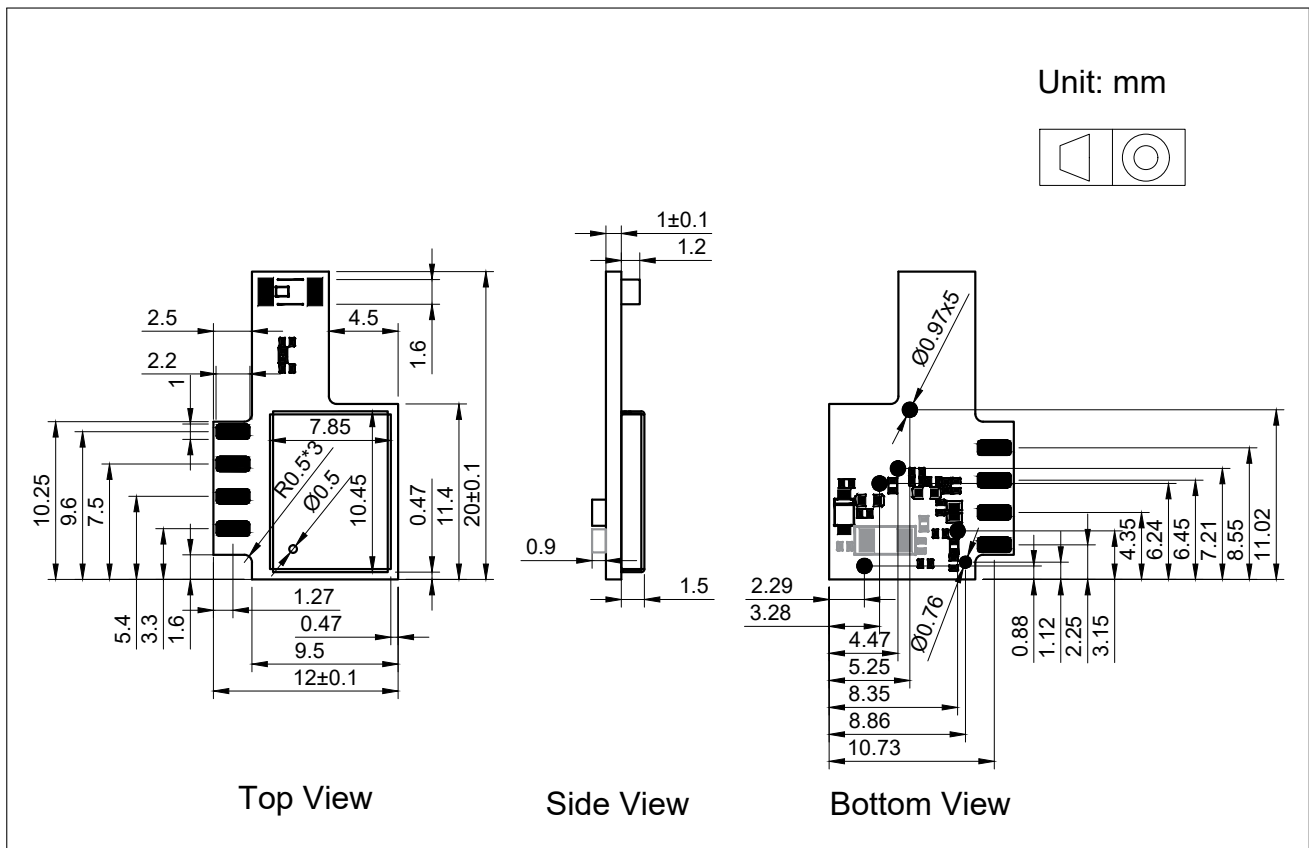


Figure 4: Physical Dimensions

6.2 Shield Cover

Figure below shows the shield cover of ESP32-C3-WIZ2012:

- XXXXX: Model ID
- QR code content: Model ID + Fab ID + YYMM + MAC address
- FCC ID: Will be updated once obtain certification
- IC ID Will be updated once obtain certification



Figure 5: ESP32-C3-WIZ2012 Shield Cover

7 Product Handling

7.1 Storage Conditions

The products sealed in moisture barrier bags (MBB) should be stored in a non-condensing atmospheric environment of $< 40\text{ }^{\circ}\text{C}$ and $/90\%\text{RH}$. 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 $25\pm 5\text{ }^{\circ}\text{C}$ and $/60\%\text{RH}$. If the above conditions are not met, the module needs to be baked.

7.2 Electrostatic Discharge (ESD)

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

7.3 Reflow Profile

Solder the module in a single reflow.

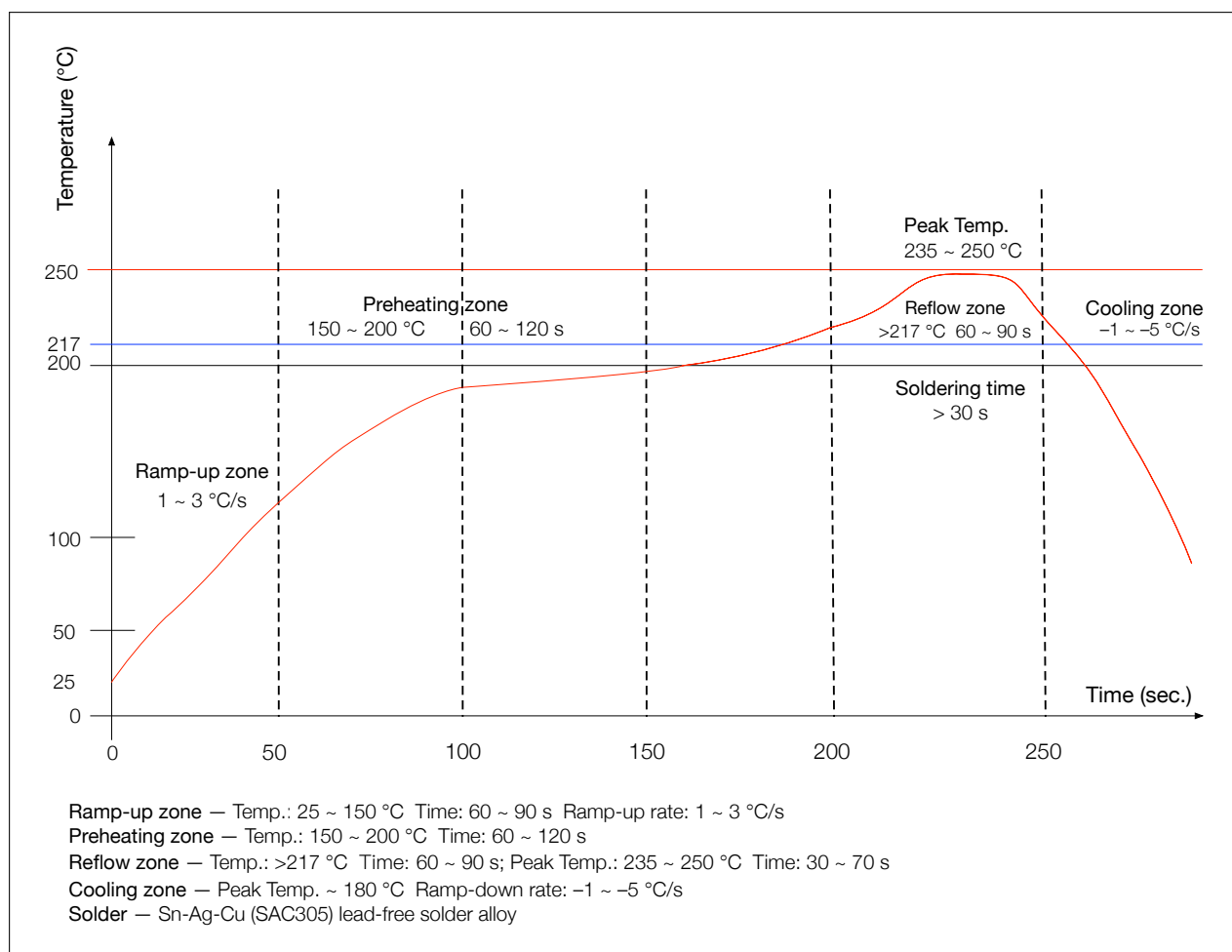


Figure 6: Reflow Profile

8 Learning Resources

8.1 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.

- [*ESP32-C3 Technical Reference Manual*](#)

Detailed information on how to use ESP32-C3 family's memory and peripherals.

- [*Espressif Products Ordering Information*](#)

8.2 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
2021-03-18	V0.6	• Added a note about pull-up and pull-down resistors above Table 2; • Updated antenna type.
2021-03-09	V0.5	• Added Chapter 4 <i>Electrical Characteristics</i>; • Updated Chapter 5 <i>Module Schematics</i>.
2020-12-14	V0.2	• Updated Wi-Fi operating frequency to 2412 ~ 2484 MHz; • Updated notes for Table 4; • Updated C13 from 100 pF to 10 nF in Chapter 5 <i>Module Schematics</i>; • Added Chapter 6.2 <i>Shield Cover</i>.
2020-12-07	V0.1	Draft



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