E101- C5WN8 series

User Manual



Chengdu Ebyte Electronic Technology Co.,Ltd.

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1 Function Overview

1.1 Introduction

The E101-C5WN8-PS and E101-C5WN8-XS are developed based on the ESP32-C5 series chip solution .

The E101-C5WN8-PS and E101-C5WN8-XS are 2.4 & 5 GHz dual-band universal Wi-Fi 6 + Bluetooth®5(LE) modules with rich peripheral interfaces, 8MB of embedded flash memory , and a RISC-V 32-bit single-core processor. The chips integrate a wide range of peripherals, including GPIO, SPI, parallel I/O, UART, I2C, I2S, RMT (TX/RX), pulse counter, LED PWM, USB serial/JTAG controller, MCPWM, CAN FD controller, SDIO slave controller, bit regulator, event task matrix, ADC, temperature sensor, undervoltage monitor, analog voltage comparator, system timer, general-purpose timer, RTC timer, watchdog timer, etc. , and can be used in smart homes, industrial automation, healthcare, consumer electronics, and other fields.



E101-C5WN8-PS



E101-C5WN8-XS

1.2 Module Features

CPU and on-chip memory

- It features a built-in ESP32-C5 chip, a RISC-V 32-bit single-core processor, supporting clock frequencies up to 240 MHz.
- ROM: 320 KB
- HP SRAM: 384 KB
- LP SRAM: 16 KB

Wi-Fi

- Operating in dual-band 2.4 & 5 GHz, 1T1R
- Operating channel center frequency range: 2412 ~ 2484 MHz, 5180 ~ 5885 MHz
- Compatible with IEEE 802.11ax protocol:
  - ➢20 MHz-only non-AP mode
  - ➢Uplink and downlink Orthogonal Frequency Division Multiple Access (OFDMA) are particularly suitable for multi-user concurrent transmission in high-density applications.
  - ➢Multiple-user multiple-input multiple-output (MU-MIMO) improves network capacity.
  - ➢Beamforming receivers improve signal quality.
  - ➢Spatial reuse maximizes parallel transmission.
  - ➢Target wake-up time (TWT) provides a better energy-saving mechanism.
- Compatible with IEEE 802.11ac protocol:
  - ➢Supports 20 MHz bandwidth
  - ➢Downlink full-bandwidth multi-user multiple-input multiple-output (MU-MIMO)

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- Fully compatible with IEEE 802.11b/g/n protocols:
  - ➢Supports 20 MHz and 40 MHz bandwidth
  - ➢Data rates up to 150 Mbps
  - ➢Wireless Multimedia (WMM)
  - ➢Frame aggregation (TX/RX A-MPDU, TX/RX A-MSDU)
  - ➢Immediate Block Acknowledgment (ACK)
  - ➢Fragmentation and defragmentation
  - ➢Transmission opportunity (TXOP)
  - ➢Beacon Automatic Detection (Hardware TSF)
  - ➢4 virtual Wi-Fi ports
  - ➢It also supports infrastructure networks. BSS) Station mode, SoftAP mode, Station + SoftAP mode, and promiscuous mode . Note that when the ESP32-C5 scans in Station mode, the SoftAP channel will change simultaneously.
  - ➢Antenna diversity
  - ➢802.11 mc FTM

Bluetooth®

- Bluetooth Low Energy (Bluetooth LE): Bluetooth®5(LE)
- Bluetooth Mesh 1.1
- High power mode (20 dBm transmit power)
- Bluetooth direction finding (AoA/AoD) based on angle of arrival and angle of departure.
- Periodic broadcasts with replies (PAwR)
- Subrating connection mode (LE connection subrating)
- Power control (LE power control)
- Supported speeds: 125 Kbps, 500 Kbps, 1 Mbps, 2 Mbps
- Extended broadcast and multi-broadcast support (LE advertising extensions)
- Concurrent operation of multiple roles including broadcaster/observer/central device/peripheral device

IEEE 802.15.4

- Compatible with IEEE 802.15.4-2015 protocol
- Operating in the 2.4 GHz band, it supports OQPSK PHY.
- Data rate: 250 Kbps
- Supports Thread 1.4
- Supports Zigbee 3.0

Abundant peripherals

- GPIO, SPI, Parallel I/O, UART, I2C, I2S, RMT (TX/RX), Pulse Counter, LED PWM, USB Serial/TAG Controller, MCPWM, CAN FD Controller, SDIO Slave Controller, Bit Regulator, Event Task Matrix, ADC, Temperature Sensor, Undervoltage Monitor, Analog Voltage Comparator, System Timer, General Purpose Timer, RTC Timer, Watchdog Timer, etc.

Module integrated components

- 48 MHz Integrated Crystal Oscillator
- SPI flash

Antenna selection

- E101- C5WN8-PS : Onboard PCB Antenna
- E101- C5WN8-XS : Connect an external antenna via connector or module pins.

Working conditions

- Operating voltage/supply voltage: 3.0 ~ 3.6 V
- Operating ambient temperature: -40 ~ 85 ℃

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2 Module Parameter Characteristics

2.1 Absolute Maximum Rating

symbol	parameter	Minimum value	Maximum value	unit
VDD	Power pin voltage	-0.3	3.6	V
T STORE	Storage temperature	-40	10 5	°C

Table 1-1 Absolute Maximum Ratings

Note: Exceeding the maximum rated value may result in permanent module burnout.

2.2 Recommended Working Conditions

symbol	parameter	Minimum value	Typical value	Maximum value	unit
VDD	Power pin voltage	3.0	3.3	3.6	V
IVDD	External power supply current	0.5	—	—	A
T	Recommended operating temperature	-40	—	85	°C

Table 1-2 Recommended Working Conditions

2.3 Basic Parameters

Module model		E101-C5WN8-PS	E101-C5WN8-XS
5GHz operating channel center frequency range		5180~5885 MHz	5180~5885 MHz
2.4GHz operating channel center frequency range		2412~2484MHz	2412~2484MHz
Bluetooth		6.0	6.0
Wi-Fi		Protocol IEEE 802.11b/g/n /ax	Protocol IEEE 802.11b/g/n /ax
Chip Model		ESP32-C5HR8	ESP32-C5HR8
Antenna type		PCB antenna	IPEX-1
distance	Between modules	280m	560m
FLASH		8MB (4/16MB customizable)	8MB (4/16MB customizable)
PSRAM		8MB	8MB

Table 1-3 Basic Parameters

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2.4 DC Electrical Characteristics (3.3V, 25°C)

parameter	illustrate	Minimum value	Typical value	Maximum value	unit
CIN	pin capacitors	—	2	—	pF
VIH	High-level input voltage	0.75 × VDD [1]	—	VDD [1] + 0.3	V
VIL	Low-level input voltage	-0.3	—	0.25 × VDD	V
IIH	High-level input current	—	—	50	nA
IIL	Low-level input current	—	—	50	nA
V OH [2]	High-level output voltage	0.8 × VDD [1]	—	—	V
VOL [2]	Low-level output voltage	—	—	0.1 × VDD [1]	V
IOH	High-level pull-up current (VDD [1] = 3.3V,VOH>= 2.64V, PAD_DRIVER=3)	—	40	—	mA
IOL	Low-level sink current (VDD [1] = 3.3V, VOL = 0.495V, PAD_DRIVER = 3)	—	28	—	mA
RPU	Internal weak pull-up resistor	—	45	—	kΩ
RPD	Internal weak pull-down resistor	—	45	—	kΩ
VIH_nRST	Chip reset release voltage (CHIP_PU should meet the voltage range)	0.75 × VDD [1]	—	VDD 1 + 0.3	V
VIL_nRST	Chip reset voltage (CHIP_PU should meet the voltage range)	-0.3	—	0.25 × VDD [1]	V

Table 1-4 DC Electrical Characteristics (3.3V, 25°C)

1. VDD [1] – Voltage of the power pins in each power domain.
2. VOL [2] and VOH 2 are test values under high resistance load conditions ·

2.5 Power Consumption Characteristics

2.5.1 Power Consumption in Active Mode

The following power consumption data were measured under conditions of a 3.3V power supply and an ambient temperature of 25 °C . All transmit power consumption data were measured with 100% duty cycle. All receive power consumption data were measured with peripherals off and the CPU idle.

Work mode	Radio frequency mode	Description	Peak value (mA)
Active (RF operation)	Launch (TX)	802.11b, 1 Mbps, DSSS @ 19dBm	337
		802.11g, 54 Mbps, OFDM @ 15.7dBm	272
		802.11n, HT20, MCS7 @ 15.9dBm	272
		802.11n, HT40, MCS7 @ 15dBm	265
		802.11ax, MCS9 @ 14dBm	249
	Receive (RX)	802.11b/g/n, HT20	94
		802.11n, HT40	102

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		802.11ax, HE20	94

Table 1-5 - Wi-Fi (2.4 GHz) power consumption characteristics in Active mode

Work mode	Radio frequency mode	Description	Peak value (mA)
Active (RF operation)	Launch (TX)	802.11a, 6 Mbps, OFDM @ 17.5dBm	397
		802.11n, HT20, MCS7 @ 14.6dBm	364
		802.11n, HT40, MCS7 @ 14.4dBm	361
		802.11ac, VHT20, MCS7 @ 14.4dBm	364
		802.11ax, HE20, MCS7 @ 14.4dBm	365
	Receive (RX)	802.11a/n, HT20	121
		802.11n, HT40	128
		802.11ac, VHT20	120
		802.11ax, HE20	122

Table 1-6 Power consumption characteristics of Wi-Fi (5 GHz) in Active mode.

Work mode	Radio frequency mode	Description	Peak value (mA)
Active (RF operation)	Launch (TX)	Bluetooth Low Energy @ 19.7dBm	364
		Bluetooth Low Energy @ 7dBm	205
		Bluetooth Low Energy @ 0.5dBm	171
		Bluetooth Low Energy @ 19.7dBm	364
		Bluetooth Low Energy @ -16.7dBm	105
	Receive (RX)	Bluetooth Low Energy	85

Table 1-7 Low-power Bluetooth features in Active mode

Work mode	Radio frequency mode	Description	Peak value (mA)
Active (RF operation)	Launch (TX)	802.15.4 @ 19.5dBm	360
		802.15.4 @ 6.8dBm	206
		802.15.4 @ 0dBm	180
		802.15.4 @ -17dBm	105
	Receive (RX)	802.15.4	85

Table 1-8 Power consumption characteristics of 802.15.4 in Active mode.

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2.6 Radio Frequency Characteristics

- This chapter provides a table of the product's radio frequency characteristics.
- RF data is obtained after connecting the RF cable at the antenna port and includes losses from the RF front-end circuitry. The external antenna used in the module under test with an external antenna connector has a 50 Ω impedance.
- The center frequency range of the operating channel should conform to national or regional standards and specifications. The software can configure the center frequency range of the operating channel; please refer to the "ESP RF Test Guide" for details .
- Unless otherwise specified, all RF tests were performed under conditions of a 3.3 V (±5%) power supply and an ambient temperature of 25 °C .

2.6.1 2.4 GHz Wi-Fi Radio Frequency

Name	Description
Operating channel center frequency range	2412 ~ 2484 MHz
wireless standards	IEEE 802.11b/g/n/ax

Table 1-9 2.4 GHz Wi-Fi Radio Frequency Specifications

2.6.1.1 2.4 GHz Wi-Fi Radio Frequency Transmitter (TX) Characteristics

Rate	Minimum value (dBm)	Typical value (dBm)	Maximum value (dBm)
802.11b, 1 Mbps, DSSS	—	19.5	—
802.11b, 11 Mbps, CCK	—	19.5	—
802.11g, 6 Mbps, OFDM	—	18.5	—
802.11g, 54 Mbps, OFDM	—	16.5	—
802.11n, HT20, MCS0	—	18.5	—
802.11n, HT20, MCS7	—	16.5	—
802.11n, HT40, MCS0	—	17.5	—
802.11n, HT40, MCS7	—	15.5	—
802.11ax, HE20, MCS0	—	18.5	—
802.11ax, HE20, MCS9	—	14.5	—

Table 1-10 Transmit Power of 2.4 GHz Spectrum Template and EVM Compliant with 802.11 Standard

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Rate	Minimum value (dBm)	Typical value (dBm)	Maximum value (dBm)
802.11b, 1 Mbps, DSSS	—	-25.0	-10.0
802.11b, 11 Mbps, CCK	—	-25.0	-10.0
802.11g, 6 Mbps, OFDM	—	-25.0	-5.0
802.11g, 54 Mbps, OFDM	—	-30.0	-25.0
802.11n, HT20, MCS0	—	-25.0	-5.0
802.11n, HT20, MCS7	—	-31.5	-27.0
802.11n, HT40, MCS0	—	-25.0	-5.0
802.11n, HT40, MCS7	—	-31.5	-27.0
802.11ax, HE20, MCS0	—	-25.0	-5.0
802.11ax, HE20, MCS9	—	-34.5	-32.0

Table 1-11 Transmitted EVM Test at 11 2.4 GHz

Note: The transmit power for each test item of the EVM is the typical value provided in Table 1-12 2.4 GHz spectrum template and transmit power when the EVM complies with the 802.11 standard.-

2.6.1.2 2.4 GHz Wi-Fi Radio Frequency Receiver (RX) Features

The packet error rate (PER) under the 802.11b standard shall not exceed 8%, and under the 802.11g/n/ax standard shall not exceed 10%.

Rate	Minimum value (dBm)	Typical value (dBm)	Maximum value (dBm)
802.11b, 1 Mbps, DSSS	—	-100.0	—
802.11b, 2 Mbps, DSSS	—	-97.0	—
802.11b, 5.5 Mbps, CCK	—	-94.0	—
802.11b, 11 Mbps, CCK	—	-90.0	—
802.11g, 6 Mbps, OFDM	—	-95.0	—
802.11g, 9 Mbps, OFDM	—	-93.0	—
802.11g, 12 Mbps, OFDM	—	-92.0	—
802.11g, 18 Mbps, OFDM	—	-90.0	—
802.11g, 24 Mbps, OFDM	—	-87.0	—
802.11g, 36 Mbps, OFDM	—	-84.0	—
802.11g, 48 Mbps, OFDM	—	-80.0	—
802.11g, 54 Mbps, OFDM	—	-78.0	—
802.11n, HT20, MCS0	—	-94.5	—
802.11n, HT20, MCS1	—	-93.0	—
802.11n, HT20, MCS2	—	-90.0	—
802.11n, HT20, MCS3	—	-87.0	—
802.11n, HT20, MCS4	—	-83.5	—
802.11n, HT20, MCS5	—	-79.0	—
802.11n, HT20, MCS6	—	-77.0	—
802.11n, HT20, MCS7	—	-76.0	—
802.11n, HT40, MCS0	—	-92.0	—
802.11n, HT40, MCS1	—	-90.0	—

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Rate	Minimum value (dBm)	Typical value (dBm)	Maximum value (dBm)
802.11n, HT40, MCS2	—	-87.0	—
802.11n, HT40, MCS3	—	-83.0	—
802.11n, HT40, MCS4	—	-81.0	—
802.11n, HT40, MCS5	—	-76.0	—
802.11n, HT40, MCS6	—	-74.0	—
802.11n, HT40, MCS7	—	-73.0	—
802.11ax, HE20, MCS0	—	-94.5	—
802.11ax, HE20, MCS1	—	-91.5	—
802.11ax, HE20, MCS2	—	-89.0	—
802.11ax, HE20, MCS3	—	-86.0	—
802.11ax, HE20, MCS4	—	-83.0	—
802.11ax, HE20, MCS5	—	-79.0	—
802.11ax, HE20, MCS6	—	-77.5	—
802.11ax, HE20, MCS7	—	-75.5	—
802.11ax, HE20, MCS8	—	-71.5	—
802.11ax, HE20, MCS9	—	-69.5	—

Table 1-12 Receiver Sensitivity at 12 GHz and 2.4 GHz

Rate	Minimum value (dBm)	Typical value (dBm)	Maximum value (dBm)
802.11b, 1 Mbps, DSSS	—	5	—
802.11b, 11 Mbps, CCK	—	5	—
802.11g, 6 Mbps, OFDM	—	5	—
802.11g, 54 Mbps, OFDM	—	0	—
802.11n, HT20, MCS0	—	5	—
802.11n, HT20, MCS7	—	0	—
802.11n, HT40, MCS0	—	5	—
802.11n, HT40, MCS7	—	0	—
802.11ax, HE20, MCS0	—	5	—
802.11ax, HE20, MCS9	—	0	—

Table 1-13 Maximum received signal level at 13 2.4 GHz

Rate	Minimum value (dBm)	Typical value (dBm)	Maximum value (dBm)
802.11b, 1 Mbps, DSSS	—	41	—
802.11b, 11 Mbps, CCK	—	40	—
802.11g, 6 Mbps, OFDM	—	37	—
802.11g, 54 Mbps, OFDM	—	17	—
802.11n, HT20, MCS0	—	34	—
802.11n, HT20, MCS7	—	16	—
802.11n, HT40, MCS0	—	24	—
802.11n, HT40, MCS7	—	13	—

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Rate	Minimum value (dBm)	Typical value (dBm)	Maximum value (dBm)
802.11ax, HE20, MCS0	—	38	—
802.11ax, HE20, MCS9	—	12	—

Table 1-14 Adjacent Channel Suppression at 2.4 GHz Receiver

2.6.2 5 GHz Wi-Fi Radio Frequency

Name	Description
Operating channel center frequency range	5180 ~ 5885 MHz
wireless standards	IEEE 802.11a/n/ac/ax

Table 1 - 15 5 GHz Wi-Fi RF Specifications

2.6.2.1 5 GHz Wi-Fi Radio Frequency Transmitter (TX) Characteristics

Rate	Minimum value (dBm)	Typical value (dBm)	Maximum value (dBm)
802.11a, 6 Mbps, OFDM	—	18.5	—
802.11a, 54 Mbps, OFDM	—	16.5	—
802.11n, HT20, MCS0	—	18.5	—
802.11n, HT20, MCS7	—	15.5	—
802.11n, HT40, MCS0	—	17.5	—
802.11n, HT40, MCS7	—	14.5	—
802.11ac, VHT20, MCS0	—	18.5	—
802.11ac, VHT20, MCS7	—	15.5	—
802.11ax, HE20, MCS0	—	18.5	—
802.11ax, HE20, MCS7	—	15.5	—

Table 1-16 Transmit Power of 5 GHz Spectrum Template and EVM Compliant with 802.11 Standard

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Rate	Minimum value (dBm)	Typical value (dBm)	Maximum value (dBm)
802.11a, 6 Mbps, OFDM	—	-25.0	-5.0
802.11a, 54 Mbps, OFDM	—	-29.0	-25.0
802.11n, HT20, MCS0	—	-25.0	-5.0
802.11n, HT20, MCS7	—	-31.0	-27.0
802.11n, HT40, MCS0	—	-25.0	-5.0
802.11n, HT40, MCS7	—	-31.0	-27.0
802.11ac, VHT20, MCS0	—	-25.0	-5.0
802.11ac, VHT20, MCS7	—	-31.0	-27.0
802.11ax, HE20, MCS0	—	-25.0	-5.0
802.11ax, HE20, MCS7	—	-31.5	-27.0

Table 1- 17 5 GHz Transmit EVM Test

Note: The transmit power corresponding to each test item for transmitting the EVM is the typical value provided by the 5 GHz spectrum template in Table 1-18 and the transmit power when the EVM complies with the 802.11 standard.

2.6.2.2 5 GHz Wi-Fi Radio Frequency Receiver (RX) Features

Rate	Minimum value (dBm)	Typical value (dBm)	Maximum value (dBm)
802.11a, 6 Mbps, OFDM	—	-94.5	—
802.11a, 9 Mbps, OFDM	—	-93.0	—
802.11a, 12 Mbps, OFDM	—	-91.5	—
802.11a, 18 Mbps, OFDM	—	-89.5	—
802.11a, 24 Mbps, OFDM	—	-86.5	—
802.11a, 36 Mbps, OFDM	—	-83.5	—
802.11a, 48 Mbps, OFDM	—	-78.5	—
802.11a, 54 Mbps, OFDM	—	-76.5	—
802.11n, HT20, MCS0	—	-94.0	—
802.11n, HT20, MCS1	—	-92.5	—
802.11n, HT20, MCS2	—	-89.5	—
802.11n, HT20, MCS3	—	-86.5	—
802.11n, HT20, MCS4	—	-82.5	—
802.11n, HT20, MCS5	—	-78.5	—
802.11n, HT20, MCS6	—	-77.0	—
802.11n, HT20, MCS7	—	-75.5	—
802.11n, HT40, MCS0	—	-91.5	—
802.11n, HT40, MCS1	—	-89.5	—
802.11n, HT40, MCS2	—	-86.5	—
802.11n, HT40, MCS3	—	-83.5	—
802.11n, HT40, MCS4	—	-80.5	—
802.11n, HT40, MCS5	—	-75.5	—
802.11n, HT40, MCS6	—	-73.5	—
802.11n, HT40, MCS7	—	-72.5	—

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Rate	Minimum value (dBm)	Typical value (dBm)	Maximum value (dBm)
802.11ac, VHT20, MCS0	—	-94.5	—
802.11ac, VHT20, MCS1	—	-92.5	—
802.11ac, VHT20, MCS2	—	-89.5	—
802.11ac, VHT20, MCS3	—	-86.5	—
802.11ac, VHT20, MCS4	—	-83.0	—
802.11ac, VHT20, MCS5	—	-78.5	—
802.11ac, VHT20, MCS6	—	-77.0	—
802.11ac, VHT20, MCS7	—	-75.5	—
802.11ax, HE20, MCS0	—	-94.0	—
802.11ax, HE20, MCS1	—	-91.0	—
802.11ax, HE20, MCS2	—	-88.0	—
802.11ax, HE20, MCS3	—	-85.5	—
802.11ax, HE20, MCS4	—	-82.0	—
802.11ax, HE20, MCS5	—	-78.5	—
802.11ax, HE20, MCS6	—	-77.0	—
802.11ax, HE20, MCS7	—	-74.5	—

Table 1 - 18 Receiver Sensitivity at 5 GHz

Note: The packet error rate (PER) under the 802.11a/n/ac/ax standard shall not exceed 10%.

Rate	Minimum value (dBm)	Typical value (dBm)	Maximum value (dBm)
802.11a, 6 Mbps, OFDM	—	5	—
802.11a, 54 Mbps, OFDM	—	0	—
802.11n, HT20, MCS0	—	5	—
802.11n, HT20, MCS7	—	0	—
802.11n, HT40, MCS0	—	5	—
802.11n, HT40, MCS7	—	0	—
802.11ac, VHT20, MCS0	—	5	—
802.11ac, VHT20, MCS7	—	0	—
802.11ax, HE20, MCS0	—	5	—
802.11ax, HE20, MCS7	—	0	—

Table 1-19 Maximum Received Level at 5 GHz

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Rate	Minimum value (dBm)	Typical value (dBm)	Maximum value (dBm)
802.11a, 6 Mbps, OFDM	—	29	—
802.11a, 54 Mbps, OFDM	—	9	—
802.11n, HT20, MCS0	—	26	—
802.11n, HT20, MCS7	—	8	—
802.11n, HT40, MCS0	—	29	—
802.11n, HT40, MCS7	—	11	—
802.11ac, VHT20, MCS0	—	25	—
802.11ac, VHT20, MCS7	—	6	—
802.11ax, HE20, MCS0	—	25	—
802.11ax, HE20, MCS7	—	6	—

Table 1- 20 Adjacent Channel Suppression at 5 GHz Receiver

2.6.3 Bluetooth Low Energy Radio Frequency

Name	Description
Operating channel center frequency range	2402 ~ 2480 MHz
RF transmit power range	-15~20 dBm

Table 1-21 Bluetooth Low Energy RF Specifications

2.6.3.1 Bluetooth Low Energy Radio Transmitter (TX) Features

Parameter	Description	Minimum value	Typical value	Maximum value	unit
Carrier frequency offset and drift	Max. |fn | n=0, 1, 2, 3, ...k	—	7.0	—	kHz
	Max. |f0 - fn | n=2, 3, 4, ...k	—	0.6	—	kHz
	Max. |fn - fn-5 | n=6, 7, 8, ...k	—	0.6	—	kHz
	|f1 - f0 |	—	0.3	—	kHz
Modulation characteristics	Δ F 1avg	—	250.0	—	kHz
	Min. Δ F2max (at least 99.9% of Δ F2max)	—	255.0	—	kHz
	Δ F2avg/Δ F 1avg	—	0.98	—	—
In-band firing	± 2 MHz offset	—	-33	—	dBm
	± 3 MHz offset	—	-40	—	dBm
	> ± 3 MHz offset	—	-45	—	dBm

Table 1-22 Bluetooth Low Energy - Transmitter Characteristics - 1 Mbps

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Parameter	Description	Minimum value	Typical value	Maximum value	unit
Carrier frequency offset and drift	Max. |fn | n=0, 1, 2, 3, ...k	—	7.0	—	kHz
	Max. |f0 - fn | n=2, 3, 4, ...k	—	0.6	—	kHz
	Max. |fn - fn-5 | n=6, 7, 8, ...k	—	0.7	—	kHz
	|f1 - f0 |	—	0.3	—	kHz
Modulation characteristics	Δ F 1avg	—	495.1	—	kHz
	Min. Δ F2max (at least 99.9% of Δ F2max)	—	515.0	—	kHz
	Δ F2avg/Δ F 1avg	—	0.99	—	—
In-band firing	± 2 MHz offset	—	-33	—	dBm
	± 3 MHz offset	—	-40	—	dBm
	> ± 3 MHz offset	—	-45	—	dBm

Table 1-23 Bluetooth Low Energy - Transmitter Characteristics - 2 Mbps

Parameter	Description	Minimum value	Typical value	Maximum value	unit
Carrier frequency offset and drift	Max. |fn | n=0, 1, 2, 3, ...k	—	7.0	—	kHz
	Max. |f0 - fn | n=1, 2, 3, ...k	—	0.3	—	kHz
	|f0 - f3 |	—	0.3	—	kHz
	Max. |fn - fn-3 | n=7, 8, 9, ...k	—	0.4	—	kHz
Modulation characteristics	Δ F 1avg	—	251.2	—	kHz
	Min. ΔF1max (at least 99.9% of ΔF1max)	—	256.7	—	kHz
In-band firing	± 2 MHz offset	—	-31	—	dBm
	± 3 MHz offset	—	-40	—	dBm
	> ± 3 MHz offset	—	-43	—	dBm

Table 1-24 Bluetooth Low Energy - Transmitter Characteristics - 125 Kbps

Parameter	Description	Minimum value	Typical value	Maximum value	unit
Carrier frequency offset and drift	Max. |fn | n=0, 1, 2, 3, ...k	—	7.0	—	kHz
	Max. |f0 - fn | n=1, 2, 3, ...k	—	0.5	—	kHz
	|f0 - f3 |	—	0.2	—	kHz
	Max. |fn - fn-3 | n=7, 8, 9, ...k	—	0.5	—	kHz
Modulation characteristics	Δ F2avg	—	246.3	—	kHz
	Min. Δ F2max (at least 99.9% of Δ F2max)	—	253.3	—	kHz
In-band firing	± 2 MHz offset	—	-31	—	dBm
	± 3 MHz offset	—	-40	—	dBm
	> ± 3 MHz offset	—	-43	—	dBm

Table 1-25 Bluetooth Low Energy - Transmitter Characteristics - 500 Kbps

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2.6.3.2 Low Power Bluetooth RF Receiver (RX) Features

Parameter		Description	Minimum value	Typical value	Maximum value	unit
Sensitivity @ 30.8% PER		—	—	-98.5	—	dBm
Maximum received signal @ 30.8% PER		—	—	5	—	dBm
Receive Selective C/I	Common channel	F = F0 MHz	—	9	—	dB
	Adjacent Channels	F = F0 + 1 MHz	—	-4	—	dB
		F = F0 – 1 MHz	—	-3	—	dB
		F = F0 + 2 MHz	—	-31	—	dB
		F = F0 – 2 MHz	—	-34	—	dB
		F = F0 + 3 MHz	—	-33	—	dB
		F = F0 – 3 MHz	—	-43	—	dB
		F ≥ F0 + 4 MHz	—	-37	—	dB
		F ≤ F0 – 4 MHz	—	-50	—	dB
	Mirror frequency	—	—	-28	—	dB
	Adjacent channel mirror frequency interference	F = Fimage + 1 MHz	—	-27	—	dB
		F = Fimage – 1 MHz	—	-30	—	dB
Out-of-band blocking		30 MHz ~ 2000 MHz	—	-13	—	dBm
		2003 MHz ~ 2399 MHz	—	-25	—	dBm
		2484 MHz ~ 2997 MHz	—	-20	—	dBm
		3000 MHz ~ 12.75 GHz	—	-20	—	dBm
Intermodulation		—	—	-41	—	dBm

Table 1- 26 Bluetooth Low Energy - Receiver Characteristics - 1 Mbps

Parameter		Description	Minimum value	Typical value	Maximum value	unit
Sensitivity @ 30.8% PER		—	—	-96.0	—	dBm
Maximum received signal @ 30.8% PER		—	—	5	—	dBm
Receive Selective C/I	Common channel	F = F0 MHz	—	8	—	dB
	Adjacent Channels	F = F0 + 2 MHz	—	-8	—	dB
		F = F0 – 2 MHz	—	-10	—	dB
		F = F0 + 4 MHz	—	-27	—	dB
		F = F0 – 4 MHz	—	-42	—	dB
		F = F0 + 6 MHz	—	-39	—	dB
		F = F0 – 6 MHz	—	-50	—	dB
		F ≥ F0 + 8 MHz	—	-48	—	dB
		F ≤ F0 – 8 MHz	—	-54	—	dB
	Mirror frequency	—	—	-27	—	dB
	Adjacent channel mirror frequency interference	F = Fimage + 2 MHz	—	-26	—	dB
		F = Fimage – 2 MHz	—	-28	—	dB
Out-of-band blocking		30 MHz ~ 2000 MHz	—	-13	—	dBm
		2003 MHz ~ 2399 MHz	—	-25	—	dBm
		2484 MHz ~ 2997 MHz	—	-20	—	dBm
		3000 MHz ~ 12.75 GHz	—	-20	—	dBm

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Parameter	Description	Minimum value	Typical value	Maximum value	unit
Intermodulation	—	—	-39	—	dBm

Table 1-27 Bluetooth Low Energy - Receiver Characteristics - 2 Mbps

Parameter		Description	Minimum value	Typical value	Maximum value	unit
Sensitivity @ 30.8% PER		—	—	-106.5	—	dBm
Maximum received signal @ 30.8% PER		—	—	5	—	dBm
Receive Selective C/I	Common channel	F = F0 MHz	—	3	—	dB
	Adjacent Channels	F = F0 + 1 MHz	—	-6	—	dB
		F = F0 – 1 MHz	—	-7	—	dB
		F = F0 + 2 MHz	—	-34	—	dB
		F = F0 – 2 MHz	—	-39	—	dB
		F = F0 + 3 MHz	—	-30	—	dB
		F = F0 – 3 MHz	—	-47	—	dB
		F ≥ F0 + 4 MHz	—	-46	—	dB
		F ≤ F0 – 4 MHz	—	-54	—	dB
	Mirror frequency	—	—	-28	—	dB
	Adjacent channel mirror frequency interference	F = Fimage + 1 MHz	—	-34	—	dB
		F = Fimage – 1 MHz	—	-31	—	dB

Table 1-28 Bluetooth Low Energy - Receiver Characteristics - 125 Kbps

Parameter		Description	Minimum value	Typical value	Maximum value	unit
Sensitivity @ 30.8% PER		—	—	-103.0	—	dBm
Maximum received signal @ 30.8% PER		—	—	5	—	dBm
Receive Selective C/I	Common channel	F = F0 MHz	—	3	—	dB
	Adjacent Channels	F = F0 + 1 MHz	—	-6	—	dB
		F = F0 – 1 MHz	—	-7	—	dB
		F = F0 + 2 MHz	—	-33	—	dB
		F = F0 – 2 MHz	—	-38	—	dB
		F = F0 + 3 MHz	—	-38	—	dB
		F = F0 – 3 MHz	—	-47	—	dB
		F ≥ F0 + 4 MHz	—	-41	—	dB
		F ≤ F0 – 4 MHz	—	-52	—	dB
	Mirror frequency	—	—	-twenty three	—	dB
	Adjacent channel mirror frequency interference	F = Fimage + 1 MHz	—	-29	—	dB
		F = Fimage – 1 MHz	—	-29	—	dB

Table 1-29 Bluetooth Low Energy - Receiver Characteristics - 500 Kbps

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2.6.4 802.15.4 Radio Frequency

Name	Description
Operating channel center frequency range	2402 ~ 2480 MHz

Table 1-30 802.15.4 RF Specifications

Note: Zigbee has 16 channels in the 2.4 GHz band, from channel 11 to channel 26, with a channel spacing of 5 MHz.

2.6.4.1 802.15.4 Radio Frequency Transmitter (TX) Characteristics

Parameter	Minimum value	Typical value	Maximum value	unit
RF transmit power	-15.0	—	20.0	dBm
EVM	—	4.0%	—	—

Table 1-31 Transmitter Characteristics of 802.15.4 - 250 Kbps

2.6.4.2 802.15.4 Radio Frequency Receiver (RX) Characteristics

Parameter		Description	Minimum value	Typical value	Maximum value
Sensitivity @1% PER		—	—	-103.5	—
Maximum received signal @1% PER		—	—	5	—
Relative interference level	Adjacent Channels	F = F0 + 5 MHz	—	28	—
		F = F0 – 5 MHz	—	32	—
	Replacement Channel	F = F0 + 10 MHz	—	48	—
		F = F0 – 10 MHz	—	53	—

Table 1- 32 802.15.4 Receiver Characteristics - 250 Kbps

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3 Hardware Description

3.1 Functional Block Diagram

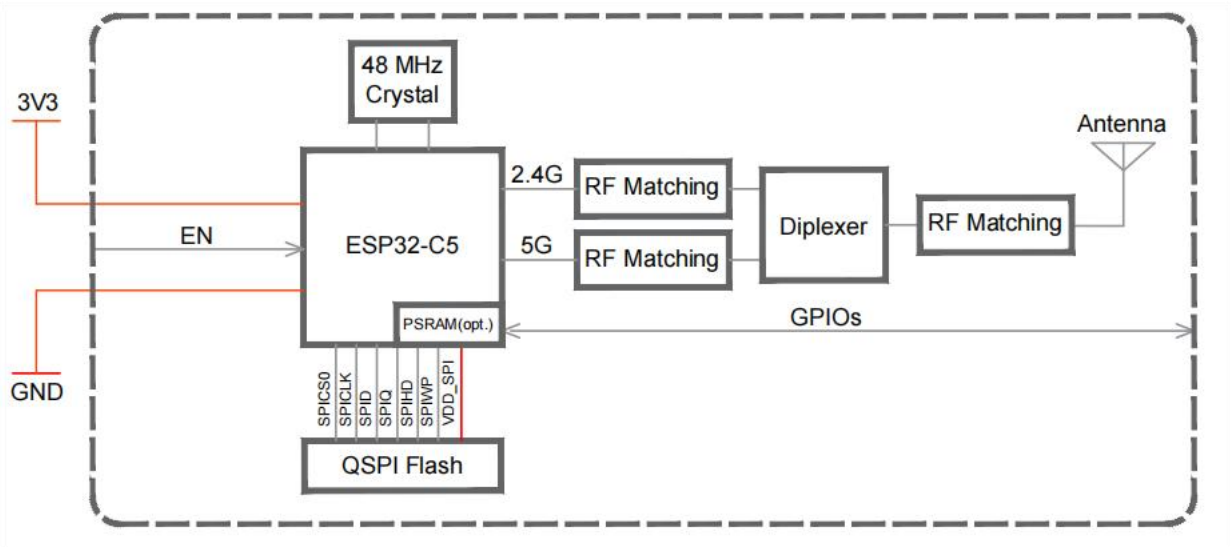


Figure 1 Functional Block Diagram of E101-C5WN8-PS

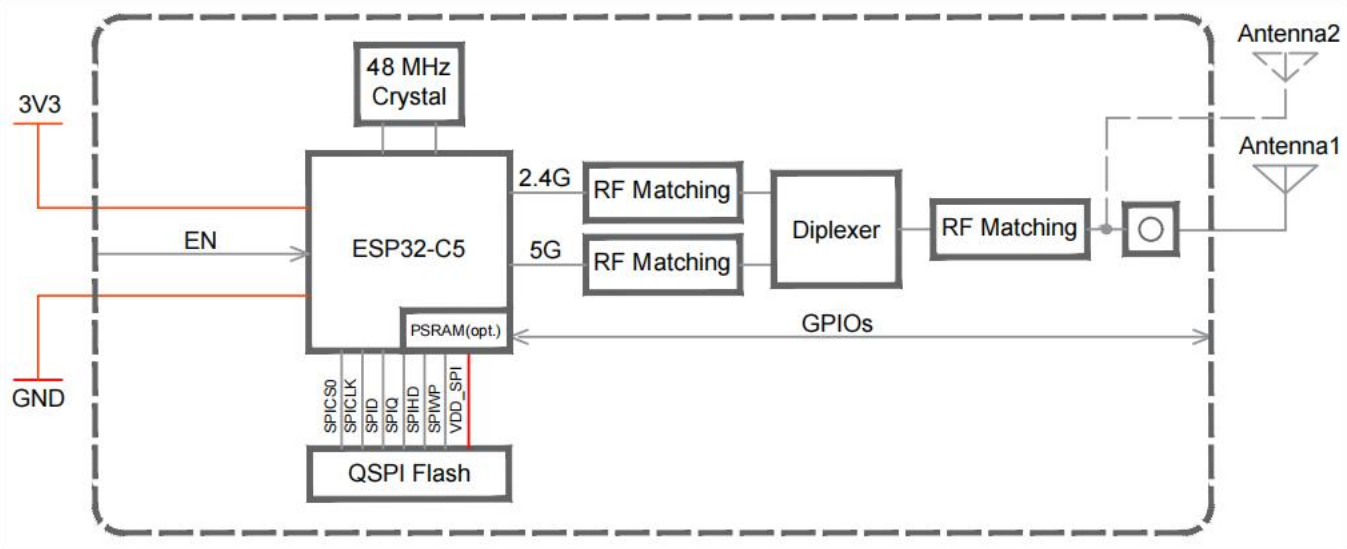


Figure 2 Functional Block Diagram of E101-C5WN8-XS

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3.2 Pin Definitions

The E101-C5WN8-PS has 29 pins, and the E101-C5WN8-XS has 32 pins. The pin layout diagram shows the approximate location of the pins on the module. For the actual layout drawn to scale, please refer to Figure 3.4 , Module Dimensions.

3.2.1 E101- C5WN8-PS Pin Definitions

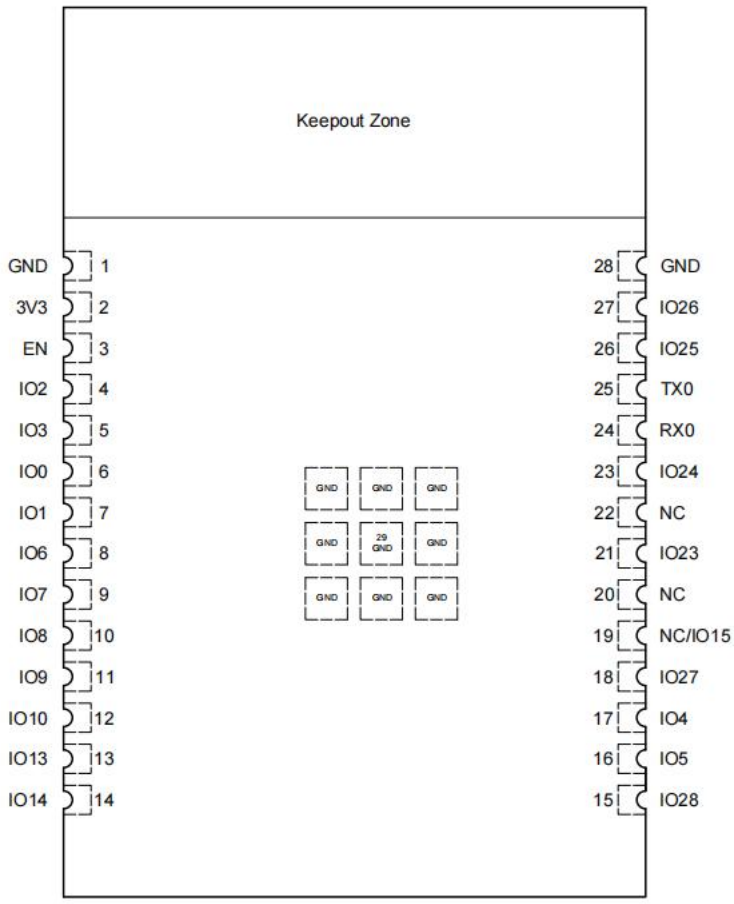


Figure 3 Pin layout diagram of E101-C5WN8-PS (top view)

Pin definitions:

Name	Serial Number	Type	Function
GND	1	P	Grounding
VCC	2	P	3.3V power supply
EN	3	I	High level: Chip enabled; Low level: Chip off; Note that the EN pin must not be left floating.
IO2	4	I/O/T	MTMS, GPIO2, LP_GPIO2, LP_UART_RTSN, LP_I2C_SDA, ADC1_CH1, FSPIQ
IO3	5	I/O/T	MTDI, GPIO3, LP_GPIO3, LP_UART_CTSN, LP_I2C_SCL, ADC1_CH2
IO0	6	I/O/T	GPIO0, XTAL_32K_P, LP_GPIO0, LP_UART_DTRN

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IO1	7	I/O/T	GPIO1, XTAL_32K_N, LP_GPIO1, LP_UART_DSRN, ADC1_CH0
IO6	8	I/O/T	GPIO6, LP_GPIO6, ADC1_CH5, FSPICLK
IO7	9	I/O/T	GPIO7, LP_GPIO7, FSPID, SDIO_DATA1
IO8	10	I/O/T	GPIO8, PAD_COMP0, SDIO_DATA0
IO9	11	I/O/T	GPIO9, PAD_COMP1, SDIO_CLK
IO10	12	I/O/T	GPIO10, FSPICS0, SDIO_CMD
IO13	13	I/O/T	GPIO13, USB_D-, SDIO_DATA3
IO14	14	I/O/T	GPIO14, USB_D+, SDIO_DATA2
IO28	15	I/O/T	GPIO28
IO5	16	I/O/T	MTDO, GPIO5, LP_GPIO5, LP_UART_TXD, ADC1_CH4, FSPIWP
IO4	17	I/O/T	MTCK, GPIO4, LP_GPIO4, LP_UART_RXD, ADC1_CH3, FSPIHD
IO27	18	I/O/T	GPIO27
IO15	19	I/O/T	SPICS1, GPIO153
NC	20	-	No connect
IO23	21	I/O/T	GPIO23
NC	22	-	No connect
IO24	23	I/O/T	GPIO24
RX0	24	I/O/T	U0RXD, GPIO12
TX0	25	I/O/T	U0TXD, GPIO11
IO25	26	I/O/T	GPIO25
IO26	27	I/O/T	GPIO26
GND	28	P	Grounding
EPAD	29	P	Grounding

Note:

1. P: Power supply or ground ; I: Input; O: Output; T: Can be set to high impedance.
2. In modules with integrated SPI PSRAM, this pin is used as SPICS1 of the SPI PSRAM and cannot be used for other functions; in modules without integrated SPI PSRAM, this pin can be used as GPIO15.
3. EPADs do not need to be soldered to the baseplate, but soldering them to the baseplate's GND will provide better heat dissipation. If you do want to solder the EPADs to the baseplate, ensure you use an appropriate amount of solder paste to avoid excessive solder paste causing too much distance between the module and the baseplate, which will affect the fit between the pins and the baseplate.
4. To ensure proper power supply to the ESP32-C5 chip upon power-up, an RC delay circuit needs to be added to the EN pin. The recommended values for RC are typically R=10 kΩ and C=1μF, but the specific values should be adjusted based on the power-up sequence of the module power supply and the power-up/reset sequence of the chip. For detailed power-up information, please refer to the ESP32-C5 chip datasheet.
5. For detailed pinouts and applications, please refer to " ESP 32-C5". Series Chip Technical Specifications and ESP 32-C5 Technical Reference Manual .

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3.2.1 E101-C5WN8-PS Pin Definitions

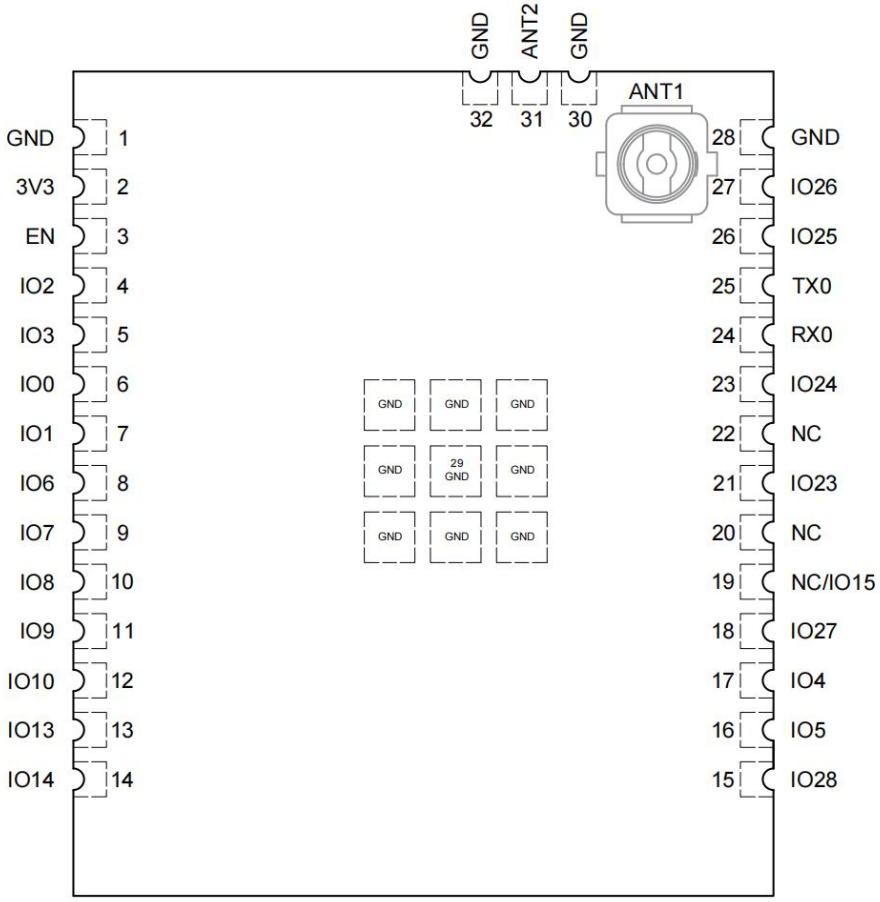


Figure 4. Pin layout diagram of E101-C5WN8 -XS (top view)

Pin definitions:

Name	Serial No.	Type	Function
GND	1	P	Grounding
VCC	2	P	3.3V power supply
EN	3	I	High level: Chip enabled; Low level: Chip off; Note that the EN pin must not be left floating.
IO2	4	I/O/T	MTMS, GPIO2, LP_GPIO2, LP_UART_RTSN, LP_I2C_SDA, ADC1_CH1, FSPIQ
IO3	5	I/O/T	MTDI, GPIO3, LP_GPIO3, LP_UART_CTSN, LP_I2C_SCL, ADC1_CH2
IO0	6	I/O/T	GPIO0, XTAL_32K_P, LP_GPIO0, LP_UART_DTRN
IO1	7	I/O/T	GPIO1, XTAL_32K_N, LP_GPIO1, LP_UART_DSRN, ADC1_CH0
IO6	8	I/O/T	GPIO6, LP_GPIO6, ADC1_CH5, FSPICLK
IO7	9	I/O/T	GPIO7, LP_GPIO7, FSPID, SDIO_DATA1
IO8	10	I/O/T	GPIO8, PAD_COMP0, SDIO_DATA0
IO9	11	I/O/T	GPIO9, PAD_COMP1, SDIO_CLK
IO10	12	I/O/T	GPIO10, FSPICS0, SDIO_CMD
IO13	13	I/O/T	GPIO13, USB_D-, SDIO_DATA3
IO14	14	I/O/T	GPIO14, USB_D+, SDIO_DATA2

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Name	Serial No.	Type	Function
IO28	15	I/O/T	GPIO28
IO5	16	I/O/T	MTDO, GPIO5, LP_GPIO5, LP_UART_TXD, ADC1_CH4, FSPIWP
IO4	17	I/O/T	MTCK, GPIO4, LP_GPIO4, LP_UART_RXD, ADC1_CH3, FSPIHD
IO27	18	I/O/T	GPIO27
IO15	19	I/O/T	SPICS1, GPIO153
NC	20	-	No connect
IO23	21	I/O/T	GPIO23
NC	22	-	No connect
IO24	23	I/O/T	GPIO24
RX0	24	I/O/T	U0RXD, GPIO12
TX0	25	I/O/T	U0TXD, GPIO11
IO25	26	I/O/T	GPIO25
IO26	27	I/O/T	GPIO26
GND	28	P	Grounding
EPAD	29	P	Grounding
GND	30	P	Grounding
ANT2	31	I/O	Radio frequency inputs and outputs are currently disabled.
GND	32	P	Grounding

Note:

1. P: Power supply or ground ; I: Input; O: Output; T: Can be set to high impedance.
2. In modules with integrated SPI PSRAM, this pin is used as SPICS1 of the SPI PSRAM and cannot be used for other functions; in modules without integrated SPI PSRAM, this pin can be used as GPIO15.
3. EPADs do not need to be soldered to the baseplate, but soldering them to the baseplate's GND will provide better heat dissipation. If you do want to solder the EPADs to the baseplate, ensure you use an appropriate amount of solder paste to avoid excessive solder paste causing too much distance between the module and the baseplate, which will affect the fit between the pins and the baseplate.
4. To ensure proper power supply to the ESP32-C5 chip upon power-up, an RC delay circuit needs to be added to the EN pin. The recommended values for RC are typically R=10 kΩ and C=1μF, but the specific values should be adjusted based on the power-up sequence of the module power supply and the power-up/reset sequence of the chip. For detailed power-up information, please refer to the ESP32-C5 chip datasheet.
5. For detailed pinouts and applications, please refer to " ESP 32-C5". Series Chip Technical Specifications and ESP 32-C5 Technical Reference Manual .

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3.3 Recommended Schematic Diagram

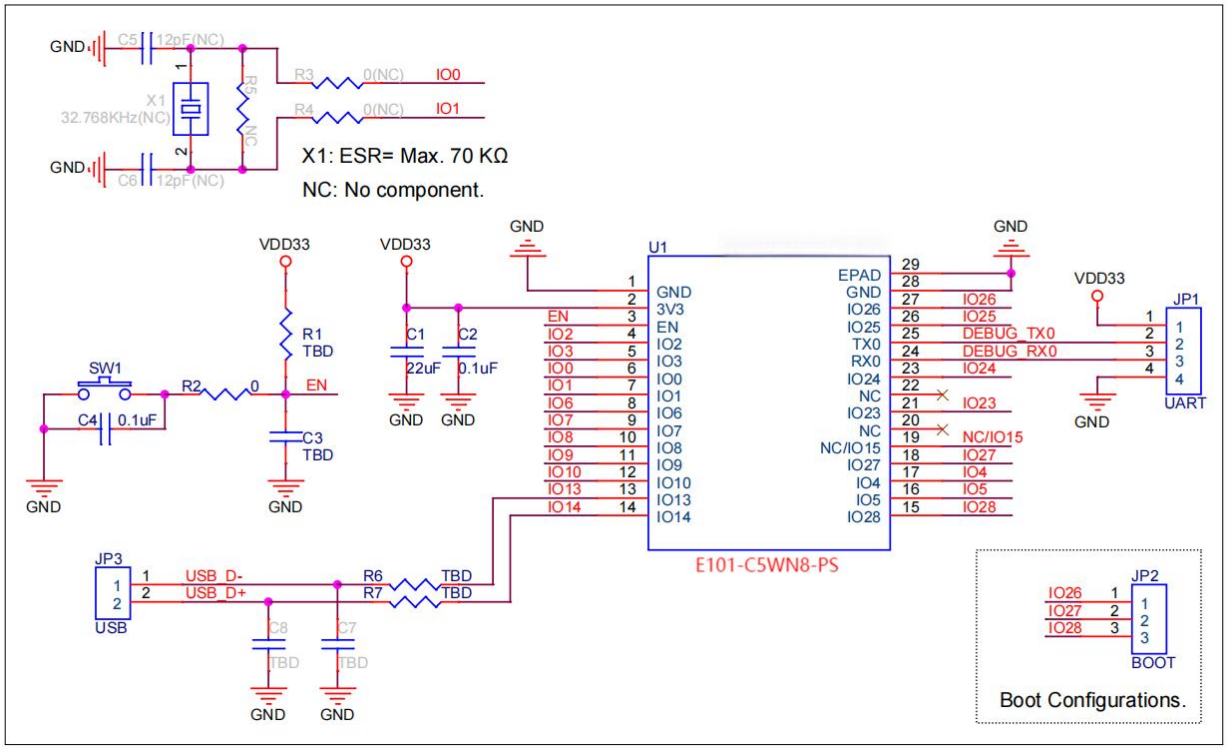


Figure 5. Recommended schematic diagram of E101-C5WN8- PS

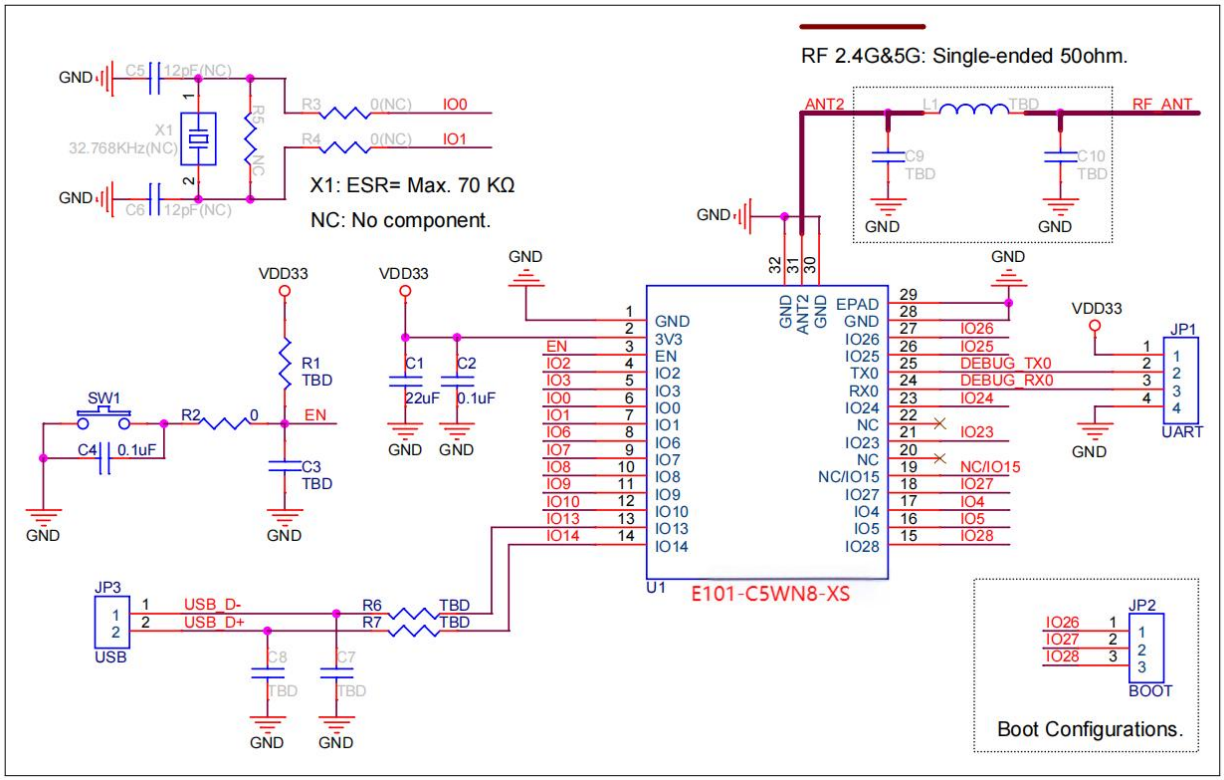


Figure 6. Recommended schematic diagram of E101-C5WN8 -XS

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3.4 Module Size

3.4.1 Dimensional drawing of E101-C5WN8-PS

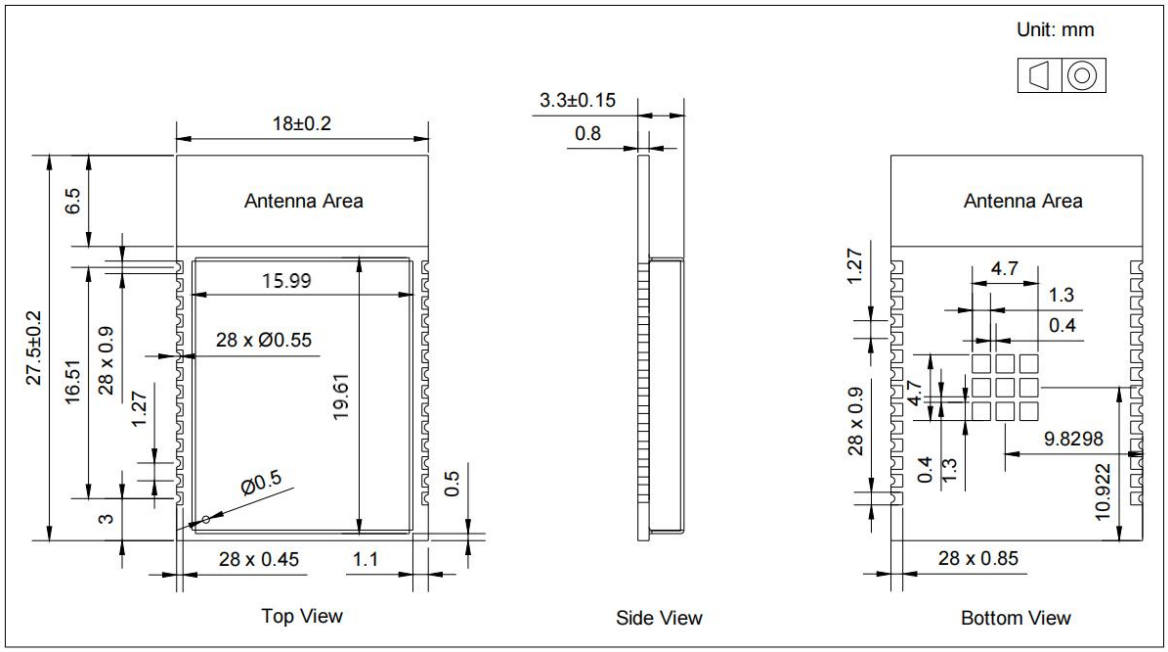


Figure 7 Module dimensions

3.4.2 Dimensional drawing of E101-C5WN8-XS

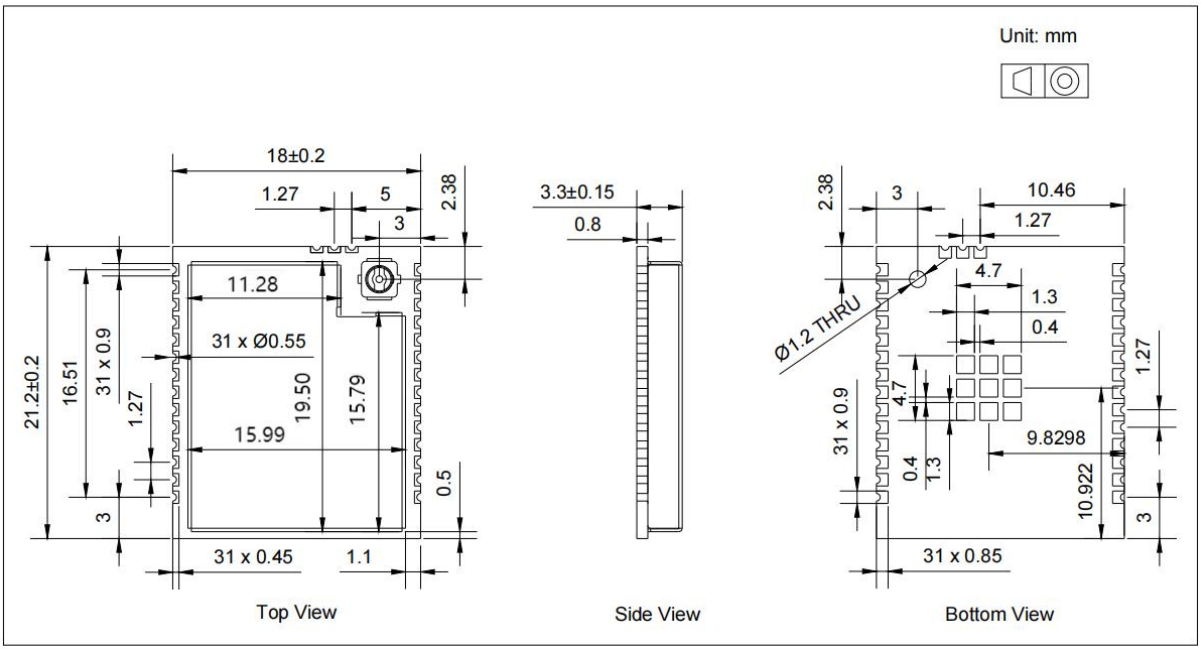


Figure 8 Module Dimensions

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3.5 PCB Package Pattern

3.5.1 E101-C5WN8-PS

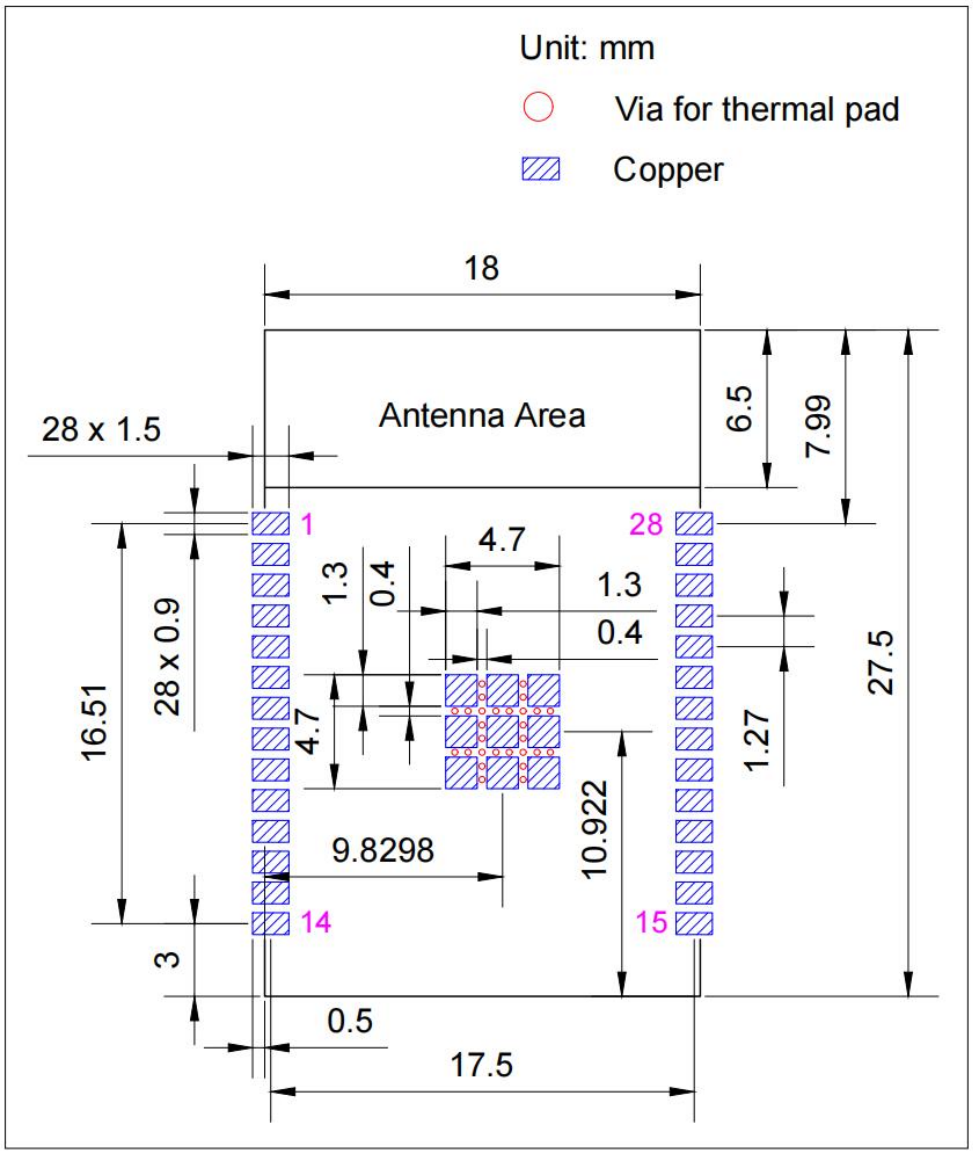


Figure 9 PCB Package

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3.5.2 E101-C5WN8-XS

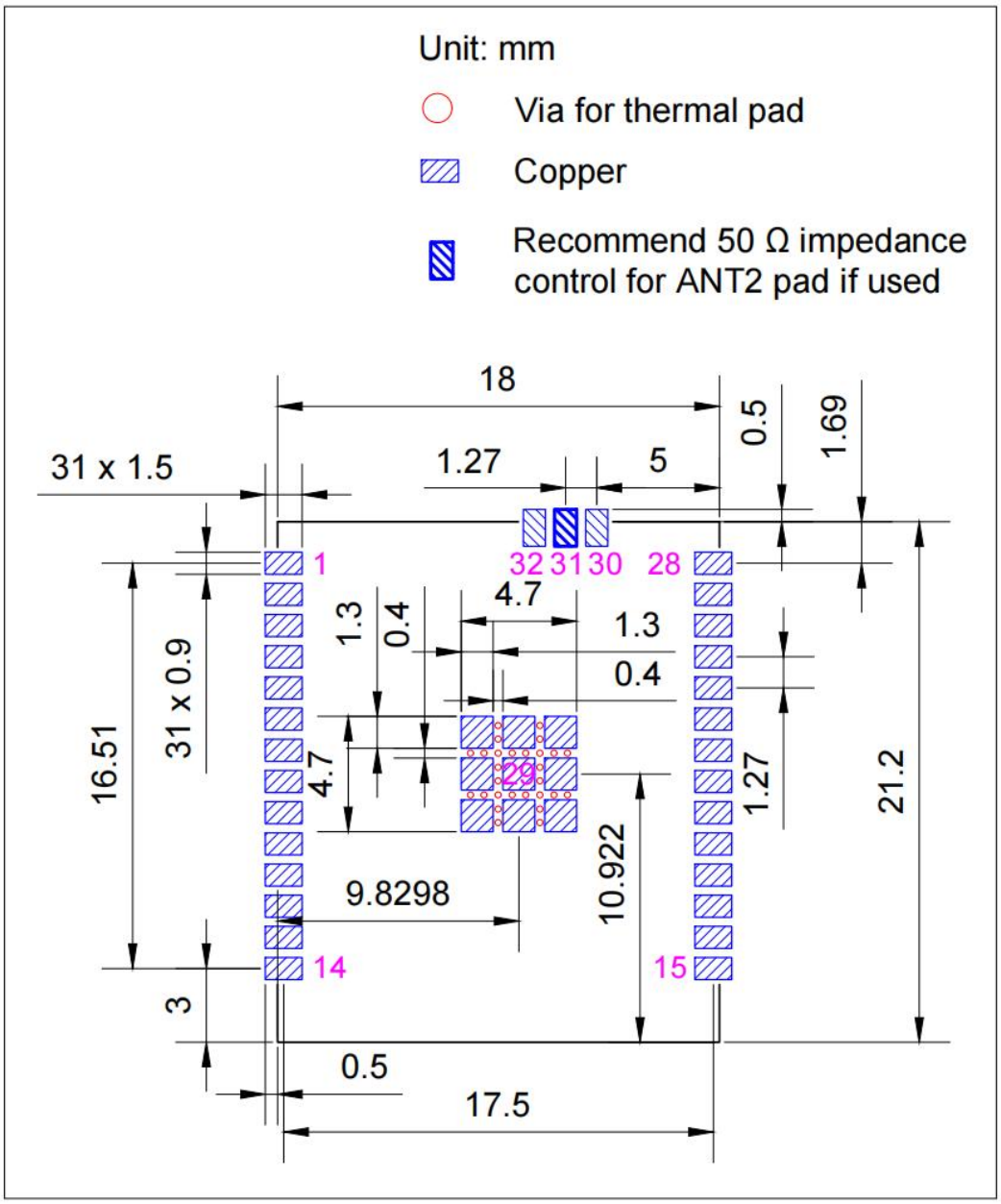


Figure 10 PCB Package

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3.6 External Antenna Connector Dimensions

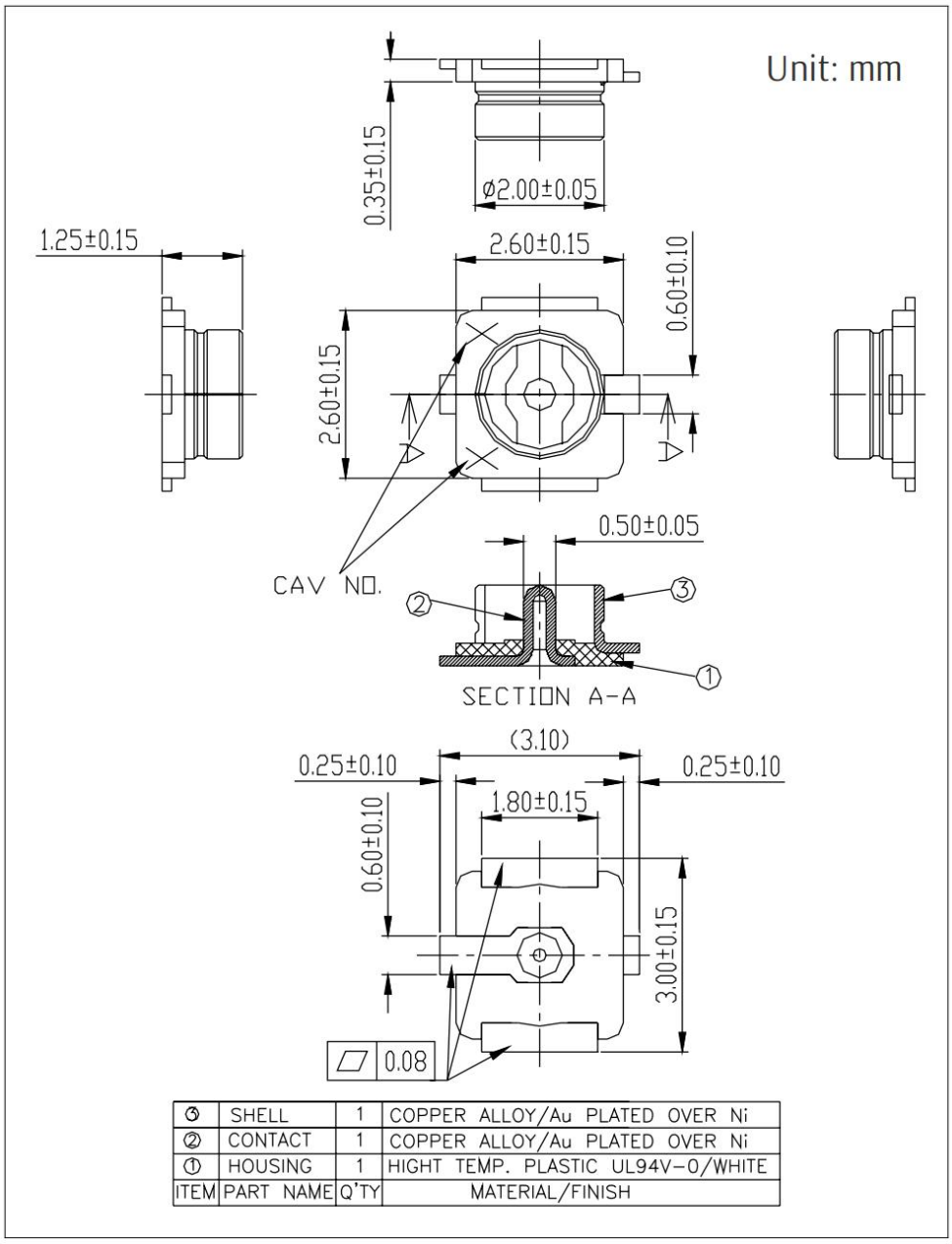


Figure 11 External antenna connector size

Note: The E101-C5WN8-XS antenna is recommended to meet the following requirements:

① 2.4 GHz & 5 GHz frequency bands;

② ② 50Ω impedance;

③ ③ Maximum gain of 3.86 dBi (2.4 GHz) or 3.65 dBi (5 GHz);

④ ④ Interface specifications compatible with the module antenna connector interface.

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4 Module Startup and Application

Please see " ESP 32-C5" for details . Series Chip Technical Specifications and ESP 32-C5 Technical Reference Manual .

5 Frequently Asked Questions

5.1 Transmission distance is not ideal

- When there are obstacles in line-of-sight communication, the communication distance will be reduced accordingly;
- Temperature, humidity, and co-channel interference can all lead to increased packet loss rates in communications.
- The ground absorbs and reflects radio waves, and the test results are poor when the ground is close to the ground.
- Seawater has a strong ability to absorb radio waves, so testing results are poor at the seaside.
- If there are metal objects near the antenna, or if it is placed inside a metal casing, the signal attenuation will be very severe.
- Power register settings are incorrect; air speed is set too high (the higher the air speed, the shorter the distance).
- At room temperature, the power supply voltage is lower than the recommended value; the lower the voltage, the lower the power output.

5.2 The module is easily damaged.

- Please check the power supply and ensure it is within the recommended voltage range. Exceeding the maximum value will cause permanent damage to the module.
- Please check the power supply stability; the voltage should not fluctuate significantly or frequently.
- Please ensure anti-static operation during installation and use, as high-frequency devices are sensitive to electrostatic discharge.
- Please ensure that the humidity is not too high during installation and use, as some components are humidity-sensitive.
- Unless there are special requirements, it is not recommended to use it at excessively high or low temperatures.

5.3 The error rate is too high .

- If there is interference from a co-channel signal nearby, move away from the source of interference or change the frequency or channel to avoid the interference.
- The clock waveform on the UART is not standard. Check for interference on the UART line.
- An inadequate power supply can also cause garbled characters, so it is essential to ensure the reliability of the power supply.

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6 Welding Operation Instructions

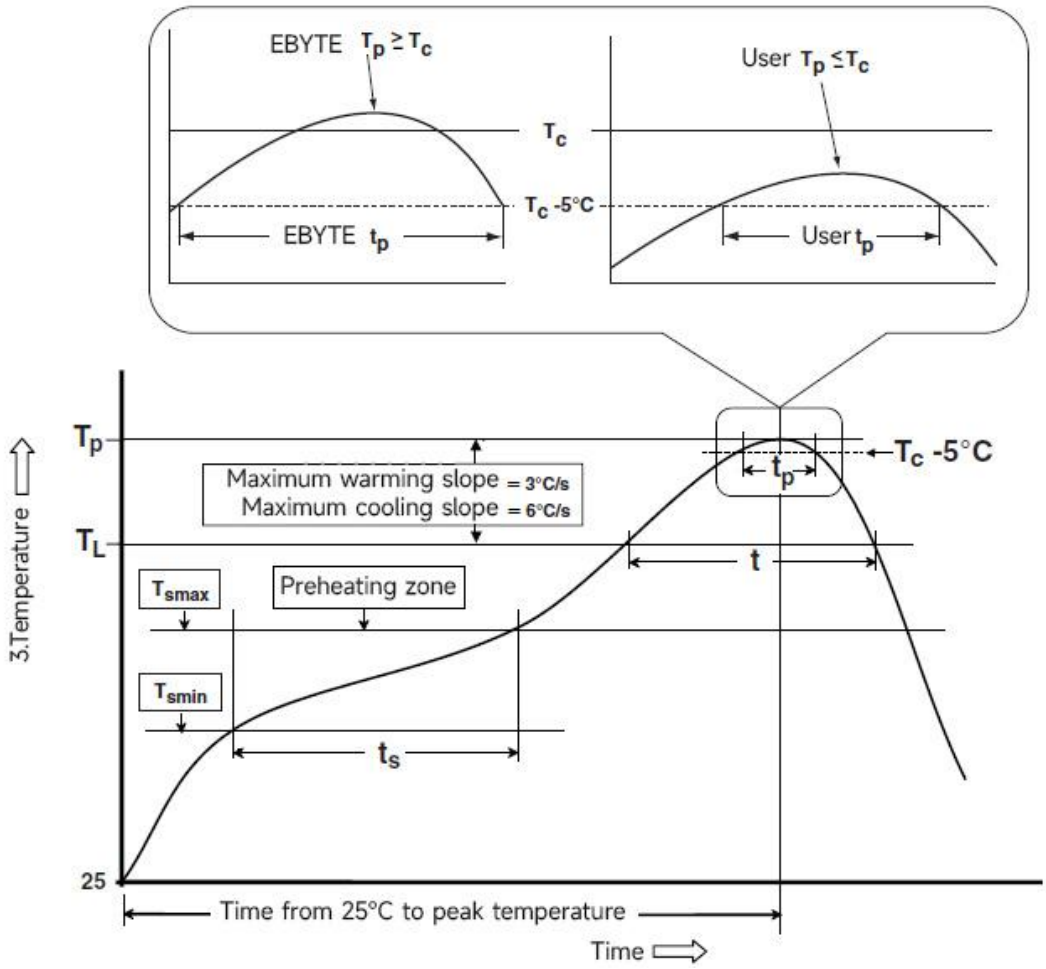
6.1 Reflow soldering temperature

Reflow soldering profile characteristics		Lead-based assembly	Lead-free assembly
Preheating/Insulation	Minimum temperature (Tsmin)	100℃	150℃
	Maximum temperature (Tsmax)	150℃	200℃
	Time (T smin ~ T smax)	60-120 seconds	60-120 seconds
Temperature rise slope (T_L~T_p)		3℃/second, maximum value	3℃/second, maximum value
Liquid phase temperature (T_L)		183℃	217℃
T_L above the holding time		60~ 90 seconds	60~ 90 seconds
Package peak temperature Tp		Users must not exceed the temperature specified on the product's "humidity sensitivity" label.	Users must not exceed the temperature specified on the product's "humidity sensitivity" label.
(Tp) within 5°C of the specified grading temperature (Tc) is shown in the figure below.		20 seconds	30 seconds
Cooling slope (Tp ~ T_L)		6℃/second, maximum value	6℃/second, maximum value
Time from room temperature to peak temperature		6 minutes, the longest	8 minutes, the longest
* The peak temperature (Tp) tolerance of the temperature profile is defined as the user's upper limit.			

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6.2 Reflow Soldering Profile

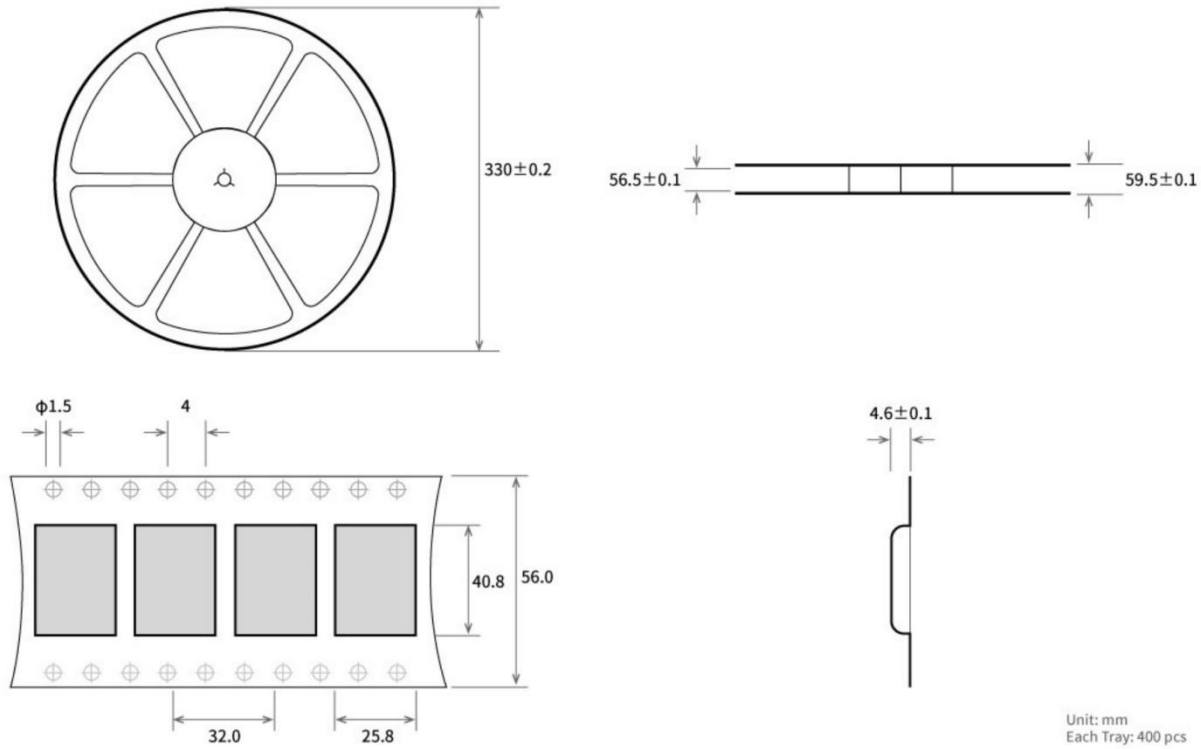


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7 Packaging

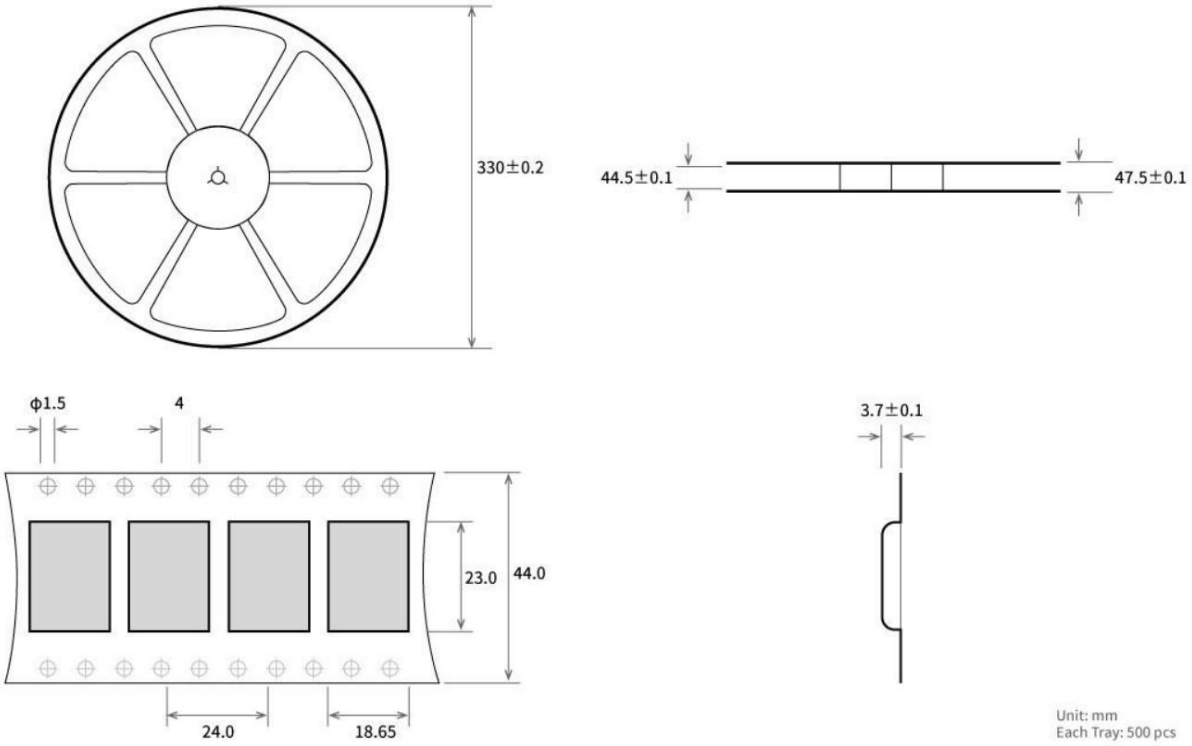
7.1 Packaging Method for E101-C5WN8-PS



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7.2 Packaging method for E101-C5WN8-XS



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8 Disclaimer

- This manual aims to provide a comprehensive and detailed introduction based on existing materials. Our company reserves the right to modify the content of this manual without further notice.
- This manual is for guidance only, and all information contained herein does not constitute any express or implied warranty.

Revision History

Version	Revision Date	Revision Notes	Maintainer
1.0	2025-10-1 1	Initial version	ALL
1.1	2026-1-14	Description of Correction	Hao

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