

# ESP32S3WROOM1

# ESP32S3WROOM1U

## Datasheet

2.4 GHz WiFi (802.11 b/g/n) and Bluetooth® 5 (LE) module  
Built around ESP32S3 series of SoCs, Xtensa® dualcore 32bit LX7 microprocessor  
Flash up to 16 MB, PSRAM up to 8 MB  
36 GPIOs, rich set of peripherals  
Onboard PCB antenna or external antenna connector



ESP32S3WROOM1



ESP32S3WROOM1U



Pre-release v0.6  
Espressif Systems  
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# 1 ModuleOverview

Note:

Check the link or the QR code to make sure that you use the latest version of this document:  
[https://www.espressif.com/sites/default/files/documentation/esp32-s3-wroom-1\\_wroom-1u\\_datasheet\\_en.pdf](https://www.espressif.com/sites/default/files/documentation/esp32-s3-wroom-1_wroom-1u_datasheet_en.pdf)



## 1.1 Features

### CPU and OnChip Memory

- ESP32-S3 series of SoCs embedded, Xtensa® dual-core 32-bit LX7 microprocessor, up to 240 MHz
- 384KBROM
- 512 KB SRAM
- 16 KB SRAM in RTC
- Up to 8 MB PSRAM

### WiFi

- 802.11 b/g/n
- Bit rate: 802.11n up to 150 Mbps
- A-MPDU and A-MSDU aggregation
- 0.4  $\mu$ s guard interval support
- Center frequency range of operating channel: 2412 ~ 2484 MHz

### Bluetooth

- Bluetooth LE: Bluetooth 5, Bluetooth mesh
- 2MbpsPHY
- Long range mode
- Advertising extensions
- Multiple advertisement sets
- Channel selection algorithm #2

### Peripherals

- GPIO, SPI, LCD interface, Camera interface, UART, I2C, I2S, remote control, pulse counter, LED PWM, USB 1.1 OTG, USB Serial/JTAG controller, MCPWM, SDIO host, GDMA, TWAI® controller (compatible with ISO 11898-1), ADC, touch sensor, temperature sensor, timers and watchdogs

### Integrated Components on Module

- 40 MHz crystal oscillator
- Up to 16 MB SPI flash

### Antenna Options

- On-board PCB antenna (ESP32-S3-WROOM-1)
- External antenna via a connector (ESP32-S3-WROOM-1U)

### Operating Conditions

- Operating voltage/Power supply: 3.0 ~ 3.6V
- Operating ambient temperature:
  - 65 °C version: –40 ~ 65 °C
  - 85 °C version: –40 ~ 85 °C
  - 105 °C version: –40 ~ 105 °C
- Dimensions: See Table 1

## 1.2 Description

ESP32-S3-WROOM-1 and ESP32-S3-WROOM-1U are two powerful, generic Wi-Fi + Bluetooth LE MCU modules that are built around the ESP32-S3 series of SoCs. On top of a rich set of peripherals, the acceleration

for neural network computing and signal processing workloads provided by the SoC make the modules an ideal choice for a wide variety of application scenarios related to AI and Artificial Intelligence of Things (AIoT), such as wake word detection, speech commands recognition, face detection and recognition, smart home, smart appliances, smart control panel, smart speaker, etc.

ESP32-S3-WROOM-1 comes with a PCB antenna. ESP32-S3-WROOM-1U comes with an external antenna connector. A wide selection of module variants are available for customers as shown in Table 1. Among the module variants, those embed ESP32-S3R8 operate at  $-40 \sim 65$  °C ambient temperature, ESP32-S3-WROOM-1-H4 and ESP32-S3-WROOM-1U-H4 operate at  $-40 \sim 105$  °C ambient temperature, and other module variants operate at  $-40 \sim 85$  °C ambient temperature.

Table 1: Ordering Information

Ordering Code	Chip	Embedded Flash (MB)	PSRAM (MB)	Dimensions (mm)
ESP32-S3-WROOM-1-N4	ESP32-S3	4	0	
ESP32-S3-WROOM-1-N8	ESP32-S3	8	0	
ESP32-S3-WROOM-1-N16	ESP32-S3	16	0	
ESP32-S3-WROOM-1-H4(105°C)	ESP32-S3	4	0	
ESP32-S3-WROOM-1-N4R2	ESP32-S3R2	4	2(QuadSPI)	
ESP32-S3-WROOM-1-N8R2	ESP32-S3R2	8	2(QuadSPI)	
ESP32-S3-WROOM-1-N16R2	ESP32-S3R2	16	2(QuadSPI)	
ESP32-S3-WROOM-1-N4R8(65°C)	ESP32-S3R8	4	8(OctalSPI)	
ESP32-S3-WROOM-1-N8R8(65°C)	ESP32-S3R8	8	8(OctalSPI)	
ESP32-S3-WROOM-1-N16R8(65°C)	ESP32-S3R8	16	8(OctalSPI)	
ESP32-S3-WROOM-1U-N4	ESP32-S3	4	0	
ESP32-S3-WROOM-1U-N8	ESP32-S3	8	0	
ESP32-S3-WROOM-1U-N16	ESP32-S3	16	0	
ESP32-S3-WROOM-1U-H4(105°C)	ESP32-S3	4	0	
ESP32-S3-WROOM-1U-N4R2	ESP32-S3R2	4	2(QuadSPI)	
ESP32-S3-WROOM-1U-N8R2	ESP32-S3R2	8	2(QuadSPI)	
ESP32-S3-WROOM-1U-N16R2	ESP32-S3R2	16	2(QuadSPI)	
ESP32-S3-WROOM-1U-N4R8(65°C)	ESP32-S3R8	4	8(OctalSPI)	
ESP32-S3-WROOM-1U-N8R8(65°C)	ESP32-S3R8	8	8(OctalSPI)	
ESP32-S3-WROOM-1U-N16R8(65°C)	ESP32-S3R8	16	8(OctalSPI)	

At the core of the modules is an ESP32-S3 series of SoC \*, an Xtensa® 32-bit LX7 CPU that operates at up to 240 MHz. You can power off the CPU and make use of the low-power co-processor to constantly monitor the peripherals for changes or crossing of thresholds.

ESP32-S3 integrates a rich set of peripherals including SPI, LCD, Camera interface, UART, I2C, I2S, remote control, pulse counter, LED PWM, USB Serial/JTAG controller, MCPWM, SDIO host, GDMA, TWAI® controller (compatible with ISO 11898-1), ADC, touch sensor, temperature sensor, timers and watchdogs, as well as up to 45 GPIOs. It also includes a full-speed USB 1.1 On-The-Go (OTG) interface to enable USB communication.

## Note:

\* For more information on ESP32-S3 series of SoCs, please refer to [ESP32-S3 Series Datasheet](#).

## 1.3 Applications

- Generic Low-power IoT Sensor Hub
- Generic Low-power IoT Data Loggers
- Cameras for Video Streaming
- Over-the-top (OTT) Devices
- USB Devices
- Speech Recognition
- Image Recognition
- Mesh Network
- Home Automation
- Smart Building
- Industrial Automation
- Smart Agriculture
- Audio Applications
- Health Care Applications
- Wi-Fi-enabled Toys
- Wearable Electronics
- Retail & Catering Applications

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## 2 BlockDiagram

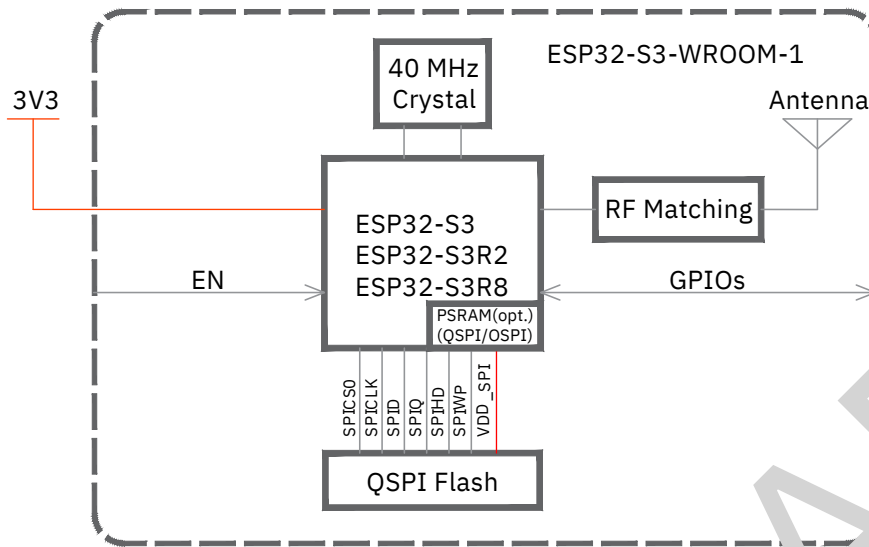


Figure 1: ESP32S3WROOM1 Block Diagram

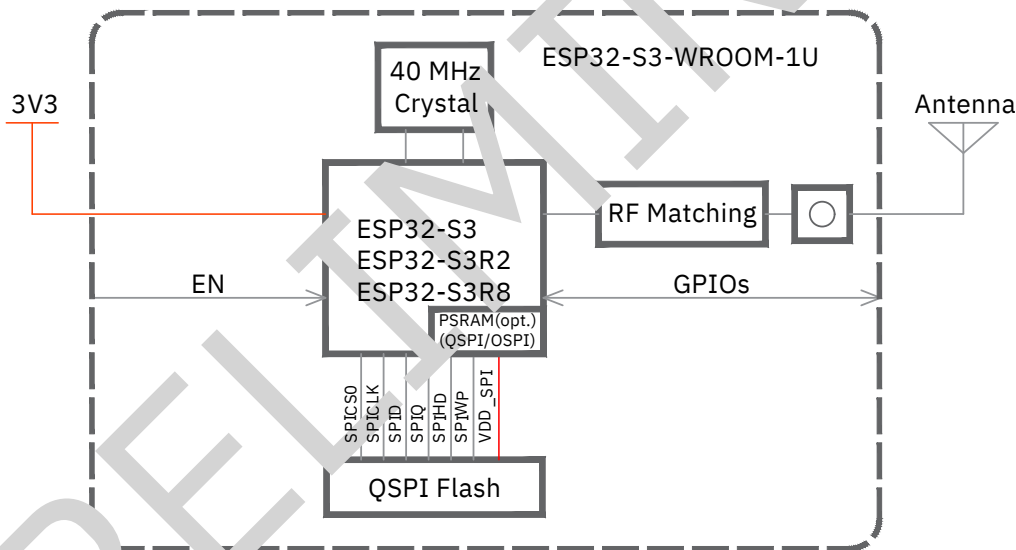


Figure 2: ESP32S3WROOM1U Block Diagram



## 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*.

The pin diagram is applicable for ESP32-S3-WROOM-1 and ESP32-S3-WROOM-1U, but the latter has no keepout zone.

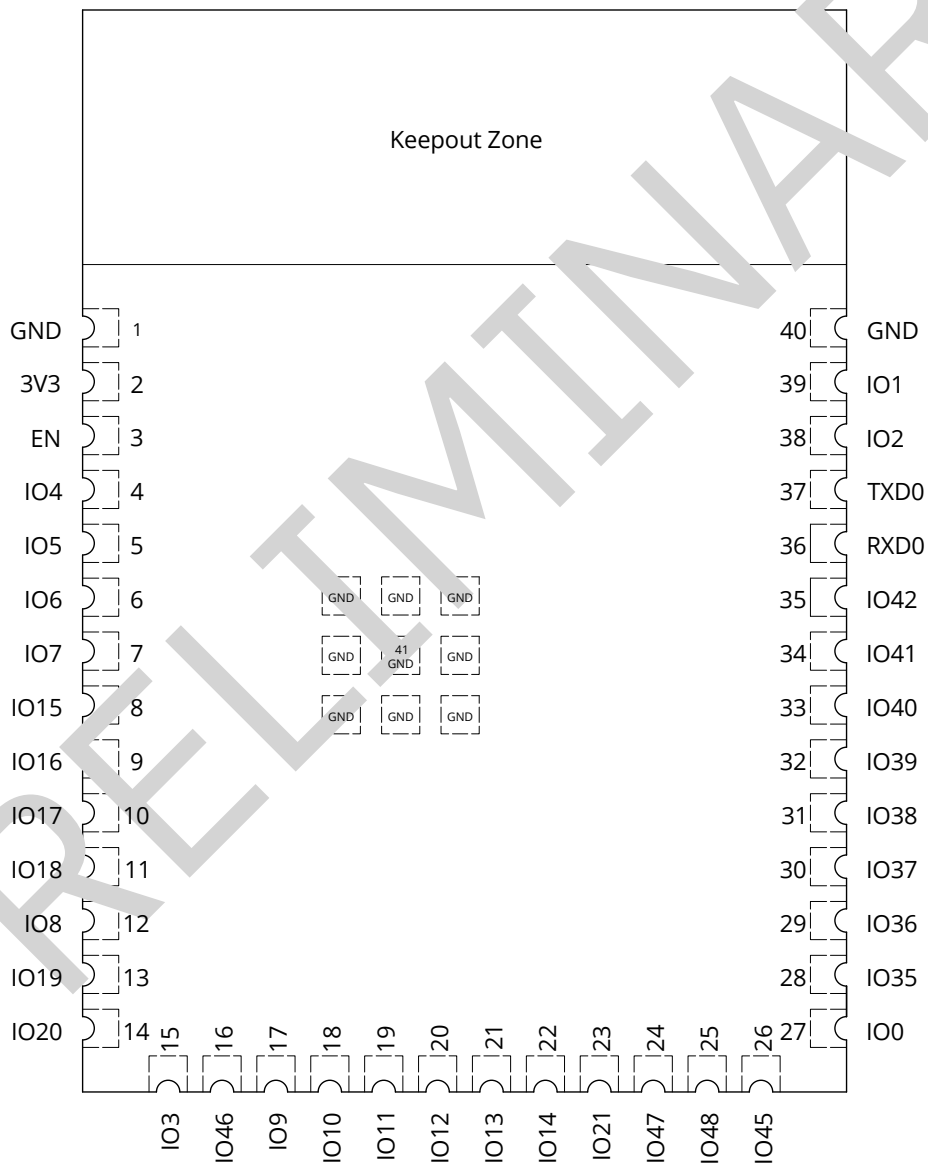


Figure 3: Pin Layout (Top View)

## 3.2 Pin Description

The module has 41 pins. See pin definitions in Table 2.

For explanations of pin names and function names, as well as configurations of peripheral pins, please refer to [ESP32-S3 Series Datasheet](#).

Table 2: Pin Definitions

Name	No.	Type	Function
GND	1	P	GND
3V3	2	P	Power supply
High:			on, enables the chip.
EN	3	I	Low: off, the chip powers off.
Note:			Do not leave the EN pin floating.
IO4	4	I/O/T	RTC_GPIO4, GPIO4, TOUCH4, ADC1_CH3
IO5	5	I/O/T	RTC_GPIO5, GPIO5, TOUCH5, ADC1_CH4
IO6	6	I/O/T	RTC_GPIO6, GPIO6, TOUCH6, ADC1_CH5
IO7	7	I/O/T	RTC_GPIO7, GPIO7, TOUCH7, ADC1_CH6
IO15	8	I/O/T	RTC_GPIO15, GPIO15, U0RTS, ADC2_CH4, XTAL_32K_P
IO16	9	I/O/T	RTC_GPIO16, GPIO16, U0CTS, ADC2_CH5, XTAL_32K_N
IO17	10	I/O/T	RTC_GPIO17, GPIO17, U1TXD, ADC2_CH6
IO18	11	I/O/T	RTC_GPIO18, GPIO18, U1RXD, ADC2_CH7, CLK_OUT3
IO8	12	I/O/T	RTC_GPIO8, GPIO8, TOUCH8, ADC1_CH7, SUBSPICS1
IO19	13	I/O/T	RTC_GPIO19, GPIO19, U1RTS, ADC2_CH8, CLK_OUT2, USB_D-
IO20	14	I/O/T	RTC_GPIO20, GPIO20, U1CTS, ADC2_CH9, CLK_OUT1, USB_D+
IO3	15	I/O/T	RTC_GPIO3, GPIO3, TOUCH3, ADC1_CH2
IO46	16	I/O/T	GPIO46
IO9	17	I/O/T	RTC_GPIO9, GPIO9, TOUCH9, ADC1_CH8, FSPIHD, SUBSPIHD
IO10	18	I/O/T	RTC_GPIO10, GPIO10, TOUCH10, ADC1_CH9, FSPICS0, FSPIH04, SUBSPICS0
IO11	19	I/O/T	RTC_GPIO11, GPIO11, TOUCH11, ADC2_CH0, FSPID, FSPII05, SUBSPID
IO12	20	I/O/T	RTC_GPIO12, GPIO12, TOUCH12, ADC2_CH1, FSPICK, FSPII06, SUBSPICK
IO13	21	I/O/T	RTC_GPIO13, GPIO13, TOUCH13, ADC2_CH2, FSPIQ, FSPII07, SUBSPIQ
IO14	22	I/O/T	RTC_GPIO14, GPIO14, TOUCH14, ADC2_CH3, FSPIWP, FSPIDQS, SUBSPIWP
IO21	23	I/O/T	RTC_GPIO21, GPIO21
IO47	24	I/O/T	SPICK_P_DIFF, GPIO47, SUBSPICK_P_DIFF
IO48	25	I/O/T	SPICK_N_DIFF, GPIO48, SUBSPICK_N_DIFF
IO45	26	I/O/T	GPIO45
IO0	27	I/O/T	RTC_GPIO0, GPIO0
IO35b	28	I/O/T	SPII06, GPIO35, FSPID, SUBSPID
IO36b	29	I/O/T	SPII07, GPIO36, FSPICK, SUBSPICK

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Name	No.	Type	Function
IO37b	30	I/O/T	SPIDQS,GPIO37,FSPIQ,SUBSPIQ
IO38	31	I/O/T	GPIO38,FSPIWP,SUBSPIWP
IO39	32	I/O/T	MTCK,GPIO39,CLK_OUT3,SUBSPICS1
IO40	33	I/O/T	MTDO,GPIO40,CLK_OUT2
IO41	34	I/O/T	MTDI,GPIO41,CLK_OUT1
IO42	35	I/O/T	MTMS,GPIO42
RXD0	36	I/O/T	U0RXD,GPIO44,CLK_OUT2
TXD0	37	I/O/T	U0TXD,GPIO43,CLK_OUT1
IO2	38	I/O/T	RTC_GPIO2,GPIO2,TOUCH2,ADC1_CH1
IO1	39	I/O/T	RTC_GPIO1,GPIO1,TOUCH1,ADC1_CH0
GND	40	P	GND
EPAD	41	P	GND

<sup>a</sup>

P: power supply; I: input; O: output; T: high impedance. Pin functions in bold font are the default pin functions.

<sup>b</sup> In module variants that have embedded OSPI PSRAM, i.e., that embed ESP32-S3R8, pins IO35, IO36, and IO37 connect to the OSPI PSRAM and are not available for other uses.

### 3.3 Strapping Pins

**Note:**

The content below is excerpted from Section Strapping Pins in [ESP32-S3 Series Datasheet](#). For the strapping pin mapping between the chip and modules, please refer to Chapter 5 [Module Schematics](#).

ESP32-S3 has four strapping pins:

- GPIO0
- GPIO45
- GPIO46
- GPIO3

Software can read the values of corresponding bits from register “GPIO\_STRAPPING”.

During the chip’s system reset (power-on-reset, RTC watchdog reset, brownout reset, analog super watchdog reset, and crystal clock glitch detection 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.

GPIO0, GPIO45 and GPIO46 are connected to the chip’s internal weak pull-up/pull-down during the chip reset. Consequently, if they are unconnected or the connected external circuit is high-impedance, the internal weak pull-up/pull-down will determine the default input level of these strapping pins.

GPIO3 is floating by default. Its strapping value can be configured to determine the source of the JTAG signal inside the CPU, as shown in Table 4. In this case, the strapping value is controlled by the external circuit that cannot be in a high impedance state. Table 3 shows more configuration combinations of EFUSE\_DIS\_USB\_JTAG, EFUSE\_DIS\_PAD\_JTAG, and EFUSE\_STRAP\_JTAG\_SEL that determine the JTAG signal source.

Table 3: JTAG Signal Source Selection

EFUSE_STRAP_JTAG_SEL 1	EFUSE_DIS_USB_JTAG	EFUSE_DIS_PAD_JTAG	JTAG Signal Source
0	0	0	Refer to Table 4
don't care	0	0	USB Serial/JTAG controller
don't care	0	1	USB controller
don't care	1	0	Serial/JTAG controller
	1	1	On-chip JTAG pins

N/A

To change the strapping bit values, users 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-S3.

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

Refer to Table 4 for a detailed configuration of the strapping pins.

Table 4: Strapping Pins

VDD_SPI Voltage	1		
Pin Default	3.3V	1.8V	
GPIO45 Pull-down	0	1	
Booting Mode	2		
Pin Default	SPI Boot	Download	Boot
GPIO0 Pull-up	1	0	
GPIO46 Pull-down	Don't care	0	
Enabling/Disabling ROM Messages Print During Booting	3	4	
Pin Default	Enabled	Disabled	
	GPIO46 Pull-down		See the fourth note
JTAG Signal Selection			
EFUSE_DIS_USB_JTAG = 0, EFUSE_DIS_PAD_JTAG = 0, Pin Default			
EFUSE_STRAP_JTAG_SEL = 1			
0:	JTAG signal from on-chip JTAG pins		
GPIO3	N/A		
1:	JTAG signal from USB Serial/JTAG controller		

Note:

- VDD\_SPI voltage is determined either by the strapping value of GPIO45 or by VDD\_SPI\_TIEH. When EFUSE\_VDD\_SPI\_FORCE is 0, VDD\_SPI voltage is determined by the strapping value of GPIO45; when EFUSE\_VDD\_SPI\_FORCE is 1, VDD\_SPI voltage is determined by VDD\_SPI\_TIEH.
- The strapping combination of GPIO46 = 1 and GPIO0 = 0 is invalid and will trigger unexpected behavior.
- ROM boot messages can be printed over U0TXD (by default) or GPIO17 (U1TXD), depending on the eFuse bit EFUSE\_UART\_PRINT\_CHANNEL.
- When both EFUSE\_DIS\_USB\_SERIAL\_JTAG and EFUSE\_DIS\_USB\_OTG are 0, ROM boot messages will be printed to the USB Serial/JTAG controller. Otherwise, the messages will be printed to UART, controlled by GPIO46 and EFUSE\_UART\_PRINT\_CONTROL. Specifically, when EFUSE\_UART\_PRINT\_CONTROL value is:
  - 0, print is normal during boot and not controlled by GPIO46.
  - 1 and GPIO46 is 0, print is normal during boot; but if GPIO46 is 1, print is disabled.

2 and GPIO46 is 0, print is disabled; but if GPIO46 is 1, print is normal. 3, print is disabled and not controlled by GPIO46.

Figure 4 shows the setup and hold times for the strapping pin before and after the CHIP\_PU signal goes high. Details about the parameters are listed in Table 5.

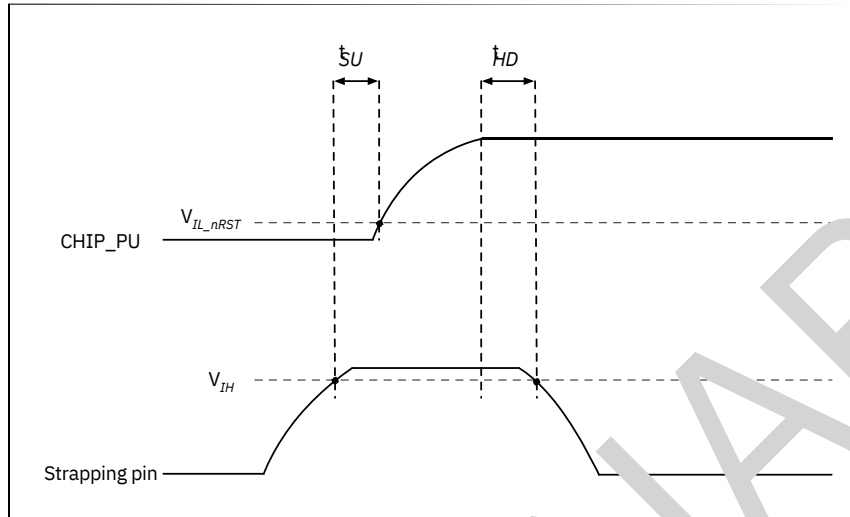


Figure 4: Setup and Hold Times for the Strapping Pin

Table 5: Parameter Descriptions of Setup and Hold Times for the Strapping Pin

	Parameter	Description	Min(ms)
tSU	Setup time	before CHIP_PU goes from low to high	0
tHD	Hold time	after CHIP_PU goes high	3

## 4 Electrical Characteristics

The values presented in this section are preliminary and may change with the final release of this datasheet.

### 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 6: Absolute Maximum Ratings

Symbol	Parameter	Min	Max	Unit
VDD33	Power supply voltage	-0.3	3.6	V
TSTORE	Storage temperature	-40	105	°C

### 4.2 Recommended Operating Conditions

Table 7: Recommended Operating Conditions

Symbol	Parameter	Min	Typ	Max	Unit
VDD33	Power supply voltage	3.0	3.3	3.6	V
I <sub>VDD</sub>	Current delivered by external power supply	0.5	—	—	A
T <sub>A</sub>	Operating ambient temperature	65	—	85	°C
	—	—	—	—	—
	—	—	—	—	—

### 4.3 DC Characteristics (3.3V, 25°C)

Table 8: DC Characteristics (3.3 V, 25 °C)

Symbol	Parameter	Min	Typ	Max	Unit
C <sub>IN</sub>	Pin capacitance	—	2	—	pF
V <sub>IH</sub>	High-level input voltage	0.75 × VDD1	—	VDD1 + 0.3	V
V <sub>IL</sub>	Low-level input voltage	-0.3	—	0.25 × VDD1	V
I <sub>IH</sub>	High-level input current	—	—	50	nA
I <sub>IL</sub>	Low-level input current	—	—	50	nA
V <sub>2OH</sub>	High-level output voltage	0.8 × VDD1	—	—	V
V <sub>2OL</sub>	Low-level output voltage	—	—	0.1 × VDD1	V
I <sub>OH</sub>	High-level source current (VDD1 = 3.3 V, V <sub>OH</sub> ≥ 2.64 V, PAD_DRIVER = 3)	—	40	—	mA
I <sub>OL</sub>	Low-level sink current (VDD1 = 3.3 V, V <sub>OL</sub> = 0.495 V, PAD_DRIVER = 3)	—	—	28	mA

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Table 8 – cont'd from previous page

Symbol	Parameter	Min	Typ	Max	Unit
RPU Internal	weakpull-upresistor	—	45	—	kΩ
RPD Internal	weakpull-downresistor	—	45	—	kΩ
Chip reset	release voltage (EN voltage is within the specified range)	$V_{IH\_nRST} \geq 0.75 \times VDD$	—	VDD1+ 0.3	V
Chip reset	voltage (EN voltage is within the specified range)	$V_{IL\_nRST} \leq 0.3$	—	$0.25 \times VDD1$	V

<sup>1</sup>  
VDD is the I/O voltage for pins of a particular power domain.

<sup>2</sup>  
VOH and VOL 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-S3 Series Datasheet](#).

Table 9: Current Consumption Depending on RF Modes

Workmode	Description	Peak (mA)
802.11b	1Mbps, @20.5dBm	355
802.11g	54Mbps, @18dBm	297
TX		
802.11n	HT20, MCS7, @17.5dBm	286
Active (RF working)		
802.11n	HT40, MCS7, @17dBm	285
802.11b/g/n	HT20	95
RX		
802.11n	HT40	97

<sup>1</sup>  
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.

<sup>2</sup>  
The current consumption figures for in RX mode are for cases when the peripherals are disabled and the CPU idle.

Note that the data in Table 10 only applies to the module variants that embed the chip variant ESP32-S3.

Table 10: Current Consumption Depending on Work Modes

	Workmode	Description	Typ	Unit
Light-sleep	—		240	μA
Deep-sleep	RTCmemory and RTC peripherals are powered on.		8	μA
Hibernation	RTC memory is powered on. RTC peripherals are powered off.		7	μA
Poweroff	CHIP_PU is set to low level. The chip is powered off.		1	μA

## 4.5 WiFi RF Characteristics

### 4.5.1 WiFi RF Standards

Table 11: WiFi RF Standards

Name	Description
Center frequency range of operating channel	1 2412~2484MHz
Wi-Fi wireless standard	IEEE802.11b/g/n
11b: 1, 2, 5.5 and 11 Mbps	
20MHz 11g: 6, 9, 12, 18, 24, 36, 48, 54 Mbps	
Data rate	
11n: MCS0-7, 72.2 Mbps (Max)	
40MHz 11n: MCS0-7, 150Mbps (Max)	
Antenna type	PCB antenna, external antenna via the connector

1

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

2

For the modules that use external antennas, the output impedance is 50  $\Omega$ . For other modules without external antennas, the output impedance is irrelevant.

#### 4.5.2 WiFi RF Transmitter (TX) Specifications

Target TX power is configurable based on device or certification requirements. The default characteristics are provided in Table 12.

Table 12: TX Power with Spectral Mask and EVM Meeting 802.11 Standards

Rate	Min (dBm)	Typ (dBm)	Max (dBm)
802.11b, 1Mbps	-20.5	-	-
802.11b, 11Mbps	-20.5	-	-
802.11g, 6Mbps	-20.0	-	-
802.11g, 54Mbps	-18.0	-	-
802.11n, HT20, MCS0	-19.0	-	-
802.11n, HT20, MCS7	-17.5	-	-
802.11n, HT40, MCS0	-18.5	-	-
802.11n, HT40, MCS7	-17.0	-	-

Table 13: TX EVM Test

Rate	Min (dB)	Typ (dB)	SL1 (dB)
802.11b, 1 Mbps, @20.5 dBm	-	-24.5	-10
802.11b, 11 Mbps, @20.5 dBm	-	-24.5	-10
802.11g, 6 Mbps, @20 dBm	-	-23.0	-5
802.11g, 54 Mbps, @18 dBm	-	-29.5	-25
802.11n, HT20, MCS 0, @19 dBm	-	-24.0	-5
802.11n, HT20, MCS 7, @17.5 dBm	-	-30.5	-27
802.11n, HT40, MCS 0, @18.5 dBm	-	-25.0	-5
802.11n, HT40, MCS 7, @17 dBm	-	-30.0	-27

1

SL stands for standard limit value.



## 4.5.3 WiFIRFReceiver(RX)Specifications

Table 14: RX Sensitivity

Rate	Min (dBm)	Typ (dBm)	Max (dBm)
802.11b, 1 Mbps	—	-98.2	—
802.11b, 2 Mbps	—	-95.6	—
802.11b, 5.5 Mbps	—	-92.8	—
802.11b, 11 Mbps	—	-88.5	—
802.11g, 6 Mbps	—	-93.0	—
802.11g, 9 Mbps	—	-92.0	—
802.11g, 12 Mbps	—	-90.8	—
802.11g, 18 Mbps	—	-88.5	—
802.11g, 24 Mbps	—	-85.5	—
802.11g, 36 Mbps	—	-82.2	—
802.11g, 48 Mbps	—	-78.0	—
802.11g, 54 Mbps	—	-76.2	—
802.11n, HT20, MCS 0	—	-93.0	—
802.11n, HT20, MCS 1	—	-90.6	—
802.11n, HT20, MCS 2	—	-88.4	—
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	—	-74.2	—
802.11n, HT40, MCS 0	—	-90.0	—
802.11n, HT40, MCS 1	—	-87.5	—
802.11n, HT40, MCS 2	—	-85.0	—
802.11n, HT40, MCS 3	—	-82.0	—
802.11n, HT40, MCS 4	—	-78.5	—
802.11n, HT40, MCS 5	—	-74.4	—
802.11n, HT40, MCS 6	—	-72.5	—
802.11n, HT40, MCS 7	—	-71.2	—

Table 15: 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	—

Cont'd on next page

Table 15 – cont'd from previous page

Min Typ Rate	(dBm)	(dBm)	Max (dBm)
802.11n, HT40, MCS0 –5			–
802.11n, HT40, MCS7 –0			–

Table 16: RX Adjacent Channel Rejection

Rate	Min Typ	(dB)	(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 BluetoothLERadio

Table 17: Bluetooth LE Frequency

Parameter	Min Typ	(MHz)	(MHz)	Max (MHz)
Center frequency of operating channel			2402 –	2480

### 4.6.1 BluetoothLE RF Transmitter (TX) Specifications

Table 18: Transmitter Characteristics Bluetooth LE 1 Mbps

Parameter	Description	Min	Typ	Max	Unit
RF transmit power	RF power control range	–25.00	0	20.00	dBm
	Gain control step	– 3.00			–dB
Carrier frequency offset	Max $ f_n - f_0 $	–2.50			–kHz
	Carrier frequency offset and drift	–2.00			–kHz
	Max $ f_n - f_n - 5 $	–1.40			–kHz
	Max $ f_1 - f_0 $	–1.00			–kHz
Modulation characteristics	Avg $\Delta f_{avg}$	–249.00			–kHz
	Min $\Delta f_{2max}$ (for at least 99.9% of all $\Delta f_{2max}$ )	–198.00			–kHz
In-band spurious emissions	$\Delta f_{avg} / \Delta f_{1avg}$	–0.86			–
	$\pm 2\text{MHz offset}$	–37.00			–dBm
	$\pm 3\text{MHz offset}$	–42.00			–dBm

Table 18 – cont'd from previous page

Parameter	Description	Min	Typ	Max	Unit
	>±3MHzoffset	—	—44.00	—	dBm

Table 19: Transmitter Characteristics Bluetooth LE 2 Mbps

Parameter	Description	Min	Typ	Max	Unit
RF transmit power	RFpowercontrolrange	—25.00	0	20.00	dBm
	Gaincontrolstep	—3.00	—	—	dB
Carrier frequency offset and drift	Max $ f_n $ n=0,1,2,..k	—2.50	—	—	kHz
	Max $ f_0-f_n $	—2.00	—	—	kHz
	Max $ f_n-f_{n-5} $	—1.40	—	—	kHz
	Max $ f_1-f_0 $	—1.00	—	—	kHz
Modulation characteristics	$\Delta f_{1avg}$	—499.00	—	—	kHz
	Min $\Delta f_{2max}$ (for at least 99.9% of all $\Delta f_{2max}$ )	—	—	—	—
In-band spurious emissions	$\Delta f_{2avg}/\Delta f_{1avg}$	—0.89	—	—	dBm
	±4MHzoffset	—42.00	—	—	dBm
	±5MHzoffset	—44.00	—	—	dBm
	>±5MHzoffset	—47.00	—	—	dBm

Table 20: Transmitter Characteristics Bluetooth LE 125 Kbps

Parameter	Description	Min	Typ	Max	Unit
RF transmit power	RFpowercontrolrange	—25.00	0	20.00	dBm
	Gaincontrolstep	—3.00	—	—	dB
Carrier frequency offset and drift	Max $ f_n $ n=0,1,2,..k	—0.80	—	—	kHz
	Max $ f_0-f_n $	—1.00	—	—	kHz
Modulation characteristics	$ f_n-f_{n-3} $	—0.30	—	—	kHz
	$ f_0-f_3 $	—1.00	—	—	kHz
In-band spurious emissions	$\Delta f_{1avg}$	—248.00	—	—	kHz
	Min $\Delta f_{1max}$ (for at least 99.9% of all $\Delta f_{1max}$ )	—	—	—	—
In-band spurious emissions	±2MHzoffset	—37.00	—	—	dBm
	±3MHzoffset	—42.00	—	—	dBm
	>±3MHzoffset	—44.00	—	—	dBm

Table 21: Transmitter Characteristics Bluetooth LE 500 Kbps

Parameter	Description	Min	Typ	Max	Unit
RF transmit power	RFpowercontrolrange	—25.00	0	20.00	dBm
	Gaincontrolstep	—3.00	—	—	dB
Carrier frequency offset and drift	Max $ f_n $ n=0,1,2,..k	—0.80	—	—	kHz
	Max $ f_0-f_n $	—1.00	—	—	kHz

Cont'd on next page

Table 21 – cont'd from previous page

Parameter	Description	Min	Typ	Max	Unit
	$ f_n - f_{n-3} $	—	0.85	—	kHz
	$ f_0 - f_3 $	—	0.34	—	kHz
Modulation characteristics	$\Delta f_{2avg}$	—	213.00	—	kHz
	Min $\Delta f_{2max}$ (for at least 99.9% of all $\Delta f_{2max}$ )	—	196.00	—	kHz
In-band spurious emissions	$\pm 2\text{MHz offset}$	—	-37.00	—	dBm
	$\pm 3\text{MHz offset}$	—	-42.00	—	dBm
	$> \pm 3\text{MHz offset}$	—	-44.00	—	dBm

4.6.2 Bluetooth LE RF Receiver (RX) Specifications

Table 22: Receiver Characteristics Bluetooth LE 1 Mbps

Parameter	Description	Min	Typ	Max	Unit
Sensitivity	@30.8%PER	—	-96.5	—	dBm
Maximum received signal	@30.8%PER	-8	—	—	dBm
Co-channel	C/I $F=F_0\text{MHz}$	-9	—	—	dB
Adjacent channel selectivity	C/I				
		$F=F_0+1\text{MHz}$	-3	—	dB
		$F=F_0-1\text{MHz}$	-3	—	dB
		$F=F_0+2\text{MHz}$	-28	—	dB
		$F=F_0-2\text{MHz}$	-30	—	dB
		$F=F_0+3\text{MHz}$	-31	—	dB
		$F=F_0-3\text{MHz}$	-33	—	dB
		$F>F_0+3\text{MHz}$	-32	—	dB
	$F>F_0-3\text{MHz}$	-36	—	dB	
Image frequency		-32	—	—	dB
Adjacent channel to image frequency					
		$F=F_{image}+1\text{MHz}$	-39	—	dB
	$F=F_{image}-1\text{MHz}$	-31	—	—	dBm
Out-of-band blocking performance					
		30MHz~2000MHz	-9	—	dBm
		2003MHz~2399MHz	-18	—	dBm
		2484MHz~2997MHz	-15	—	dBm
	3000MHz~12.75GHz	-5	—	—	dBm
Intermodulation		-29	—	—	

Table 23: Receiver Characteristics Bluetooth LE 2 Mbps

Parameter	Description	Min	Typ	Max	Unit
Sensitivity	@30.8%PER	—	-92.5	—	dBm
Maximum received signal	@30.8%PER	-3	—	—	dBm
Co-channel	C/I $F=F_0\text{MHz}$	-10	—	—	dB
	$F=F_0+2\text{MHz}$	-8	—	—	dB
	$F=F_0-2\text{MHz}$	-5	—	—	dB

Cont'd on next page

Table 23 – cont'd from previous page

Parameter	Description	Min	Typ	Max	Unit
		$F=F_0+4\text{MHz}$	-31	-	dB
		$F=F_0-4\text{MHz}$	-33	-	dB
		$F=F_0+6\text{MHz}$	-37	-	dB
		$F=F_0-6\text{MHz}$	-37	-	dB
		$F>F_0+6\text{MHz}$	-40	-	dB
		$F>F_0-6\text{MHz}$	-40	-	dB
Image frequency		-	-31	-	dB
Adjacent channel to image frequency		$F=F_{\text{image}}+2\text{MHz}$	-37	-	dB
		$F=F_{\text{image}}-2\text{MHz}$	-8	-	dB
Out-of-band blocking performance		30MHz~2000MHz	-15	-	dBm
		2003MHz~2399MHz	-19	-	dBm
		2484MHz~2997MHz	-15	-	dBm
		3000MHz~12.75GHz	-6	-	dBm
Intermodulation		-	-29	-	dBm

Table 24: Receiver Characteristics Bluetooth LE 125 Kbps

Parameter	Description	Min	Typ	Max	Unit
Sensitivity	@30.8%PER	-	-103.5	-	dBm
Maximum received signal	@30.8%PER	-8	-	-	dBm
Co-channel C/I	$F=F_0\text{MHz}$	-6	-	-	dB
Adjacent channel selectivity C/I		$F=F_0+1\text{MHz}$	-6	-	dB
		$F=F_0-1\text{MHz}$	-5	-	dB
		$F=F_0+2\text{MHz}$	-32	-	dB
		$F=F_0-2\text{MHz}$	-39	-	dB
		$F=F_0+3\text{MHz}$	-35	-	dB
		$F=F_0-3\text{MHz}$	-45	-	dB
		$F>F_0+3\text{MHz}$	-35	-	dB
		$F>F_0-3\text{MHz}$	-48	-	dB
Image frequency		-	-35	-	dB
Adjacent channel to image frequency		$F=F_{\text{image}}+1\text{MHz}$	-49	-	dB
		$F=F_{\text{image}}-1\text{MHz}$	-32	-	dB

Table 25: Receiver Characteristics Bluetooth LE 500 Kbps

Parameter	Description	Min	Typ	Max	Unit
Sensitivity	@30.8%PER	-	-100	-	dBm
Maximum received signal	@30.8%PER	-8	-	-	dBm
Co-channel C/I	$F=F_0\text{MHz}$	-4	-	-	dB
	$F=F_0+1\text{MHz}$	-5	-	-	dB
	$F=F_0-1\text{MHz}$	-5	-	-	dB
	$F=F_0+2\text{MHz}$	-28	-	-	dB

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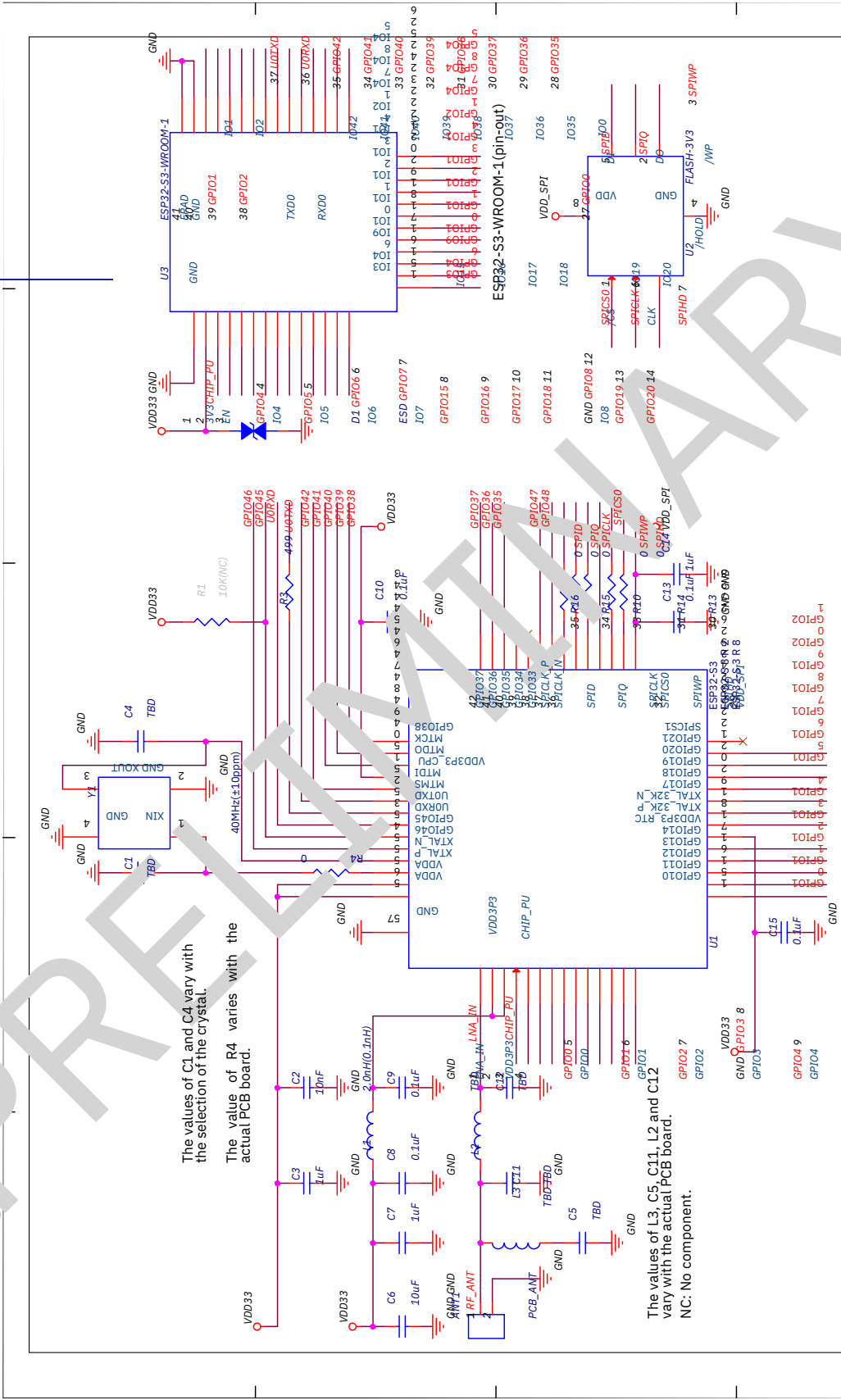
Adjacent channel selectivity C/I

Table 25 – cont'd from previous page

Parameter	Description	Min	Typ	Max	Unit
		$F=F_0-2\text{MHz}$	-36	—	dB
		$F=F_0+3\text{MHz}$	-36	—	dB
		$F=F_0-3\text{MHz}$	-38	—	dB
		$F>F_0+3\text{MHz}$	-37	—	dB
		$F>F_0-3\text{MHz}$	-41	—	dB
Image frequency		—	-37	—	dB
Adjacent channel to image frequency		$F=F_{\text{image}}+1\text{MHz}$	-44	—	dB
		$F=F_{\text{image}}-1\text{MHz}$	-28	—	dB

# 5 ModuleSchematics

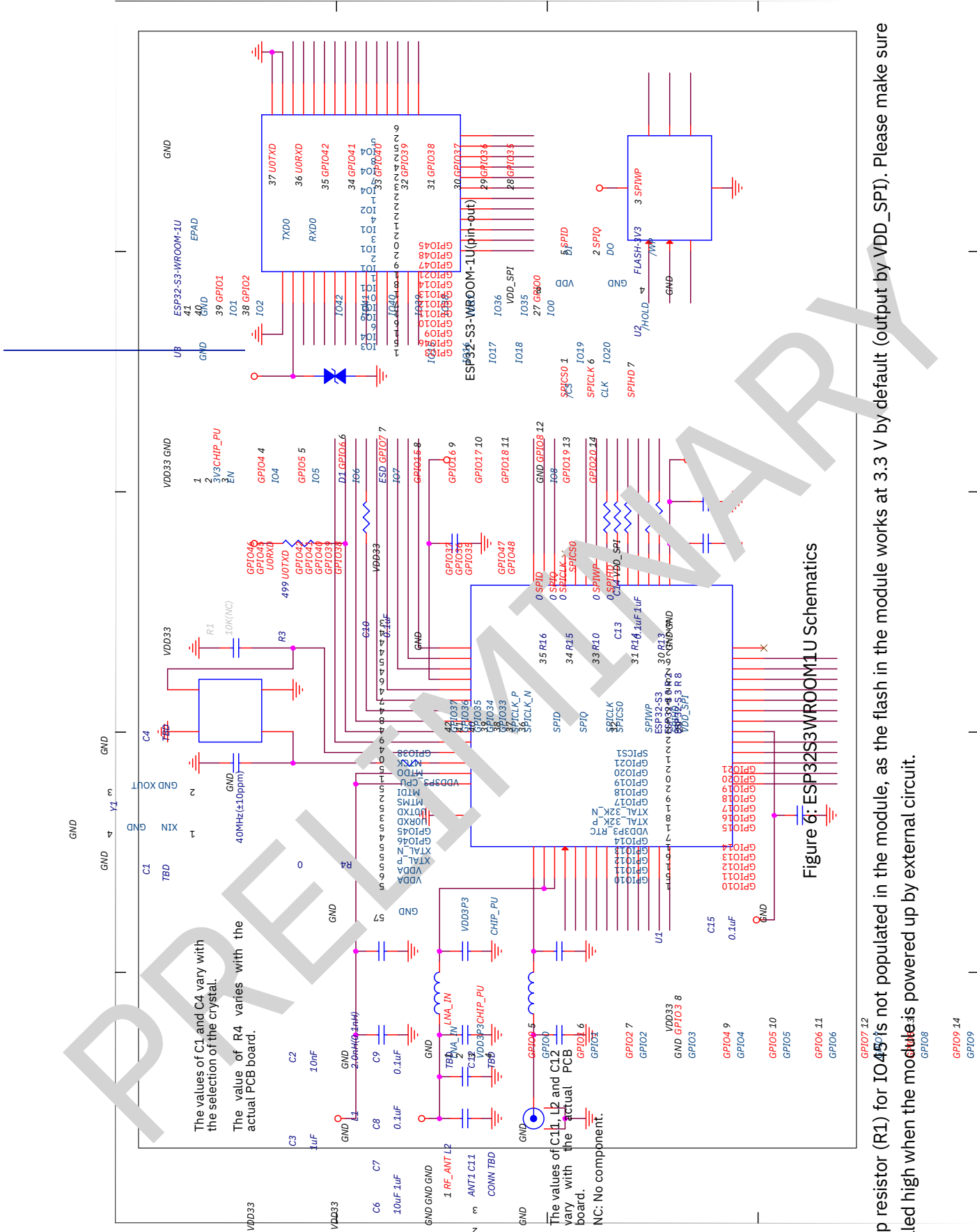
This is the reference design of the module.



The values of C1 and C4 vary with the selection of the crystal.  
The value of R4 varies with the actual PCB board.

The values of L3, C5, C11, L2 and C12 vary with the actual PCB board.  
NC: No component.

Figure 5: ESP32S3WROOM1 Schematics



Internal pull-up resistor (R1) for IO45 is not populated in the module, as the flash in the module works at 3.3 V by default (output by VDD\_SPI). Please make sure IO45 is not pulled high when the module is powered up by external circuit.



## 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).

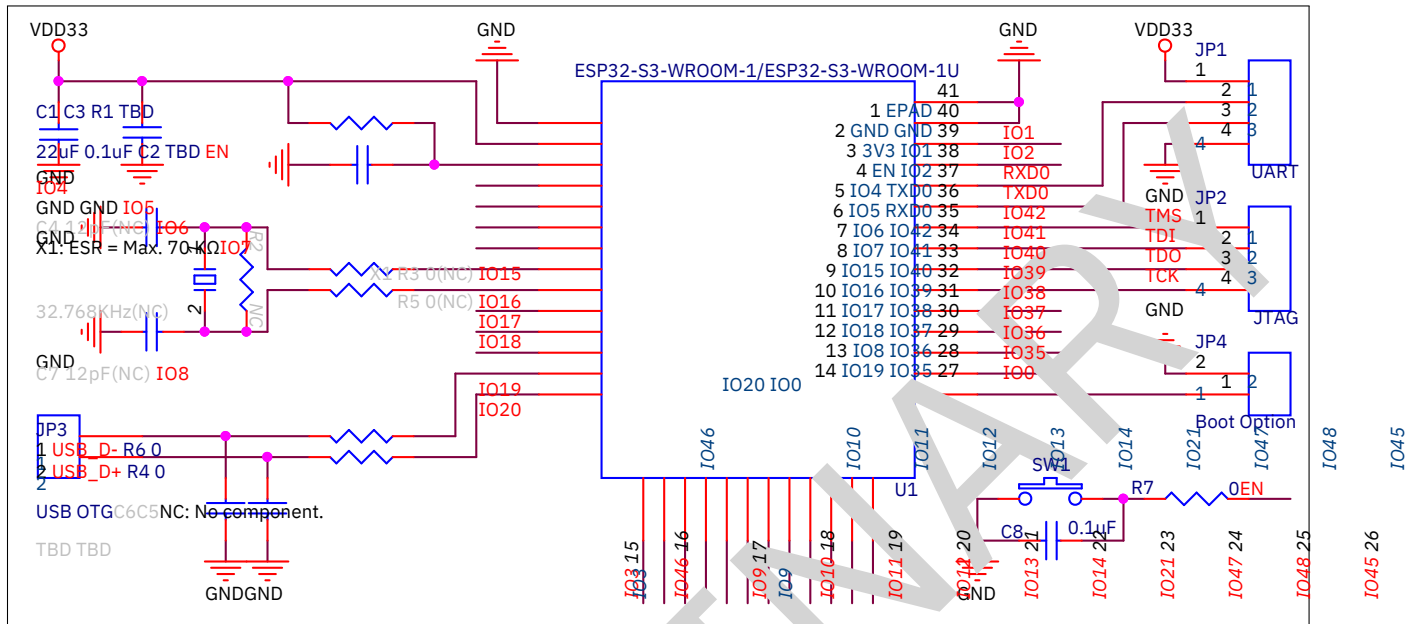


Figure 7: Peripheral Schematics

- Soldering the EPAD to the ground of the base board is not a must, however, it can optimize thermal performance. If you choose to solder it, please apply the correct amount of soldering paste.
- To ensure that the power supply to the ESP32-S3 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  $R = 10\text{ k}\Omega$  and  $C = 1\text{ }\mu\text{F}$ . 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 ESP32-S3's power-up and reset sequence timing diagram, please refer to Section *Power Scheme* in [ESP32-S3 Series Datasheet](#).

## 7 Physical Dimensions and PCB Land Pattern

### 7.1 Physical Dimensions

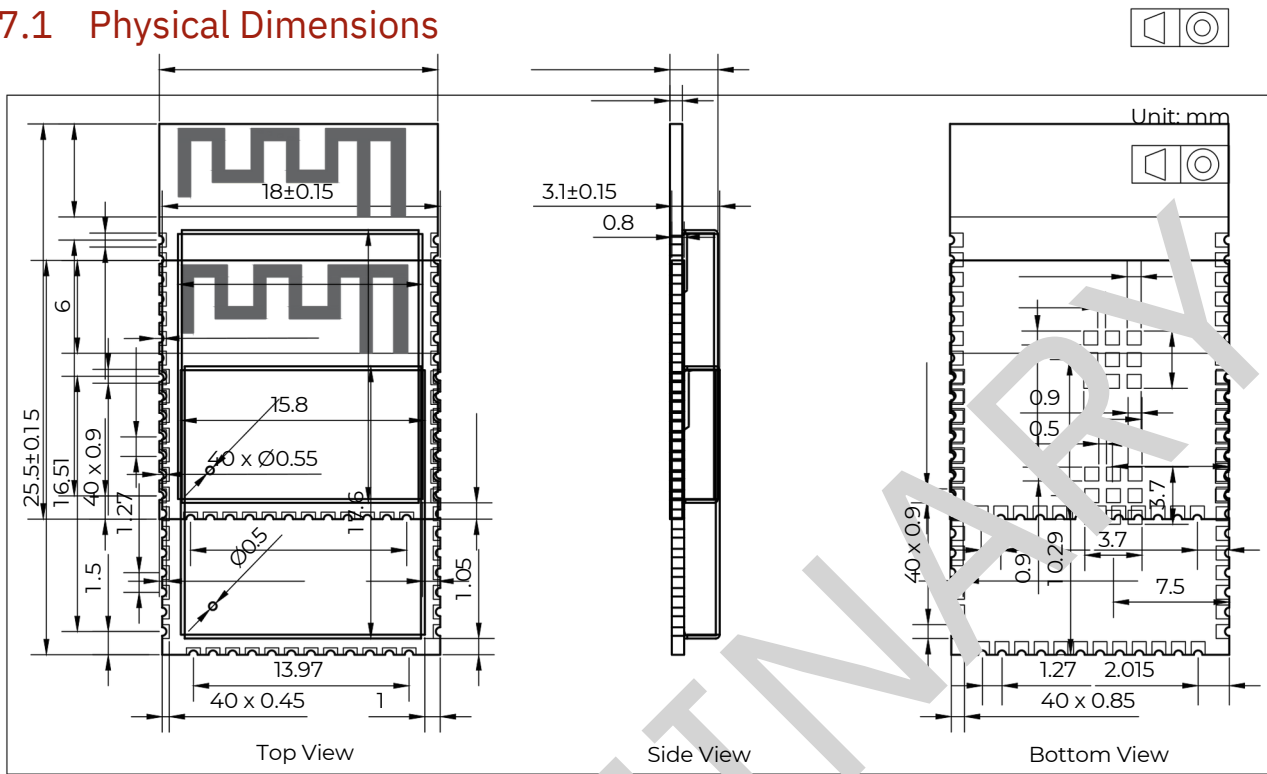


Figure 8: ESP32S3WROOM1 Physical Dimensions

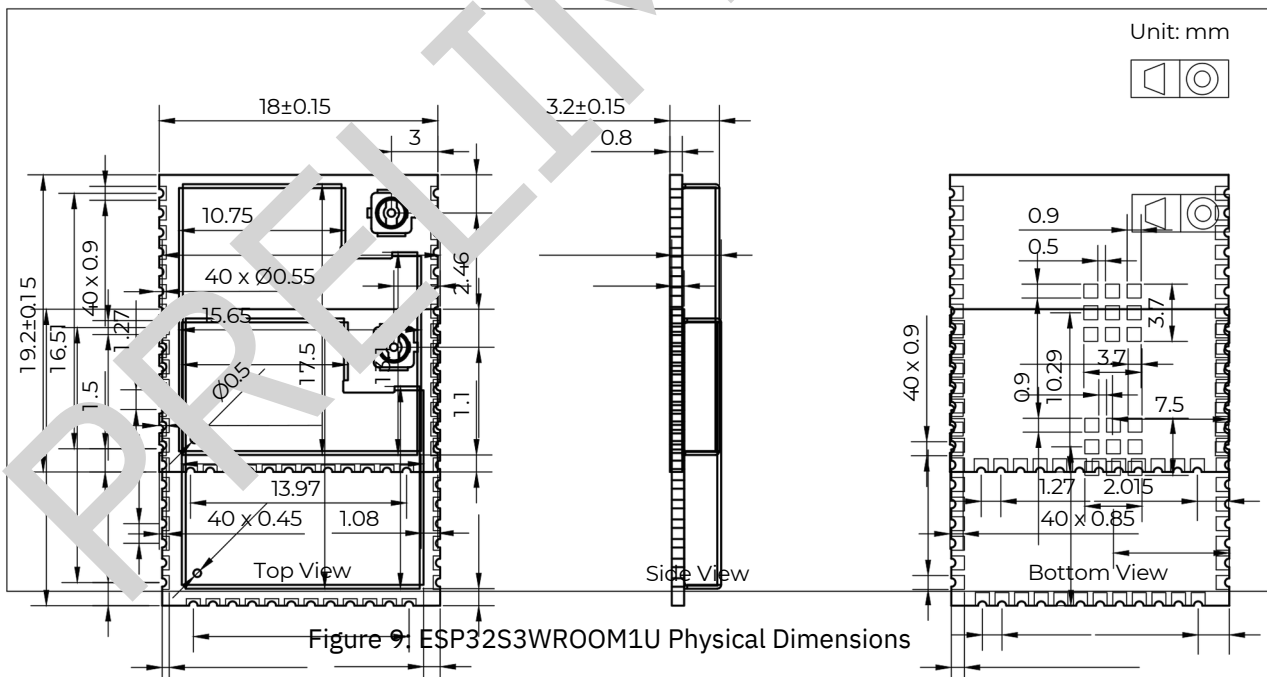


Figure 9: ESP32S3WROOM1U Physical Dimensions

**Note:**

For information about tape, reel, and product marking, please refer to [Espressif Module Package Information](#).





### 7.3 DimensionsofExternalAntennaConnector

ESP32-S3-WROOM-1U uses the first generation external antenna connector as shown in Figure 12. This connector is compatible with the following connectors:

- U.FL Series connector from Hirose
- MHF I connector from I-PEX
- AMC connector from Amphenol

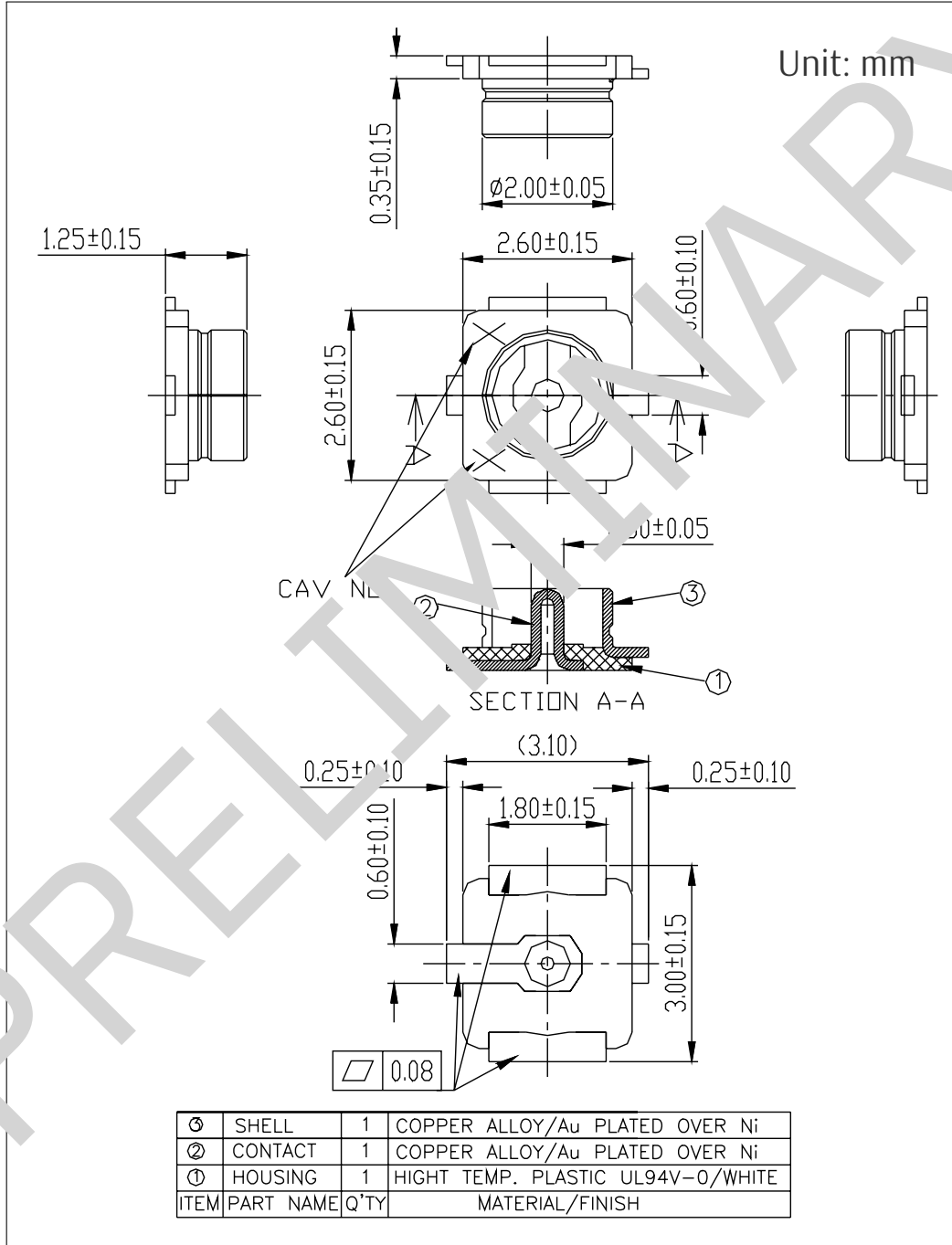


Figure 12: Dimensions of External Antenna Connector

## 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  $< 40\text{ }^{\circ}\text{C}$  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.

### 8.2 Electrostatic Discharge (ESD)

- Human body model (HBM):  $\pm 2000\text{ V}$
- Charged-device model (CDM):  $\pm 500\text{ V}$

### 8.3 Reflow Profile

Solder the module in a single reflow.

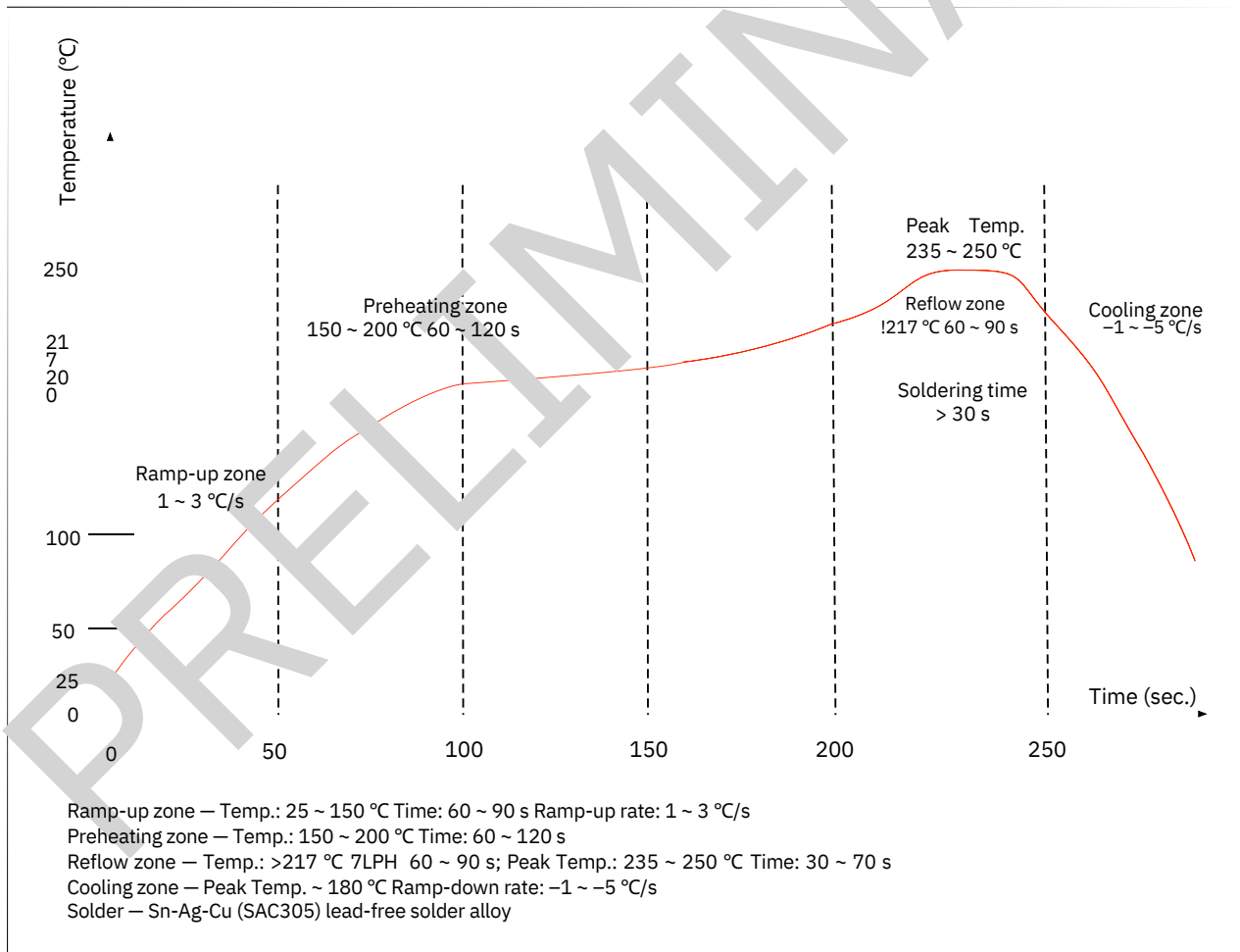


Figure 13: Reflow Profile

## 9 Related Documentation and Resources

### Related Documentation

- [ESP32-S3 Series Datasheet](#) – Specifications of the ESP32-S3 hardware.
- [ESP32-S3 Technical Reference Manual](#) – Detailed information on how to use the ESP32-S3 memory and peripherals.
- [ESP32-S3 Hardware Design Guidelines](#) – Guidelines on how to integrate the ESP32-S3 into your hardware product.
- *Certificates*  
<http://espressif.com/en/support/documents/certificates>
- *Documentation Updates and Update Notification Subscription*  
<http://espressif.com/en/support/download/documents>

### Developer Zone

- *ESP-IDF* and other development frameworks on GitHub.  
<http://github.com/espressif>
- *ESP32 BBS Forum* – Engineer-to-Engineer (E2E) Community for Espressif products where you can post questions, share knowledge, explore ideas, and help solve problems with fellow engineers.  
<http://esp32.com/>
- *The ESP Journal* – Best Practices, Articles, and Notes from Espressif folks.  
<http://blog.espressif.com/>
- See the tabs *SDKs and Demos, Apps, Tools, AT Firmware*.  
<http://espressif.com/en/support/download/sdks-demos>

### Products

- *ESP32-S3 Series SoCs* – Browse through all ESP32-S3 SoCs.  
<http://espressif.com/en/products/socs?id=ESP32-S3>
- *ESP32-S3 Series Modules* – Browse through all ESP32-S3-based modules.  
<http://espressif.com/en/products/modules?id=ESP32-S3>
- *ESP32-S3 Series DevKits* – Browse through all ESP32-S3-based devkits.  
<http://espressif.com/en/products/devkits?id=ESP32-S3>
- *ESP Product Selector* – Find an Espressif hardware product suitable for your needs by comparing or applying filters.  
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## Revision History

Date	Version	Release notes
2021-10-29	v0.6	Overall update for chip revision 1
2021-07-19	v0.5.1	Preliminary release, for chip revision 0

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