ESP8684-MINI-1
ESP8684-MINI-1U
Datasheet

Small-sized 2.4 GHz Wi-Fi (802.11 b/g/n) and Bluetooth$^{®}$ 5 module
Built around ESP8684 series of SoCs, RISC-V single-core microprocessor
14 GPIOs
On-board PCB antenna or external antenna connector

ESP8684-MINI-1

ESP8684-MINI-1U

Version0.5
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1   Module Overview

> **Note:**
>
> Check the link or the QR code to make sure that you use the latest version of this document:
> https://espressif.com/sites/default/files/documentation/esp8684-mini-1_mini-1u_datasheet_en.pdf

1.1   Features

CPU and On-Chip Memory

- ESP8684H2 or ESP8684H4 embedded, 32-bit RISC-V single-core processor, up to 120 MHz

- 576 KB ROM

- 272 KB SRAM (16 KB for cache)

- SiP flash (see details in Table 1 *Ordering Information*)

- Access to flash accelerated by cache

- Supports flash in-Circuit Programming (ICP)

Wi-Fi

- IEEE 802.11 b/g/n-compliant

- Center frequency range of operating channel: 2412 ~ 2484 MHz

- Supports 20 MHz bandwidth in 2.4 GHz band

- 1T1R mode with data rate up to 72.2 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)

- 3 × virtual Wi-Fi interfaces

- Simultaneous support for Infrastructure BSS in Station mode, SoftAP mode, Station + SoftAP mode, and promiscuous mode

Note that when ESP8684 series scans in Station mode, the SoftAP channel will change along with the Station channel

Bluetooth®

- Bluetooth LE: Bluetooth 5

- High power mode 20 dBm

- Speed: 125 kbps, 500 kbps, 1 Mbps, 2 Mbps

- Advertising extensions

- Multiple advertisement sets

- Channel selection algorithm #2

- Internal co-existence mechanism between Wi-Fi and Bluetooth to share the same antenna

Peripherals

- GPIO, SPI, UART, I2C, LED PWM controller, general DMA controller, temperature sensor, SAR ADC

Integrated Components on Module

- 26 MHz crystal oscillator

Antenna Options

- On-board PCB antenna (ESP8684-MINI-1)

- External antenna via a connector (ESP8684-MINI-1U)

Operating Conditions

- Operating voltage/Power supply: 3.0 ~ 3.6 V

- Operating ambient temperature: –40 ~ 105 °C

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1.2   Description

ESP8684-MINI-1 and ESP8684-MINI-1U are two general-purpose Wi-Fi and Bluetooth LE modules. The rich set of peripherals and a small size make the two modules an ideal choice for smart homes, industrial automation, health care, consumer electronics, etc.

The ordering information for the two modules is as follows:

Table 1: Ordering Information

Module	Ordering code	Chip embedded	SiP Flash[1]	Ambient Temp.[2] (°C)	Size[3] (mm)
ESP8684-MINI-1 (ANT)	ESP8684-MINI-1-H2	ESP8684H2	2 MB	–40 ~ 105	13.2 × 16.6 × 2.4
	ESP8684-MINI-1-H4	ESP8684H4	4 MB		
ESP8684-MINI-1U (CONN)	ESP8684-MINI-1U-H2	ESP8684H2	2 MB	–40 ~ 105	
	ESP8684-MINI-1U-H4	ESP8684H4	4 MB		13.2 × 12.5 × 2.4

[1] The flash is integrated in the chip's package.

[2] Ambient temperature specifies the recommended temperature range of the environment immediately outside the Espressif module.

[3] For details, refer to Section 7.1 *Physical Dimensions*.

ESP8684-MINI-1 comes with a PCB antenna. ESP8684-MINI-1U comes with a connector for an external antenna. Both ESP8684-MINI-1 and ESP8684-MINI-1U are available in two variants that integrate the ESP8684H2 and ESP8684H4 chip respectively.

The ESP8684H2 and the ESP8684H4 chip fall into the same category, namely ESP8684 chip series. ESP8684 series of chips have a 32-bit RISC-V single-core processor. They integrate a rich set of peripherals, ranging from UART, I2C, LED PWM controller, general DMA controller, temperature sensor, and SAR ADC. It also includes SPI, Dual SPI and Quad SPI interfaces.

ESP8684H2 and ESP8684H4 chip vary only in the size of system in package (SiP) flash. For details, please refer to *ESP8684 Series Comparison* in *ESP8684 Series Datasheet*.

1.3   Applications

- Smart Home
  - Light control
  - Smart button
  - Smart plug
  - Indoor positioning
- Industrial Automation
  - Industrial robot
  - Industrial field bus
- Consumer Electronics
  - Smart watch and bracelet
  - Over-the-top (OTT) devices
  - Logger toys and proximity sensing toys
- Health Care
  - Health monitor
  - Baby monitor
- Smart Agriculture
  - Smart greenhouse
  - Smart irrigation

- – Agriculture robot
- – Service robot
- Retail and Catering
- Generic Low-power IoT Sensor Hubs
  - – POS machines
- Generic Low-power IoT Data Loggers

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Figure 1: ESP8684-MINI-1 Block Diagram

Figure 2: ESP8684-MINI-1U 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 layout of ESP8684-MINI-1U is the same as that of ESP8684-MINI-1, except that ESP8684-MINI-1U has no keepout zone.
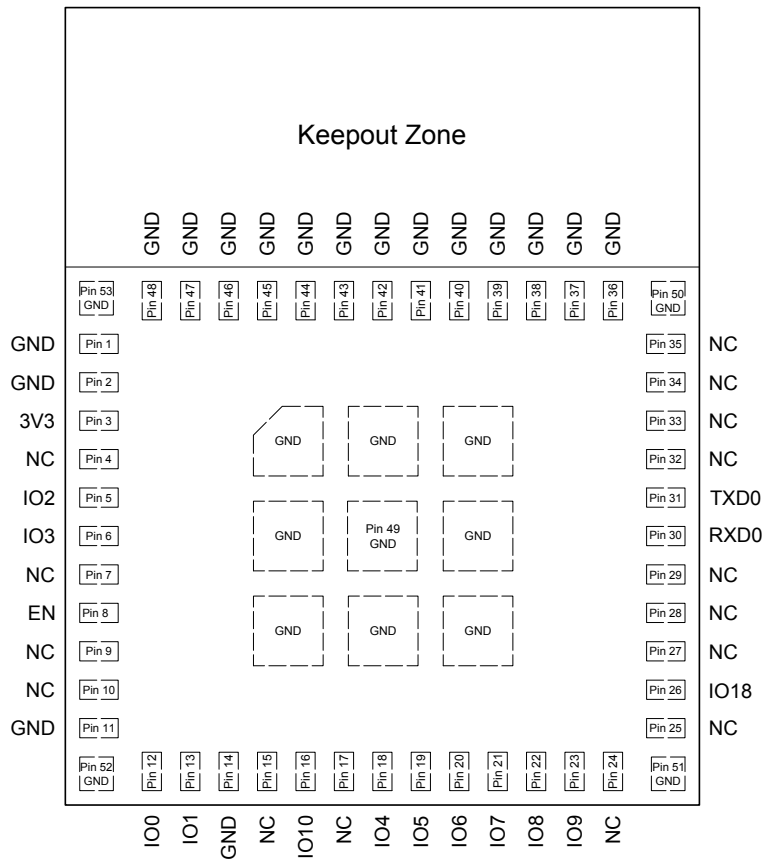
Figure 3: ESP8684-MINI-1 Pin Layout (Top View)

3.2 Pin Description

The module has 53 pins. See pin definitions in Table 2.

For peripheral pin configurations, please refer to *ESP8684 Series Datasheet*.

Table 2: Pin Definitions

Name	No.	Type[1]	Function
GND	1, 2, 11, 14, 36-53	P	Ground
3V3	3	P	Power supply

Cont'd on next page

<p style="text-align:center">Table 2 – cont'd from previous page</p>

Name	No.	Type[1]	Function
NC	4, 7, 9, 10, 15, 17, 24, 25, 27, 28, 29, 32-35	—	Not connected
IO2	5	I/O/T	GPIO2, ADC1_CH2, FSPIQ
IO3	6	I/O/T	GPIO3, ADC1_CH3
EN	8	I	High: on, enables the chip. Low: off, the chip powers off. Note: Do not leave the EN pin floating.
IO0	12	I/O/T	GPIO0, ADC1_CH0
IO1	13	I/O/T	GPIO1, ADC1_CH1
IO10	16	I/O/T	GPIO10, FSPICS0
IO4	18	I/O/T	GPIO4, ADC1_CH4, FSPIHD, MTMS
IO5	19	I/O/T	GPIO5, FSPIWP, MTDI
IO6	20	I/O/T	GPIO6, FSPICLK, MTCK
IO7	21	I/O/T	GPIO7, FSPID, MTDO
IO8	22	I/O/T	GPIO8
IO9	23	I/O/T	GPIO9
IO18	26	I/O/T	GPIO18
RXD0	30	I/O/T	GPIO19, U0RXD
TXD0	31	I/O/T	GPIO20, U0TXD

[1] P: power supply; I: input; O: output; T: high impedance.

3.3   Strapping Pins

> **Note:**
> The content below is excerpted from Section Strapping Pins in *ESP8684 Series Datasheet*. For the strapping pin mapping between the chip and modules, please refer to Chapter 5 *Module Schematics*.

ESP8684 series has two strapping pins:

- GPIO8
- GPIO9

Software can read the values of GPIO8 and GPIO9 from GPIO_STRAPPING field in GPIO_STRAP_REG register. For register description, please refer to Section GPIO Matrix Register Summary in *ESP8684 Technical Reference Manual*.

During the chip's power-on reset, RTC watchdog reset, and brownout 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.

By default, GPIO9 is connected to the internal weak pull-up resistor. If GPIO9 is not connected or connected to an external high-impedance circuit, the latched bit value will be "1".

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 ESP8684.

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

Table 3 lists detailed booting configurations of the strapping pins.

Table 3: Strapping Pins

Booting Mode [1]			
Pin	Default	SPI Boot	Download Boot
GPIO8	N/A	Don't care	1
GPIO9	Internal weak pull-up	1	0
Enabling/Disabling ROM Messages Print During Booting			
Pin	Default	Functionality	
GPIO8	N/A	When the value of eFuse field EFUSE_UART_PRINT_CONTROL is 0 (default), print is enabled and not controlled by GPIO8. 1, if GPIO8 is 0, print is enabled; if GPIO8 is 1, it is disabled. 2, if GPIO8 is 0, print is disabled; if GPIO8 is 1, it is enabled. 3, print is disabled and not controlled by GPIO8.	

[1] The strapping combination of GPIO8 = 0 and GPIO9 = 0 is invalid and will trigger unexpected behavior.

Figure 4 shows the setup and hold times for the strapping pins before and after the CHIP_EN signal goes high. Details about the parameters are listed in Table 4.
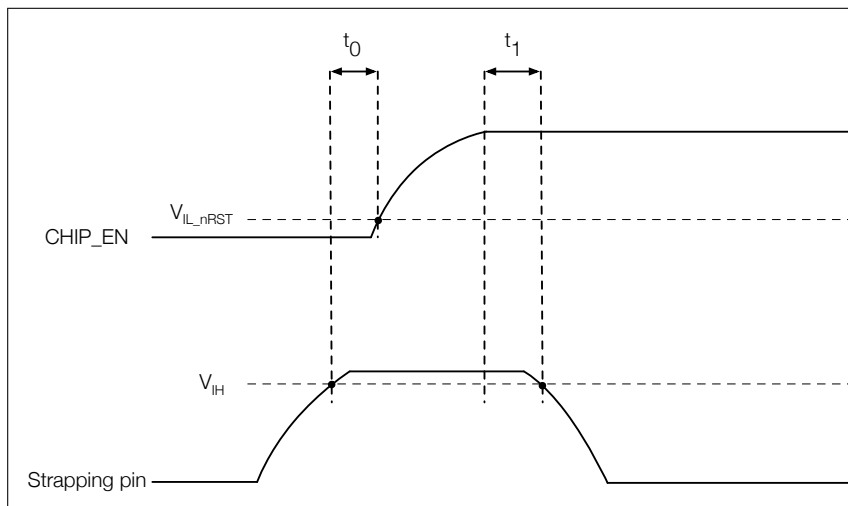

Figure 4: Setup and Hold Times for the Strapping Pins

Table 4: Parameter Descriptions of Setup and Hold Times for the Strapping Pins

Parameter	Description	Min (ms)
t_0	Setup time before CHIP_EN goes from low to high	0
t_1	Hold time after CHIP_EN goes high	3

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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 beyond the absolute maximum ratings listed in the table below may cause permanent damage to the device. These are stress ratings only, and do not refer to the functional operation of the device. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

Table 5: Absolute Maximum Ratings

Symbol	Parameter	Min	Max	Unit
VDD33	Voltage applied to power supply pins per power domain	–0.3	3.6	V
T_{STORE}	Storage temperature	–40	105	°C

4.2   Recommended Operating Conditions

Table 6: Recommended Operating Conditions

Symbol	Parameter	Min	Typ	Max	Unit
VDD33	Voltage applied to power supply pin	3.0	3.3	3.6	V
I_{VDD}	Current delivered by external power supply	0.5	—	—	A
T_A	Operating ambient temperature	-40	—	105	°C

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

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 *ESP8684 Series Datasheet*.

Table 8: Current Consumption Depending on RF Modes

Work mode	Description		Peak (mA)
Active (RF working)	TX	802.11b, 1 Mbps, @21 dBm	370
		802.11g, 54 Mbps, @19 dBm	320
		802.11n, HT20, MCS7, @18 dBm	300
	RX	802.11b/g/n, HT20	65

[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 in Low-Power Modes

Work mode	Description	Typ	Unit
Light-sleep	—	140	μA
Deep-sleep	Only RTC timer is powered on	5	μA
Power off	CHIP_EN is set to low level, and the chip is powered off	1	μA

Table 10: Current Consumption in Modem-sleep Mode

Work mode	Frequency (MHz)	Description	Typ[1] (mA)	Typ[2] (mA)
Modem-sleep[3]	80	WFI (Wait-for-Interrupt)	9.4	10.3
		CPU run at full speed	12.1	13.0
	120	WFI (Wait-for-Interrupt)	10.7	11.5
		CPU run at full speed	14.7	15.6

[1] Current consumption when all peripheral clocks are **disabled**.

[2] Current consumption when all peripheral clocks are **enabled**. In practice, the current consumption might be different depending on which peripherals are enabled.

[3] In Modem-sleep mode, Wi-Fi is clock gated, and the current consumption might be higher when accessing flash. For a flash rated at 80 Mbit/s, in SPI 2-line mode the consumption is 10 mA.

4.5   Wi-Fi Radio

4.5.1   Wi-Fi RF Standards

Table 11: 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)
Antenna type	PCB antenna and external antenna 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 antenna connectors, the output impedance is 50 Ω. For other modules without external antenna connectors, the output impedance is irrelevant.

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 12.

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

Rate	Min (dBm)	Typ (dBm)	Max (dBm)
802.11b, 1 Mbps	—	21	—
802.11b, 11 Mbps	—	21	—
802.11g, 6 Mbps	—	21	—
802.11g, 54 Mbps	—	19	—
802.11n, HT20, MCS0	—	20	—
802.11n, HT20, MCS7	—	18	—

Table 13: TX EVM Test

Rate	Min (dB)	Typ (dB)	SL[1] (dB)
802.11b, 1 Mbps, @21 dBm	—	-24	−10
802.11b, 11 Mbps, @21 dBm	—	-24	−10
802.11g, 6 Mbps, @21 dBm	—	-23	−5
802.11g, 54 Mbps, @19 dBm	—	-30	−25
802.11n, HT20, MCS0, @20 dBm	—	-25	−5
802.11n, HT20, MCS7, @18 dBm	—	-31	−27

[1] SL stands for standard limit value.

4.5.3   Wi-Fi RF Receiver (RX) Specifications

Table 14: RX Sensitivity

Rate	Min (dBm)	Typ (dBm)	Max (dBm)
802.11b, 1 Mbps	—	-98.0	—
802.11b, 2 Mbps	—	-96.5	—
802.11b, 5.5 Mbps	—	−94.0	—
802.11b, 11 Mbps	—	−90.0	—
802.11g, 6 Mbps	—	−94.0	—
802.11g, 9 Mbps	—	−92.0	—
802.11g, 12 Mbps	—	−91.0	—
802.11g, 18 Mbps	—	−89.0	—
802.11g, 24 Mbps	—	−86.0	—
802.11g, 36 Mbps	—	−83.0	—
802.11g, 48 Mbps	—	−78.5	—
802.11g, 54 Mbps	—	−77.0	—
802.11n, HT20, MCS0	—	−92.5	—
802.11n, HT20, MCS1	—	−90.5	—
802.11n, HT20, MCS2	—	−87.5	—
802.11n, HT20, MCS3	—	−84.5	—
802.11n, HT20, MCS4	—	−81.5	—
802.11n, HT20, MCS5	—	−77.5	—
802.11n, HT20, MCS6	—	−75.5	—
802.11n, HT20, MCS7	—	−74.0	—

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, MCS0	—	5	—
802.11n, HT20, MCS7	—	0	—

Table 16: RX Adjacent Channel Rejection

Rate	Min (dB)	Typ (dB)	Max (dB)
802.11b, 1 Mbps	—	35	—
802.11b, 11 Mbps	—	35	—

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Table 16 – cont'd from previous page

Rate	Min (dB)	Typ (dB)	Max (dB)
802.11g, 6 Mbps	—	31	—
802.11g, 54 Mbps	—	20	—
802.11n, HT20, MCS0	—	16	—
802.11n, HT20, MCS7	—	25	—

4.6   Bluetooth LE Radio

4.6.1   Bluetooth LE RF Transmitter (TX) Specifications

Table 17: Transmitter General Characteristics

Parameter	Min	Typ	Max	Unit
RF transmit power	—	3	—	dBm
Gain control step	—	3	—	dB
RF power control range	−24	—	21	dBm

Table 18: Transmitter Characteristics - Bluetooth LE 1 Mbps

Parameter	Description	Min	Typ	Max	Unit
In-band emissions	F = F0 ± 2 MHz	—	−32.0	—	dBm
	F = F0 ± 3 MHz	—	−38.0	—	dBm
	F = F0 ± > 3 MHz	—	−41.0	—	dBm
Modulation characteristics	$\Delta f1_{avg}$	—	249.0	—	kHz
	$\Delta f2_{max}$	—	246.0	—	kHz
	$\Delta f2_{avg}/\Delta f1_{avg}$	—	1.1	—	—
Carrier frequency offset	$\text{Max } |f_n||_{n=0, 1, 2, ..k}$	—	2.0	—	kHz
Carrier frequency drift	$\text{Max } |f_0 - f_n||_{n=2, 3, 4, ..k}$	—	1.0	—	kHz
	$\text{Max } |f_0 - f_1|$	—	0.5	—	kHz
	$\text{Max } |f_n - f_{n-5}||_{n=6, 7, 8, ..k}$	—	1.0	—	kHz

Table 19: Transmitter Characteristics - Bluetooth LE 2 Mbps

Parameter	Description	Min	Typ	Max	Unit
In-band emissions	F = F0 ± 4 MHz	—	−40.0	—	dBm
	F = F0 ± 5 MHz	—	−43.0	—	dBm
	F = F0 ± > 5 MHz	—	−44.0	—	dBm
Modulation characteristics	$\Delta f1_{avg}$	—	498.0	—	kHz
	$\Delta f2_{max}$	—	589.0	—	kHz
	$\Delta f2_{avg}/\Delta f1_{avg}$	—	1.2	—	—
Carrier frequency offset	$\text{Max } |f_n||_{n=0, 1, 2, ..k}$	—	1.0	—	kHz

Cont'd on next page

Table 19 – cont'd from previous page

Parameter	Description	Min	Typ	Max	Unit
Carrier frequency drift	Max $|f_0 - f_n|_{n=2, 3, 4, ..k}$	—	3.0	—	kHz
	Max $|f_0 - f_1|$	—	2.4	—	kHz
	Max $|f_n - f_{n-5}|_{n=6, 7, 8, ..k}$	—	1.2	—	kHz

Table 20: Transmitter Characteristics - Bluetooth LE 125 Kbps

Parameter	Description	Min	Typ	Max	Unit
In-band emissions	F = F0 ± 2 MHz	—	−32.0	—	dBm
	F = F0 ± 3 MHz	—	−38.0	—	dBm
	F = F0 ± > 3 MHz	—	−41.0	—	dBm
Modulation characteristics	$\Delta f1_{avg}$	—	248.0	—	kHz
	$\Delta f1_{max}$	—	224.0	—	kHz
Carrier frequency offset	Max $|f_n|_{n=0, 1, 2, ..k}$	—	0.5	—	kHz
Carrier frequency drift	Max $|f_0 - f_n|_{n=1, 2, 3, ..k}$	—	0.7	—	kHz
	Max $|f_0 - f_3|$	—	0.2	—	kHz
	Max $|f_n - f_{n-3}|_{n=7, 8, 9, ..k}$	—	0.7	—	kHz

Table 21: Transmitter Characteristics - Bluetooth LE 500 Kbps

Parameter	Description	Min	Typ	Max	Unit
In-band emissions	F = F0 ± 2 MHz	—	−32.0	—	dBm
	F = F0 ± 3 MHz	—	−38.0	—	dBm
	F = F0 ± > 3 MHz	—	−41.0	—	dBm
Modulation characteristics	$\Delta f2_{avg}$	—	273.0	—	kHz
	$\Delta f2_{max}$	—	243.0	—	kHz
Carrier frequency offset	Max $|f_n|_{n=0, 1, 2, ..k}$	—	0.5	—	kHz
Carrier frequency drift	Max $|f_0 - f_n|_{n=1, 2, 3, ..k}$	—	0.7	—	kHz
	Max $|f_0 - f_3|$	—	0.7	—	kHz
	Max $|f_n - f_{n-3}|_{n=7, 8, 9, ..k}$	—	0.2	—	kHz

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	—	—	−98	—	dBm
Maximum received signal @30.8% PER	—	—	8	—	dBm
Co-channel C/I	—	—	8	—	dB

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Table 22 – cont'd from previous page

Parameter	Description	Min	Typ	Max	Unit
Adjacent channel selectivity C/I	F = F0 + 1 MHz	—	–1	—	dB
	F = F0 – 1 MHz	—	–3	—	dB
	F = F0 + 2 MHz	—	–26	—	dB
	F = F0 – 2 MHz	—	–28	—	dB
	$F \geq F0 + 3$ MHz[1]	—	—	—	dB
	$F \leq F0 - 3$ MHz	—	–31	—	dB
Image frequency	—	—	–33	—	dB
Adjacent channel to image frequency	$F = F_{image} + 1$ MHz	—	–32	—	dB
	$F = F_{image} - 1$ MHz	—	–34	—	dB
Out-of-band blocking performance	30 MHz ∼ 2000 MHz	—	–23	—	dBm
	2003 MHz ∼ 2399 MHz	—	–30	—	dBm
	2484 MHz ∼ 2997 MHz	—	–10	—	dBm
	3000 MHz ∼ 12.75 GHz	—	–17	—	dBm
Intermodulation	—	—	–31	—	dBm

[1] Refer to the value of adjacent channel to image frequency when $F = F_{image} - 1$ MHz.

Table 23: Receiver Characteristics - Bluetooth LE 2 Mbps

Parameter	Description	Min	Typ	Max	Unit
Sensitivity @30.8% PER	—	—	–95	—	dBm
Maximum received signal @30.8% PER	—	—	8	—	dBm
Co-channel C/I	F = F0 MHz	—	9	—	dB
Adjacent channel selectivity C/I	F = F0 + 2 MHz	—	–11	—	dB
	F = F0 – 2 MHz	—	–7	—	dB
	F = F0 + 4 MHz[1]	—	—	—	dB
	F = F0 – 4 MHz	—	–30	—	dB
	$F \geq F0 + 6$ MHz	—	–35	—	dB
	$F \leq F0 - 6$ MHz	—	–29	—	dB
Image frequency	—	—	–35	—	dB
Adjacent channel to image frequency	$F = F_{image} + 2$ MHz	—	–35	—	dB
	$F = F_{image} - 2$ MHz[2]	—	—	—	dB
Out-of-band blocking performance	30 MHz ∼ 2000 MHz	—	–30	—	dBm
	2003 MHz ∼ 2399 MHz	—	–34	—	dBm
	2484 MHz ∼ 2997 MHz	—	–19	—	dBm
	3000 MHz ∼ 12.75 GHz	—	–28	—	dBm
Intermodulation	—	—	–33	—	dBm

[1] Refer to the value of Image frequency.

[2] Refer to the value of Adjacent channel selectivity C/I when F = F0 + 2 MHz.

Table 24: Receiver Characteristics - Bluetooth LE 125 Kbps

Parameter	Description	Min	Typ	Max	Unit
Sensitivity @30.8% PER	—	—	−106	—	dBm
Maximum received signal @30.8% PER	—	—	8	—	dBm
Co-channel C/I	F = F0 MHz	—	3	—	dB
Adjacent channel selectivity C/I	F = F0 + 1 MHz	—	−7	—	dB
	F = F0 − 1 MHz	—	−5	—	dB
	F = F0 + 2 MHz	—	-35	—	dB
	F = F0 − 2 MHz	—	−34	—	dB
	F ≥ F0 + 3 MHz[1]	—	—	—	dB
	F ≤ F0 − 3 MHz	—	−37	—	dB
Image frequency	—	—	−41	—	dB
Adjacent channel to image frequency	F = F_{image} + 1 MHz	—	−43	—	dB
	F = F_{image} − 1 MHz	—	−38	—	dB

[1] Refer to the value of Adjacent channel to image frequency when F = F_{image} − 1 MHz.

Table 25: Receiver Characteristics - Bluetooth LE 500 Kbps

Parameter	Description	Min	Typ	Max	Unit
Sensitivity @30.8% PER	—	—	−102	—	dBm
Maximum received signal @30.8% PER	—	—	8	—	dBm
Co-channel C/I	F = F0 MHz	—	4	—	dB
Adjacent channel selectivity C/I	F = F0 + 1 MHz	—	−6	—	dB
	F = F0 − 1 MHz	—	−5	—	dB
	F = F0 + 2 MHz	—	−29	—	dB
	F = F0 − 2 MHz	—	−32	—	dB
	F ≥ F0 + 3 MHz[1]	—	—	—	dB
	F ≤ F0 − 3 MHz	—	−36	—	dB
Image frequency	—	—	−34	—	dB
Adjacent channel to image frequency	F = F_{image} + 1 MHz	—	−37	—	dB
	F = F_{image} − 1 MHz	—	−31	—	dB

[1] Refer to the value of Adjacent channel to image frequency when F = F_{image} − 1 MHz.

5   Module Schematics

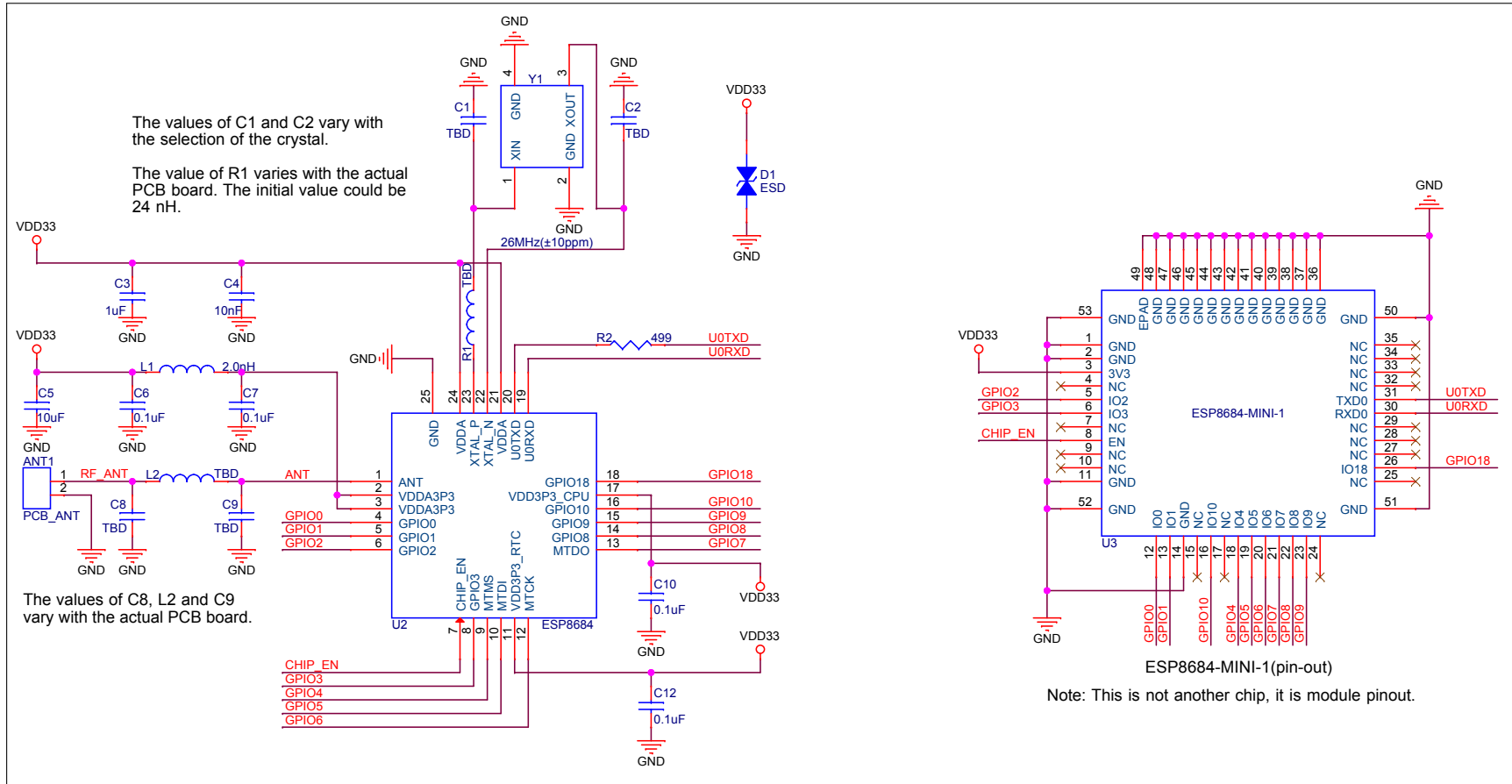This is the reference design of the module.
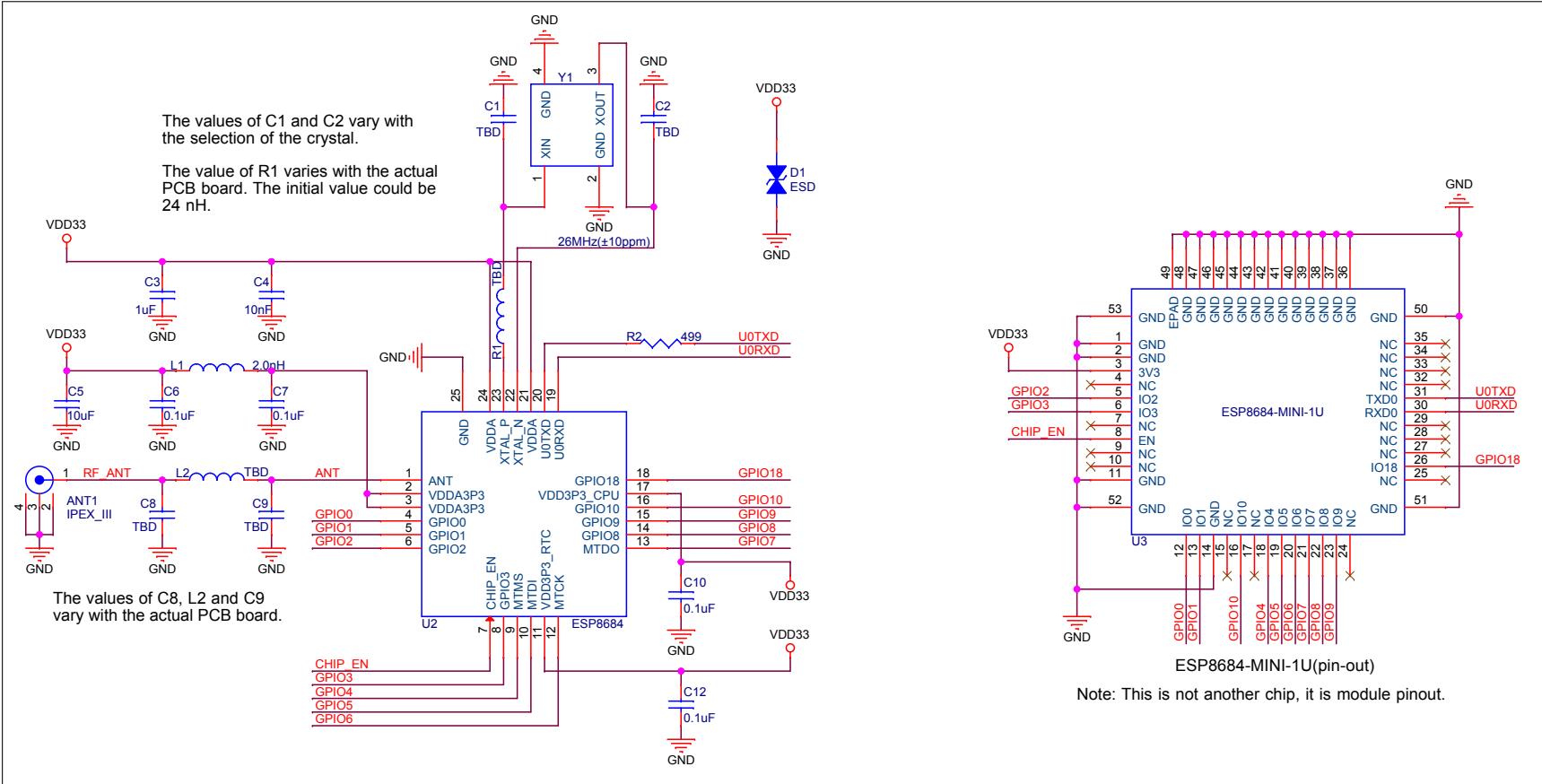

Figure 5: ESP8684-MINI-1 Schematics

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

The value of R1 varies with the actual PCB board. The initial value could be 24 nH.

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

ESP8684-MINI-1U(pin-out)

Note: This is not another chip, it is module pinout.

Figure 6: ESP8684-MINI-1U 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 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 ESP8684 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 ESP8684's power-up and reset sequence timing diagram, please refer to Section *Power Scheme* in *ESP8684 Series Datasheet*.

- JTAG interface is optional.

- Boot Option, TXD0 and RXD0 are used as firmware download and debug port.

7   Physical Dimensions and PCB Land Pattern

7.1   Physical Dimensions
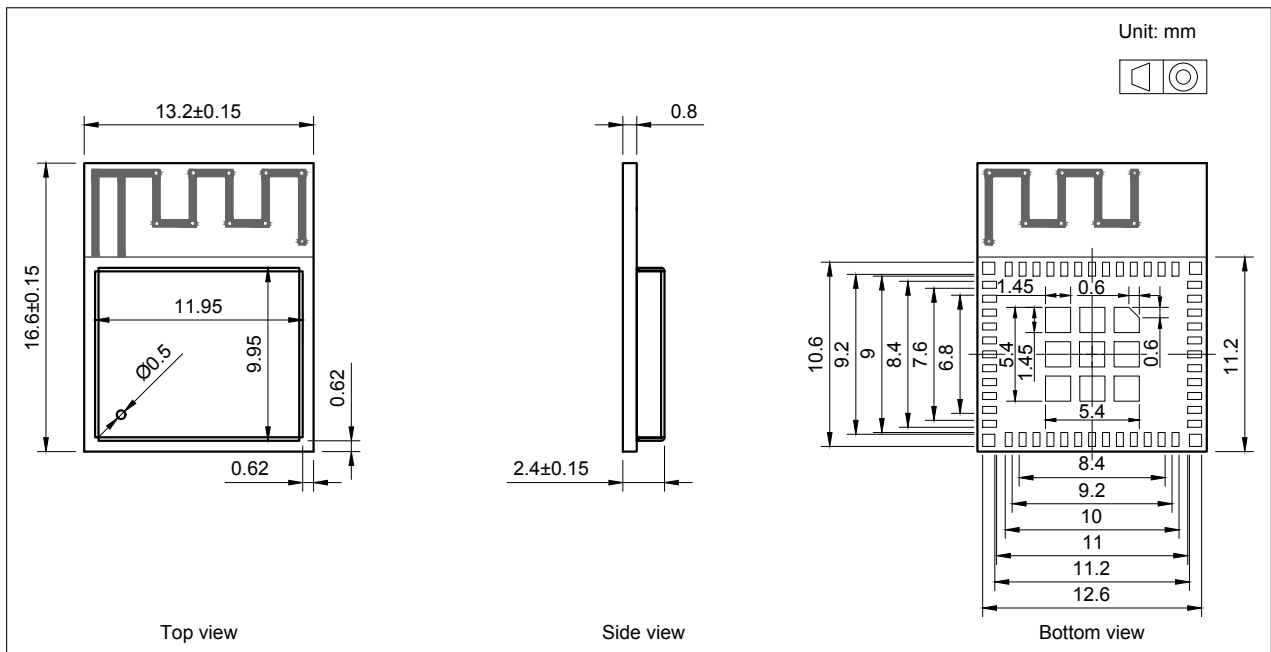
Figure 8: ESP8684-MINI-1 Physical Dimensions
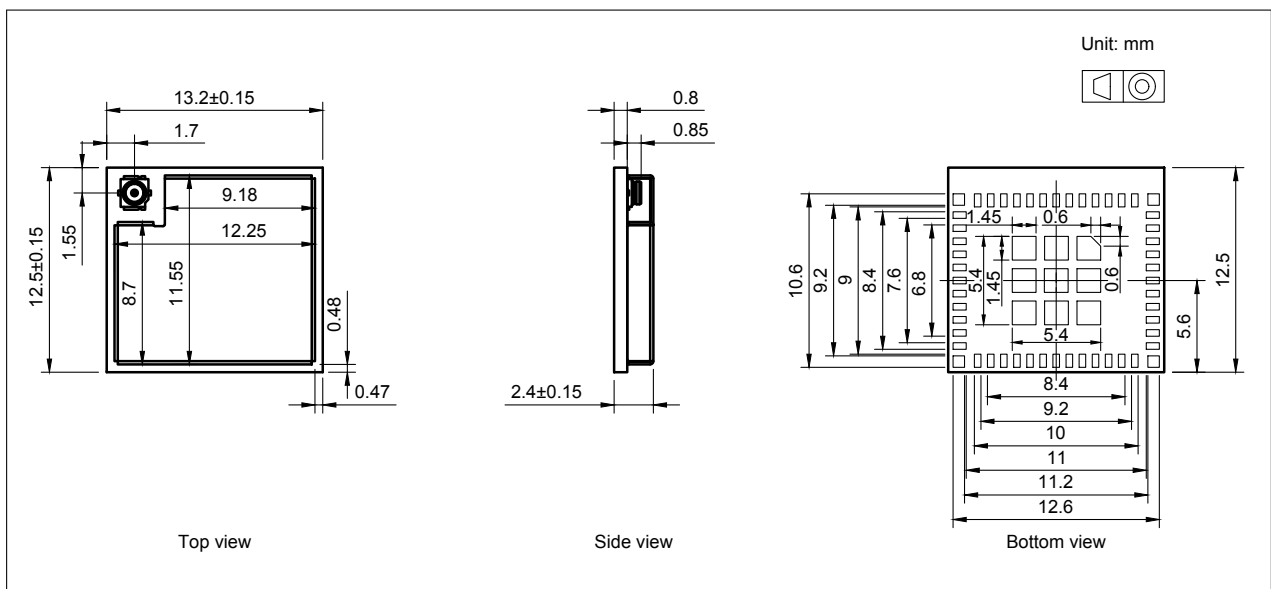
Figure 9: ESP8684-MINI-1U Physical Dimensions

Note:

For information about tape, reel, and product marking, please refer to *Espressif Module Package Information*.

7.2   Recommended PCB Land Pattern
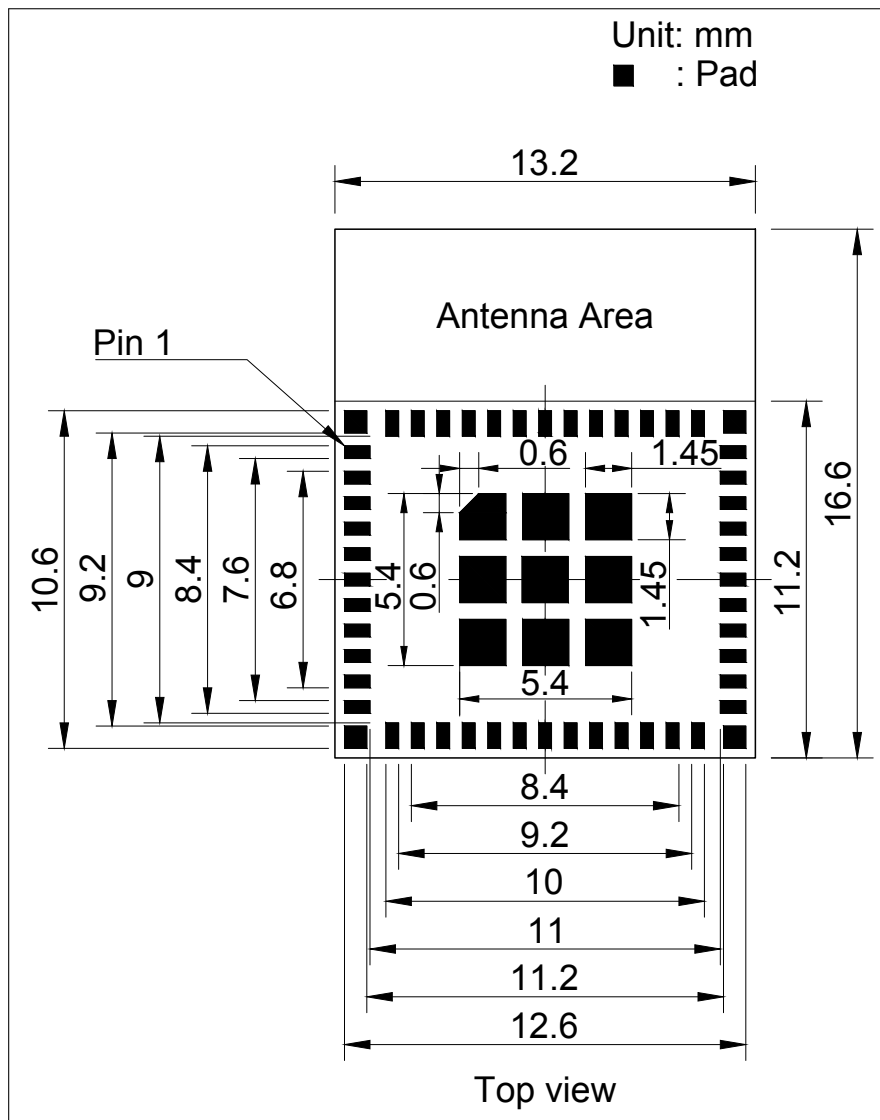
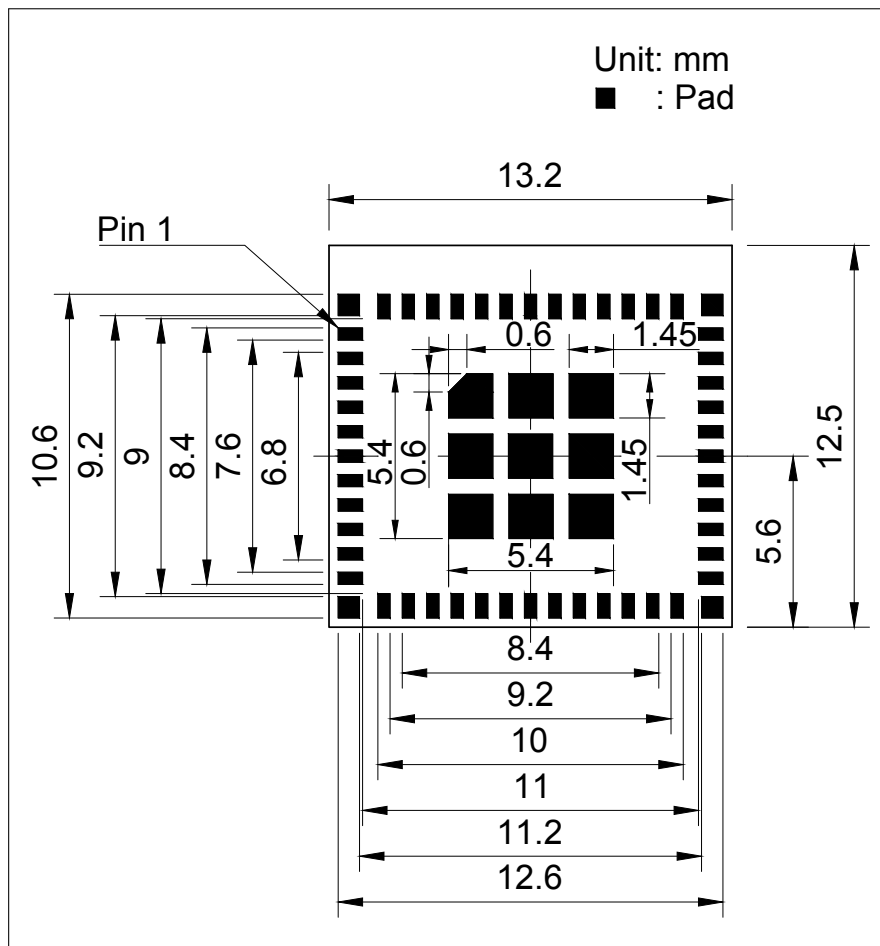**Figure 10: ESP8684-MINI-1 Recommended PCB Land Pattern**

Figure 11: ESP8684-MINI-1U Recommended PCB Land Pattern

7.3 Dimensions of External Antenna Connector

ESP8684-MINI-1U uses the third generation external antenna connector as shown in Figure 12. This connector is compatible with the following connectors:

- W.FL Series connector from Hirose

- MHF III connector from I-PEX

- AMMC connector from Amphenol
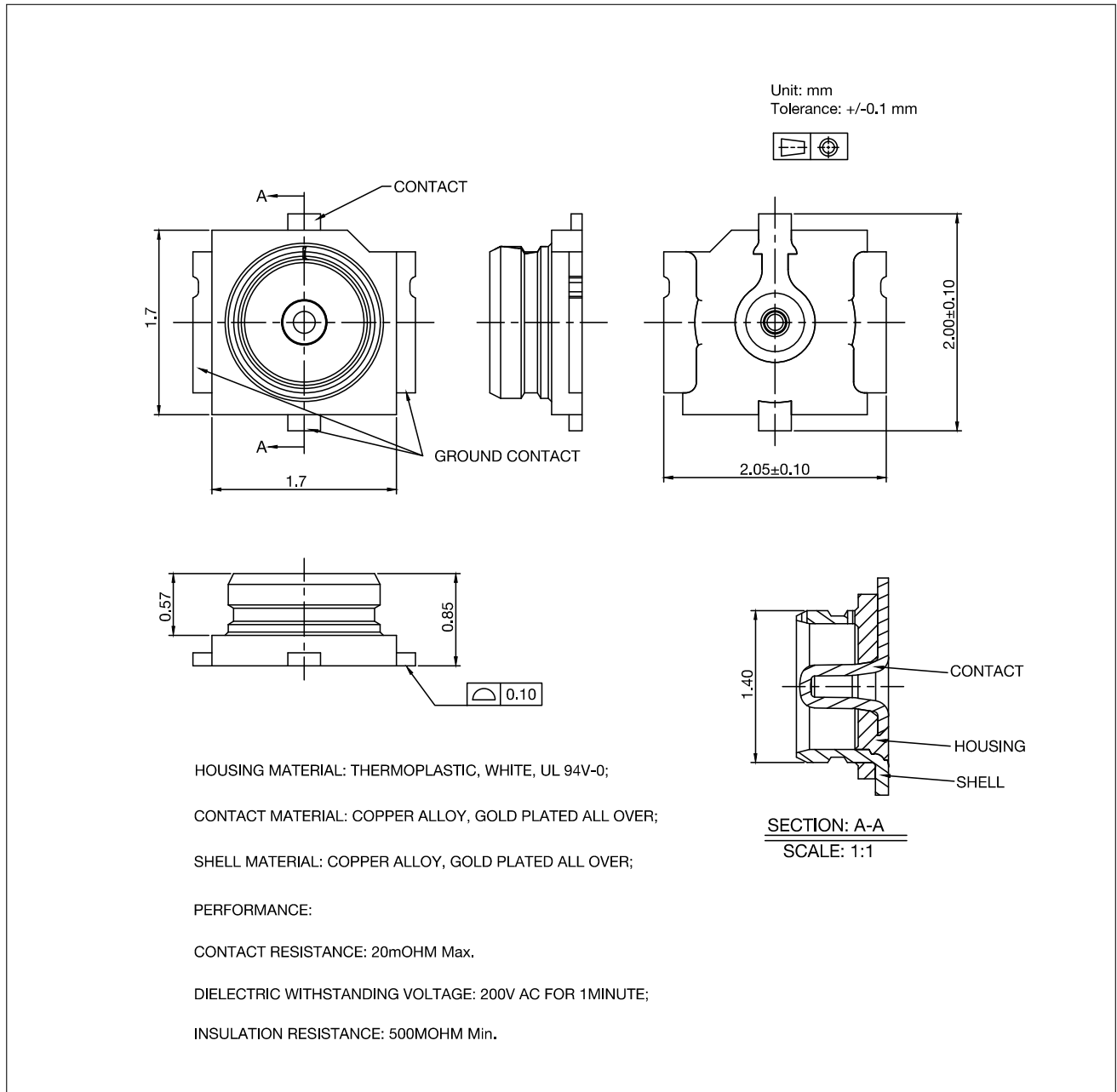
Figure 12: Dimensions of External Antenna Connector

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 °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.
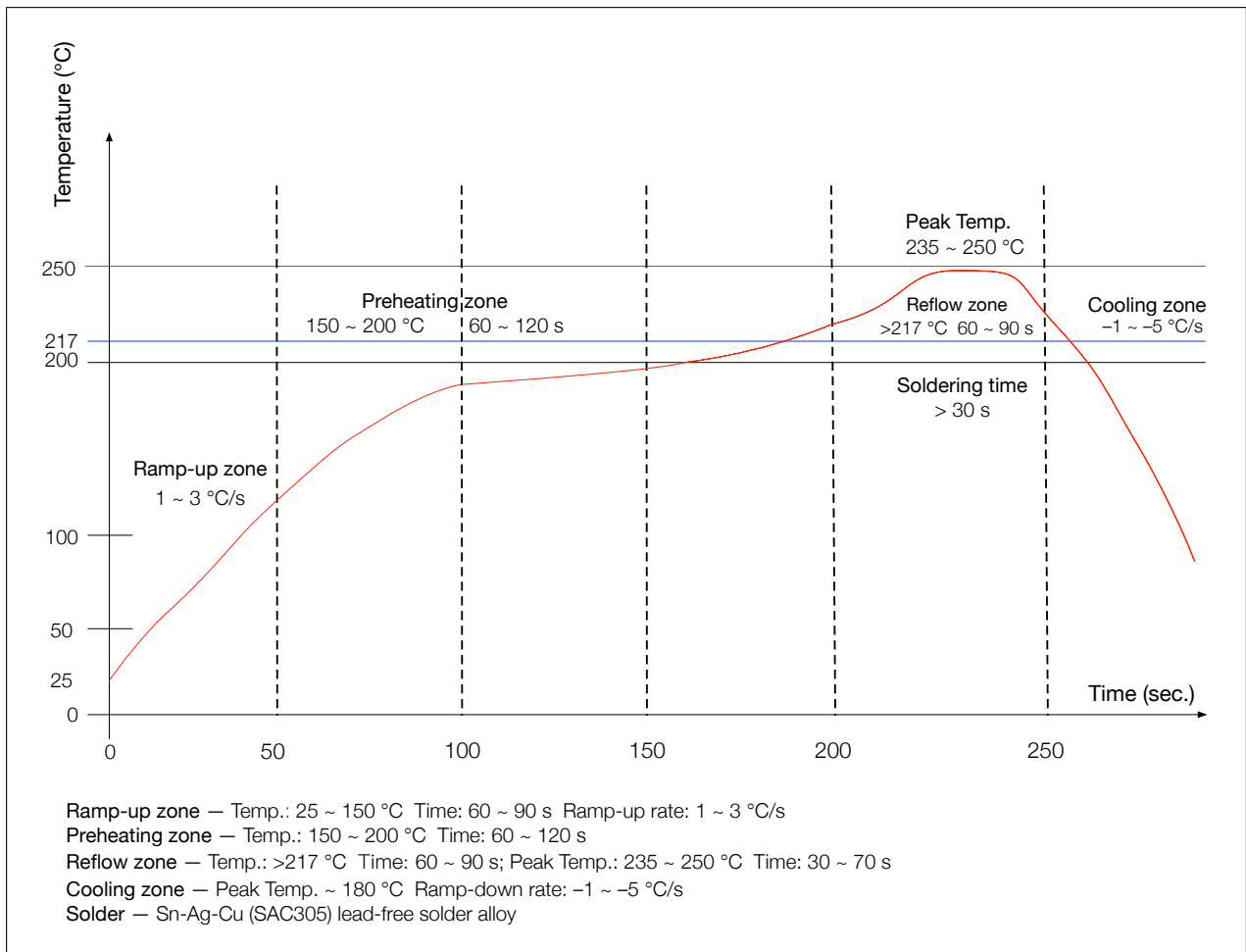
Figure 13: Reflow Profile

8.4   Ultrasonic Vibration

Avoid exposing Espressif modules to vibration from ultrasonic equipment, such as ultrasonic welders or ultrasonic cleaners. This vibration may induce resonance in the in-module crystal and lead to its malfunction or even failure. As a consequence, **the module may stop working or its performance may deteriorate**.

9   Related Documentation and Resources

Related Documentation

- <u>ESP8684 Series Datasheet</u> – Specifications of the ESP8684 hardware.
- <u>ESP8684 Technical Reference Manual</u> – Detailed information on how to use the ESP8684 memory and peripherals.
- <u>ESP8684 Hardware Design Guidelines</u> – Guidelines on how to integrate the ESP8684 into your hardware product.
- *Certificates*
  https://espressif.com/en/support/documents/certificates
- *Documentation Updates and Update Notification Subscription*
  https://espressif.com/en/support/download/documents

Developer Zone

- *ESP-IDF* and other development frameworks on GitHub.
  https://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.
  https://esp32.com/
- *The ESP Journal* – Best Practices, Articles, and Notes from Espressif folks.
  https://blog.espressif.com/
- See the tabs *SDKs and Demos*, *Apps*, *Tools*, *AT Firmware*.
  https://espressif.com/en/support/download/sdks-demos

Products

- *ESP8684 Series SoCs* – Browse through all ESP8684 SoCs.
  https://espressif.com/en/products/socs?id=ESP8684
- *ESP8684 Series Modules* – Browse through all ESP8684-based modules.
  https://espressif.com/en/products/modules?id=ESP8684
- *ESP8684 Series DevKits* – Browse through all ESP8684-based devkits.
  https://espressif.com/en/products/devkits?id=ESP8684
- *ESP Product Selector* – Find an Espressif hardware product suitable for your needs by comparing or applying filters.
  https://products.espressif.com/#/product-selector?language=en

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  https://espressif.com/en/contact-us/sales-questions

Revision History

Date	Version	Release notes
2021-08-22	V0.5	Updated Chapter 4 *Electrical Characteristics* based on 26 MHz crystal
2022-02-16	v0.1	Preliminary release