ESP32-PICO-V3-ZERO (ACK)

Datasheet

Version 1.1
Espressif Systems

About This Document

This document provides the specifications for the ESP32-PICO-V3-ZERO module.

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1 Module Overview

1.1 Features

MCU

- ESP32 embedded, Xtensa® dual-core 32-bit LX6 microprocessor, up to 240 MHz
- 448 KB ROM for booting and core functions
- 520 KB SRAM for data and instructions
- 16 KB SRAM in RTC

Wi-Fi

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

Bluetooth®

- Bluetooth V4.2 BR/EDR and Bluetooth LE specification
- Class-1, class-2 and class-3 transmitter
- AFH
- CVSD and SBC

Hardware

- Interfaces: 2 × UART (one for connection to the host and the other for debugging), EN pin, and interrupt pin
- 40 MHz crystal oscillator
- 4 MB SPI flash
- Operating voltage/Power supply: 3.0 ~ 3.6 V
- Operating temperature range: –40 ~ 85 °C
- Dimensions: (16 × 23 × 2.3) mm

Certification

- Bluetooth certification: BQB (ID: D050108)
- RF certification:
  - FCC (ID: 2AC7Z-ESP32PICOZERO)
  - SRRC (CMIIT ID: 2020DP3148)
  - IC (ID: 21098-ESP32PICOV3)
  - RCM
  - CE-RED
- Green certification: REACH/RoHS

1.2 Description

The ESP32-PICO-V3-ZERO is a module that is based on ESP32-PICO-V3, a System-in-Package (SiP) device. It provides complete Wi-Fi and Bluetooth® functionalities with embedded Xtensa® dual-core 32-bit LX6 microprocessor. The module integrates a 4 MB SPI flash.

At the core of this module is the ESP32 chip, which is a single 2.4 GHz Wi-Fi and Bluetooth combo chip designed with TSMC's 40 nm low-power technology. ESP32-PICO-V3-ZERO integrates all peripheral components seamlessly, including a crystal oscillator, flash, filter capacitors and RF matching links in one single package. Module assembly and testing are already done at SiP level. As such, ESP32-PICO-V3-ZERO reduces the complexity of supply chain and improves control efficiency. It is ultra-small in size, with robust performance and low energy consumption.

ESP32-PICO-V3-ZERO is a module for Alexa Connect Kit (ACK), a managed service that makes it easy to integrate Alexa into your products. With ESP32-PICO-V3-ZERO and its default firmware, you can connect your devices or system to Alexa and the Internet without worrying about managing cloud services, writing an Alexa Skill, or developing complex networking and security firmware. If you add ESP32-PICO-V3-ZERO to your device, you can easily, quickly and economically create products that customers love.

Note:

- For more information on ESP32, please refer to *ESP32 Datasheet*.
- For more information on ESP32-PICO-V3, please refer to *ESP32-PICO-V3 Datasheet*.

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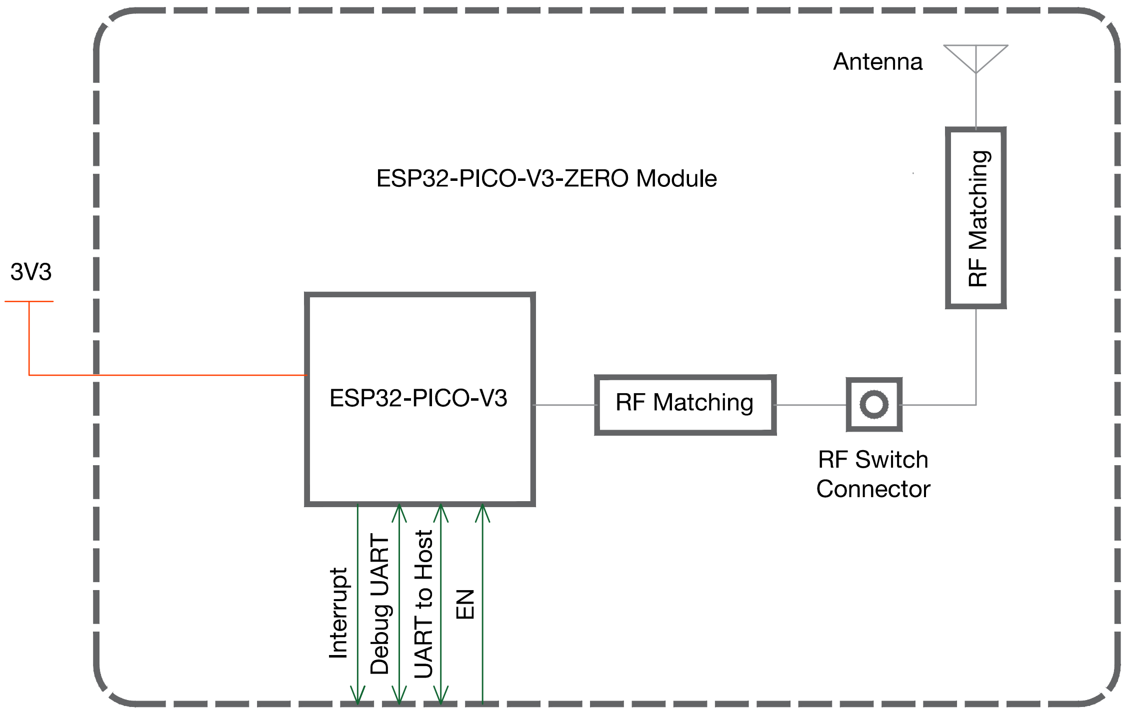

Figure 1: ESP32-PICO-V3-ZERO Block Diagram

3 Pin Definitions

3.1 Pin Layout

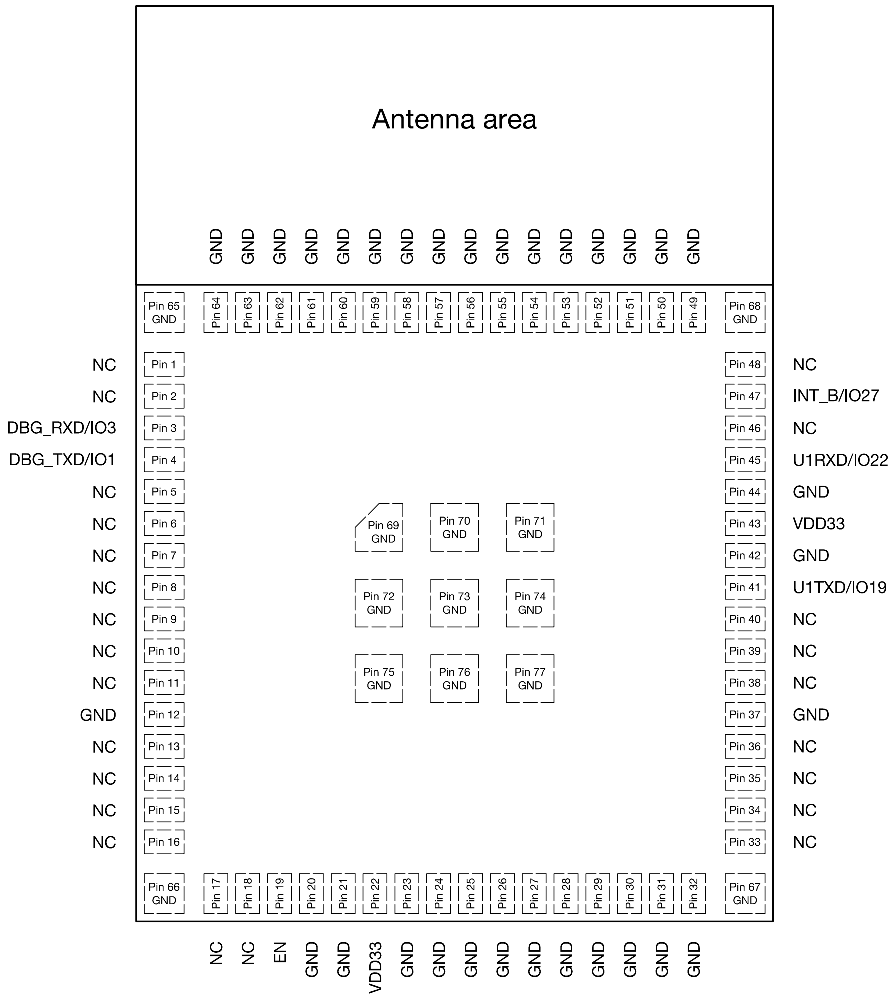

Figure 2: Pin Layout of ESP32-PICO-V3-ZERO (Top View)

> **Note:**
> The pin diagram shows the approximate location of pins on the module. For the actual mechanical diagram, please refer to Figure 4 *Physical Dimensions*.

3.2 Pin Description

The ESP32-PICO-V3-ZERO module has 77 pins. See pin definitions in Table 1.

Table 1: Pin Definitions

Name	No.	Type	Function
NC	1, 2, 5 ~ 11, 13 ~ 18, 33 ~ 36, 38 ~ 40, 46, 48	NA	Do not connect. These pins must be left floating.
DBG_RXD/IO3	3	I	GPIO3, Debugging UART RX, GPIO3
DBG_TXD/IO1	4	O	GPIO1, Debugging UART TX, GPIO1
EN	19	I	High: On; enables the module Low: Off; the module powers off Note: Do not leave this pin floating.
VDD33	22	P	Power supply (3.0 V ~ 3.6 V)
U1TXD/IO19	41	O	UART TX, connected to host RX, GPIO19
VDD33	43	P	Power supply (3.0 V ~ 3.6 V)
U1RXD/IO22	45	I	UART RX, connected to host TX, GPIO22
INT_B/IO27	47	O	Host interrupt, connected to host GPIO, GPIO27
GND	12, 20, 21, 23 ~ 32, 37, 42, 44, 49 ~ 77	P	Ground

Note:

1. IO7/IO8/IO9/IO10/IO20 belong to VDD_SDIO power domain and cannot work when VDD_SDIO power shuts down.
2. For peripheral pin configurations, please refer to *ESP32 Datasheet*.

4 Electrical Characteristics

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 that should follow the recommended operating conditions.

Table 2: Absolute Maximum Ratings

Symbol	Parameter	Min	Max	Unit
VDD33	Power supply voltage	–0.3	3.6	V
T_{STORE}	Storage temperature	–40	85	°C

4.2 Recommended Operating Conditions

Table 3: Recommended Operating Conditions

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

4.3 DC Characteristics (3.3 V, 25 °C)

Table 4: 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}	High-level output voltage	0.8×VDD[1]	-	-	V
V_{OL}	Low-level output voltage	-	-	0.1×VDD[1]	V

<table>
<tr><th>Symbol</th><th colspan="2">Parameter</th><th>Min</th><th>Typ</th><th>Max</th><th>Unit</th></tr>
<tr><td rowspan="2">I_{OH}</td><td rowspan="2">High-level source current (VDD^1 = 3.3 V, $V_{OH} \geq$ 2.64 V, output drive strength set to the maximum)</td><td>VDD3P3_CPU power domain [1, 2]</td><td>-</td><td>40</td><td>-</td><td>mA</td></tr>
<tr><td>VDD3P3_RTC power domain [1, 2]</td><td>-</td><td>40</td><td>-</td><td>mA</td></tr>
<tr><td>I_{OL}</td><td colspan="2">Low-level sink current (VDD^1 = 3.3 V, V_{OL} = 0.495 V, output drive strength set to the maximum)</td><td>-</td><td>28</td><td>-</td><td>mA</td></tr>
<tr><td>R_{PU}</td><td colspan="2">Resistance of internal pull-up resistor</td><td>-</td><td>45</td><td>-</td><td>kΩ</td></tr>
<tr><td>R_{PD}</td><td colspan="2">Resistance of internal pull-down resistor</td><td>-</td><td>45</td><td>-</td><td>kΩ</td></tr>
<tr><td>V_{IL_nRST}</td><td colspan="2">Low-level input voltage of CHIP_PU to power off the chip</td><td>-</td><td>-</td><td>0.6</td><td>V</td></tr>
</table>

Note:

1. Please see Appendix IO_MUX of *ESP32 Datasheet* for IO's power domain. VDD is the I/O voltage for a particular power domain of pins.
2. For VDD3P3_CPU and VDD3P3_RTC power domain, per-pin current sourced in the same domain is gradually reduced from around 40 mA to around 29 mA, $V_{OH} \geq$ 2.64 V, as the number of current-source pins increases.

4.4 Current Consumption Characteristics

With the use of advanced power-management technologies, ESP32 can switch between different power modes.

For details on different power modes, please refer to Section *RTC and Low-Power Management* in *ESP32 Datasheet*.

Table 5: Current Consumption Depending on RF Modes

Work mode	Description		Average (mA)	Peak (mA)
Active (RF working)	TX	802.11b, 20 MHz, 1 Mbps, @19.5 dBm	233	368
		802.11g, 20 MHz, 54 Mbps, @14 dBm	181	258
		802.11n, 20 MHz, MCS7, @13 dBm	178	248
		802.11n, 40 MHz, MCS7, @13 dBm	162	205
	RX	802.11b/g/n, 20 MHz	110	111
		802.11n, 40 MHz	116	117

Note:

- 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 50% duty cycle.
- The current consumption figures for in RX mode are for cases when the peripherals are disabled and the CPU idle.

Table 6: Current Consumption Depending on Work Modes

Work mode	Description		Current consumption (Typ)
Modem-sleep	The CPU is powered on	240 MHz	30 ~ 68 mA
		160 MHz	27 ~ 44 mA
		Normal speed: 80 MHz	20 ~ 31 mA
Light-sleep	—		0.8 mA
Deep-sleep	The ULP co-processor is powered on.		150 μA
	ULP sensor-monitored pattern		100 μA @1% duty
	RTC timer + RTC memory		10 μA
	RTC timer only		5 μA
Power off	CHIP_PU is set to low level, the chip is powered off.		1 μA

Note:

- The current consumption figures in Modem-sleep mode are for cases where the CPU is powered on and the cache idle.
- When Wi-Fi is enabled, the chip switches between Active and Modem-sleep modes. Therefore, current consumption changes accordingly.
- In Modem-sleep mode, the CPU frequency changes automatically. The frequency depends on the CPU load and the peripherals used.
- During Deep-sleep, when the ULP co-processor is powered on, peripherals such as GPIO and I²C are able to operate.

4.5 Wi-Fi RF Characteristics

4.5.1 Wi-Fi RF Standards

Table 7: Wi-Fi RF Standards

Name		Description
Center frequency range of operating channel ^{note1}		2412 ~ 2484 MHz
Wi-Fi wireless standard		IEEE 802.11b/g/n
Data rate	20 MHz	11b: 1, 2, 5.5 and 11 Mbps 11g: 6, 9, 12, 18, 24, 36, 48, 54 Mbps 11n: MCS0-7, 72.2 Mbps (Max)
	40 MHz	11n: MCS0-7, 150 Mbps (Max)
Antenna type		PCB antenna, IPEX antenna

Note:

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 IPEX antennas, the output impedance is 50 Ω. For other modules without IPEX antennas, users do not need to concern about the output impedance.

4.5.2 Transmitter Characteristics

Table 8: Transmitter Characteristics

Parameter	Rate	Typ	Unit
TX Power *note*	11b, 1 Mbps	19.5	dBm
	11b, 11 Mbps	19.5	
	11g, 6 Mbps	18	
	11g, 54 Mbps	14	
	11n, HT20, MCS0	18	
	11n, HT20, MCS7	13	
	11n, HT40, MCS0	18	
	11n, HT40, MCS7	13	

Note:
Target TX power is configurable based on device or certification requirements.

4.5.3 Receiver Characteristics

Table 9: Receiver Characteristics

Parameter	Rate	Typ	Unit
RX Sensitivity	1 Mbps	–97	dBm
	2 Mbps	–94	
	5.5 Mbps	–91	
	11 Mbps	–88	
	6 Mbps	–92	
	9 Mbps	–91	
	12 Mbps	–89	
	18 Mbps	–87	
	24 Mbps	–84	
	36 Mbps	–80	
	48 Mbps	–76	
	54 Mbps	–75	
	11n, HT20, MCS0	–91	
	11n, HT20, MCS1	–88	
	11n, HT20, MCS2	–85	
	11n, HT20, MCS3	–83	
	11n, HT20, MCS4	–80	
	11n, HT20, MCS5	–75	
	11n, HT20, MCS6	–74	
	11n, HT20, MCS7	–72	
	11n, HT40, MCS0	–88	
	11n, HT40, MCS1	–85	
	11n, HT40, MCS2	–82	
	11n, HT40, MCS3	–80	
	11n, HT40, MCS4	–76	
	11n, HT40, MCS5	–72	

Parameter	Rate	Typ	Unit
	11n, HT40, MCS6	–71	
	11n, HT40, MCS7	–69	
RX Maximum Input Level	11b, 1 Mbps	5	dBm
	11b, 11 Mbps	5	
	11g, 6 Mbps	0	
	11g, 54 Mbps	–8	
	11n, HT20, MCS0	0	
	11n, HT20, MCS7	–8	
	11n, HT40, MCS0	0	
	11n, HT40, MCS7	–8	
Adjacent Channel Rejection	11b, 11 Mbps	35	dB
	11g, 6 Mbps	27	
	11g, 54 Mbps	13	
	11n, HT20, MCS0	27	
	11n, HT20, MCS7	12	
	11n, HT40, MCS0	16	
	11n, HT40, MCS7	7	

4.6 Bluetooth Radio

4.6.1 Receiver – Basic Data Rate

Table 10: Receiver Characteristics – Basic Data Rate

Parameter	Conditions	Min	Typ	Max	Unit
Sensitivity @0.1% BER	-	–90	–89	–88	dBm
Maximum received signal @0.1% BER	-	0	-	-	dBm
Co-channel C/I	-	-	+7	-	dB
Adjacent channel selectivity C/I	F = F0 + 1 MHz	-	-	–6	dB
	F = F0 – 1 MHz	-	-	–6	dB
	F = F0 + 2 MHz	-	-	–25	dB
	F = F0 – 2 MHz	-	-	–33	dB
	F = F0 + 3 MHz	-	-	–25	dB
	F = F0 – 3 MHz	-	-	–45	dB
Out-of-band blocking performance	30 MHz ~ 2000 MHz	–10	-	-	dBm
	2000 MHz ~ 2400 MHz	–27	-	-	dBm
	2500 MHz ~ 3000 MHz	–27	-	-	dBm
	3000 MHz ~ 12.5 GHz	–10	-	-	dBm
Intermodulation	-	–36	-	-	dBm

4.6.2 Transmitter – Basic Data Rate

Table 11: Transmitter Characteristics – Basic Data Rate

Parameter	Conditions	Min	Typ	Max	Unit
RF transmit power (see note under Table 11)	-	-	0	-	dBm
Gain control step	-	-	3	-	dB
RF power control range	-	–12	-	+9	dBm
+20 dB bandwidth	-	-	0.9	-	MHz
Adjacent channel transmit power	F = F0 ± 2 MHz	-	–55	-	dBm
	F = F0 ± 3 MHz	-	–55	-	dBm
	F = F0 ± > 3 MHz	-	–59	-	dBm
$\Delta\ f1_{\text{avg}}$	-	-	-	155	kHz
$\Delta\ f2_{\text{max}}$	-	127	-	-	kHz
$\Delta\ f2_{\text{avg}}/\Delta\ f1_{\text{avg}}$	-	-	0.92	-	-
ICFT	-	-	–7	-	kHz
Drift rate	-	-	0.7	-	kHz/50 μs
Drift (DH1)	-	-	6	-	kHz
Drift (DH5)	-	-	6	-	kHz

Note:
There are a total of eight power levels from 0 to 7, and the transmit power ranges from –12 dBm to 9 dBm. When the power level rises by 1, the transmit power increases by 3 dB. Power level 4 is used by default and the corresponding transmit power is 0 dBm.

4.6.3 Receiver – Enhanced Data Rate

Table 12: Receiver Characteristics – Enhanced Data Rate

Parameter	Conditions	Min	Typ	Max	Unit
$\pi/4$ DQPSK					
Sensitivity @0.01% BER	-	–90	–89	–88	dBm
Maximum received signal @0.01% BER	-	-	0	-	dBm
Co-channel C/I	-	-	11	-	dB
Adjacent channel selectivity C/I	F = F0 + 1 MHz	-	–7	-	dB
	F = F0 – 1 MHz	-	–7	-	dB
	F = F0 + 2 MHz	-	–25	-	dB
	F = F0 – 2 MHz	-	–35	-	dB
	F = F0 + 3 MHz	-	–25	-	dB
	F = F0 – 3 MHz	-	–45	-	dB
8DPSK					
Sensitivity @0.01% BER	-	–84	–83	–82	dBm
Maximum received signal @0.01% BER	-	-	–5	-	dBm
C/I c-channel	-	-	18	-	dB
Adjacent channel selectivity C/I	F = F0 + 1 MHz	-	2	-	dB
	F = F0 – 1 MHz	-	2	-	dB
	F = F0 + 2 MHz	-	–25	-	dB

Parameter	Conditions	Min	Typ	Max	Unit
	F = F0 – 2 MHz	-	–25	-	dB
	F = F0 + 3 MHz	-	–25	-	dB
	F = F0 – 3 MHz	-	–38	-	dB

4.6.4 Transmitter – Enhanced Data Rate

Table 13: Transmitter Characteristics – Enhanced Data Rate

Parameter	Conditions	Min	Typ	Max	Unit
RF transmit power (see note under Table 11)	-	-	0	-	dBm
Gain control step	-	-	3	-	dB
RF power control range	-	–12	-	+9	dBm
$\pi/4$ DQPSK max w0	-	-	–0.72	-	kHz
$\pi/4$ DQPSK max wi	-	-	–6	-	kHz
$\pi/4$ DQPSK max |wi + w0|	-	-	–7.42	-	kHz
8DPSK max w0	-	-	0.7	-	kHz
8DPSK max wi	-	-	–9.6	-	kHz
8DPSK max |wi + w0|	-	-	–10	-	kHz
$\pi/4$ DQPSK modulation accuracy	RMS DEVM	-	4.28	-	%
	99% DEVM	-	100	-	%
	Peak DEVM	-	13.3	-	%
8 DPSK modulation accuracy	RMS DEVM	-	5.8	-	%
	99% DEVM	-	100	-	%
	Peak DEVM	-	14	-	%
In-band spurious emissions	F = F0 ± 1 MHz	-	–46	-	dBm
	F = F0 ± 2 MHz	-	–44	-	dBm
	F = F0 ± 3 MHz	-	–49	-	dBm
	F = F0 +/– > 3 MHz	-	-	–53	dBm
EDR differential phase coding	-	-	100	-	%

4.7 Bluetooth LE Radio

4.7.1 Receiver

Table 14: Receiver Characteristics – BLE

Parameter	Conditions	Min	Typ	Max	Unit
Sensitivity @30.8% PER	-	–94	–93	–92	dBm
Maximum received signal @30.8% PER	-	0	-	-	dBm
Co-channel C/I	-	-	+10	-	dB
Adjacent channel selectivity C/I	F = F0 + 1 MHz	-	–5	-	dB
	F = F0 – 1 MHz	-	–5	-	dB
	F = F0 + 2 MHz	-	–25	-	dB
	F = F0 – 2 MHz	-	–35	-	dB

Parameter	Conditions	Min	Typ	Max	Unit
	F = F0 + 3 MHz	-	–25	-	dB
	F = F0 – 3 MHz	-	–45	-	dB
Out-of-band blocking performance	30 MHz ~ 2000 MHz	–10	-	-	dBm
	2000 MHz ~ 2400 MHz	–27	-	-	dBm
	2500 MHz ~ 3000 MHz	–27	-	-	dBm
	3000 MHz ~ 12.5 GHz	–10	-	-	dBm
Intermodulation	-	–36	-	-	dBm

4.7.2 Transmitter

Table 15: Transmitter Characteristics – BLE

Parameter	Conditions	Min	Typ	Max	Unit
RF transmit power (see note under Table 11)	-	-	0	-	dBm
Gain control step	-	-	3	-	dB
RF power control range	-	–12	-	+9	dBm
Adjacent channel transmit power	F = F0 ± 2 MHz	-	–55	-	dBm
	F = F0 ± 3 MHz	-	–57	-	dBm
	F = F0 ± > 3 MHz	-	–59	-	dBm
$\Delta\ f1_{\text{avg}}$	-	-	-	265	kHz
$\Delta\ f2_{\text{max}}$	-	210	-	-	kHz
$\Delta\ f2_{\text{avg}}/\Delta\ f1_{\text{avg}}$	-	-	+0.92	-	-
ICFT	-	-	–10	-	kHz
Drift rate	-	-	0.7	-	kHz/50 μs
Drift	-	-	2	-	kHz

5 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).

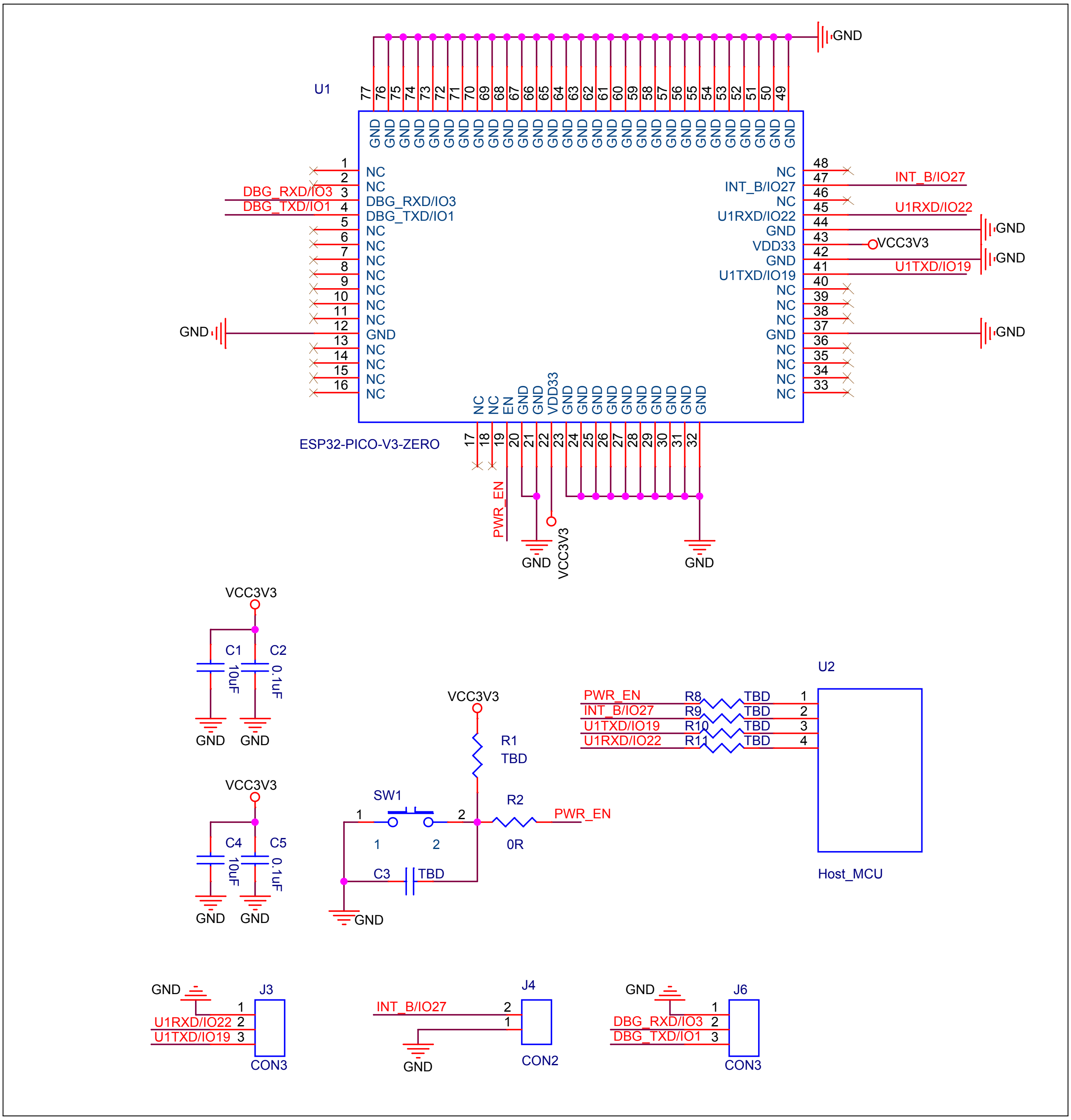

Figure 3: ESP32-PICO-V3-ZERO Module Peripheral Schematics

> **Note:**
> To ensure the power supply to the ESP32 chip 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 ESP32's power-up and reset sequence timing diagram, please refer to Section *Power Scheme* in ESP32 Datasheet.

6 Physical Dimensions and PCB Layout

6.1 Physical Dimensions

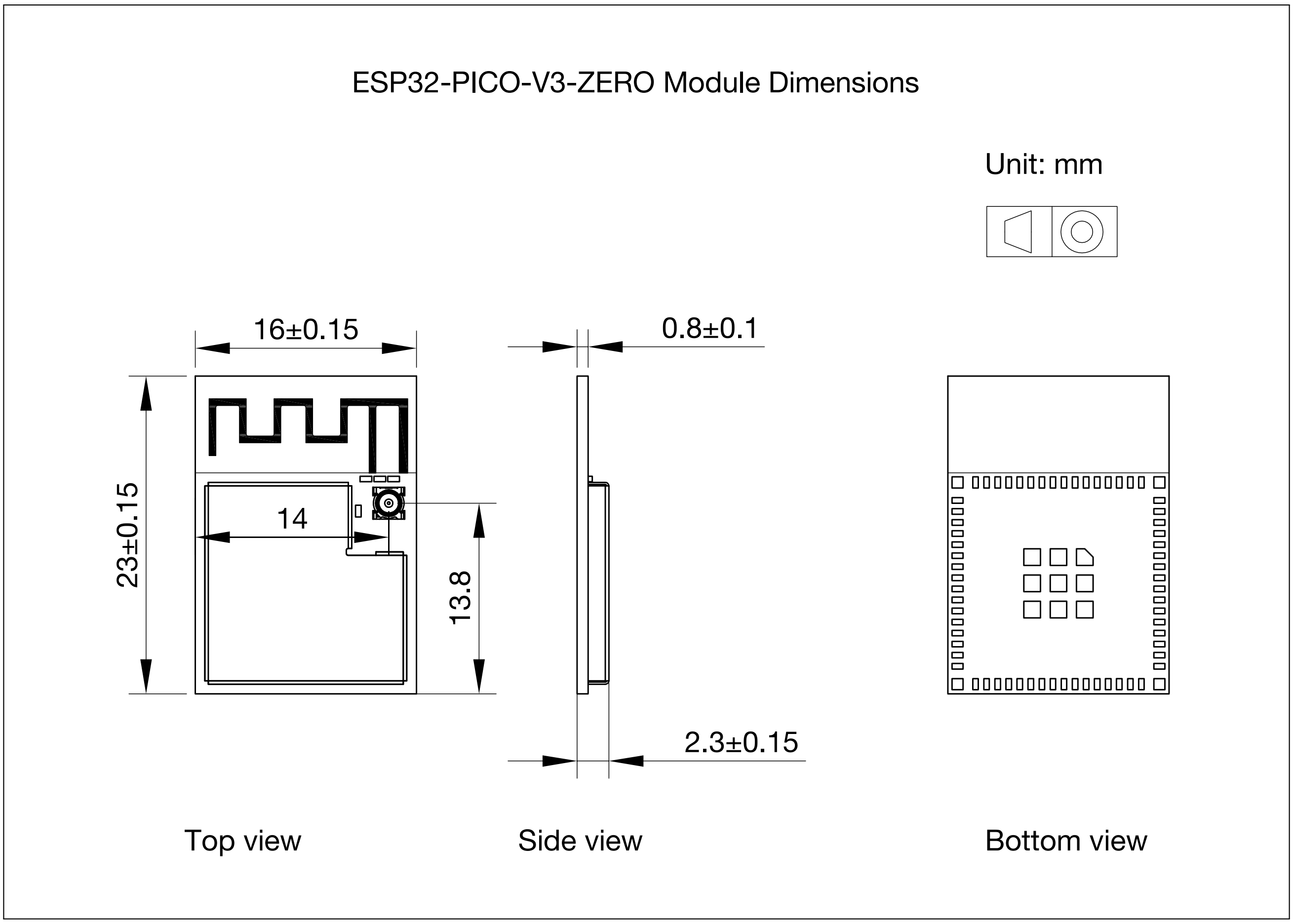

Figure 4: Physical Dimensions

6.2 PCB Layout

6.2.1 Recommended PCB Land Pattern

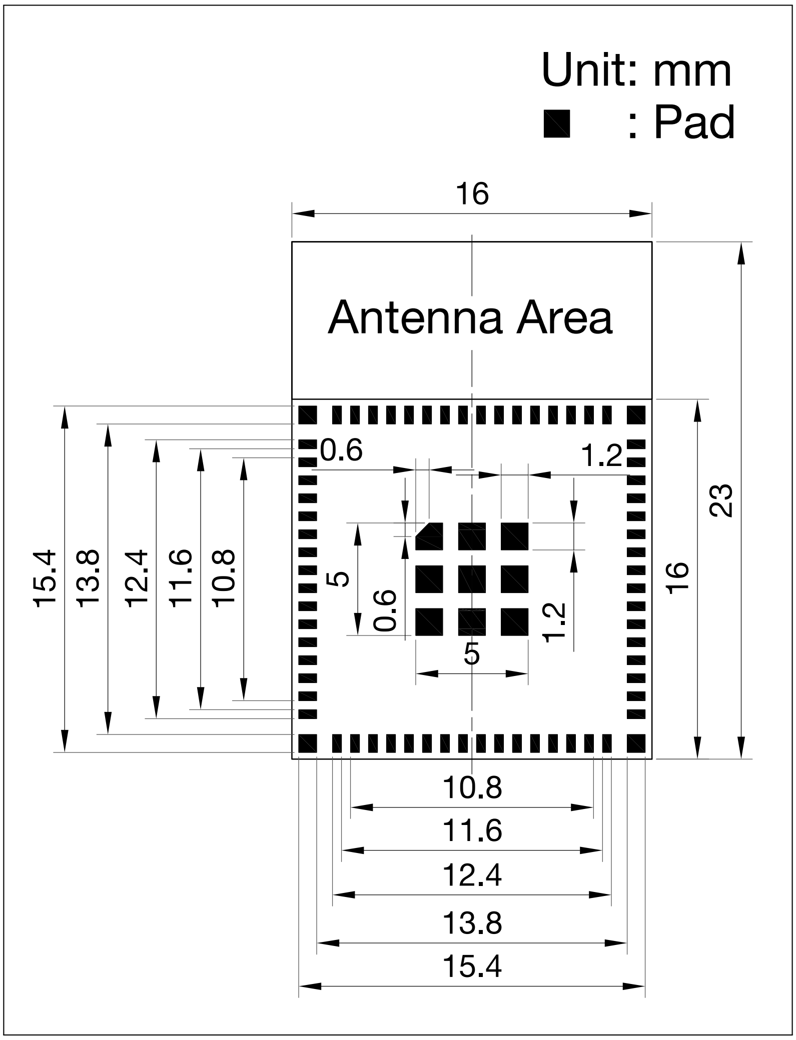

Figure 5: Recommended PCB Land Pattern

6.2.2 PCB Layout Guide

To achieve the optimum RF performance on a device with on-board antenna, please follow the guidelines below.

The module uses an inverted-F antenna design, and the antenna area of the module should have specific placement against the base board. The feed point of the antenna should be as close to the board as possible. The PCB antenna area should be placed outside the base board whenever possible while the module be put as close as possible to the edge of the base board.

As is shown in Figure 6, examples 3 and 4 of the module position on the base board are highly recommended, while examples 1, 2, and 5 are not recommended.

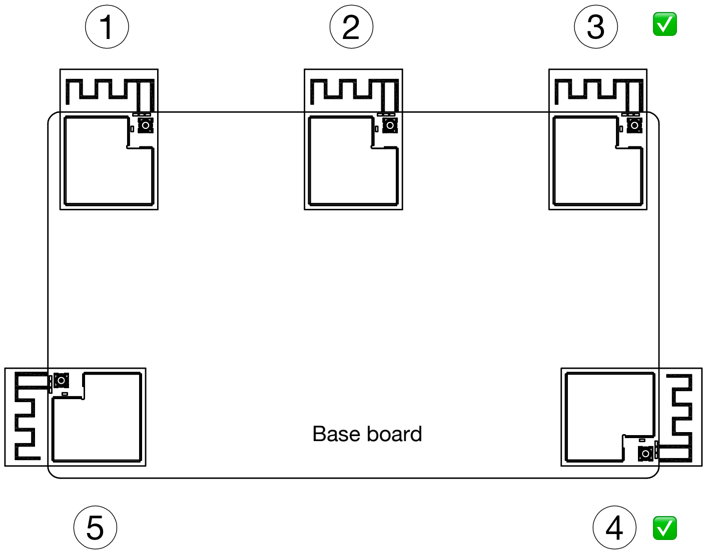

Figure 6: Module Placement on a Base Board

If the positions recommended above are not possible, then please make sure that the module is not covered by any metal shell and that a clearance area (without copper, routing, or components) outside the antenna is large enough, as shown in Figure 7. In addition, if there is base board under the antenna area, it is recommended to cut it off to minimize its impact on the antenna.

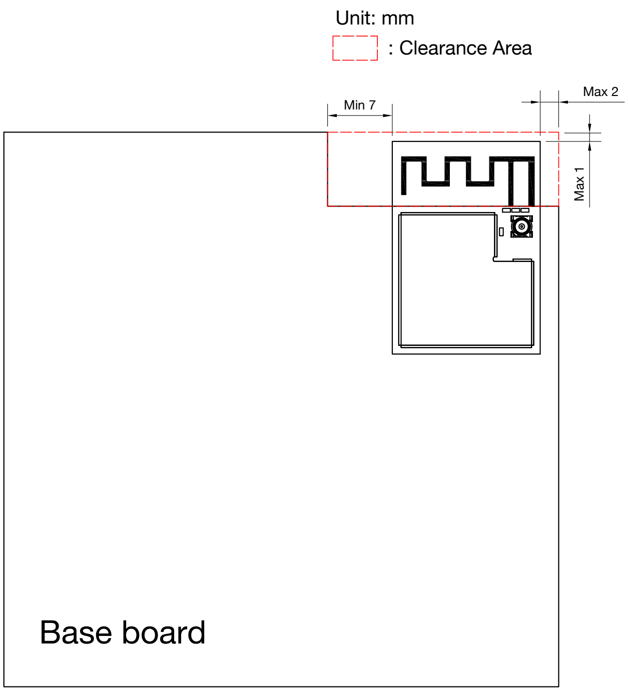

Figure 7: Keepout Zone for Module's Antenna on the Base Board

If the PCB layout does not follow the above rules, then RF throughput and RF range testing should be performed to ensure that the end product performance is satisfactory. When designing an end product, pay attention to the impact of enclosure on the antenna and verify the device performance by making RF verification.

6.3 IPEX Connector Dimensions

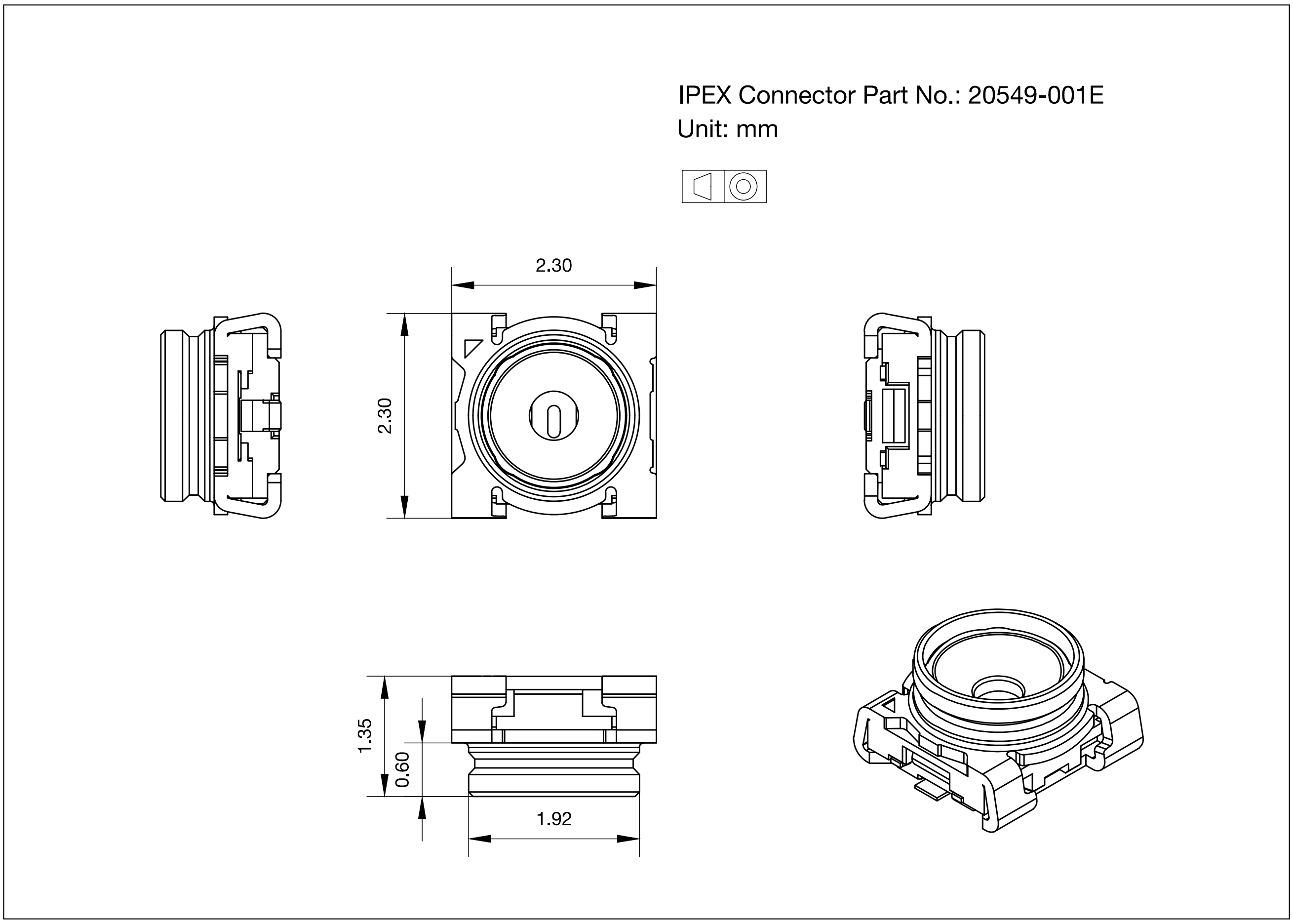

Figure 8: IPEX Connector Dimensions

7 Product Handling

7.1 Storage Condition

The products sealed in Moisture Barrier Bag (MBB) should be stored in a noncondensing atmospheric environment of < 40 °C/90% RH.

The module is rated at moisture sensitivity level (MSL) 3.

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

7.2 ESD

- Human body model (HBM): 2000 V
- Charged-device model (CDM): 500 V
- Air discharge: 6000 V
- Contact discharge: 4000 V

7.3 Reflow Profile

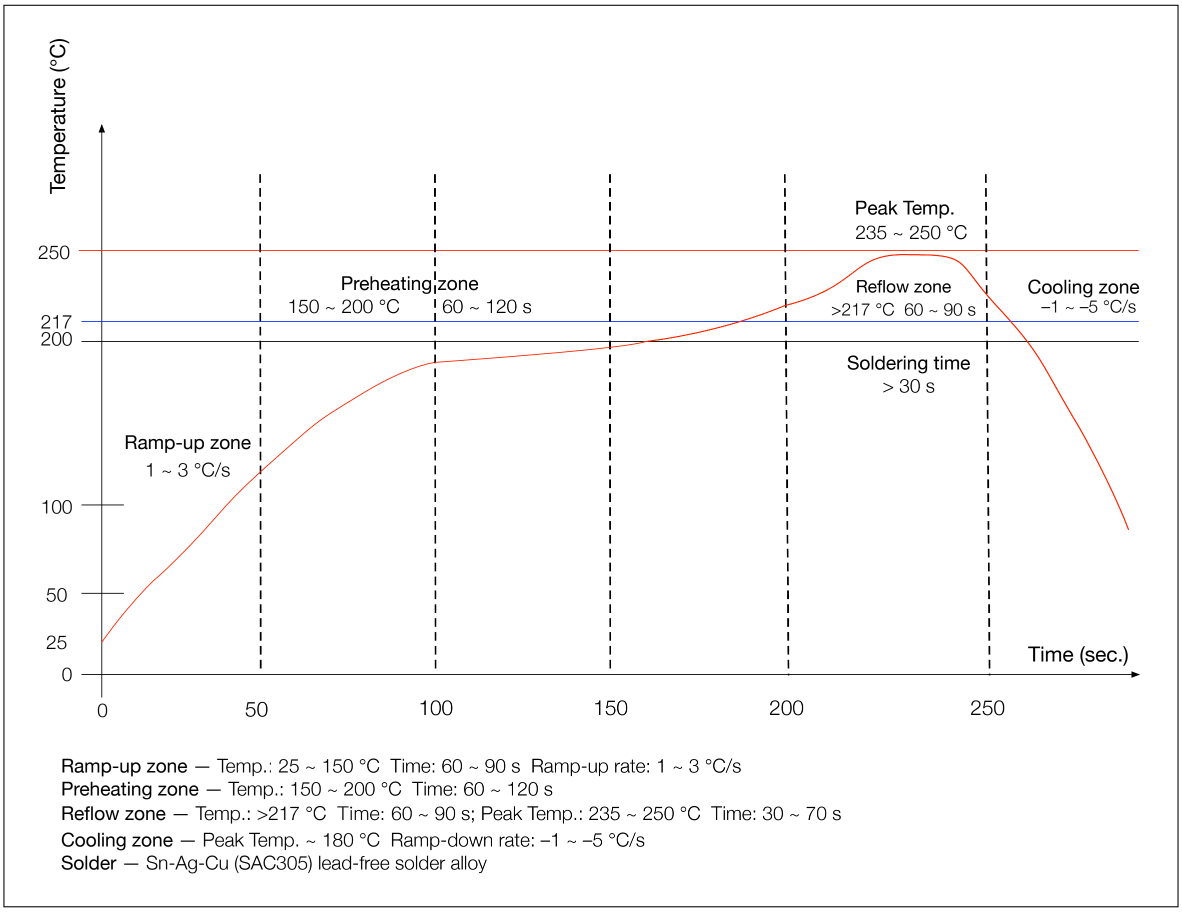

Figure 9: Reflow Profile

> **Note:**
> Solder the module in a single reflow.

8 Learning Resources

8.1 Must-Read Documents

The following link provides documents related to ESP32.

- *ESP32 Datasheet*
  This document provides an introduction to the specifications of the ESP32 hardware, including overview, pin definitions, functional description, peripheral interface, electrical characteristics, etc.
- *ESP32 ECO V3 User Guide*
  This document describes differences between V3 and previous ESP32 silicon wafer revisions.
- *ECO and Workarounds for Bugs in ESP32*
  This document details hardware errata and workarounds in the ESP32.
- *ESP-IDF Programming Guide*
  It hosts extensive documentation for ESP-IDF ranging from hardware guides to API reference.
- *ESP32 Technical Reference Manual*
  The manual provides detailed information on how to use the ESP32 memory and peripherals.
- ESP32 Hardware Resources
  The zip files include the schematics, PCB layout, Gerber and BOM list of ESP32 modules and development boards.
- *ESP32 Hardware Design Guidelines*
  The guidelines outline recommended design practices when developing standalone or add-on systems based on the ESP32 series of products, including the ESP32 chip, the ESP32 modules and development boards.
- *ESP32 AT Instruction Set and Examples*
  This document introduces the ESP32 AT commands, explains how to use them, and provides examples of several common AT commands.
- *Espressif Products Ordering Information*

8.2 Must-Have Resources

Here are the ESP32-related must-have resources.

- ESP32 BBS
  This is an Engineer-to-Engineer (E2E) Community for ESP32 where you can post questions, share knowledge, explore ideas, and help solve problems with fellow engineers.
- ESP32 GitHub
  ESP32 development projects are freely distributed under Espressif's MIT license on GitHub. It is established to help developers get started with ESP32 and foster innovation and the growth of general knowledge about the hardware and software surrounding ESP32 devices.
- ESP32 Tools
  This is a webpage where users can download ESP32 Flash Download Tools and the zip file "ESP32 Certification and Test".

- ESP-IDF
  This webpage links users to the official IoT development framework for ESP32.
- ESP32 Resources
  This webpage provides the links to all available ESP32 documents, SDK and tools.

Revision History

Date	Version	Release notes
2021-02-09	V1.1	Deleted Reset Circuit and Discharge Circuit for VDD33 Rail in Section 5: *Peripheral Schematics* Modified the note below Figure 9: *Reflow Profile*
2020-11-03	V1.0	First release

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