

ESP32-PICO-V3

Datasheet



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

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1. 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

Bluetooth®

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

Hardware

- Interfaces: ADC, DAC, touch sensor, SD/SDIO/MMC Host Controller, SPI, SDIO/SPI Slave Controller, EMAC, motor PWM, LED PWM, UART, I²C, I²S, infrared remote controller, GPIO, pulse counter
- 40 MHz crystal oscillator
- 4 MB SPI flash
- Operating voltage/Power supply: 3.0 ~ 3.6 V
- Operating temperature range: -40 ~ 85 °C
- Dimensions: (7 × 7 × 0.94) mm

Wi-Fi

- 802.11 b/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

1.2 Description

The ESP32-PICO-V3 is a System-in-Package (SiP) device that is based on ESP32 with ECO V3 wafer, providing complete Wi-Fi and Bluetooth® functionalities. It integrates a 4 MB SPI flash.

At the core of ESP32-PICO-V3 is the ESP32 (ECO V3) 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 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 reduces the complexity of supply chain and improves control efficiency.

With its ultra-small size, robust performance and low-energy consumption, ESP32-PICO-V3 is well suited for any space-limited or battery-operated applications, such as wearable electronics, medical equipment, sensors and other IoT products.

Comparing to other ESP32 series chips, ESP32-PICO-V3 has an additional pin GPIO20. For chip security purpose, flash pins DI, DO, /HOLD, /WP are not led out.

Note:

- For details on ESP32, please refer to the document [ESP32 Datasheet](#).
- For details on ESP32 ECO V3, please refer to [ESP32 ECO V3 User Guide](#).

1.3 Applications

- Generic Low-power IoT Sensor Hub
- Generic Low-power IoT Data Loggers
- Cameras for Video Streaming
- Over-the-top (OTT) 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. Block Diagram

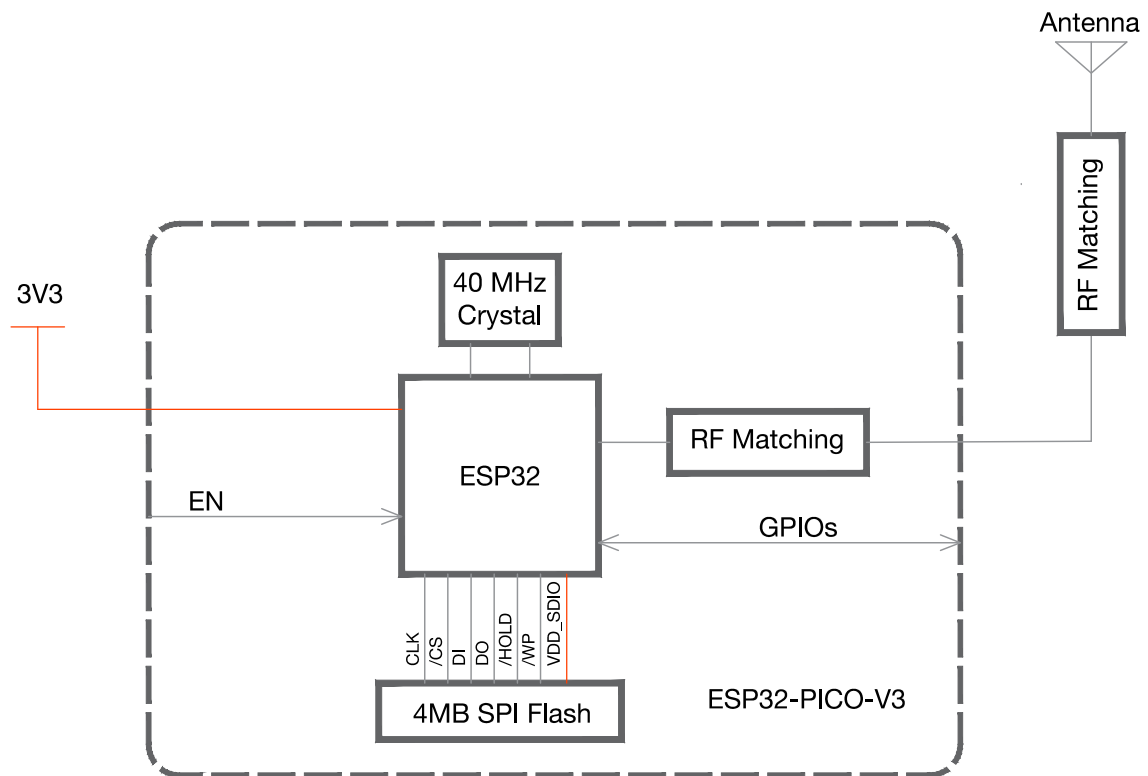


Figure 1: ESP32-PICO-V3 Block Diagram

3. Pin Definitions

3.1 Pin Layout

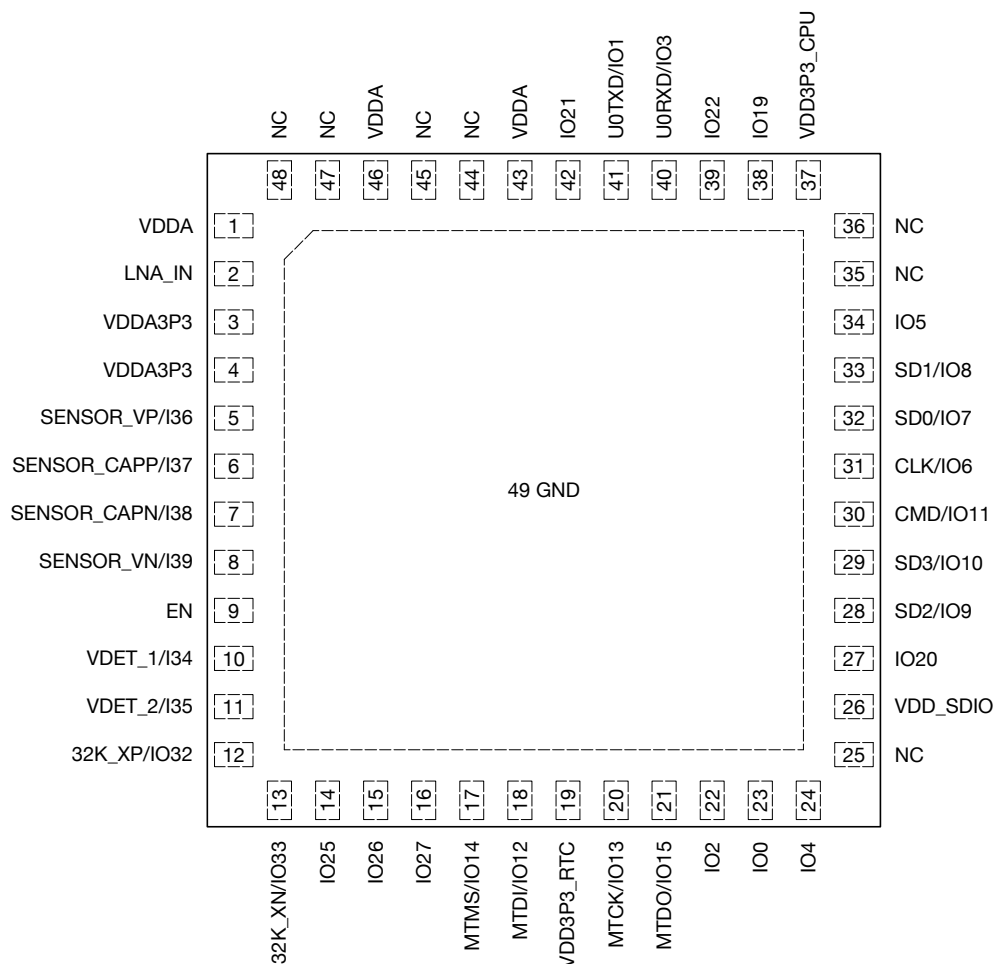


Figure 2: Pin Layout of ESP32-PICO-V3 (Top View)

Note:

The pin diagram shows the approximate location of pins. For the actual mechanical diagram, please refer to Figure 7.

3.2 Pin Description

ESP32-PICO-V3 has 48 pins. See pin definitions in Table 1.

Table 1: Pin Definitions

Name	No.	Type	Function
VDDA	1	P	Analog power supply (3.0 V ~ 3.6 V)

Name	No.	Type	Function
LNA_IN	2	I/O	RF input and output
VDDA3P3	3	P	Analog power supply (3.0 V ~ 3.6 V)
VDDA3P3	4	P	Analog power supply (3.0 V ~ 3.6 V)
SENSOR_VP/I36	5	I	GPIO36, ADC1_CH0, RTC_GPIO0
SENSOR_CAPP/I37	6	I	GPIO37, ADC1_CH1, RTC_GPIO1
SENSOR_CAPN/I38	7	I	GPIO38, ADC1_CH2, RTC_GPIO2
SENSOR_VN/I39	8	I	GPIO39, ADC1_CH3, RTC_GPIO3
EN	9	I	High: On; enables the SiP Low: Off; the SiP powers off Note: Do not leave this pin floating.
VDET_1/I34	10	I	ADC1_CH6, RTC_GPIO4
VDET_2/I35	11	I	ADC1_CH7, RTC_GPIO5
32K_XP/I032	12	I/O	32K_XP (32.768 kHz crystal oscillator input), ADC1_CH4, TOUCH9, RTC_GPIO9
32K_XN/I033	13	I/O	32K_XN (32.768 kHz crystal oscillator output), ADC1_CH5, TOUCH8, RTC_GPIO8
IO25	14	I/O	GPIO25, DAC_1, ADC2_CH8, RTC_GPIO6, EMAC_RXD0
IO26	15	I/O	GPIO26, DAC_2, ADC2_CH9, RTC_GPIO7, EMAC_RXD1
IO27	16	I/O	GPIO27, ADC2_CH7, TOUCH7, RTC_GPIO17, EMAC_RX_DV
MTMS/I014	17	I/O	ADC2_CH6, TOUCH6, RTC_GPIO16, MTMS, HSPICLK, HS2_CLK, SD_CLK, EMAC_TXD2
MTDI/I012	18	I/O	ADC2_CH5, TOUCH5, RTC_GPIO15, MTDI, HSPIQ, HS2_DATA2, SD_DATA2, EMAC_TXD3
VDD3P3_RTC	19	P	Input power supply for RTC IO (3.0 V ~ 3.6 V)
MTCK/I013	20	I/O	ADC2_CH4, TOUCH4, RTC_GPIO14, MTCK, HSPID, HS2_DATA3, SD_DATA3, EMAC_RX_ER
MTDO/I015	21	I/O	ADC2_CH3, TOUCH3, RTC_GPIO13, MTDO, HSPICS0, HS2_CMD, SD_CMD, EMAC_RXD3
IO2	22	I/O	ADC2_CH2, TOUCH2, RTC_GPIO12, HSPIWP, HS2_DATA0, SD_DATA0
IO0	23	I/O	ADC2_CH1, TOUCH1, RTC_GPIO11, CLK_OUT1, EMAC_TX_CLK
IO4	24	I/O	ADC2_CH0, TOUCH0, RTC_GPIO10, HSPIHD, HS2_DATA1, SD_DATA1, EMAC_TX_ER
NC	25	—	NC
VDD_SDIO	26	P	Output power supply. See note 1 under the table.
IO20	27	I/O	GPIO20. See note 3 under the table.
SD2/I09	28	I/O	GPIO9, SD_DATA2, HS1_DATA2, U1RXD. See note 3 under the table.
SD3/I010	29	I/O	GPIO10, SD_DATA3, HS1_DATA3, U1TXD. See note 3 under the table.
CMD/I011	30	I/O	See note 2 , note 3 under the table.
CLK/I06	31	I/O	See note 2 , note 3 under the table.
SD0/I07	32	I/O	GPIO7, SD_DATA0, HS1_DATA0, U2RTS. See note 3 under the table.
SD1/I08	33	I/O	GPIO8, SD_DATA1, HS1_DATA1, U2CTS. See note 3 under the table.
IO5	34	I/O	GPIO5, VSPICS0, HS1_DATA6, EMAC_RX_CLK

Name	No.	Type	Function
NC	35	—	NC
NC	36	—	NC
VDD3P3_CPU	37	P	Input power supply for CPU IO (1.8 V ~ 3.6 V)
IO19	38	I/O	GPIO19, VSPIQ, U0CTS, EMAC_TXD0
IO22	39	I/O	GPIO22, VSPIWP, U0RTS, EMAC_TXD1
U0RXD/IO3	40	I/O	GPIO3, U0RXD, CLK_OUT2
U0TXD/IO1	41	I/O	GPIO1, U0TXD, CLK_OUT3, EMAC_RXD2
IO21	42	I/O	GPIO21, VSPIHD, EMAC_TX_EN
VDDA	43	P	Analog power supply (3.0 V ~ 3.6 V)
NC	44	—	NC
NC	45	—	NC
VDDA	46	P	Analog power supply (3.0 V ~ 3.6 V)
NC	47	—	NC
NC	48	—	NC

Notice:

- Note that the embedded flash is connected to VDD_SDIO which is driven directly by VDD3P3_RTC through a 6 Ω resistor. Due to this resistor, there is some voltage drop on this pin from VDD3P3_RTC.
- Pins CMD/IO11 and CLK/IO6 are used for connecting the embedded flash, and are not recommended for other uses. For details, please see Section 5 Schematics.
- IO6/IO7/IO8/IO9/IO10/IO11/IO20 belong to VDD_SDIO power domain and cannot work when VDD_SDIO power shuts down.
- For peripheral pin configurations, please refer to [ESP32 Datasheet](#).

3.3 Compatibility with ESP32-PICO-D4

ESP32-PICO-V3 is a new product but it is very similar to ESP32-PICO-D4. It may be possible to update an ESP32-PICO-D4 hardware design to use ESP32-PICO-V3 with minimal or no hardware changes, but please pay attention to the following:

- Usage of six pins has changed:

Table 2: Usage of Pins on ESP32-PICO-V3 and ESP32-PICO-D4

Pin No.	ESP32-PICO-V3	ESP32-PICO-D4
25	Not connected	GPIO16, used by embedded flash
27	GPIO20, can be used	GPIO17, used by embedded flash
32	SD0 (GPIO7), can be used	SD0 (GPIO7), used by embedded flash
33	SD1 (GPIO8), can be used	SD1 (GPIO8), used by embedded flash
35	Not connected	GPIO18, can be used
36	Not connected	GPIO23, can be used

- None of the embedded flash data pins are connected externally on ESP32-PICO-V3. These are connected internally to GPIO16, GPIO17, GPIO18, and GPIO23.
- It is not possible to connect an external PSRAM chip to ESP32-PICO-V3.
- If a 32.768 kHz crystal is connected to ESP32-PICO-D4 then please refer to [ESP32 ECO V3 User Guide](#) for information about necessary hardware changes for ESP32-PICO-V3.
- Refer to [ESP32 ECO V3 User Guide](#) for information about possible software changes and optimizations for ESP32 ECO V3.
- EMC compliance and RF performance tests should be repeated after a design is updated to use ESP32-PICO-V3.
- Refer to [ESP32-PICO-D4 Datasheet](#) for more information about ESP32-PICO-D4.

3.4 Strapping Pins

ESP32 has five strapping pins: MTDI, GPIO0, GPIO2, MTDO, GPIO5. The pin-pin mapping between ESP32 and the SiP is as follows, which can be seen in Chapter 5 *Schematics*:

- MTDI = IO12
- GPIO0 = IO0
- GPIO2 = IO2
- MTDO = IO15
- GPIO5 = IO5

Software can read the values of these five bits from register "GPIO_STRAPPING".

During the chip's system reset release (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. The strapping bits configure the device's boot mode, the operating voltage of VDD_SDIO and other initial system settings.

Each strapping pin is connected to its internal pull-up/pull-down during the chip reset. Consequently, if a strapping pin is unconnected or the connected external circuit is high-impedance, the internal weak pull-up/pull-down will determine the default input level of the strapping pins.

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.

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

Refer to Table 3 for a detailed boot-mode configuration by strapping pins.

Table 3: Strapping Pins

Voltage of Internal LDO (VDD_SDIO)			
Pin	Default	3.3 V	1.8 V
MTDI	Pull-down	0	1
Bootling Mode			
Pin	Default	SPI Boot	Download Boot
GPIO0	Pull-up	1	0

GPIO2	Pull-down	Don't-care		0	
Enabling/Disabling Debugging Log Print over U0TXD During Booting					
Pin	Default	U0TXD Active		U0TXD Silent	
MTDO	Pull-up	1		0	
Timing of SDIO Slave					
Pin	Default	FE Sampling FE Output	FE Sampling RE Output	RE Sampling FE Output	RE Sampling RE Output
MTDO	Pull-up	0	0	1	1
GPIO5	Pull-up	0	1	0	1

Note:

- FE: falling-edge, RE: rising-edge.
- Firmware can configure register bits to change the settings of "Voltage of Internal LDO (VDD_SDIO)" and "Timing of SDIO Slave", after booting.
- The operating voltage of ESP32-PICO-V3's integrated external SPI flash is 3.3 V. Therefore, the strapping pin MTDI should hold bit "0" during the SiP power-on reset.

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 4: Absolute Maximum Ratings

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

Note:

Please see Appendix IO_MUX of [ESP32 Datasheet](#) for IO's power domain.

4.2 Recommended Operating Conditions

Table 5: 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 6: 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

Symbol	Parameter		Min	Typ	Max	Unit
I_{OH}	High-level source current (VDD ¹ = 3.3 V, V _{OH} >= 2.64 V, output drive strength set to the maximum)	VDD3P3_CPU power domain ^{1, 2}	-	40	-	mA
		VDD3P3_RTC power domain ^{1, 2}	-	40	-	mA
		VDD_SDIO power domain ^{1, 3}	-	20	-	mA
I_{OL}	Low-level sink current (VDD ¹ = 3.3 V, V _{OL} = 0.495 V, output drive strength set to the maximum)		-	28	-	mA
R_{PU}	Resistance of internal pull-up resistor		-	45	-	kΩ
R_{PD}	Resistance of internal pull-down resistor		-	45	-	kΩ
V_{IL_nRST}	Low-level input voltage of CHIP_PU to power off the chip		-	-	0.6	V

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, $V_{OH} \geq 2.64\text{ V}$, as the number of current-source pins increases.
3. Pins occupied by flash and/or PSRAM in the VDD_SDIO power domain were excluded from the test.

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 7: 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 8: 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 μ A
	ULP sensor-monitored pattern		100 μ A @1% duty
	RTC timer + RTC memory		10 μ A
	RTC timer only		5 μ A
Power off	CHIP_PU is set to low level, the chip is powered off.		1 μ A

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.
- The "ULP sensor-monitored pattern" refers to the mode where the ULP coprocessor or the sensor works periodically. When ADC works with a duty cycle of 1%, the typical current consumption is 100 μ A.

4.5 Wi-Fi RF Characteristics

4.5.1 Wi-Fi RF Standards

Table 9: 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)

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 10: Transmitter Characteristics

Parameter	Rate	Typ	Unit
TX Power <i>note</i>	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 11: 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	

Parameter	Rate	Typ	Unit
	11n, HT40, MCS3	-80	
	11n, HT40, MCS4	-76	
	11n, HT40, MCS5	-72	
	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 12: 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 13: Transmitter Characteristics – Basic Data Rate

Parameter	Conditions	Min	Typ	Max	Unit
RF transmit power	-	-	0	-	dBm
Gain control step	-	-	3	-	dB
RF power control range	-	-12	-	+9	dBm
+20 dB bandwidth	-	-	0.9	-	MHz
Adjacent channel transmit power	$F = F_0 \pm 2 \text{ MHz}$	-	-55	-	dBm
	$F = F_0 \pm 3 \text{ MHz}$	-	-55	-	dBm
	$F = F_0 \pm > 3 \text{ MHz}$	-	-59	-	dBm
$\Delta f_{1\text{avg}}$	-	-	-	155	kHz
$\Delta f_{2\text{max}}$	-	127	-	-	kHz
$\Delta f_{2\text{avg}}/\Delta f_{1\text{avg}}$	-	-	0.92	-	-
ICFT	-	-	-7	-	kHz
Drift rate	-	-	0.7	-	kHz/50 μs
Drift (DH1)	-	-	6	-	kHz
Drift (DH5)	-	-	6	-	kHz

4.6.3 Receiver – Enhanced Data Rate

Table 14: 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	$F = F_0 + 1 \text{ MHz}$	-	-7	-	dB
	$F = F_0 - 1 \text{ MHz}$	-	-7	-	dB
	$F = F_0 + 2 \text{ MHz}$	-	-25	-	dB
	$F = F_0 - 2 \text{ MHz}$	-	-35	-	dB
	$F = F_0 + 3 \text{ MHz}$	-	-25	-	dB
	$F = F_0 - 3 \text{ MHz}$	-	-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	$F = F_0 + 1 \text{ MHz}$	-	2	-	dB
	$F = F_0 - 1 \text{ MHz}$	-	2	-	dB
	$F = F_0 + 2 \text{ MHz}$	-	-25	-	dB
	$F = F_0 - 2 \text{ MHz}$	-	-25	-	dB
	$F = F_0 + 3 \text{ MHz}$	-	-25	-	dB
	$F = F_0 - 3 \text{ MHz}$	-	-38	-	dB

4.6.4 Transmitter – Enhanced Data Rate

Table 15: Transmitter Characteristics – Enhanced Data Rate

Parameter	Conditions	Min	Typ	Max	Unit
RF transmit power	-	-	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 \pm 1 MHz	-	-46	-	dBm
	F = F0 \pm 2 MHz	-	-44	-	dBm
	F = F0 \pm 3 MHz	-	-49	-	dBm
	F = F0 \pm > 3 MHz	-	-	-53	dBm
EDR differential phase coding	-	-	100	-	%

4.7 Bluetooth LE Radio

4.7.1 Receiver

Table 16: 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
	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

Parameter	Conditions	Min	Typ	Max	Unit
Intermodulation	-	-36	-	-	dBm

4.7.2 Transmitter

Table 17: Transmitter Characteristics – BLE

Parameter	Conditions	Min	Typ	Max	Unit
RF transmit power	-	-	0 <i>note</i>	-	dBm
Gain control step	-	-	3	-	dB
RF power control range	-	-12	-	+9	dBm
Adjacent channel transmit power	$F = F_0 \pm 2 \text{ MHz}$	-	-55	-	dBm
	$F = F_0 \pm 3 \text{ MHz}$	-	-57	-	dBm
	$F = F_0 \pm > 3 \text{ MHz}$	-	-59	-	dBm
$\Delta f_{1\text{avg}}$	-	-	-	265	kHz
$\Delta f_{2\text{max}}$	-	210	-	-	kHz
$\Delta f_{2\text{avg}}/\Delta f_{1\text{avg}}$	-	-	+0.92	-	-
ICFT	-	-	-10	-	kHz
Drift rate	-	-	0.7	-	kHz/50 μs
Drift	-	-	2	-	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.

5. Schematics

This is the reference design of the module.

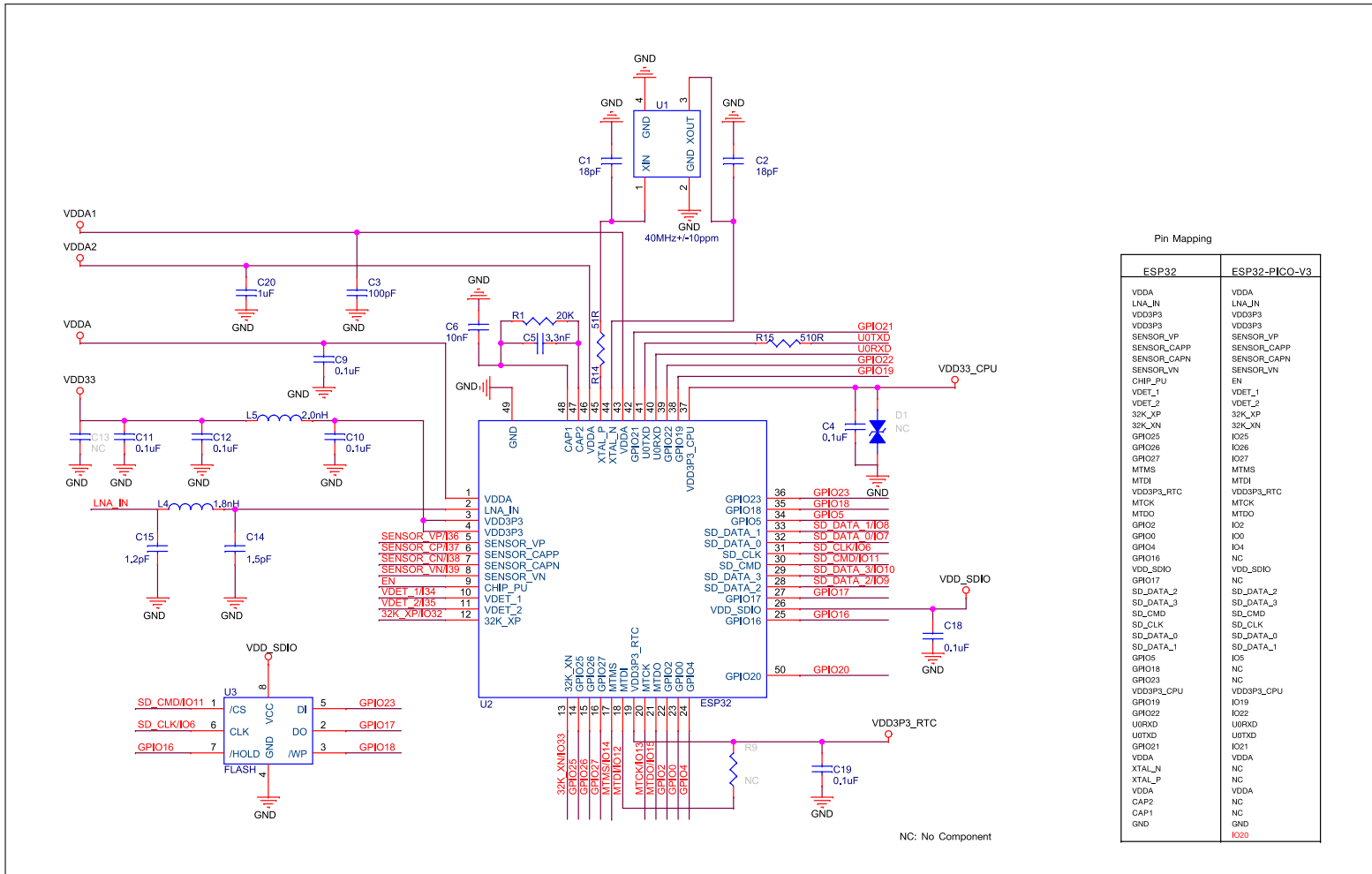


Figure 3: ESP32-PICO-V3 Schematics

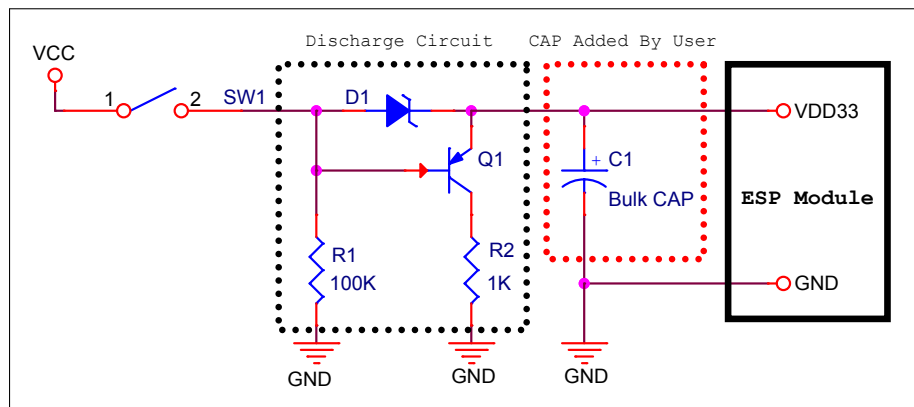


Figure 5: Discharge Circuit for VDD33 Rail

Note:

The discharge circuit can be applied in scenarios where ESP32 is powered on and off repeatedly by switching the power rails, and there is a large capacitor on the VDD33 rail. For details, please refer to Section *Power Scheme* in [ESP32 Datasheet](#).

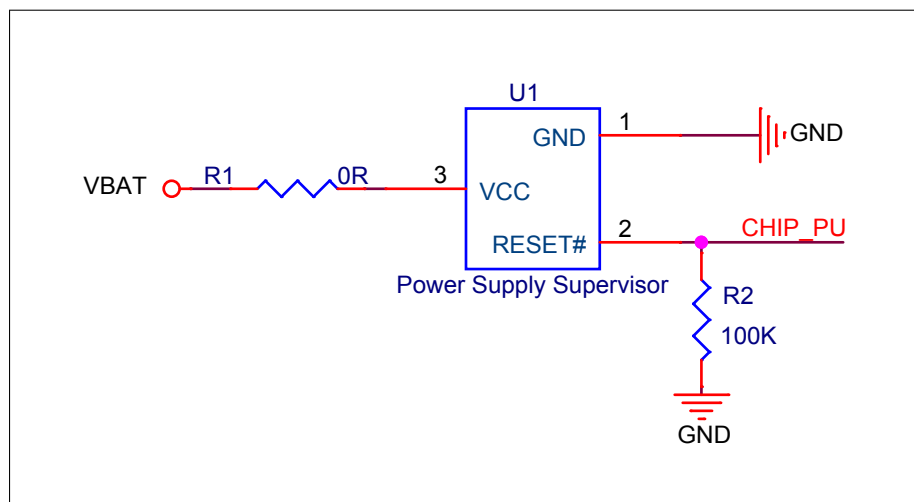


Figure 6: Reset Circuit

Note:

When battery is used as the power supply for ESP32 series of chips and modules, a supply voltage supervisor is recommended to avoid boot failure due to low voltage. Users are recommended to pull CHIP_PU low if the power supply for ESP32 is below 3.0 V.

7. Package Information

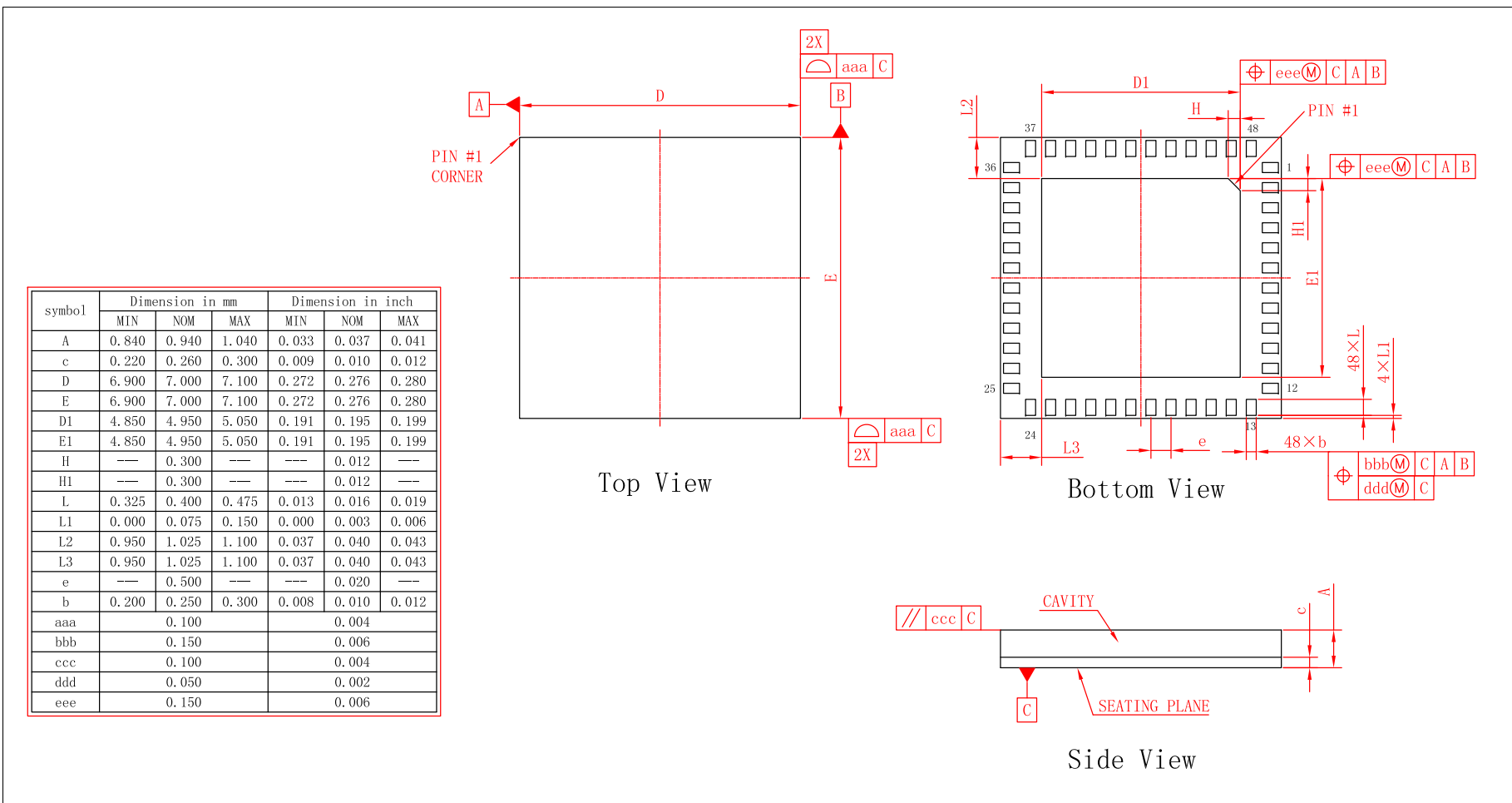


Figure 7: ESP32-PICO-V3 Package

8. Product Handling

8.1 Storage Condition

The products sealed in Moisture Barrier Bag (MBB) should be stored in a noncondensing atmospheric environment of $< 40^{\circ}\text{C}/90\%\text{RH}$.

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

After unpacking, the module must be soldered within 168 hours with factory conditions $25\pm 5^{\circ}\text{C}/60\%\text{RH}$. The module needs to be baked if the above conditions are not met.

8.2 ESD

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

8.3 Reflow Profile

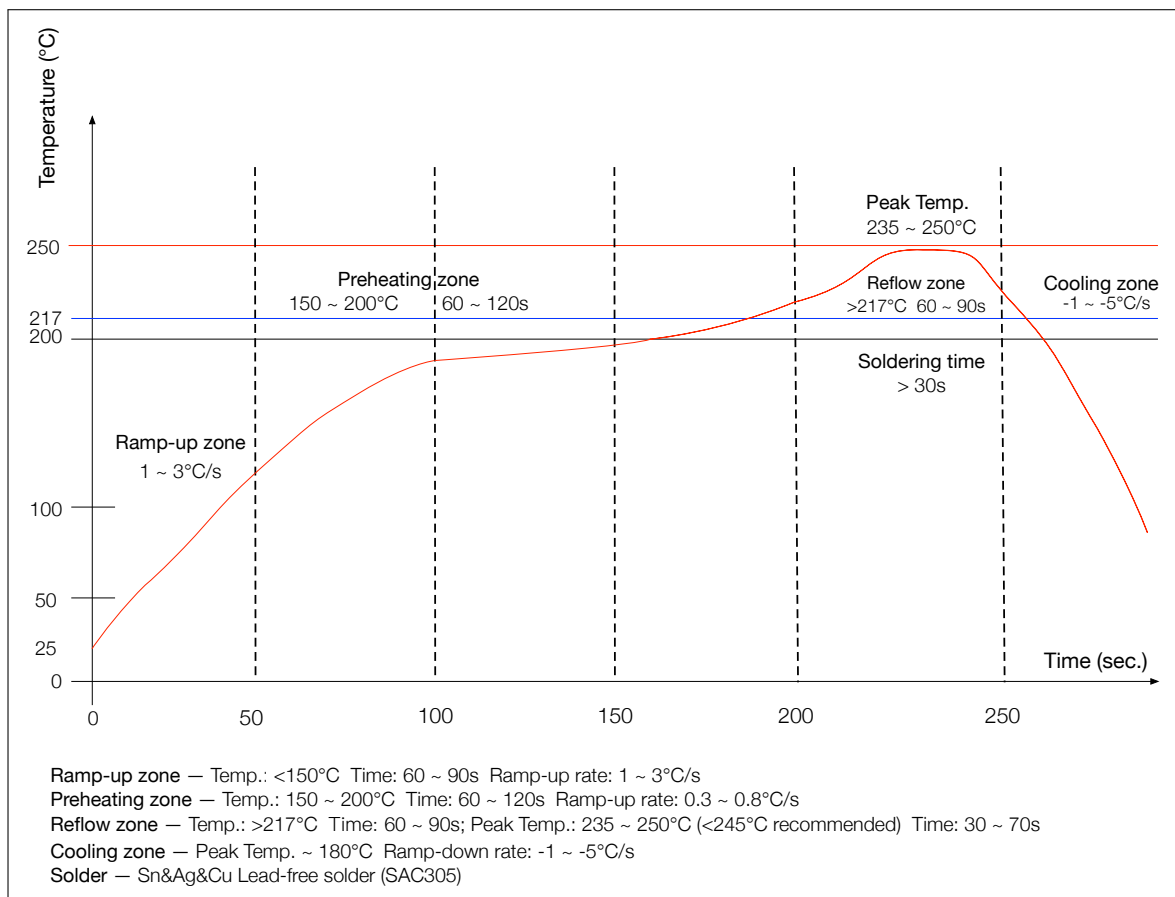


Figure 8: Reflow Profile

Note:

Solder the module in a single reflow. If the PCBA requires multiple reflows, place the module on the PCB during the final reflow.

9. MAC Addresses and eFuse

The eFuse in ESP32 has been burnt into 48-bit `mac_address`. The actual addresses the chip uses in station, AP, BLE, and Ethernet modes correspond to `mac_address` in the following way:

- Station mode: `mac_address`
- AP mode: `mac_address + 1`
- BLE mode: `mac_address + 2`
- Ethernet mode: `mac_address + 3`

In the 1 Kbit eFuse, 256 bits are used for the system (MAC address and chip configuration) and the remaining 768 bits are reserved for customer applications, including flash-encryption and chip-ID.

10. Learning Resources

10.1 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](#)

10.2 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
2020-04-16	V1.0	First release

Mouser Electronics

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[Espressif:](#)

[ESP32-PICO-V3](#)