

ESP32M16 Series WiFi module uses Expressif ESP32 D0WD SoC. Its footprint is exactly the same as that of Expressif ESP32 WROOM-32 module. The difference:

- Tighter tolerance RF components with wider operating temperature range are used to provide consistent and improved RF circuit performance from -40°C to +105°C.
- An ISSI 4 MB flash, IS25LP032-JBLE; or 16 MB flash, IS25LP128-JBLE with operating temperature range from -40°C to +105°C is used .



## Specifications:

### ■ CPU

- Expressif ESP32 D0WD, Xtensa dual core 32 bit LX6 microprocessors, up to 600 MIPS.
- 448KB ROM, 520KB SRAM, 4MB or 16 MB flash
- 16KB SRAM in RTC
- QPSI supports multiple flash/SRAM chips
- Internal 8 MHz oscillator with calibration
- Internal RC oscillator
- Embedded 40 MHz crystal oscillator
- External 32 KHz crystal oscillator
- Two timer group. 2x64 bit timers and 1x main watch dog in each group
- 34 GPIO pins
- 12 bit SAR ADC up to 18 channels
- 2x8 bit DAC
- 10xtouch sensors
- 4xSPI, 2xI<sup>2</sup>S, 2xI<sup>2</sup>C, 3xUART
- 1 host (SD/eMMC/SDIO), 1 slave (SDIO/SPI)
- Ethernet MAC interface with dedicated DMA and IEEE 1588 support
- CAN 2.0, IR (TX/RX), Motor PWM
- LED PWM up to 16 channels

### ■ WiFi Features

- 802.11 b/g/n, 802.11n (2.4 GHz).up to 150 Mbps
- WMM
- TX/RX A-MPDU, RX A-MSDU
- Immediate Block ACK
- Defragmentation
- Automatic Beacon monitoring (hardware TSF)
- 4x virtual WiFi interfaces
- Security
  - Secure boot, flash encryption
  - Cryptographic hardware acceleration, AES, Hash (SHA-2), RSA, ECC

### ■ Security

- 38 castellated pins.
- Integrated PCB trace antenna or u.FL connector
- Operation voltage: 3.0V to 3.6V

## Model Summaries

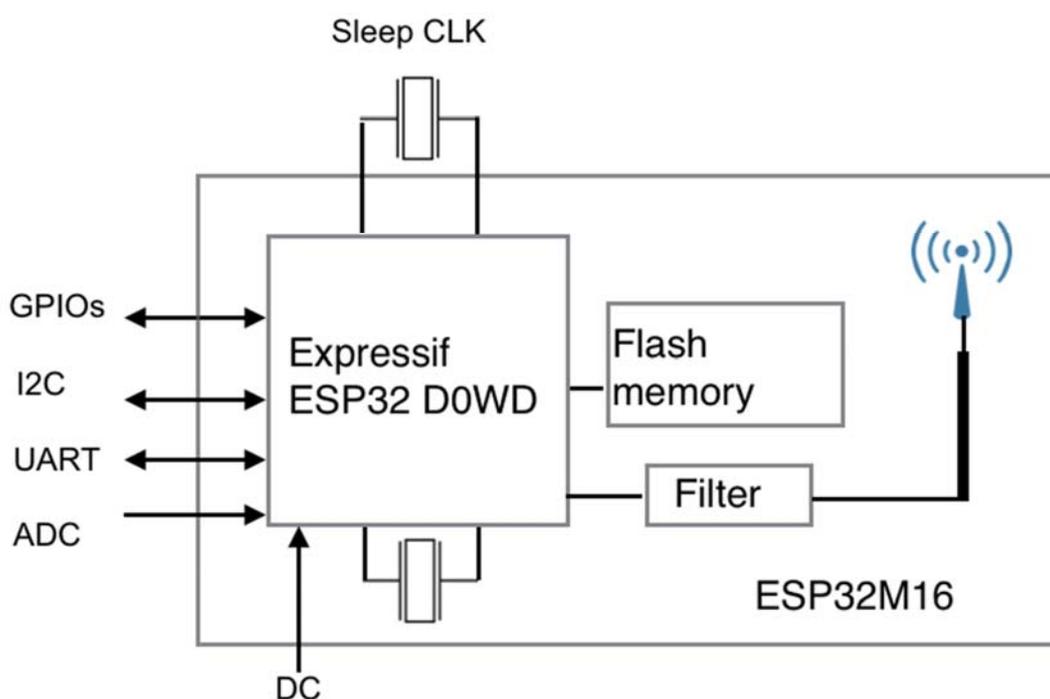
module	ESP32M4	ESP32F4.	ESP32E4.	ESP32M16	ESP32F16	ESP32E16.
SoC	ESP32-D0WD	ESP32-D0WD	ESP32-D0WD	ESP32-D0WD	ESP-D0WD	ESP32-D0WD
Flash memory	4MB, IS25LP032-JBLE	4MB, IS25LP032-	4MB, IS25LP032-	16MB, IS25LP128-JBLE	16MB, IS25LP128-JBLE	16MB, IS25LP128-JBLE
Size	18x25.5	18x25.5	18x25.5	18x25.5	20x29.5	18x25.5
WiFi Antenna	PCB trace	PCB trace	u.FL	PCB trace	PCB trace	u.FL
Max TX						
Operating temp.	-40°C to +105°C	-40°C to +105°C	-40°C to +105°C	-40°C to +105°C	-40°C to +105°C	-40°C to +105°C
Price at 1K pcs		\$3.46		\$4.33		\$4.49
Availability				Sample 03/2020		Sample 03/2020

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## 1. Introduction

ESP32M16 Series use Expressif ESP32 D0WD SoC. Its footprint is the same as that of Expressif ESP32-WROOM module.



There are two CPU cores that can be individually controlled, and the CPU clock frequency is adjustable from 80 MHz to 240 MHz. The main CPU can be powered off and use the low power co-processor to constantly monitor the peripherals for changes or crossing of thresholds. ESP32 integrates a rich set of peripherals, ranging from capacitive touch sensors, Hall sensors, SD card interfaces, Ethernet, high-speed SPI, UART, I<sup>2</sup>S, and I<sup>2</sup>C.

### Module Performance Enhancement

Improvements of ESP32M4, ESP32M16, ESP32E4, ESP32E16 are using:

- Tighter tolerance RF components with wider operating temperature range are used to provide consistent and improved RF circuit performance from -40°C to +105°C.
- An ISSI 4 MB flash, IS25LP032-JBLE; or 16 MB flash, IS25LP128-JBLE with operating temperature range from -40°C to +105°C.

ESP32M4, ESP32M16, ESP32E4, and ESP32E16 are referred as ESP32M16 in this product specifications.

### ESP32M16

- Uses an Expressif ESP32 D0WD SoC.
- 448KB ROM, 520KB SDRAM

- 16 MB flash, ISSI, IS25LP128-JBLE
- Integrated PCB trace antenna.
- Size: 18x25.5mm.

### ESP32F16

- The same as ESP32M16
- Integrated PCB trace inverted F antenna
- size: 20x29.5mm

### ESP32M4

- The same as ESP32M16
- 448KB ROM, 520KB SDRAM
- 4MB flash, ISSI, IS25LP032-JBLE.
- Integrated PCB trace antenna
- size: 18x25.5mm

### ESP32E16

- Uses an Expressif ESP32 D0WD SoC.
- 448KB ROM, 520KB SDRAM
- 16 MB flash, ISSI, IS25LP128-JBLE
- An u.FL connector for external antenna.
- Size: 18x25.5mm.

### ESP32E4

- Uses an Expressif ESP32 D0WD SoC.
- 448KB ROM, 520KB SDRAM
- 4 MB flash, ISSI, IS25LP032-JBLE
- An u.FL connector for external antenna.
- Size: 18x25.5mm.

## 2. Product Descriptions

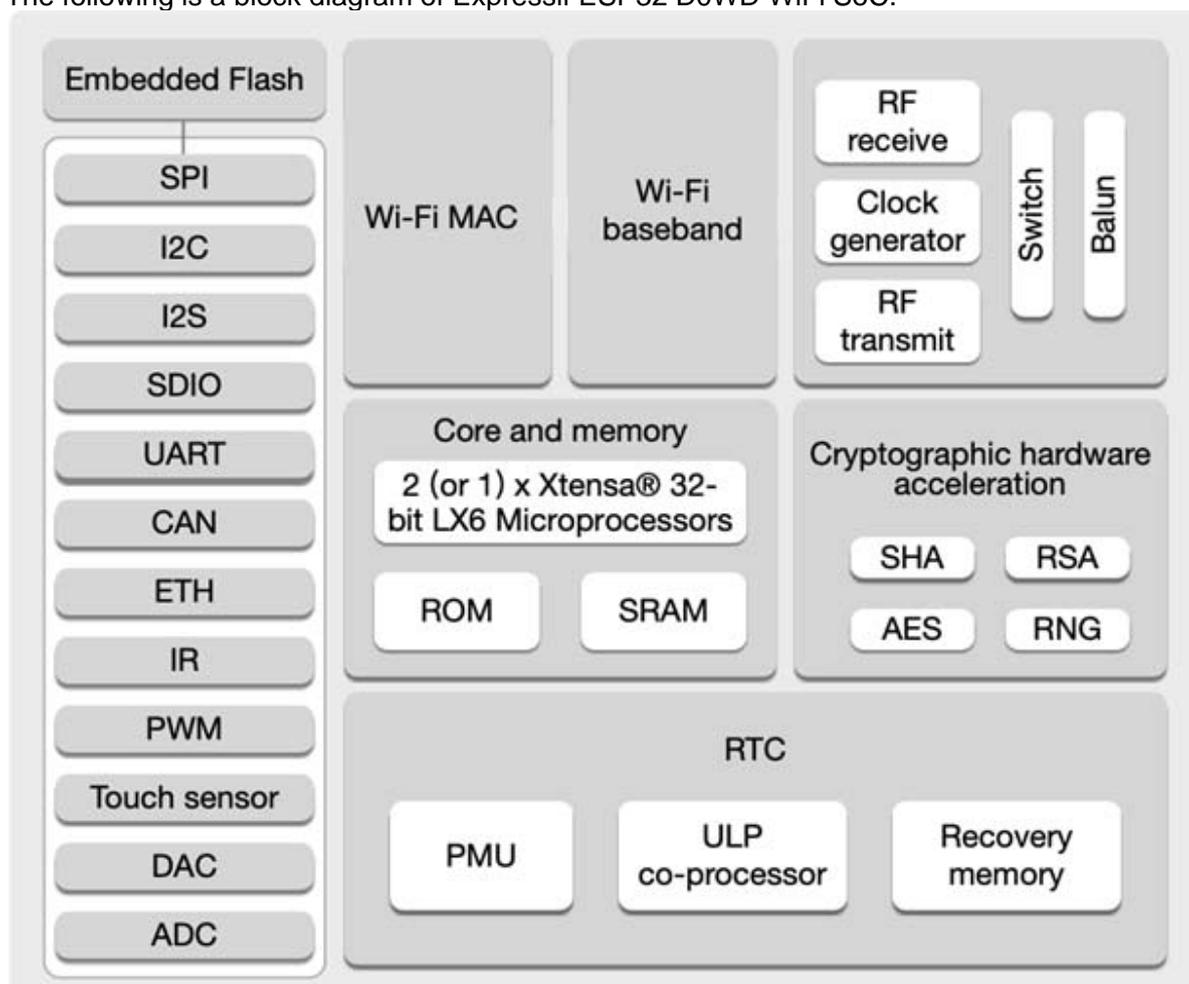
Please download specifications of SoC ESP32 D0WD from this webpage.

<https://www.fanstel.com/wirelessdocument>

Specifications of the original module, ESP32-WROOM can also be downloaded from the same webpage.

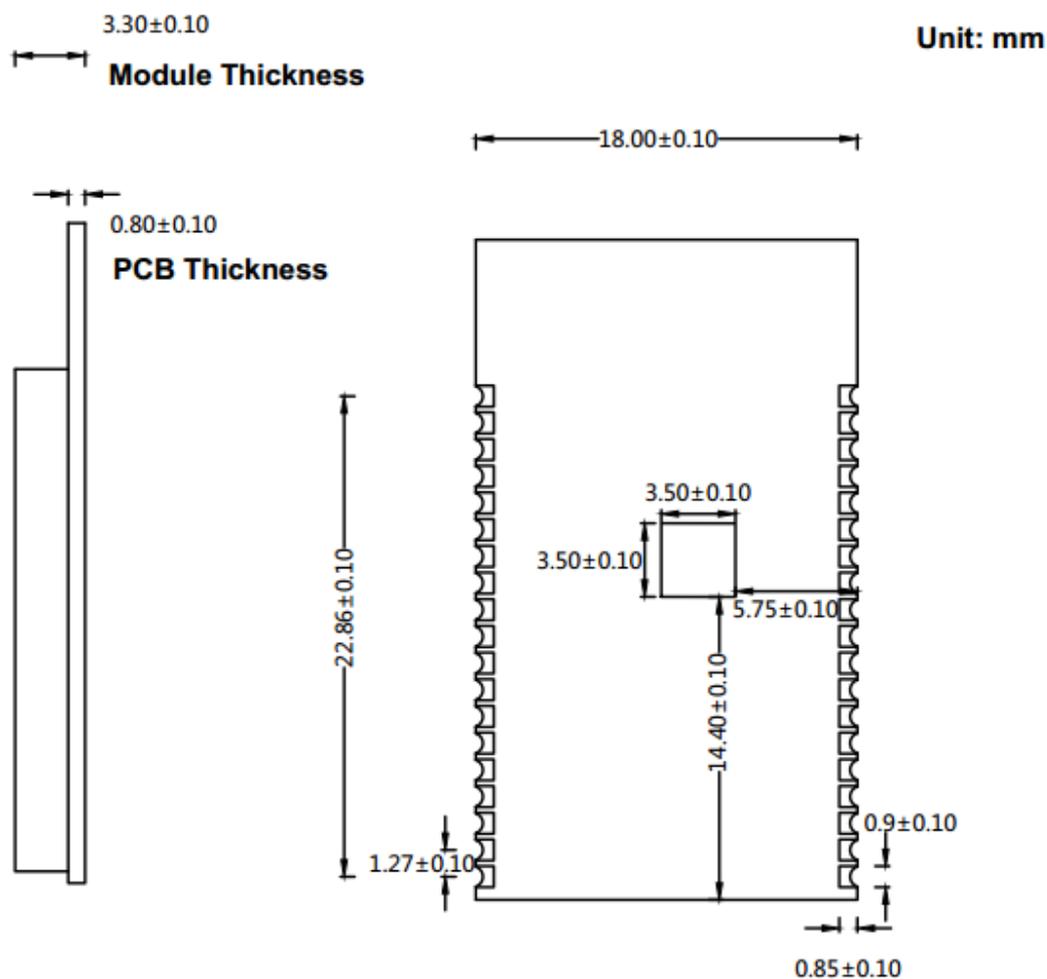
### Block Diagram of ESP32 D0WD

The following is a block diagram of Expressif ESP32 D0WD WiFi SoC.



## Mechanical Drawings

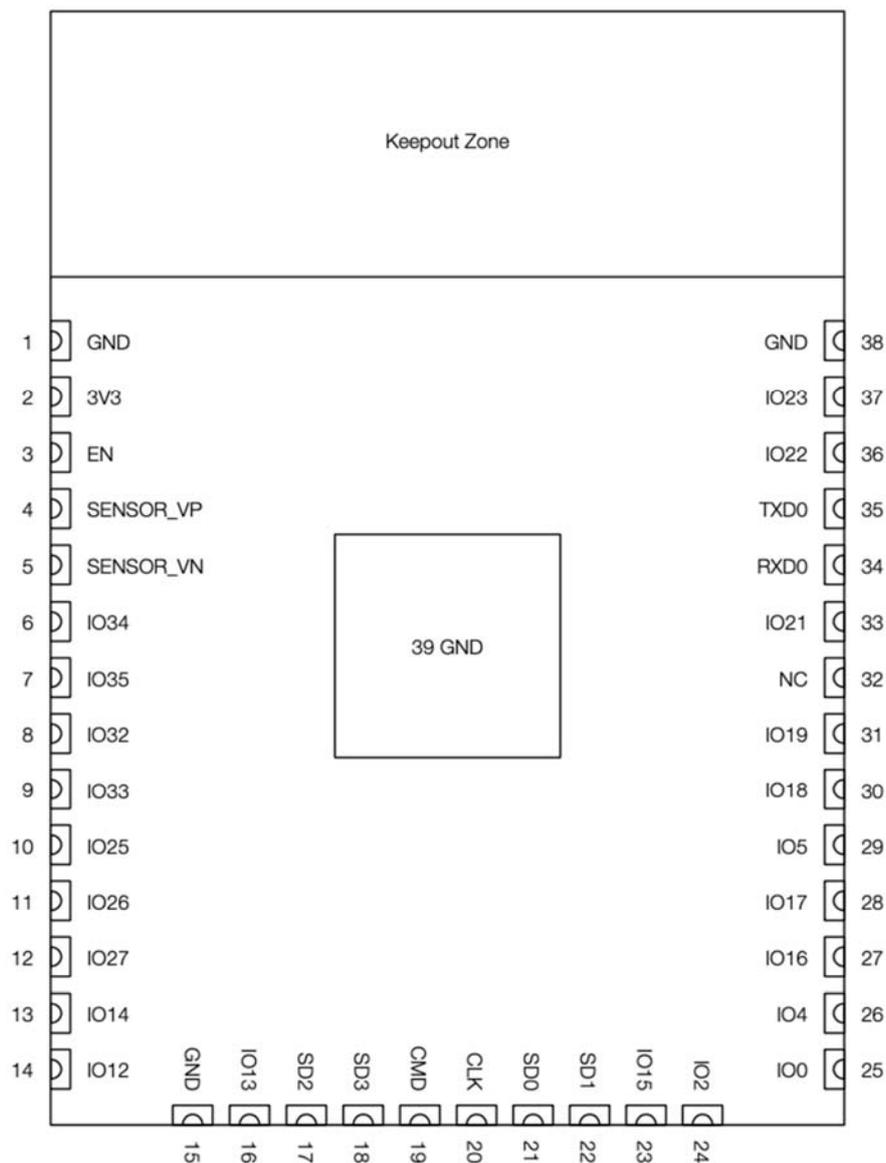
The followings are mechanical drawings of ESP32M16, top view.



## Pin Assignments of ESP32M16

The followings are ESP32M16 pin assignment. Pin functions are in a table in next section. Please refer to Espressif ESP32 D0WD and ESP32 WROOM Product Specifications for detailed descriptions and features supported.

ESP32M16 pin assignments.



ESP32M16	ESP32 D0WD	pin name	Descriptions
pin#	pin#	pin name	Descriptions
1	49	GND	Ground
2	46	3V3	DC power supply
3	9	EN	Module enable signal, active high
4	5	Sensor-VP	GPIO36, ADC1_CH0, RTC_GPIO0
5	8	Sensor_VN	GPIO39, ADC1_CH3, RTC_GPIO3

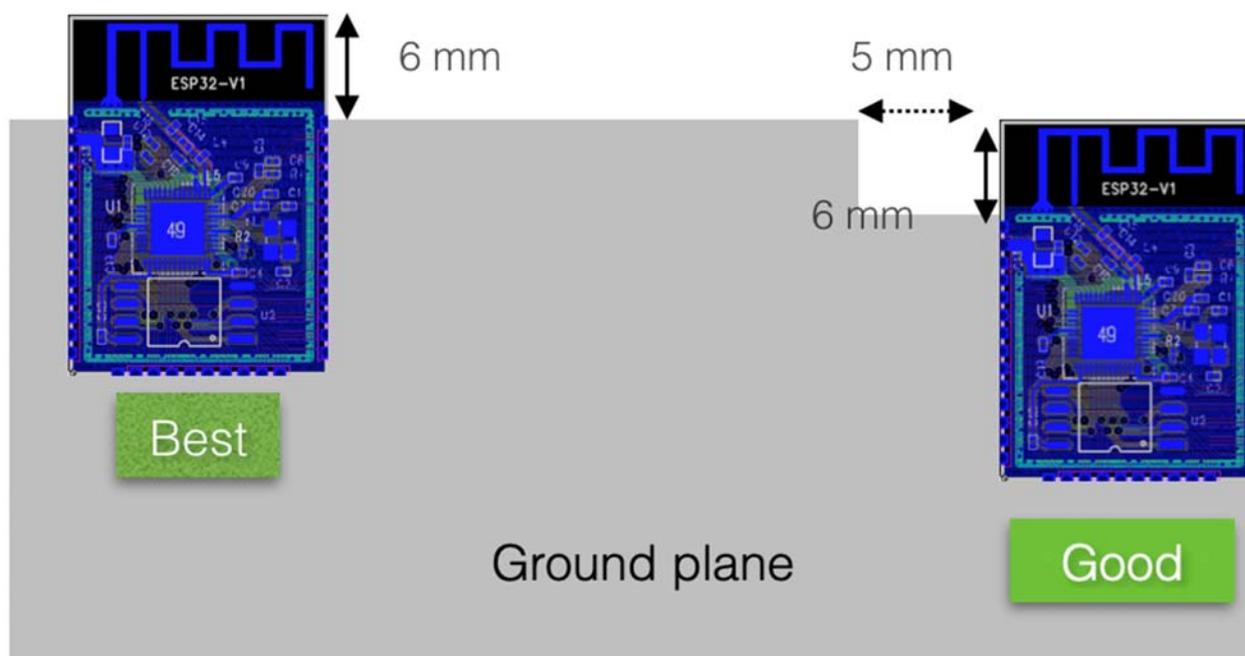
6	10	IO34	GPIO34, ADC1_CH6, RTC_GPIO4
7	11	IO35	GPIO35, ADC1_CH7, RTC_GPIO5
8	12	IO32	GPIO32, XTAL_32K_P(32.768 kHz crystal input), ADC1_CH4, Touch9, RTC_GPIO9
9	13	IO33	GPIO33, XTAL_32K_N(32.768 kHz crystal output), ADC1_CH5, Touch8, RTC_GPIO8
10	14	IO25	GPIO25, DAC_1, ADC2_CH8, RTC_GPIO6, EMAC_RDX0
11	15	IO26	GPIO26, DAC_2, ADC2_CH9, RTC_GPIO7, EMAC_RDX1
12	16	IO27	GPIO27, ADC2_CH7, Touch7, RTC_GPIO17, EMAC_RX_DV
13	17	IO14	GPIO14, ADC2_CH6, Touch6, RTC_GPIO16, MTMS, HSPICLK, HS2_CLK, SD_CLK, EMAC_TXD2
14	18	IO12	GPIO12, ADC2_CH5, Touch5, RTC_GPIO15, MTDI, HSPIQ, HS2_DATA2, SD_DATA2, EMAC_TXD3
15	49	GND	Ground
16	20	IO13	GPIO13, ADC2_CH4, Touch4, RTC_GPIO14, MTCLK, HSPID, HS2_DATA3, SD_DATA3, EMAC_RX_ER
17	28	SD2	GPIO9, SD_DATA2, SPIHD, HS1_DATA2, U1RXD
18	29	SD3	GPIO10, SD_DATA3, SPIWP, HS1_DATA3, U1TXD
19	30	CMD	GPIO11, SD_CMD, SPICSO, HS1_CMD, U1RTS
20	31	CLK	GPIO6, SD_CLK, SPICLK, HS1_CLK, U1CTS
21	32	SD0	GPIO7, SD_DATA0, SPIQ, HS1_DATA0, U2RTS
22	33	SD1	GPIO8, SD_DATA1, SPID, HS1_DATA1, U2CTS
23	21	IO15	GPIO15, ADC2_CH3, Touch3, MTDO, HSPICS0, RTC_GPIO13, HS2_CMD, SD_CMD, EMAC_RXD3
24	22	IO2	GPIO2, ADC2_CH2, Touch2, HSPIWP, RTC_GPIO12, HS2_DATA0, SD_DATA0
25	23	IO0	GPIO0, ADC2_CH1, Touch1, RTC_GPIO11, CLK_OUT1, EMAC_TX_CLK
26	24	IO4	GPIO4, ADC2_CH0, Touch0, HSPIHD, RTC_GPIO10, HS2_DATA1, SD_DATA1, EMAC_TX_ER
27	25	IO16	GPIO16, HS1_DATA4, U2RXD, EMAC_CLK_OUT
28	27	IO17	GPIO17, HS1_DATA5, U2TXD, EMAC_CLK_OUT_180
29	34	IO5	GPIO5, VSPICS0, HS1_DATA6, EMAC_RX_CLK
30	35	IO18	GPIO18, VSPICLK, HS1_DATA7
31	38	IO19	GPIO19, VSPIQ, U0CTS, EMAC_TXD0
32		NC	
33	42	IO21	GPIO21, VSPIHD, EMAC_TXEN
34	40	RXD0	GPIO3, U0RXD, CLK_OUT2
35	41	TXD0	GPIO1, U0TXD, CLK_OUT3, EMAC_RXD2
36	39	IO22	GPIO22, VSPIWP, U0RTS, EMAC_TXD1
37	36	IO23	GPIO23, VSPID, HS1_STROBE
38	49	GND	Ground
39	49	GND PAD	Ground pad

## Pin Function

### Mounting ESP32M4 on the Host PCB

The following figure shows recommended mounting of ESP32M4 module on the host PCB.

- For the best WiFi range performance, the antenna area of module shall extend 6 mm outside the edge of host PCB board, or 6 mm outside the edge of a ground plane.
- The next choice is to place a module on a corner of host PCB, the antenna area shall extend 6 mm from the edge of ground plane. Ground plane shall be at least 5 mm from the edge of the antenna area of module.
- We don't recommend mounting ESP32M4
- module in the middle of a host PCB.



1.ESP32M4 module extends 6 mm from edge or ground plane of the host PCB board.

### 3. Firmware Development

Please use Expressif Firmware development environment for ESP32-WROOM module.

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.

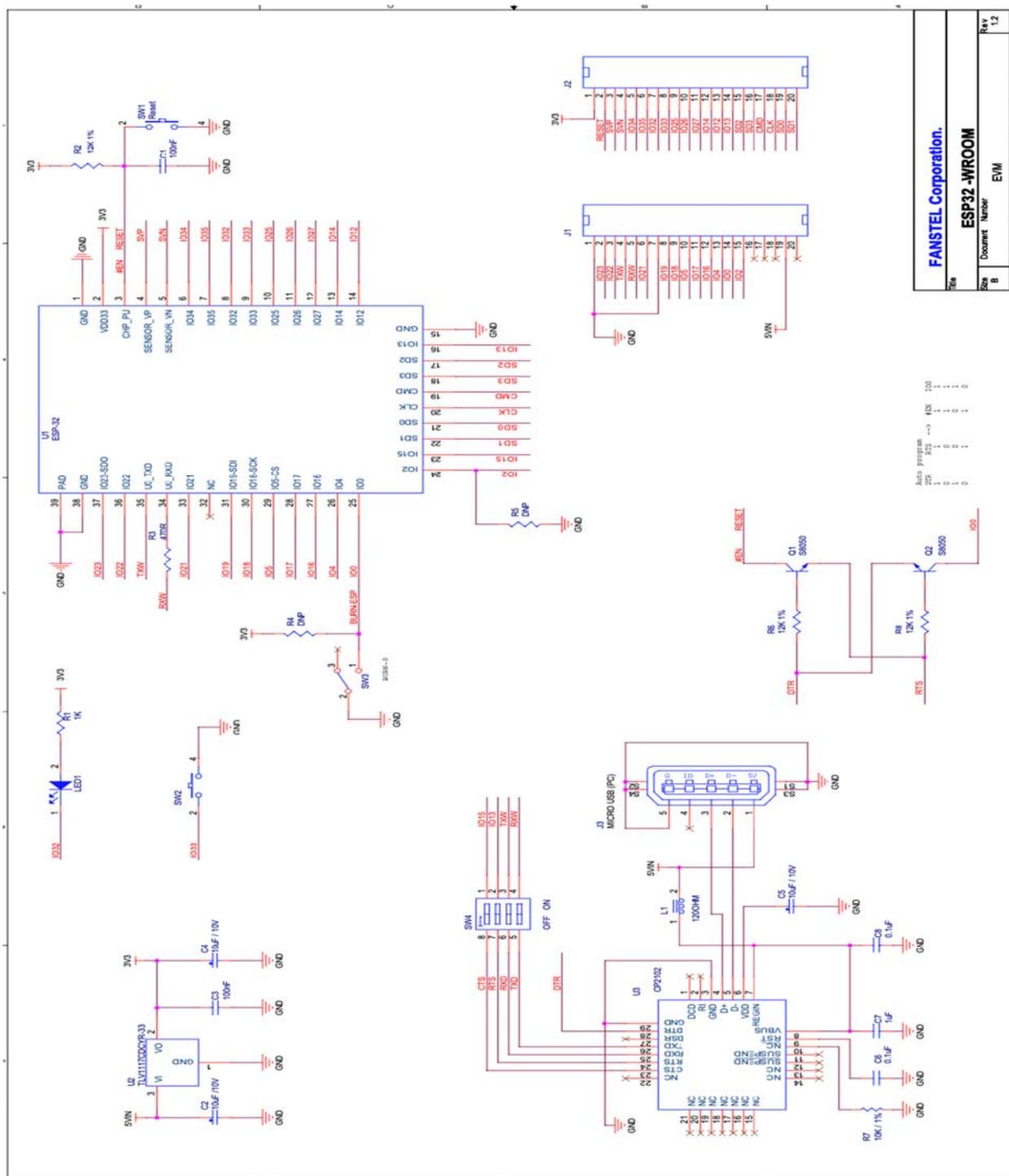
#### 4. ESP32M4 Evaluation Board

TO BE PROVIDED.



## ESP32M4 EvaluationBoard Schematics

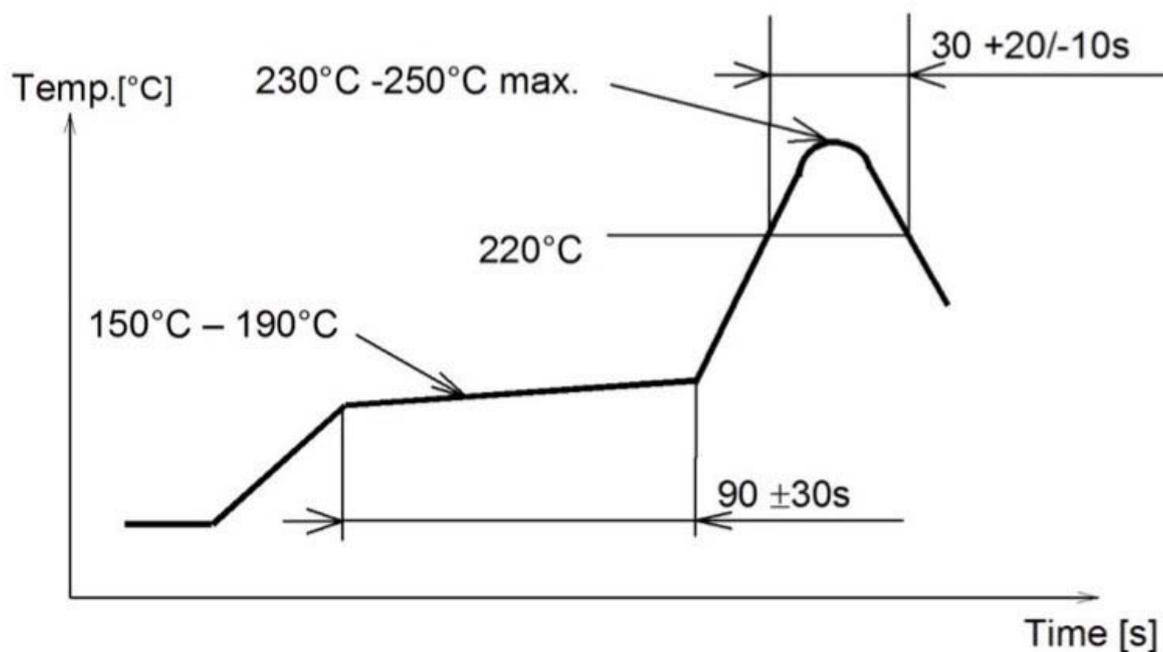
Evaluation board EV-ESP32M4 schematics:



## 5. Miscellaneous

### Soldering Temperature-Time Profile for Re-Flow Soldering

Maximum number of cycles for re-flow is 2. No opposite side re-flow is allowed due to module weight.



### Cautions, Design Notes, and Installation Notes

Failure to follow the guidelines set forth in this document may result in degrading of the product's functions and damage to the product.

#### Design Notes

- (1) Follow the conditions written in this specification, especially the control signals of this module.
- (2) The supply voltage has to be free of AC ripple voltage (for example from a battery or a low noise regulator output). For noisy supply voltages, provide a decoupling circuit (for example a ferrite in series connection and a bypass capacitor to ground of at least 47uF directly at the module).
- (3) This product should not be mechanically stressed when installed.
- (4) Keep this product away from heat. Heat is the major cause of decreasing the life of these products.
- (5) Avoid assembly and use of the target equipment in conditions where the products' temperature may exceed the maximum tolerance.
- (6) The supply voltage should not be exceedingly high or reversed. It should not carry noise and/or spikes.

(7) this product away from other high frequency circuits.

#### *Notes on Antenna and PCB Layout*

(1) Don't use a module with internal antenna inside a metal case.

(2) For PCB layout:

- Avoid running any signal line below module whenever possible,
- No ground plane below antenna,
- If possible, cut-off the portion of main board PCB below antenna.

#### *Installation Notes*

(1) Reflow soldering is possible twice based on the time-temperature profile in this data sheets. Set up the temperature at the soldering portion of this product according to this reflow profile.

(2) Carefully position the products so that their heat will not burn into printed circuitboards or affect the other components that are susceptible to heat.

(3) Carefully locate these products so that their temperatures will not increase due to the effects of heat generated by neighboring components.

(4) If a vinyl-covered wire comes into contact with the products, then the cover will melt and generate toxic gas, damaging the insulation. Never allow contact between the cover and these products to occur.

(5) This product should not be mechanically stressed or vibrated when reflowed.

(6) If you want to repair your board by hand soldering, please keep the conditions of this chapter.

(7) Do not wash this product.

(8) Refer to the recommended pattern when designing a board.

(9) Pressing on parts of the metal cover or fastening objects to the metal will cause damage to the unit.

#### *Usage Condition Notes*

(1) Take measures to protect the unit against static electricity. If pulses or other transient loads (a large load applied in a short time) are applied to the products, check and evaluate their operation before assembly on the final products.

(2) Do not use dropped products.

(3) Do not touch, damage or soil the pins.

(4) Follow the recommended condition ratings about the power supply applied to this product.

(5) Electrode peeling strength: Do not add pressure of more than 4.9N when soldered on PCB

(6) Pressing on parts of the metal cover or fastening objects to the metal cover will cause damage.

(7) These products are intended for general purpose and standard use in general electronic equipment, such as home appliances, office equipment, information and communication equipment.

#### **Storage Notes**

(1) The module should not be stressed mechanically during storage.

(2) Do not store these products in the following conditions or the performance characteristics of the product, such as RF performance will be adversely affected:

- Storage in salty air or in an environment with a high concentration of corrosive gas.
- Storage in direct sunlight
- Storage in an environment where the temperature may be outside the range specified.
- Storage of the products for more than one year after the date of delivery storage period.

(3) Keep this product away from water, poisonous gas and corrosive gas.

(4) This product should not be stressed or shocked when transported.

(5) Follow the specification when stacking packed crates (max. 10).

#### **Safety Conditions**

These specifications are intended to preserve the quality assurance of products and individual components. Before use, check and evaluate the operation when mounted on your products. Abide by these specifications, without deviation when using the products. These products may short-circuit. If electrical shocks, smoke, fire, and/or accidents involving human life are anticipated when a short circuit occurs, then provide the following failsafe functions, as a minimum.

(1) Ensure the safety of the whole system by installing a protection circuit and a protection device.

(2) Ensure the safety of the whole system by installing a redundant circuit or another system to prevent a dual fault causing an unsafe status.

#### **Other Cautions**

(1) This specification sheet is copyrighted. Reproduction of this data sheet is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices.

(2) Do not use the products for other purposes than those listed.

(3) Be sure to provide an appropriate failsafe function on your product to prevent an additional damage that may be caused by the abnormal function or the failure of the product.

(4) This product has been manufactured without any ozone chemical controlled under the Montreal Protocol.

(5) These products are not intended for other uses, other than under the special conditions shown below. Before using these products under such special conditions, check their performance and

reliability under the said special conditions carefully to determine whether or not they can be used in such a manner.

- In liquid, such as water, salt water, oil, alkali, or organic solvent, or in places where liquid may splash.
  - In direct sunlight, outdoors, or in a dusty environment
  - In an environment where condensation occurs.
  - In an environment with a high concentration of harmful gas.
- (6) If an abnormal voltage is applied due to a problem occurring in other components or circuits, replace these products with new products because they may not be able to provide normal performance even if their electronic characteristics and appearances appear satisfactory.
- (7) When you have any question or uncertainty, contact Fanstel.

**Packaging and Lot Number**

Production modules are delivered in reel, 1000 modules in each reel. Lot number for modules made after May 2019, can be used to track silicon version of SoC, module PCB version, and production test code version.



<p>(K) Cust. PO:2630427  </p> <p>(4K) Cust. PO line:00003  </p> <p>(P) Cust. P/N : 1914-1019-2-ND  </p> <p>(1T) Lot :D0V218B-0000000  </p> 	<p>(Q) QTY :1000  </p> <p>(1P) MFG P/N : BT840F  </p> <p>(6D) Ship Date :20190522  </p> <p>(9D) Date : 1920  </p> <p>(4L) COO: CN  </p>
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MSL	3/260°C
(E)	e4
<b>RoHS</b>	

**Lot: D0 V2 18B - 00 00 000**

D0: 2 digits, version number of SoC.

V2: 2 digits, version number of module PCB.

18B: the first 2 digits for production test codes released year and the last digit for month in hex format. A=October, B=November, C=December. 18B was released in November 2018.

00 00 000, 7 digits, reserved for 2nd SoC for modules with 2 SoCs.

**FCC LABEL**

The Original Equipment Manufacturer (OEM) must ensure that the OEM modular transmitter must be labeled with its own FCC ID number. This includes a clearly visible label on the outside of the final product enclosure that displays the contents shown below. If the FCC ID is not visible when the equipment is installed inside another device, then the outside of the device into which the equipment is installed must also display a label referring to the enclosed equipment

The end product with this module may subject to perform FCC part 15 unintentional emission test requirement and be properly authorized.

This device is intended for OEM integrator only.

## **Revision History**

- January 2020, Ver 0.10: Initial draft release

## Contact Us

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**Federal Communications Commission (FCC) Statement**

You are cautioned that changes or modifications not expressly approved by the part responsible for compliance could void the user's authority to operate the equipment.

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

- 1) this device may not cause harmful interference, and
- 2) this device must accept any interference received, including interference that may cause undesired operation of the device.

**FCC RF Radiation Exposure Statement:**

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. End users must follow the specific operating instructions for satisfying RF exposure compliance. This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

**RF exposure warning**

This equipment must be installed and operated in accordance with provided instructions and the antenna(s) used for this transmitter must be installed to provide a separation distance of at least 20 cm from all persons and must not be co-located or operating in conjunction with any other antenna or transmitter. End-users and installers must be provided with antenna installation instructions and transmitter operating conditions for satisfying RF exposure compliance.

**Industry Canada (IC) Statement**

This device complies with Industry Canada licence-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

**Canada, avis d'Industry Canada (IC)**

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes:

- (1) l'appareil ne doit pas produire de brouillage, et
- (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

**Informations concernant l'exposition aux fréquences radio (RF)**

Cet équipement est conforme avec l'exposition aux radiations IC définies pour un environnement noncontrôlé. Cet équipement doit être installé et utilisé à une distance minimum de 20 cm entre le radiateur et votre corps. Cet émetteur ne doit pas être co-localisées ou opérant en conjonction avec une autre antenne ou transmetteur. Les utilisateurs finaux et les installateurs doivent être informés des instructions d'installation de l'antenne et des conditions de fonctionnement de l'émetteur afin de satisfaire à la conformité d'exposition RF.

**Note: The end product shall has the words “Contains Transmitter Module FCC ID:X8WESP32M16, IC: 4100A-ESP32M16”**

**Information for the OEM and Integrators**

The following statement must be included with all versions of this document supplied to an OEM or integrator, but should not be distributed to the end user.

- (1) This device is intended for OEM integrators only.
- (2) Please see the full Grant of Equipment document for other restrictions.

This radio transmitter IC: 4100A-ESP32M16 has been approved by Innovation, Science and Economic Development Canada to operate with the antenna types listed below, with the maximum permissible gain indicated. Antenna types not included in this list that have a gain greater than the maximum gain indicated for any type listed are strictly prohibited for use with this device.

PCB Antenna

ESP32M: 2.22 dBi; 50.0 ohms

ESP32F: 1.70 dBi; 50.0 ohms

Dipole Antenna

ESP32E: 0dBi; 50.0 ohms

Cet émetteur radio IC: 4100A-ESP32M16 a été approuvé par Innovation, Sciences et Développement économique Canada fonctionnera avec les types d'antennes énumérés ci-dessous, avec le gain maximal admissible indiqué. Les types d'antennes non inclus dans cette liste qui ont un gain supérieur au gain maximum indiqué pour tout type répertorié sont strictement interdit pour une utilisation avec cet appareil.

PCB Antenna

ESP32M: 2.22 dBi; 50.0 ohms

ESP32F: 1.70 dBi; 50.0 ohms

Dipole Antenna

ESP32E: 0dBi; 50.0 ohms