

## ESP32M4/M16/E16 WiFi Modules

Ver 1.00 Sep. 2020

ESP32M16 Series WiFi module uses Expressif ESP32 D0WD SoC. Its footprint is exactly the same as that of Expressif ESP32 WROOM-32D 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.
- Maximum WiFi TX is +23.98 dBm.



### 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
- 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
  - Simultaneous support for Infrastructure Station, SoftAP, and Promiscuous modes
- GPIOs
  - 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
  - Hall sensor
- Security
  - Secure boot, flash encryption
  - Cryptographic hardware acceleration, AES, Hash (SHA-2), RSA, ECC
- 38 castellated pins.
- Integrated PCB trace antenna or u.FL connector
- Operation voltage: 3.0V to 3.6V
- FCC ID: X8WESP32M16
- ISID ID: 4100A-ESP32M16
- CE: Compliant

### Model Summaries

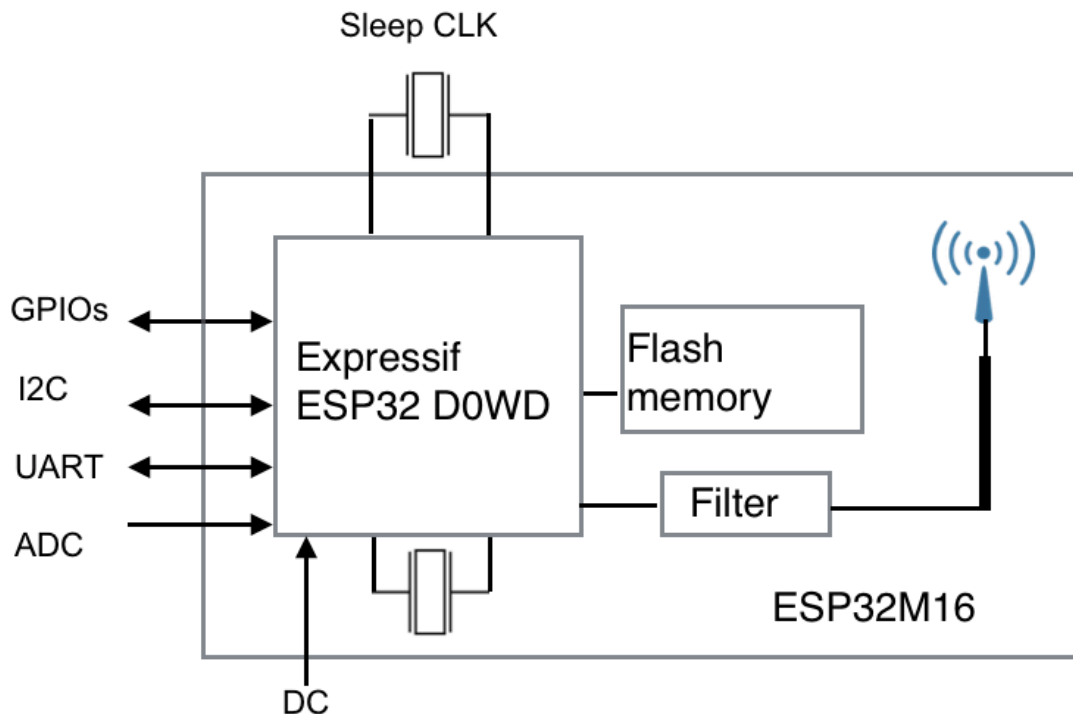
module	ESP32M4	ESP32M16	ESP32E16.
SoC	ESP32-D0WD	ESP32-D0WD	ESP32-D0WD
Flash	4MB, IS25LP032-JBLE	16MB, IS25LP128-JBLE	16MB, IS25LP128-JBLE
Size	18x25.5	18x25.5	18x25.5
BT Antenna	PCB trace	PCB trace	u.FL
Max TX	+23.98 dBm	+23.98 dBm	+23.98 dBm
Max. Antenna gain	+2.22 dBi	+2.22 dBi	0 dBi
Operating temp.	-40°C to +105°C	-40°C to +105°C	-40°C to +105°C
Availability	Production	Production	Production

## Table Of Contents

1. Introduction.....	3
Module Performance Enhancement.....	3
ESP32M4 .....	3
ESP32M16 .....	4
ESP32E16.....	4
2. Product Descriptions .....	5
Block Diagram of ESP32 D0WD .....	5
Mechanical Drawings .....	6
Pin Assignments of ESP32M16.....	7
Pin Function.....	8
Mounting ESP32M16 on the Host PCB.....	9
3. Firmware Development and Application Examples .....	10
BLE to WiFi Gateway, BWG840F/BWG840X.....	10
BLE/LoRa to LTE/WiFi/PoE Ethernet Gateways, LEW840X .....	10
4. ESP32M16 Evaluation Board .....	11
5. Miscellaneous.....	12
Soldering Temperature-Time Profile for Re-Flow Soldering .....	12
Cautions, Design Notes, and Installation Notes .....	12
Packaging and Lot Number .....	16
FCC Label .....	16
Revision History .....	17
Contact Us .....	18

## 1. Introduction

ESP32M16 Series use Expressif ESP32 D0WD SoC. Its footprint is the same as that of Expressif ESP32-WROOM-32D 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, ESP32E16:

- 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.

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

### ESP32M4

- A clone of Expressif ESP32-WROOM-32D with
  - ◆ Operating temperature -40°C to +105°C,
  - ◆ Maximum WiFi TX power +23.98 dBm.
- 448KB ROM, 520KB SDRAM

## ESP32M4/M16/E16 WiFi Modules

- 4MB flash, ISSI, IS25LP032-JBLE.
- Integrated PCB trace antenna
- size: 18x25.5mm

### ESP32M16

- A clone of Expressif ESP32-WROOM-32D with
  - ◆ Operating temperature -40°C to +105°C,
  - ◆ Maximum WiFi TX power +23.98 dBm.
  - ◆ 16 MB flash, ISSI, IS25LP128-JBLE
- 448KB ROM, 520KB SDRAM
- Integrated PCB trace antenna.
- Size: 18x25.5mm.

### ESP32E16

- A clone of Expressif ESP32-WROOM-32D with
  - ◆ Operating temperature -40°C to +105°C,
  - ◆ Maximum WiFi TX power +23.98 dBm.
  - ◆ 16 MB flash, ISSI, IS25LP128-JBLE
  - ◆ An u.FL connector replacing integrated PCB antenna.
  - ◆ Certified with ANT000, 0 dBi antenna.
- 448KB ROM, 520KB SDRAM
- Size: 18x25.5mm.

## ESP32M4/M16/E16 WiFi Modules

### 2. Product Descriptions

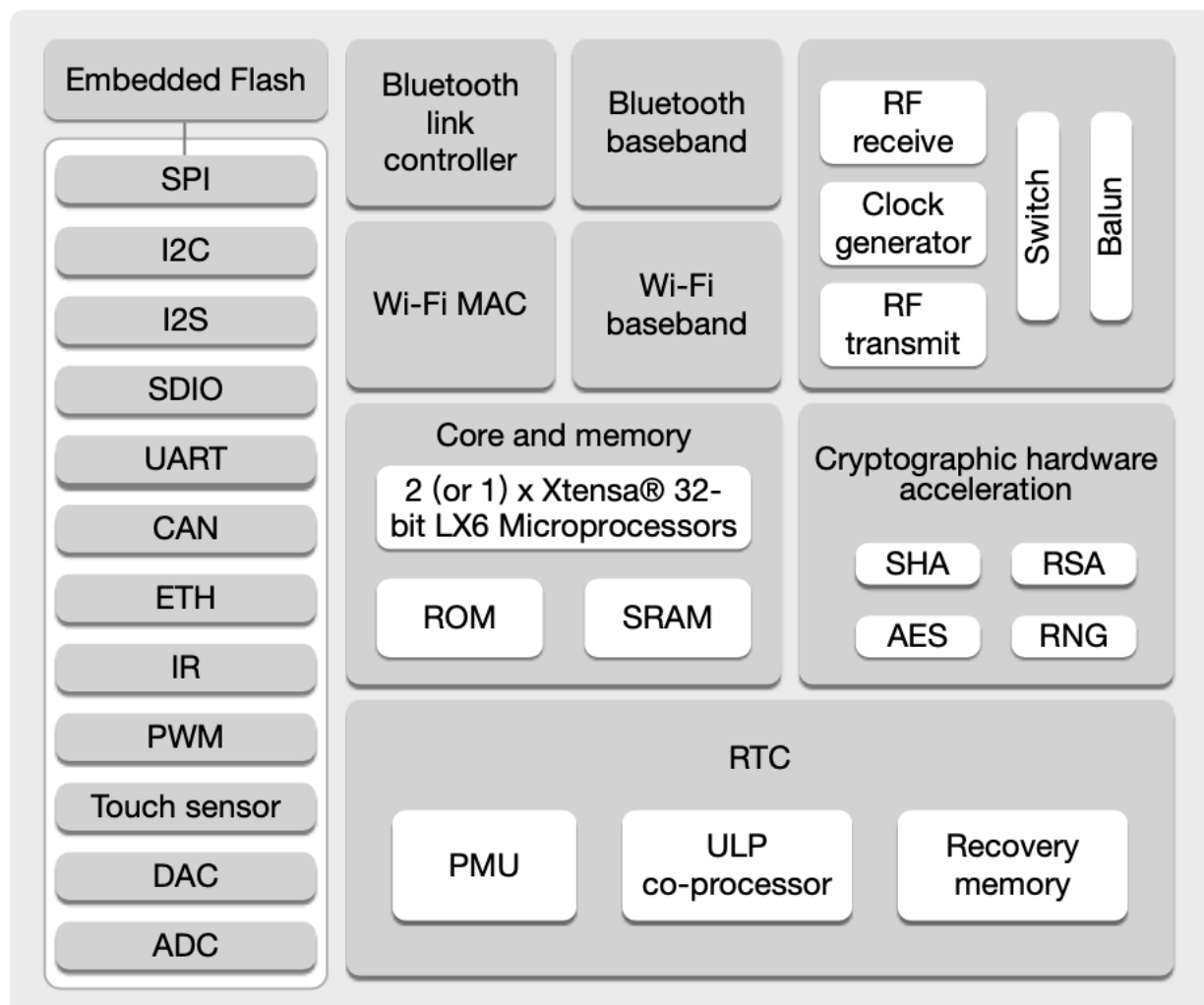
Please download specifications of SoC ESP32 D0WD from this webpage.

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

Specifications of the original module, ESP32-WROOM-32D can also be downloaded from the same webpage.

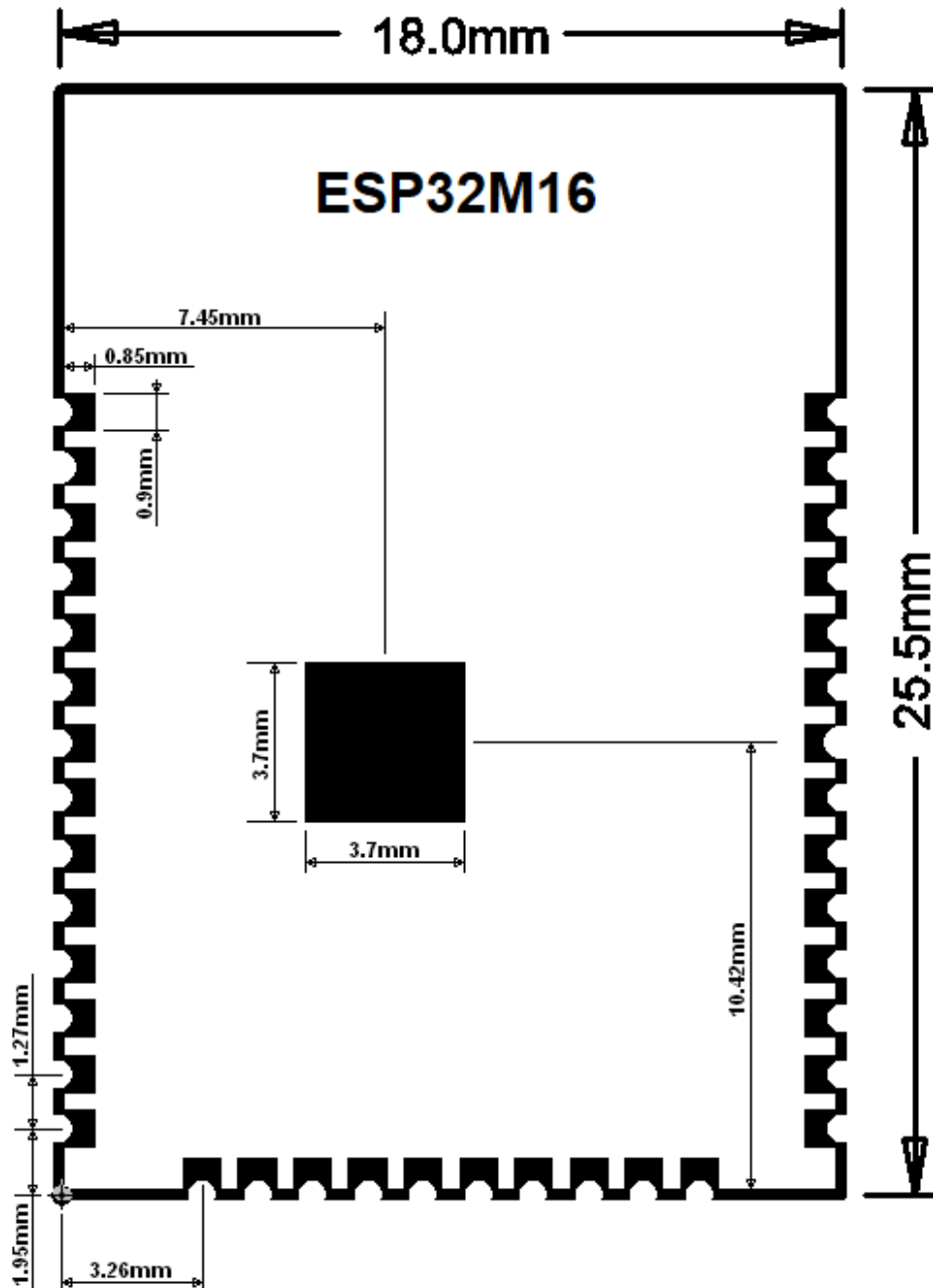
### Block Diagram of ESP32 D0WD

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



## Mechanical Drawings

The followings are mechanical drawings of ESP32M16, top view.

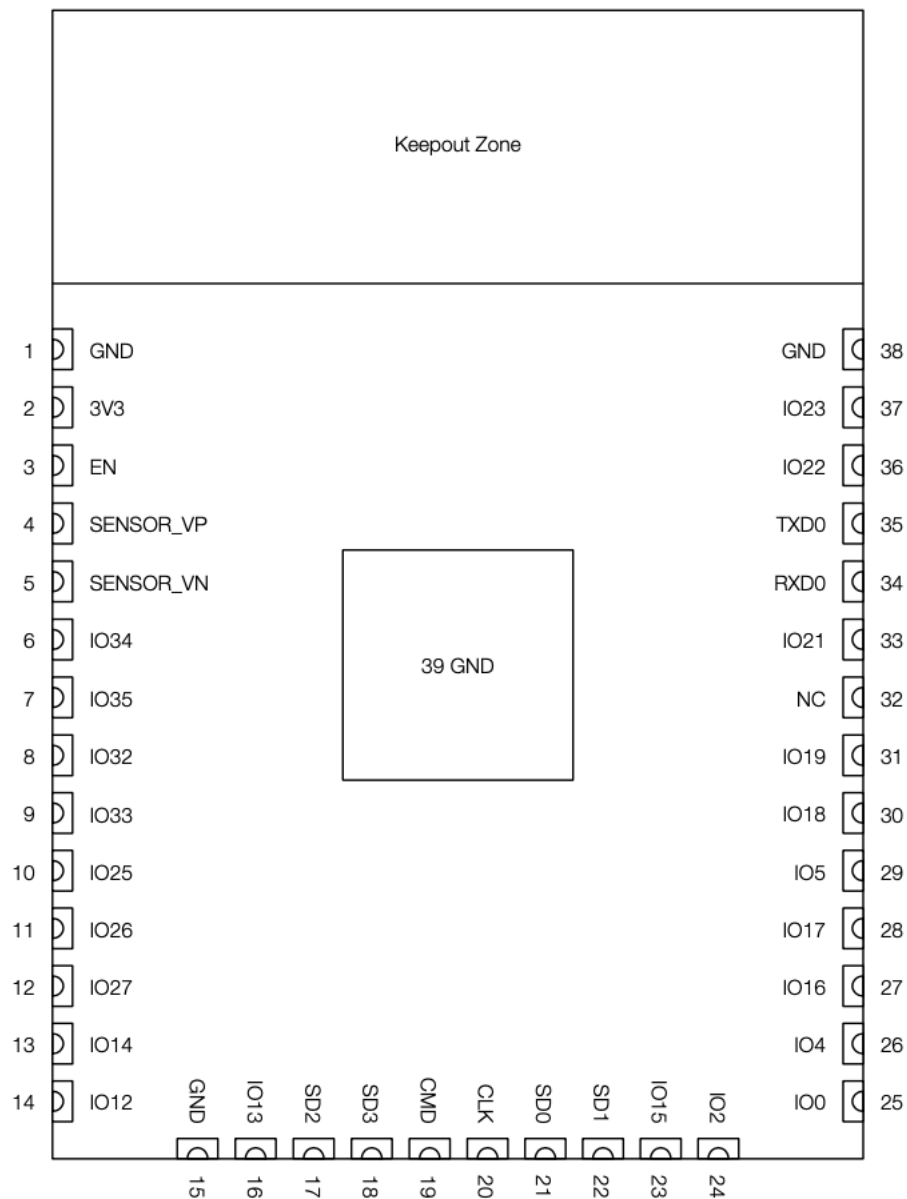


# ESP32M4/M16/E16 WiFi Modules

## 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-32D Product Specifications for detailed descriptions and features supported.

ESP32M16 pin assignments.



## Pin Function

ESP32M16	ESP32 D0WD		
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



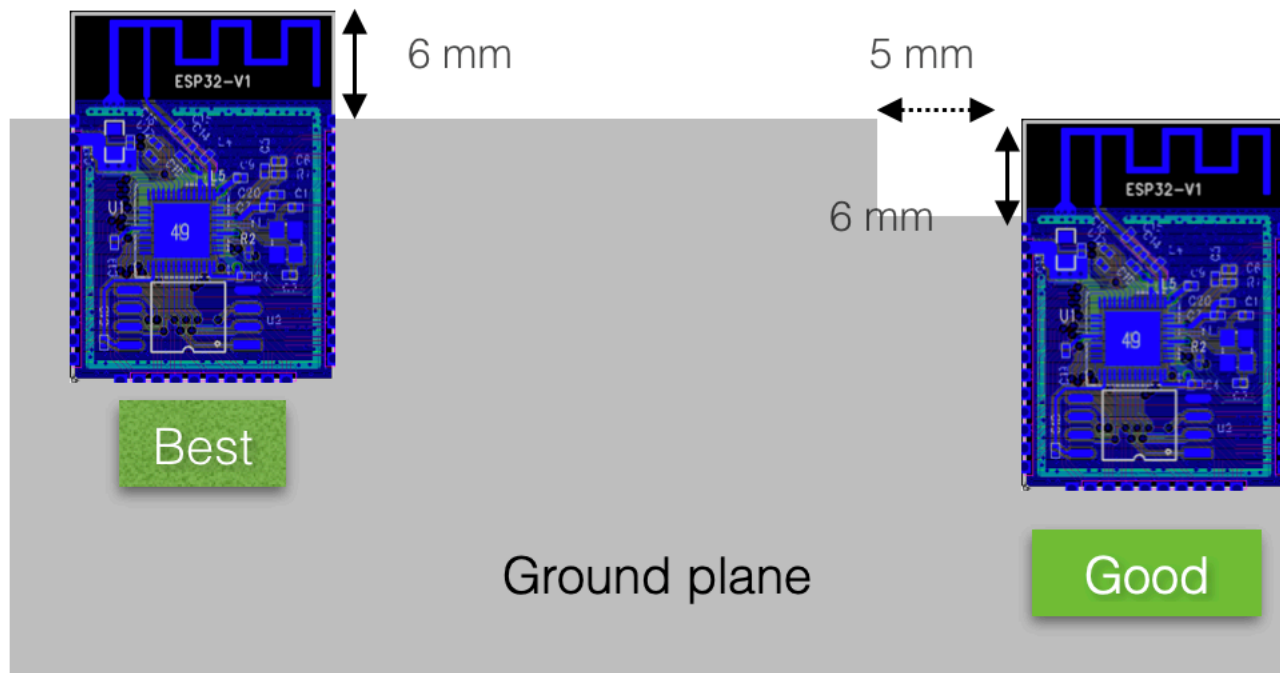
## ESP32M4/M16/E16 WiFi Modules

Ver 1.00 Sep. 2020

### Mounting ESP32M16 on the Host PCB

The following figure shows recommended mounting of ESP32M16 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 ESP32M16 module in the middle of a host PCB.



1. ESP32M4 module extends 6 mm from edge or ground plane of the host PCB board.
2. No ground plane on all layers for at least 5mm from edge of module. Longer distance for longer Bluetooth range.

For the best Bluetooth range performance, keep all external metal at least 30mm from the antenna area.

## ESP32M4/M16/E16 WiFi Modules

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### 3. Firmware Development and Application Examples

Please use Expressif or third parties' firmware development environment for ESP32-WROOM-32D module.

ESP32M4 and ESP32M16 are used in Fanstel open source gateways. They can be used as application examples. Document and source codes can be downloaded from:

<https://www.fanstel.com/download-opensource>

- Gateway schematics
- Hex and source codes for using Mongoose OS to connect to a MQTT broker in Google cloud. Mongoose OS supports connection to AWS and Microsoft cloud servers.
- Android OS app.

#### **BLE to WiFi Gateway, BWG840F/BWG840X**

BWG840F and BWG840X are Bluetooth/Thread/Zigbee to WiFi gateways. To develop firmware for ESP32M4 or ESP32M16, you need:

- A DK-BWG840F or a DK-BWG840X Development Kit. The USB cable assembly included in DK is required to load codes into WiFi module.

#### **BLE/LoRa to LTE/WiFi/PoE Ethernet Gateways, LEW840X**

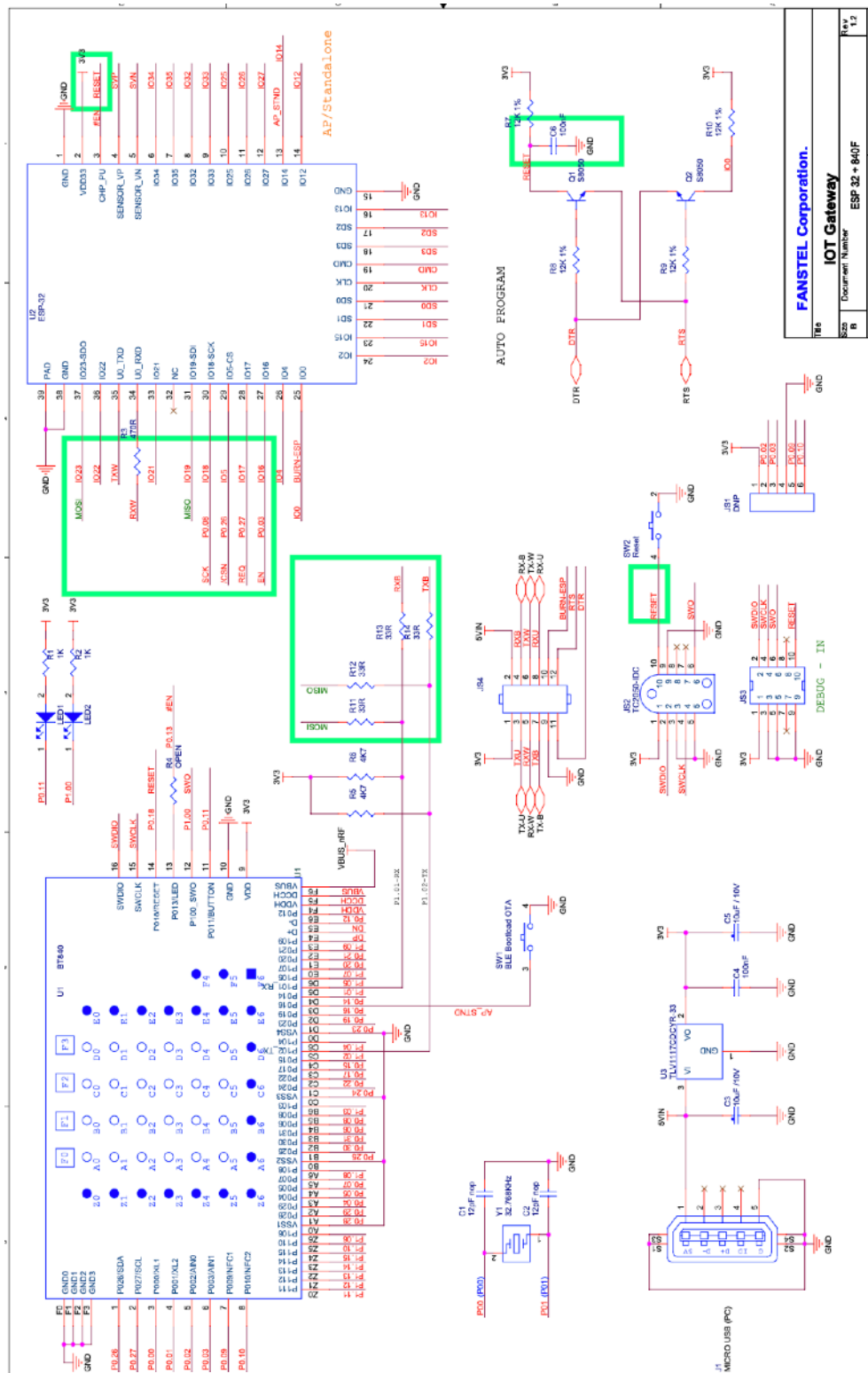
ESP32M16 is the main CPU routing BLE or LoRa sensor data to LTE, WiFi, or Ethernet. To develop firmware, you need:

- An EW840F5P, an EE840XE5P, or a LEWR840E5P gateway
- Programming Kit, PK-LEW840X.

## 4. ESP32M16 Evaluation Board

The following is schematics of DK-BWG840F with a ESP32M4 module. LEWR840E5P gateway schematics canoe downloaded from:

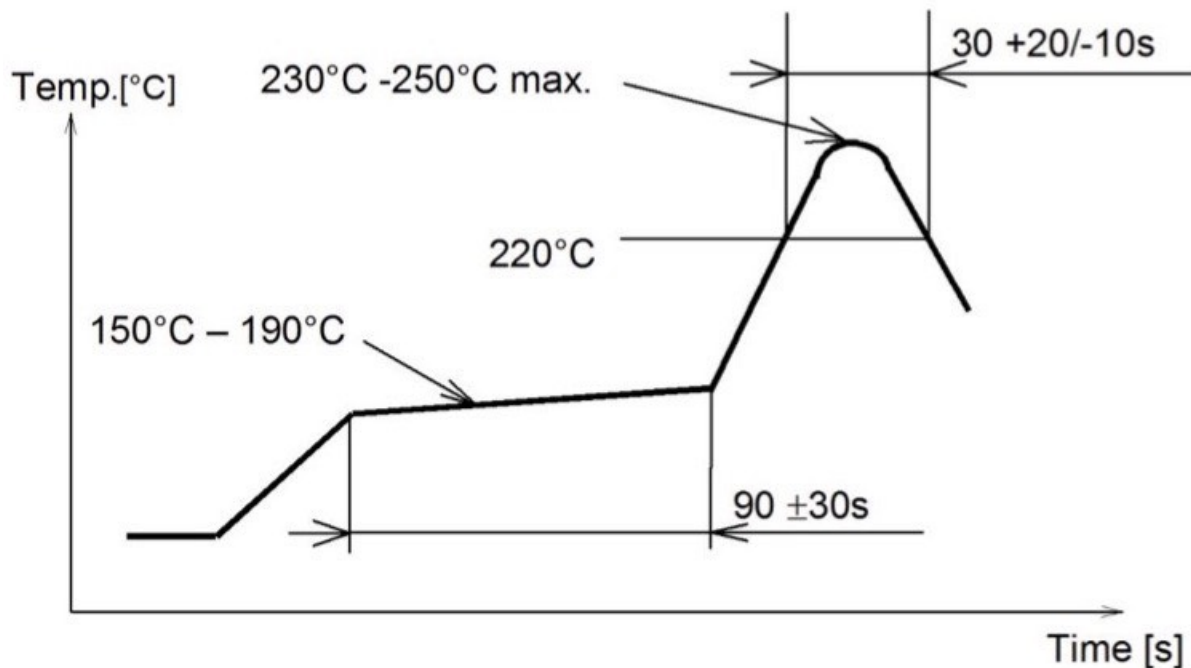
<https://www.fanstel.com/download-opensource>



## 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.

## ESP32M4/M16/E16 WiFi Modules

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### *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 circuit boards 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.

## ESP32M4/M16/E16 WiFi Modules

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### *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.











## ESP32M4/M16/E16 WiFi Modules

- 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.



## ESP32M4/M16/E16 WiFi Modules

### Revision History

- January 2020, Ver 0.10: Initial draft release
- May 2020, Ver 0.90: Add FCC, ISED, CE certifications
- Sep. 2020, Ver. 1.00: Initial release

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