



# **ESP-12L Datasheet**

**Version V1**

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## 1. Product overview

The ESP-12L WiFi module was developed by Ai-Thinker Technology. The core processor ESP8266 integrates the industry-leading Tensilica L106 ultra-low-power 32-bit micro MCU in a small package with 16-bit Lite mode, clocked at Supports 80 MHz and 160 MHz, supports RTOS, and integrates Wi-Fi MAC/BB/RF/PA/LNA.

The ESP-12L WiFi module supports the standard IEEE802.11 b/g/n protocol, a complete TCP/IP protocol stack. Users can use this module to add networking capabilities to existing devices or to build separate network controllers.

The ESP8266 is a high-performance wireless SOC that offers maximum utility at the lowest cost and unlimited possibilities for embedding WiFi functionality into other systems.

The ESP8266 is a complete and self-contained WiFi network solution that can operate independently or as a slave running on other host MCUs. The ESP8266 is capable of booting directly from an external flash memory when it is powered by an application and is the only application processor in the device. The built-in cache helps improve system performance and reduce memory requirements.

In another case, the ESP8266 is responsible for wireless Internet access. When it comes to the task of the WiFi adapter, it can be added to any micro controller-based design. The connection is simple and easy, just by SPI / SDIO interface or I2C / UART port. Just fine.

The ESP8266's powerful on-chip processing and storage capabilities allow it to integrate sensors and other application-specific devices through the GPIO port, minimizing system resources during minimal up-front development and operation.

## Features

- The smallest 802.11b/g/n Wi-Fi SOC module
- Low power 32-bit CPU, can also serve as the application processor
- Up to 160MHz clock speed
- Built-in 10 bit high precision ADC
- Supports UART/GPIO/IIC/PWM/ADC
- SMD-16 package for easy welding
- Integrated Wi-Fi MAC/BB/RF/PA/LNA
- Support multiple sleep patterns. Deep sleep current as low as 20uA
- UART baud rate up to 4Mbps
- Embedded LWIP protocol stack
- Supports STA/AP/STA + AP operation mode
- Support Smart Config/AirKiss technology
- Supports remote firmware upgrade (FOTA)
- General AT commands can be used quickly
- Support for the two development, integration of windows, Linux development environment

## Product Specification

Table1.1 Product Specification Description

<b>Module Model</b>	<b>ESP-12L</b>
<b>Package</b>	<b>SMD16</b>
<b>Size</b>	<b>24*16*3(<math>\pm 0.2</math>)mm</b>
<b>Certification</b>	<b>FCC/CE</b>
<b>SPI Flash</b>	<b>Default 32Mbit</b>
<b>Interface</b>	<b>UART/GPIO/ADC/PWM</b>
<b>IO Port</b>	<b>9</b>
<b>UART Baud rate</b>	<b>Support 300 ~ 4608000 bps , Default 115200 bps</b>
<b>Frequency Range</b>	<b>2412 ~ 2462MHz</b>
<b>Antenna</b>	<b>PCB Antenna</b>
<b>Transmit Power</b>	<b>802.11b: 12.4 dBm (@11Mbps)</b> <b>802.11g: 11.9 dBm (@54Mbps)</b> <b>802.11n: 12 dBm (@HT20, MCS7)</b>
<b>Receiving Sensitivity</b>	<b>CCK, 1 Mbps : -90dBm</b> <b>CCK, 11 Mbps: -85dBm</b> <b>6 Mbps (1/2 BPSK): -88dBm</b> <b>54 Mbps (3/4 64-QAM): -70dBm</b> <b>HT20, MCS7 (65 Mbps, 72.2 Mbps): -67dBm</b>
<b>Power (Typical Values)</b>	<b>Continuous Transmission=&gt;Average: ~71mA, Peak: 500mA</b> <b>Modem Sleep: ~20mA</b> <b>Light Sleep: ~2mA</b> <b>Deep Sleep: ~0.02mA</b>
<b>Security</b>	<b>WEP/WPA-PSK/WPA2-PSK</b>
<b>Power Supply</b>	<b>Voltage 3.0V ~ 3.6V, Typical 3.3V, Current &gt;500mA</b>
<b>Operating Temperature</b>	<b>-20 °C ~ 85 °C</b>
<b>Storage Environment</b>	<b>-40 °C ~ 85 °C , &lt; 90%RH</b>

Table 2.2 Pin function description

<b>No.</b>	<b>Pin Name</b>	<b>Functional Description</b>
<b>1</b>	<b>RST</b>	<b>Reset Pin, Active Low</b>
<b>2</b>	<b>ADC</b>	<b>AD conversion, Input voltage range 0~1V, the value range is 0~1024.</b>
<b>3</b>	<b>EN</b>	<b>Chip Enabled Pin, Active High</b>
<b>4</b>	<b>IO16</b>	<b>Connect with RST pin to wake up Deep Sleep</b>
<b>5</b>	<b>IO14</b>	<b>GPIO14; HSPI_CLK</b>
<b>6</b>	<b>IO12</b>	<b>GPIO12; HSPI_MISO</b>
<b>7</b>	<b>IO13</b>	<b>GPIO13; HSPI_MOSI; UART0_CTS</b>
<b>8</b>	<b>VCC</b>	<b>Module power supply pin, Voltage 3.0V ~ 3.6V</b>

<b>9</b>	<b>GND</b>	<b>GND</b>
<b>10</b>	<b>IO15</b>	<b>GPIO15; MTDO; HSPICS; UART0_RTS</b>
<b>11</b>	<b>IO2</b>	<b>GPIO2; UART1_TXD</b>
<b>12</b>	<b>IO0</b>	<b>GPIO0;HSPI_MISO;I2SI_DATA</b>
<b>13</b>	<b>IO4</b>	<b>GPIO4</b>
<b>14</b>	<b>IO5</b>	<b>GPIO5;IR_R</b>
<b>15</b>	<b>RXD</b>	<b>UART0_RXD; GPIO3</b>
<b>16</b>	<b>TXD</b>	<b>UART0_TXD; GPIO1</b>

Table 2.3 Description of the ESP series module boot mode

<b>Mode</b>	<b>CH_PD(EN)</b>	<b>RST</b>	<b>GPIO15</b>	<b>GPIO0</b>	<b>GPIO2</b>	<b>TXD0</b>
<b>Download mode</b>	<b>high</b>	<b>high</b>	<b>low</b>	<b>low</b>	<b>high</b>	<b>high</b>
<b>Running mode</b>	<b>high</b>	<b>high</b>	<b>low</b>	<b>high</b>	<b>high</b>	<b>high</b>

**Notes:** Some of the pins inside the module have been pulled or pulled down, please refer to the schematic diagram.

### 3. Electrical Characteristics

## Electrical Characteristics

Parameter	Symbol	Min	Typ	Max	Unit	
Storage temperature	-	-40	Normal	85	°C	
Operating temperature	-	-20	20	85	°C	
Maximum soldering temperature	IPC/JEDEC J-STD-020	-	-	260	°C	
Supply voltage	VDD	2.7	3.3	3.6	V	
I/O	$V_{IL}/V_{IH}$	-	-0.3/0.75V <sub>IO</sub>	-	0.25V <sub>IO</sub> /3.6	V
	$V_{OL}/V_{OH}$	-	N/0.8V <sub>IO</sub>	-	0.1V <sub>IO</sub> /N	V
	$I_{MAX}$	-	-	-	12	V

## Wi-Fi Radio

Description	Min	Typ	Max	Unit
Input frequency	2400	-	2483.5	MHz
Input reflection	-	-	-10	dB
<b>Output Power</b>				
PA output power at 72.2 Mbps	15.5	16.5	17.5	dBm
PA output power in 11b mode	19.5	20.5	21.5	dBm
<b>Sensitivity</b>				
CCK, 1 Mbps		-90		dBm
CCK, 11 Mbps		-85		dBm
6 Mbps (1/2 BPSK)		-88		dBm



54 Mbps (3/4 64-QAM)		-70		dBm
HT20, MCS7 (65Mbps,72.2 Mbps)		-67		dBm
Adjacent channel rejection				
OFDM, 6 Mbps		37		dB
OFDM, 54 Mbps		21		dB
HT20, MCS0		37		dB
HT20, MCS7		20		dB

## Power Consumption

The following power consumption data were obtained from the tests with a 3.3V power supply and a voltage stabilizer, in 25°C ambient temperature. All data are based on 50% duty cycle in continuous transmission mode.

Modes	Min	Typ	Max	Unit
<b>Tx 802.11b, CCK 11Mbps, POUT=+17dBm</b>	-	170	-	mA
<b>Tx 802.11g, OFDM 54Mbps, POUT =+15dBm</b>	-	140	-	mA
<b>Tx 802.11n, MCS7, POUT =+13dBm</b>	-	120	-	mA
<b>Rx 802.11b, 1024 bytes packet length , -80 dBm</b>	-	50	-	mA

<b>Rx 802.11g, 1024 bytes packet length , -70 dBm</b>	-	56	-	mA
<b>Rx 802.11n, 1024 bytes packet length , -65 dBm</b>	-	56	-	mA
<b>Modem-sleep①</b>	-	20	-	mA
<b>Light-sleep②</b>	-	2	-	mA
<b>Deep-sleep③</b>	-	20	-	uA
<b>Power Off</b>	-	0.5	-	uA

### Notes:

- **Modem-sleep** is used when such applications as PWM or I2S require the CPU to be working. In cases where Wi-Fi connectivity is maintained and data transmission is not required, the Wi-Fi Modem circuit can be shut down to save power, according to 802.11 standards (such as U-APSD). For example, in DTIM3, when ESP8266EX sleeps for 300 ms and wakes up for 3 ms to receive Beacon packages from AP, the overall average current consumption is about 20 mA.
- **Light-sleep** is used for applications whose CPU may be suspended, such as Wi-Fi switch. In cases where Wi-Fi connectivity is maintained and data transmission is not required, Wi-Fi Modem circuit and CPU can be shut down to save power, according to 802.11 standards (such as U-APSD). For example, in DTIM3, when ESP8266EX sleeps for 300 ms and wakes up for 3 ms to receive Beacon packages from AP, the overall average current consumption is about 2 mA.
- **Deep-sleep** is for applications that do not require Wi-Fi connectivity and only transmit data over long time lags, e.g., a temperature sensor that measures temperature every 100s. For example, when ESP8266EX sleeps for 300s then wakes up to connect to AP (taking about 0.3 ~ 1s), the overall average current consumption is far less than 1 mA. The current consumption of 20  $\mu$  A was obtained at the voltage of 2.5V.

## 8. Contact Us

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## FCC WARNING

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.

Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

NOTE: 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.

To maintain compliance with FCC's RF Exposure guidelines, This equipment should be installed and operated with minimum distance between 20cm the radiator your body: Use only the supplied antenna.

## ATTENTION

a.OEM integrator is responsible for ensuring that the end-user has no manual instructions to remove or install module.

b.The module is limited to installation in mobile or fixed applications, according to Part 2.1091(b)

c.Separate approval is required for all other operating configurations, including portable configurations with respect to Part 2.1093 and different antenna configurations

This device is intended only for OEM integrators under the following conditions:

- 1) The antenna must be installed such that 20 cm is maintained between the antenna and users, and
- 2) This device and its antenna(s) must not be co - located with any other transmitters except in accordance with FCC multi - transmitter product procedures. Referring to the multi - transmitter policy, multipletransmitter(s) and module(s) can be operated simultaneously without C2P.
- 3) For all products market in US, OEM has to limit the operation channels in CH1 to CH11 for 2.4G band by supplied firmware programming tool. OEM shall not supply any tool or info to the end - user regarding to Regulatory Domain change.

## USERS MANUAL OF THE END PRODUCT:

In the users manual of the end product, the end user has to be informed to keep at least 20cm separation with the antenna while this end product is installed and operated. The end user has to be informed that the FCC radio - frequency exposure guidelines for an uncontrolled environment can be satisfied. The end user has to also be informed that any changes or modifications not expressly approved by the manufacturer could void the user's authority to operate this equipment.

If the size of the end product is smaller than 8x10cm, then additional FCC part 15.19 statement is required to be available in the users manual: This device complies with Part 15 of 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.

## LABEL OF THE END PRODUCT:

The final end product must be labeled in a visible area with the following " Contains FCC ID: 2ARI3-BW1X. If the size of the end product is larger than 8x10cm, then the following FCC part 15.19 statement has to also be available on the label: This device complies with Part 15 of 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.