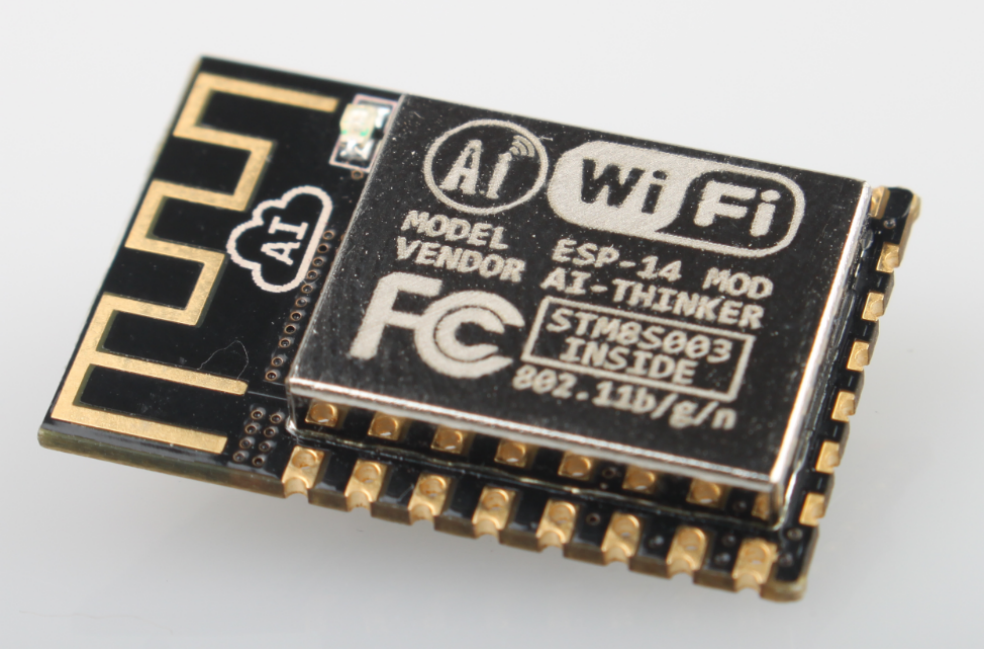


# ESP-12F WiFi module

Specifications

Version 1.0

August 23, 2015

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Table of Contents

1. Product Overview

ESP-12F WiFi module is a security technology developed by the Letter to the module integrated core processor ESP8266 smaller package size Tensilica L106 industry-leading ultra-low power 32-bit micro MCU, with 16 compact mode frequency support 80 MHz and 160 MHz, supports RTOS, integrated Wi-Fi MAC / BB / RF / PA / LNA, on-board antenna.

The module supports standard IEEE802.11 b / g / n protocol, a complete TCP / IP protocol stack. Users can use the module for the existing equipment to add networking capabilities, you can build a separate network controller.

ESP8266 is a high performance wireless SOC, at the lowest cost to provide maximum practicality, the WiFi functionality into other systems offer endless possibilities.

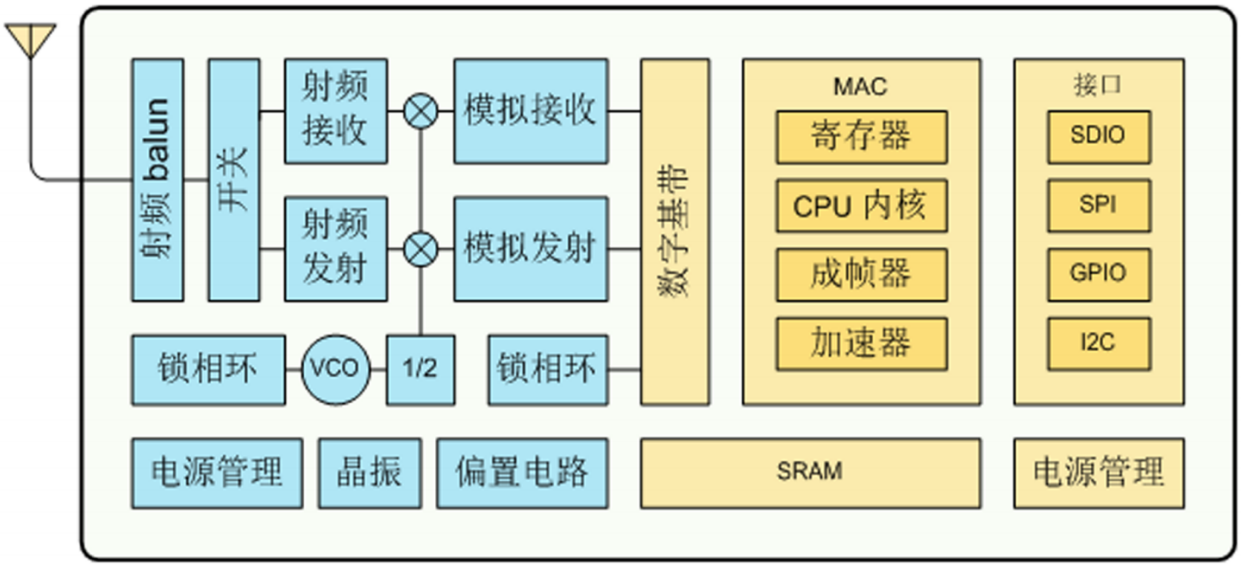


**Figure 1 ESP8266EX Chart**

ESP8266EX is a complete and self-contained WiFi network solution that can run independently, it can also be mounted as a slave to another host MCU operation. ESP8266EX when the device is mounted as the only application should — Use processor can boot directly from the external flash memory. Built-in cache system is conducive to mention high- performance and reduce memory requirements.

Also — species case, ESP8266EX responsible for wireless Internet access WiFi adapter undertake the task, you can add it to any microcontroller-based design, the connection is simple and easy YES, simply by SPI / SDIO interface or I2C / UART port can.

ESP8266EX powerful processing chip and the memory can be subjected to, it can be integrated through the GPIO port sensors and other application-specific equipment to achieve the lowest pre-development and operation occupy minimal system resources.

Within a highly integrated chip ESP8266EX, including the antenna switch balun, power management converter, thus with minimal external circuitry, and the entire solution including front-end modules, including in the design of the PCB occupied space to a minimum.

There ESP8266EX system manifested leading features are: energy in the sleep / wake quickly switch between modes, with low-power operation of the adaptive radio bias, front-end signal processing functions, troubleshooting and radio systems coexist characteristic for the elimination of cellular / Bluetooth / DDR / LVDS / LCD interference.

1.1 Features

• 802.11 b / g / n

• Built Tensilica L106 ultra-low power 32-bit micro MCU, clocked at 80 MHz and supports 160 MHz, support for RTOS

• Built-in 10 bit precision ADC

• Built-in TCP / IP protocol stack

• Built TR switch, balun, LNA, power amplifier and matching network

• Built-in PLL, voltage regulator and power management components, 802.11b mode +20 dBm output power

The guard interval • A-MPDU, A-MSDU aggregation and 0.4 s of

• WiFi @ 2.4 GHz, supports WPA / WPA2 security mode

• Supports remote upgrade and cloud AT OTA upgrade

• Support STA / AP / STA + AP mode

• Support Smart Config function (including Android and iOS devices)

• HSPI, UART, I2C, I2S, IR Remote Control, PWM, GPIO

• Deep sleep holding current 10 uA, shutdown current of less than 5 uA

• Within 2 ms of wake-up, connect and transfer data packets

• Standby power consumption is less than 1.0 mW (DTIM3)

• Operating temperature range: -40 ℃- 125 ℃

### 1.2. The main parameters

Table 1 describes the main parameters of the module.

Table 1 Parameters Table

| Category | Parameters | Explanation |
|---|---|---|
| Radio parameters | Standards Certification | FCC/CE/TELEC |
| | Wireless Standard | 802.11 b/g/n |
| | Frequency Range | 2.4GHz-2.5GHz (2400M-2483.5M) |
| Hardware parameters | Data access | UART/HSPI/I2C/I2S/Ir Remote Contorl |
| | | GPIO/PWM |
| | Operating Voltage | 3.0~3.6V（Suggested 3.3V） |
| | Working current | Mean： 80mA |
| | Operating temperature | -40°~125° |
| | Storage temperature | At room temperature |
| | Package Size | 16mm * 24mm * 3mm |
| | External Connector | N/A |
| Software parameters | Wireless Network Mode | station/softAP/SoftAP+station |
| | Security Mechanism | WPA/WPA2 |
| | Encryption Type | WEP/TKIP/AES |
| | Upgrading firmware | Local serial programming / Cloud Upgrade / Host Download Burn |
| | Software Development | Supports customer-defined server<br>To provide secondary development SDK |
| | Network protocol | IPv4, TCP/UDP/HTTP/FTP |
| | User Profiles | AT + instruction set, cloud server, Android/iOS APP |

## 2. Interface Definition

ESP-12F received a total of 18 interfaces, Table 2 is the interface definition.

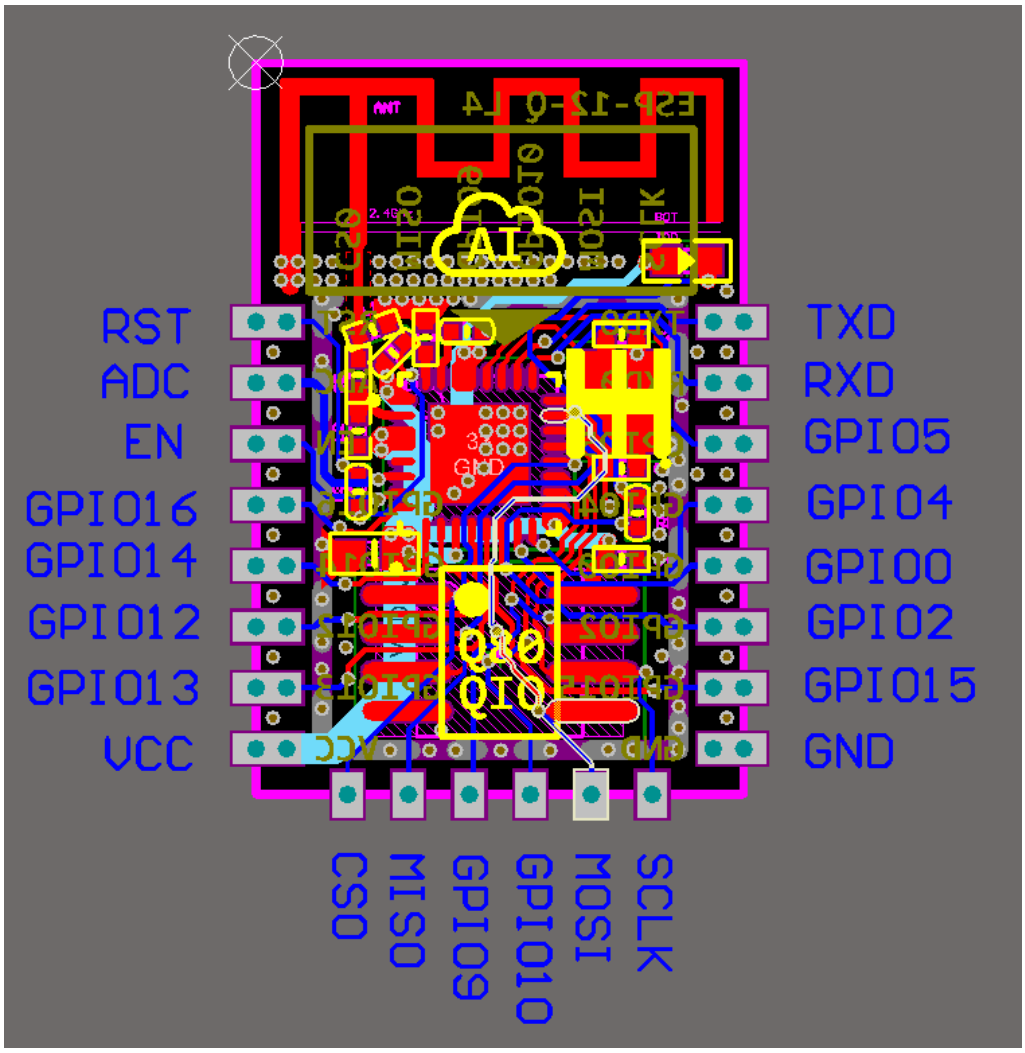


**Figure 2 ESP-12F pin map**

Table 2 ESP-12F pin function definitions

| No. | **Pin** Name | Function Description |
|---|---|---|
| 1 | RST | Reset Module |
| 2 | ADC | A / D conversion result. Input voltage range of 0 ~ 1V, in the range: 0 to 1024 |
| 3 | EN | Chip Enable end, high effective |
| 4 | IO16 | GPIO16; do wake deep sleep when receiving RST pin。 |

| | | |
|---|---|---|
| 5 | IO14 | GPIO14; HSPI_CLK |
| 6 | IO12 | GPIO12; HSPI_MISO |
| 7 | IO13 | GPIO13; HSPI_MOSI; UART0_CTS |
| 8 | VCC | powered by 3.3V |
| 9 | CS0 | Chip Select |
| 10 | MISO | Slave Master Input Output |
| 11 | IO9 | GPIO9 |
| 12 | IO10 | GBIO10 |
| 13 | MOSI | Master Out Slave |
| 14 | SCLK | Clock |
| 15 | GND | GND |
| 16 | IO15 | GPIO15; MTDO; HSPICS; UART0_RTS |
| 17 | IO2 | GPIO2; UART1_TXD |
| 18 | IO0 | GPIO0 |
| 19 | IO4 | GPIO4 |
| 20 | IO5 | GPIO5 |
| 21 | RXD | UART0_RXD; GPIO3 |
| 22 | TXD | UART0_TXD; GPIO1 |

| Mode | GPIO15 | GPIO0 | GPIO2 |
|---|---|---|---|
| **UART** Download mode | Low | Low | High |
| **Flash Boot** Mode | Low | High | High |

| Parameters | Smallest value | Typical values | Maximum | Unit |
|---|---|---|---|---|

| | | | | |
|---|---|---|---|---|
| Input Frequency | 2412 | | 2484 | MHz |
| Input resistance | | 50 | | Ω |
| Input reflection | | | -10 | dB |
| 72.2 Mbps down, PA output power | 14 | 15 | 16 | dBm |
| Under 11b mode, PA output power | 17.5 | 18.5 | 19.5 | dBm |
| Sensitivity | | | | |
| DSSS, 1 Mbps | | -98 | | dBm |
| CCK, 11 Mbps | | -91 | | dBm |
| 6 Mbps (1/2 BPSK) | | -93 | | dBm |
| 54 Mbps (3/4 64-QAM) | | -75 | | dBm |
| HT20, MCS7 (65 Mbps, 72.2 Mbps) | | -72 | | dBm |
| Adjacent suppression | | | | |
| OFDM, 6 Mbps | | 37 | | dB |
| OFDM, 54 Mbps | | 21 | | dB |
| HT20, MCS0 | | 37 | | dB |
| HT20, MCS7 | | 20 | | dB |

**3. The shape and dimensions**

ESP-12F SMD module appearance Size inch of 16mm * 24mm * 3mm (Figure 3). The module uses a capacity of 4MB, packaged as SOP-210 mil of SPI Flash. Modules using a 3 DBi of PCB-board antenna.

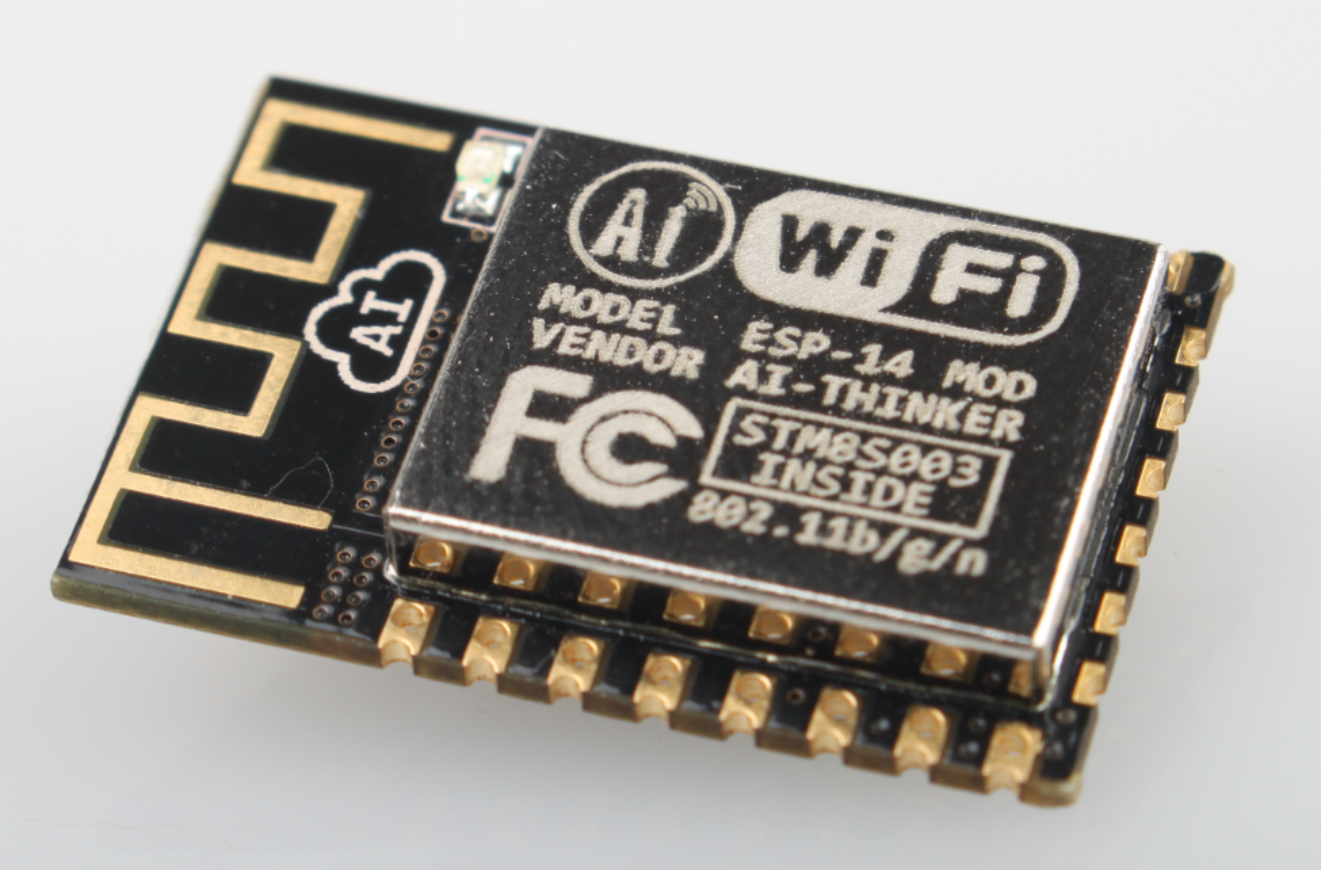


**Figure 3 ESP-12F module appearances**

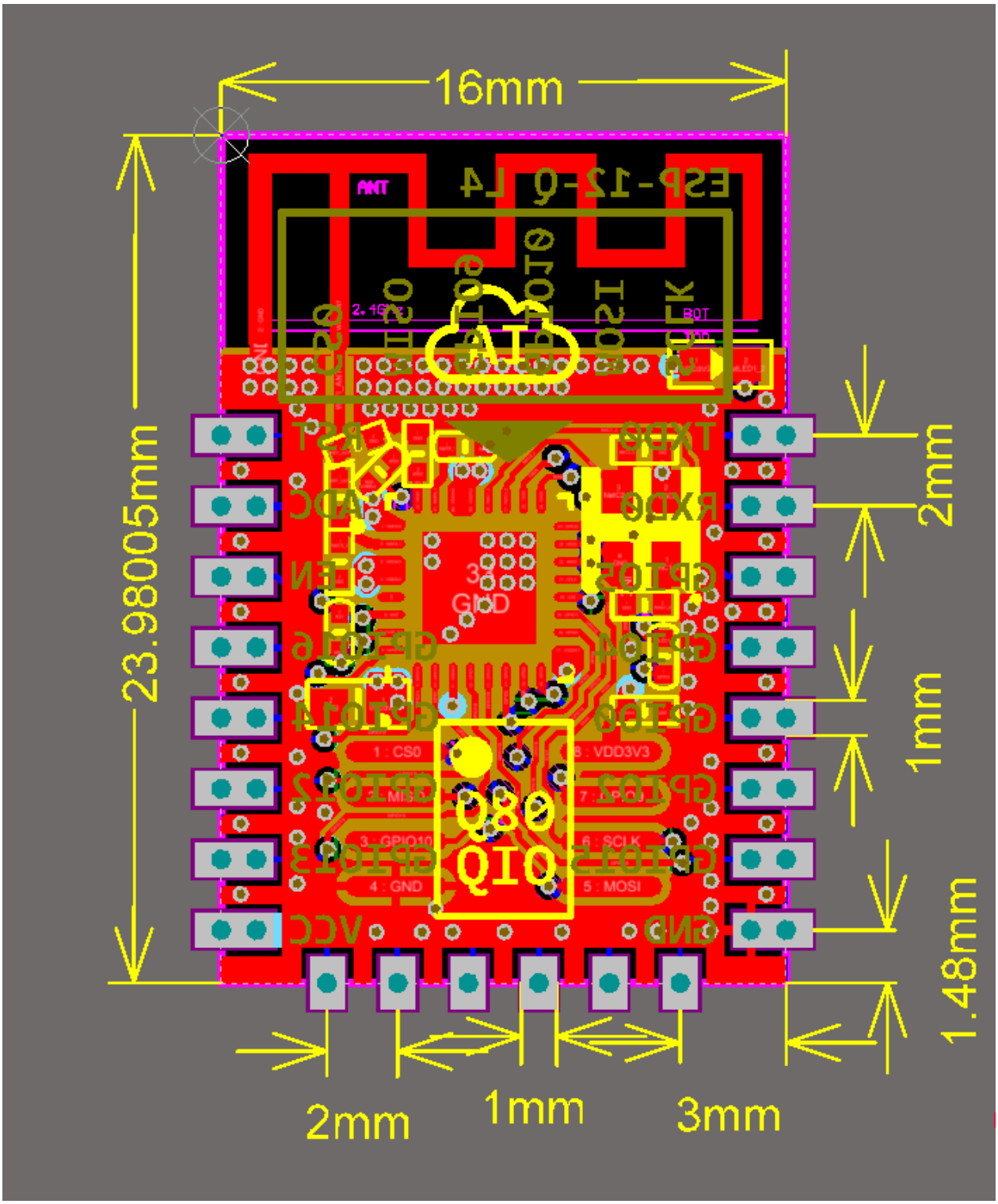


**Figure 4 ESP-12F module size view of a smooth surface**

Table 5 ESP-12F Module Size Chart

| Long | Width | Height | Size PAD (bottom) | Pin Foot spacing |
|---|---|---|---|---|
| 16 mm | 24 mm | 3 mm | 0.9 mm x 1.7 mm | 2 mm |

**4. Functional Description**

4.1. MCU

ESP8266EX built Tensilica L106 ultra-low power 32-bit micro MCU, with 16 compact mode, clocked at 80 MHz and supports 160 MHz, is compatible with the RTOS. Using the WiFi protocol stack is currently only 20% of MIPS, the other can be used for application development. MCU chip through the following interfaces and other parts of synergies 工 as:

1. Connect the memory controller can also be used to access external memory encoding RAM / ROM interfaces (iBus)

2. The same connection data RAM memory controller interfaces (dBus)

3. Access register AHB interface

4.2 Storage Description

4.2.1. Built-in SRAM and ROM

Auto body built ESP8266EX chip memory controller, comprising ROM and SRAM. MCU can access the storage controller iBus, dBus and AHB interface. These interfaces are accessible ROM or RAM unit, memory arbiter to determine the running order in the order of arrival. Based on the current Division I Demo SDK use SRAM, the user can remaining SRAM space: (next station mode, even after routed, heap + data area generally available around 36KB) RAM size <36kB not programmable ROM on ESP8266EX sheet Currently, users the program stored in the SPI Flash.

4.2.2. SPI Flash

Current ESP8266EX chip SPI interface supports external Flash, a theoretical maximum support to 16 MB of SPI flash. At present, the module is 4MB of external SPI Flash.

Recommendations Flash Capacity: 1 MB-16MB.

Supported SPI mode: Standard SPI, Dual SPI, DIO SPI, QIO SPI, and Quad SPI. Note that you need to select the corresponding mode in the download tool when downloading firmware, or after downloading the program will not be run correctly.

4.3. Crystal

Currently crystal 40M, 26M and 24M support, please pay attention to selecting the corresponding type of crystals in the download tool use. Crystal input and output of the applied determination of adjusted capacitors C1, C2 may be set to a fixed value, the value range in 6pF ~ 22pF, specific values need to be adjusted after the system test. Based on the current market situation in the mainstream of the crystal, the crystal 26Mhz General points added input and output capacitors C1, C2 in less than 10pF; General points 40MHz crystal input and output capacitance added 10pF <C1, C2 <22pF.

Optional precision crystal itself need to ± 10PPM. Crystal operating temperature -20 ° C- 85 ° C.

Crystal position as close to the chip XTAL Pins (traces not too long), while crystal alignment to be wrapped up well shielded land.

Crystal input and output traces can not punch alignment, that can not cross-layer. Crystal input and output traces can not cross, cross-layer cross too.

Crystal input and output bypass capacitors placed left and right side close to the chip, please, try not to put 走 line.

4 layers beneath the crystal can not take the high-frequency digital signal, the best situation is below the crystal does not go any signal lines, paved TOP crystal surface area the better. Crystal sensitive devices around the crystal can not have magnetic induction devices, such as large inductors.

4.4. Interface Description

Table 6 Interface Description

| Interface Name | Pin | Function Description |
|---|---|---|
| HSPI Connector | IO12(MISO), IO13(MOSI), IO14(CLK), IO15(CS) | External 4SPI Flash, display and MCU like. |
| PWM-connector | IO12(R), IO15(G),IO13(B) | The demo offers four PWM (to 8 users can expand their own way), it can be used to control lights, buzzers, relays and motors. |
| IR-connector | IO14(IR_T), IO5(IR_R) | IR Remote Control4 interfaces implemented by software, interface NEC coding and modulation and demodulation, using 38KHz modulated carrier. |

| | | |
|---|---|---|
| ADC Connector | TOUT | This is useful for the detection VDD3P3 (Pin3, Pin4) supply voltage and TOUT (Pin6) input voltage (not both). It can be used for sensor applications. |
| I2C Connector | IO14(SCL), IO2(SDA) | External sensors and displays and other |
| UART Connector | UART0: TXD(U0TXD), RXD(U0RXD), IO15(RTS), IO13(CTS)<br>UART1: IO2(TXD) | May be devices, external UART interface.<br>Download: U0TXD + U0RXD or GPIO2 + U0RXD<br>Communication (UART0): U0TXD, U0RXD, MTDO (U0RTS), MTCK (U0CTS) Debug: UART1_TXD (GPIO2) can be used as a print debug information. |
| | | UART0 default on ESP8266EX power output will be some printed information. This sensitive applications, you can use the internal UART pin swapping function in initialization time, will U0TXD, U0RXD were exchanged with U0RTS, U0CTS. Admiral MTDO MTCK hardware connected to the corresponding external MCU serial-connector to communicate. |
| I2S接口 | I2S Enter：<br>IO12 (I2SI_DATA) ;<br>IO13 (I2SI_BCK );<br>IO14 (I2SI_WS); | Use main audio capture, processing and transmission. |
| | I2S Export：<br>IO15 (I2SO_BCK );<br>IO3 (I2SO_DATA);<br>IO2 (I2SO_WS ). | |

4.5. Maximum Ratings

| RATINGS | Condition | Value | Unit |
|---|---|---|---|
| Storage temperature | | -40 to 125 | ℃ |
| Maximum soldering temperature | | 260 | ℃ |
| Supply voltage | IPC/JEDEC J-STD-020 | +3.0 to +3.6 | V |

4.6. The recommendations of the working environment

| Working environment | Name | Min | Average | Maximum | Unit |
|---|---|---|---|---|---|
| Operating temperature | | -40 | 20 | 125 | ℃ |
| Supply voltage | VDD | 3.0 | 3.3 | 3.6 | V |

4.7 Digital Port Characteristics

| End-connector | Typical values | Min | Average | Maximum | Unit |
|---|---|---|---|---|---|
| Input logic level low | $V_{IL}$ | -0.3 | | 0.25VDD | V |
| Input logic level ADVANCED | $V_{IH}$ | 0.75VDD | | VDD+0.3 | V |
| Output logic level low | $V_{OL}$ | N | | 0.1VDD | V |
| Output Logic Level ADVANCED | $V_{OH}$ | 0.8VDD | | N | V |

Note: Unless otherwise specified, the test conditions: VDD = 3.3 V, temperature is 20 ℃

5. RF parameters

| Description | Min | Average | Maximum | Unit |
|---|---|---|---|---|
| Input Frequency | 2400 | | 2483.5 | MHz |
| Input impedance value | | 50 | | ohm |
| Enter the reflectance values | | | -10 | dB |
| PA output power of 72.2 Mbps | 15.5 | 16.5 | 17.5 | dBm |
| 11b mode at PA output power | 19.5 | 20.5 | 21.5 | dBm |
| Receiver sensitivity | | | | |
| CCK, 1 Mbps | | -98 | | dBm |
| CCK, 11 Mbps | | -91 | | dBm |
| 6 Mbps (1/2 BPSK) | | -93 | | dBm |
| 54 Mbps (3/4 64-QAM) | | -75 | | dBm |
| HT20, MCS7 (65 Mbps, 72.2 Mbps) | | -72 | | dBm |
| Adjacent suppression | | | | |
| OFDM, 6 Mbps | | 37 | | dB |
| OFDM, 54 Mbps | | 21 | | dB |
| HT20, MCS0 | | 37 | | dB |
| HT20, MCS7 | | 20 | | dB |

6. Power

The following data is based on a 3.3V power supply, ambient temperature of 25 ° C, and measured using the internal regulator.

[1] All measurements were carried out at no SAW filter, the antenna interface is complete.

[2] all transmit data based on a 90% duty cycle, continuous transmission mode at measured.

**Table 11 Power**

| Mode | Min | Average | Maximum | Unit |
|---|---|---|---|---|
| Transfer 802.11b, CCK 11Mbps, POUT=+17dBm | | 170 | | mA |
| Transfer 802.11g, OFDM 54Mbps, POUT =+15dBm | | 140 | | mA |
| Transfer 802.11n, MCS7, POUT =+13dBm | | 120 | | mA |
| Receiving 802.11b, packet length of 1024 bytes, -80dBm | | 50 | | mA |
| Receiving 802.11g, packet length of 1024 bytes, -70dBm | | 56 | | mA |
| Receiving 802.11n, packet length of 1024 bytes, -65dBm | | 56 | | mA |
| Modem-Sleep① | | 15 | | mA |
| Light-Sleep② | | 0.9 | | mA |
| Deep-Sleep③ | | 10 | | uA |
| Power Off | | 0.5 | | uA |

Note ①: Modem-Sleep Use to require CPU has been in working condition, such as PWM or I2S should use, etc. In keeping WiFi connection, if no data transmission, according to the 802.11 standard (such as U-APSD), turn off WiFi Modem circuit power. For example, in DTIM3, each sleep 300mS, wake 3mS received the Beacon AP packages, etc., the overall average current of about 15mA.

Note ②: Light-Sleep may be suspended for the CPU applications such as WiFi switch. In keeping WiFi connection, if no data transmission, according to the 802.11 standard (such as U-APSD), closed circuit and pause WiFi Modem CPU to save power. For example, in DTIM3, each sleep 300 ms, wake 3ms received the Beacon AP packages, etc., the overall average current of approximately 0.9 mA.

Note ③: Deep-Sleep has remained without a WiFi connection, long time to send a packet of applications, such as 一 second temperature sensor measurements every 100 seconds. For example, every 300 s after waking need 0.3s - 1s even send data on AP, the overall average current can be far less than 1mA.

7. tilt warming

**Table 12 tilt warming**

| | |
|---|---|
| Tilt the maximum temperature TS -TL<br>Preheat | Maximum of 3 ℃ / sec |
| The minimum temperature value (TS Min.)<br>Typical temperatures (TS Typ.)<br>Temperature value is largest (TS Max.)<br>Time (TS) | 150℃<br>175℃<br>200℃<br>60~180秒 |
| Tilt temperature (TL to TP) | Maximum of 3 ℃ / sec |
| Duration / temperature (TL) / time (TL) | 217℃/60~150秒 |
| Peak temperature (TP) | Maximum temperature 260 ℃, sustained 10 seconds |
| Target temperature peak (TP target) | 260℃+0/-5℃ |
| Actual peak (tP) 5 ℃ Duration | 20~40秒 |
| Tilt cooling | Maximum 6 ℃ / sec |
| Time (t) from the desired peak temperature was adjusted to 25 ℃ | Maximum 8 minutes |

8.
Schematic

**Figure 5 ESP-12F Schematic**

(3) Technical Support E-mail: support@aithinker.com