ESP-WROOM-02

Serial to WiFi Module

Version 0.1

Espressif Systems IOT Team

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Table of Content

1. Preambles

Espressif Systems' Smart Connectivity Platform (ESCP) is a set of high performance, high integration wireless SOCs, designed for space and power constrained mobile platform designers. It provides unsurpassed ability to embed Wi-Fi capabilities within other systems, or to function as a standalone application, with the lowest cost, and minimal space requirement.

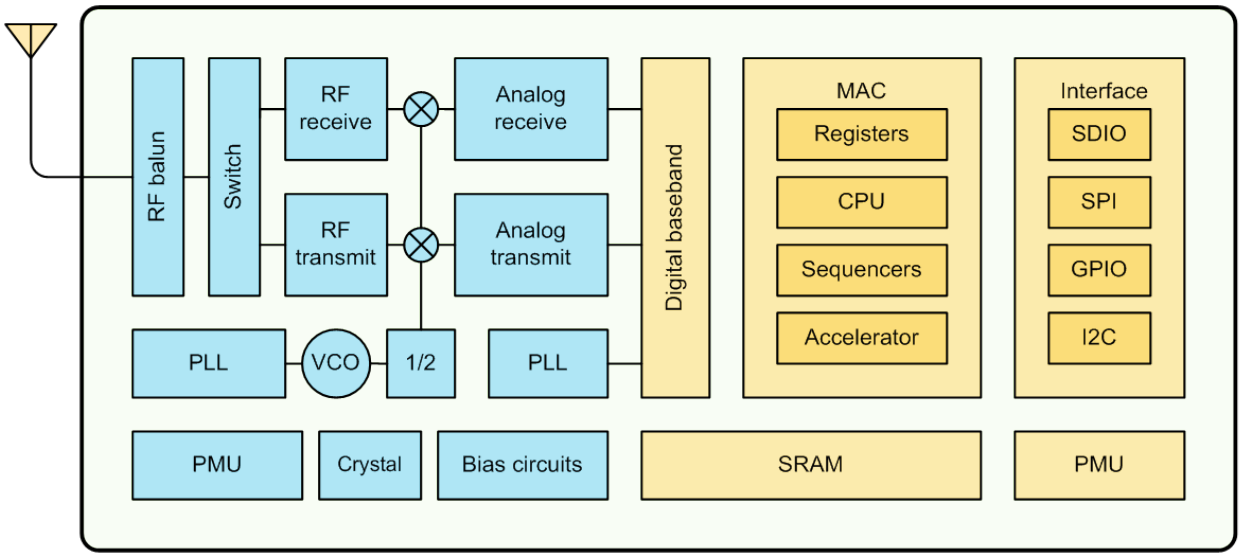


Figure 1 ESP8266EX Block Diagram

ESP8266EX offers a complete and self-contained Wi-Fi networking solution; it can be used to host the application or to offload Wi-Fi networking functions from another application processor.

When ESP8266EX hosts the application, it boots up directly from an external flash. In has integrated cache to improve the performance of the system in such applications.

Alternately, serving as a Wi-Fi adapter, wireless internet access can be added to any micro controller-based design with simple connectivity (SPI/SDIO or I2C/UART interface).

ESP8266EX is among the most integrated WiFi chip in the industry; it integrates the antenna switches, RF balun, power amplifier, low noise receive amplifier, filters, power management modules, it requires minimal external circuitry, and the entire solution, including front-end module, is designed to occupy minimal PCB area.

ESP8266EX also integrates an enhanced version of Tensilica's L106 Diamond series 32-bit processor, with on-chip SRAM, besides the Wi-Fi functionalities. ESP8266EX is often integrated with external sensors and other application specific devices through its GPIOs; codes for such applications are provided in examples in the SDK.

Espressif Systems' Smart Connectivity Platform (ESCP) demonstrates sophisticated system-level features include fast sleep/wake context switching for energy-efficient VoIP, adaptive radio biasing

for low-power operation, advance signal processing, and spur cancellation and radio co-existence features for common cellular, Bluetooth, DDR, LVDS, LCD interference mitigation.

2. Features

- 802.11 b/g/n protocol
- Wi-Fi 2.4 GHz, support WPA/WPA2
- Integrated 10-bit ADC
- Integrated TCP/IP protocol stack
- Integrated TR switch, balun, LNA, power amplifier and matching network
- Integrated PLL, regulators, and power management units
- +20dBm output power in 802.11b mode
- Supports antenna diversity
- Deep sleep power <10uA, Power down leakage current < 5uA
- Integrated low power 32-bit MCU
- SPI, UART
- STBC, 1x1 MIMO, 2x1 MIMO
- A-MPDU & A-MSDU aggregation & 0.4ìs guard interval
- Wake up and transmit packets in < 2ms
- Standby power consumption of < 1.0mW (DTIM3)
- Operating temperature range -40C ~ 125C

3. Major Applications

ESP8266EX widely applies to Internet-of-Things applications, such as:

- Home Appliances
- Home Automation, smart lights and plugs
- Mesh Network
- Industrial Wireless Control and Sensor Networks
- Baby Monitors
- IP Cameras
- Wi-Fi Location-aware Devices
- Security ID Tags

- Wi-Fi Position System Beacons

4. Pin Descriptions

NO.	Pin Name	Function
1	VDD	3.3V Power Supply
2	EN	Chip Enable. Active high.
3	GND	Ground
4	RST	Module reset
5	TOUT	ADC pin
6	RXD	UART0_RXD; GPIO3
7	TXD	UART0_TXD; GPIO1
8	IO0	GPIO0
9	IO2	GPIO2; UART1_TXD
10	IO4	GPIO4
11	IO5	GPIO5
12	IO12	GPIO12; HSPI_MISO
13	IO13	GPIO13; HSPI_MOSI; UART0_CTS
14	IO14	GPIO14; HSPI_CLK
15	IO15	GPIO15; MTDO; HSPICS; UART0_RTS
16	IO16	GPIO16; Deep-Sleep Wakeup

Table 1 Pin Descriptions

Note:

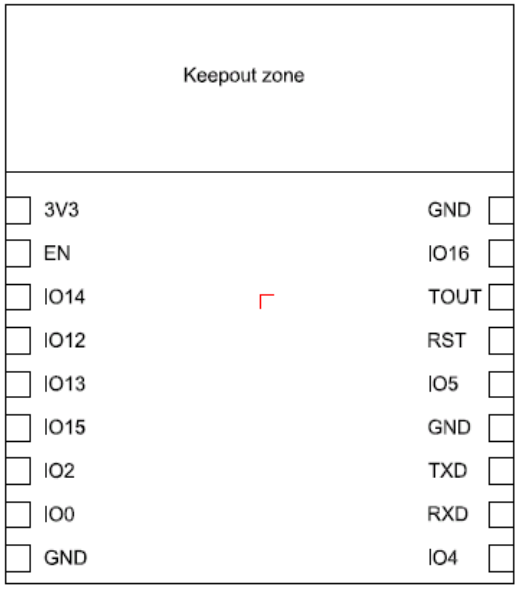
GPIO15	GPIO0	GPIO2
Low	Low	High

Table 2 UART Download Mode

GPIO15	GPIO0	GPIO2
Low	High	High

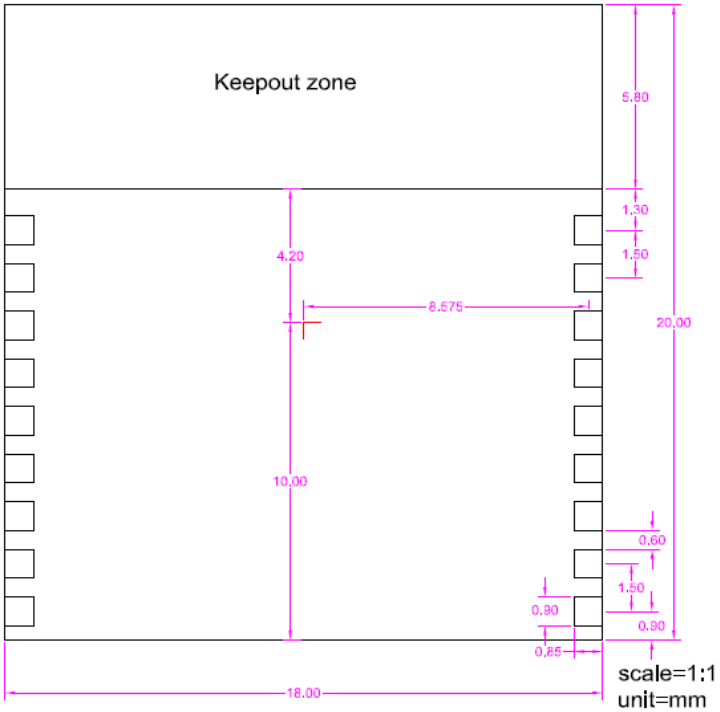
Table 3 Flash Boot Mode

5. Packaging and Dimension



Module pInmap
(Top vIew)

Figure 2 [Module Pin out, 18pin, 18.0 mm x 20.0 mm, Top view]



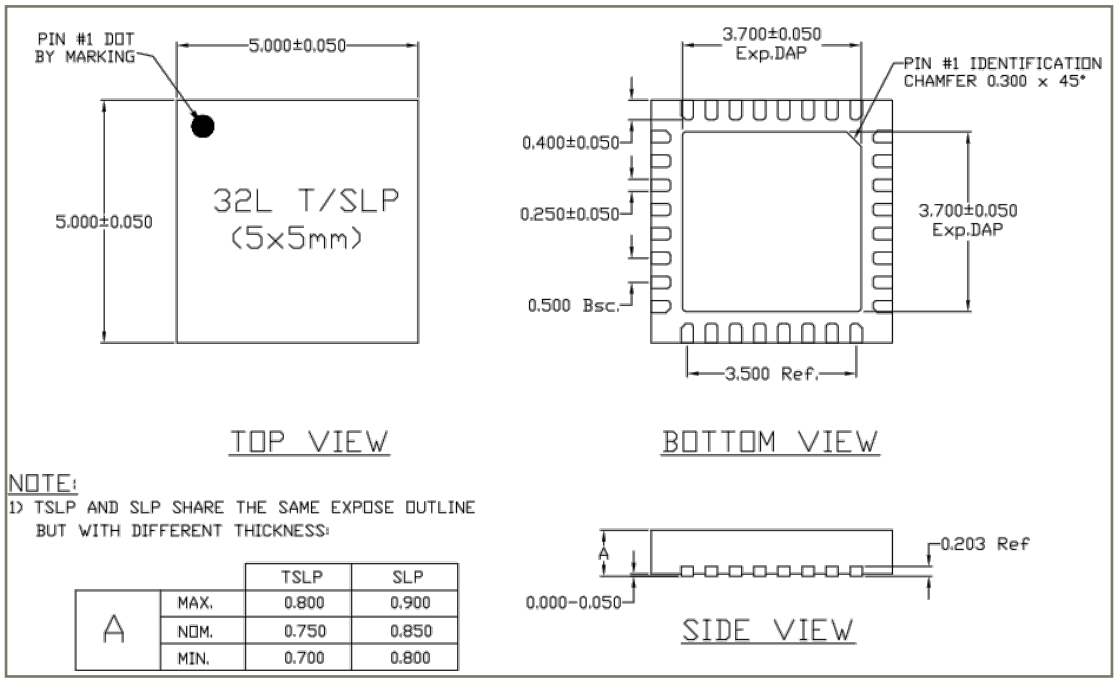
Module Dimension
(Top view)

Figure 3 Top View of ESP-WROOM-02 WiFi Module

Length	Width	Height	PAD Size(Bottom)	Pin Pitch
18mm	20mm	3mm	0.9x1.7mm	1.5mm

Table 4 Dimension of ESP-WROOM-02 WiFi Module

Note: Keep-out Zone is reserved for PCB antenna.



		TSLP	SLP
A	MAX.	0.800	0.900
	NOM.	0.750	0.850
	MIN.	0.700	0.800

Figure 4 ESP8266EX QFN32 Package Dimensions

6. Functional Descriptions

MCU

ESP8266EX is embedded with Tensilica L106 32-bit Diamond series 32-bit processor (MCU), which features extra low power consumption and 16-bit RSIC. The CPU clock speed is 80MHz. It can also reach a maximum value of 160MHz.

ESP8266EX is often integrated with external sensors and other specific devices through its GPIOs; codes for such applications are provided in examples in the SDK.

Memory and External SPI Flash

According to our current version of SDK provided, SRAM space that is available to users is like this:

RAM size < 45kB (PS: when ESP8266EX is working under the station mode and is connected to the router, programmable space accessible to user in heap and data section is around 45kB.)

There is no programmable ROM in the SoC, therefore, user program must be stored in an external SPI flash. Take 4Mbit SPI flash as an example, the programmable space that is accessible for users is less than 64KB. The maximum memory size of external SPI flash that can be applied is up to 128Mbit.

Crystal

The reference clock for the module can be generated from a 26M/40M/24MHz crystal.

Interfaces

Interface	Description
SDIO	Support 4 bit 25MHz SDIO v1.1 and 4 bit 50MHz SDIO v2.0.
UART	Standard Universal Asynchronous Receiver Transmitter (UART) interface for serial communication. Support two UART ports, which are UART0 and UART1.
SPI	SPI is mainly used for communication with other devices. It can also be used for programming the flash memory.
Programmable I/Os	There are up to 16 digital I/Os that can be controlled by firmware on the device.
ADC	ESP8266EX integrates a 10-bit analog ADC with analog input range from 0V to 1.0V.
I2C	ESP8266EX can support as I2C master or I2C slave.
Note:	Test conditions: VDD = 3.3V, Temperature = 20 °C, if nothing special is stated.

Table 5 Descriptions of Interfaces

Note: Test conditions: VDD = 3.3V, Temperature = 20 °C, if nothing special is stated.

Absolute Maximum Ratings

Rating	Condition	Value	Unit
Storage Temperature		-40 to 125	°C
Maximum Soldering Temperature		260	°C
Supply Voltage	IPC/JEDEC J-STD-020	+3.0 to +3.6	V

Table 6 Absolute Maximum Ratings

Recommended Operating Conditions

Operating Condition	Symbol	Min	Typ	Max	Unit
Operating Temperature		-40	20	125	°C
Supply voltage	VDD	3.0	3.3	3.6	V

Table 7 Recommended Operating Conditions

Digital Terminal Characteristics

Terminals	Symbol	Min	Typ	Max	Unit
Input logic level low	V_{IL}	-0.3		0.25VDD	V
Input logic level high	V_{IH}	0.75VDD		VDD+0.3	V
Output logic level low	V_{OL}	N		0.1VDD	V
Output logic level high	V_{OH}	0.8VDD		N	V

Table 8 Digital Terminal Characteristics

Note: Test conditions: VDD = 3.3V, Temperature = 20 °C, if nothing special is stated.

7. RF Performance

Description	Min.	Typ.	Max	Unit
Input frequency	2400		2483.5	MHz
Input impedance		50		ohm
Input reflection			-10	dB
Output power of PA for 72.2Mbps	15.5	16.5	17.5	dBm
Output power of PA for 11b mode	19.5	20.5	21.5	dBm
Sensitivity				
CCK, 1Mbps		-98		dBm
CCK, 11Mbps		-91		dBm
6Mbps (1/2 BPSK)		-93		dBm
54Mbps (3/4 64-QAM)		-75		dBm
HT20, MCS7 (65Mbps, 72.2Mbps)		-71		dBm
Adjacent Channel Rejection				
OFDM, 6Mbps		37		dB
OFDM, 54Mbps		21		dB
HT20, MCS0		37		dB
HT20, MCS7		20		dB

Table 9 RF Performance

8. Current Consumption

Mode Min Typ Max Unit	Min	Typ	Max	Unit
Transmit 802.11b, DSSS 1Mbps, POUT=+19.5dBm		215		mA
Transmit 802.11b, CCK 11Mbps, POUT=+18.5dBm		197		mA
Transmit 802.11g, OFDM 54Mbps, POUT =+16dBm		145		mA
Transmit 802.11n, MCS7, POUT=+14dBm		135		mA
Receive 802.11b, packet length=1024 byte, -80dBm		60		mA
Receive 802.11g, packet length=1024 byte, -70dBm		60		mA
Receive 802.11n, packet length=1024 byte, -65dBm		62		mA
Modem Sleep①		15		mA
Light Sleep②		0.5		mA
Power save mode DTIM 1		1.2		mA
Power save mode DTIM 3		0.9		mA
Deep Sleep(RTC)③		10		uA
Total shutdown		0.5		uA

Table 11 Power Consumption

①: Modem-Sleep requires the CPU to be working, as in PWM or I2S applications. According to 802.11 standards (like U-APSD), it saves power to shut down the Wi-Fi Modem circuit while maintaining a Wi-Fi connection with no data transmission. E.g. in DTIM3, to maintain a sleep 300ms-wake 3ms cycle to receive AP's Beacon packages, the current is about 15mA.

②: During Light-Sleep, the CPU may be suspended in applications like Wi-Fi switch. Without data transmission, the Wi-Fi Modem circuit can be turned off and CPU suspended to save power according to the 802.11 standard (U-APSD). E.g. in DTIM3, to maintain a sleep 300ms-wake 3ms cycle to receive AP's Beacon packages, the current is about 0.9mA.

③: Deep-Sleep does not require Wi-Fi connection to be maintained. For application with long time lags between data transmission, e.g. a temperature sensor that checks the temperature every 100s,

sleep 300s and waking up to connect to the AP (taking about 0.3~1s), the overall average current is less than 1mA.

9. Reflow Profile

T_S max to T_L (Ramp-up Rate)	3°C/second max
Preheat Temperature Min.(T_S Min.) Temperature Typical.(T_S Typ.) Temperature Min.(T_S Max.) Time(T_S)	 150°C 175°C 200°C 60~180 seconds
Ramp-up rate (T_L to T_P)	3°C/second max
Time Maintained Above: --Temperature(T_L)/Time(T_L)	 217°C/60~150 seconds
Peak Temperature(T_P)	260°C max. for 10 seconds
Target Peak Temperature (T_P Target)	260°C +0/-5°C
Time within 5°C of actual peak(t_P)	20~40 seconds
Ramp-down Rate	6°C/second max
Tune 25°C to Peak Temperature (t)	8 minutes max

Table 12 Instructions