E01C-ML01SP4

SI24R1+ 2.4GHz 100mW SPI SMD Wireless Module



Chengdu Ebyte Electronic Technology Co.,Ltd.

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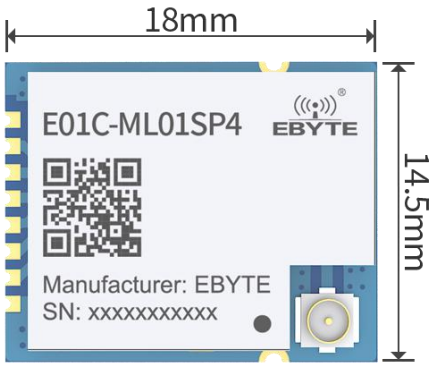
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1 Overview

1.1 Introduction



E01C-ML01SP4 is a small size 2.4ghz SMD wireless module, maximum transmitting power of 100mW, which is independently developed based on domestic SI24R1.

Built-in power amplifier (PA) and low noise amplifier (LNA) on the original basis, the maximum transmission power reaches 100mW, while the receiving sensitivity is further improved, and the overall communication stability is less than power amplifier and low noise amplifier The products have been greatly improved.

This product uses industrial-grade high-precision 16MHz crystal.

Since E01C-ML01SP4 is a radio frequency transceiver module, it needs to use MCU driver or use a dedicated SPI debugging tool.

1.2 Features

- Small size 14.5*18mm;
- The maximum transmit power is 100mW, software multi-level adjustable;
- Communication distance can reach 2KM under ideal conditions;
- Global license-free ISM 2.4GHz band;
- Air data rate : 2Mbps, 1Mbps and 250kbps;
- 125 communication channels to meet the needs of multi-point communication, packet, frequency hopping and other applications;
- Connect to MCU through SPI interface, the speed is 0 ～ 10Mbps;
- Power supply 2.0～3.6V, more than 3.3V can guarantee the best performance;
- Professional RF shielding cover, anti-interference, anti-static;
- IPEX interface, convenient for connecting coaxial cable or external antenna (shared with IPEX interface);

1.3 Application

- Smart home and industrial sensors;
- Security system, positioning system;
- Wireless remote control, drone;
- Wireless game remote control;
- Health care products;
- Wireless voice, wireless headphones;
- Automotive industry applications.

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2 Technical Parameters

2.1 Limit Parameter

Main parameter	Performance		Remarks
	Min	Max	
Voltage supply（V）	0	3.6	Voltage over 3.6V will cause permanent damage to module
Blocking power（dBm）	-	10	Chances of burn is slim when modules are used in short distance
Working temperature（℃）	-40	85	Industrial

2.2 Working parameters

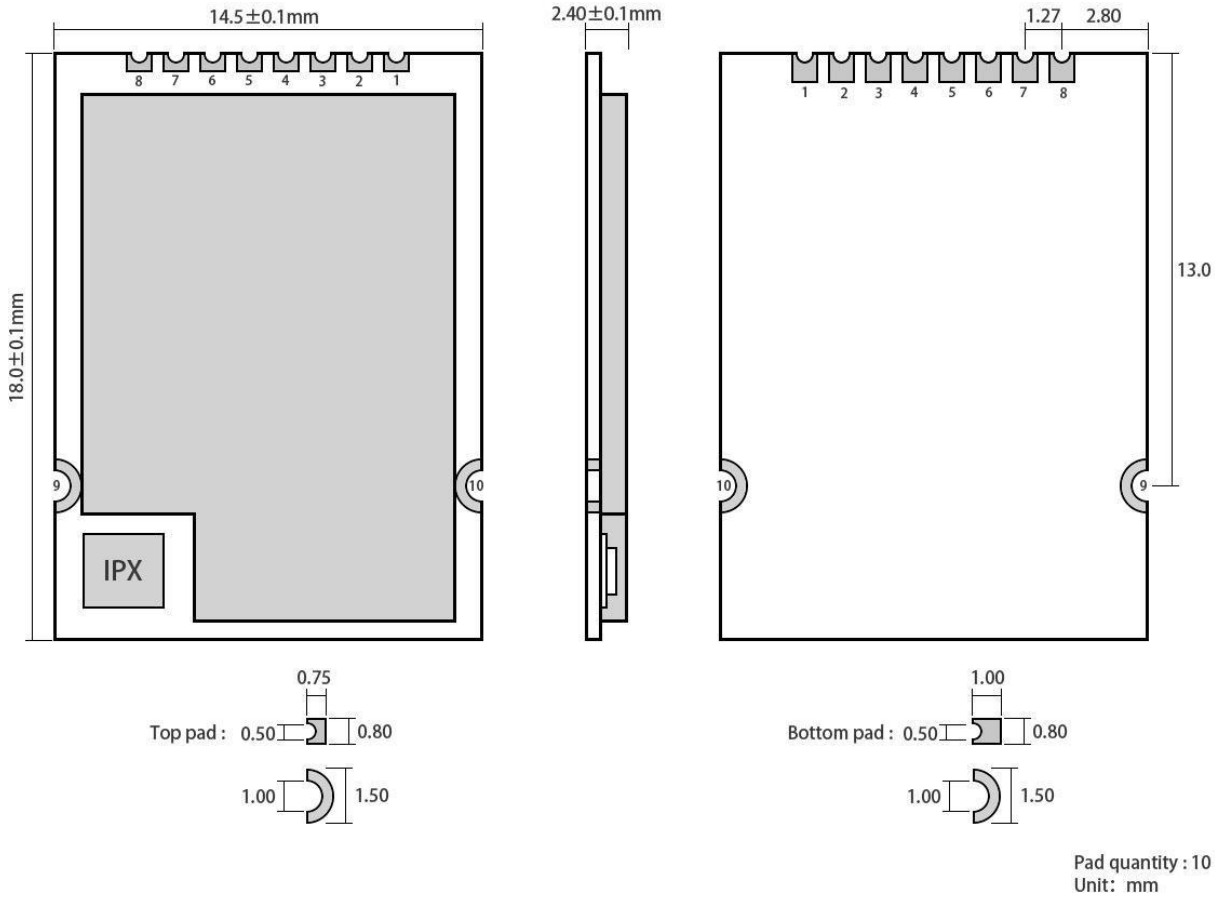
Main parameter		Performance			Remarks
		Min.	Typ.	Max.	
Operating voltage（V）		2.0	3.3	3.6	≥3.3 V ensures output power
Communication level（V）			3.3		For 5V TTL, it may be at risk of burning down
Working temperature（℃）		-40	-	85	Industrial design
Operating frequency（GHz）		2.4	-	2.525	Support ISM band
Power consumption	TX current（mA）		113		Instant power consumption
	RX current（mA）		24		
	Sleep current（μA）		2		Software shut off
Max Tx power（dBm）		19.7	20	20.2	
Receiving sensitivity（dBm）		-96.5	-96	-97.5	Air data rate is 250kbps
Air data rate（bps）		250k	-	2M	User programming control

Main parameter	Value	Remarks
Distance	2000m	In open and clear air, at height of 2.5m，air data rate:250kbps
FIFO	32Byte	Max packet length per time
Crystal Frequency	16MHz	
Modulation	GFSK	
Package	SMD	
Connector	1.27mm 插针	
Communication interface	SPI	0～10Mbps
Size	14.5*18mm	Without SMA
Antenna	IPEX	50 ohm impedance match

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3 Size and pin definition



Pin No.	Pin item	Pin direction	Application
1	VCC		Power supply between 2.0 and 3.6V
2	CE	Input	Module control pin
3	CSN	Input	Chip select pin for starting new SPI communication
4	SCK	Input	SPI clock pin
5	MOSI	Input	SPI data input pin
6	MISO	Output	SPI data output pin
7	IRQ	Output	Interrupt request，valid in low level
8	GND		Ground, connected to power reference ground
9	GND		Ground, connected to power reference ground
10	GND		Ground, connected to power reference ground

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4 Basic operation

4.1 Hardware design

- It is recommended to use a DC stabilized power supply. The power supply ripple factor is as small as possible, and the module needs to be reliably grounded;
- Please pay attention to the correct connection of the positive and negative poles of the power supply. Reverse connection may cause permanent damage to the module;
- Please check the power supply to ensure it is within the recommended voltage otherwise when it exceeds the maximum value the module will be permanently damaged;
- Please check the stability of the power supply, the voltage cannot be fluctuated frequently;
- When designing the power supply circuit for the module, it is often recommended to reserve more than 30% of the margin, so the whole machine is beneficial for long-term stable operation;
- The module should be as far away as possible from the power supply, transformers, high-frequency wiring and other parts with large electromagnetic interference;
- Bottom Layer; High-frequency digital routing, high-frequency analog routing, and power routing must be avoided under the module. If it is necessary to pass through the module, assume that the module is soldered to the Top Layer, and the copper is spread on the Top Layer of the module contact part(well grounded), it must be close to the digital part of the module and routed in the Bottom Layer;
- Assuming the module is soldered or placed over the Top Layer, it is wrong to randomly route over the Bottom Layer or other layers, which will affect the module's spurs and receiving sensitivity to varying degrees;
- It is assumed that there are devices with large electromagnetic interference around the module that will greatly affect the performance. It is recommended to keep them away from the module according to the strength of the interference. If necessary, appropriate isolation and shielding can be done; Assume that there are traces with large electromagnetic interference (high-frequency digital, high-frequency analog, power traces) around the module that will greatly affect the performance of the module. It is recommended to stay away from the module according to the strength of the interference. If necessary, appropriate isolation and shielding can be done;
- Try to stay away from some physical layers such as TTL protocol at 2.4GHz , for example: USB3.0;
- The antenna installation structure has a great impact on the performance of the module. Be sure to ensure that the antenna is exposed, preferably vertically.When the module is installed inside the case, a high-quality antenna extension cable can be used to extend the antenna to the outside of the case;
- Do not install the antenna inside the metal case,it will greatly reduce the transmission distance.

4.2 Software programming

- This module is SI24R1+PA+LNA, and its driving mode is exactly the same as SI24R1. Users can operate in full accordance with the SI24R1 chip manual (see the SI24R1 manual for details);

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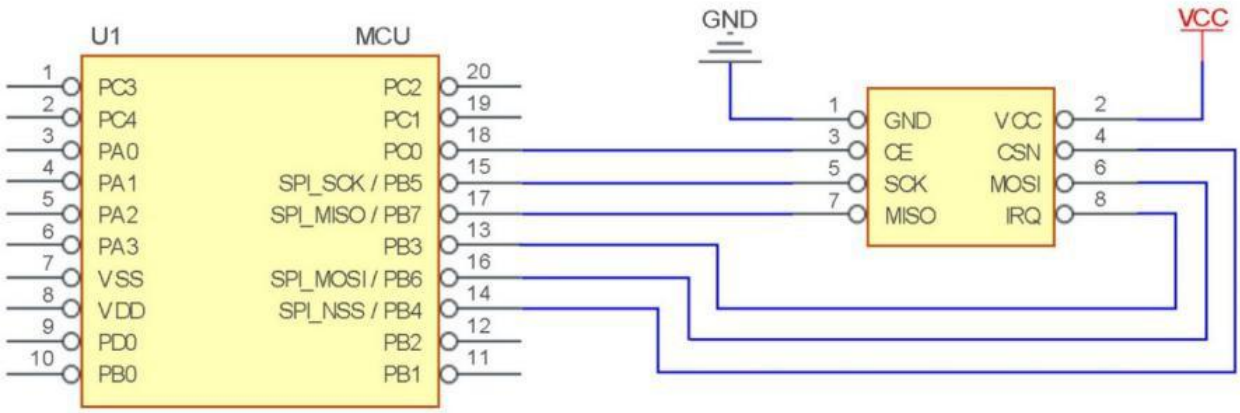
- Power step:

SI24R1Register setting table：

Address(Hex)	Mnemonic	Bit	Reset Value	Description
06	RF_SETUP			Rf configuration
	RF_PWR	2:0	110	TX transmitting power 111:7dBm 110:4dBm 101:3dBm 100:1dBm 011:0dBm 010:-4dBm 001:-6dBm 000:-12dBm

- 011：Front 0dBm, output 20dBm;
- 010：Front -4dBm，output 17dBm;
- 011：Front -6dBm，output 14dBm;
- 000：Front -12dBm，output 8dBm;
- IRQ is an interrupt pin. It is used to wake up the microcontroller and achieve fast response; users can leave it unconnected and use SPI to query the interrupt status (not recommended, not conducive to overall power consumption, low efficiency);
- CE can be connected to high level for a long time, but the module must be set to POWER DOWN power-down mode when writing to the register. It is recommended that CE be controlled by MCU pin.
- The CE pin is connected to the LNA enable pin. When CE=1, LNA is turned on, and when CE=0, LNA is turned off. This operation is completely consistent with the transceiver mode of nRF24L01; in other words, the user does not need to care about LNA operation at all;
- If the user needs to answer automatically, the CE pin must remain high during transmission. The correct operation is: CE=1 to trigger the transmission. After knowing that the transmission is completed, CE=0, instead of CE=0 after 10us. The reason is: After SI24R1 is sent, it will immediately switch to receiving mode. At this time, if CE= 0, the LNA has been turned off, which is not conducive to receiving sensitivity.

5 Basic application



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6 FAQ

6.1 Communication range is too short

- The communication distance will be affected when obstacle exists;
- Data lose rate will be affected by temperature, humidity and co-channel interference;
- The ground will absorb and reflect wireless radio wave, so the performance will be poor when testing near ground.;
- Sea water has great ability in absorbing wireless radio wave, so performance will be poor when testing near the sea;
- The signal will be affected when the antenna is near metal object or put in a metal case;
- Power register was set incorrectly, air data rate is set as too high (the higher the air data rate, the shorter the distance);
- The power supply low voltage under room temperature is lower than 2.5V, the lower the voltage, the lower the transmitting power;
- Due to antenna quality or poor matching between antenna and module.

6.2 Module is easy to damage

- Please check the power supply to ensure that it is between the recommended power supply voltage. If the maximum value is exceeded, the module will be permanently damaged;
- Please check the stability of power source, the voltage cannot fluctuate too much;
- Please make sure anti-static measure are taken when installing and using, high frequency devices have electrostatic susceptibility;
- Please ensure the humidity is within limited range, some parts are sensitive to humidity;
- Please avoid using modules under too high or too low temperature.

6.3 BER(Bit Error Rate) is high

- There are co-channel signal interference nearby, please be away from interference sources or modify frequency and channel to avoid interference;
- The clock waveform on the SPI is not standard. Check whether there is interference on the SPI line. The SPI bus line should not be too long;
- Poor power supply may cause messy code. Make sure that the power supply is reliable;
- The extension line and feeder quality are poor or too long, so the bit error rate is hig.

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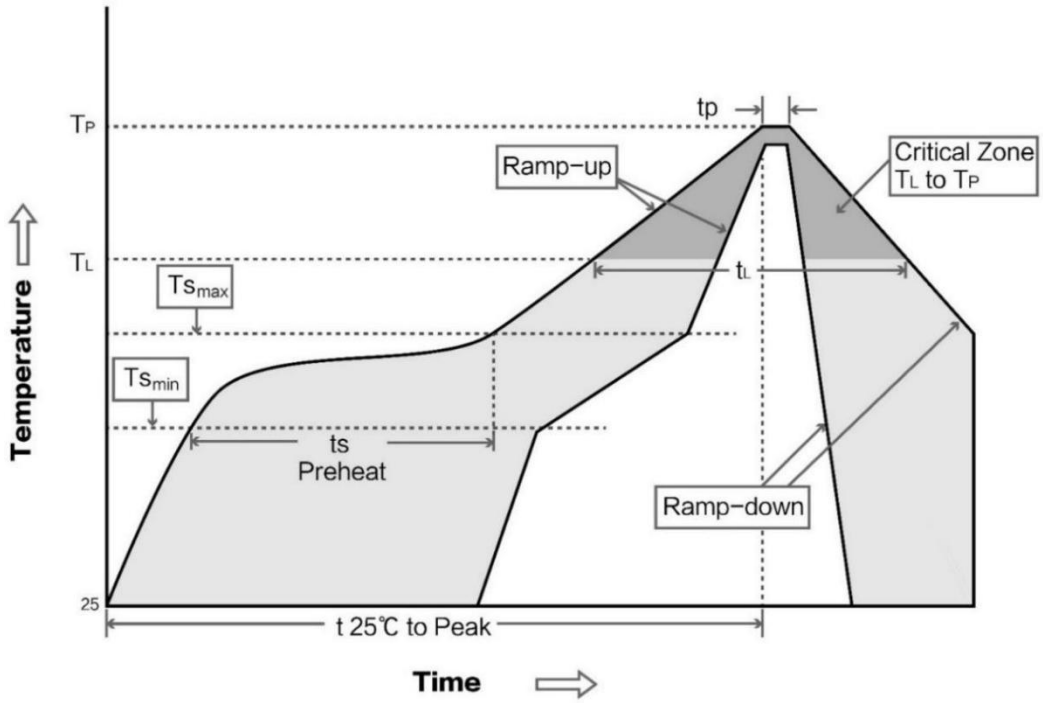
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7 Welding guidance

7.1 Reflow Soldering Temperature

Profile Feature	Sn-Pb Assembly	Pb-Free Assembly
Solder Paste	Sn63/Pb37	Sn96.5/Ag3/Cu0.5
Preheat Temperature min （Tsmin）	100℃	150℃
Preheat temperature max (Tsmax)	150℃	200℃
Preheat Time (Tsmin to Tsmax)(ts)	60-120 sec	60-120 sec
Average ramp-up rate(Tsmax to Tp)	3℃/second max	3℃/second max
Liquidous Temperature (TL)	183℃	217℃
Time（tL）Maintained Above（TL）	60-90 sec	30-90 sec
Peak temperature（Tp）	220-235℃	230-250℃
Aveage ramp-down rate（Tp to Tsmax）	6℃/second max	6℃/second max
Time 25℃ to peak temperature	6 minutes max	8 minutes max

7.2 Reflow Soldering Curve



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8 E01 series

Model	IC	Frequency	Tx power	Distance	Package	Antenna
		Hz	dBm	m		
E01-ML01S	nRF24L01+	2.4G	0	100	SMD	PCB
E01-ML01D	nRF24L01+	2.4G	0	100	DIP	PCB
E01-ML01IPX	nRF24L01+	2.4G	0	200	SMD	IPEX
E01-2G4M13S	nRF24L01+	2.4G	13	1200	SMD	PCB
E01-ML01SP2	nRF24L01+	2.4G	20	1800	SMD	PCB/IPEX
E01-ML01SP4	nRF24L01+	2.4G	20	2000	SMD	IPEX
E01-ML01DP4	nRF24L01+	2.4G	20	1800	DIP	PCB
E01-ML01DP5	nRF24L01+	2.4G	20	2500	DIP	SMA-K
E01-2G4M27D	nRF24L01+	2.4G	27	5000	DIP	SMA-K
All wireless modules of the E01 series can communicate with each other						

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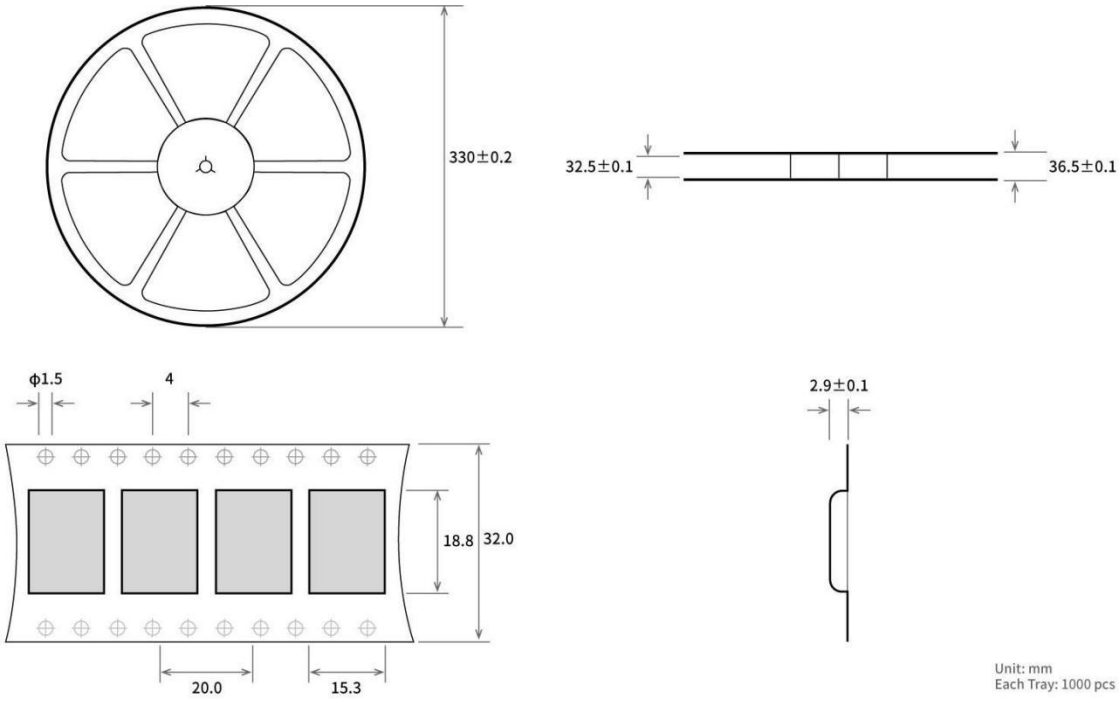
9 Antenna recommendation

9.1 Recommendation

The antenna is an important role in the communication process. A good antenna can largely improve the communication system. Therefore, we recommend some antennas for wireless modules with excellent performance and reasonable price.

Model No.	Type	Frequeny	Gain dBi	Size	Cable	Interface	Function feature
		Hz	dBi	mm	cm		
TX2400-NP-5010	Flexible antenna	2.4G	2.0	10x50	-	IPEX	FPC soft antenna
TX2400-JZ-3	Rubber antenna	2.4G	2.0	30	-	SMA-J	Short straight & omnidirectional
TX2400-JZ-5	Rubber antenna	2.4G	2.0	50	-	SMA-J	Short straight & omnidirectional
TX2400-JW-5	Rubber antenna	2.4G	2.0	50	-	SMA-J	Flexible & omnidirectional
TX2400-JK-11	Rubber antenna	2.4G	2.5	110	-	SMA-J	Bendable glue stick & omnidirectional
TX2400-JK-20	Rubber antenna	2.4G	3.0	200	-	SMA-J	Bendable glue stick & omnidirectional
TX2400-XPL-150	Sucker antenna	2.4G	3.5	150	150	SMA-J	Small & cost-effective

10 Batch packaging



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Revision history

Version	Date	Description	Issued by
1.0	2020-12-21	Initial version	Linson

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