# E01C-ML01DP4 User Manual

## SI24R1 2.4GHz 100mW SPI DPI Wireless Module



Chengdu Ebyte Electronic Technology Co.,Ltd.

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# Contents

Disclaimer....2
Chapter1. Overview....3
1.1 Brief introduction....3
1.2 Features....3
1.3 Application....3
Chapter2. Specifications....4
2.1 Limit parameter....4
2.2 Operating parameter....4
Chapter3. Size and pin definition....5
Chapter4. Basic operation....6
4.1 Hardware design....6
4.2 Software editing....7
Chapter5. Circuit diagram....8
Chapter6. FAQ....8
6.1 Communication range is too short....8
6.2 Module is easy to damage....8
6.3 BER(Bit Error Rate) is high....9
Chapter7. Soldering guidance....9
Chapter8. Related models....9
Chapter9. Bulk packaging....10
Revision history....10
About us....11

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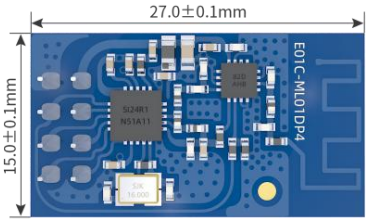
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# Chapter1. Overview

## 1.1 Brief introduction

E01C-ML01DP4 is a 2.4GHz direct plug-in wireless module with a maximum transmission power of 100mW and a built-in PCB antenna based on the domestic SI24R1.




Built-in power amplifier (PA) and low noise amplifier (LNA) on the original basis, so that the maximum transmission power reaches 100mW, while the receiving sensitivity is further improved, and the overall communication stability is compared with no power amplifier and low noise amplifier. The products have been greatly improved.

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

Because E01C-ML01DP4 is a pure radio frequency transceiver module, it needs to use MCU driver or use a dedicated SPI debugging tool.

## 1.2 Features

- The maximum transmission power is 100mW, and the software is multi-level adjustable;
- Under ideal conditions, the communication distance can reach 1.8km;
- Support the global license-free ISM 2.4GHz frequency band;
- Support 2Mbps, 1Mbps and 250kbps air rate;
- 125 communication channels to meet application requirements such as multipoint communication, grouping, and frequency hopping;
- Connect with MCU through SPI interface, rate 0～10Mbps;
- Support 2.0～3.6V power supply, power supply greater than 3.3V can guarantee the best performance;
- Industrial standard design, supporting long-term use at -40～+85℃;
- Comes with PCB onboard antenna, no need for external antenna;

## 1.3 Application

- Smart home and industrial sensors, etc.;
- Security system, positioning system;
- Wireless remote control, UAV;
- Wireless game remote control;
- Healthcare products;
- Wireless voice, wireless headset;
- Automotive industry applications.

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# Chapter2. Specifications

## 2.1 Limit parameter

| Main parameter | Performance | | Remarks |
|---|---|---|---|
| | Min. | Max. | |
| Power 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 |
| Operating temperature（℃） | -40 | 85 | Industrial grade |

## 2.2 Operating parameter

| Main parameter | | Performance | | | Remarks |
|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | |
| Operating voltage（V） | | 2.0 | 3.3 | 3.6 | ≥3.3V ensures output power |
| Communication level（V） | | | 3.3 | | For 5V TTL, it may be at risk of burning down |
| Operating temperature（℃） | | -40 | - | 85 | Industrial design |
| Operating frequency（GHz） | | 2.4 | - | 2.525 | Support ISM band |
| Power consumption | Tx current | | 130 | | Instantaneous power consumption |
| | Rx current | | 21 | | |
| | Sleep current(μA) | | 2 | | Software is shut down |
| Max Tx power（dBm） | | 19.7 | 20 | 20.2 | |
| Receiving sensitivity（dBm） | | -95.5 | -96 | -97.5 | Air data rate is 250kbps |
| Air data rate（bps） | | 250k | - | 2M | Controlled via user’s programming |

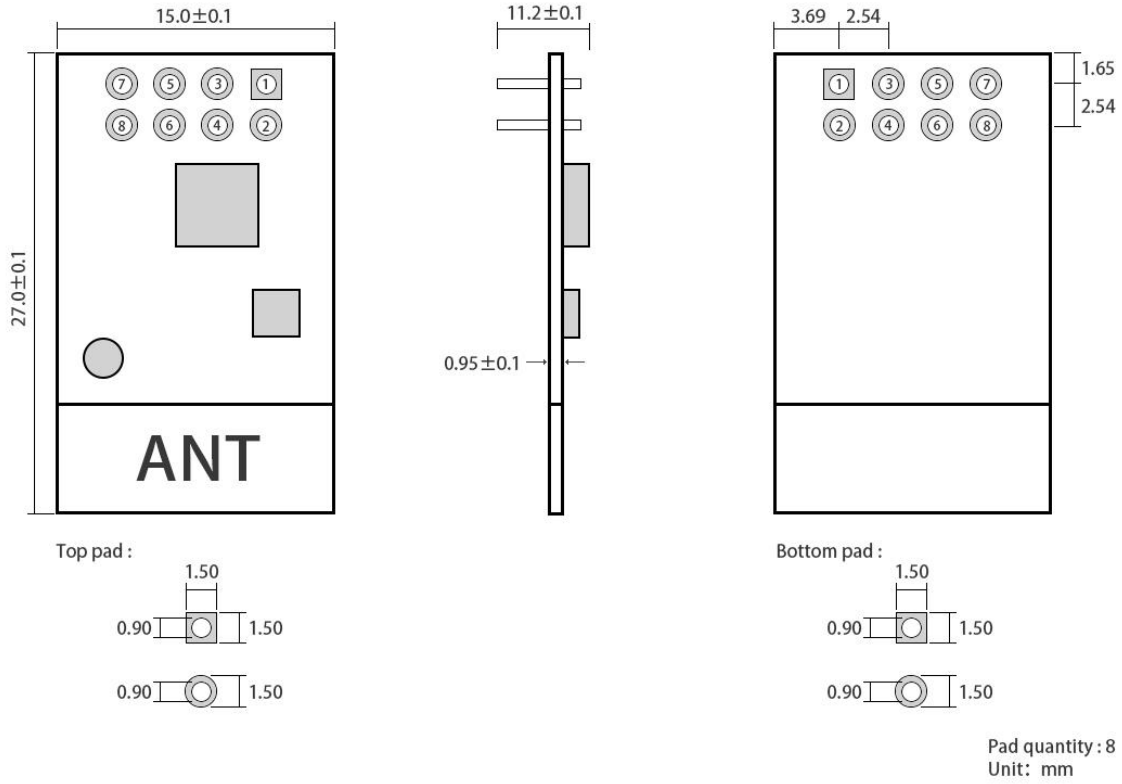
| Main parameter | Description | Remark |
|---|---|---|
| Reference distance | 1800m | Test condition： clear and open area, antenna gain: 5dBi， antenna height: 2.5m，air data rate: 250kbps |
| FIFO | 32Byte | Max length transmitted each time |
| Crystal frequency | 16MHz | |
| Modulation | GFSK | |
| Package | DPI | |
| Connector | 2.54mm Pin header | |
| Communication interface | SPI | 0～10Mbps |

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| | | |
|---|---|---|
| Size | 15 * 27mm | With out SMA |
| Antenna | PCB | The equivalent impedance is about 50Ω |

# Chapter3. Size and pin definition




| Pin No. | Pin item | Pin direction | Pin application |
|---|---|---|---|
| 1 | GND | | Ground wire, connected to the power reference ground |
| 2 | VCC | | The power supply must be between 2.0～3.6V |
| 3 | CE | Input | Module control pin |
| 4 | CSN | Inout | Module chip select pin, used to start a SPI communication |
| 5 | SCK | Input | Module SPI bus clock |
| 6 | MOSI | Input | Module SPI data input pin |
| 7 | MISO | Output | Module SPI data output pin |
| 8 | IRQ | Output | Module interrupt signal output, active low |

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# Chapter4. 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 can not 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;
- 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.
- If the communication line uses a 5V level, a 1k-5.1k resistor must be connected in series (not recommended, there is still a risk of damage);
- Try to stay away from some physical layers such as TTL protocol at 2.4GHz , for example: USB3.0;
- The mounting structure of antenna has a great influence on the performance of the module. It is necessary to ensure that the antenna is exposed, preferably vertically upward. When the module is mounted inside the case, use a good antenna extension cable to extend the antenna to the outside;
- The antenna must not be installed inside the metal case, which will cause the transmission distance to be greatly weakened.
- Conductors or other sources of interference should be avoided around the onboard PCB antenna.

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## 4.2 Software editing

- The drive mode of this module SI24R1+PA+LNA is completely equivalent to SI24R1, and users can operate according to the SI24R1 chip manual (see SI24R1 manual for details);

  Power bin:

  SI24R1 register setting table:

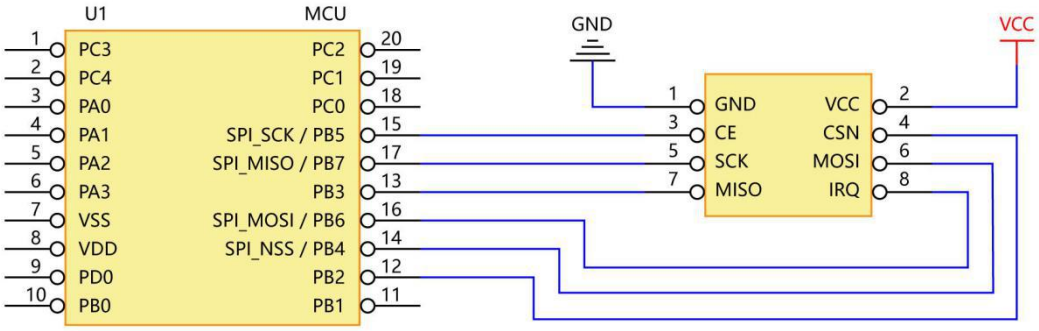
| Address(Hex) | | Mnemonic | Bit | Reset Value | Description |
|---|---|---|---|---|---|
| 06 | | RF_SETUP | | | RF configuration |
| | | RF_PWR | 2:0 | 110 | Set TX Power<br>111:7dBm 110:4dBm<br>101:3dBm 100:1dBm<br>011:0dBm 010:-4dBm<br>001:-6dBm 000:-12dBm |

- 011：Pre-stage 0dBm，Output20dBm；
- 010：Pre-stage-4dBm，Output 17dBm；
- 011：Pre-stage-6dBm，Output 14dBm;
- 000：Pre-stage-12dBm, Output 8dBm;
- IRQ is an interrupt pin, which can be used to wake up the microcontroller and achieve fast response; it can be disconnected, and the interrupt status can be obtained by SPI query (not recommended, not conducive to overall power consumption, and low efficiency);
- CE can be connected to the high level for a long time, but the module must be set to POWER DOWN power-down mode when writing the register. It is recommended that CE be controlled by the MCU pin;
- The CE pin is connected to the LNA enable pin. When CE=1, the LNA is turned on, and when CE=0, the LNA is turned off. This operation is completely consistent with the transceiver mode of nRF24L01; that is, the user does not need to care about LNA operation at all;
- If the user needs to answer automatically, the CE pin must be kept high during the transmission process, and the high level time cannot be longer than 10us as mentioned in the SI24R1 manual. 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.

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# Chapter5. Circuit diagram




# Chapter6. FAQ

## 6.1 Communication range is too short

- When there is a straight line communication obstacle, the communication distance will be attenuated accordingly;
- Temperature, humidity, and co-frequency interference will increase the communication packet loss rate;
- The ground absorbs and reflects radio waves, and the test results near the ground are poor;
- Sea water has a strong ability to absorb radio waves, so the seaside test results are poor;
- If there is a metal object near the antenna or placed in a metal shell, the signal attenuation will be very serious;
- The power register setting is wrong, the air speed setting is too high (the higher the air speed, the closer the distance);
- The low voltage of the power supply at room temperature is lower than the recommended value, the lower the voltage, the lower the power output;
- The poor matching degree of the antenna and the module or the quality of the antenna itself.

## 6.2 Module is easy to damage

- Please check the power supply to ensure that it is within the recommended power supply voltage. If it exceeds the maximum value, it will cause permanent damage to the module;
- Please check the stability of the power supply, the voltage should not fluctuate greatly and frequently;
- Please ensure anti-static operation during installation and use, and high-frequency components are electrostatically sensitive;
- Please ensure that the humidity during installation and use should not be too high, and some components are humidity sensitive devices;
- If there is no special requirement, it is not recommended to use at too high or too low temperature.

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## 6.3 BER(Bit Error Rate) is high

- There is co-frequency signal interference nearby, stay away from the interference source or modify the frequency and channel to avoid interference;
- The clock waveform on SPI is not standard, check whether there is interference on the SPI line, and the SPI bus line should not be too long;
- Unsatisfactory power supply may also cause garbled codes. Ensure the reliability of the power supply;
- Poor or too long extension cords and feeders will also cause high bit error rates.

# Chapter7. Soldering guidance

This product is a direct plug-in module. When welding the module, the welder must work in accordance with the norms for discharging static electricity. This product is an electrostatic sensitive product. If the module is not welded according to the rules, the module may be permanently damaged.

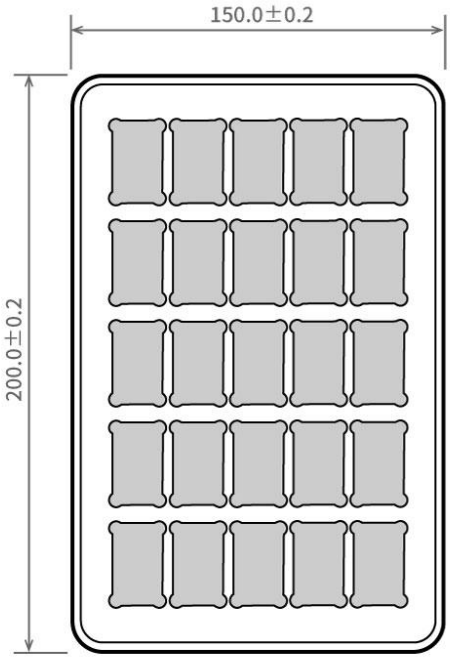
# Chapter8. Related models

| Model | IC | Frequency | Power | Distance | Pakage | Antenna |
|---|---|---|---|---|---|---|
| | | Hz | dBm | m | | |
| E01-ML01S | nRF24L01+ | 2.4G | 0 | 100 | SMD | PCB |
| E01-ML01D | nRF24L01+ | 2.4G | 0 | 100 | DPI | 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 |
| E01C-ML01DP4 | nRF24L01+ | 2.4G | 20 | 1800 | DPI | PCB |
| E01-ML01DP5 | nRF24L01+ | 2.4G | 20 | 2500 | DPI | SMA-K |
| E01-2G4M27D | nRF24L01+ | 2.4G | 27 | 5000 | DPI | SMA-K |
| All wireless modules of the E01 series can communicate with each other | | | | | | |

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# Chapter9. Bulk packaging






Unit: mm
Each Layer: 25 pcs
Each Package: 4 layers

## Revision history

| Version | Date | Description | Issued by |
|---|---|---|---|
| 1.0 | 2020-11-30 | initial version | Linson |

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