nRF24L01P Wireless Module
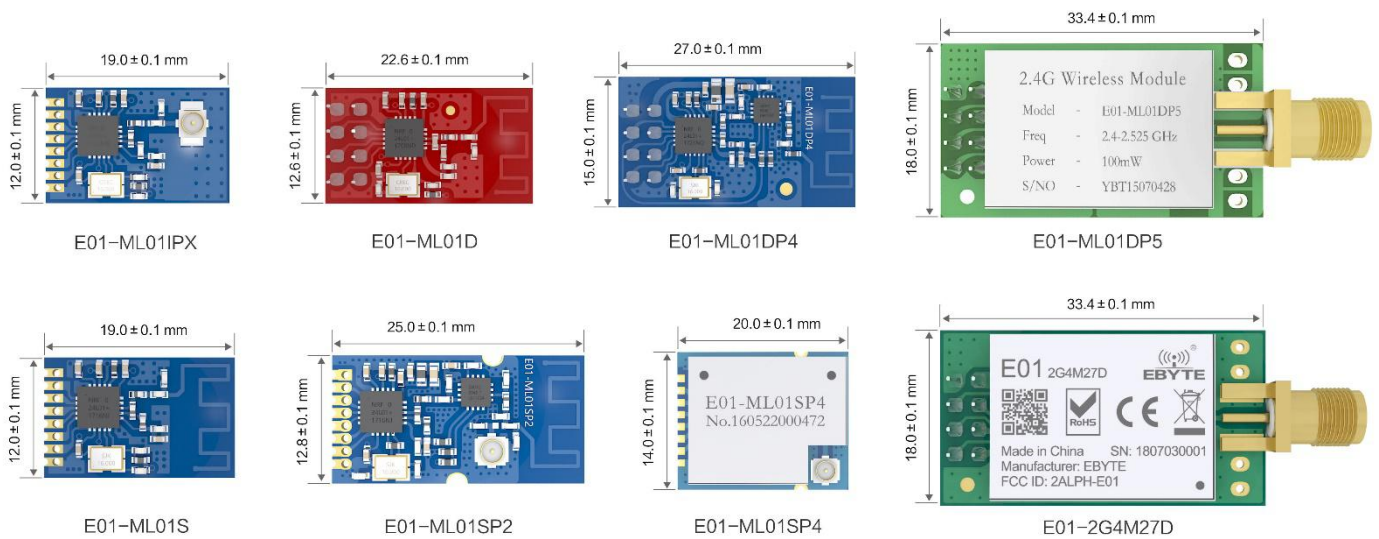
E01 Series

User Manual

Version	Date	Description	Issued by
1.00	2017/11/15	Initial version	huaa
1.10	2018/5/22	Added contents	huaa
1.20	2018/8/13	Added E01 (2G4M27D)	Huaa

Brief Introduction

E01 series 2.4Ghz wireless transceiver module based on nRF24L01P with SPI interface features small size and various application usage.

E01 series modules are embedded with imported electronic parts, such as industrial crystals with high precision and TCXO. With built-in PA and LNA, the 20dBm module has better performance for communication and operating range; 0dBm modules with imported parts owns excellent RF performance, especially popular among users who require low power consumption.

E01 series strictly stick to the design rules home and abroad of FCC, CE, CCC and meet the related RF certifications and export standards. As hardware platform,users need to carry out secondary development.

Model	Antenna	Packing	Transmitting power	Distance
E01-ML01D	PCB	DIP	0dBm	100m
E01-ML01DP4	PCB	DIP	20dBm	1800m
E01-ML01DP5	SMA-K	DIP	20dBm	2500m
E01-2G4M27D	SMA-K	DIP	27dBm	3500m
E01-ML01IPX	IPEX	SMD	0dBm	200m
E01-ML01S	PCB	SMD	0dBm	100m
E01-ML01SP2	PCB/ IPEX	SMD	20dBm	1500m
E01-ML01SP4	IPEX	SMD	20dBm	2000m

Contents

1. Technical Parameter

1.1. General parameter

Model	Core IC	Size	Net Weight	Operating Temperature	Operating Humidity	Storage Temperature
E01-ML01D	nRF24L01P	12.6 * 22.6 mm	1.1±0.1g	-40 ~ 85°C	10% ~ 90%	-40 ~ 125°C
E01-ML01DP4	nRF24L01P	15 * 27 mm	1.4±0.1g	-40 ~ 85°C	10% ~ 90%	-40 ~ 125°C
E01-ML01DP5	nRF24L01P	18 * 33.4 mm	4.9±0.1g	-40 ~ 85°C	10% ~ 90%	-40 ~ 125°C
E01-2G4M27D	nRF24L01P	18 * 33.4 mm	5.1±0.1g	-40 ~ 85°C	10% ~ 90%	-40 ~ 125°C
E01-ML01IPX	nRF24L01P	12 * 19 mm	0.6±0.1g	-40 ~ 85°C	10% ~ 90%	-40 ~ 125°C
E01-ML01S	nRF24L01P	12 * 19 mm	0.5±0.1g	-40 ~ 85°C	10% ~ 90%	-40 ~ 125°C
E01-ML01SP2	nRF24L01P	12.8 * 25 mm	0.8±0.1g	-40 ~ 85°C	10% ~ 90%	-40 ~ 125°C
E01-ML01SP4	nRF24L01P	14.8 * 18 mm	1.2±0.1g	-40 ~ 85°C	10% ~ 90%	-40 ~ 125°C

1.2. Electrical parameter

1.2.1. Transmitting current

Model	Min	Typ	Max	Unit	Remarks
E01-ML01D	12	13	14	mA	
E01-ML01DP4	100	110	120	mA	● When designing current supply circuit, 30% margin is recommended to be remained so as to ensure long-term stable operation of the whole module;
E01-ML01DP5	120	130	140	mA	● The current at the instant of transmitting may be high, but the total energy consumed may be lower due to very short transmitting time;
E01-2G4M27D@3.3V	480	490	500	mA	
E01-2G4M27D@5.0V	380	390	400	mA	
E01-ML01IPX	12	13	14	mA	● When using external antenna, the impedance matching degree at different frequency points between antenna and module may affect the transmitting current value at different levels.
E01-ML01S	12	13	14	mA	
E01-ML01SP2	120	130	140	mA	
E01-ML01SP4	110	120	130	mA	

1.2.2. Receiving current

Model	Min	Typ	Max	Unit	Remarks
E01-ML01D	11	12	13	mA	
E01-ML01DP4	18	20	22	mA	
E01-ML01DP5	18	20	22	mA	● The current consumed when the RF chip is only working at receiving mode is called as receiving current, the tested receiving current may be higher for some RF chips with communication protocol or the developers have loaded their own protocol to the whole module;
E01-2G4M27D@3.3V	22	23	24	mA	
E01-2G4M27D@5.0V	21	22	23	mA	
E01-ML01IPX	11	12	13	mA	● The current at pure receiving mode will be mA level, users can realize μA level of receiving current through firmware development.
E01-ML01S	11	12	13	mA	
E01-ML01SP2	19	21	23	mA	
E01-ML01SP4	24	26	28	mA	

1.2.3. Turn-off current

Model	Min	Typ	Max	Unit	Remarks
E01-ML01D	0.5	1.0	2.0	μA	The turn-off current means the current consumed by CPU, RAM, Clock and some registers which remain operating. SoC is at very low power consumption status; ● The turn-off current is always lower than the current consumed when the power supply source of the whole module is at no-load status.
E01-ML01DP4	0.5	1.0	2.0	μA	
E01-ML01DP5	0.5	1.0	2.0	μA	
E01-2G4M27D	450	455	460	μA	
E01-ML01IPX	0.5	1.0	2.0	μA	
E01-ML01S	0.5	1.0	2.0	μA	
E01-ML01SP2	0.5	1.0	2.0	μA	
E01-ML01SP4	0.5	1.0	2.0	μA	

1.2.4. Voltage supply

Model	Min	Typ	Max	Unit	Remarks
E01-ML01D	2.0	3.3	3.6	V DC	●If the module stays at maximum voltage for a long time, it may be damaged; ● The power supply pin has certain surge-resistance ability, but the potential pulse is higher than the maximum power supply voltage; ●The power supply is not advisable to be below 3.0V, or the RF parameters will be influenced at different degree. ● For max 30dBm, voltage is no less than 4.75V, or RF parameters will be affected to different extend.
E01-ML01DP4	2.0	3.3	3.6	V DC	
E01-ML01DP5	2.0	3.3	3.6	V DC	
E01-2G4M27D	2.5	3.3	5.5	V DC	
E01-ML01IPX	2.0	3.3	3.6	V DC	
E01-ML01S	2.0	3.3	3.6	V DC	
E01-ML01SP2	2.0	3.3	3.6	V DC	
E01-ML01SP4	2.0	3.3	3.6	V DC	

1.2.5. Communication level

Model	Min	Typ	Max	Unit	Remarks
E01-ML01D	2.0	3.3	3.6	V DC	●If the module stays at maximum communication level for a long time, it may be damaged; ●The module is compatible with some 5.0V MCU; Because there's too much model, pls refer to the real testing or consult our sales; ●There are various ways to switch communication level, but it will affect the whole power consumption to a large extend.
E01-ML01DP4	2.0	3.3	3.6	V DC	
E01-ML01DP5	2.0	3.3	3.6	V DC	
E01-2G4M27D	2.0	3.3	3.6	V DC	
E01-ML01IPX	2.0	3.3	3.6	V DC	
E01-ML01S	2.0	3.3	3.6	V DC	
E01-ML01SP2	2.0	3.3	3.6	V DC	
E01-ML01SP4	2.0	3.3	3.6	V DC	

1.3.   RF parameter

1.3.1.   Transmitting power

Model	Min	Typ	Max	Unit	Remarks
E01-ML01D	-0.2	0	0.3	dBm	● Due to the error of the materials, each LRC component has ±0.1% error, so error accumulation will occur since multiple LRC components are used in the whole RF circuit, and the transmitting currents will be different at different modules; ● The power consumption can be lowered by lowering the transmitting power, but the efficiency of the internal PA will be decreased by lowering transmitting power due to various reasons; ● The transmitting power will be lowered by lowering the power supply voltage.
E01-ML01DP4	19.7	20	20.4	dBm	
E01-ML01DP5	19.7	20	20.4	dBm	
E01-2G4M27D	26.5	27	27.5	dBm	
E01-ML01IPX	-0.2	0	0.3	dBm	
E01-ML01S	-0.2	0	0.3	dBm	
E01-ML01SP2	19.7	20	20.4	dBm	
E01-ML01SP4	19.7	20	20.4	dBm	

1.3.2.   Receiving sensitivity

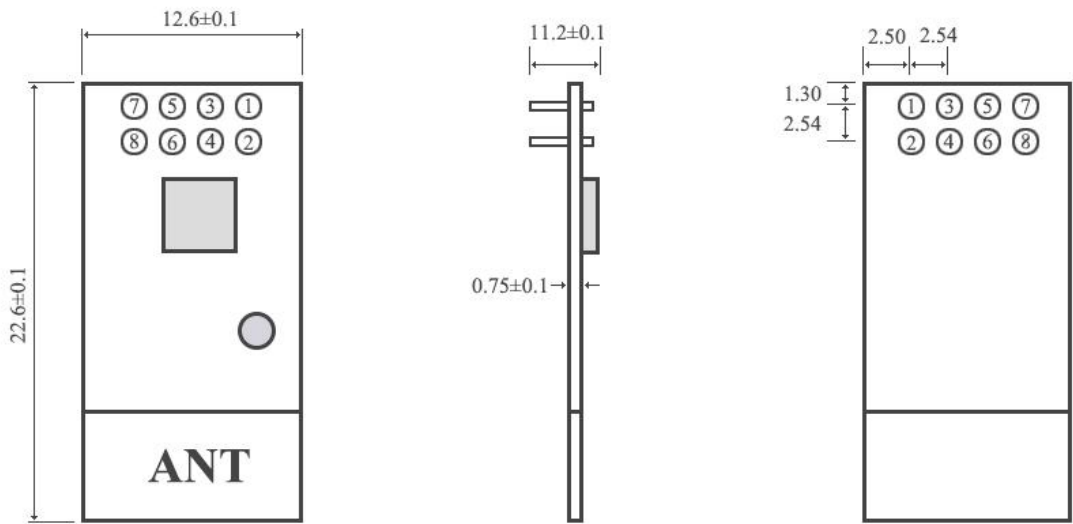| Model	Min	Typ	Max	Unit	Remarks
E01-ML01D	-92.0	-93.0	-94.0	dBm	● The sensitivity is tested under the air data rate 250kbps; ● Due to the error of the materials, each LRC component has ±0.1% error, so error accumulation will occur since multiple LRC components are used in the whole RF circuit, and the transmitting currents will be different at different modules; ●The receiving sensitivity will be reduced and communication range will be shortened while increasing the air data rate.
E01-ML01DP4	-95.5	-96.0	-97.5	dBm	
E01-ML01DP5	-95.5	-96.0	-97.5	dBm	
E01-2G4M27D	-98.0	-99.0	-100.0	dBm	
E01-ML01IPX	-92.0	-93.0	-94.0	dBm	
E01-ML01S	-92.0	-93.0	-94.0	dBm	
E01-ML01SP2	-95.5	-96.0	-97.5	dBm	
E01-ML01SP4	-95.5	-96.0	-97.5	dBm	

1.3.3.   Recommended operating frequency

Model	Min	Typ	Max	Unit	Remarks
E01-ML01D	2400	2430	2525	MHz	● To work within the recommended frequency can assure the modules to meet all the parameters; ● It is recommended to avoid the crowded integral frequency such as 433.0MHz, 868.0MHz, 915MHz, 240MHz etc.
E01-ML01DP4	2400	2430	2525	MHz	
E01-ML01DP5	2400	2430	2525	MHz	
E01-2G4M27D	2400	2430	2525	MHz	
E01-ML01IPX	2400	2430	2525	MHz	
E01-ML01S	2400	2430	2525	MHz	
E01-ML01SP2	2400	2430	2525	MHz	
E01-ML01SP4	2400	2430	2525	MHz	

1.4.   Tested distance

| Model	Min	Typ	Max	Unit	Remarks
E01-ML01D	90	100	110	m	●The external antenna used is of 5dBi gain and vertical polarization. The height is 2.5 meters;
E01-ML01DP4	1600	1800	1980	m	
E01-ML01DP5	2300	2500	2800	m	●The interval between each data packet is 2s, sending 100 packets with 30 bytes in each packet, the range at data lose rate of lower than 5% is valid range;
E01-2G4M27D	3150	3500	3850	m	
E01-ML01IPX	180	200	230	m	●In order to obtain meaningful and reproducible results, we conducted the tests in clear air with little electromagnetic interference at suburb areas;
E01-ML01S	90	100	120	m	
E01-ML01SP2	1300	1500	1600	m	
E01-ML01SP4	1800	2000	2300	m	●Distance may be shorter with interference or obstacles.

2.   Mechanical Characteristics

2.1.   E01-ML01D

Pin No.	Pin item	Pin direction	Pin application
1	GND		Ground
2	VCC		Power supply 1.9V~3.6V DC
3	CE	input	Chip enable
4	CSN	input	SPI Chip select
5	SCK	input	SPI Clock
6	MOSI	input	SPI master output slave input
7	MISO	Output	SPI master input slave output
8	IRQ	Output	Interrupt request
★ Find more details on 《nRF24L01P Datasheet》from Nordic ★			

2.2. E01-ML01DP4
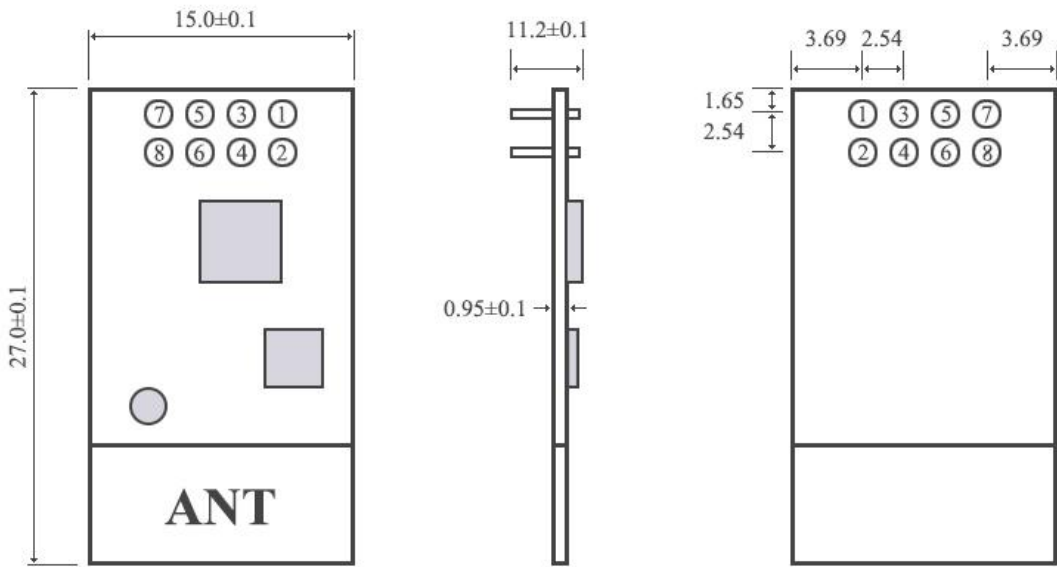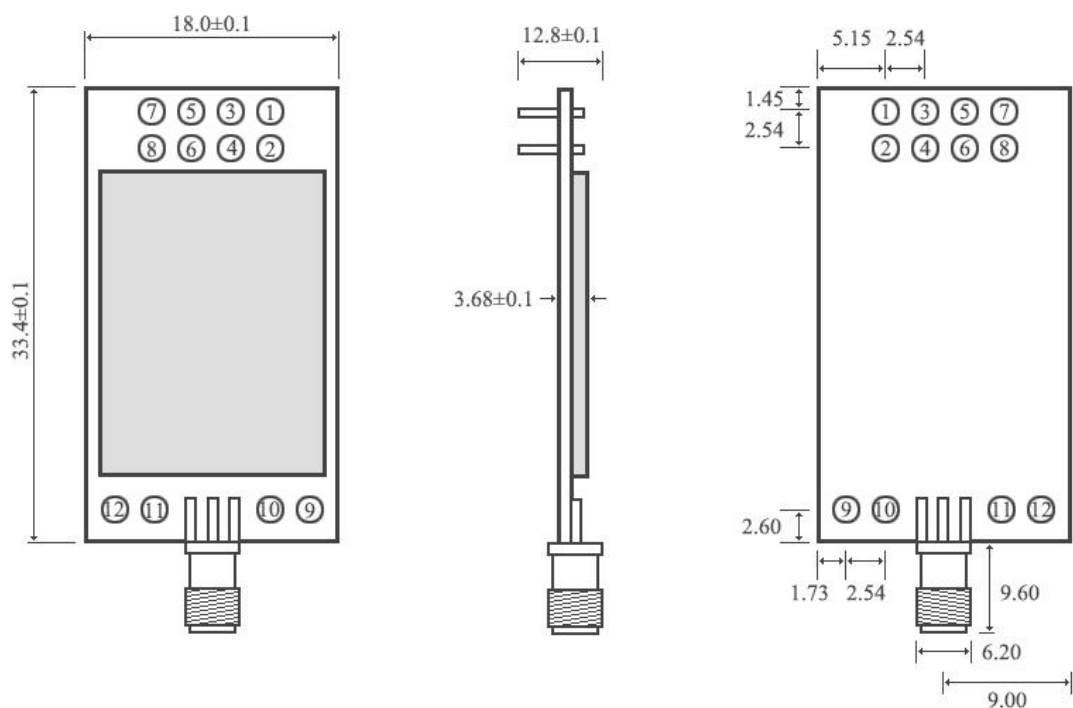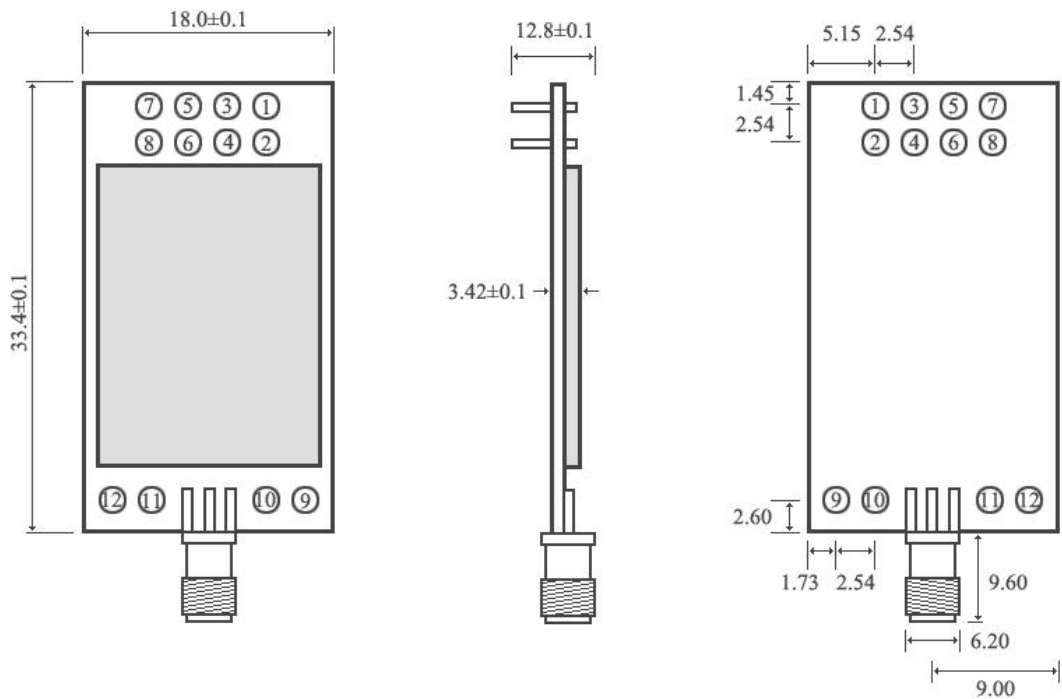

Pin No.	Pin item	Pin direction	Pin application
1	GND		Ground,connect to power reference ground.
2	VCC		Power supply 2.0 V~3.6V DC
3	CE	input	Chip enable
4	CSN	input	SPI Chip select
5	SCK	input	SPI Clock
6	MOSI	input	SPI master output slave input
7	MISO	Output	SPI master input slave output
8	IRQ	Output	Interrupt request, valid in low communication level
★ Find more details on 《nRF24L01P Datasheet》 from Nordic ★			

2.3. E01-ML01DP5

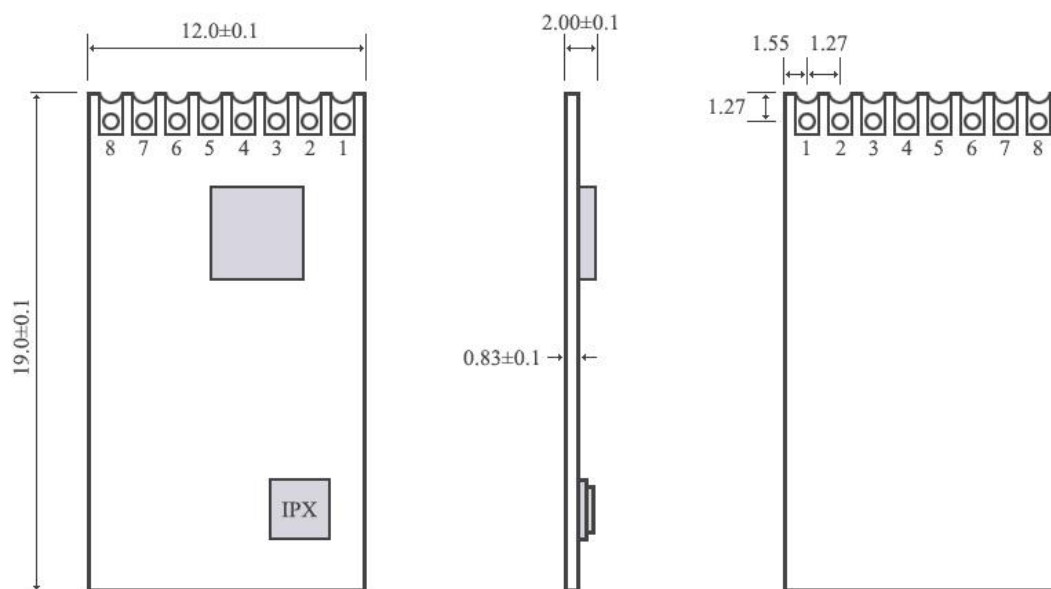| Pin No.	Pin item	Pin direction	Pin application
1	GND		Ground
2	VCC		Power supply 2.0V~3.6V DC
3	CE	input	Chip enable
4	CSN	input	SPI Chip select
5	SCK	input	SPI Clock
6	MOSI	input	SPI master output slave input
7	MISO	Output	SPI master input slave output
8	IRQ	Output	Interrupt request, valid in low communication level
★ Find more details on 《nRF24L01P Datasheet》from Nordic ★			

2.4. E01-2G4M27D

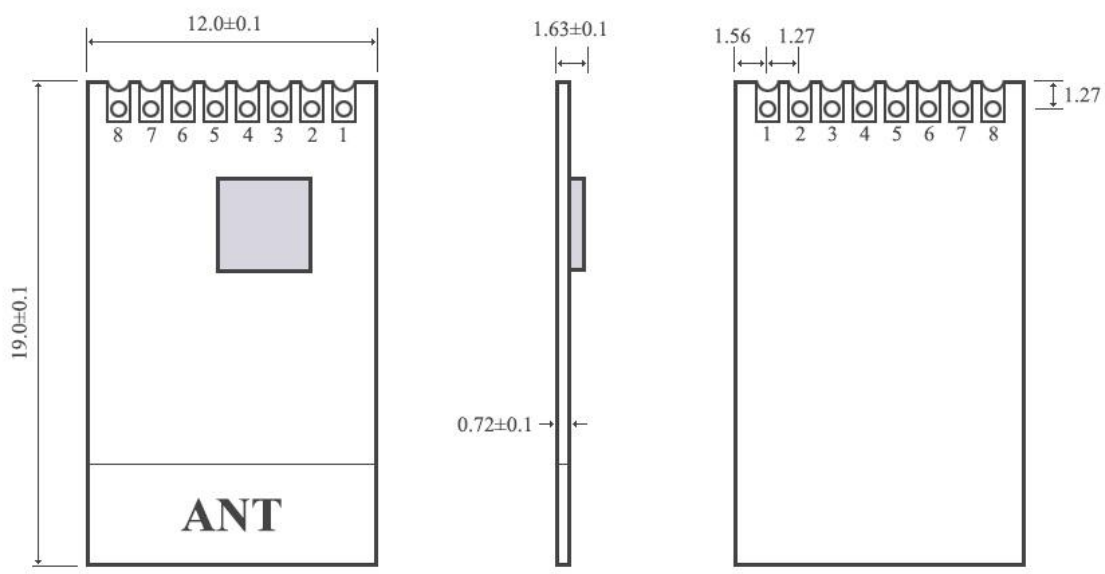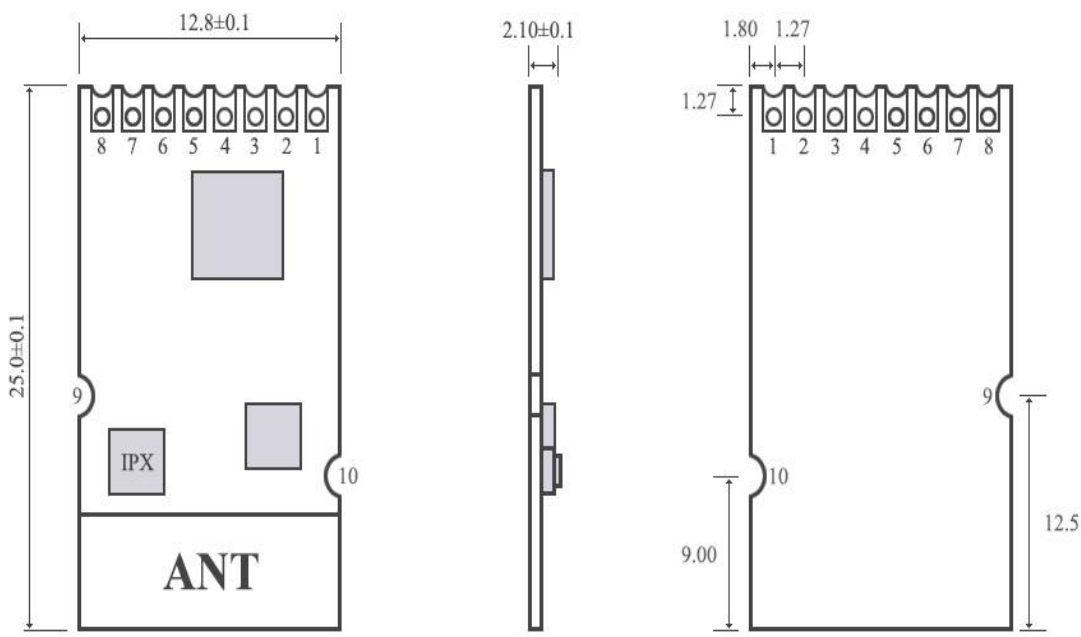| Pin No.	Pin item	Pin direction	Pin application
1	GND		Ground
2	VCC		Power supply 2.5V~5.5V DC, it's recommended to use 3.3V.
3	CE	input	Chip enable
4	CSN	input	SPI Chip select
5	SCK	input	SPI Clock
6	MOSI	input	SPI master output slave input
7	MISO	Output	SPI master input slave output
8	IRQ	Output	Interrupt request, valid in low communication level
★ Find more details on 《nRF24L01P Datasheet》 from Nordic ★			

2.5. E01-ML01IPX

Pin No.	Pin item	Pin direction	Pin application
1	VCC		Power supply 1.9V~3.6V DC
2	CE	Input	Chip enable
3	CSN	Input	SPI Chip select
4	SCK	Input	SPI Clock
5	MOSI	Input	SPI master output slave input
6	MISO	Output	SPI master input slave output
7	IRQ	Output	Interrupt request, valid in low communication level
8	GND		Ground
★ Find more details on 《nRF24L01P Datasheet》 from Nordic ★			

2.6. E01-ML01S

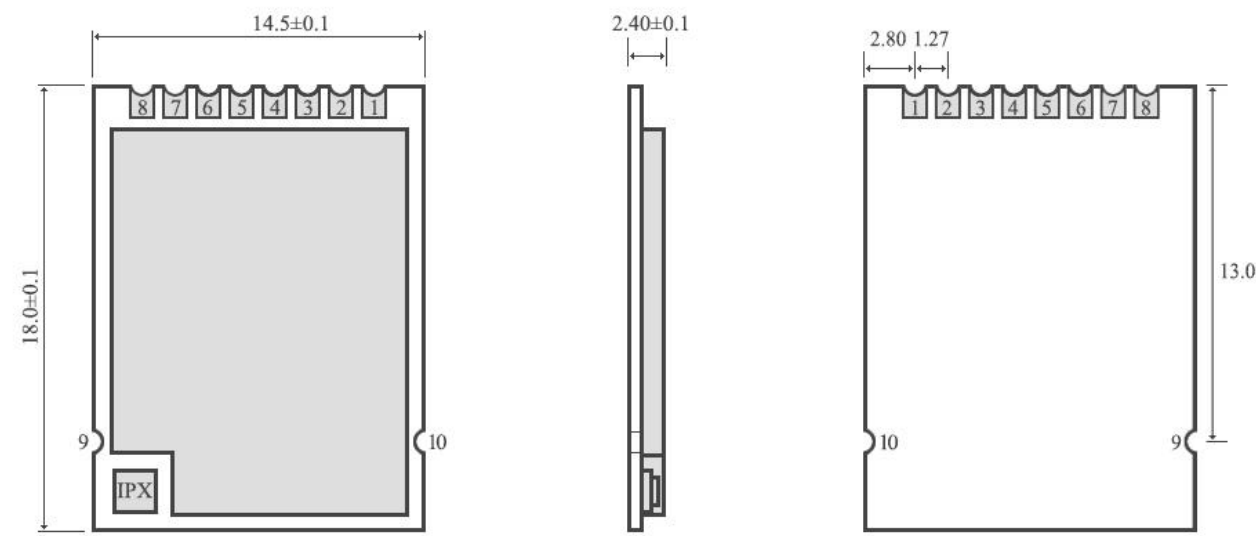| Pin No.	Pin item	Pin direction	Pin application
1	VCC		Power supply 1.9V~3.6V DC
2	CE	Input	Chip enable
3	CSN	Input	SPI Chip select
4	SCK	Input	SPI Clock
5	MOSI	Input	SPI master output slave input
6	MISO	Output	SPI master input slave output
7	IRQ	Output	Interrupt request, valid in low communication level
8	GND		Ground
★ Find more details on 《nRF24L01P Datasheet》 from Nordic ★			

2.7. E01-ML01SP2

Pin No.	Pin item	Pin direction	Pin application
1	VCC		Power supply 2.0 V~3.6V DC
2	CE	Input	Chip enable
3	CSN	Input	SPI Chip select
4	SCK	Input	SPI Clock
5	MOSI	Input	SPI master output slave input
6	MISO	Output	SPI master input slave output
7	IRQ	Output	Interrupt request, valid in low communication level
8	GND		Ground
9	GND		Ground
10	GND		Ground
★ Find more details on 《nRF24L01P Datasheet》 from Nordic ★			

2.8. E01-ML01SP4

| Pin No.	Pin item	Pin direction	Pin application
1	VCC		Power supply 2.0 V~3.6V DC
2	CE	Input	Chip enable
3	CSN	Input	SPI Chip select
4	SCK	Input	SPI Clock
5	MOSI	Input	SPI master output slave input
6	MISO	Output	SPI master input slave output
7	IRQ	Output	Interrupt request, valid in low communication level
8	GND		Ground
9	GND		Ground
10	GND		Ground
★ Find more details on 《nRF24L01P Datasheet》 from Nordic ★			

3. Recommended Circuit Diagram
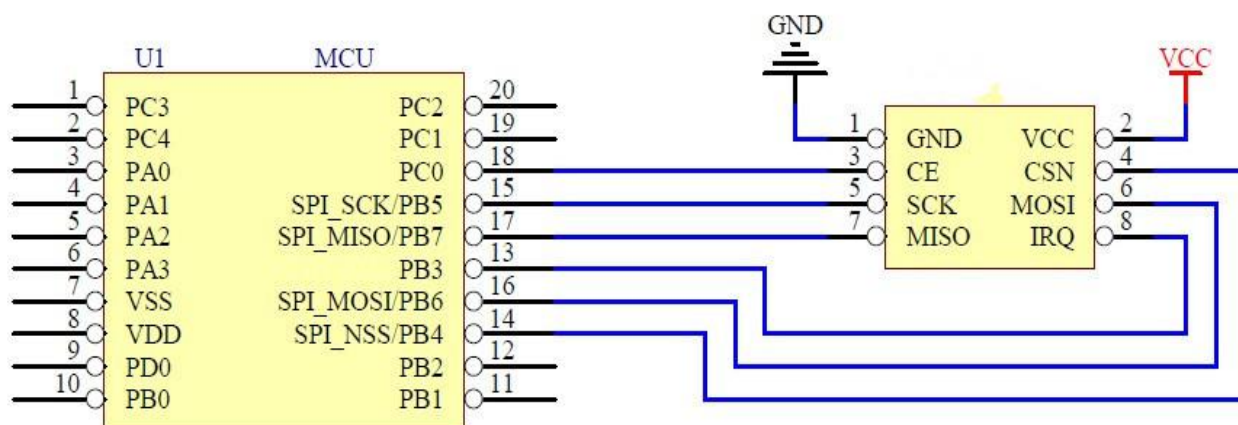
| No.	Brief introduction of connection between module and MCU (STM8)
1	CE pin can be high level for long-term, but it needs to set as POWER DOWN mode when the module writes registers, and it is recommended that CE is controlled by MCU pin.
2	As interrupt pin for IRQ, it can be used to wake-up MCU and achieve fast response; But the user can get the interrupt status through SPI (not recommended, it is not conducive to the overall power consumption, and with low efficiency）.

4. Electrical Parameters

In different power of nRF24L01P, the real transmitting power of E01-2G4M27D, 3.3V, as below:

3.3V Corresponding Power				
Frequency	Pre 0dBm	Pre -6dBm	Pre -12dBm	Pre -18dBm
2400MHz	27.2	24	18.5	9.8
2420MHz	27.2	24.2	18.7	10.2
2440MHz	27.2	24.4	18.8	10.4
2460MHz	27.1	24.3	18.8	10.5
2480MHz	27.1	24.2	18.8	10.6
2500MHz	26.8	23.9	18.6	10.4
2525MHz	26.2	23.1	17.8	9.7

带内平坦度
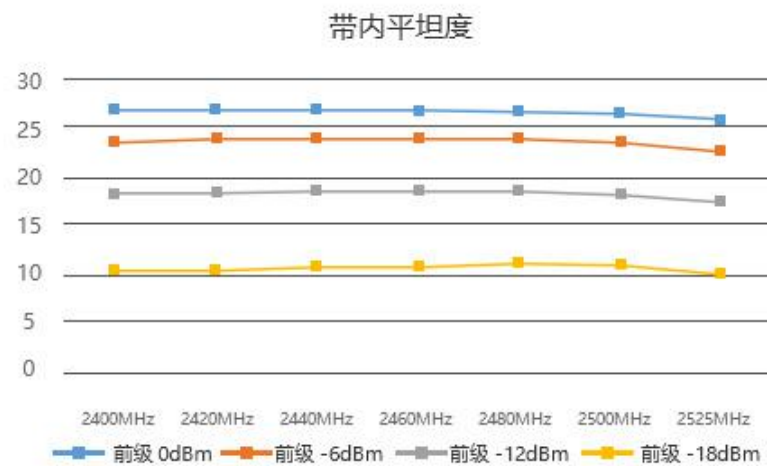
The real transmitting power of E01-2G4M27D in different voltage, testing under 2460MHz:

Voltage supply	2460M Corresponding Power			
	Pre 0dBm	Pre −6dBm	Pre −12dBm	Pre −18dBm
5.5V	28	24.5	18.8	10.7
5V	28	24.5	18.9	10.7
4.5V	28	24.5	19	10.7
4V	27.9	24.5	19	10.6
3.5V	27.5	24.3	18.9	10.5
3V	26.5	23.9	18.6	10.1
2.5V	24.5	22.1	17	8.7

图标标题
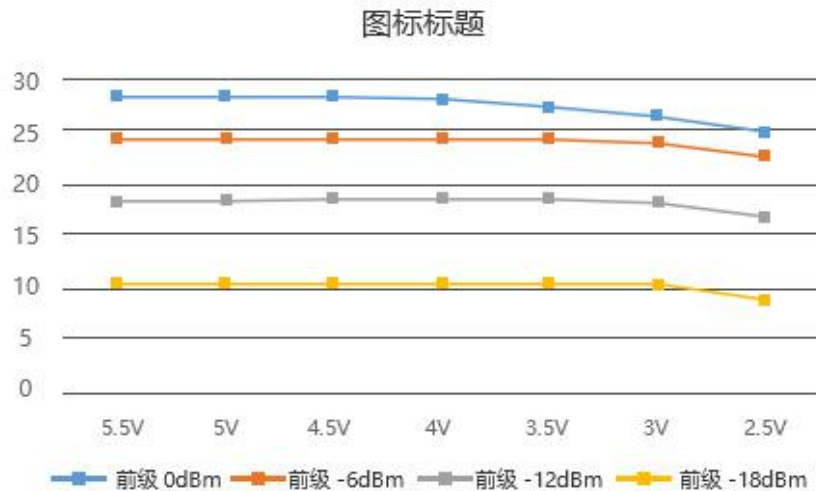
The corresponding register value of nRF24L01+transmitting power output:

SPI RF-SETUP (RF_PWR)	RF output power	DC current consumption
11	0dBm	11.3mA
10	-6dBm	9.0mA
01	-12dBm	7.5mA
00	-18dBm	7.0mA

5. Antenna Type
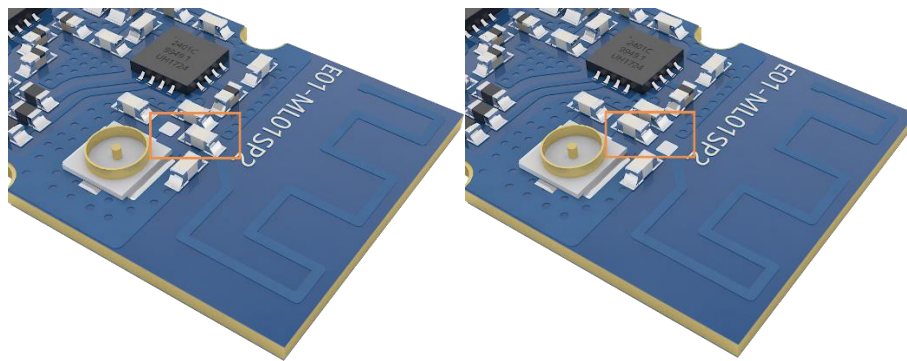
The default 0R resistance of E01-ML01SP2 is as above(left), the antenna type is PCB; To change the antenna type as IPEX, then change the 0R resistance as the left one. This is suitable for other E01 models.

6. Notes

[Static] High-frequency analog devices have static-sensitive characteristics. Please avoid human contact with the electronic components on the module as much as possible (All our production processes are performed according to the IC manufacturer's official anti-static standards).

[Soldering] When soldering, the soldering iron needs to be well grounded. For mass production, the production personnel is required to wear a grounded wired electrostatic wristband.

[Power] The quality of the power supply has a great influence on the performance of the module. Make sure that the power supply of the module has a small ripple, and you must avoid large power jitter. It is recommended to use π-type filters (ceramic capacitors/tantalum capacitors + inductors).

[Ground] The module ground wire uses a single point grounding method. It is recommended to use a 0 ohm resistor or a 10 ohm inductor to separate it from the reference ground of other parts of the circuit.

[Antenna] The antenna installation structure has a great influence on the performance of the module. Make sure that the antenna is exposed, preferably vertically upwards. When the module is installed inside the enclosure, a good antenna extension cable can be used to extend the antenna outside the enclosure. The antenna must not be installed inside the metal shell, which will cause the transmission distance to be greatly weakened.

[Interference] If there are wireless modules working at other bands within the same product, it is necessary to reasonably plan the frequency and

take measures such as shielding to reduce the influence of harmonic interference and inter-modulation interference.

[Crystal] If there is a crystal near the circuit board on the module, increase the linear distance between the crystal and circuit board as much as possible.

7. Production Guidance

7.1. Reflow Soldering Temperature

Profile Feature	Curve characteristics	Sn-Pb Assembly	Pb-Free Assembly
Solder Paste	Solder paste	Sn63/Pb37	Sn96.5/Ag3/Cu0.5
Preheat Temperature min （Tsmin）	Mini. preheating temperature	100℃	150℃
Preheat temperature max (Tsmax)	Max. preheating temperature	150℃	200℃
Preheat Time (Tsmin to Tsmax)(ts)	Preheating time	60-120 sec	60-120 sec
Average ramp-up rate(Tsmax to Tp)	Average rising rate	3℃/second max	3℃/second max
Liquidous Temperature (TL)	Liquidus temperature	183℃	217℃
Time （tL）Maintained Above （TL）	The time above the liquidus	60-90 sec	30-90 sec
Peak temperature （Tp）	Peak temperature	220-235℃	230-250℃
Aveage ramp-down rate （Tp to Tsmax）	Average rate of decline	6℃/second max	6℃/second max
Time 25℃ to peak temperature	The time from 25℃ to peak temperature	6 minutes max	8 minutes max

7.2. Reflow Curving Diagram
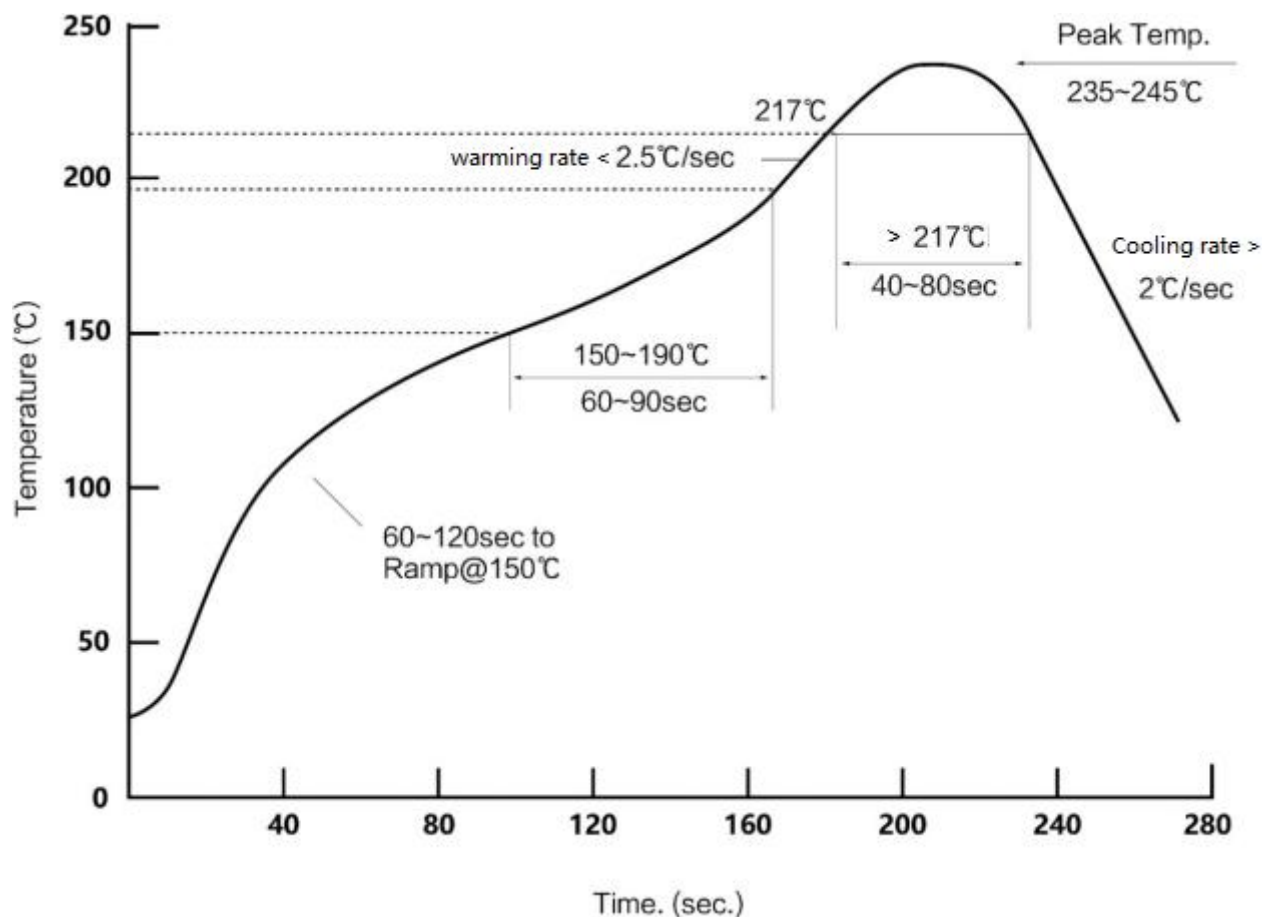
8. FAQ

8.1. 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.
- Seawater 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 the recommended value, the lower the voltage, the lower the transmitting power.
- Due to antenna quality or poor matching between antenna and module.

8.2. Module is easy to damage

- Please check the power supply source, ensure it is within the recommended value, voltage higher than that will damage the module.
- Please check the stability of power source, the voltage cannot fluctuate too much.
- Please make sure antistatic 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.

9. Important Notes

- All rights to interpret and modify this manual belong to Ebyte.
- This manual will be updated based on the upgrade of firmware and hardware, please refer to the latest version.
- Please refer to our website for new product information

10. About Us

Technical support: support@cdebyte.com

Documents and RF Setting download link: www.cdebyte.com/en/

成都亿佰特电子科技有限公司
Chengdu Ebyte Electronic Technology Co.,Ltd.

Tel: +86-28-61399028 Ext. 812

Fax: 028-64146160

Web: www.cdebyte.com/en/

Address: Innovation Center D347, 4# XI-XIN Road,Chengdu, Sichuan, China