



# **E01C-ML01S User Manual**

**Si24R1 2.4GHz SPI SMD Wireless Module**



Chengdu Ebyte Electronic Technology Co.,Ltd.

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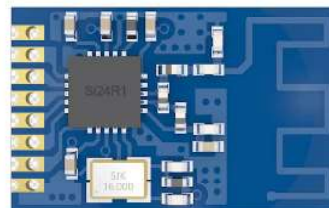
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# 1. Overview

## 1.1 Brief introduction

E01C-ML01S is a small size SMD module based on Si24R1, operates at 2.4Ghz with PCB antenna, using industrial-grade high-precision 16MHz crystal oscillator. The RF performance of it and components selection during R&D are all in accordance with industrial grade standards.

The user needs to use the MCU driver or use a dedicated SPI debugging tool to develop E01C-ML01S.



## 1.2 Features

- Small size, 12x19mm;
- Communication distance tested is up to 300m;
- The maximum transmit power is 5mW, and the software is multi-level adjustable;
- Global license-free ISM 2.4GHz frequency band;
- 2Mbps, 1Mbps and 250kbps air rate;
- Frequency: 2402-2480MHz Maximum radio-frequency power transmitted in the frequency band(s) 5.8dBm in which the radio equipment operates.
- Connect with MCU through SPI interface, the rate is 0~10Mbps;
- 2.0~3.6V power supply, power supply greater than 3.3V can guarantee the best performance;
- Industrial standard design for long-term use at -40~+85°C;
- Comes with PCB onboard antenna, no need for external antenna;
- Fully compatible with E01-ML01S in software, hardware and packaging.

## 1.3 Application

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

## 2. Specification and parameter

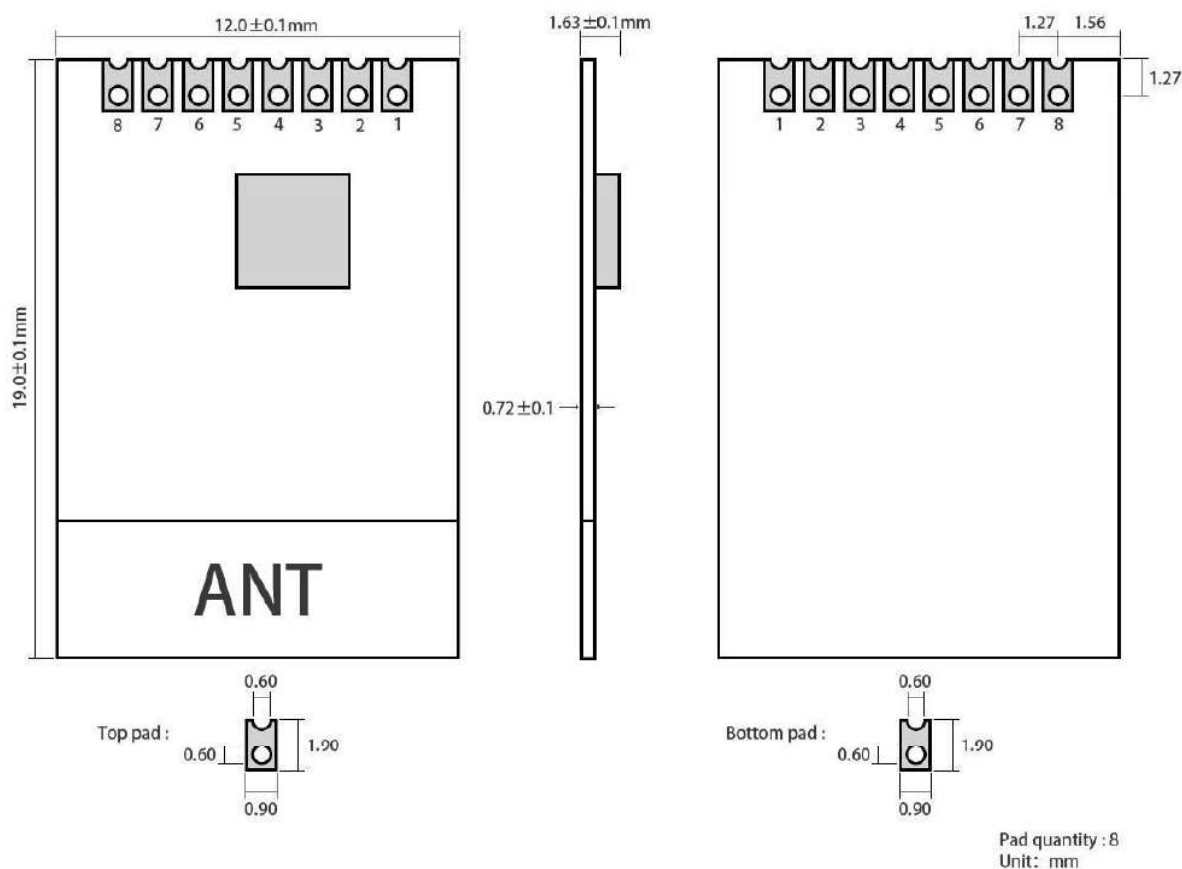
### 2.1 Limit parameter

Main parameter	Performance		Remark
	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 ( °C )	-40	85	

### 2.2 Operating parameter

Main parameter	Description	Remark
Distance for reference	300m	Test condition: clear and open area, antenna gain:3.3dBi, antenna height: 2.5m, air data rate: 250kbps
FIFO	32Byte	Max length transmitted each time
Crystal frequency	16MHz	
Modulation	GFSK	
Package	SMD	
Connector	1.27mm	
Communication interface	SPI	0-10Mbps
Size	12 * 19mm	Without SMA
Antenna	PCB antenna	50ohm impedance

### 3. Size and pin definition



Pin No.	Pin item	Pin direction	Pin application
1	VCC		Power supply must be 2.0 ~ 3.6V
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.
8	GND		Ground



## 4. Basic operation

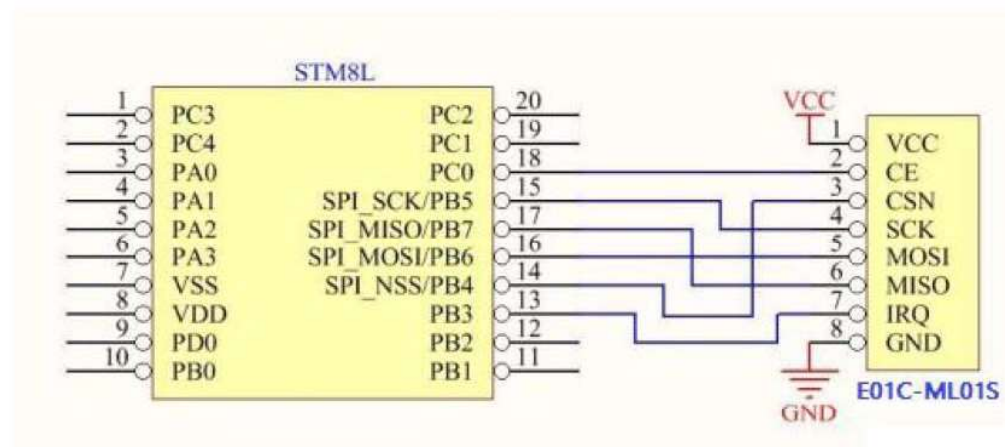
### 4.1 Hardware design

- 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 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.

### 4.2 Software editing

- Insert the module into the user circuit board, use the microcontroller to communicate with the module by SPI or serial port, and operate the control register and the transceiver buffer through the SPI command to complete the wireless data transmit and receive function.
- 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) ;
- 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;

## 5 Circuit diagram



## 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 source, ensure it is 2.0V~3.6V, voltage higher than 3.6V 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.

### 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;
- 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 high;

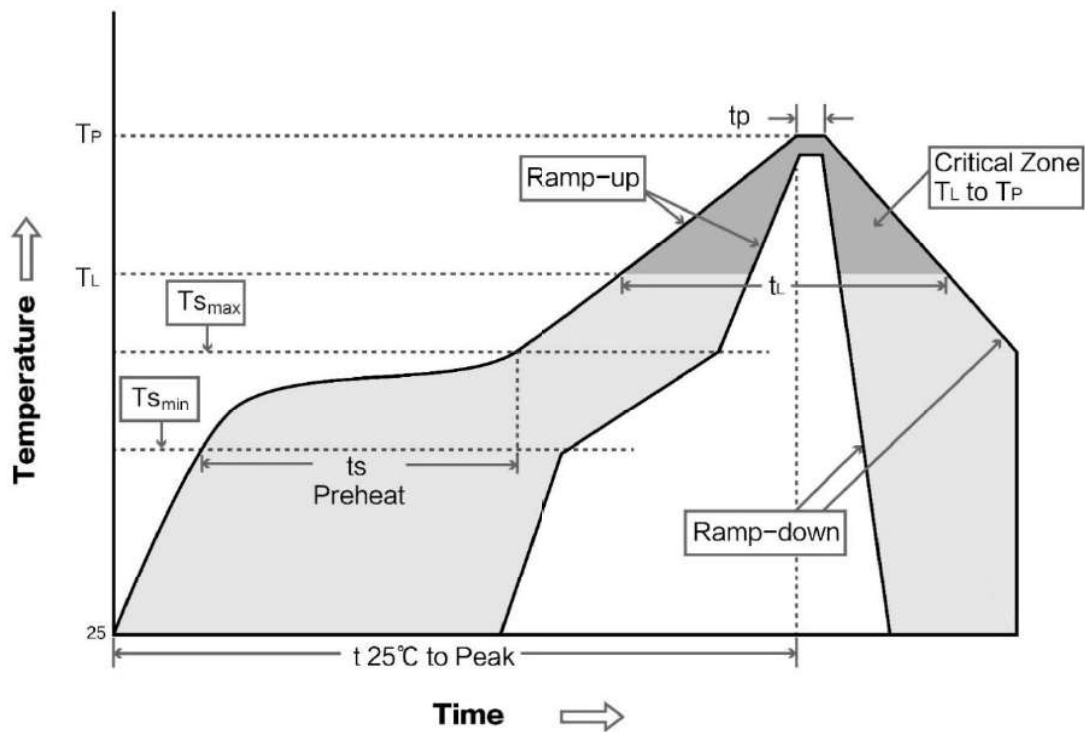
## 7.Soldering guidance



## 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 (T <sub>smin</sub> )	Min preheating temp.	100℃	150℃
Preheat temperature max (T <sub>smax</sub> )	Mx preheating temp.	150℃	200℃
Preheat Time (T <sub>smin</sub> to T <sub>smax</sub> )(t <sub>s</sub> )	Preheating time	60-120 sec	60-120 sec
Average ramp-up rate(T <sub>smax</sub> to T <sub>p</sub> )	Average ramp-up rate	3℃/second max	3℃/second max
Liquidous Temperature (T <sub>L</sub> )	Liquid phase temp.	183℃	217℃
Time (t <sub>L</sub> ) Maintained Above (T <sub>L</sub> )	Time below liquid phase line	60-90 sec	30-90 sec
Peak temperature (T <sub>p</sub> )	Peak temp.	220-235℃	230-250℃
Average ramp-down rate (T <sub>p</sub> to T <sub>smax</sub> )	Average ramp-down rate	6℃/second max	6℃/second max
Time 25℃ to peak temperature	Time to peak temperature for 25℃	6 minutes max	8 minutes max

## 7.2 Reflow soldering curve



## 8 Packing method for bulk order



## LEGAL STATEMENT

### FCC STATEMENT:

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

Please notice that if the FCC identification number is not visible when the module is installed inside another device, then the outside of the device into which the module is installed must also display a label referring to the enclosed module. This exterior label can use wording such as the following: "Contains FCC ID: 2AJ5SEM00556" any similar wording that expresses the same meaning may be used.

### ISED STATEMENT:

This device contains license-exempt transmitter(s)/receiver(s) that comply with Innovation, Science and Economic Development Canada's license-exempt RSS(s). Operation is subject to the following two conditions:

- (1) This device may not cause interference.
- (2) This device must accept any interference, including interference that may cause undesired operation of the device.

L'émetteur/récepteur exempt de licence contenu dans le présent appareil est conforme aux

CNR d'Innovation, Sciences et Développement économique Canada applicables aux appareils radio exempts de licence.

L'exploitation est autorisée aux deux conditions suivantes :

- 1) L'appareil ne doit pas produire de brouillage;
- 2) L'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Please notice that if the ISED identification number is not visible when the module is installed inside another device, then the outside of the device into which the module is installed must also display a label referring to the enclosed module. This exterior label can use wording such as the following: "Contains IC: 22061-EM00556" any similar wording that expresses the same meaning may be used.

Notez que si le numéro d'identification ISED n'est pas visible lorsque le module est installé dans un autre appareil, une étiquette indiquant le module attaché doit également être affichée à l'extérieur de l'appareil où le module est installé. L'étiquette extérieure peut être libellée comme suit: « contient IC: 22061-EM00556 » toute expression similaire qui exprime le même sens.

#### Notice to OEM integrator

The device must be professionally installed. The intended use is generally not for the general public. It is generally for industry/commercial use. The connector is within the transmitter enclosure and can only be accessed by disassembly of the transmitter that is not normally required. The user has no access to the connector. Installation must be controlled. Installation requires special training. This module has been assessed against the following FCC rule parts: CFR 47 FCC Part 15 C (15.247, DTS). It is applicable to the modular transmitter.

This radio transmitter FCC ID: 2AJ5SEM00556 has been approved by Federal Communications Commission to operate with the antenna types listed below, with the maximum permissible gain indicated. Antenna types not included in this list that have a gain greater than the maximum gain indicated for any type listed are strictly prohibited for use with this device. The concrete contents to check are the following three points.

- 1 ) Must use antenna such as 2.4G SRD with gain not exceeding 3.3 dBi;
  - 2 ) Should be installed so that the end user cannot modify the antenna;
  - 3 ) Feed line should be designed in 50ohm
- Fine tuning of return loss etc. can be performed using a matching network.

L'émetteur radio FCC ID: 2AJ5SEM00556 a été approuvé par la FCC

Utilisez les types d'antennes énumérés ci - dessous et indiquez le gain maximal admissible. Le gain du type d'antenne non inclus dans cette liste est supérieur au gain maximal de l'un des types énumérés et ne doit pas être utilisé avec cet équipement.

Le contenu spécifique de l'inspection comprend les trois points suivants.

- 1 ) Une antenne dont le gain ne dépasse pas 3.3 dBi, telle que 2.4G SRD, doit être utilisée;
  - 2 ) Doit être installée là où l'utilisateur final ne peut pas modifier l'antenne;
  - 3 ) La ligne d'alimentation doit être conçue pour 50 ohms
- Le réseau correspondant peut être utilisé pour affiner la perte de retour, etc.

Antennas:

2.4G SRD
PCB antenna & 3.3 dBi

Must use the device only in host devices that meet the FCC/ISED RF exposure category of portable. This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

The end user manual shall include FCC Part 15 /ISED RSS GEN compliance statements related to the transmitter as shown in this manual (FCC/IC Canada statement). Host manufacturer is responsible for compliance of the host system with module installed with all other applicable requirements for the system such as Part 15 B, ICES 003. Host manufacturer is strongly recommended to confirm compliance with FCC/ISED requirements for the transmitter when the module is installed in the host.

Must have on the host device a label showing Contains FCC ID: 2AJ5SEM00556 , IC: 22061-EM00556

The use condition limitations extend to professional users, then instructions must state that this information also extends to the host manufacturer's instruction manual.

This module is stand-alone modular. If the end product will involve the Multiple simultaneously transmitting condition or different operational conditions for a stand-alone modular transmitter in a host, host manufacturer have to consult with module manufacturer for the installation method in end system. Any company of the host device which install this modular should perform the test of radiated & conducted emission and spurious emission etc. according to FCC Part 15C: 15.247 and 15.209 & 15.207, 15B class B requirement, only if the test result comply with FCC part 15C: 15.247 and 15.209 & 15.207, 15B class B requirement. Then the host can be sold legally. This modular transmitter is only FCC authorized for the specific rule parts ( 47CFR Part 15.247) listed on the grant, and that the host product manufacturer is responsible for compliance to any other FCC rules that apply to the host not covered by the modular transmitter grant of certification. Host manufacturer is strongly recommended to confirm compliance with FCC/ISED requirements for the transmitter when the module is installed in the host. Must have on the host device a label showing Contains FCC ID: 2AJ5SEM00556 and Contains IC: 22061-EM00556

l'hôte doit utiliser l'instrument uniquement dans des dispositifs qui répondent à la FCC / (catégorie d'exposition RF portable. le manuel de l'utilisateur final doit inclure

la partie 15 / (fac RSS Gen déclarations de conformité relatives à l'émetteur que de montrer dans ce manuel. le fabricant est responsable de la conformité de l'hôte, le système d'accueil avec le module installé avec toutes les autres exigences applicables du système comme la partie 15 b, ICES - 003. accueillir le fabricant est fortement recommandé de confirmer la conformité avec les exigences de la FCC / (émetteur lorsque le module est installé dans l'hôte. le dispositif d'accueil doit avoir une étiquette indiquant contient FCC ID: 2AJ5SEM00556 , IC: 22061-EM00556

## Installation Guidance

The final host / module combination may also need to be evaluated against the FCC Part 15B criteria for unintentional radiators in order to be properly authorized for operation as a Part 15 digital device. The user's manual or instruction manual for an intentional or unintentional radiator shall caution the user that changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment. In cases where the manual is provided only in a form other than paper, such as on a computer disk or over the Internet, the information required by this section may be included in the manual in that alternative form, provided the user can reasonably be expected to have the capability to access information in that form.

To ensure compliance with all non-transmitter functions the host manufacturer is responsible for ensuring compliance with the module(s) installed and fully operational. For example, if a host was previously authorized as an unintentional radiator under the Declaration of Conformity procedure without a transmitter certified module and a module is added, the host manufacturer is responsible for ensuring that after the module is installed and operational the host continues to be compliant with the Part 15B unintentional radiator requirements.

The use condition limitations extend to professional users, then instructions must state that this information also extends to the host manufacturer's instruction manual. This module is a limit module. host manufacturer should confirm with module manufacturer for the installation method in end system.

RF exposure evaluation when it is necessary to demonstrate compliance in a specific host.

## Revision history

Version	Date	Description	Issued by
1.0	2020-06-19	Original version	Ren
1.1	2020-06-29	Format updated	Ren
1.2	2020-07-24		Ren
1.3	2021-03-25		Ren

## About us

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