# E62-433T20D User Manual

## 433MHz 100mW Wireless Module



Chengdu Ebyte Electronic Technology Co.,Ltd.

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# 1. Overview

## 1.1 Introduction




E62-433T20D is a full-duplex wireless transceiver module with TTL level output, operates at 425-450MHz (default: 433MHz), transparent transmission is available.

Module features FHSS (Frequency-Hopping Spread Spectrum). During the transmitting procedure, both sides will perform frequency-hopping operation automatically in at most 52 channels on the basis of frequency-hopping logic (the number of FHSS channel and sequence are configurable.), which greatly improves the anti-interference performance.

Module features TDD (Time Division Duplex). User can transmit data while receiving, not have to wait for the end of receiving. The module can transmit data continuously with some particular combination of air data rate (like air data rate is 64k, 9600bsp) and baud rate. Under this circumstance, there is no limitation for the size of the data user can transmit in one transmission operation and it achieve a very low latency communication link.

The module features FEC (Forward Error Correction) algorithm, which ensure its high coding efficiency & good correction performance. In the case of sudden interference, it can correct the interfered data packets proactively, so that the reliability & transmission range are improved correspondingly. But without FEC, those data packets can only be dropped.

## 1.2 Features

- Communication distance tested is up to 2.5km
- Maximum transmission power of 25mW, software multi-level adjustable;
- Support the global license-free ISM 433MHz band;
- Support air date rate of 5kbps～50kbps;
- Support advanced FHSS frequency hopping, improve anti-interference performance.
- Based on TDD, time division full duplex bidirectional pass-through can be realized.
- Low power consumption for battery supplied applications;
- Support 3.3V~5.5V power supply, power supply over 5.0V can guarantee the best performance;
- Industrial grade standard design, support -40 ~ 85 °C for working over a long time;
- SMA access point, Easy connection of coaxial cable or external antenna.

## 1.3 Application

- Home security alarm and remote keyless entry;
- Smart home and industrial sensors;
- Wireless alarm security system;
- Building automation solutions;
- Wireless industrial-grade remote control;

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- Health care products;
- Advanced Meter Reading Architecture(AMI);
- Automotive industry applications.

# 2. Specification and parameter

## 2.1 Limit parameter

| Main parameter | Performance | | Remarks |
|---|---|---|---|
| | Min. | Max. | |
| Power supply（V） | 0 | 5.5 | Voltage over 5.5V 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 | - |

## 2.2 Operating parameter

| Main parameter | | Performance | | | Remark |
|---|---|---|---|---|---|
| | | Min | Typ. | Max. | |
| Operating voltage（V） | | 3.3 | 5.0 | 5.5 | ≥5.0 V 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（MHz） | | 425 | - | 450.5 | Support ISM band |
| Power consumption | Transmitting current [mA] | - | 104 | - | Instant power consumption |
| | Receiving current [mA] | - | 33 | - | - |
| | Turn-off current [μA] | - | 4 | - | Software is shut down |
| Max Tx power（dBm） | | 19.6 | 20.0 | 21.4 | - |
| Receiving sensitivity（dBm） | | -105 | -106 | -107 | Air data rate is 64kbps |
| Air data rate（bps） | | 16k | 64k | 128k | Controlled via user's programming |

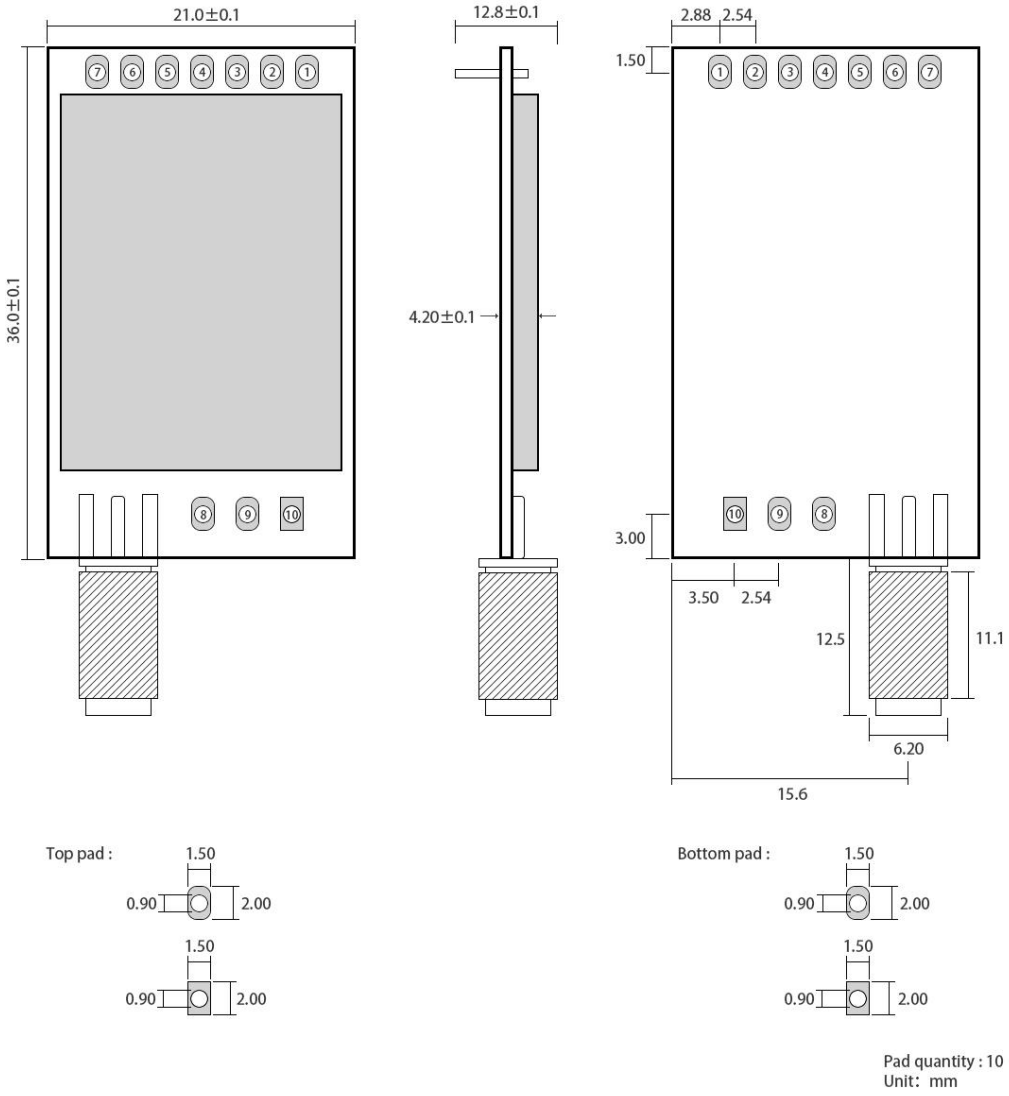
| Main parameter | Description | Remark |
|---|---|---|
| Distance for reference | 3000m | Test condition：clear and open area, antenna gain: 5dBi，antenna height: 2.5m，air data rate: 64kbps |
| TX length | 1024 Byte | Internal automatic time division logic subcontracting |
| Buffer | 2048 Byte | Internal Buffer |

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| | | |
|---|---|---|
| Modulation | GFSK | - |
| Communication interface | UART | - |
| Package | DIP | - |
| Connector | 2.54mm | - |
| Size | 21*36mm | - |
| Antenna | SMA-K | 50 ohm impedance |

# 3 Size and pin definition



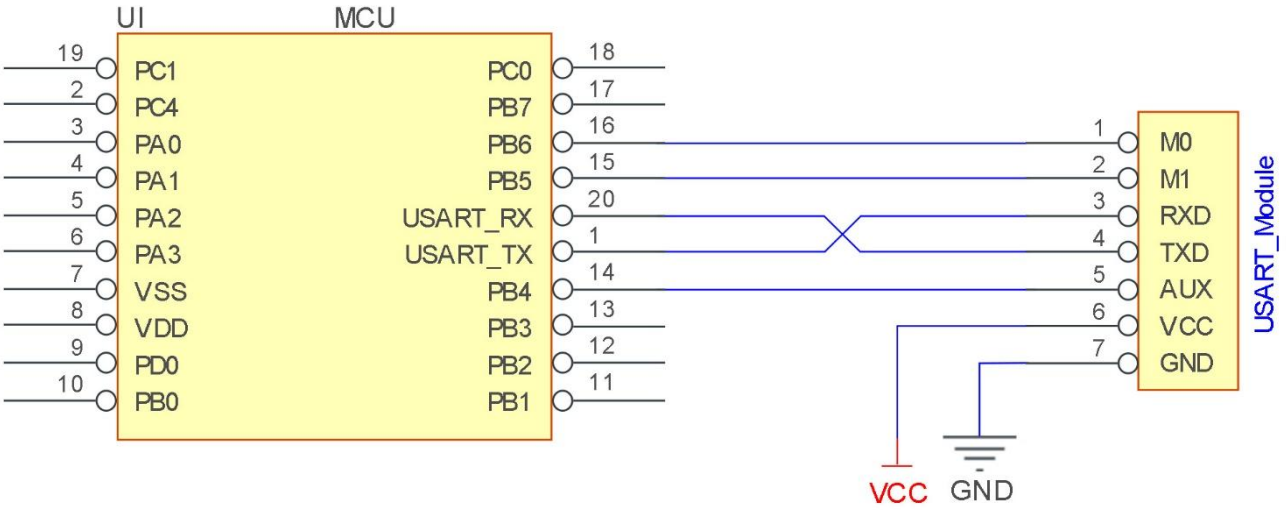

| No. | Name | Direction | Function |
|---|---|---|---|
| 1 | M0 | Input (weak pull-up) | Determine the two working modes of the module: low level is the transmission mode and high level is the configuration mode.(not |

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| | | | |
|---|---|---|---|
| | | | suspended, if not used, could be grounded). |
| 2 | LOCK | Input | Module synchronization indication: high level indicates that both sides of communication have been synchronized, and data transmission can be carried out; low level indicates that both sides have not been synchronized, at which time data transmission will lead to data loss |
| 3 | RXD | Input | TTL UART inputs, connects to external (MCU, PC) TXD output pin. Can be configured as open-drain or pull-up input. |
| 4 | TXD | Output | TTL UART outputs, connects to external RXD (MCU, PC) input pin. Can be configured as open-drain or push-pull output |
| 5 | AUX | Output | To indicate module ' s working status & wakes up the external MCU. During the procedure of self-check initialization, the pin outputs low level. Can be configured as push-pull output (suspending is allowed). |
| 6 | VCC | Input | Power supply ： 2.1~ 5.5V DC |
| 7 | GND | Input | Ground |
| 8 | Fixed orifice | - | Fixed orifice |
| 9 | Fixed orifice | - | Fixed orifice |
| 10 | Fixed orifice | - | Fixed orifice |

# 4 Connect to MCU




| No. | Description（STM8L MCU） |
|---|---|
| 1 | The UART module is TTL level., please collect with MCU. |

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| | |
|---|---|
| 2 | For some MCU works at 5VDC, it may need to add 4-10K pull-up resistor for the TXD & AUX pin. |

# 5 Function description

## 5.1 Reset

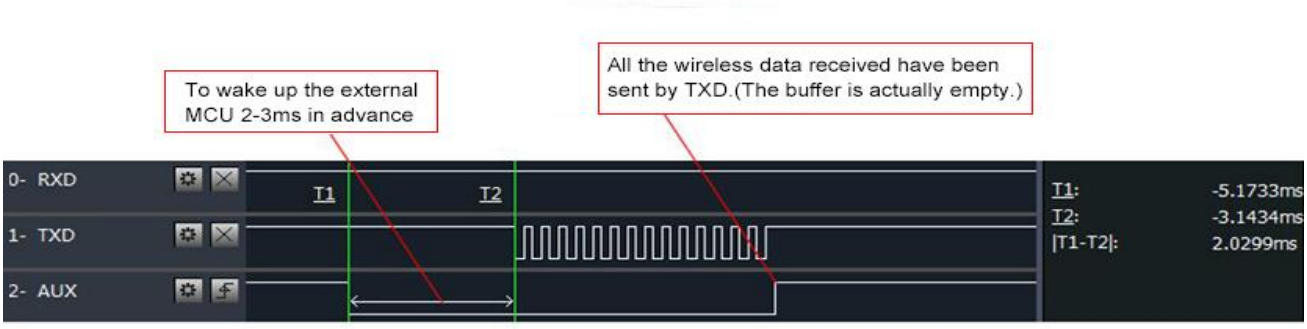
When the module is powered, AUX outputs low level immediately, conducts hardware self-check and sets the operating mode based on user's parameters. During the process, the AUX remains low level. After the process completed, the AUX outputs high level and starts to work as per the operating mode combined by M1 and M0. Therefore, users need to wait the AUX rising edge as the start of module's normal work.

## 5.2 AUX description

- AUX Pin can be used as indication for wireless send & receive buffer and self-check.
- It can indicate whether there are data that are not sent yet via wireless way, or whether all wireless data has been sent through UART, or whether the module is still in the process of self-check initialization.

### 5.2.1 Indication of UART output

- To wake up external MCU




**Timing Sequence Diagram of AUX when TXD pin transmits**

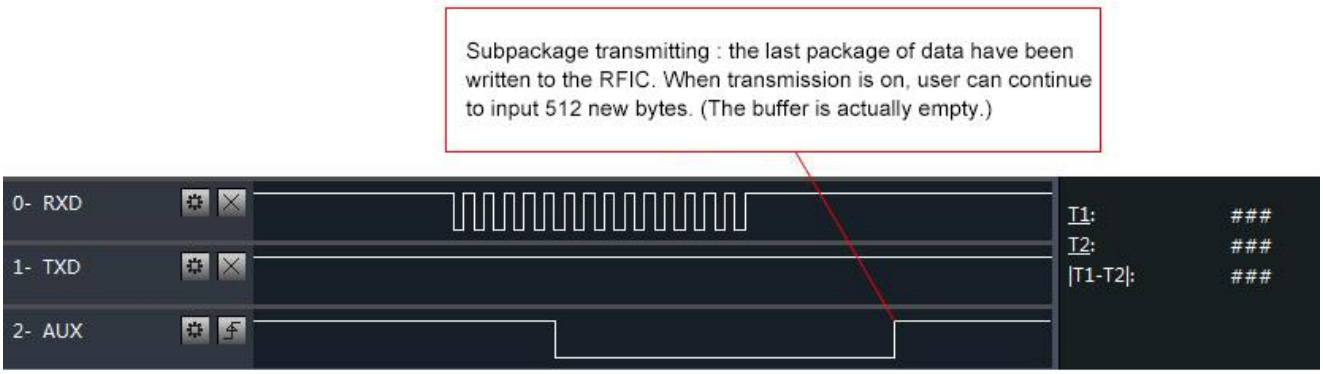
### 5.2.2 Indication of wireless transmitting

- Buffer (empty): the internal 256 bytes data in the buffer are written to the RFIC (Auto sub-packaging).
- When AUX=1, the user can input data less than 256 bytes continuously without overflow. Buffer (not empty): when AUX=0, the internal 256 bytes data in the buffer have not been written to the RFIC completely. If the user starts to transmit data at this circumstance, it may cause overtime when the module is waiting for the user data, or transmitting wireless sub package.

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- When AUX = 1, it does not mean that all the UART data of the module have been transmitted already, perhaps the last packet of data is still in transmission.




**Timing Sequence Diagram of AUX when RXD pin receives**

5.2.3 Configuration procedure of module

- Only happened when power-on resetting or exiting sleep mode




**Timing Sequence Diagram of AUX when self-check**

5.6.4 Notes for AUX

| No. | Description |
|---|---|
| 1 | For function 1 & function 2 mentioned above, the priority should be given to the one with low level output, which means if it meets each of any low level output condition, AUX outputs low level, if none of the low level condition is met, AUX outputs high level. |
| 2 | When AUX outputs low level, it means the module is busy & cannot conduct operating mode checking. Within 1ms since AUX outputs high level, the mode switch will be completed. |
| 3 | After switching to new operating mode, it will not work in the new mode immediately until AUX rising edge lasts for 2ms . If AUX stays on the high level, the operating mode switch can be affected immediately. |
| 4 | When the user switches to other operating modes from mode 3 (sleep mode) or it’s still in reset process, the module will |

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| | |
|---|---|
| | reset user parameters, during which AUX outputs low level. |

# 6. Operating mode

Contents in below table are the introduction of input status of M1 & M0 and their corresponding mode:

| Mode(0-3) | M1 | M0 | Mode introduction | Remark |
|---|---|---|---|---|
| Mode 0 Transmitting | 0 | 0 | UART and wireless channel are open, transparent transmission is on. | Both side must be in module 0 when transmitting. |
| Mode 1 configuration | 0 | 1 | Serial port at fixed 9600bps baud rate, wireless off, configurable parameters | -See detailed explanation of working parameters |

## 6.1 Mode switch

| No. | Remarks |
|---|---|
| 1 | The user can decide the operating mode by the combination of M1 and M0. The two GPIO of MCU can be used to switch mode. After modifying M1 or M0, it will start to work in new mode 1 ms later if the module is free. If there are any serial data that are yet to finish wireless transmitting, it will start to work in new mode after the UART transmitting finished. After the module receives the wireless data & transmits the data through serial port, it will start to work in new mode after the transmitting finished. Therefore, the mode-switch is only valid when AUX outputs 1, otherwise it will delay. |
| 2 | For example, in mode 0 or mode 1, if the user inputs massive data consecutively and switches operating mode at the same time, the mode-switch operation is invalid. New mode checking can only be started after all the user's data process completed. It is recommended to check AUX pinout status and wait 2ms after AUX outputs high level before switching the mode. |
| 3 | If the module switches from other modes to stand-by mode, it will work in stand-by mode only after all the remained data process completed. The feature can be used to save power consumption. For example, when the transmitter works in mode 0, after the external MCU transmits data "12345", it can switch to sleep mode immediately without waiting the rising edge of the AUX pin, also the user's main MCU will go dormancy immediately. Then the module will transmit all the data through wireless transmission & go dormancy 1ms later automatically, which reduces MCU working time & save power. |
| 4 | Likewise, this feature can be used in any mode-switch. The module will start to work in new mode within 1ms after completing present mode task, which enables the user to omit the procedure of AUX inquiry and switch mode swiftly. For example, when switching from transmitting mode to receiving mode, the user MCU can go dormancy before mode-switch, using external interrupt function to get AUX change so that the mode-switch can be realized. |
| 5 | This operation is very flexible and efficient. It is totally designed on the basis of the user MCU's convenience, at the same time the work load and power consumption of the whole system has been reduced and the efficiency of whole system is largely improved. |

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## 6.2 Transmission mode (Mode 0)

| Type | When M0 = 0, module works in mode 0 |
|---|---|
| Ordinary transmitting operation | User can transmit the data when the modules are synced (PINLOCK = 1(high level)). Benefit of the TDD feature, user can perform transmitting while receiving. The maximum size of the data which can be transmit at one time is 2048 Bytes. After the AUX has turned to 0(low-level), User can perform another 2048 Bytes transmitting operation. The TDD feature is available whatever the air data rate or the baud rate is. |
| Continuous transmitting operation | The module can transmit data continuously with some particular combination of air data rate and baud rate, which has been show below.<br>Air Data Rate = 16Kbps, Baud rate <= 2400bps;<br>Air Data Rate = 32Kbps, Baud rate <= 4800bps;<br>Air Data Rate = 64Kbps, Baud rate <= 9600bps;<br>Air Data Rate = 128Kbps, Baud rate <= 19200bps;<br>Notes: Although higher air data rate brings lower transmission delay and it allows user transmits the data continuously at higher baud rate, the communication range will be shorter. |

## 6.3Configure mode (Mode 1)

| Type | When M0 = 1, module works in mode 1. |
|---|---|
| Transmitting | N/A. User can configure the module at baud rate = 9600bps, parity = 8N1. |
| Receiving | N/A. User can configure the module at baud rate = 9600bps, parity = 8N1. |

# 7.Instruction format

In command mode（mode 2：M1=1, M0=0）, it supports below instructions on list.

Only support 9600 and 8N1 format when setting

| No. | Instruction format | Illustration |
|---|---|---|
| 1 | C0 + working parameters | C0 + 5 bytes working parameters are sent in hexadecimal format. 6 bytes in total and must be send in succession.<br>( Save the parameters when power-down ) |
| 2 | C1 C1 C1 | Three C1 are sent in hexadecimal format. The module returns the saved parameters and must be send in succession. |
| 3 | C2 + working parameters | C2 + 5 bytes working parameters are sent in hexadecimal format. 6 bytes in total and must be send in succession. ( Do not save the parameters when power-down ) |
| 4 | C3 C3 C3 | Three C3 are sent in hexadecimal format. The module returns the version information and they must be send in succession. |
| 5 | C4 C4 C4 | Three C4 are sent in hexadecimal format. The module will reset one time and they must be send in succession. |
| 6 | C5+C5+C5 | Three C5 are sent in hexadecimal format. The module returns the current RSSI signal strength value |

## 7.1 Default parameter

| | **Default parameter values：** C0 01 0A 1A 0A 44 |
|---|---|

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| Model | Frequency | Address | Channel | launch mode | Baud rate | Parity | Transmitting power |
|---|---|---|---|---|---|---|---|
| E62-433T20D | 425-450.5M Hz | 1 | 10 | 64kbps | 9600 | 8N1 | 100mW |

## 7.2 Reading operating parameters

| Instruction format | Description |
|---|---|
| C1+C1+C1 | In parameter setting mode（M0=1），<br>User gives the module instruction (HEX format): C1 C1 C1,<br>Module returns the present configuration parameters.<br>For example, C0 01 0A 1A 0A 44. |

## 7.3 Reading version number

| Instruction format | Description |
|---|---|
| C3+C3+C3 | In command mode（M0=0，M1=1），<br>User gives the module instruction (HEX format): C3 C3 C3,<br>Module returns its present version number, for example C3 62 xx yy.<br>62 here means the module model (E62 series); xx is the version number and yy refers to the other module features. |

## 7.4 Parameter setting instruction

C0 and C2 are operating parameters. The difference between C0 command and C2 command is that C0 command will write parameters into the internal flash memory and can be saved when power-down, while C2 command cannot be saved when power-down, because C2 command is temporarily mend instruction. C2 is recommended for the occasion that need to change the operating parameters frequently, such as C2 01 0A 1A 0A 44

| No. | Item | Description | Notes |
|---|---|---|---|
| 0 | HEAD | Fix 0xC0 or 0xC2, it means this frame data is control command | ● Must be 0xC0 or 0xC2<br>C0: Save the parameters when power-down<br>C2: Do not save the parameters when power-down |
| 1 | ID | Frequency-hopping sequence ID（default 01H） | ● Frequency-hopping sequence is decided by frequency-hopping ID, both sides must keep the same. |

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| | | | |
|---|---|---|---|
| 2 | FHSS nums | The quantity of frequency hopping channel (default 0AH) | ● Both sides must keep the same. The more quantity of frequency-hopping channel, the better anti-interference while synchronization time is longer for both sides. Otherwise the less quantity of frequency-hopping channel, the worse anti-interference while synchronization time is shorter. |
| 3 | SPED | Rate parameter, including UART baud rate and air data rate<br>7, 6 UART parity bit<br>00：8N1（default）<br>01：8O1<br>10：8E1<br>11：8N1（equal to 00）<br>----------<br>5, 4, 3 TTL UART baud rate（bps）<br>000：1200bps<br>001：2400bps<br>010：4800bps<br>011：9600bps（default）<br>100：19200bps<br>101：38400bps<br>110：57600bps<br>111：115200bps<br>----------<br>2, N/A<br>----------<br>1, 0 Air data rate（bps）<br>00：16Kbps<br>01：32Kbps<br>10：64Kbps（default）<br>11：128Kbps | ● UART mode can be different between communication parties<br>----------<br>● UART baud rate can be different between communication parties<br>● The UART baud rate has nothing to do with wireless transmission parameters & won't affect the wireless transmit / receive features.<br>----------<br>0 is recommended.<br>----------<br>● The lower the air data rate, the longer the transmitting distance, better anti-interference performance and longer transmitting time<br>● The air data rate must keep the same for both communication parties. |

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| | | | |
|---|---|---|---|
| 4 | CHAN | Communication frequency (425M+CHAN*0.5M)<br>default 0AH | ● 00H- 33H，for 425 – 450.5MHz<br>● When the frequency-hopping quantity sets as 1, the module works only at the fixed frequency (425M + CHAN * 0.5M). Otherwise the module works at a band (425MHz+CHAN*0.5MHz+FHSS_nums*0.5MHz). |
| 5 | OPTION | 7, 0 is recommended.<br>----------<br>6 IO drive mode (default 1)<br>1：TXD and AUX push-pull outputs, RXD pull-up inputs<br>0：TXD、AUX open-collector outputs, RXD open-collector inputs<br>----------<br>5, 4, 3, 0 is recommended.<br>----------<br>2 FEC switch<br>0：Turn off FEC<br>1：Turn on FEC（Default）<br>----------<br>1, 0 transmission power (approximation)<br>00： 20dBm（Default）<br>01： 17dBm<br>10： 13dBm<br>11： 10dBm | ----------<br>● This bit is used to the module internal pull-up resistor. It also increases the level's adaptability in case of open drain. But in some cases, it may need external pull-up resistor.<br>----------<br>● 0 is recommended.<br>----------<br>● After turn off FEC, the actual data transmission rate increases while anti-interference ability decreases. Also, the transmission distance is relatively short.<br>● Both communication parties must keep on the same pages about turn-on or turn-off FEC.<br>----------<br>● The external power must make sure the ability of current output more than 300mA and ensure the power supply ripple within 100mV.<br>● Low power transmission is not recommended due to its low power supply efficiency. |

**For example: The meaning of No.3 "SPED" byte：**

| The binary bit of the byte | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| The specific value (user configures) | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 |
| Meaning | UART parity bit 8N1 | | UART baud rate is 9600 | | | Air data rate is 64k | | |

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| | | |
|---|---|---|
| Corresponding hexadecimal | 1 | A |

# 8. 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.

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# 9 FAQ

## 9.1 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.

## 9.2 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.

## 9.3 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;

# 10 Production guidance

This type is DIP module, when the welder welds the module, he must be welding according to the anti-static regulation. This product is allergic to static, randomly welding the module will have the chance of damaging it permanently.

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# 11 E62 serial

| Model No. | Core IC | Frequency Hz | Tx power dBm | Distance km | Data Rate | Package | Size mm | Interface |
|---|---|---|---|---|---|---|---|---|
| E62-433T20S | - | 433M | 20 | 1 | 16k~128k | SMD | 17 * 30 | IPEX/external/spring |
| E62-433T30D | - | 433M | 30 | 3 | 16k~128k | DIP | 37 * 60 | SMA-K |
| E62-433T20D | - | 433M | 20 | 1 | 16k~128k | DIP | 21 * 36 | SMA-K |

# 12 Antenna 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.

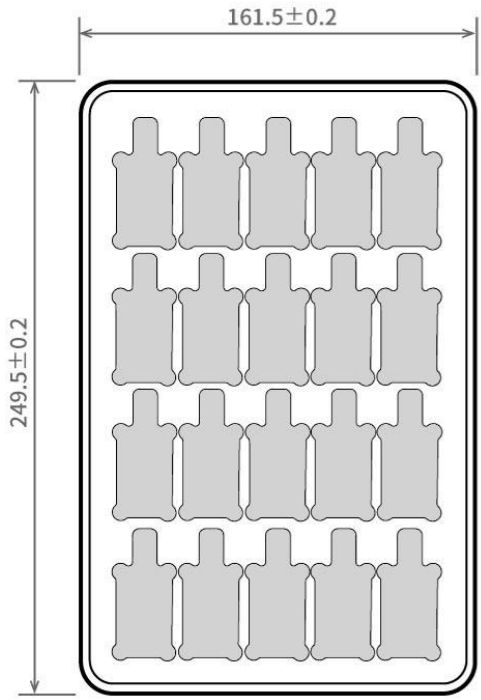
| Model No. | Type | Frequency Hz | Interface | Gain dBi | Height | Cable | Function feature |
|---|---|---|---|---|---|---|---|
| TX433-NP-4310 | Soft PCB antenna | 433M | SMA-J | 2 | 43.8*9.5mm | - | Built-in flexibility, FPC soft antenna |
| TX433-JW-5 | Rubber antenna | 433M | SMA-J | 2 | 50mm | - | Flexible &omnidirectional |
| TX433-JWG-7 | Rubber antenna | 433M | SMA-J | 2.5 | 75mm | - | Flexible &omnidirectional |
| TX433-JK-20 | Rubber antenna | 433M | SMA-J | 3 | 210mm | - | Flexible &omnidirectional |
| TX433-JK-11 | Rubber antenna | 433M | SMA-J | 2.5 | 110mm | - | Flexible &omnidirectional |
| TX433-XP-200 | Sucker antenna | 433M | SMA-J | 4 | 19cm | 200cm | Sucker antenna, High gain |
| TX433-XP-100 | Sucker antenna | 433M | SMA-J | 3.5 | 18.5cm | 100cm | Sucker antenna, High gain |
| TX433-XPH-300 | Sucker antenna | 433M | SMA-J | 6 | 96.5cm | 300cm | Car carrying Sucker antenna, High gain |
| TX433-JZG-6 | Rubber antenna | 433M | SMA-J | 2.5 | 52mm | - | Short straight &omnidirectional |
| TX433-JZ-5 | Rubber antenna | 433M | SMA-J | 2 | 52mm | - | Short straight &omnidirectional |
| TX490-XP-100 | Sucker | 490M | SMA-J | 50 | 12cm | 100cm | Sucker antenna, High gain |

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| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | antenna | | | | | | |
| TX490-JZ-5 | Rubber antenna | 490M | SMA-J | 50 | 50mm | - | Short straight &omnidirectional |

# 13.Package for batch order






Unit: mm
Each Layer: 20 pcs
Each Package: 5 layers

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# Revision history

| version | Date | Description | Issued by |
|---|---|---|---|
| 1.00 | 2017/12/13 | Initial version | huaa |
| 1.10 | 2018/01/30 | module name change | huaa |
| 1.20 | 2018/10/25 | version updating | huaa |
| 1.4 | 2023-5-16 | Bug fixes | Yan |
| 1.5 | 2023-8-8 | Bug fixes | Hao |

# About us

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