E33-433T13D

SX1212　433MHz　TTL

Point-point Wake-up　Wireless Module



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1. Introduction

1.1 Feature

E33-433T13D is a 20mW wireless transceiver module, which operates at 425-440.5MHz (default: 433MHz), based on originally imported RFIC SX1212 from Switzerland, transparent transmission is available, TTL level. The outstanding advantage of this module is point to point wake-up, which is very suitable for ultra-low power consumption applications.



The module has the function of data encryption & compression The data of the module transmitted over the air features randomness. And with the rigorous encryption & decryption, data interception becomes pointless. The function of data compression can decrease the transmission time & probability of being interfered, while improving the reliability & transmission efficiency.

No.	Usage	Description
1	Receiving current	About 3.0mA operation current at RX status.
2	Point-to-point wake up	Only the target module can be awakened among other modules in the same channel, which saves the power consumption on the whole.
2	Fixed transmission	Module can communicate with other modules which work in different channels and address, easy for networking and repeater. Module A transmits AA BB CC to module B (address: 0x00 01, channel: 0x80), HEX format is 00 01 80 AA BB CC (00 01 refers to the address of module B, 80 refers to the channel of module B), then module B receives AA BB CC (only module B).
4	Power-saving	In power-saving mode, the module maximum receiving response time as 2000ms, which the average current is below 20uA.
5	Sleep	When module works in sleep mode, transmitting & receiving is not available, while the configuration is available. The typical current is 1.2uA in this mode.
6	Applicable condition	433MHz is a free band, users could apply to use for free. 433MHz has better diffraction ability as compare to 2.4GHz, but air data rate is inferior to 2.4GHz.

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1.2 Electrical parameter

No.	Item	Parameter details	Description
1	Size	21 * 36mm	Excluding SMA connector
2	Weight	6.7g	Including SMA connector
3	Frequency band	425 - 440.5MHz	Default: 433.0MHz, channel:32
4	Process	Lead-free, SMT	-
5	Connector	1 * 7 * 2.54mm	Drop-in
6	Operation voltage	2.3~ 5.2V DC	Note: the voltage higher than 5.5V is forbidden
7	Communication level	Maximum 5.2V	Recommended difference between supply voltage is less than 0.3V to lower power consumption
8	Operation Range	1000m	Test condition : clear and open area& 12dBm , antenna gain: 5dBi, height:> 2m, air data rate: 2kbps
9	Transmitting power	Maximum 12dBm	Eight optional level(12, 9, 6, 3, 0, -3, -6, -9dBm)
10	Air data rate	2kbps	Four optional level (2, 5, 10, 15kbps)
11	Sleep current	2.0uA	M1=1,M0=1 (Mode 3)
12	Transmitting current	55mA@12dBm	≥150mA (recommended)
13	Receiving current	3.0mA	（Mode 0 or Mode 1）
14	Communication interface	UART	8N1, 8E1, 8O1, Eight kinds of UART baud rate, from 1200 to 115200 bps
15	Driving mode	UART	Can be configured to push-pull/high pull, open-drain
16	Transmitting length	512 bytes buffer	58 bytes per package
17	Receiving length	512 bytes buffer	58 bytes per package
18	Address	4096	Easy for networking, point to point transmission (no broadcasting)
19	Antenna type	SMA-K	50 Ω characteristic impedance, selected from 0R resistor
20	Operating temperature	-40 ~ +85℃	-
21	Operating humidity	10% ~ 90%	Relative humidity, no condensation
22	Storage temperature	-40 ~ +125℃	-
23	Receiving sensitivity	-110dBm@2kbps	Sensitivity has nothing to do with serial baud rate or timing

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1.3 E33 series

Model	Interface	Frequency (Hz)	Power (dBm)	Operation range (km)	Air data rate (bps)	Packing
E33-433T13D	UART	433M	12	1.0	2k~15k	Drop-in
E33-433T13D is compatible with other E33 series in different TX powers						

1.4 FAQ

No.	Question	Description
1	Air data rate	Low air rate is recommended, the higher the air rate ,the shorter the range and higher data loss.
2	Antenna selection	Antenna and module frequency must match with each other, the higher the antenna gain higher the better, the lowe SWR the better. Sucker antenna is recommended.
3	Messy codes	One reason is serail port baud rate does not match, another one may be due to inadequate power supply.
4	High delay	Turn off the FEC on both sides, increase air data rate.
5	RX response time	Valid under Mode 1 & 2, the longer the time, the lower the power consumption and the longer the delay.

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2. Operation Modes

2.1 Fixed transmission

	Format	Values
Fixed transmission format (hexadecimal) for example: 00 03 04 AA BB CC 00 03 are the address of target module; 04 is the channel of target module; AA BB CC are the data to be sent.		
Transmitter A	HEX	Address: 00 01; Channel: 02
Receiver B	HEX	Address: 00 03; Channel: 04
Receiver C	HEX	Address: 00 05; Channel: 04
Receiver D	HEX	Address: 00 07; Channel: 06
Module A must be in fixed transmission mode.		
Module A sends	HEX	00 03 04 AA BB CC
Module B receives	HEX	AA BB CC
Module C receives	HEX	Null
Module D receives	HEX	Null
The receivers cannot receive data unless the address and channel match. Only 1 data packet length is supported for fixed transmission (refer to electrical parameters); If the data exceeds 1 data packet length, it will be sub-packed automatically.		

2.2 Broadcast transmission

	Format	Values
Fixed transmission format (hexadecimal) for example: FF FF 04 AA BB CC FF FF are broadcast address; 04 is the channel of target module; AA BB CC are the data to be sent.		
Transmitter A	HEX	Address: 00 01; Channel: 02
Receiver B	HEX	Address: 00 03; Channel: 04
Receiver C	HEX	Address: 00 05; Channel: 04
Receiver D	HEX	Address: 00 07; Channel: 06
Module A must be in fixed transmission mode.		
Module A sends	HEX	FF FF 04 AA BB CC
Module B receives	HEX	AA BB CC
Module C receives	HEX	AA BB CC
Module D receives	HEX	Null
All modules in the target channel will receive data. Only 1 data packet length is supported for fixed transmission (refer to electrical parameters); If the data exceeds 1 data packet length, it will be sub-packed automatically.		

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2.3 Broadcast address

1.	For example: Set the address of module A as 0xFF FF, and channel as 0x04;
2.	When module is the transmitter (transparent transmission), all modules under channel 0x04 will receive the data, the purpose of broadcast is realized.

2.4 Monitor address

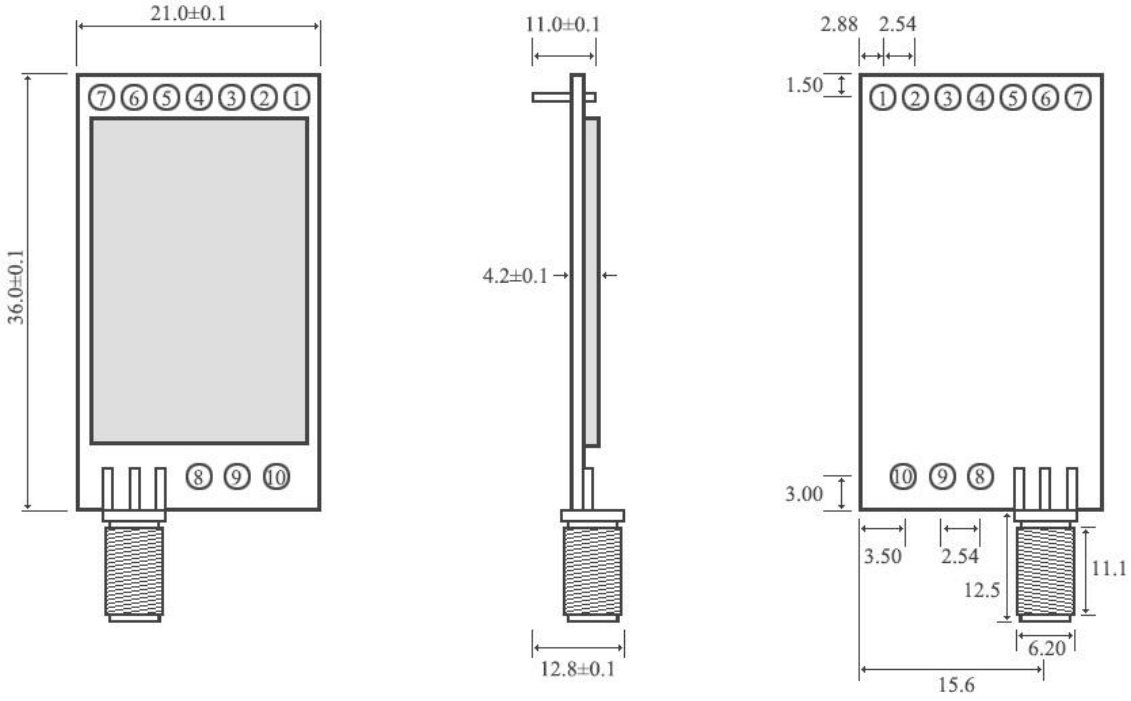
1.	For example: Set the address of module A as 0xFF FF, and channel as 0x04;
2.	When module is the receiver, it can receive the data sent from all modules under channel 0x04, the purpose of monitor is realized.

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3. Functional description

3.1 Pin definition

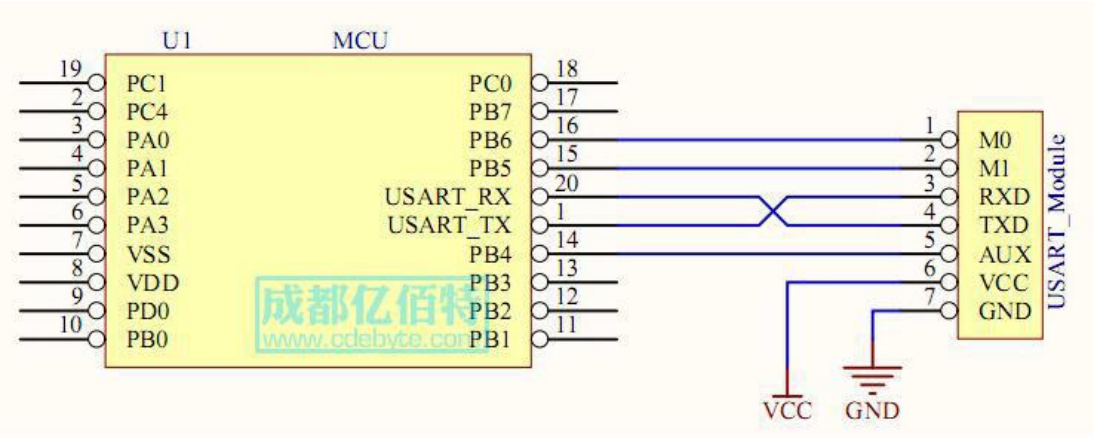


Pin No.	Pin	Pin direction	Pin application
1	M0	Input (weak pull-up)	Work with M1 & decide the four operating modes. Floating is not allowed, can be ground.
2	M1	Input (weak pull-up)	Work with M0 & decide the four operating modes. Floating is not allowed, can be ground.
3	RXD	Input	TTL UART inputs, connects 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 open-drain output or push-pull output (floating is allowed).
6	VCC		Power supply 2.3V-5.5V DC
7	GND		Ground
8	Fixing hole		Fixing hole
9	Fixing hole		Fixing hole
10	Fixing hole		Fixing hole

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3.2 Connect to MCU



No.	Description（STM8L MCU）
1	The UART module is TTL level.
2	For some MCU works at 5VDC, it may need to add 4-10K pull-up resistor for the TXD & AUX pin.

3.3 Reset

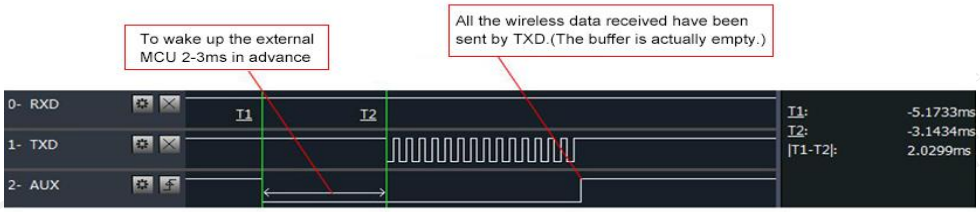
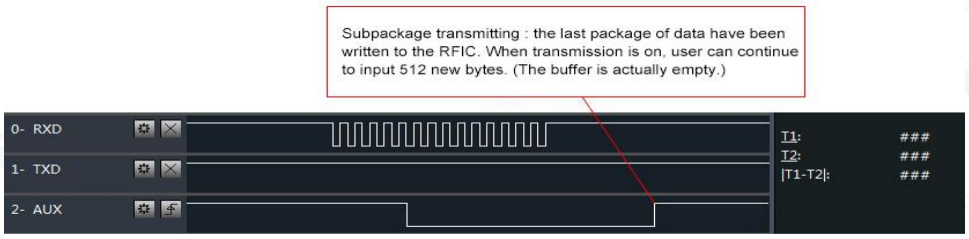
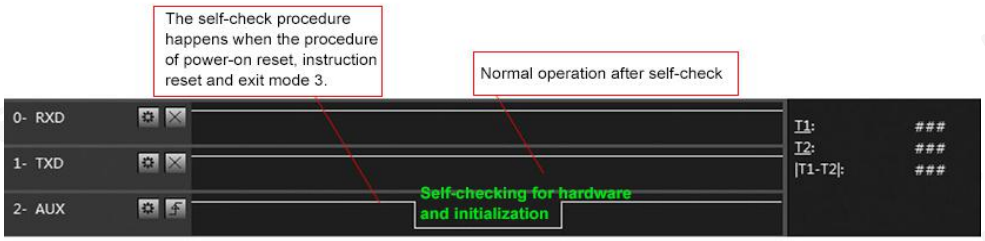
No.	Description
1	When the module is powered, AUX outputs low level immediately, conducts hardware self-check and sets the operating mode on the basis of the user parameters. During the process, the AUX keeps low level. After the process completed, the AUX outputs high level and starts to work as per the operating mode combined by M1 and M0. Therefore, the user needs to wait the AUX rising edge as the starting point of module’ s normal work.

3.4 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 yet to send 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.

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No.	Description
1	【Indication of UART output】can be used to wake up external MCU.  **Timing Sequence Diagram of AUX when TXD pin transmits**
2	【Indication of wireless transmitting】 Buffer (empty): the internal 512 bytes data in the buffer are written to the RFIC (Auto subpackage). When AUX=1, the user can input data less than 512 bytes continuously without overflow. Buffer (not empty): when AUX=0, the internal 512 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 subpackage. Notes: 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**
3	【Configuration procedure of module】 Only happened when power-on resetting or exiting sleep mode.  **Timing Sequence Diagram of AUX when self-check**

No.	Notes for AUX
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 won’ t be work in the new mode immediately until AUX rising edge 2ms later. If AUX is on the high level, the operating mode switch can be effected 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 reset user parameters, during which AUX outputs low level.

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4. Operating mode

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

Mode (0-3)	M1	M0	Description	Remark
Mode 0 Normal	0	0	UART and wireless channel are open, transparent transmission is on.	The receiver must work in mode 0 or mode 1.
Mode 1 Wake-up	0	1	UART and wireless channel are open. The difference between normal mode and wake-up mode is it will add preamble code automatically before data packet transmission so that it can awaken the receiver works in mode 2.	The receiver can work in mode 0, mode 1 or mode 2.
Mode 2 Power-saving	1	0	UART is disabled. Wireless module works at WOR mode (wake on radio). It will open the UART and transmit data after receiving the wireless data.	1,the transmitter must work in mode 1. 2,transmitting is not allowed in this mode.
Mode 3 Sleep	1	1	Parameter setting.	-

4.1 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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4.2 Normal mode (Mode 0)

	When M1 = 0 & M0 = 0, module works in mode 0
Transmitting	The module can receive the user data via serial port, and transmit wireless data package of 58 bytes. When the data inputted by user is up to 58 byte, the module will start wireless transmission. During which the user can input data continuously for transmission. When the required transmission bytes are less than 58 bytes, the module will wait 3-byte time and treat it as data termination unless continuous data inputted by user. Then the module will transmit all the data through wireless channel. When the module receives the first data packet from user, the AUX outputs low level. After all the data are transmitted into RF chip and transmission is started , AUX outputs high level. At this time, it means that the last wireless data package transmission is started, which enables the user to input another 512 bytes continuously. The data package transmitted from the module working in mode 0 can only be received by the module working in mode 0 or 1.
Receiving	The wireless receiving function of the module is on, the data packet transmitted from the module working in mode 0 & mode 1 can be received. After the data packet is received, the AUX outputs low level, 5ms later the module starts to transmit wireless data through serial port TXD pin. After all the wireless data have been transmitted via serial port, the AUX outputs high level.

4.3 Wake-up mode (Mode 1)

	When M1 = 0 & M0 = 1, module works in mode 1.
Transmitting	The condition of data packet transmission & AUX function is the same as mode 0. The only difference is that the module will add preamble code before each data packet automatically. The preamble code length depends on the wake-up time set in the user parameters. The purpose of the preamble code is waking up the receiving module works in mode 2. Therefore, the data package transmitted from mode 1 can be received by mode 0, mode1 and mode 2.
Receiving	The same as that in mode 0.

4.4 Power-saving mode (Mode 2)

	When M1 = 1 & M0 = 0, module works in mode 2.
Transmitting	UART is closed, the module cannot receive any serial port data from outside MCU. Hence the function of wireless transmission is not available for the module working in this mode.
Receiving	In mode 2, it is required the data transmitter works in mode 1. The wireless module monitors the preamble code at regular time. Once it gets the preamble code, it will remain as receiving status and waiting for the completion of receiving the entire valid data package. Then the AUX outputs low level, 5ms later the serial port is open to transmit received wireless data through TXD. Finally AUX outputs high level after process completed. The wireless module stays in “power-saving – monitoring” working status (polling). By setting different wake-up time, the module will have different receiving response delay (2s in maximum) and average power consumption (30uA in minimum). The user needs to achieve a balance between communication delay time & average power consumption.

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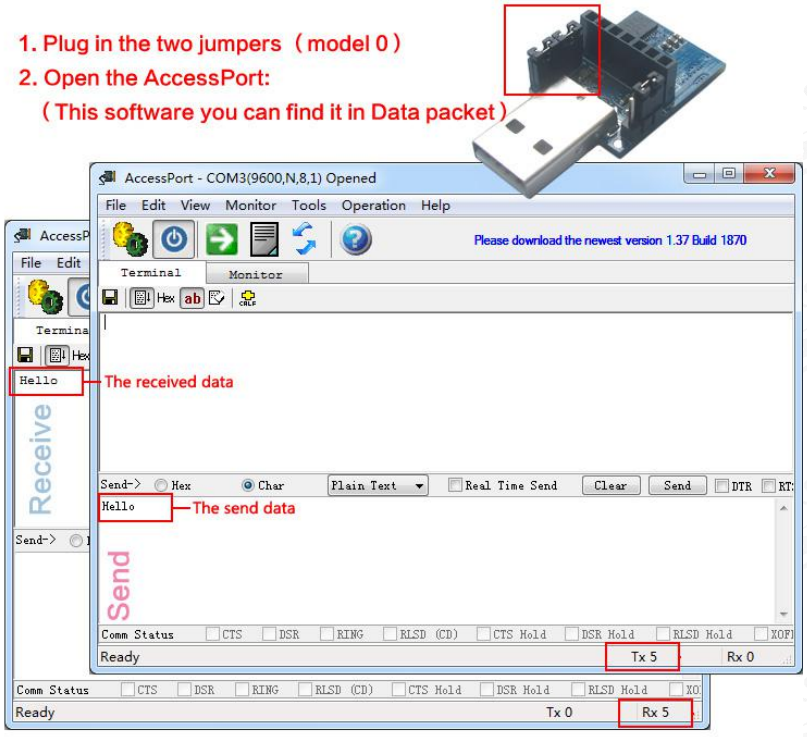
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4.5 Sleep mode (Mode 3)

	When M1=1 ,M0=1, module works in mode 3
Transmitting	N/A
Receiving	N/A
Parameter setting	This mode can be used for parameter setting. It uses serial port 9600 & 8N1 to set module working parameters through specific instruction format. (pls refer to parameters setting for details)
Notes	When the mode changes from stand-by mode to others, the module will reset its parameters, during which the AUX keeps low level and then outputs high level after reset completed. It is recommended to check the AUX rising edge for user.

4.6 Quick communication test

Steps	Operation
1	Plug the USB test board (E15-USB-T2) into computer, make sure the driver is installed correctly. Plug mode-select jumper in the USB test board (M1 = 0, M0 = 0), make module work in mode 0.
2	Optional power supply, 3.3V or 5V.
3	Operate AccessPort software and select the correct serial port code.



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5. Instruction format

In sleep mode（mode 3：M1=1, M0=1），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 sent in succession. (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 sent in succession.
3	C2 + working parameters	C2 + 5 bytes working parameters are sent in hexadecimal format. 6 bytes in total and must be sent 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 sent in succession.
5	C4 C4 C4	Three C4 are sent in hexadecimal format. The module will reset one time and they must be sent in succession.

5.1 Default parameter

	Default parameter values：C0 00 00 18 10 40						
Model	Frequency	Address	Channel	Air data rate	Baud rate	Parity	Transmitting power
E33-433T13D	433MHz	0x0000	0x10	2kbps	9600	8N1	20mW

5.2 Parameter setting instruction

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 00 00 18 10 40.

No.	Item	Description	Remark
0	HEAD	Fix 0xC0 or 0xC2, it means this frame data is control command	Must be 0xC0 or 0xC2 C0: Save the parameters when power-off C2: Do not save the parameters when power-off
1	ADDH	7，6，5，4：N/A ---------- 3，2，1，0：high address 12bit High address byte of module（the default 00H）	0(recommended) ---------- 00H-0FH
2	ADDL	Low address byte of module（the default 00H）	00H-FFH
3	SPED	Rate parameter，including UART baud rate and air data rate 7，6 UART parity bit	● UART mode can be different between communication parties

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		00：8N1（default） 01：8O1 10：8E1 11：8N1（equal to 00） --- 5，4，3 TTL UART baud rate（bps） 000：1200bps 001：2400bps 010：4800bps 011：9600bps（default） 100：19200bps 101：38400bps 110：57600bps 111：115200bps --- 2， N/A --- 1，0 Air data rate（bps） 00：2Kbps（default） 01：5Kbps 10：10Kbps 11：15Kbps	--- UART baud rate can be different between communication parties ● The UART baud rate has nothing to do with wireless transmission parameters & won’t affect the wireless transmit / receive features. --- ● 0(recommended) --- ● The lower the air data rate, the longer the transmitting distance, better anti-interference performance and longer transmitting time The air data rate must keep the same for both communication parties.
4	CHAN	7, 6, 5, N/A --- 4, 3, 2, 1, 0: Communication frequency（425M + CHAN * 0.5M） default 10H（433MHz）	● 0(recommended) --- ● 00H-1FH，for 425 - 440.5MHz
5	OPTION	7， Fixed transmission（similar to MODBUS） 0： Transparent transmission mode（default） 1： Fixed transmission mode --- 6 IO drive mode(the default 1) 1：TXD and AUX push-pull outputs, RXD pull-up inputs 0：TXD, AUX open-collector outputs, RXD open-collector inputs --- 5，4，3 wireless wake-up time（for the receiver, it means the monitor	● In fixed transmission mode, the first three bytes of each user's data frame can be used as high/low address and channel. The module changes its address and channel when transmit. And it will revert to original setting after complete the process. --- ● 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. --- ● The transmit & receive module work in mode 0, whose delay time is

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		interval time ,while for the transmitter it means continuously sending preamble code time.) 000：250ms（default） 001：500ms 010：750ms 011：1000ms 100：1250ms 101：1500ms 110：1750ms 111：2000ms	invalid & can be arbitrary value. ● The transmitter works in mode 1 can transmit the preamble code of the corresponding time continuously. ● When the receiver works in mode 2, the time means the monitor interval time (wireless wake-up). Only the data from transmitter that works in mode 1 can be received. ● The wake-up time set by transmitter cannot be less than the monitor interval time of receiver; otherwise, it may lead to data loss. In case of two-way communication, both parties should keep the wake-up time the same. ● The longer the wake-up time, the lower the average receive current consumption.
		----------	----------
		2, 1, 0 transmission power (approximation) 000： 12dBm（Default） 001： 9dBm 010： 6dBm 011： 3dBm 100： 0dBm 101： -3dBm 101： -6dBm 111： -9dBm	● The external power must make sure the ability of current output more than 200mA and ensure the power supply ripple within 100mV. ● Low power transmission is not recommended due to its low power supply efficiency.

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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	0	0
Meaning	UART parity bit 8N1		UART baud rate is 9600			Air data rate is 2k		
Corresponding hexadecimal	1				8			

5.3 Reading operating parameters

Instruction format	Description
C1+C1+C1	In sleep mode (M0=1, M1=1), User gives the module instruction (HEX format): C1 C1 C1, Module returns the present configuration parameters. For example, C0 00 00 18 10 40.

5.4 Reading version number

Instruction format	Description
C3+C3+C3	In sleep mode (M0=1, M1=1), User gives the module instruction (HEX format): C3 C3 C3, Module returns its present version number, for example C3 33 xx yy. 32 here means the module model (E33 series); xx is the version number and yy refers to the other module features.

5.5 Reset instruction

Instruction format	Description
C4+C4+C4	In sleep mode (M0=1, M1=1), User gives the module instruction (HEX format): C4 C4 C4, the module resets for one time. During the reset process, the module will conduct self-check, AUX outputs low level. After reset completing, the AUX outputs high level, then the module starts to work regularly which the working mode can be switched or be given another instruction.

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6. Parameter setting

Step	Operation	Description
1	Install Driver	Please install the USB adapter driver (CP2102).
2	Pull out the jumper	Pull the M0, M1 jumper out, 3.3V or 5V are available for jumper.
3	Connect to module	Connect the module with USB adapter. Connect to the USB interface of PC.
4	Open serial port	Operate the parameter setting software, choose corresponding serial number and press the "OpenPort" button. Please choose other serial numbers until open successfully.
5	Interface	Press "Preset" button, the interface will be as below. If failed, please check if the module is in mode 3, or if the driver has been installed.
6	Input parameter	Please adjust the parameter as your request according to the corresponding setting, then click "SetParam" button, write the new parameter to the module.
7	Complete the operation	Please operate the "Fifth step" if you need to reconfigure, if the configuration is completed, please click "ClosePort" and then take off the module.
8	Commands Configuration	Parameter configuration is also available for MCU (in mode 3).



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7. Customization

★Please contact us for customization.

★Ebyte has established profound cooperation with various well-known enterprises.



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Revision history

Version	Date	Description	Operator
1.1	2020-8-20	Initial Version	Li

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