E51 Series Modules User Manual

EFR32FG25 470/510/868/915MHz SMD SoC Module



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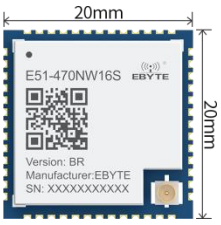
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1 Introduction

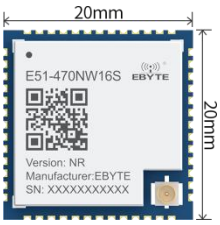
1.1 Brief Introduction

The E51 series modules are long-range, low-power transmission Wi-Sun modules that are equipped with Silicon Labs' EFR32FG25 family of chips, enabling wireless broadcasts of up to 0.3~2.5 kilometers with minimal data loss in dense urban canyon environments. It also supports Orthogonal Frequency Division Multiplexing Modulation (OFDM), a technique introduced in Wi-SUN Field Area Networks (FANs), enabling high data bandwidths of up to 3.6 Mbps. With the increased data rate, large networks with thousands of nodes can be realized for applications such as smart cities and smart utilities.

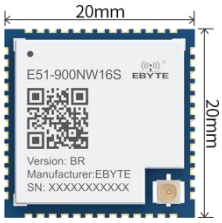
E51 series modules are available in four models: E51-470NW16S(NR)①, E51-470NW16S(BR)②, E51-900NW16S(NR)①, E51-900NW16S(BR)②. The four products are of the same package size, can be pin-to-pin, and are rich in interface resources and support for the secondary development of users, and can be widely used in the IoT industry. They can be widely used in IOT industry.



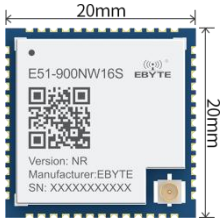
E51-470NW16S(BR)



E51-470NW16S(NR)



E51-900NW16S(BR)



E51-900NW16S(NR)

Note: E51-470NW16S(NR)① and E51-900NW16S(NR)① are node modules; E51-470NW16S(BR)② and E51-900NW16S(BR)② are gateway routing modules; for detailed notes, please refer to Terminology Notes in Section 1.3.

1.2 Features

Wi-SUN network protocol features

- Complies with IEEE Wi-SUN standard protocol
- Communication rate of up to 50~2400 Kbps
- Supports mobile nodes, reliable data transmission
- Supports concurrent communication, intelligent network topology
- Supports automatic frequency hopping, greatly improving the anti-interference ability of communication
- Supports thousands of network points to meet the needs of large-scale networking applications.

Operating bands

- E51-470NW16S(NR), E51-470NW16S(BR) operating bands 470-510 MHz
- E51-900NW16S(NR), E51-900NW16S(BR) operating bands 860-925 MHz

Low-power wireless system-on-chip

- High-performance 32-bit 97.5 MHz ARM Cortex®-M33 with DSP instructions and floating-point unit for efficient signal processing

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- Up to 1152 kB of Flash program memory
- Up to 256 kB of RAM data memory
- Up to +16 dBm of transmit power

Wide selection of MCU peripherals

- Pin out up to 35 general-purpose I/O pins with output state hold and asynchronous interrupts
- Analog-to-digital converter (ADC)
- 12-bit @ 1 Msps
- 16-bit @ 76.9 ksps
- 2 × Analog Comparator (ACMP)
- 2-channel digital-to-analog converter (VDAC)
- Low-energy sensor interface (LESENSE)
- 16-channel DMA controller 12 16-channel peripheral reflection system (PRS) 6 16-bit timer/counter with 3 compare/capture/PWM channels DMA controller
- 12-channel Peripheral Reflection System (PRS)
- 6 x 16-bit timers/counters with 3 compare/capture/PWM channels
- 2 x 32-bit timers/counters with 3 compare/capture/PWM channels
- 32-bit real-time counter
- 24-bit low-energy timer for waveform generation
- 2 x watchdog timer
- 1 x USB2.0 full-speed port (device only)
- 5 x EUSART (Upgraded Universal Synchronous/Asynchronous Receiver/Transmitter)
- EUSART0 running in EM2
- SPI and IrDA supported by EUSART
- 2 I2C interfaces with SMBus support
- Chip Temperature Sensor with ±2° C Accuracy over the Full Temperature Range

Wide operating range

- 2.0 to 5.5 V power supply, supports OFDM mode power
- -40 to +125 degrees Celsius

Supported modulation formats

- Wi-SUN MR OFDM MCS 0-6 (all 4 options)
- 802.15.4 SUN MR O-QPSK with DSSS
- Wi-SUN FSK
- with fully configurable molding capabilities 2 (G)FSK with fully configurable molding
- (G)MSK

Chip-level security features

- Secure boot via Root of Trust and Secure Trailer Loader (RTSL)
- Hardware cryptographic acceleration (up to 256-bit) via DPA against AES128/256, SHA-1, SHA-2
- ECC (up to 256-bit), ECDSA, ECDH, and J-Pake
- True Random Number Generator (TRNG) compliant with NIST SP800-90 and AIS-31
- ARM® TrustZone®
- Secure debugging with locking/unlocking

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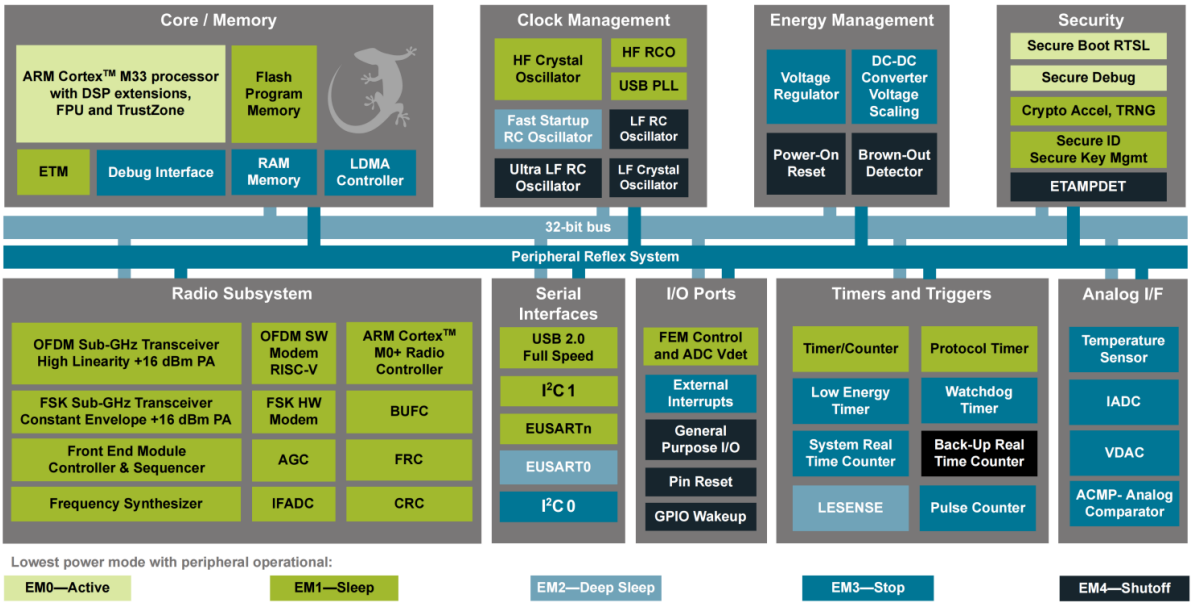
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Protocol Support

- Proprietary Product Private Protocol
- Wi-SUN

Encapsulation

- Patch Stamp Hole 20mm(L) x 20mm(W) x 3mm(H)



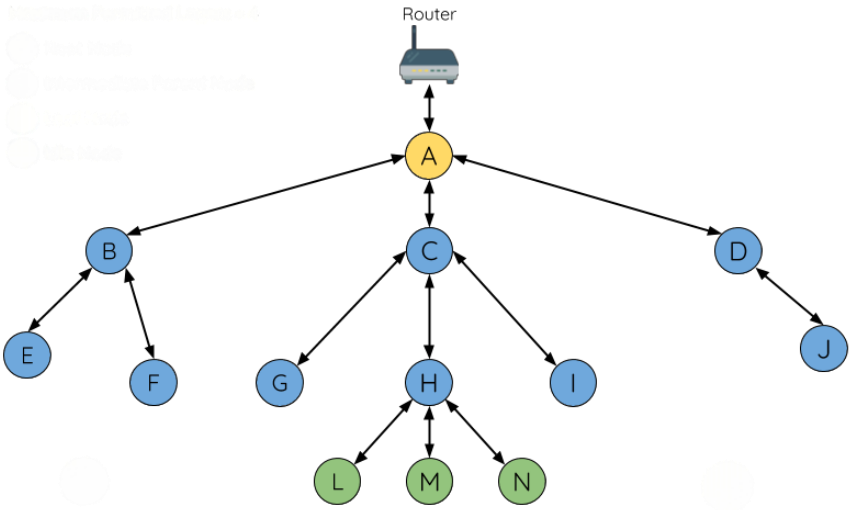
Internal Function Block Diagram of EFR32FG25 Series Chip

1.3 Glossary of terms

- Wi-SUN (Wireless Utility Networks), translated as Smart Wireless Networks in Chinese, is a collective name for a series of standard wireless communication networks based on IEEE 802.15.4 as the underlying protocol.
- BR (Board Router): edge router, edge ;
- NR (Node Router): node with relay function, also can be expressed by node;
- PAN (personal area netw): personal area network;
- FAN (Wireless Utility Field Area Network): FAN1.0 adopts FSK modulation (below 300kbps). And FAN1.1 can utilize OFDM modulation (2.4Mbps or less) in addition to FSK modulation (300kbps or less), which enables high-speed communication.
- Network topology:

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1.4 Application Scenarios

Wi-SUN (i.e., Wireless Smart Ubiquitous Networking) is the leading IPv6 sub-1 GHz mesh technology for smart city and smart utility applications.Wi-SUN delivers smart ubiquitous networking for service providers, utilities, municipalities/local governments, and other enterprises by enabling interoperable, multi-service, and secure wireless mesh networks.Wi-SUN can be used for large-scale outdoor IoT wireless communication networks in a wide range of applications, including line-powered and battery-powered nodes. Wi-SUN can be used for large-scale outdoor IoT wireless communication networks in a wide range of applications covering both line-powered and battery-powered nodes.

Silicon Labs' EFR32FG25 family of chips are certified by the Wi-SUN Alliance, a global industry association dedicated to seamless LPWAN connectivity. SUN is purpose-built for extended long-range capabilities, high data throughput and IPv6 support to simplify wireless infrastructure for industrial applications and smart city evolution.

- Smart Cities/Municipal Infrastructure;
- Industrial Applications/Building Automation/Power Distribution Automation;
- Building Security Systems;
- Smart Home;
- Smart Lighting/Street Lighting;
- Advanced Meter Reading Architecture (AMI);
- Smart Meters/Smart Metering.

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2 Specification

2.1 Limit parameters

RF parameters	Parameter value	Remarks
Transmit power Receive sensitivity (GFSK)	470-510 MHz	Corresponding models are: E51-470NW16S(NR), E51-470NW16S(BR)
	860-925 MHz	Corresponding models are: E51-900NW16S(NR), E51-900NW16S(BR) and support 868/915 MHz European and American bands
Receive sensitivity (OFDM)	16 dBm	Software adjustable, user-developed settings required
Measured distance	-117.7 dBm	10 kbps 2GFSK signal, Δf = ± 25 kHz, BER < 0.1%2
Transmit power	-116.8 dBm	10% Packet Error Rate (PER) without interference,
Receive sensitivity (GFSK)	2.5 km	OFDM Option4, MCS0, header MCS0, with PL = 20 octets

2.2 Electrical parameters

Electrical parameters	min	typical	Max	unit	Remarks
Supply voltage	3.0	5.0	5.5	V	≥5.0V guarantees output power, above 5.5V may risk damaging the module
Communication level	-	3.3	-	V	Using 5.0V TTL recommends adding level shifting
Transmit current	73	-	81	mA	Instantaneous power consumption
Receive current	7.5	-	11	mA	——
Operating temperature	-40	-	85	℃	——
Operating humidity	10	-	90	%	——
Storage temperature	-50	-	125	℃	——

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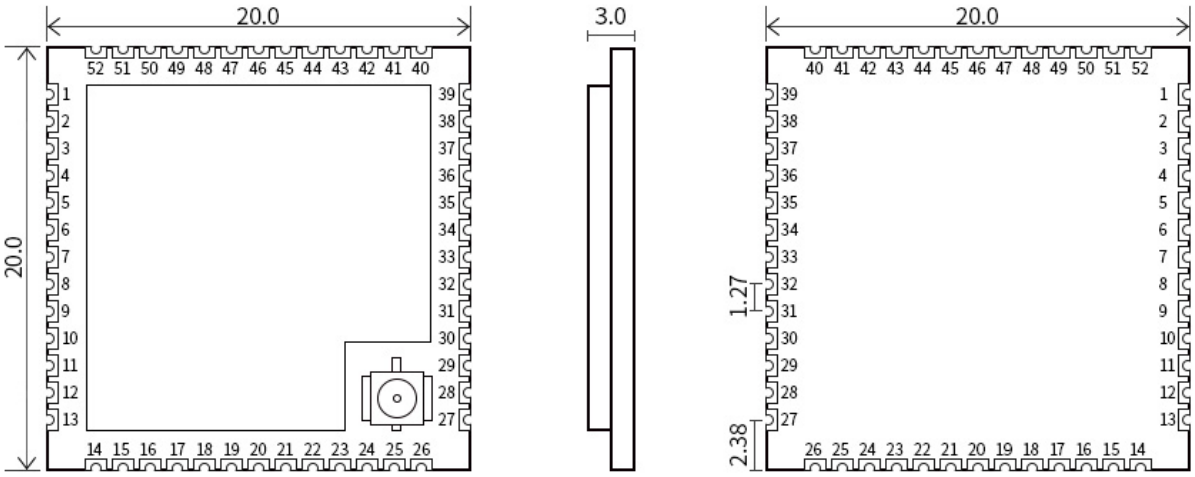
2.3 Hardware parameters

Hardware parameters	parameter value	Remarks
Full name of IC	EFR32FG25A121F1152IM56-B	Support OFDM, replaceable with other models of the same series, welcome to inquire
Core	ARM Cortex®-M33	Main frequency 97.5MHz, high-performance 32-bit ARM processor with DSP instruction and floating-point unit
FLASH	1152 KB	Replaceable with other models of the same series, up to 1152 KB, welcome to inquire
RAM	256 KB	Replaceable with other models of the same series, up to 256 KB, welcome to inquire
Crystal frequency	39MHz/32.768KHz	Module is internally accessed
Size	20 * 20 mm	——
Antenna form	IPEX/Stamp Hole	Equivalent impedance approx. 50Ω
Communication interface	UART	——
Packaging method	Patch Stamp Hole	Foot spacing 1.27mm
Weight	2.07±0.1g	——

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3 Mechanical Dimensions and Pin Definitions



Note: The four module packages are the same size.

No	Name	Pin Direction	Pin Usage
1	GND	Outputs	Ground, connect to power reference ground
2	GND	Outputs	Ground, connect to power reference ground
3	GND	Outputs	Ground, connect to power reference ground
4	GND	Outputs	Ground, connect to power reference ground
5	PD07	Inputs/Outputs	Configurable general-purpose IO ports (see EFR32FG25 manual for details)
6	PD06	Inputs/Outputs	Configurable general-purpose IO ports (see EFR32FG25 manual for details)
7	PD05	Inputs/Outputs	Configurable general-purpose IO ports (see EFR32FG25 manual)
8	PD04	Inputs/Outputs	Configurable general-purpose IO port (see EFR32FG25 manual for details)
9	PD03	Inputs/Outputs	Configurable general-purpose IO port (see EFR32FG25 manual for details)
10	PD02	Inputs/Outputs	Ground, connect to power reference ground
-	PD01	-	Unpinned, inside the module as LFXTAL_I has been connected to a

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			32.768KHz crystal (see EFR32FG25 manual for details)
-	PD00	-	Unpinned, inside the module as LFXTAL_O has been connected to a 32.768KHz crystal (see EFR32FG25 manual for details)
11	GND	Outputs	Ground, connected to the power supply reference ground
12	+5V	Inputs	Power supply input +5V
13	+5V	Inputs	Power supply input +5V
14	PC00	Inputs/Outputs	Configurable General Purpose IO Port (see EFR32FG25 manual for details)
15	PC01	Inputs/Outputs	Configurable General Purpose IO Port (see EFR32FG25 manual for details)
16	PC02	Inputs/Outputs	Configurable General Purpose IO Port (see EFR32FG25 manual for details)
17	PC03	Inputs/Outputs	Configurable General Purpose IO Port (see EFR32FG25 manual for details)
18	PC04	Inputs/Outputs	Configurable General Purpose IO Port (see EFR32FG25 manual for details)
19	PC05	Inputs/Outputs	Configurable General Purpose IO Port (see EFR32FG25 manual for details) See EFR32FG25 manual for details)
20	PC06	Inputs/Outputs	Configurable general-purpose IO ports (see EFR32FG25 manual for details)
21	PC07	Inputs/Outputs	Configurable general-purpose IO ports (see EFR32FG25 manual for details) EFR32FG25 manual)
22	PC08	Inputs/Outputs	Configurable General Purpose IO Port (see EFR32FG25 manual for details)
23	PC09	Inputs/Outputs	Configurable General Purpose IO Port (see EFR32FG25 manual for details)
24	PC10	Inputs/Outputs	Configurable General Purpose IO Port (see EFR32FG25 manual for details)
25	NRST	Outputs	Chip reset trigger input pin, active low
26	GND	Outputs	Ground, connects to power reference ground
27	GND	Outputs	Ground, connects to power reference ground
28	GND	Outputs	Ground, connects to power reference ground
29	ANT	Outputs	Antenna connector, stamp hole (50Ω characteristic impedance) to IPEX-1 connector
30	GND	Outputs	Ground, connects to power reference ground
31	GND	Outputs	Ground, connects to power reference ground
32	GND	Outputs	Ground, connects to power reference ground
33	GND	Outputs	Ground, connects to power reference ground
34	PB05	Input/Output	Configurable general purpose IO ports (see EFR32FG25 manual for details)
35	PB04	Input/Output	Configurable general-purpose IO port (see EFR32FG25 manual for details)
36	PB03	Input/Output	Configurable general-purpose IO port (see EFR32FG25 manual for

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			details)
37	PB02	Input/Output	Configurable general-purpose IO port (see EFR32FG25 manual for details)
38	PB01	Input/Output	Configurable general-purpose IO port (see EFR32FG25 manual for details)
39	PB00	Input/Output	Configurable general-purpose IO port (see EFR32FG25 manual for details) EFR32FG25 manual)
40	GND	Output	Ground, connected to power reference ground
41	PA00	Input/Output	Configurable general-purpose IO port (see EFR32FG25 manual for details)
42	PA01	Input/Output	Program debug/download port SWCLK
43	PA02	Input/Output	Program debug/download port SWDIO
44	PA03	Input/Output	Configurable general-purpose IO port (see EFR32FG25 manual for details)
45	PA04	Input/Output	Configurable general-purpose IO port (see EFR32FG25 manual for details)
46	PA05	Input/Output	Configurable general-purpose IO port (see EFR32FG25 manual for details) (see EFR32FG25 manual)
47	PA06	Input/Output	Configurable general-purpose IO port (see EFR32FG25 manual for details)
48	PA07	Input/Output	Configurable general-purpose IO port (see EFR32FG25 manual for details) IO ports (see EFR32FG25 manual for details)
49	PA08	Input/Output	Ground, connected to power reference ground
50	PA09	Input/Output	Configurable general-purpose IO port (see EFR32FG25 manual for details)
51	PA10	Input/Output	Program debug/download port SWCLK
52	PA11	Input/Output	Program debug/download port SWDIO

4 Basic operations

4.1 Quick Start Guide

- E51 series modules are characterized by simplicity and ease of use. In order to allow users to quickly familiarize and module, this section will guide the user through a simple setup to achieve a variety of modes of configuration and communication.
- This section of the test process are used for cli instruction set, the user quickly understand the usage of cli instructions.

Hardware to be used in this section:	
1	E51-900NW16S(BR)

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2	E51-900NW16S(NR)
3	E51-470NW16S(BR)
4	E51-470NW16S(NR)
Software to be used in this section:	
1	XCOM Serial Assistant

Notes:

1) E51-900NW16S(BR), E51-470NW16S(BR) are edge gateway devices, they hold the same way of using except the channel.

2) E51-900NW16S(NR), E51-470NW16S(NR) are node devices, they are used in the same way except for the channel.

(3) The cli command in the factory firmware explains that the command needs to end with a carriage return line feed.

4.1.1 Details of supported channels in the 470MHz/900MHz band

1）Currently only support standard WISUN FAN 1.1 network

2) Currently, only CN channels are supported in the 470MHz band

Domain	Phy Operating Mode ID	Channel Plan ID	Description
CN	2	160	2-FSK 470.2MHz 50KBS
CN	3	160	2-FSK 470.2MHz 1 00KBS

3) The currently supported channels in the 900MHz band are as follows

Domain	Phy Operating Mode ID	Channel Plan ID	Description
NA	2	1	2-FSK 902.2MHz 50 kbps
NA	3	1	2-FSK 902.2MHz 100 kbps
NA	[84-87]	1	OFDM 902.2MHz 150-450kbps
NA	[68-71]	2	OFDM 902.4 MHz 300-900 kbps

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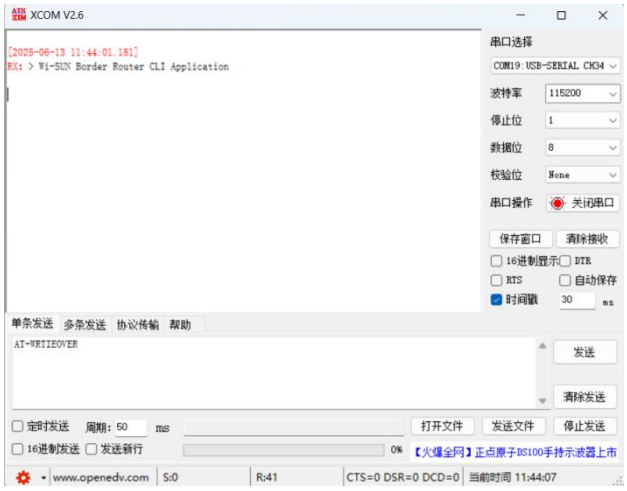
NA	8	3	2-FSK 902.6 MHz 300 kbps
NA	[51-55]	4	OFDM 902.8 MHz 400-1600 kbps
NA	[34-39]	5	OFDM 903.2 MHz 400-3600 kbps
JP	2	21	2-FSK 920.6 MHz 50 kbps
JP	[84-87]	21	OFDM 920.6 MHz 150-450 kbps
JP	4	22	2-FSK 920.9 MHz 100 kbps
JP	[68-71]	22	OFDM 920.9 MHz 300-900kbps
JP	[51-55]	24	OFDM 921.1 MHz 400-1600 kbps
EU	1	32	2-FSK 863.1 MHz 50 kbps
EU	3	33	2-FSK 863.1 MHz 100 kbps
EU	5	33	2-FSK 863.1 MHz 150 kbps
EU	[84-87]	33	OFDM 863.1 MHz 150-450 kbps
EU	1	34	2-FSK 870.1 MHz 50 kbps
EU	3	35	2-FSK 870.2 MHz 100 kbps

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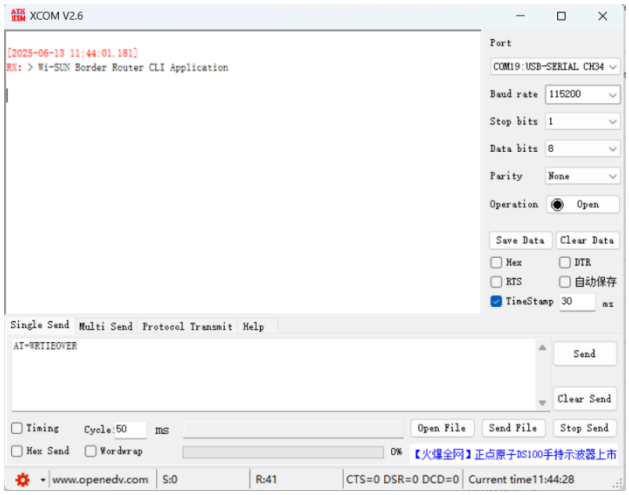
BZ	2	1	2-FSK 902.2 MHz 50 kbps FEC
BZ	3	1	2-FSK 902.2 MHz 100 kbps
BZ	[84-87]	1	OFDM 902.2 MHz 150-450 kbps
BZ	[68-71]	2	OFDM 902.4 MHz 300-900 kbps
BZ	[51-55]	4	OFDM 902.8 MHz 400-1600 kbps
BZ	[34-39]	5	OFDM 903.2 MHz 400-2400 kbps

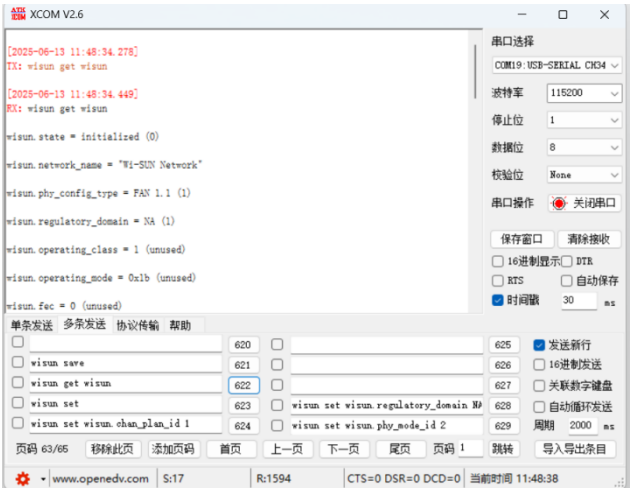
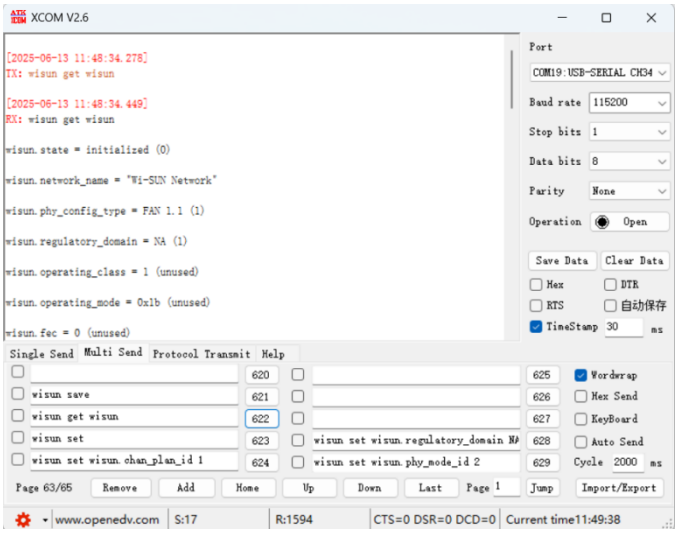
4.1.2 BR-side command descriptions

No	Step-by-step details	schema
1	Power-up Printing	

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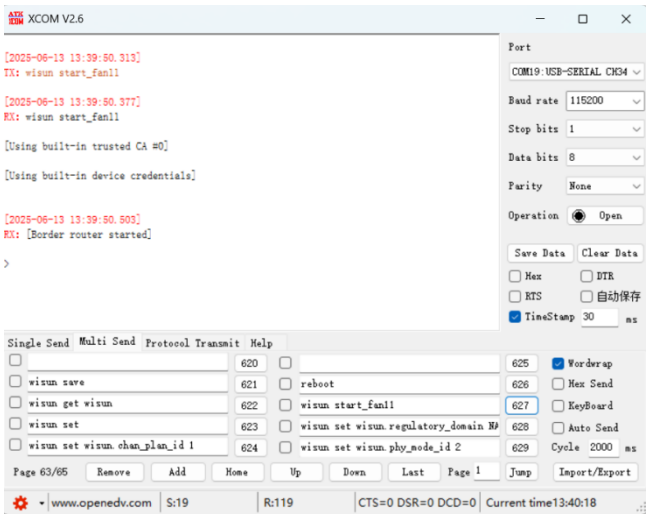
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<tr>
<td rowspan="2">2</td>
<td rowspan="2">Explanation of Commonly Used Commands (Detailed description of the commands can be found in the command manual)

● wisun get <section>. [setting] Query instruction For example, wisun get wisun;
● wisun set [section]. <setting> set a parameter value;
● wisun save save parameter to flash Note that wisun save needs to be called after wisun set parameter;
● wisun start_fan11 start wisun fan1.1 network;
● wisun stop stop wisun network;
● wisun mac_ allow <mac set mac filter; wisun set [section]. allow <mac> set mac filter;
● wisun ping <remote address> ping remote ipv6 address;
● wisun reset reset wisun related parameters;
● wisun socket_close close socket;
● wisun socket_read read data in the specified socket id; wisun socket_read read data in the specified socket id. id;</td>
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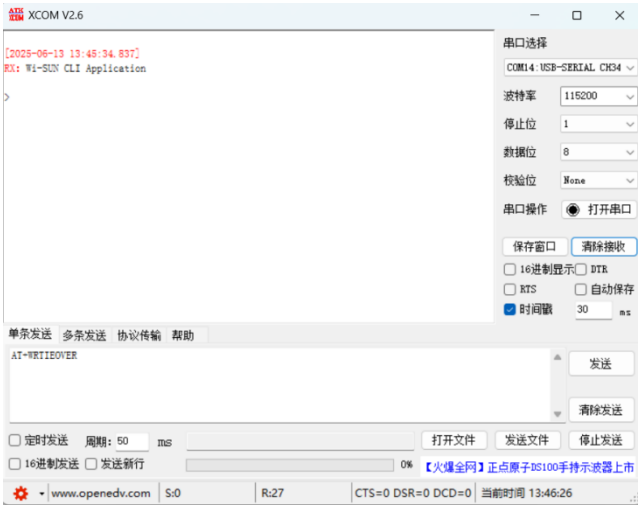
	• wisun socket_write Write data to the specified socket id; • wisun tcp_client Establish tcp client based on ipv6; • wisun tcp_server Establish tcp server based on ipv6; • wisun udp_client Establish udp client; • wisun udp_server establish udp server; • reboot reboot the device;	
3	Open the fan1.1 network (the prompt border router started indicates successful opening)	 
4	1) Set up power-on autostart wisun network • wisun set app.autostart 1 • wisun save • reboot 2) Set up modification of phy (note that it needs to correspond to the value in the	

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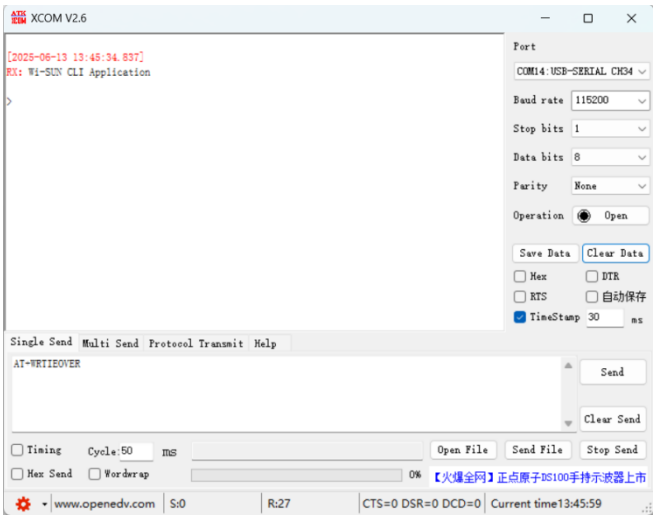
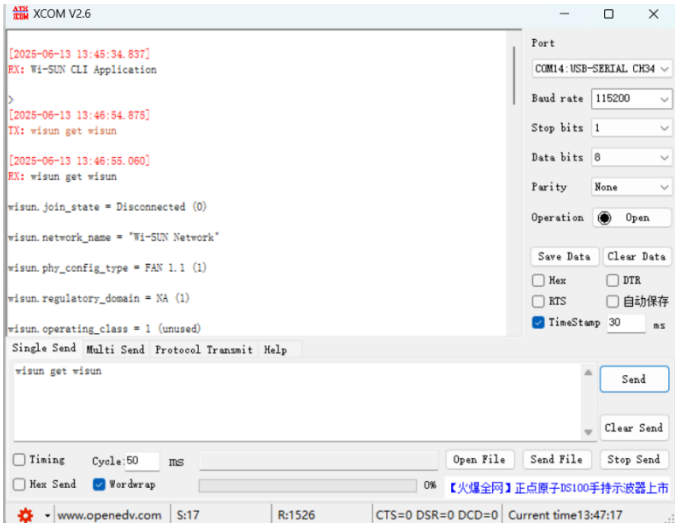
	phy table) • wisun set wisun.regulatory_domain NA • wisun set wisun.chan_plan_id 1 • wisun set wisun.phy_mode_id 2 • wisun save • Reboot 3) Set up power-up to automatically turn on wisun network • wisun set app.autostart 1 • wisun save • reboot 4) Set to modify phy (note that it needs to correspond to the value in the phy table) • wisun set wisun.regulatory_domain NA • wisun set wisun.chan_plan_id 1 • wisun set wisun.phy_mode_id 2 • wisun save •reboot

4.1.3 Node-side command descriptions

No	Step-by-step details	schema
1	Power-up Printing	

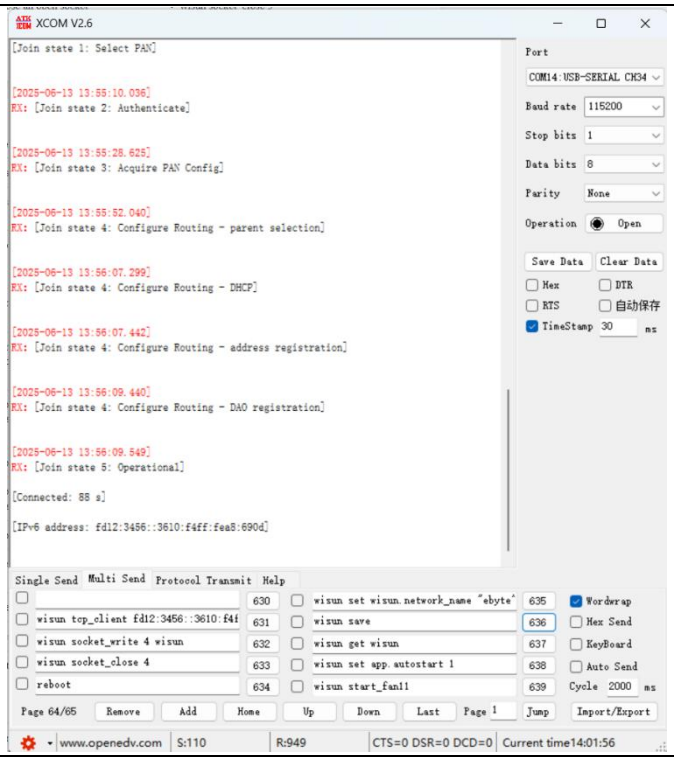
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2	Explanation of Commonly Used Instructions (Detailed description of the instructions can be found in the instruction manual) • wisun get <section>. [setting] Query instruction For example, wisun get wisun; • wisun set [section]. <setting> set a certain parameter value; • wisun save save parameter to flash Note that wisun save needs to be called after wisun set parameter to save; • wisun join_fan11 join wisun fan1.1 network; • wisun disconnect Disconnect the wisun network connection; • wisun mac_allow <mac Set mac filtering; • wisun ping <remote address> ping remote ipv6 address; • wisun reset resets wisun-related parameters; • wisun socket_close closes the socket; • wisun socket_read reads the data in the specified socket id; • wisun socket_write Write data to the specified socket id; • wisun tcp_client Establish a tcp client based on ipv6;	 

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	• wisun tcp_server Establish a tcp server based on ipv6; • wisun udp_client establish udp client; • wisun udp_server establish udp server; •reboot reboot the device;	
3	Join fan1.1 network (wait for the prompt ipv6 address that is marked as a network to join successfully, pay attention to change the longer time is expected to be about 100s)	 

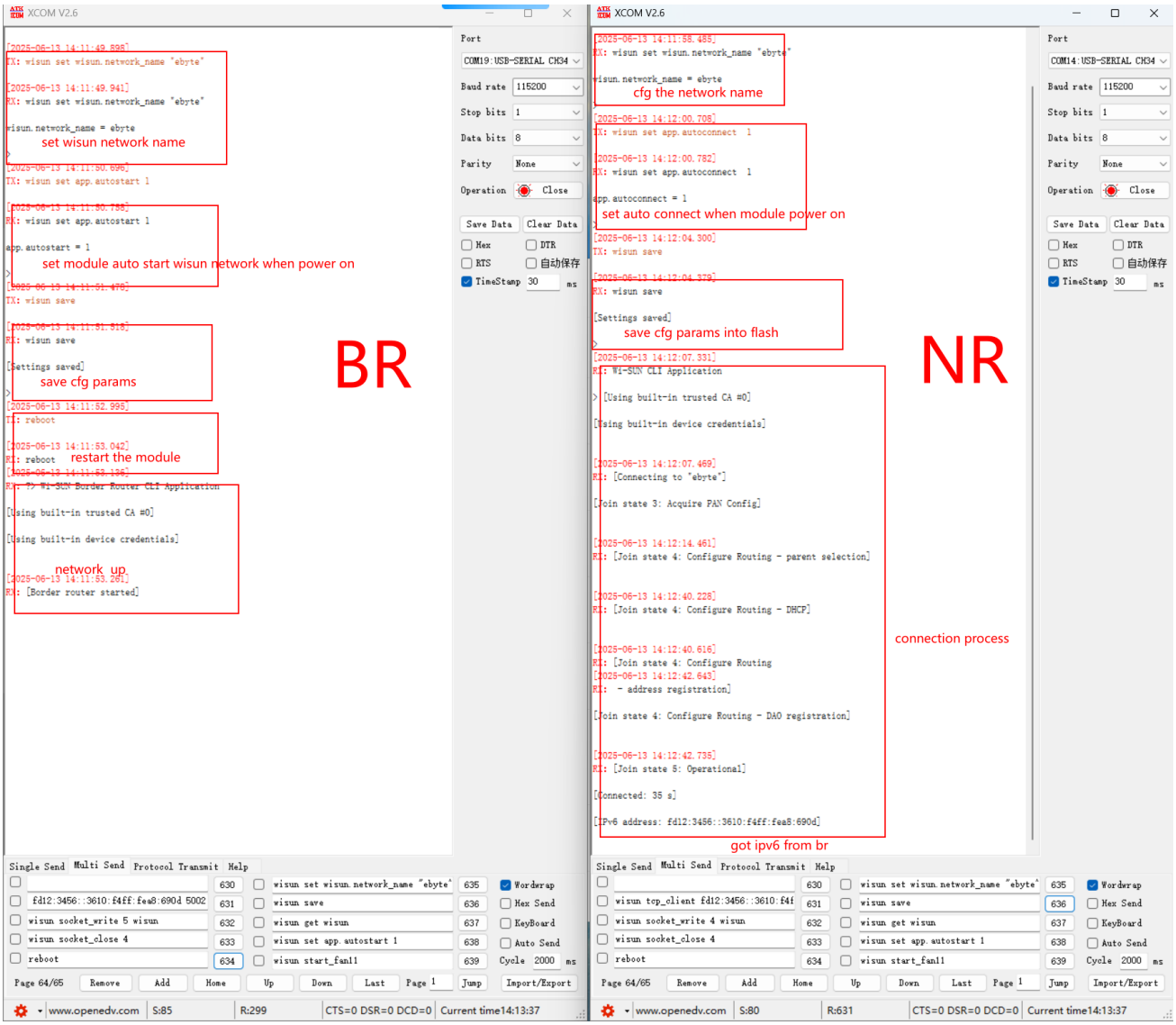
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4	1) Set up power-up to automatically turn on the wisun network wisun set app.autoconnect 1 wisun save manual key reset 2) Set up to modify the phy (note that it needs to correspond to the value in the phy table) wisun set wisun.regulatory_domain NA wisun set wisun.chan_plan_id 1 wisun set wisun.phy_mode_id 2 wisun save reboot join fan1.1 network (wait for the prompt ipv6 address that is marked as a network to join successfully, note that the change time is longer expected to be about 100s)

4.1.4 Demonstration of BR and Node networking and establishing a tcp connection.

- wisun network establishment process



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Figure 1 Schematic

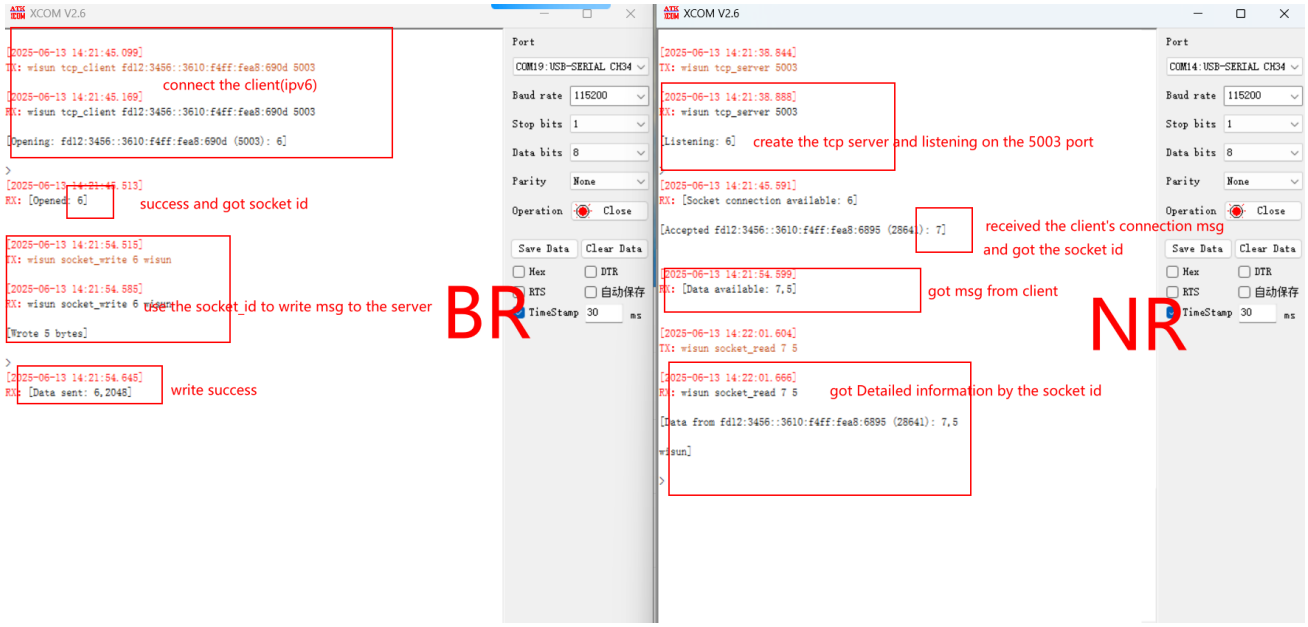


Figure 2 Schematic

4.2 Hardware design

- Recommend the use of DC regulated power supply to the module for power supply, power supply ripple factor as small as possible, the module needs to be reliably grounded;
- Please note that the power supply positive and negative poles of the correct connection, such as reverse may lead to permanent damage to the module;
- Please check the power supply to ensure that the power supply voltage in the recommended supply voltage, such as more than the maximum value will cause permanent damage to the module;
- Please check the stability of the power supply, the voltage should not be large and frequent fluctuations;
- in the design of power supply circuit for module In the design of power supply circuit for the module, it is often recommended to retain more than 30% of the margin, the whole machine is conducive to long-term stable work;
- module should be as far away as possible from the power supply, transformers, high-frequency alignment and other electromagnetic interference parts;
- high-frequency digital alignments, high-frequency analog alignments, power supply alignments must be avoided below the module, if it is really necessary to pass through the module below the assumption that the module is welded in the Top Layer, the module in contact with some of the Top Layer paved copper (all of them are). Top Layer copper (all copper and good grounding), must be close to the digital part of the module and alignment in the Bottom Layer;
- assuming that the module is welded or placed in the Top Layer, in the Bottom Layer or other layers of the arbitrary alignment is also wrong, will affect the module's stray to varying degrees, as well as the sensitivity of the reception;
- assuming that the module is surrounded by the existence of a larger Electromagnetic interference devices around the module will also greatly affect the performance of the module, according to the intensity of the interference is recommended to be appropriate away from the module, if the situation permits you can do appropriate isolation and shielding;
- Assuming that the module is surrounded by a large electromagnetic interference of the alignment (high-frequency digital, high-frequency analog, power supply alignment) will also greatly affect the performance of the module,

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according to the intensity of the interference is recommended to be appropriate away from the module, if the situation permits you can do appropriate isolation and shielding ;

- communication line if you use 5V level, must be connected in series with 1k-5.1k resistor (not recommended, there is still a risk of damage);
- try to stay away from some of the physical layer is also 2.4GHz TTL protocols, such as: USB3.0;
- antenna mounting structure of the module has a greater impact on the performance of the antenna to ensure that the antenna is exposed, preferably vertically upward. When the module is installed inside the chassis, you can use a high-quality antenna extension cable to extend the antenna to the outside of the chassis;
- antenna must not be installed inside the metal shell, which will lead to a great weakening of the transmission distance.
- If the module is connected to an external MCU, it is recommended to add a 200R protection resistor to the RXD/TXD of the external MCU.

4.3 Software authoring

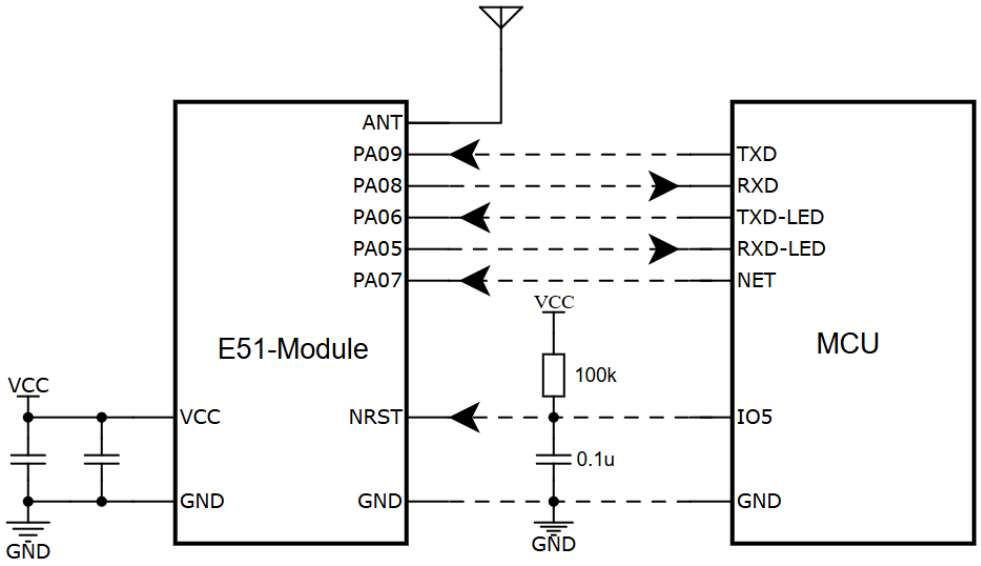
- This module is equipped with EFR32FG25 series chips, its driving method is completely equivalent to EFR32FG25 series chips, users can follow the EFR32FG25 series chip booklet completely;
- Module has access to 39MHz high-frequency crystal inside;
- Module has access to 32.768KHz low-frequency crystal inside;
- EFR32FG25A121F1152IM56 chip: Silicon Labs official website information download;
- Silicon Labs Wi-SUN SDK download address: gecko_sdk (Github);

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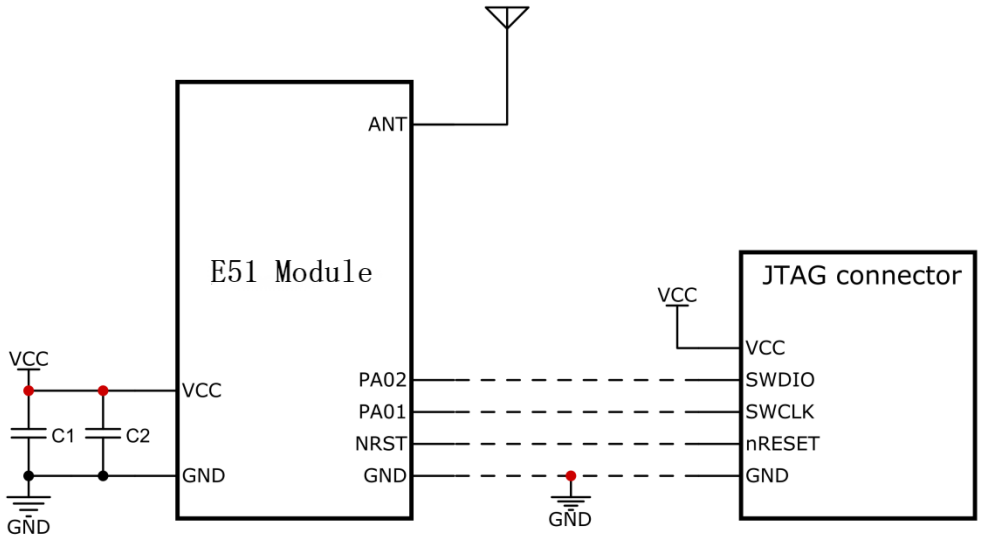
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5 Basic Applications

5.1 Basic Circuit Wiring Diagram



5.2 J-Link program download/debugging wiring diagram



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6 Common problems

6.1 Unsatisfactory transmission distance

- When there is a straight line communication obstacle, the communication distance will be attenuated accordingly;
- Temperature, humidity, same frequency interference, which will lead to communication packet loss rate increase;
- Ground absorption, reflection of radio waves, close to the ground test effect is poor;
- seawater has a strong absorption of radio waves, so the effect of the test is poor by the sea;
- antenna near the metal objects, or placed in a metal shell, the signal attenuation will be very serious;
- power register setting error, air rate setting is too high (the higher the air rate, the closer the distance); room temperature power supply low voltage is lower than the recommended voltage, the lower the power generation; the use of antenna and module matching degree is higher or the quality of the antenna itself The power register is set incorrectly, the air rate is set too high (the higher the air rate, the closer the distance);
- The low voltage of the power supply under room temperature is lower than the recommended value, and the lower the voltage, the lower the power;
- The antenna is poorly matched with the module or the antenna itself has quality problems.

6.2 Modules are fragile

- Please check the power supply to ensure that the recommended power supply voltage, such as exceeding the maximum value will cause permanent damage to the module;
- Please check the stability of the power supply, the voltage can not be substantial frequent fluctuations;
- Please ensure that the installation and use of the process of anti-static operation, high-frequency devices electrostatic sensitivity;
- Please ensure that the installation and use of the process of humidity should not be too high, some of the components are humidity-sensitive devices;
- If there is no special demand is not recommended to use the module in the too high, too low temperature. If there is no special demand, it is not recommended to use it under too high or too low temperature.

6.3 BER is too high

- Nearby is the same frequency signal interference, away from the source of interference or modify the frequency, channel to avoid interference;
- SPI on the clock waveform is not standard, check whether there is interference on the SPI line, SPI bus alignment should not be too long;
- Power supply is not ideal may cause garbled, be sure to ensure the reliability of the power supply;
- Extension cable, feeder line quality is poor or too long, will also cause high BER.

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7 Welding instructions

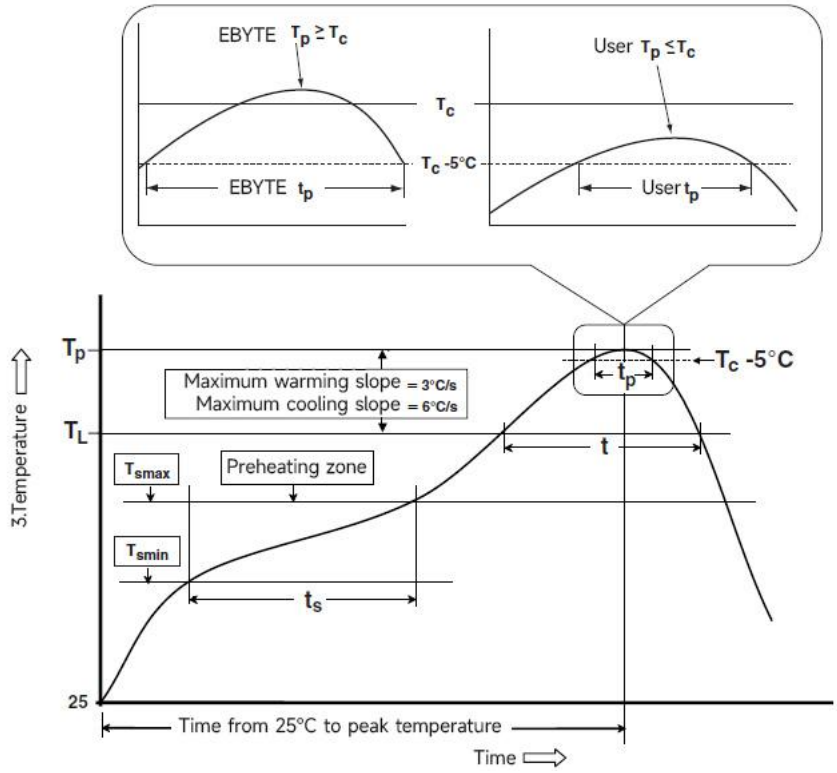
7.1 Reflow temperature

Reflow Profile Characteristics		Leaded process assembly	Lead-free process assembly
Preheating/Holding	Minimum temperature (Tsmin)	100℃	150℃
	Maximum temperature (Tsmax)	150℃	200℃
	Time (Tsmin~Tsmin)	60-120 秒	60-120 秒
Temperature Ramp-Up Slope (TL~Tp)		3°C/sec, max.	3°C/sec, max.
Liquid Phase Temperature (TL)		183°C	217°C
Holding Time Above TL		60~90 sec	60~90 sec
Encapsulation Peak Temperature Tp		The user must not exceed the temperature indicated on the product's “Moisture Sensitivity” label.	The user must not exceed the temperature indicated on the product's “Moisture Sensitivity” label.
Time (Tp) Within 5°C of Specified Classification Temperature (Tc), see below		20 seconds	30 seconds
Cooling Slope (Tp~TL)		6℃/sec, max	6℃/sec, max.
Room Temperature to Peak Temperature Time		6 minutes, max	8 minutes, max.
※The peak temperature (Tp) tolerance of the temperature profile is defined as the user's upper limit.			

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7.2 Reflow Profile



8 Related Models

Product Model	carrier frequency Hz	firing power dBm	Test Distance km	Package form	Product Size mm	communications interface	Product Model
E22-400M22S	SX1268	433/470M	22	7	SMD	14*20	SPI
E22-900M22S	SX1262	868/915M	22	7	SMD	14*20	SPI
E22-400M30S	SX1268	433/470M	30	12	SMD	24*38.5	SPI
E22-900M30S	SX1262	868/915M	30	12	SMD	24*38.5	SPI
E22-230T22S	SX1262	230M	22	5	SMD	16*26	TTL
E22-400T22S	SX1268	433/470M	22	5	SMD	16*26	TTL
E22-900T22S	SX1262	868/915M	22	5	SMD	16*26	TTL
E22-230T30S	SX1262	230M	30	10	SMD	25*40.5	TTL
E22-400T30S	SX1268	433/470M	30	10	SMD	25*40.5	TTL
E22-900T30S	SX1262	868/915M	30	10	SMD	25*40.5	TTL

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9 Antenna Guide

9.1 Antenna Recommendations

Antenna is an important role in the communication process, often poor-quality antenna will have a great impact on the communication system, so we recommend some of the antenna as a supporting our wireless module and the performance is more excellent and reasonably priced antenna.

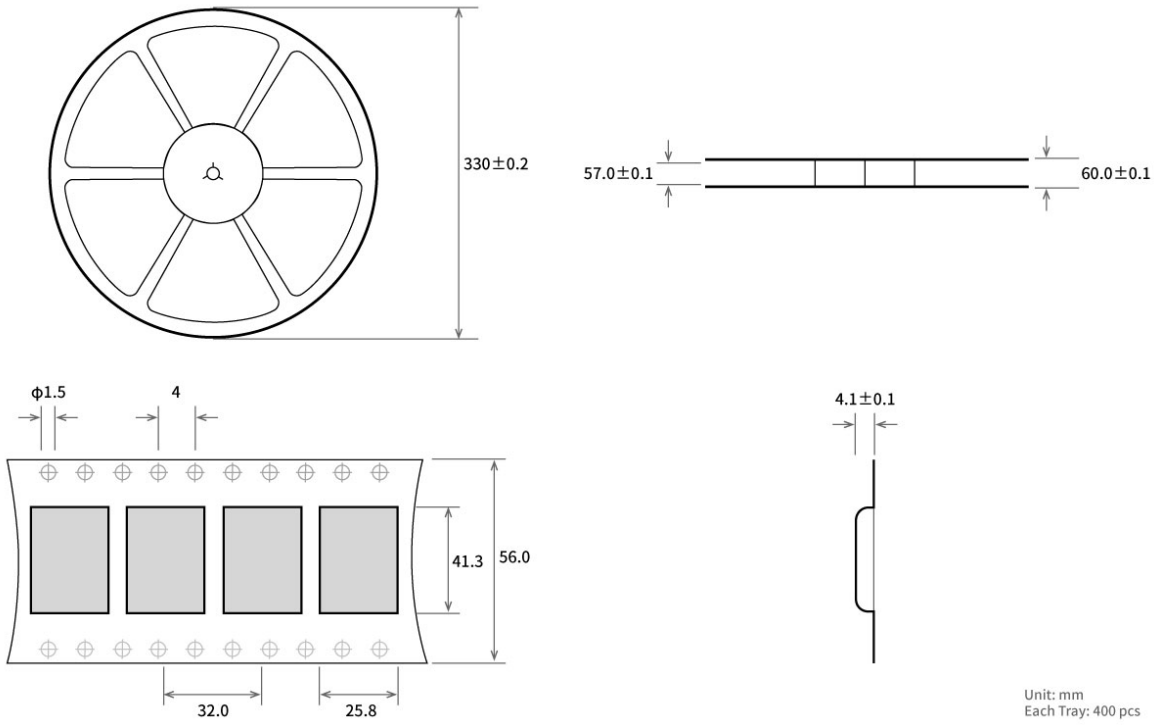
Product Model	types	frequency band Hz	interface	gain dBi	Height mm	Feeder cm	Features
TX433-NP-4310	Flexible Antennas	433M	welding	2.0	43.8*9.5	-	Built-in flexible, FPC soft antenna
TX433-JZ-5	Glue Stick Antennas	433M	SMA-J	2.0	52	-	Ultra-short straight, omni-directional antenna
TX433-JZG-6	Glue Stick Antennas	433M	SMA-J	2.5	62	-	Ultra-short straight, omni-directional antenna
TX433-JW-5	Glue Stick Antennas	433M	SMA-J	2.0	50	-	Bendable adhesive stick, omni-directional antenna
TX433-JWG-7	Glue Stick Antennas	433M	SMA-J	2.5	75	-	Bendable adhesive stick, omni-directional antenna
TX433-JK-11	Glue Stick Antennas	433M	SMA-J	2.5	110	-	Bendable adhesive stick, omni-directional antenna
TX433-JK-20	Glue Stick Antennas	433M	SMA-J	3.0	210	-	Bendable adhesive stick, omni-directional antenna
TX433-XPL-100	Suction Antennas	433M	SMA-J	3.5	185	100	Small sucker antenna, cost-effective
TX433-XP-200	Suction Antenna	433M	SMA-J	4.0	190	200	Medium-sized sucker antenna, low loss
TX433-XPH-300	Suction Antennas	433M	SMA-J	6.0	965	300	Large sucker antenna, high gain
TX490-JZ-5	Glue Stick Antennas	470/490M	SMA-J	2.0	50	-	Ultra-short straight, omni-directional antenna
TX490-XPL-100	Suction Antennas	470/490M	SMA-J	3.5	120	10	Small sucker antenna, cost-effective

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TX868-JKS-IPX20	Glue Stick Antennas	830-894M	IPEX-1	3.0	197	20	Bendable adhesive stick, omni-directional antenna
TX868-JZLW-15	Glue Stick Antennas	830-920M	IPEX-1	3.0	165	15	Ultra-short straight Omni Antenna
TX868-XPL-100	Suction Antennas	848-888M	SMA-J	3.5	290	100	Medium Suction Cup Antenna, Low Loss
TX915-XPL-100	Suction Antennas	900-925M	SMA-J	3.5	260	100	Medium Suction Cup Antenna, Low Loss

10 Batch packing method



Revision history

Version	revision date	Revision Notes	Defender
1.0	2023-8-1	Manual Releases	Ning
1.1	2025-5-28	New Models Added	Hao

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1.2	2025-9-11	Content revision	Hao

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