E51-470NW16S User Manual

EFR32FG25　　470/510MHz　　SMD SoC Module

Chengdu Ebyte Electronic Technology Co.,Ltd.

Catalog

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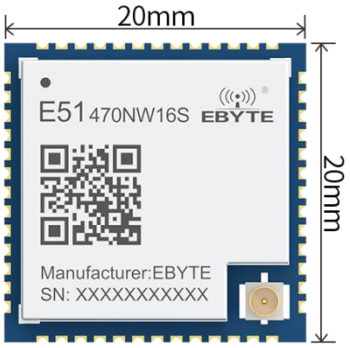
Chapter Ⅰ Overview

1.1 Brief Introduction

The E51-470NW16S is the ideal SoC (System on chip) hardware module for long distance, low power transmission, and it is equipped with Silicon Labs' EFR32FG25 series chip, which can achieve wireless broadcasting up to 0.3 to 2.5 kilometers in dense urban canyon environments with minimal data loss. It also supports the orthogonal Frequency division multiplexing modulation (OFDM) technology introduced in Wi-SUN Field Local Area Network (FAN), which can achieve high data bandwidth of up to 3.6 Mbps. As data rates increase, the large networks required for applications such as smart cities and smart utilities can be realized, where nodes can be in the thousands.

The E51-470NW16S wireless communication module has small dimensions, rich interface resources, and supports users' secondary development, which can be widely used in the Internet of Things industry。



1.2 Module Features

Low power wireless system on chip

- High-performance 32-bit 97.5MHz ARM Cortex®-M33 with DSP instructions and floating-point unit for efficient signal processing
- Up to 1152 kB of flash program memory
- RAM Up to 256 kB of data memory
- Up to +16 dBm transmit power

A wide selection of MCU peripherals

- Leads to up to 35 generic I/O pins with output state hold and asynchronous interrupt capabilities
- 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-channel Peripheral Reflection System (PRS)
- 6 16-bit timers/counters with 3 compare/capture /PWM channels
- 2 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 USB2.0 full speed port (device only)
- 5 x EUSART (Upgraded Universal Synchronous/Asynchronous Receiver/Transmitter)
  - EUSART0 runs in EM2
  - SPI and IrDA are supported by EUSART

Two I2C ports that support SMBus

chip temperature sensor with ±2° C accuracy over the entire temperature range

Wide operating range

- 2.0 to 5.5 V power supply, support OFDM mode power supply
- -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
- 2 (G)FSK with fully configurable molding functions
- MSK (G)

Chip-level security features

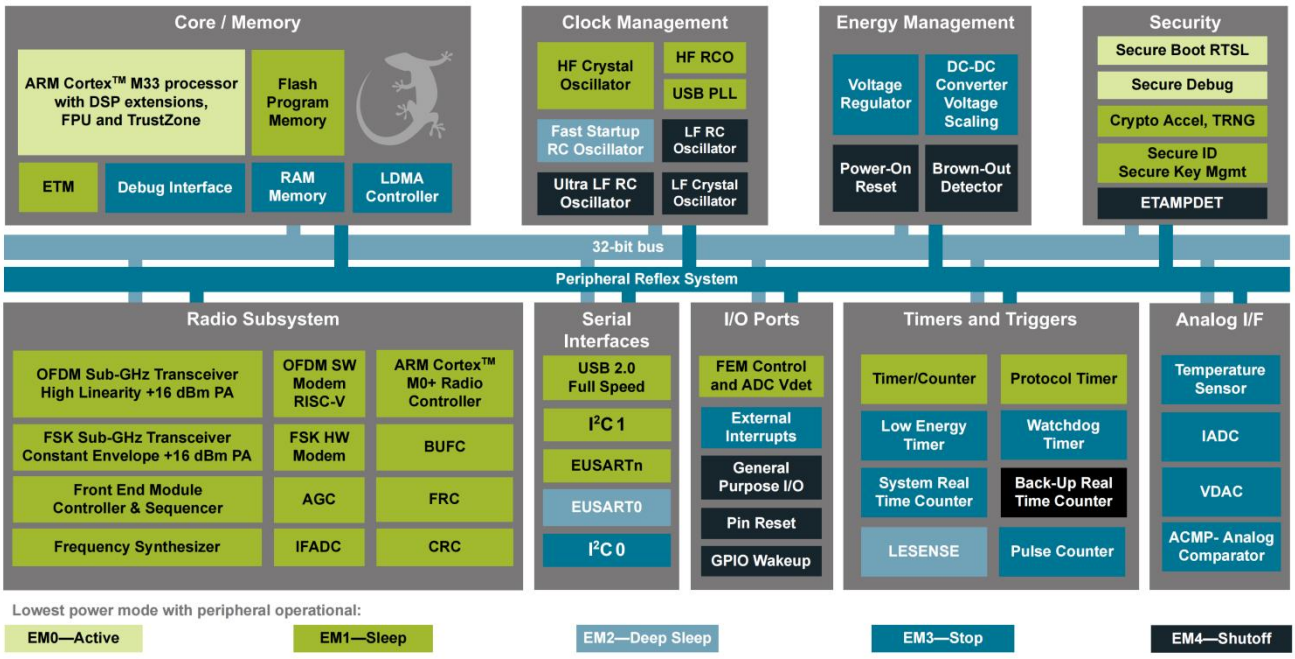
- Secure boot through Trust Root and Secure Loader (RTSL)
- Hardware encryption acceleration (up to 256 bits) with DPA countermeasures of AES128/256, SHA-1, SHA-2
- ECC (up to 256 bits), ECDSA, ECDH, and J-Pake
- True random number generator (TRNG), compliant with NIST SP800-90 and AIS-31 standards
- ARM® TrustZone®
- Secure debugging with lock/unlock

Protocal Support

- Proprietary Product Proprietary Agreement
- Wi - SUN

Package

- Patch stamp hole 20mm(L) x 20mm(W) x 3mm(H)



EFR32FG25 series chip internal function block diagram

1.3 Application

Wi-SUN (Wireless Intelligent Ubiquitous Network) is the leading IPv6 sub-1 GHz grid technology for smart city and smart utility applications. Wi-SUN delivers intelligent ubiquitous networks to service providers, utilities, municipal/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 covering line-powered and battery-powered nodes.

Silicon Labs' EFR32FG25 family of chips is certified by the Wi-SUN Alliance, a global industry association dedicated to seamless LPWAN connectivity. Wi-SUN is built on an open standard Internet Protocol (IP) and API foundation that enables developers to extend existing infrastructure platforms to add new features. Wi-SUN is designed to extend long range capabilities, high data throughput and IPv6 support to simplify the wireless infrastructure for industrial applications and smart city evolution.

- Smart City/Municipal Infrastructure;

- Industrial applications/Building automation/Distribution automation;
- Building security system;
- Smart home;
- Smart lighting/Street lighting;
- Advanced Meter Reading Architecture (AMI);
- Smart meter/Smart metering.

Chapter II Specification parameters

2.1 Limiting parameter

RF Parameters	Parameter value	Notes
Working Frequency	470~510 MHz	——
Power	16 dBm	The software is adjustable and needs to be developed by the user
Receiving sensitivity (GFSK)	-117.7 dBm	10 kbps 2GFSK signal, Δf = ± 25 kHz, BER<0.1%2
Receiving sensitivity (OFDM)	-116.8 dBm	10% packet error rate (PER) without interference, OFDM Option4, MCS0, header MCS0, with PL = 20 octets
Measured distance	2.5 km	Clear and open, antenna gain 3.5dBi, antenna height 2 meters, air speed 10kbps

2.2 Electrical parameter

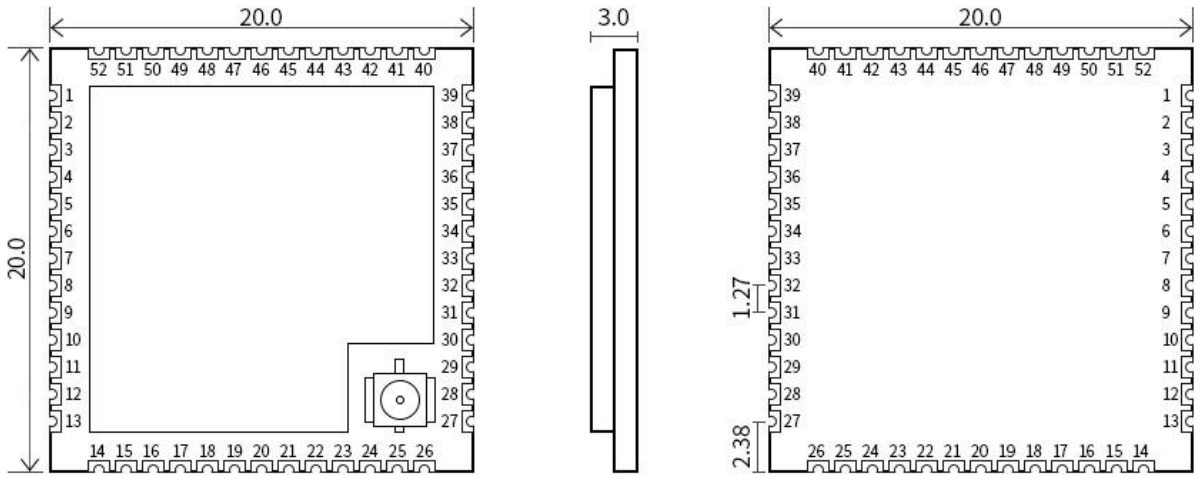
Electrical parameter	Min	Typical value	Max	Unit	Notes
Supply voltage	2.0	5.0	5.5	V	≥5.0V The output power is guaranteed, and more than 5.5V May damage the module.
Communication level	-	3.3	-	V	Level switching is recommended with 5.0V TTL
Emission current	-	81	-	mA	Instantaneous power consumption
Receiving current	-	11	-	mA	——
Sleep current	-	2.6	-	μA	EM2 Deep sleep
Operating temperature	-40	-	125	℃	——
Working humidity	10	-	90	%	——
Storage	-50	-	150	℃	——

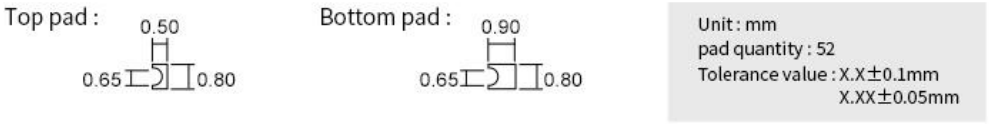
temperature					

2.3 Hardware parameter

Hardware parameter	Parameter value	Notes
IC 全称	EFR32FG25A121F1152IM56-B	Support OFDM, can be replaced with other models in the same series, welcome to consult
内核	ARM Cortex®-M33	97.5MHz, high-performance 32-bit ARM processor with DSP instructions and floating point unit
FLASH	1152 KB	Can be replaced with other models in the same series, up to 1152 KB support, welcome to consult
RAM	256 KB	Can be replaced with other models in the same series, up to 256 KB support, welcome to consult
Crystal frequency	39MHz/32.768KHz	The module has been connected. Procedure
Size	20 * 20 mm	——
Antenna Type	IPEX/Stamp Hole	The equivalent impedance is about 50Ω
Communication interface	Crystal frequencyUSB2.0、EUART、SPI、EUSART、PWM、ADC	Users need to develop their own Settings
Package way	SMD/stamp holes	The distance between the feet is 1.27mm
Weight	2.07±0.1g	——

Chapter III Mechanical dimensions and pin definition





Pin No.	Pin name	Pin direction	Pin using
1	GND	output	Ground wire, connected to the power reference ground
2	GND	output	Ground wire, connected to the power reference ground
3	GND	output	Ground wire, connected to the power reference ground
4	GND	output	Ground wire, connected to the power reference ground
5	PD07	input/output	Configurable generic IO ports (see EFR32FG25 manual)
6	PD06	input/output	Configurable generic IO ports (see EFR32FG25 manual)
7	PD05	input/output	Configurable generic IO ports (see EFR32FG25 manual)
8	PD04	input/output	Configurable generic IO ports (see EFR32FG25 manual)
9	PD03	input/output	Configurable generic IO ports (see EFR32FG25 manual)
10	PD02	input/output	Configurable generic IO ports (see EFR32FG25 manual)
-	PD01	-	Undrawn, connected 32.768KHz crystal oscillator as LFXTAL_I inside the module (see EFR32FG25 manual)
-	PD00	-	Undrawn, connected 32.768KHz crystal oscillator as LFXTAL_O inside the module (see EFR32FG25 manual)
11	GND	output	Ground wire, connected to the power reference ground
12	+5V	input	Power input +5V
13	+5V	input	Power input +5V
14	PC00	input/output	Configurable generic IO ports (see EFR32FG25 manual)

15	PC01	input/output	Configurable generic IO ports (see EFR32FG25 manual)
16	PC02	input/output	Configurable generic IO ports (see EFR32FG25 manual)
17	PC03	input/output	Configurable generic IO ports (see EFR32FG25 manual)
18	PC04	input/output	Configurable generic IO ports (see EFR32FG25 manual)
19	PC05	input/output	Configurable generic IO ports (see EFR32FG25 manual)
20	PC06	input/output	Configurable generic IO ports (see EFR32FG25 manual)
21	PC07	input/output	Configurable generic IO ports (see EFR32FG25 manual)
22	PC08	input/output	Configurable generic IO ports (see EFR32FG25 manual)
23	PC09	input/output	Configurable generic IO ports (see EFR32FG25 manual)
24	PC10	input/output	Configurable generic IO ports (see EFR32FG25 manual)
25	NRST	output	Chip reset triggers input pin, low level active
26	GND	output	Ground wire, connected to the power reference ground
27	GND	output	Ground wire, connected to the power reference ground
28	GND	output	Ground wire, connected to the power reference ground
29	ANT	output	Antenna interface, stamp hole (50Ω characteristic impedance), connected to the IPEX-1 interface
30	GND	output	Ground wire, connected to the power reference ground
31	GND	output	Ground wire, connected to the power reference ground
32	GND	output	Ground wire, connected to the power reference ground
33	GND	output	Ground wire, connected to the power reference ground
34	PB05	input/output	Configurable generic IO ports (see EFR32FG25 manual)
35	PB04	input/output	Configurable generic IO ports (see EFR32FG25 manual)
36	PB03	input/output	Configurable generic IO ports (see EFR32FG25 manual)
37	PB02	input/output	Configurable generic IO ports (see EFR32FG25 manual)
38	PB01	input/output	Configurable generic IO ports (see EFR32FG25 manual)
39	PB00	input/output	Configurable generic IO ports (see EFR32FG25 manual)
40	GND	output	Ground wire, connected to the power reference ground
41	PA00	input/output	Configurable generic IO ports (see EFR32FG25 manual)
42	PA01	input/output	Program debugging/download port SWCLK
43	PA02	input/output	Program debugging/download port SWDIO
44	PA03	input/output	Configurable generic IO ports (see EFR32FG25 manual)
45	PA04	input/output	Configurable generic IO ports (see EFR32FG25 manual)
46	PA05	input/output	Configurable generic IO ports (see EFR32FG25 manual)
47	PA06	input/output	Configurable generic IO ports (see EFR32FG25 manual)
48	PA07	input/output	Configurable generic IO ports (see EFR32FG25 manual)
49	PA08	input/output	Configurable generic IO ports (see EFR32FG25 manual)
50	PA09	input/output	Configurable generic IO ports (see EFR32FG25 manual)
51	PA10	input/output	Configurable generic IO ports (see EFR32FG25 manual)
52	PA11	input/output	Configurable generic IO ports (see EFR32FG25 manual)

Chapter IV basic operations

4.1 Hardware Design

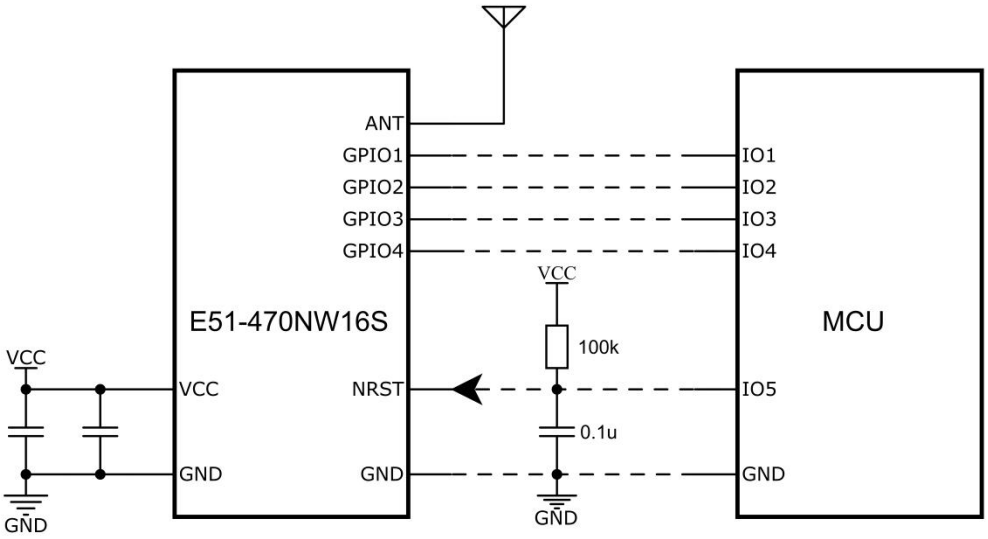
- It is recommended that the DC voltage regulated power supply be used for the module. The ripple coefficient of the power supply is as small as possible, and the module must be grounded reliably.
- Please pay attention to the correct connection of the positive and negative terminals of the power supply, such as reverse connection may cause permanent damage to the module;
- Check the power supply to ensure that the power supply voltage is within the recommended value. If the power supply voltage exceeds the maximum value, the module will be permanently damaged.
- Check the stability of the power supply and ensure that the voltage does not fluctuate greatly and frequently;
- When designing the power supply circuit for the module, it is often recommended to keep more than 30% of the margin, which is conducive to long-term stable operation of the whole machine;
- The module should be far away from the parts with large electromagnetic interference, such as the power supply, transformer, and high-frequency cable.
- The high-frequency digital cables, high-frequency analog cables, and power cables must be routed away from under the module. If you absolutely need to pass under the module, assume that the module is welded at the Top Layer. Lay copper on the Top Layer of the contact part of the module (all of it is covered with copper and well grounded) close to the digital part of the module and route the cables at the Bottom Layer.
- It is also wrong to assume that the module is welded or placed on the Top Layer, and random wiring in the Bottom Layer or other layers will affect the module's spurious and receiving sensitivity to varying degrees;
- Assuming that there are devices with large electromagnetic interference around the module, the performance of the module will be greatly affected. According to the intensity of interference, it is recommended to keep away from the module appropriately. If circumstances permit, appropriate isolation and shielding can be done.
- Assuming that there is strong electromagnetic interference (high frequency digital, high frequency analog, power supply wiring) around the module, the performance of the module will be greatly affected. According to the intensity of interference, it is recommended to keep away from the module appropriately. If circumstances permit, appropriate isolation and shielding can be done.
- If the communication line uses 5V level, it must be connected in series with 1k-5.1k resistance (not recommended, there is still risk of damage).
- Try to stay away from TTL protocols with some physical layers of 2.4GHz, such as USB3.0;
- The antenna installation structure has a great impact on the module performance. It is necessary to ensure that the antenna is exposed, preferably vertically upward. When the module is installed inside the housing, the antenna can be extended to the outside of the housing using a high-quality antenna extension cable;
- Do not install the antenna in the metal shell; the transmission distance will be greatly reduced.
- If the module is connected to an MCU, it is recommended to add 200R protection resistance to the RXD/TXD of the external MCU。

4.2 Software writing

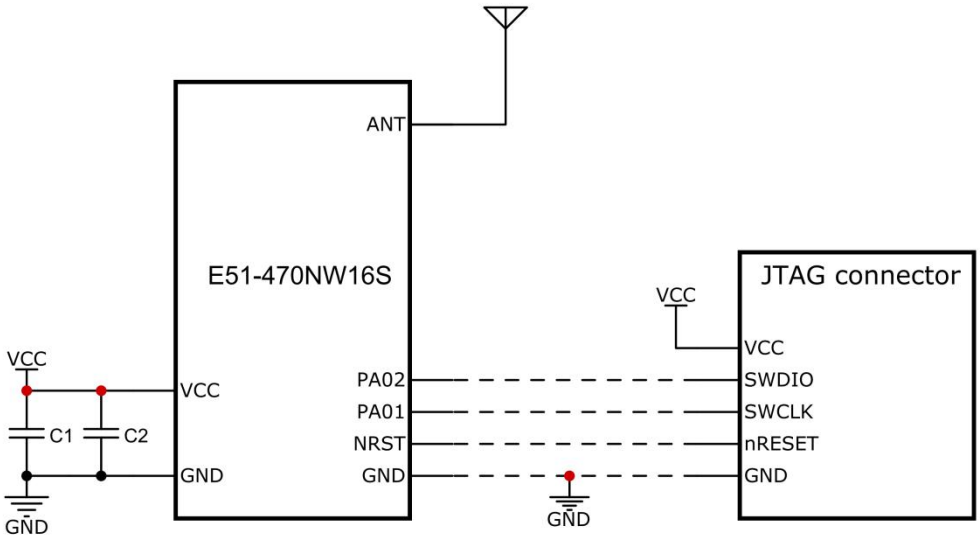
- This module is equipped with EFR32FG25 series chip, its driving mode is exactly the same as EFR32FG25 series chip, users can completely follow the EFR32FG25 series chip book to operate;
- The 39MHz high-frequency crystal oscillator has been connected to the module.
- A 32.768KHz low-frequency crystal oscillator has been connected to the module;
- EFR32FG25A121F1152IM56 chip: Silicon Labs 官网资料下载;
- Silicon Labs Wi-SUN SDK download address: gecko_sdk (Github) ;

Chapter V basic application

5.1 Basic circuit wiring diagram



5.2 J-Link program download/debugging cable diagram



Chapter VI FAQ

6.1 The transmission distance is not ideal.

- When there is a linear communication barrier, the communication distance will be attenuated accordingly;
- Temperature, humidity, same frequency interference, will lead to increased communication packet loss rate;
- The ground absorbs and reflects radio waves, and the test effect near the ground is poor;
- Sea water has a strong ability to absorb radio waves, so the seaside test results are poor;
- If there are metal objects near the antenna or placed in a metal shell, the signal attenuation will be very serious;
- Power register setting error, air speed setting is too high (the higher the air speed, the closer the distance);
- The power supply low voltage at room temperature is lower than the recommended value, the lower the voltage, the smaller the power;
- The matching degree between the antenna and the module is poor or the quality of the antenna itself is wrong.

6.2 Module easy to damage

- Check the power supply to ensure that the power supply voltage is within the recommended value. If the power supply voltage exceeds the maximum value, the module will be permanently damaged.
- Please check the stability of the power supply, the voltage should not fluctuate greatly and frequently;
- Ensure that the installation and use process are ESD preventive. The high-frequency devices are electrostatic sensitive.
- Ensure that the humidity is not too high during installation and use. Some components are humidity sensitive

devices.

- If there is no special need, it is not recommended to use at too high or too low temperatures.

6.3 The bit error rate is too high

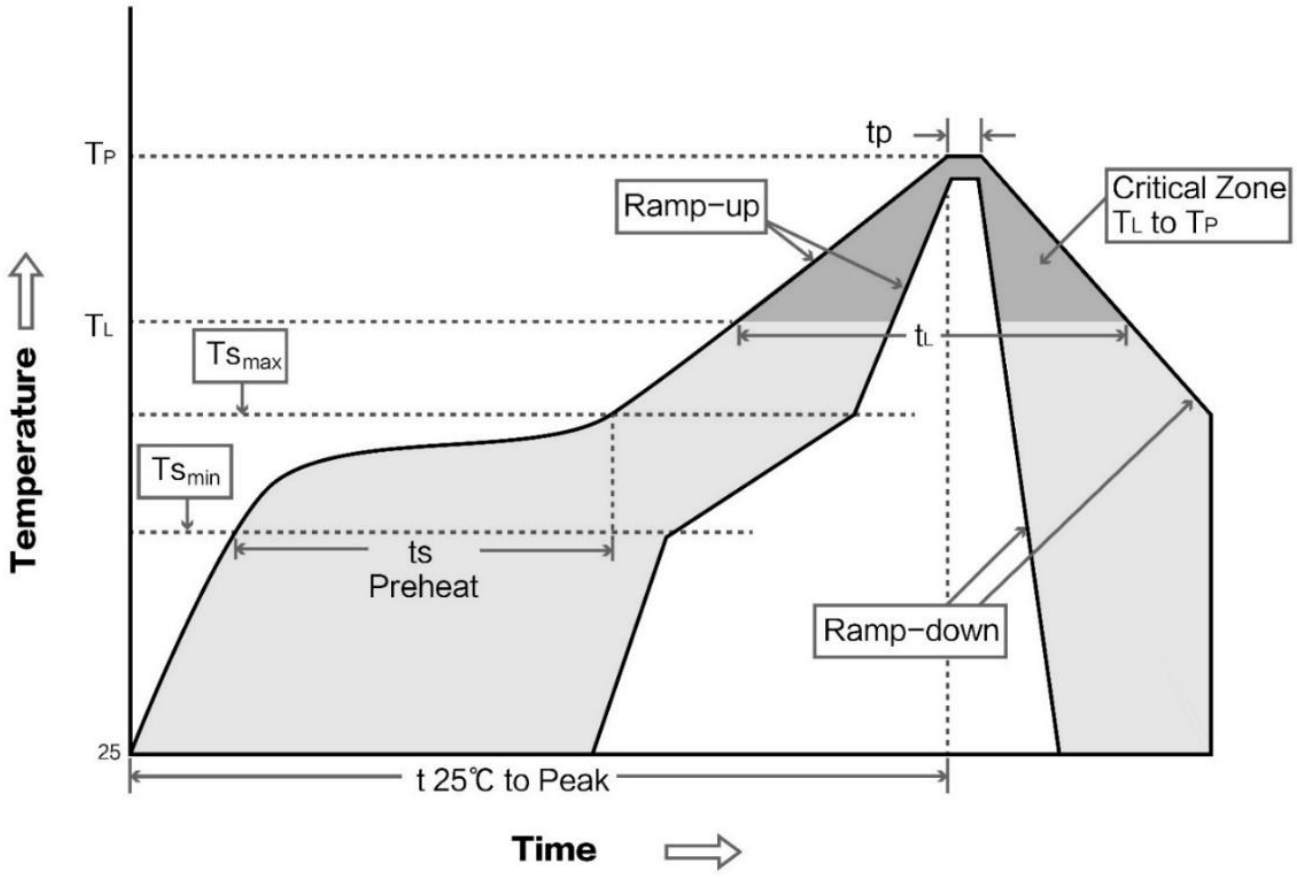
- It is nearby the same frequency signal interference, away from the interference source or modify the frequency, channel to avoid interference;
- The clock waveform on the SPI is not standard. Check whether there is interference on the SPI line. The SPI bus should not be too long.
- Power supply is not ideal may also cause garbled codes, be sure to ensure the reliability of the power supply;
- Extension wire, feeder quality is poor or too long, will also cause high bit error rate.

Chapter Ⅶ Welding operation instruction

7.1Reflow temperature

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

7.2 Reflow welding diagram



Chapter Ⅷ Related models

P/N	IC	Frequency Hz	Power dBm	Distance km	Package	Size mm	Interface
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

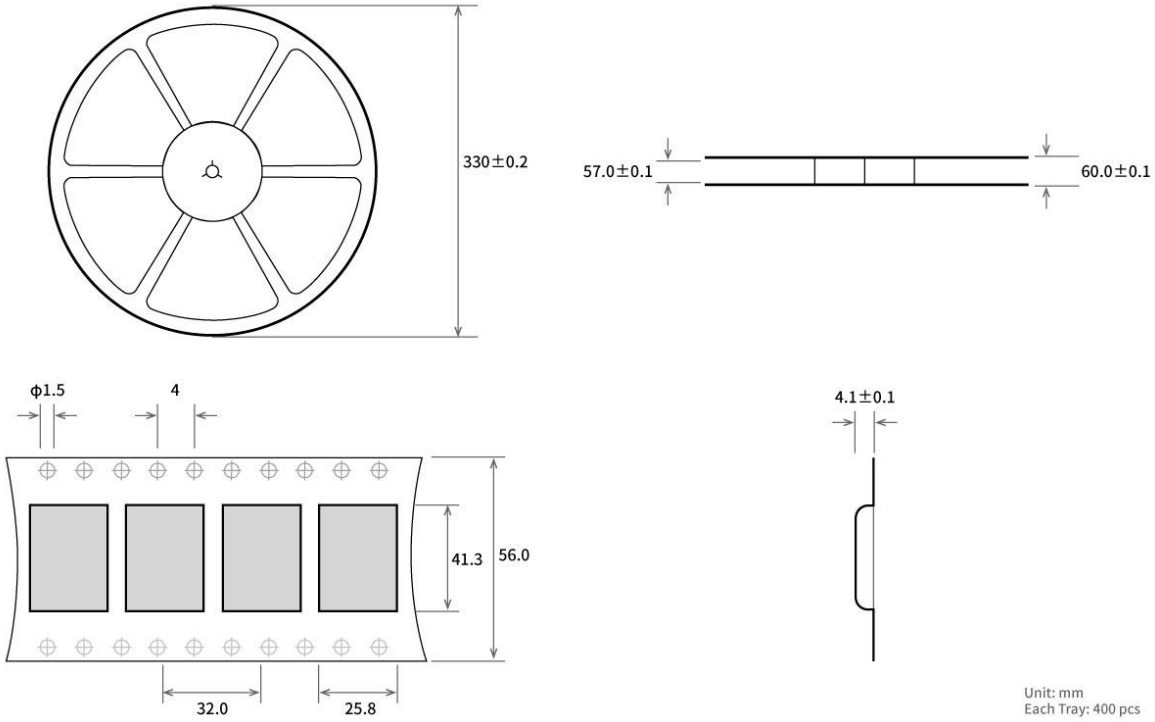
Chapter Ⅸ Antenna Guide

9.1 Antenna Recommendation

Antenna is an important role in the communication process, often poor antennas will have a great impact on the communication system, so we recommend some antennas as supporting our wireless module with better performance and reasonable price antennas.

P/N	Type	Frequency Hz	Interface	dBi dBi	Height mm	Feeder cm	Features
TX433-NP-4310	Soft antenna	433M	weld	2.0	43.8*9.5	-	Built-in flexible, FPC soft antenna
TX433-JZ-5	Rubber Antenna	433M	SMA-J	2.0	52	-	Ultra-short straight, omnidirectional antenna
TX433-JZG-6	Rubber Antenna	433M	SMA-J	2.5	62	-	Ultra-short straight, omnidirectional antenna
TX433-JW-5	Rubber Antenna	433M	SMA-J	2.0	50	-	Bend the glue stick, omnidirectional antenna
TX433-JWG-7	Rubber Antenna	433M	SMA-J	2.5	75	-	Bend the glue stick, omnidirectional antenna
TX433-JK-11	Rubber Antenna	433M	SMA-J	2.5	110	-	Bend the glue stick, omnidirectional antenna
TX433-JK-20	Rubber Antenna	433M	SMA-J	3.0	210	-	Bend the glue stick, omnidirectional antenna
TX433-XPL-100	Sucker antenna	433M	SMA-J	3.5	185	100	Small suction antenna, cost-effective
TX433-XP-200	Sucker antenna	433M	SMA-J	4.0	190	200	Neutral suction antenna, low loss
TX433-XPH-300	Sucker antenna	433M	SMA-J	6.0	965	300	Large suction antenna, high gain
TX490-JZ-5	Rubber Antenna	470/490M	SMA-J	2.0	50	-	Ultra-short straight, omnidirectional antenna
TX490-XPL-100	Sucker antenna	470/490M	SMA-J	3.5	120	100	Small suction antenna, cost-effective

Chapters X Batch packaging methods



Revision History

Version	Revise data	Revise notes	maintainer
1.0	2023-8-1	Manual release	Ning

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