



E31-400M17S



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1.Overview

1.1 Introduction

Designed by Ebyte, E31-400M17S is a micro-size(pin pitch:1.27mm) long range RF transceiving module with 400MHz central frequency(Range:425-450.5MHz); Based on AXSEM's AX5243 RF chip—a narrow-band multi-channel single-chip, the module has multiple modulation methods such as FSK / MSK / 4-FSK / GFSK. The module antenna interface is IPEX stamp hole. The Module uses a 26MHz ± 1 ppm industrial grade high precision low temperature drift active crystal oscillator to ensure the accuracy of wireless frequency, industrial performance and its stability.

The module is a pure RF transceiving hardware which requires MCU drivers or special SPI tool to configure before being put in work.

1.2 Main Features:

- The measured actual communication distance can reach 2km;
- The maximum transmission power is 17dBm (50mW);
- Broadband design 400MHz-525MHz, supporting the global license-free ISM 433MHz band;
- High receiving sensitivity and high receiving selectivity;
- Optional FEC, and automatic channel noise level tracking;
- Support multiple modulation modes (FSK / MSK / 4-FSK / GFSK / GMSK / ASK / AFSK / FM / PSK);
- Support wireless wake-up;
- Support DC 1.8 ~ 3.6V power supply, DC 3.3V-3.6V can guarantee the best performance;
- Industrial grade standard design, support long-term use from -40 to +85 °C;
- Small size design for easy integration;
- Dual antenna interface design (IPX/stamp hole) for easy secondary development and easy integration.

1.3 Applications

- Smart home and industrial sensors;
- Wireless meter reading (AMR);
- Building automation;
- Wireless network;
- Wireless remote control, drone;
- Health care products;
- Wireless audio, wireless headset;
- Compatible with: Wireless M-Bus, POCSAG, FLEX, KNX, Sigfox, Z-Wave, enocean;



2 Parameters

2.1 Limit Parameters

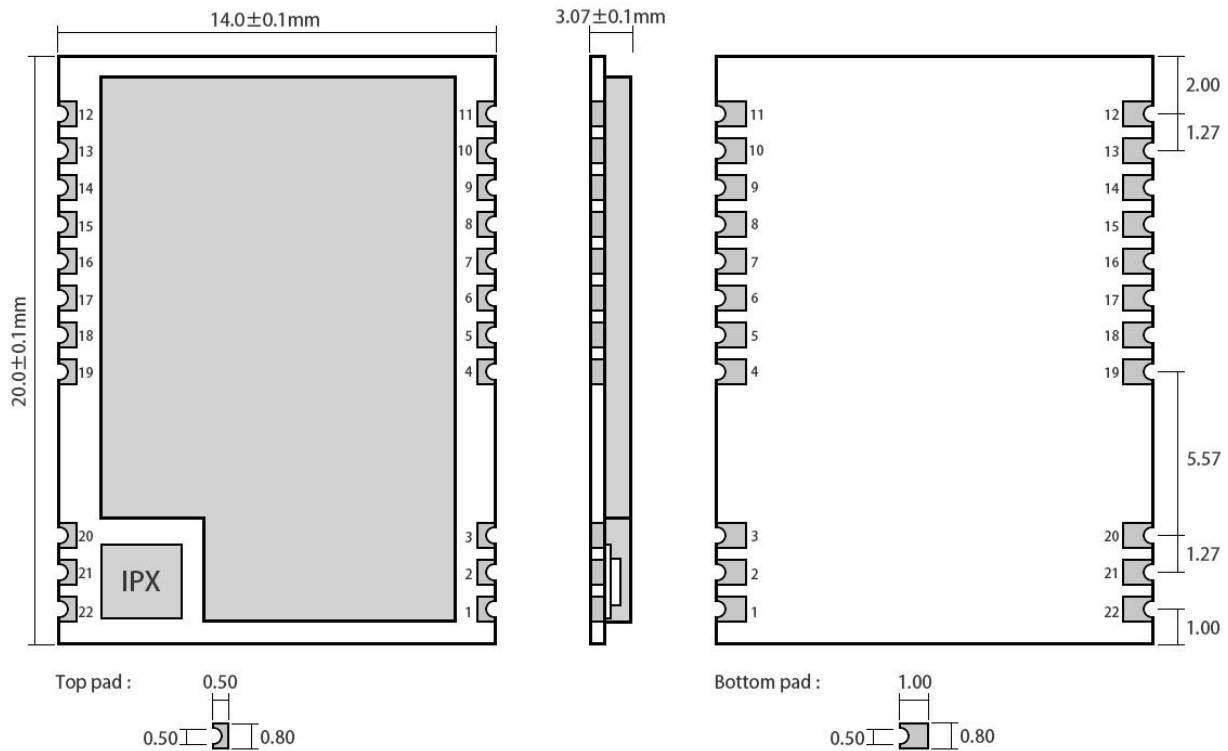
Main Parameters	Value		Remarks
	Min.	Max	
Input Voltage(V)	0	3.6	Permanent damage occurred when voltage is over 3.6V
Blocking Power(dBm)	-	10	Low chance to be damaged for short-distance transceiving
Working Temp.(°C)	-40	+85	Industrial Grade
Storage Temp.(°C)	-60	+150	-

2.2 Working Parameters

Main Parameters		Value			Remarks
		Min.	Typical	Max.	
Working Voltage(V)		1.8	3.3	3.6	DC 3.3V-3.6V can guaranty Max TX power
Tx Electrical Level(V)		-	3.3	-	5V TTL could cause permanent damage
Working Temp(°C)		-40	25	+85	Industrial Grade
Working Frequency Channel(MHz)		400	433	525	Applicable for ISM channel
Power Consumption	TX Current(mA)	70	80	90	Instantaneous power(could be different due to different Antenna performance)
	RX Current(mA)	12	13	14	Current when module receiving data.
	Sleeping Current(μA)	0.05	0.5	1	Deep sleep at ultra low power consumption(low frequency)
Max TX Power(dBm)		16	17	18	-
RX Sensitivity(dBm)		-	-135	-	At 0.1 kbps air rate
Air Rate(kbps)		-120	-121	-122	At 1.2kbps air rate(FSK/FEC)
Air Rate Range		0.1k	-	125	Adjustable by user

Parameters	Value	Remarks
Reference Tranceiving Range	2000m	Conditions: Clear Sky, Antenna Gain 5dBi, Antenna Height 2.5m, Air rate 1.2kbps
FIFO	256Byte	Max Length for single time transmitting
TCXO Frequency	26MHz	±1ppm
Protocol	GFSK(suggested)	FSK / MSK / 4-FSK / GFSK / GMSK / ASK / AFSK /FM / PSK
Encapsulation	SMD	/
Interface Type	1.27mm	/
Communication Port	SPI	0-10Mbps
Size	20*14mm	/
Weight	1.35±0.1g	/
Antenna Interfaces	IPEX/Stamp Hole	Stamp hole is suggested not to be connected when using IPX only, equivalent Impedance is around 50Ω

3. Sizes and Pins Definition



Weight : $1.35 \pm 0.1 \text{ g}$
Pad quantity : 22
Unit : mm

No.	Name	Type	Functions
1	GND	P	Ground wire, connected to the power reference ground
2	GND	P	Ground wire, connected to the power reference ground
3	GND	P	Ground wire, connected to the power reference ground
4	GND	P	Ground wire, connected to the power reference ground
5	GND	P	Ground wire, connected to the power reference ground
6	NC	-	Suspended Port
7	NC	-	Suspended Port
8	SYCLK	I/O	Crystal oscillator output; (see details from AX5243 manual)
9	VCC	P	Power supply, range 1.8 ~ 3.6V (additional external ceramic filter capacitor suggested)
10	GND	P	Ground wire, connected to the power reference ground
11	GND	P	Ground wire, connected to the power reference ground
12	GND	P	Ground wire, connected to the power reference ground
13	TCX0-P	I	The internal TCXO power supply of the module needs to be linked with the 14 pin when the TCXO pin of the AX5243 is enabled.
14	TCX0-EN	I/O	AX5243 external TCXO pin; (see AX5243 manual for details)
15	IRQ	I/O	Transceiver data interrupt; (see AX5243 manual for details)
16	SPI-MISO	O	SPI data output pin; (see AX5243 manual for details)

17	SPI-MOSI	I	SPI data input pin; (see AX5243 manual for details)
18	SPI-CLK	I	SPI clock input pin; (see AX5243 manual for details)
19	SPI-NSS	I	Module chip select pin for starting an SPI communication; (see AX5243 manual for details)
20	GND	P	Ground wire, connected to the power reference ground
21	ANT	A	Antenna interface, stamp hole (50 ohm characteristic impedance)
22	GND	P	Ground wire, connected to the power reference ground

4 User Guide

4.1 Notice for Hardware

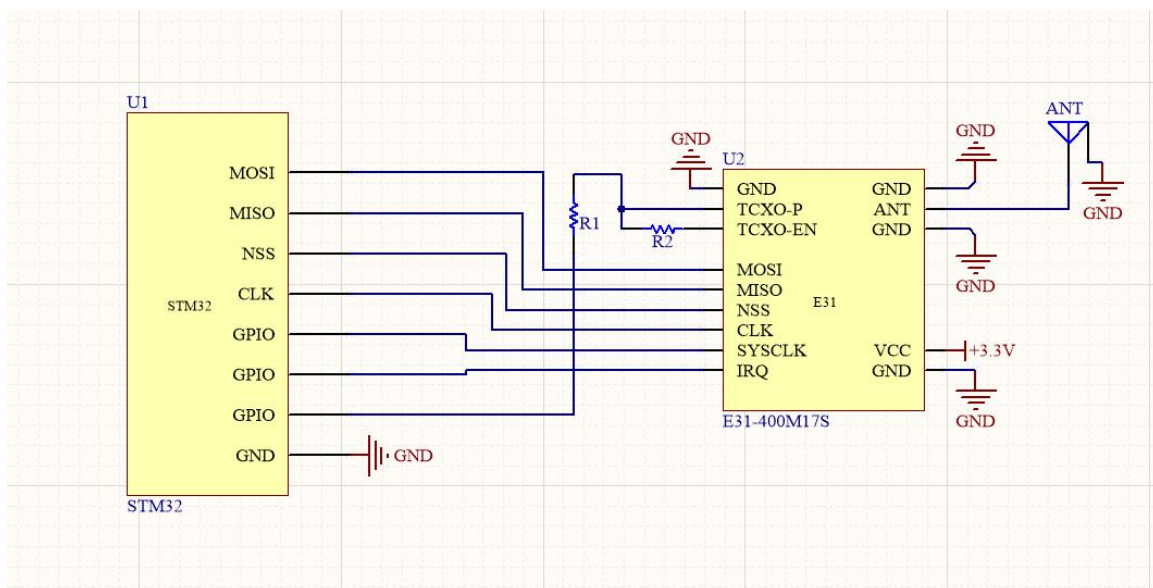
- It is recommended to use DC stabilized power supply. The power supply ripple factor should be as small as possible, and the module should be reliably grounded.
- Please ensure that the positive and negative poles of the power supply are properly connected. If the reverse connection is made, the module may be permanently damaged.
- Please ensure the power supply voltage is within the working voltage range. If the maximum voltage is exceeded, the module will be permanently damaged.
- Please check the stability of the power supply, and the voltage cannot be fluctuated frequently;
- When designing the power supply circuit for the module, it is recommended to reserve more than 30% of the margin to achieve long-term stable operation of the system;
- The installation location of 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 avoid module locations. If the wiring must pass under the module, assuming that the module is soldered to the Top Layer, the area where the module is in contact with the Top Layer should be covered with copper (all copper is well grounded), and the area must be close to the digital part of the module and routed in the Bottom Layer;
- If the module is soldered or placed in the Top Layer, it is wrong to randomly route on the Bottom Layer or other layers, which will affect the spurs and receiving sensitivity of the module to varying degrees;
- If there is a device with large electromagnetic interference around the module, it will greatly affect the performance of the module. It is recommended to maintain the distance from the module according to the strength of the interference. If circumstances permit, it is recommended to do proper isolation and shielding;
- If there are wirings with large electromagnetic interference around the module (such as high frequency digital, high frequency analog, power line), the performance of the module will be greatly affected. It is recommended to do proper isolation and shielding;
- If the communication line uses 5V level, it must be connected in series with a 1k-5.1k resistor (not recommended, there is still risk of damage);
- Try to keep away from some physical layers as much as possible to avoid electromagnetic interference to other devices;
- The antenna installation has a great influence on the performance of the module. Make sure that the antenna is exposed and preferably vertical. When the module is installed inside the casing, it is recommended to use a good antenna extension cable to extend the antenna to the outside of the casing;
- The antenna must not be installed inside the metal case, which will greatly reduce the transmission distance.

4.2 Programming

- This module is developed based on AX5243, and its driving method is completely equivalent to AX5243. Users can operate in full accordance with AX5243 user manual;
- IRQ function can be disconnected and use SPI query to obtain the interrupt status, but it is recommended to use the external interrupt of the microcontroller.
- After the sleep mode is configured on the AX5243, it is recommended to re-initialize the power configuration table.

5 Electronic Diagram

5.1 Circuit Diagram



Via R1 and R2, Module TCXO power can be choosed either from the external microcontroller or enabling AX5243

6 FAQ

6.1 Communication range is too short

- The communication distance will be affected when obstacle exists.
- Data lose rate will be affected by temperature, humidity and co-channel interference.
- The ground will absorb and reflect wireless radio wave, so the performance will be poor when testing near ground.
- Sea water has great ability in absorbing wireless radio wave, so performance will be poor when testing near the sea.
- The signal will be affected when the antenna is near metal object or put in a metal case.
- Power register was set incorrectly, air data rate is set as too high (the higher the air data rate, the shorter the distance).
- The power supply low voltage under room temperature is lower than 2.5V, the lower the voltage, the lower the transmitting power.
- Due to antenna quality or poor matching between antenna and module.

6.2 Module is easy to damage

- Please check the power supply source, ensure it is 2.0V~3.6V, voltage higher than 3.6V will damage the module.
- Please check the stability of power source, the voltage cannot fluctuate too much.
- Please make sure antistatic measure are taken when installing and using, high frequency devices have electrostatic susceptibility.
- Please ensure the humidity is within limited range, some parts are sensitive to humidity.
- Please avoid using modules under too high or too low temperature.

6.3 BER (Bit Error Rate) is high

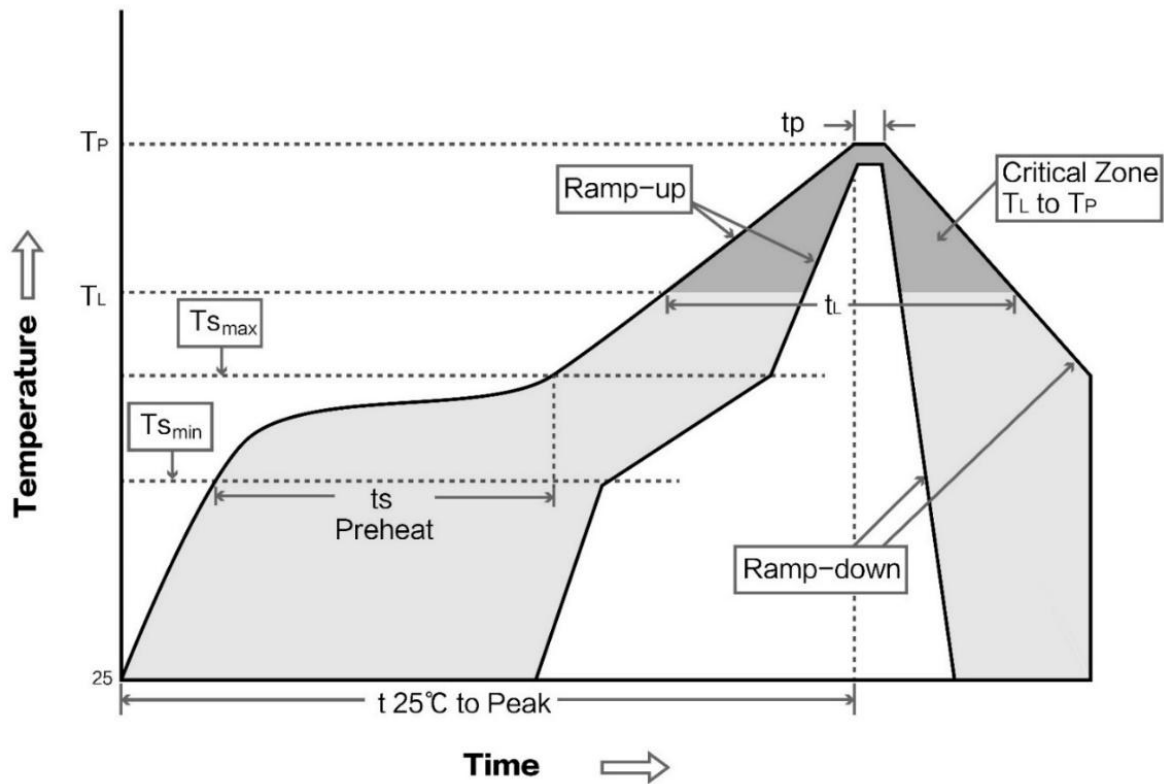
- There are co-channel signal interference nearby, please be away from interference sources or modify frequency and channel to avoid interference;
- Poor power supply may cause messy code. Make sure that the power supply is reliable.
- The extension line and feeder quality are poor or too long, so the bit error rate is high;
- The clock waveform on the SPI is not standard: Check whether there is interference on the SPI line or the SPI bus line should not be too long.

7 Soldering Guidance

7.1 Reflow Soldering Temperature

Profile Feature	Curve characteristics	Sn-Pb Assembly	Pb-Free Assembly
Solder Paste	Solder paste	Sn63/Pb37	Sn96.5/Ag3/Cu0.5
Preheat Temperature min (T _{smin})	Min preheating temp.	100°C	150°C
Preheat temperature max (T _{smax})	Mx preheating temp.	150°C	200°C
Preheat Time (T _{smin} to T _{smax})(t _s)	Preheating time	60-120 sec	60-120 sec
Average ramp-up rate(T _{smax} to T _p)	Average ramp-up rate	3°C/second max	3°C/second max
Liquidous Temperature (T _L)	Liquid phase temp.	183°C	217°C
Time(t _L)Maintained Above(T _L)	Time below liquid phase line	60-90 sec	30-90 sec
Peak temperature(T _p)	Peak temp.	220-235°C	230-250°C
Average ramp-down rate(T _p to T _{smax})	Average ramp-down rate	6°C/second max	6°C/second max
Time 25°C to peak temperature	Time to peak temperature for 25°C	6 minutes max	8 minutes max

7.2 Reflow soldering curve



8 Models:

Model	Chip	Freq. Range	Power	Tested Communicating Range	Size	Encapsulation	Communicating Interface
		Hz	dBm	km	mm		
E31-433T17S3	AX5243	425-450.5MHz	17	3	26*16	SMD	TTL
E31-433T30S	AX5243	425-450.5MHz	30	8	40.5*25	SMD	TTL
E31-400M17S	AX5243	400-525MHz	17	3	20*14	SMD	SPI

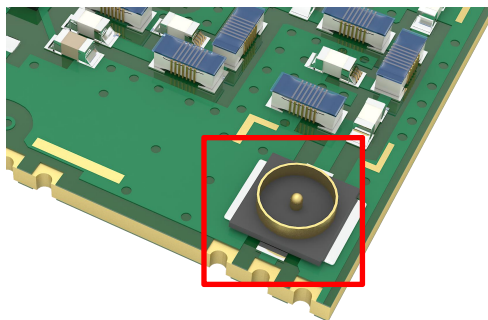
9 Antenna Guidance

9.1 Antenna Recommendation

Antenna lays an important role in the communication process. Inferior antennas often have a great negative impact on the communication system. Therefore, we recommend below antennas which are compliant with our wireless modules and have excellent performance and reasonable price.

Model	Type	Freq.	Gain	Size	Feeder Length	Interface	Features
		Hz	dBi	mm	cm		
TX2400-PCB-5010	FPC antenna	2.4G	2.0	10x50	-	IPEX	Flexible FPC soft antenna
TX2400-JZ-3	Plastic Antenna	2.4G	2.0	30	-	SMA-J	Ultra short straight, omnidirectional antenna
TX2400-JZ-5	Plastic Antenna	2.4G	2.0	50	-	SMA-J	Ultra short straight, omnidirectional antenna
TX2400-JW-5	Plastic Antenna	2.4G	2.0	50	-	SMA-J	Fixed bending, omnidirectional antenna
TX2400-JK-11	Plastic Antenna	2.4G	2.5	110	-	SMA-J	Foldable, omnidirectional antenna
TX2400-JKD-20	Plastic Antenna	2.4G	3.0	200	-	SMA-J	Foldable, omnidirectional antenna
TX2400-XPL-150	Sucker Antenna	2.4G	3.5	150	150	SMA-J	Small suction antenna, cost-effective

9.2 Antenna Interface Choosing



The module has two antenna interface modes: IPX and stamp hole. When using the IPEX interface, it is recommended not to connect that the stamp hole interface.

10 Revision History

Version	Date	Description	Issued by
1.0	2019-08-15	Initial version	--
1.1	2019-8-20	Error correction	Lyl

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