M390

LoRa Module Datasheet

V1.0.0

EasyLinkin

Sensing the World

Catalogue

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1. Product Overview

1.1 Introduction

M390 module is our self-developed LoRa module. It is integrated with LoRaWAN protocol stack, compatible with LoRaWAN specification (V1.0.3, Class A/B/C) released by LoRa Alliance, which supports the connectivity function for different end devices. The module can support wide frequency band 150~960MHz.

With UART interface to interchange data or command, M390 provides an easy way to access LoRaWAN network and explore wireless data applications.

M390 module uses Semtech's SX1268/2 chip,has many features as low power, long range and high anti-interference etc, which can be used in many applications as smart metering, smart city and smart building etc.

1.2 Features

- Low power consumption: minimum standby current 1.5uA
- High sensitivity: up to -139dBm@SF12/125KHz
- Anti-interference: high performance spread spectrum communication with efficient cycle interleaved error correction
- Compliant-with LoRaWAN Specification 1.0.3
- On-board LoRaWAN Class A/B/C protocol stack
- UART interface, stamp hole, support parameters configuration through AT command.

1.3 Applications

- Automated metering reading
- Home and building automation
- Smart agriculture
- Industrial automation

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2. Specification

2.1 General Specification

	Specification	Description
Appearance	Model	M390
	Picture	
Transmission	Protocol	LoRaWAN V1.0.3
	Topology	Star
	Device Type	Class A/B/C
	Activation Mode	OTAA/ABP
	Modulation	CSS (Chirp Spread Spectrum)
	Frequency Band	EU433MHz/CN470MHz/EU868MHz/US915MHz/AS923MHz
	Center Frequency	Can be customized
	Bandwidth	125/250/500KHz configurable
	Data Rate	0.018-37.5kbps
	RX Power	+22dBm (max)
	TX Sensitivity	-139dBm@SF12/125KHz
Interface	Supply Voltage	DC 3.3V (2.0-3.6V)
	IOs	GPIO*4, UART*1, I2C*1 (Reserved)
	Baud Rate Of Serial Port	1200/2400/4800/9600/19200/38400/57600/115200bps, default is 9600bps
	Antenna Interface	IPEX base/Stamp hole, default is IPEX base
	Antenna Type	Omni directional or Directional (Spring Antenna is recommended)

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	Pin Encapsulation	Stamp hole
	Dimension	15.5(L)*15(W)*2.5(H)mm (SMA connector not included）
Others	Operating Environment	-40℃--85℃, 10%--90%RH
	Storage Environment	-40℃--105℃, 5%--95%RH

2.2 Electrical Specification

Operating voltage: 3.3V, Operating temperature: 25±2℃.

Specification	Test condition	MIN	TYP	MAX	Unit
Supply Voltage	Guaranteed Max Power Output (22dBm)	2.0	3.3	3.6	V
Operating Current	TX,+22dBm	-	100		mA
	TX,+17dBm		68		
	RX	-	8	-	mA
	Standby (Class C)	-	8	-	mA
	Standby (Class A)	1.1	1.5	1.8	uA
Operating Frequency	Low Frequency	470	-	510	MHz
	High Frequency	862	-	932	MHz
Operating Temperature		-40	-	85	℃
Operating Humidity		10%	-	90%	RH
Transmit	OOK mode, Carrier output, PA_BOOST ON, 25±2℃				
Max Transmit Power	PA_BOOST Output Full Load Power	21	21.6	22	dBm

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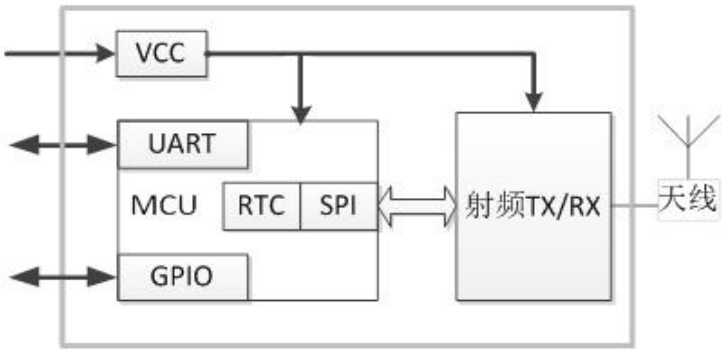
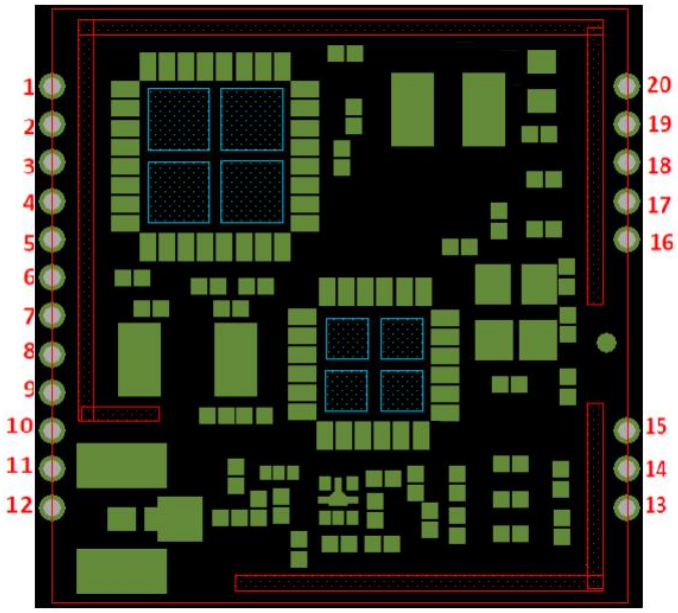
Second Harmonic		-	-36	-	dBm
Receiving	PER = 1%， CR = 4/5,CRC ON,Preamble Length = 12，Packet Length = 10				
Sensitivity	SF12，125kHz	-	-139	-	dBm
Frequency Stability		±2ppm@-40℃~85℃			

3. Interface and Design Description

3.1 Block Diagram



3.2 Pin Diagram



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3.3 Pin Description

All the IO ports are compatible with CMOS and TTL.

Name	Pin	IO	Type	Description
Power				
VCC	20	P	Supply voltage. Default: 3.3V	Make sure transient discharge current > 120mA, to avoid module reset when RF is transmitting.
GND	11/13/14/19	P	Power	Ground
UART Port				
TXD	2	O	TTL Voltage output, data transmit	
RXD	1	I	TTL Voltage input, data receive	
GPIO				
STATUS	5	O	Status indication: LOW Output: idle HIGH Output: busy In network joining process, output HIGH for 500ms once every 10s. In data transmission process, output HIGH for 50ms once every data transmission.	Attach external LED indicator. Imax=5mA
AUX	9	I/O	TBD	NC
SETA	10	I	Wake up input: When falling edge is detected, module will wake	Before data transmission, drive high level voltage to lower, waiting for 5ms, then drive it higher.

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			up, waiting for sleep or non- sleep command. If there is no command after waiting for 10s, module will be back to sleep automatically.	If PIN keeps in low voltage, module will in a continuous running state.
SETB	3	O	Data transmit indication: Output LOW voltage in 50ms before data transmit; Output HIGH voltage if no data transmit happens after 10ms.	Only HIGH voltage detected, host MCU can enter sleep mode. Otherwise it will cause data loss.
ANT				
RF_ANT	12	RF	Antenna interface, 50Ω,connect to IPEX base	To use stamp hole, please reserve antenna matching circuit on PCB, ask Easylink engineer for more information.
Others				
NRST	18	I	MCU Reset, low level voltage is valid	Power on reset circuit inside.
SWDIO	7	I/O	MCU write DATA	
SWCLK	8	I	MCU write CLK	
NC	4/6/15/16/17	--	RFU (Reserved)	Not connected

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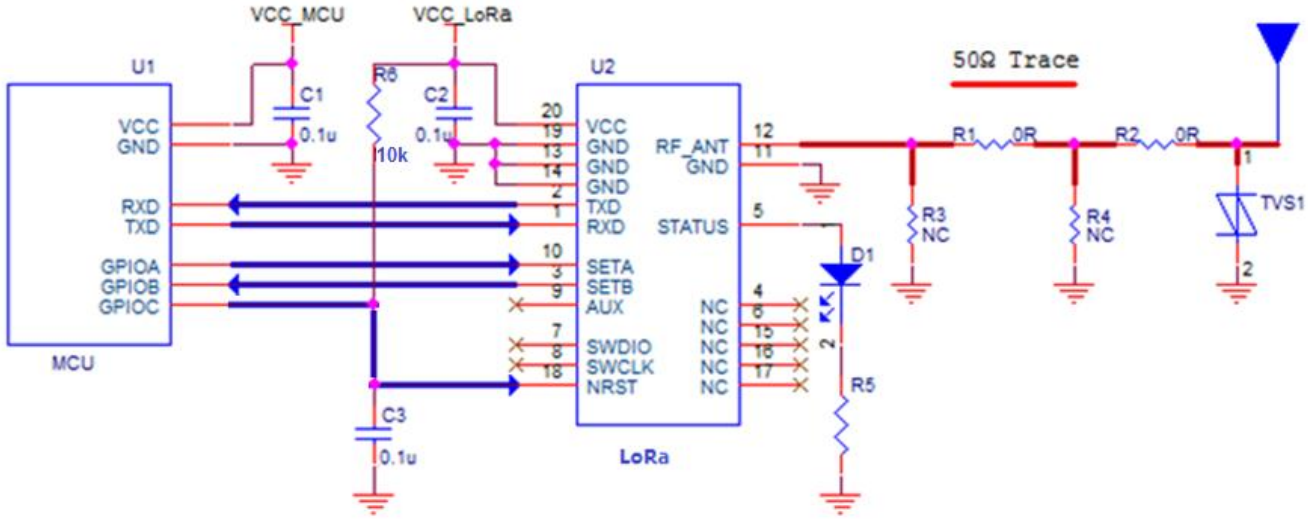
IO Pin Definition: I--Input, O--Output, I/O--Input/Output, P--Power

3.4 Interface to Host MCU

- STATUS pin can connect to external LED indicator. If this function is not needed, keep STATUS unconnected. It is OK to drop this function by no connection.
- Module can be connected to MCU directly. Please keep interface levels the same as IO level.
- There is internal pull-up resistor in GPIO pins, please reserve external pull-up resistor with driving capability.



Instructions:

- Bold red line is the RF circuit matched with 50Ω. R1, R2, R3, R4 are reserved matching circuits. R1, R2 usually mounts 0R, R3 and R4 makes no connection; Reserve TVS for ESD protection of antenna ports, such as LXES15AAA1-153.
- Bold blue line is UART and IO circuits. Notes the level match and signal direction.

3.5 Antenna Matching Circuit

Because the working frequency is low, spring antenna bandwidth is narrow and the module can be easily affected by surrounding environment which will cause frequency offset, during the circuit design process, it is better to adopt SMT soldering, add double L type or π type antenna matching line and complete 50Ω characteristic impedance of the micro-strip line. The antenna working performance can be improved by modifying the antenna matching value,which will help to improve transmission distance.

3.6 Antenna Selection

The antenna selection is depending on the device's type, antenna size, antenna cost and performance. The

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common antennas used in short distance are PCB antenna, ceramic chip antenna, spring antenna and whip antenna etc. Some key parameters should be taken into consideration for antenna selection: pattern, efficiency and bandwidth etc. The typical definition of antenna bandwidth is reflected wave attenuation less than -10dB or VSWR less than 2. The actual antenna performance needs match the PCB structure to achieve good results.

4. Product Function

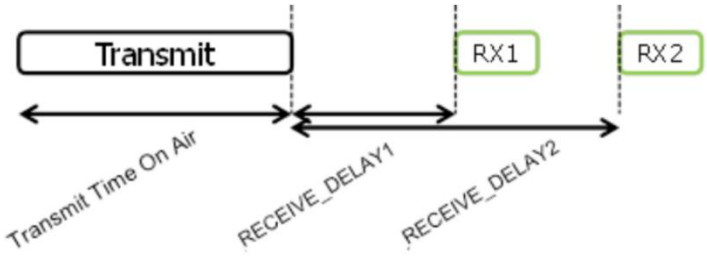
4.1 LoRaWAN™ Protocol

LoRa is a spread spectrum modulation technology for LPWAN, developed and popularized by Semtech for long range bi-directional communications.

LoRaWAN™ Specification, defined by LoRa Alliance and based on open source MAC layer protocol, provides LPWA (Low Power Wide Area) wireless connectivity for low data rate, battery-powered devices and sensors.

According to different scenarios, M390 can work in Class A,Class B or Class C mode:

- Class A:
  Class A mode is suitable for battery-powered end devices with major uplink transmission.
  This mode is the lowest power end-device system for applications that only require downlink communication from the server shortly after the end device has sent an uplink transmission. Downlink communications from the server at any other time will have to wait until the next scheduled uplink.



Class A Communication profile

- Class C:
  Class C mode has nearly continuously open receive windows, only closed when transmitting. Class C end-device will use more power to operate than Class A or Class-B but they offer the lowest latency for

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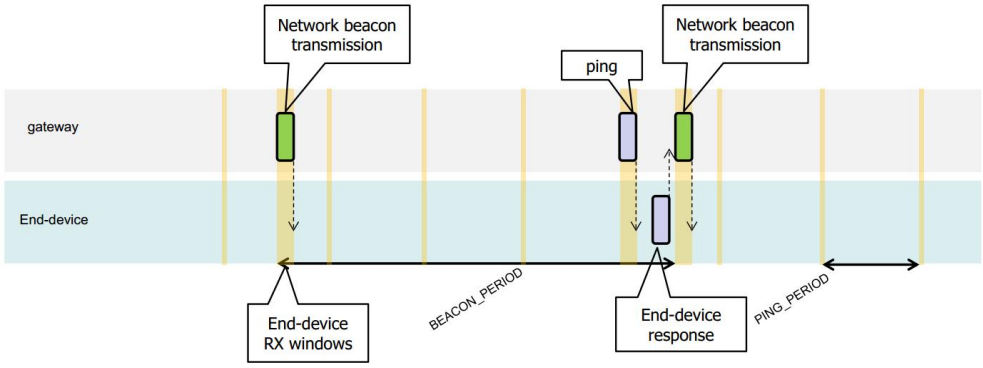
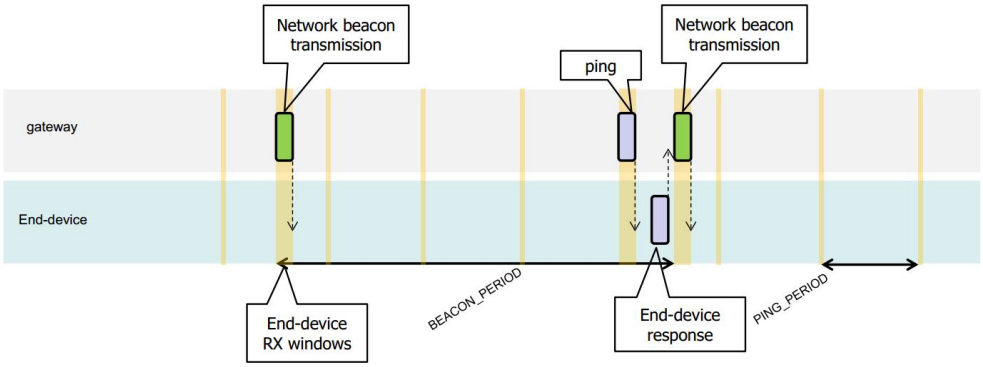
server to end-device communication.



Class C Communication profile

- Class B:

  Class B supports two-way communication, and each uplink will be followed by two receiving windows (see the figure below). The node initiates transmission according to its own communication requirements, and uses the Aloha mechanism to optimize communication collisions between nodes. At any time, the downlink transmission from the server needs to wait for the next uplink communication and perform downlink transmission in either of its two receiving windows. This mode is the most power-efficient.



Class B Communication profile

4.2 AT Mode Description

External host MCU can configure, control and transfer data using AT command via UART port on M390,which shortens development time and speeds time to variety wireless application.

For more details on AT command, please refer to < AT command function description>.

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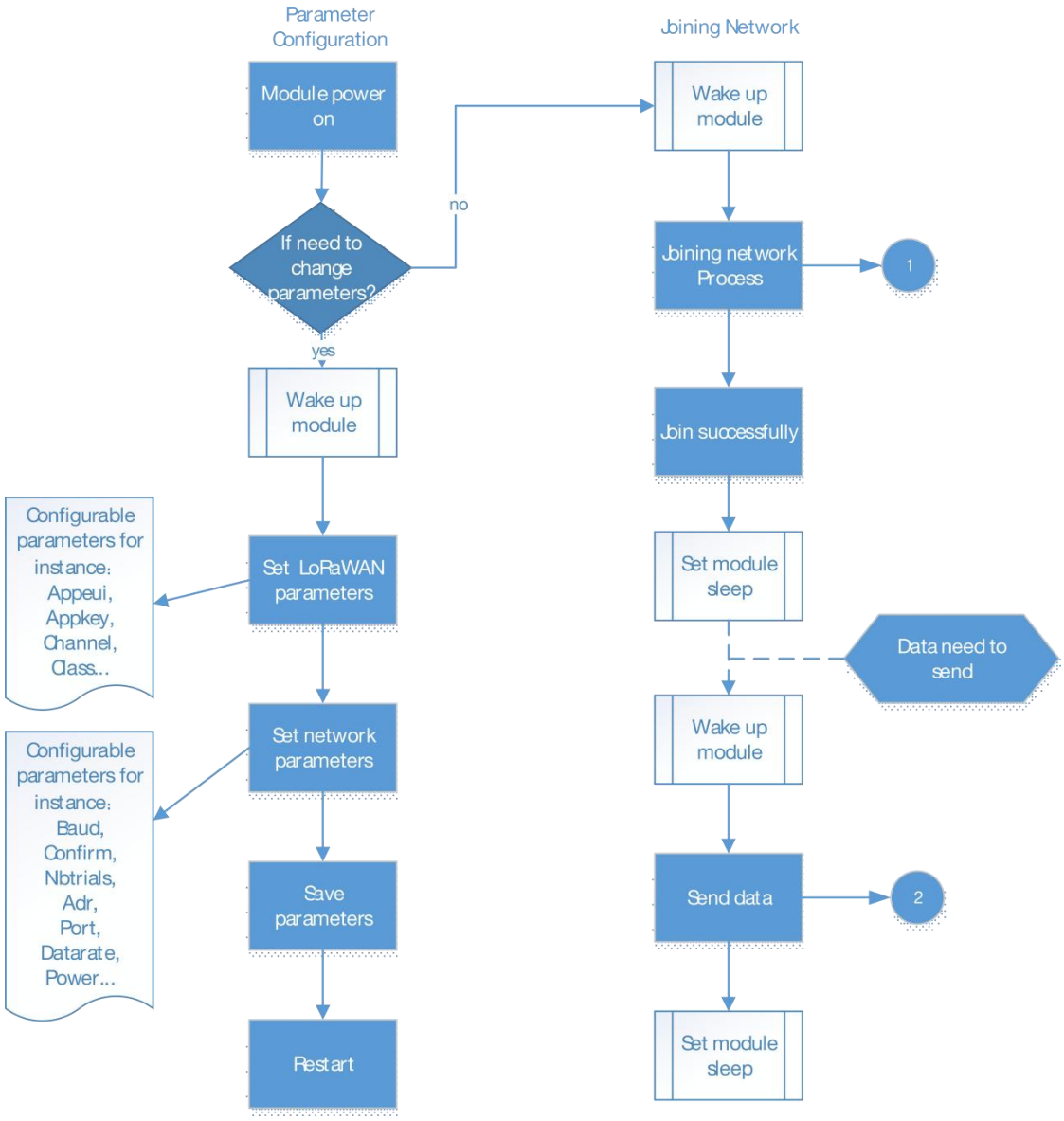

Workflow Diagram

For first use, Host MCU need configure LoRa parameters once power on, then restart the module. The joining network process is as below,

- When module is powered on, it will enter the joining process.
- After joining network successfully, it will enter the sleep mode.
- Once data is up, module will wake up by host MCU and enter data transmission process.

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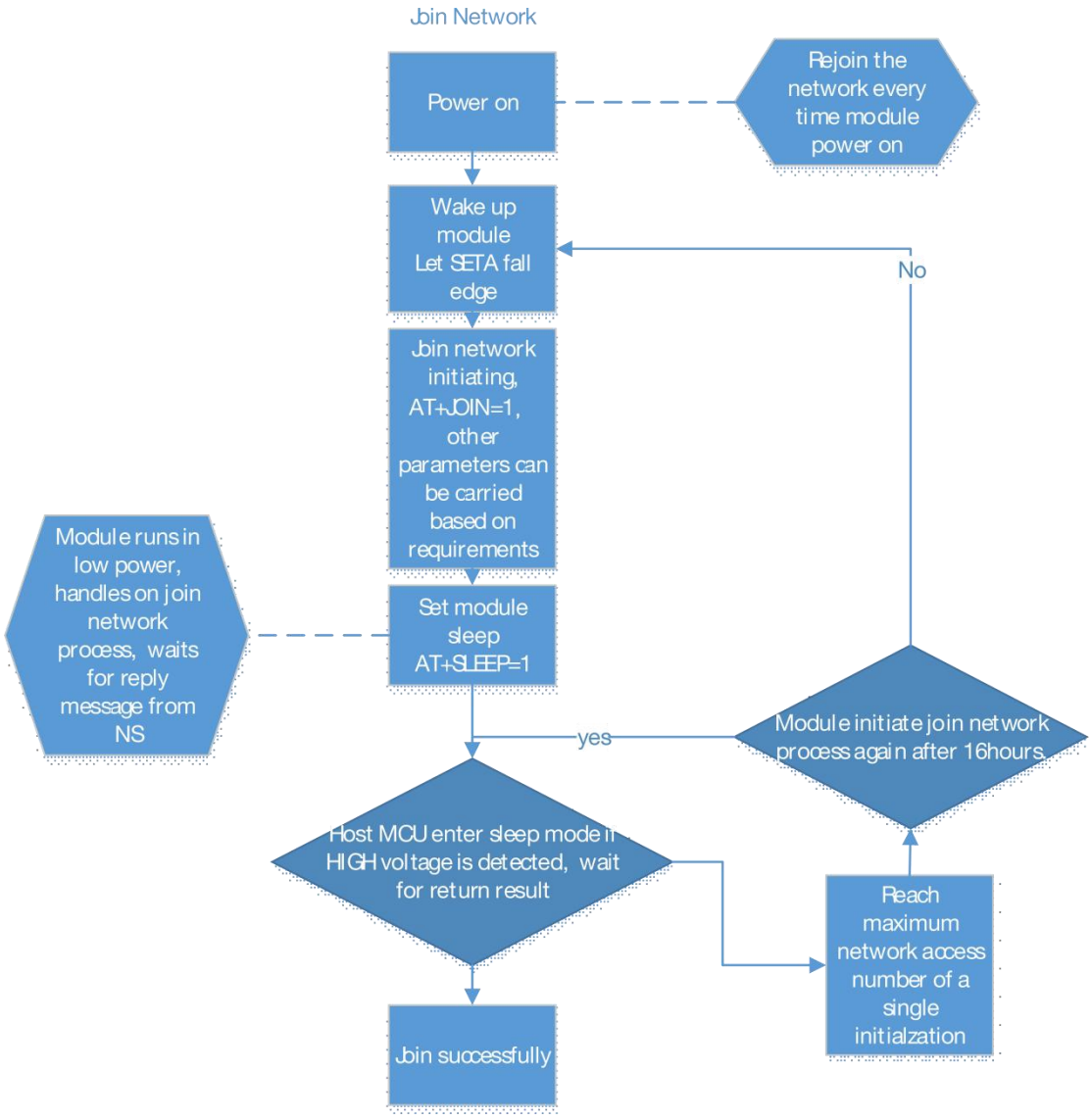

Module Joining Network Process

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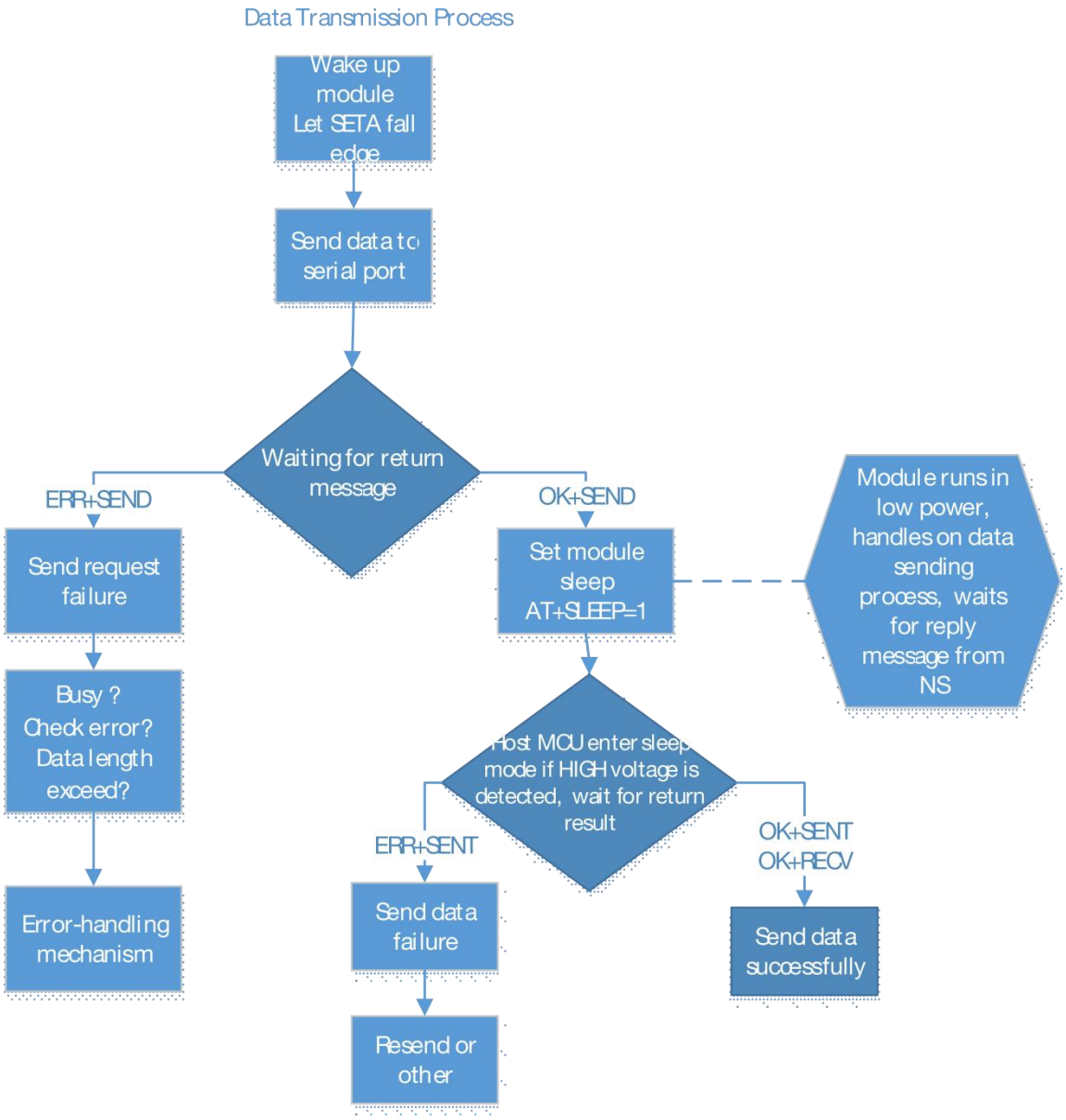

Data Transmission Process

To save as much power as possible, please set the module in sleep mode once data transmission is done. The module will wake up in the next service cycle.

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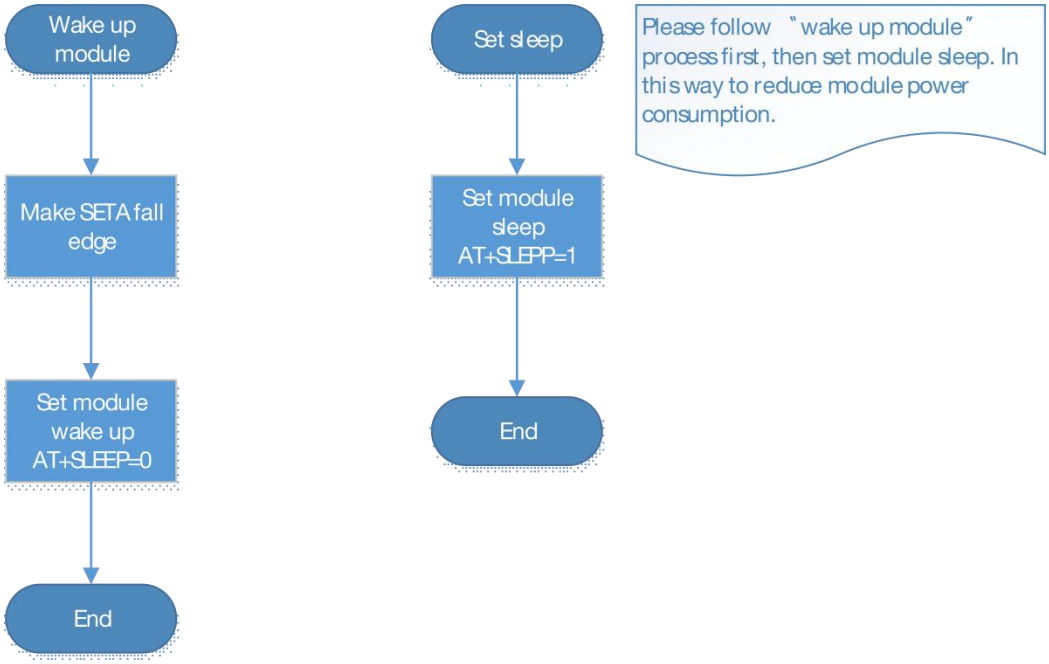

Module Wake up Flow

5. Mechanical Parameter

5.1 Outline

The top and bottom view of M390 module are shown below,

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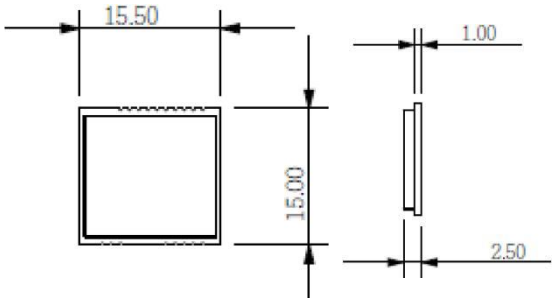
Top View

Bottom View

5.2 Package Dimension



M390 Dimension

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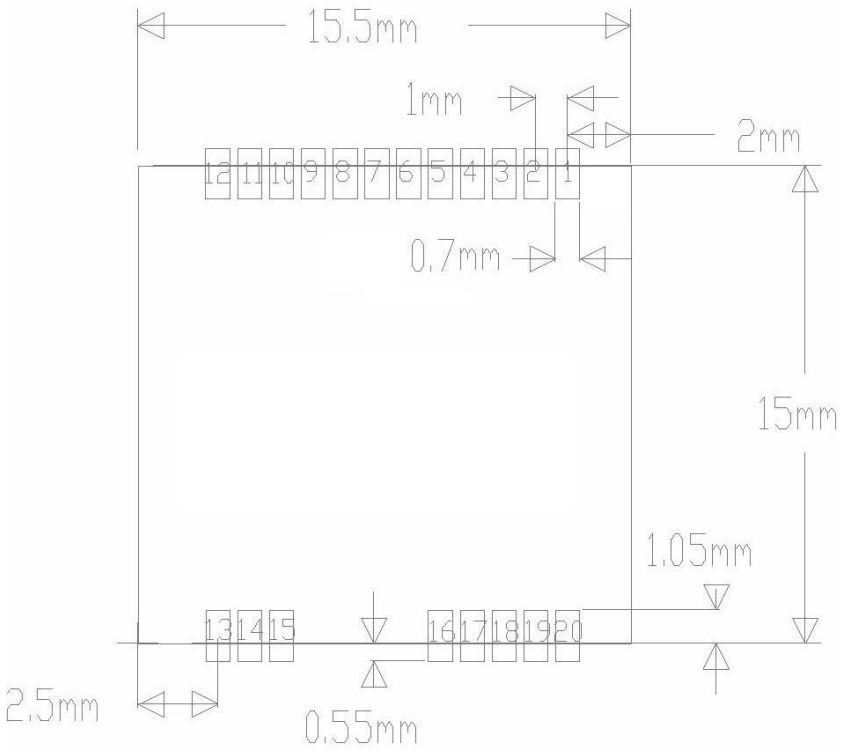

M390 Pin Size

6. Thermal Reflow Profile

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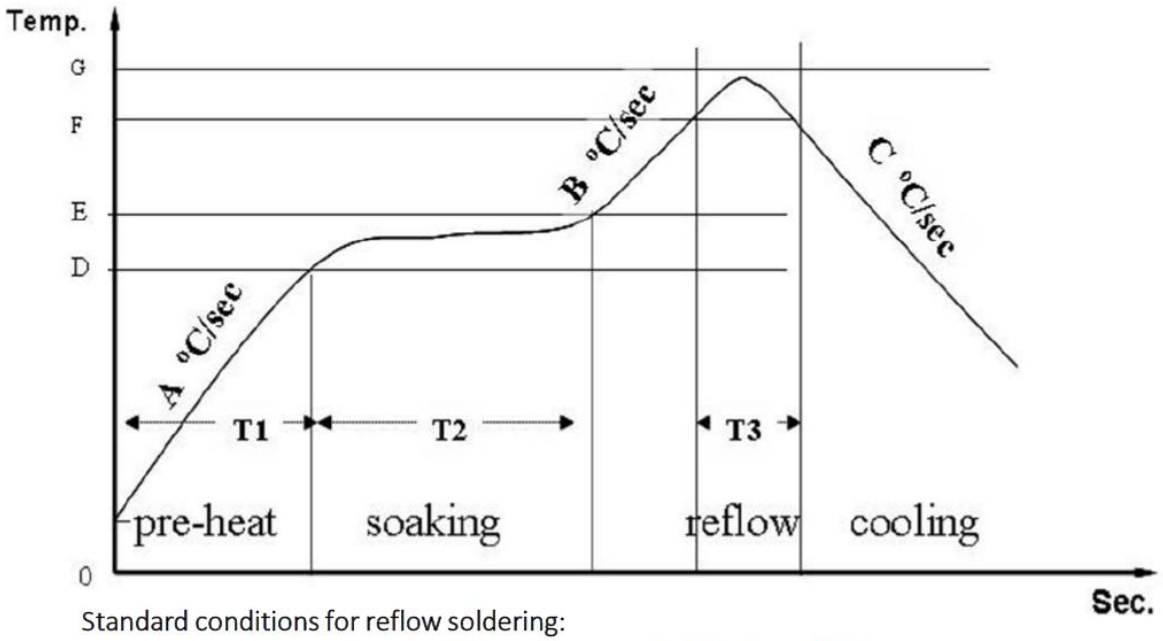

Standard conditions for reflow soldering:

- a. Pre-heating Ramp (A) (Initial temperature: 150℃): 1~2.5℃/sec;
- b. Soaking Time (T2) (150℃~180℃): 60sec~100sec;
- c. Peak Temperature (G): 230~250℃;
- d. Reflow Time (T3) (>220℃): 30~60 sec;
- e. Ramp-up Rate (B): 0~2.5℃/ sec;
- f. Ramp-down Rate (C): 1~3℃/ sec.

7. Module model description

Model	Nameplate printing	频段
M390-L	M390(L)	470-510MHz
M390-H	M390(H)	868MHz
M390-H2	M390(H2)	915MHz
M390-H3	M390(H3)	923MHz

※*Note: The nameplate printing of different models is slightly different, please refer to the actual product.*

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8. FAQ

1. What 's the difference between Class A and Class C mode?

For Class C mode, module either sends data or receives data, which is suitable for applications which require downlink control frequently and timely.

For Class A mode, the receiving window opens after sending the data and lasts for a very short time, then the module will enter the sleep-mode, which is suitable for the device which requires low power consumption. The downlink data is queued and will be sent to the module once the gateway receives the uplink data from the module.

2. Why is the module's structural dimension big?

The module is compatible for more installation modes, for example, module need overhead welding through pins, antenna need weld to module directly, welding MSA on module, or using the SMT welding process.

3. Why the SMT soldering mode is recommended?

As in China, unlicensed ISM band is in low frequency and wavelength for antenna is long. The devices are usually designed using monopole antenna (as spring antenna) and antenna performance is very important for the transmission distance. With monopole antenna and antenna matching, the module can achieve better transmission performance.

4. Can a generic antenna be used?

The antenna performance can be affected by PCB area, shell material, or the environment. If different device use the same antenna, it needs to modify antenna's matching parameters.

5. What shall be noted when devices with LoRun module are installed?

Depending on the surrounding environment, the unstable wireless communication exists, which means the signal quality between module and gateway will be compromised. So keep a certain margin for better wireless signal quality when installing the devices. See below for details,

Range of Spread Factor

Spread Factor (RegModulationCfg)	Spread Factor (chip/symbol)	SNR
7	128	-7.5 dB

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8	256	-10 dB
9	512	-12.5 dB
10	1024	-15 dB
11	2048	-17.5 dB
12	4096	-20 dB

6. What's the average power consumption for the module?

Except for 6 hours heartbeat intervals, the module is usually in sleep mode. The average power consumption vary for different applications, which can be calculated with periodic time-current model.

7. Why does the module suggest sending data in 45 bytes?

45-byte data length can meet the requirements for most applications and most sensors' information. Shorter data length can reduce transmitting time and improves the wireless signal transmission over the air, which will achieve better communication performance.

Maximum Payload Size

Data Rate	**Configuration**	**Maximum Payload Size (bytes)**
0	LoRa: SF12 / 125 kHz	51
1	LoRa: SF11 / 125 kHz	51
2	LoRa: SF10 / 125 kHz	51
3	LoRa: SF9 / 125 kHz	115
4	LoRa: SF8 / 125 kHz	222
5	LoRa: SF7 / 125 kHz	222
6	LoRa: SF7 / 250 kHz	222
7	FSK: 51 kbps	222
8…15	RFU	

8. What's ADR?

Adaptive Data Rate (ADR) is a mechanism for optimizing data rates, signal quality in the network. ADR is enabled by factory default setting. Server decides the adaptive data rate according to data length and signal quality. For other special settings, please notify Easylink engineer in advance to finish special settings at factory.

9. What's gateway access capacity (maximum access nodes)?

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Access capacity is related to the number of packets received in a certain amount of time. Theoretically, with 8 channels, a single gateway can receive maximum 1500 data packets per day.

Assume that,

- a node sends a packet once an hour
- network load is 10%

The maximum nodes can be accessed with a single gateway is 8,0000. This is a theoretical value and the actual number of nodes depends on packet-sending intervals, data length, data rate and the actual wireless environment.

9. Support

If you have any question or problem with our module, please contact us for support.

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