High Power SX1276 LoRa Transceiver Module
(868/915Mhz with switchable TCXO & PA)

SPECIFICATION

Model No.: DL-SX1276PA-HF

Version: V1.0

868Mhz/915MHz

Before using this module, please pay attention to the following important matters:

This module is an electrostatic sensitive product. Please operate it on an anti-static workbench during installation and testing.

This DL-SX1276PA-HF Wireless Module uses an external antenna by default, which is intended to be embedded in your product or application, and does equip with a metal shield itself for a better anti-interference ability. The antenna can be a wire antenna or a standard UHF antenna. You can choose a specific antenna according to the actual situation.

Metal objects and wires should be kept away from the antenna as much as possible. If the product uses a metal shell, be sure to install the antenna outside the metal shell. Otherwise, the RF signal will be seriously attenuated, which will affect the effective distance.

Disclaimer:

This specification is just for your information, all the charts and pictures used in this specification are for reference only. The actual test shall prevail for details. We do not assume any responsibility for personal injury or property loss caused by user's improper operation.

This specification is subject to change due to the continuous improvement and upgrading of the product version, and the latest version specification shall prevail. DREAMLNK reserves the right of final interpretation and modification of all contents in this specification.

Revision History

Date	Version	Formulation / Revision of Contents	Approved by
2025-3-10	V1.0	Standard Version DL-SX1276PA-HF LoRa Module (868/915Mhz)	Fagan Xu

1. Module Overview

1.1 Brief Introduction

DL-SX1276PA-HF is a high-power Spread Spectrum LoRa Transceiver Module, which was developed by DREAMLNK based on Semtech's SX1276 RF chip. For long-range transmission and better coverage concern, a power amplifier (PA) is integrated in this LoRa™ module, which increases its output power up to +30dBm (1W), by more than three times on the basis of the original SX1276 RF chip. This LoRa module innovatively adds the function of adjustable output power (switchable PA), which can switch between high and low power. When PA is enabled, the TX power reaches +30dBm @ 868/915M, while TX power can be reduced to +13dbm, when PA is disabled (with better harmonic wave).

Meanwhile, this DL-SX1276PA-HF LoRa module is equipped with a TCXO (Temperature Compensated Crystal Oscillator), which is more stable in applications such as high temperature, low speed, and narrowband transmission. By using TCXO, the RF module can better approach the design performance of the SX1276 RF chip (-149dBm @ LoRa™), and significantly improve its receiving sensitivity. Combined with high output power, sufficient link budget, and advanced LoRa™ modulation technology, this LoRa module can achieve longer communication range, stronger anti-interference ability, and better stability.

This LoRa module adopts the new generation LoRa™ Modulation technology, it features with many other advantages, such as low power consumption, long transmission distance, strong anti-interference performance, high confidentiality and strong concealment. The output power can be configured by software (20dBm), and the maximum output power of the RF module can reach 30dBm when the software is set to 20dBm power. Compare with traditional modulation (FSK/GFSK) technology, this LoRa™ Modulation technology has higher bandwidth utilization, and obvious advantages in anti-interference ability. It solves the problems of Transmission Distance, Anti-interference, Signal Blind Angle and Power Consumption that the traditional modulation cannot take into account at the same time.

1.2 Features

- Support multiple modulation methods: LoRa™, FSK, GFSK, MSK, GMSK, OOK,
- Frequency range (chip supported): 137~1020MHz;
- Recommended frequency: 860~950MHz MHz (for DL-SX1276PA-HF only)
  Note: *it has good broadband performance, 433/470Mhz also available, which is our another LoRa module --- DL-SX1276PA)*
- The working voltage is 5V, the output power can up to +30dBm (1W), and the maximum instantaneous working current is 1A.
- Switchable high and low power, the second harmonic at TX@13dBm is -60dBm
- The module is equipped with a TCXO (Temperature Compensated Crystal Oscillator), which supports narrowband transmission
- Support automatic RF signal detection CAD (Channel Activity Detection);
- Support fast frequency hopping, CRC hardware verification, and interrupt DIOx mapping;
- Industrial grade standard design, support long-term use at -30~85˚C;

- Spread spectrum factor supported: SF6/SF7/SF8/SF9/SF10/SF11/SF12;
- Bandwidth supported by the chip: 7.8/10.4/15.6/20.8/31.25/41.7/62.5/125/250/500kHz

1.3 Block Diagram

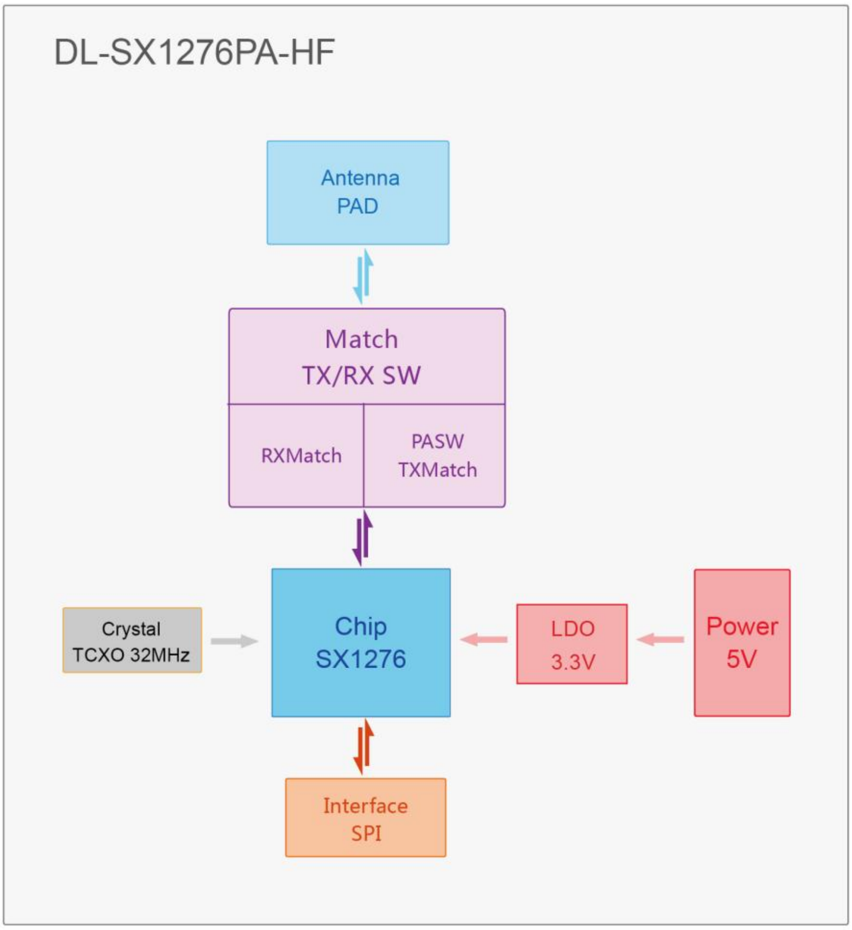


Figure 1: Block Diagram

1.4 Typical Application

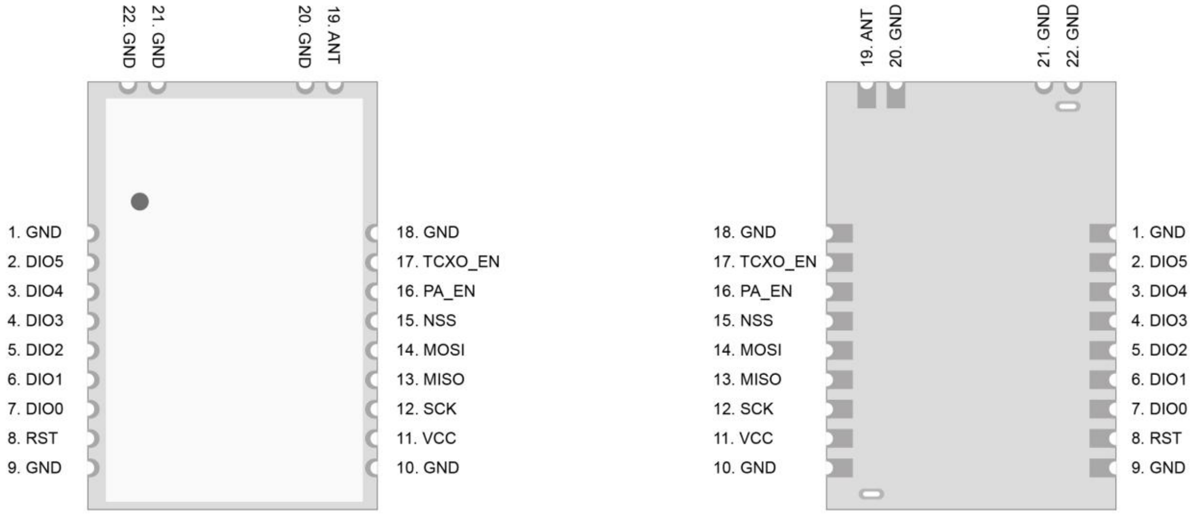
- Wireless automatic meter reading (water meter, electric meter, gas meter)
- Ultra-long distance data communication
- Smart home system
- Intelligent security monitoring
- Smart building
- Industrial controllers, sensors
- Agricultural automation solutions
- Intelligent parking system
- Container information management
- Automotive industry applications
- Supply chain logistics

2. Technical Parameter

Parameter	Min.	Typical	Max.	Unit	Remarks
Operating Conditions					
Working Voltage	3.3	5	5.5	V	To ensure maximum chip power, stable voltage should ≥ 4.7V
IO Voltage Range	-0.1	VDD	3.9	V	>3.9V may damage the chip
Working Temperature Range	-30	25	+85	℃	When the temperature difference is large, make sure that the software configuration bandwidth should not overloaded
Current Consumption					
Receiving Current	14	15.3	20	mA	@868Mhz PA Disable (PAEN=1) *PA Enable will increase 79mA Power Consumption*
TX Power (868Mhz)	27 11	29.5 12.9	30 14	dBm	@868Mhz PA Enable (PAEN=0) @868Mhz PA Disable (PAEN=1) *Instantaneous Current @ 5V Voltage & 50Ω impedance*
TX Power (915Mhz)	27 11	29.5 12.5	30 14	dBm	@915Mhz PA Enable (PAEN=0) @915Mhz PA Disable (PAEN=1) *Instantaneous Current @ 5V Voltage & 50Ω impedance*
TX Current	400 25	850 39	1260 45	mA	@868Mhz 29.5dBm PA Enable (PAEN=0) @868Mhz 13dBm PA Disable (PAEN=1) *Instantaneous Current @ 5V Voltage & 50Ω impedance*
Standby current		<5	<510	uA	Save by register PA Enable (PAEN=1) TCX0 Disable (TCX0EN=1) *TCX0 enable will increase 1.5mA Power Consumption*
RF Parameters					
Recommended Frequency (Ensure best performance)	860	868/915	950	MHz	License-free ISM frequency band, also the best matching frequency band of the module, 868/915Mhz is Recommended
LoRa Receiving Sensitivity	-140 -137 -122	-142 -139 -124	-144 -141 -126	dBm	@0.49kbps (SF=11, BW=3, 20.8 CR4/5) @0.179kbps (SF=11, BW=5, 41 CR4/5) @5.469kbps (SF=7, BW=7, 125 CR4/5)
FSK Rate Range	1.2	-	300	Kb/s	Initial software RF configuration
LoRa Rate range	0.018	-	37.5	Kb/s	Initial software RF configuration

Table 1: Technical Parameter

3. Pin Definitions



Front Side

Back Side

Figure 2: Pins Diagram

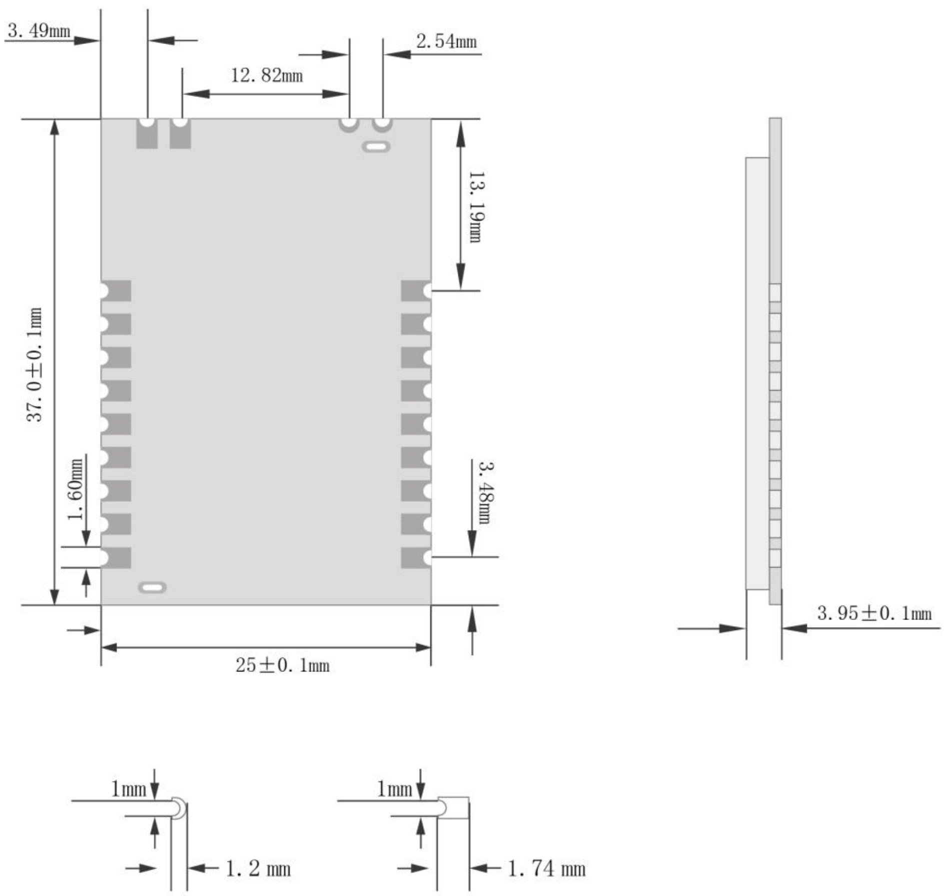
Table of pin function definitions

No	Definitions	Type	Description
1	GND	PWR	Reliable grounding
2	DIO5	I/O	General Digital I/O port, Configurable via software
3	DIO4	I/O	General Digital I/O port, Configurable via software
4	DIO3	I/O	General Digital I/O port, Configurable via software
5	DIO2	I/O	General Digital I/O port, Configurable via software
6	DIO1	I/O	General Digital I/O port, Configurable via software
7	DIO0	I/O	General Digital I/O port, Configurable via software
8	RST	I	Chip reset trigger input pin, active low level
9	GND	PWR	Reliable grounding
10	GND	PWR	Reliable grounding
11	VCC	PWR	Power supply, range 4.75~5.5V (it is recommended to add ceramic filter capacitor externally)
12	SCK	I	SPI Serial Clock Input
13	MISO	O	SPI Master Input Slave Output
14	MOSI	I	SPI Master Output Slave Input

15	NSS	I	SPI Chip Select Input, used to start/end an SPI communication
16	PA_EN	I	**Control whether PA is enabled or not** Enable the PA (low-level) can achieve TX power of up to 30dBm. Disable the PA (high-level) to lower the TX power, with a Max. output power of 13.5dBm and a higher standby current.
17	TCXO_EN	I	**Control the internal TCXO power supply** Enable the TCXO (low-level) for normal TX and RX Disable the TCXO (high-level) can reduce power consumption
18	GND	PWR	Reliable grounding
19	ANT	A IO	Analog antenna interface, 50Ω impedance
20/21/22	GND	PWR	Reliable grounding

Table 2: Pin Definitions

4. Module Size



Front Side
Back Side

Figure 3: Product Dimensions

5. Basic Circuit Diagram

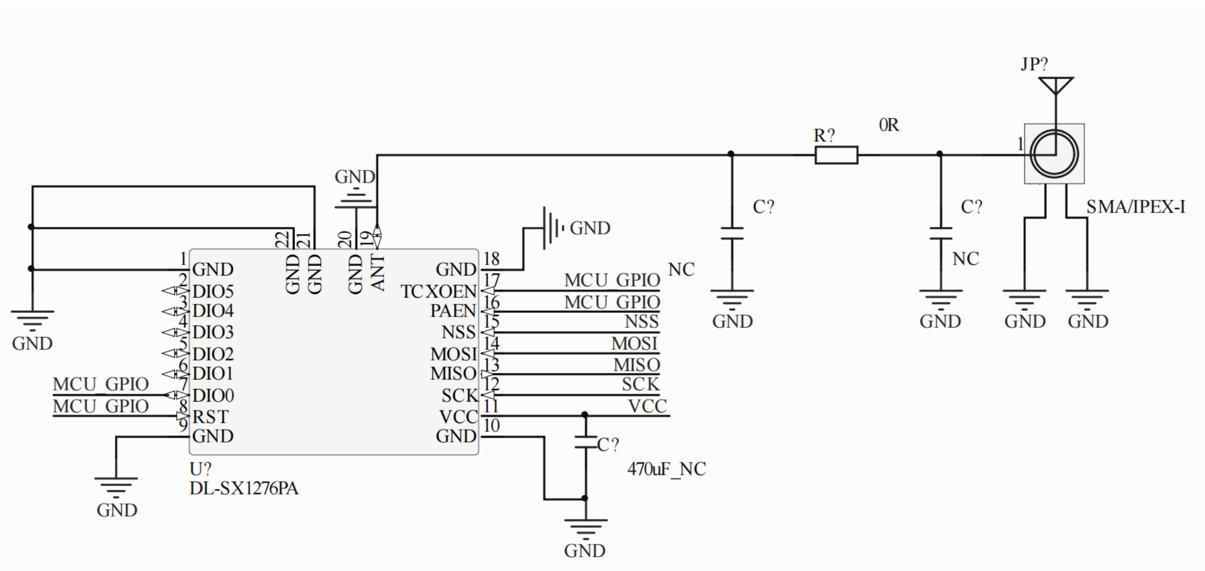


Figure 4: Basic Circuit Diagram

IO Design of DL-SX1276PA-HF:

● When making the hardware design, if there is enough GPIO ports on the MCU, all pins of the RF module can be connected to the MCU. If the pins are insufficient, for LoRa modulated data packet mode (SPI transmission mode, but not continuous mode), at least the general SPI bus (SCK、MISO、MOSI、NSS), RST, DIO0, PA_EN, TCXO_EN should be connected to the GPIO of the MCU.
● If the maximum power output is directly achieved without considering power consumption, PA_EN and TCXO_EN can be directly grounding, which can save 2 more I/Os, but keeping PA and TCXO enabled will result in increased power consumption (by several tens of milliamps).
● If RST initialization is required, or other special situations require resetting the chip, it is recommended to connect it to an MCU
● In software applications, DIO0-DIO5 can be used to map interrupt events of chips and query the interrupt source through functions.
DIO0 is used in the software to generate receive interrupt lights. If other IO functions are required, such as CAD detection, **Direct Transmission** can connect more DIOx to the MCU

See more details on SX1276 Data Sheet: DIO Mapping LoRa™ Mode:

Table 18 DIO Mapping LoRa™ Mode

Operating Mode	DIOx Mapping	DIO5	DIO4	DIO3	DIO2	DIO1	DIO0
ALL	00	ModeReady	CadDetected	CadDone	FhssChangeChannel	RxTimeout	RxDone
	01	ClkOut	PllLock	ValidHeader	FhssChangeChannel	FhssChangeChannel	TxDone
	10	ClkOut	PllLock	PayloadCrcError	FhssChangeChannel	CadDetected	CadDone
	11	-	-	-	-	-	-

Figure 5: DIO Mapping LoRa™ Mode

6. Circuit Design

6.1 Power Supply Design

● Please pay attention to the power supply voltage of the device, exceeding the recommended voltage range may cause function abnormally and permanently damage;

● Try to use a DC stabilized power supply, and the power ripple coefficient should be as small as possible; the power load when transmitting the maximum power needs to be also considered;

● The RF module needs to be grounded reliably, and try to reduce the loops in PCB layout (especially the loop between ANT Pin and GND Pin should be as short as possible); a good grounding can achieve better performance and reduce the impact of RF on other sensitive devices.

6.2 RF Routing Design

● The module should be far away from RF interference sources, such as high-frequency circuit transformer, and please do not directly route at the lower layer of the RF module. Otherwise, the receiving sensitivity may be affected;

● When using the on-board antenna, the antenna needs to be clear on both sides, and the ground (copper foil) should not be too close to the antenna at the same time, otherwise it will absorb the radiated energy;

● Route 50Ω impedance line, lay the ground and add more via holes around it

● If there is enough space on your PCBA, please reserve a π-type matching circuit, and it needs to be placed as close to the chip end as possible, please make it grounded and add via holes around it. Do remember to connect it through a 0R resistor, otherwise the antenna will open circuit; SMA ANT circular through-hole requires clearance treatment

6.3 Antenna Design

● There are many types of antennas, please choose the appropriate antenna according to your needs;

● Choose a suitable position to place the antenna, according to the antenna polarity. And it is recommended to be vertically upward;

● There should be no metal objects in the antenna radiation path, otherwise the transmission distance will be affected (such as a closed metal casing).

6.4 Wireless interference

For high-power wireless transmission, wireless interference may occur, which may affect the functions of some sensitive circuits, such as amplifiers, ADCs, RESETs, and data pins with low driving force. This situation has a significant impact on high-power transmission at 20dbm and above. The interference mainly comes from the antenna power being amplified and coupled to longer lines or devices through conduction or radiation. Therefore, when making the hardware design, the signal routing should be as short as possible; when using high power, try to use external antennas as much as possible, stay away from PCB sensitive devices, and add 100pF ground capacitance in sensitive device circuits to filter out high-frequency interference in low-speed signals to reduce wireless interference in other circuits.

****** For more information, please refer to the SX1276 Data Sheet from Semtech *****

7. Software Debugging Process

7.1 Transplant HAL interface

1). Initialize and calling the SPI interface, software or hardware SPI can be used;

2). The control of TXEN and RXEN does not require software porting as the hardware will automatically switch

3). Transplant RST, DIO0, PA_EN, TCXO_EN:

	RST	PA_EN	TCXO_EN
H	Normal operation	low power	cannot transmit or receive
L	Reset	high power	can transmit or receive

Note: During transplanting, PAEN and TCXOEN can be forcibly pulled down for porting and debugging; Special attention should be paid to verifying that the Reset function is functioning properly.

When initializing "void SX1276LoRaInit (void)", "RFO" output should be selected instead of "PABOOST". Some initialization codes are as follows:

```
SX1276LoRaSetPAOutput( RFLR_PACONFIG_PASELECT_RFO );    //  Select RFO pin output signal
SX1276LoRaSetPa20dBm( false );                          //  Max. power not exceeding 14dBm
LoRaSettings.Power = 14;                                //  Transmission power is 14dBm
SX1276LoRaSetRFPower( LoRaSettings.Power );             //  Set RF power
```

7.2 Familiar with the chip register table and related API
(Please refer data sheet: 6.4. LoRa Mode Register Map);

7.3 Make two verification PCB boards, according to the Demo Program, to complete the communication verification of transmitting and receiving;

7.4 It is recommended to use LoRa modulation. After communication normally set up, you need to optimize the modulation parameters, and change the spreading factor, bandwidth and other parameters according to your needs to control the code transmission time and communication distance (See details as below table).

7.5 The commonly used debugging parameters are as follows:

Modulation Bandwidth (BW_L)	The higher the BW, the faster the modulation rate, but the larger the signal bandwidth will reduce the sensitivity of the receiver Recommended in general application >5(41.7kHz)	SX1276LoRaSetSpreadingFactor
Spreading Factor (SF)	The higher SF can increase the sensitivity of demodulation and increase the distance, the disadvantage is that it will greatly increase the transmission time, see details in Table 7	SX1276LoRaGetSignalBandwidth

The Coding Rate (CR)	In the case of severe interference, it can increase the anti-interference, but the disadvantage is that the coding efficiency will be reduced and the baud rate will slow down. Under normal circumstances, the default CR = 4/5 can be used. Parameters: 1: 4/5, 2: 4/6, 3: 4/7, 4: 4/8	SX1276LoRaSetErrorCoding
Low-Rate Optimization (LDRO)	When a single symbol time is equal to or greater than 16.38ms, low-rate optimization needs to be turned on, see details in Table 6 Symbol Time	SX1276LoRaSetLowDatarateOptimize
Power Settings (Power)	The greater the power, the greater the required current, the farther the communication distance. Parameter: 0-20	SX1276LoRaSetRFPower

Table 5 Commonly Used Debugging Parameters

7.6 The maximum transmit power can be +20dbm, to ensure the largest link budget;

7.7 If low power consumption is required, CAD working mode (sleep-detection signal-sleep) can be used in the software to achieve low power consumption
Please refer Data sheet: Channel Activity Detection (CAD);

7.8 In LoRa mode, the corresponding table between the symbol time sent by the spreading factor and the bit rate of the actual payload is as follows: (To determine whether to start low-rate optimization)

SF \ BW	7.8	10.4	15.6	20.8	31.25	41.7	62.5	125	250	500
6	8.21	6.15	4.10	3.08	2.05	1.53	1.02	0.51	0.26	0.13
7	16.41	12.31	8.21	6.15	4.10	3.07	2.05	1.02	0.51	0.26
8	32.82	24.62	16.41	12.31	8.19	6.14	4.10	2.05	1.02	0.51
9	65.64	49.23	32.82	24.62	16.38	12.28	8.19	4.10	2.05	1.02
10	131.28	98.46	65.64	49.23	32.77	24.56	16.38	8.19	4.10	2.05
11	262.56	196.92	131.28	98.46	65.54	49.11	32.77	16.38	8.19	4.10
12	525.13	393.85	262.56	196.92	131.07	98.23	65.54	32.77	16.38	8.19

Table 6: Symbol Time (ms)

The corresponding tables of Spread Spectrum Factor (SF), Bandwidth (BW), Rate and Sensitivity (S) of the actual payload are as follows: (RF performance can be optimized according to this)

BW / SF	7.8		10.4		15.6		20.8		31.25	
	Rate (kbps)	S (dBm)	Rate (kbps)	S (dBm)	Rate (kbps)	S (dBm)	Rate (kbps)	S (dBm)	Rate (kbps)	S (dBm)
6	0.585	-134.1	0.780	-132.8	1.170	-131.1	1.560	-129.8	2.344	-128.1
7	0.341	-136.6	0.455	-135.3	0.683	-133.6	0.910	-132.3	1.367	-130.6
8	0.195	-139.1	0.260	-137.8	0.390	-136.1	0.520	-134.8	0.781	-133.1
9	0.110	-141.6	0.146	-140.3	0.219	-138.6	0.293	-137.3	0.439	-135.6
10	0.061	-144.1	0.081	-142.8	0.122	-141.1	0.163	-139.8	0.244	-138.1
11	0.034	-146.6	0.045	-145.3	0.067	-143.6	0.089	-142.3	0.134	-140.6
12	0.018	-149.1	0.024	-147.8	0.037	-146.1	0.049	-144.8	0.073	-143.1
BW / SF	41.7		62.5		125		250		500	
	Rate (kbps)	S (dBm)	Rate (kbps)	S (dBm)	Rate (kbps)	S (dBm)	Rate (kbps)	S (dBm)	Rate (kbps)	S (dBm)
6	3.128	-126.8	4.688	-125.0	9.375	-122.0	18.750	-119.0	37.500	-116.0
7	1.824	-129.3	2.734	-127.5	5.469	-124.5	10.938	-121.5	21.875	-118.5
8	1.043	-131.8	1.563	-130.0	3.125	-127.0	6.250	-124.0	12.500	-121.0
9	0.586	-134.3	0.879	-132.5	1.758	-129.5	3.516	-126.5	7.031	-123.5
10	0.326	-136.8	0.488	-135.0	0.977	-132.0	1.953	-129.0	3.906	-126.0
11	0.179	-139.3	0.269	-137.5	0.537	-134.5	1.074	-131.5	2.148	-128.5
12	0.098	-141.8	0.146	-140.0	0.293	-137.0	0.586	-134.0	1.172	-131.0

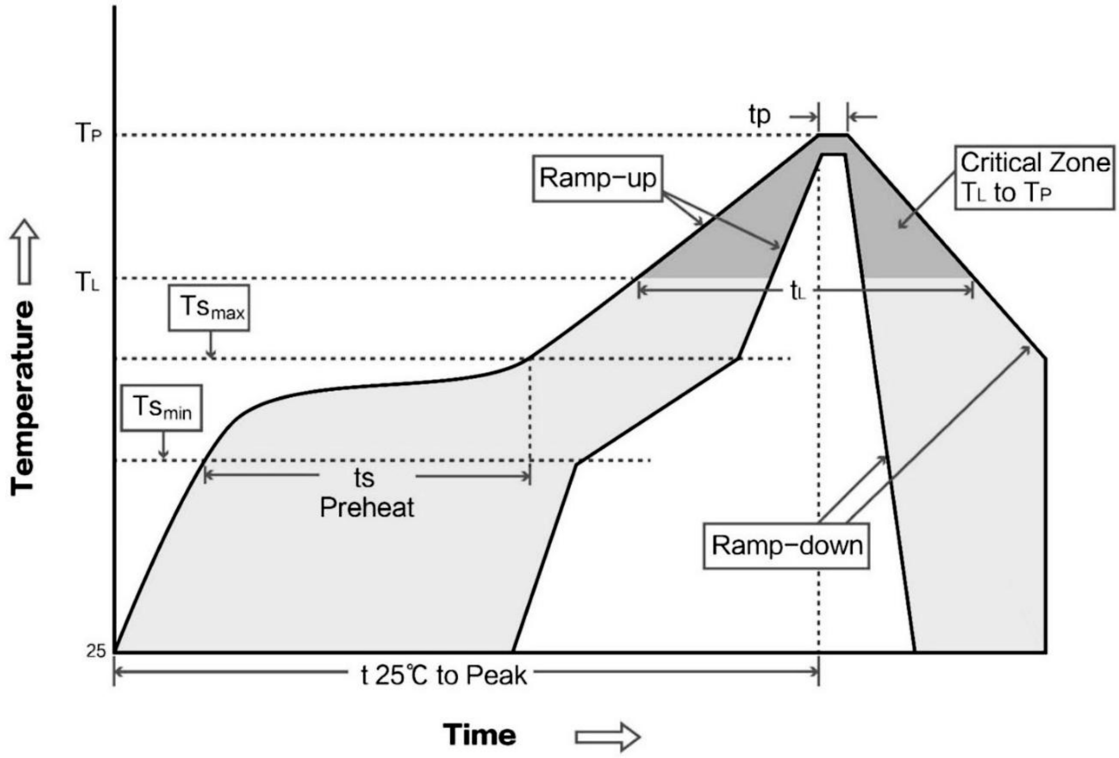
Table 7

Note: The payload data refers to the data you actually transmit, but the actual transmission time includes not only the payload, but also the preamble, the header, its encoding rate, and the check digit of the payload.

Collective reference: "LoRa™ Packet Structure" on the SX1276 Data Sheet

8. Welding Operation Guidance

8.1 Reflow Soldering Curve Chart



8.2 Reflow Soldering Temperature

IPC/JEDEC J-STD-020B the condition for lead-free reflow soldering	Big size components (thickness ≥ 2.5 mm)
The ramp-up rate (Tl to Tp)	3℃/s (max.)
Preheat Temperature	
- Temperature Minimum (Tsmin)	150℃
- Temperature Maximum (Tsmax)	200℃
- Preheat Time (ts)	60~180s
Average ramp-up rate (Tsmax to Tp)	3℃/s (Max.)
- Liquidous temperature (TL)	217℃
- Time at liquidous(tL)	60~150 second
Peak Temperature (Tp)	245+/-5℃

9. Notice for module application

(1) This module is an electrostatic sensitive product. Please operate on an anti-static workbench during installation and testing;
(2) When installing the module, make sure that nearby objects keep a sufficient safe distance from the module to prevent short-circuit damage;
(3) Liquid substance is not allowed to come into contact with this module, and this module should be used in a dry environment;
(4) Please use an independent voltage stabilizing circuit to supply power to this module, and avoid sharing with other circuits. The tolerance of the power supply should not be less than 5%.
(5) The indicators of this module are accord to commonly used international standard. If special certifications needed, we can adjust certain indicators according to your needs.

10. Contact us

Shenzhen DreamLnk Technology Co., Ltd

★ Data collection, Smart home, Internet of Things applications, Wireless remote control technology, Remote active RFID, Antennas ★

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