

MAXIIOT

LF7811 LoRa Module

Datasheet

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Maxiiot Ltd.

Document Revision Record

Version	Date	Description	
V1.0.0	2017-02-16	Preliminary version	Ming
V2.0.0	2017-09-12	Add principle diagram and design	Ming
V2.1.1	2017-11-06	Modify functional parameter	Ming

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Overview

LF7811 is a compact, low power, bidirectional transceiver module for 433MHz/470-510MHz band, provides ultra-long range spread spectrum communication and high interference immunity whilst minimising current consumption. Using Semtech's LoRa® spread spectrum modulation technique, LF7811 can achieve a sensitivity of over -139dBm using a low cost crystal and bill of materials. The high sensitivity combined with the integrated +18.6dBm power amplifier yields industry leading link budget making it optimal for any application requiring range or robustness.

The LoRa® modulation, in contrast to conventional modulation techniques, permits an increase in link budget and increases immunity to in-band interference. It achieves sensitivities 8dBm better than traditional FSK modulation and it also provides significant advantages in both blocking and selectivity, solving the traditional design compromise between range, interference immunity and energy consumption.

Product features

- ✓ Frequency: ISM band, 433MHz (470-510MHz optional)
- ✓ LoRa® Modem
- ✓ 157.6dB maximum link budget
- ✓ +18.6dBm constant RF output
- ✓ 100mW RF transmission, 7 levels adjustable
- ✓ Programmable bit rate up to 300 kbps
- ✓ High sensitivity: down to -139 dBm
- ✓ Excellent blocking immunity
- ✓ Low RX current of 10 mA, 200 nA register retention
- ✓ FSK, GFSK, MSK, GMSK, LoRa® and OOK modulation
- ✓ Built-in bit synchronizer for clock recovery
- ✓ 127dB Dynamic Range RSSI
- ✓ Automatic RF Sense and CAD with ultra-fast AFC
- ✓ Module Dimensions: 21.2*16.7*2.7mm



Typical applications

- ✓ Low power consumption IoT application
- ✓ Home and Building Automation
- ✓ Wireless Alarm and Security Systems
- ✓ Industrial Monitoring and Control
- ✓ Long range Irrigation Systems
- ✓ Smart Environmental Monitoring
- ✓ Smart Cities
- ✓ Smart Agriculture
- ✓ Automated Meter Reading
- ✓ Location Monitoring

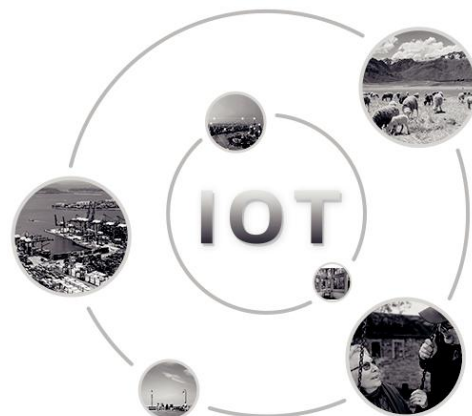


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1. Description

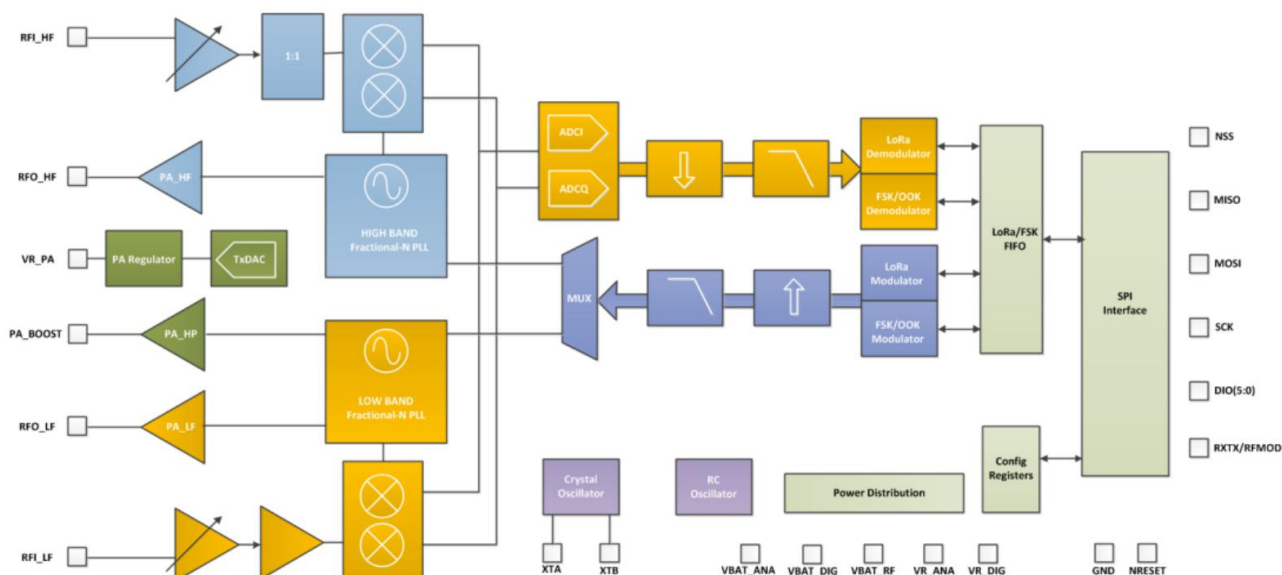
The LF7811 incorporates the LoRa® spread spectrum modem which is capable of achieving significantly longer range than existing systems based on FSK modulation. At maximum data rates of LoRa® the sensitivity is 8dB better than FSK, but using a low cost bill of materials can improve receiver sensitivity. LoRa® also provides significant advances in selectivity and blocking performance, further improving communication reliability. For maximum flexibility the user may decide on the spread spectrum modulation bandwidth (BW), spreading factor (SF) and error correction rate (CR). Another benefit of the spread modulation is that each spreading factor is orthogonal - thus multiple transmitted signals can occupy the same channel without interfering. This also permits simple coexistence with existing FSK based systems. The LF7811 offer bandwidth options ranging from 7.8 kHz to 500 kHz with spreading factors ranging from 6 to 12, and covering lower UHF bands.

LF7811 LoRa module are available in four product variants

NO.	Model	Description	Remark
1	LF7811-W	433MHz,Suitable for China, Europe	
2	LF7811-C	470-510MHz,Suitable for China	

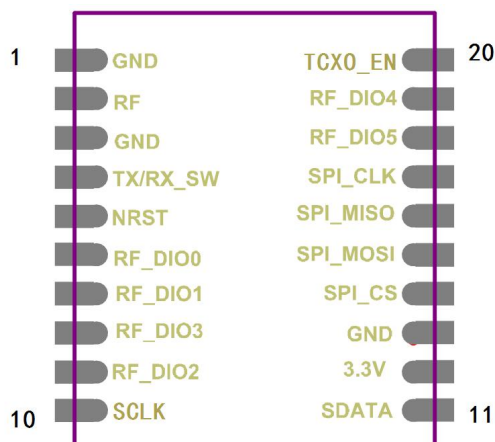
Table1.1 Product variants

1.1 Simplified Block Diagram



1.2 Pin Diagram

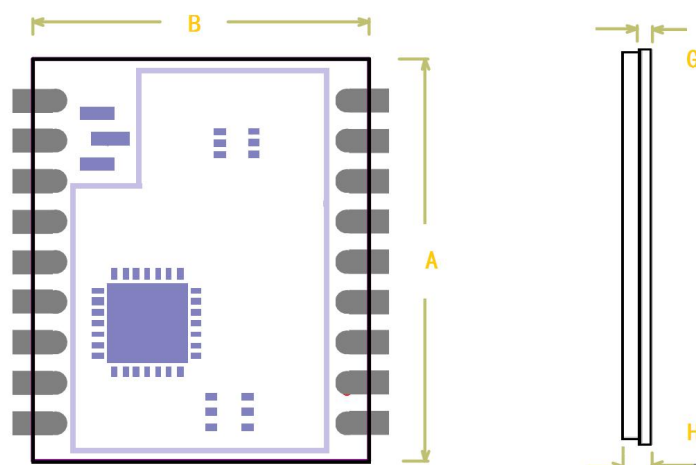
1.2.1 Pin Arrangement Diagram



1.2.2 Pin Description

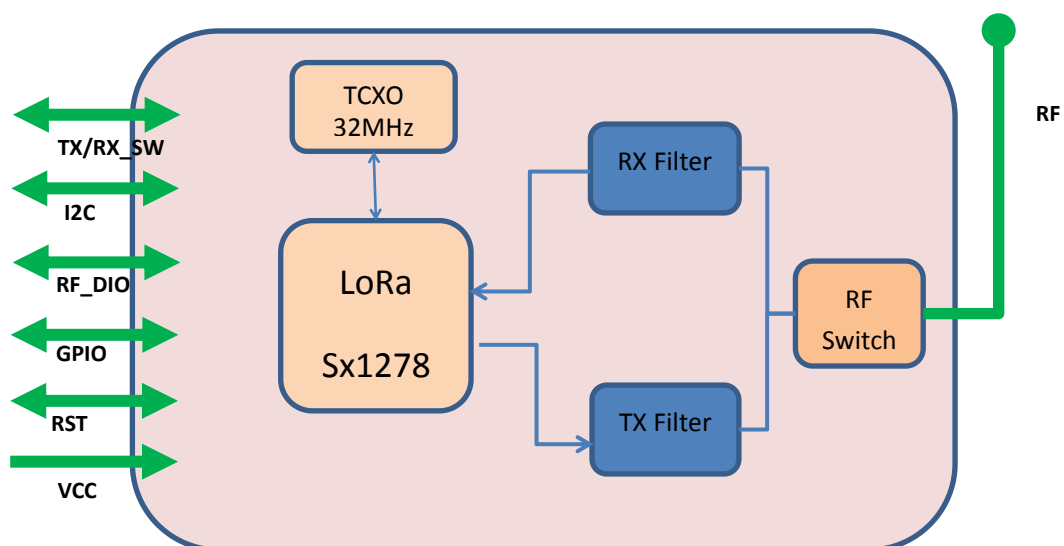
Pin Number	Pin Name	Type (I = Input O = Output)	Description
1	GND	P	Ground
2	RF	-	RF Tx/Rx, Antenna mached 50Ohm impedance
3	GND	P	Ground
4	TX/RX_SW	I	TX/RX_Switch , Tx at low level , Rx at High level
5	NRST	I	Reset , Valid at low level
6	RF_DIO0	I	Digital I/O, software configured
7	RF_DIO1	I	Digital I/O, software configured
8	RF_DIO3	I	Digital I/O, software configured
9	RF_DIO2	I	Digital I/O, software configured
10	SCLK	-	XS508 encoded IC , IIC SCLK pin, Not Connected
11	SDATA	-	XS508 encoded IC , IIC SDA pin, Not Connected
12	VCC	P	Supply Voltage +3.3V
13	GND	P	Ground
14	SPI_CS	I	SPI_CS
15	SPI_MOSI	I	SPI_MOSI
16	SPI_MISO	O	SPI_MISO / I2C_SDATA
17	SPI_CLK	I	SPI_CLK / I2C_SCLK
18	RF_DIO5	I	Digital I/O, software configured
19	RF_DIO4	I	Digital I/O, software configured
20	TCXO_EN	I	TCXO Crystal oscillator enabled, valid at low level

1.3 Dimensions

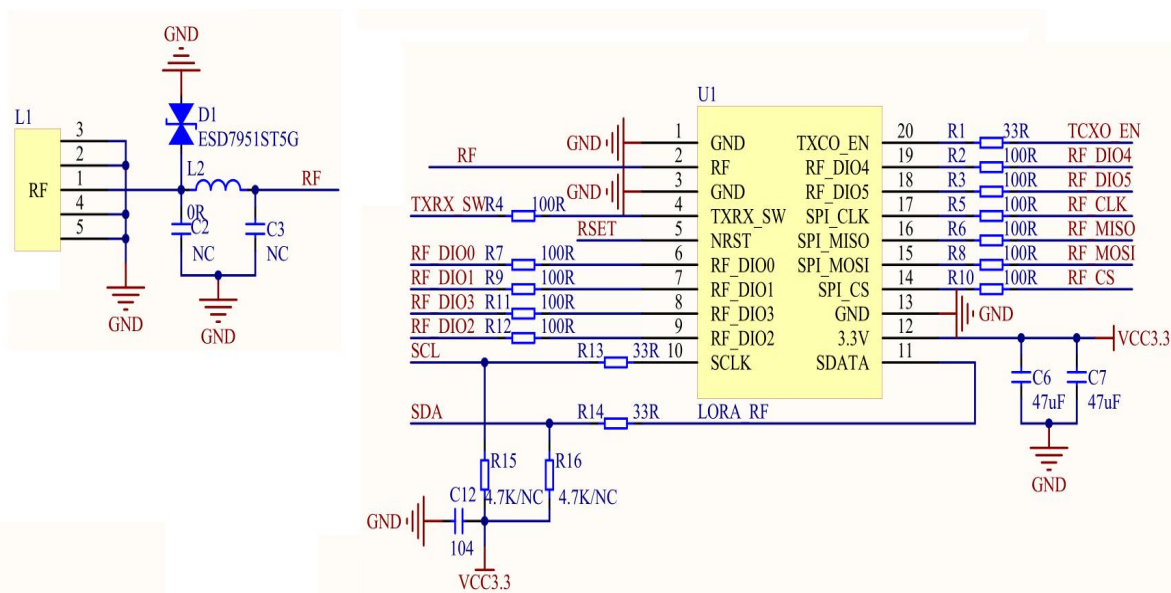


Item	Length	Random Error /Unit(mm)	Remark
A	21.2	±0.2mm	
C	16.7	±0.2mm	
G	1.0	±0.2mm	
H	2.7	±0.2mm	

1.4 Function Block Diagram



1.5 Reference Circuit



2. Electrical Characteristics

2.1 ESD Notice

LF7811 is a high performance radio frequency device. It satisfies:

- ✧ Class 2 of the JEDEC standard JESD22-A114 (Human Body Model) on all pins.
- ✧ Class III of the JEDEC standard JESD22-C101 (Charged Device Model) on all pins

It should thus be handled with all the necessary ESD precautions to avoid any permanent damage

2.2 Absolute Maximum Ratings

Exposure to absolute maximum ratings for extended periods may affect device reliability.

Item	Min	TyP	Max	Unit
Supply Voltage	-0.3	+3.3	+3.9	V
Storage Temperature	-40		+125	°C

Table 1 Absolute Maximum Ratings.

2.3 Operating Range

Item	Min	TyP	Max	Unit
Supply Voltage	+3.0	+3.3	+3.6	V
Operation Temperature	-40		+85	°C

Table 2 Operating Range

2.4 Operating Environment

Item	Description
Modulation	LoRa®
WAN Protocol	ISM Band – LoRa®
Operating Humidity	10%~90%
Dimensions	TYP. 21.2*16.7*2.7mm (W*L*H)

Table 3 Operating Environment

2.5 Electrical Specification

Supply voltage VDD = 3.3 V , temperature=25°C , FXOSC= 32 MHz , FRF = 433/470-510MHz Pout =+ 18.6dBm, shared Rx and Tx path matching.

Item	Description
Frequency	433/470~510MHz, optional
Tx Power	+18.6dBm
Receiving Sensitivity	-139dBm
Supply Voltage	+3.3V
Average Tx Current	≤108mA

Sleeping Current	≤1uA
Average Rx Current	≤20uA
Link Budget	Up to 157.6dB

Table 4 Module Specification

2.5.1 Power Consumption

Description	Conditions	Min	TyP	Max	Unit
Supply current in Sleep mode		-	0.2	1	uA
Supply current in Standby mode	Crystal oscillator enabled	-	1.6	1.8	mA
Supply current in Receive mode	LNA off	-	10.8	-	
	LNA on	-	11.5	-	mA
Supply current in Transmit mode With impedance matching	RFOP = +20 dBm,	-	108	-	mA
	RFOP = +17 dBm,	-	87	-	mA
	RFOP = +13 dBm,	-	29	-	mA
	RFOP = + 7 dBm,	-	20	-	mA

Table 5 Power consumption specification

2.5.2 Frequency Synthesis

Description	Conditions	Min	TyP	Max	Unit
Frequency Range	Programmable	433			
		470	-	510	MHz
Crystal Oscillator frequency	-	-	32	-	MHz
Crystal Oscillator wake-up time	-	-	250	-	us
Frequency synthesizer wake-up time to PLLock signal	From standby mode	-	60	-	us
Bit Rate, FSK		1.2	-	300	kbps
Bit Rate Accuracy, FSK	ABS	-	-	250	ppm
Bit Rate , OOK		1.2	-	32.768	kbps
Bit Rate , LoRa Mode	From SF6,BW500KHz	0.018	-	37.5	kbps
	To SF12,BW=7.8KHz				
Frequency diviation , FSK		0.6	-	200	KHz

Table 6 Frequency Synthesizer Specification

2.5.3 FSK / OOK Mode Receiver

All receiver tests are performed with RxBw = 10 kHz (Single Side Bandwidth) as programmed in RegRxBw . Sensitivities are reported for a 0.1% BER (with Bit Synchronizer enabled), unless otherwise specified. Blocking tests are performed with an unmodulated interferer. The wanted signal power for the Blocking Immunity, ACR, IIP2, IIP3 and AMR tests is set 3 dB above the receiver sensitivity level.

Description	Conditions	Min	TyP	Max	Unit
LNA gain	FDA=5KHz, RB=1.2kbs	-	-121	-	dBm
	FDA=5KHz, RB=4.8kbs	-	-117	-	dBm
	FDA=40KHz, RB=38.4kbs	-	-107	-	dBm
	FDA=40KHz, RB=38.4kbs	-	-95	-	dBm
	FDA=62.5KHz, RB=250kbs***	-	-	-	dBm
OOK sensitivity, highest LNA gain	BR=4.8kbs/s	-	-117	-	dB
	BR=32kbs/s	-	-108	-	dB
Blocking immunity	offset=±1MHz	-	71	-	dB
	offset=±2MHz	-	76	-	dB
	offset=±10MHz	-	84	-	dB
RSSI Dynamic Range	AGC Enabled Min	-	-127	-	dBm
	Max	-	0	-	dBm

Table 7 FSK / OOK Receiver Specification

2.5.4 FSK / OOK Mode Transmitter

Description	Conditions	Min	TYP	Max	Unit
PA_ RF output Power	Max	-	+20	-	dBm
	Min	-	-1	-	dBm
Transmitter Phase Noise	10KHz	-	-110	-	dB
	50KHz	-	-110	-	dB
	400KHz	-	-122	-	dB
	1MHz	-	-129	-	dBm

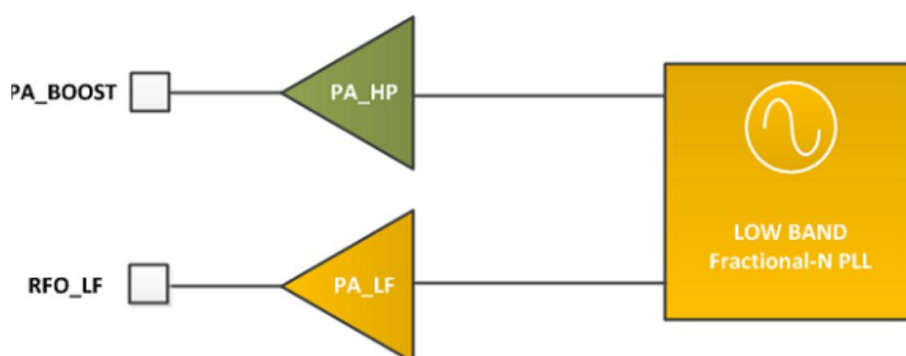
Table 8 FSK / OOK Transmitter Specification

3. Transmitter Description

The transmitter of LF7811 comprises the frequency synthesizer, modulator (both LoRa® and FSK/OOK) and power amplifier blocks, together with the DC biasing and ramping functionality that is provided through the VR_PA block

3.1 Architecture Description

The architecture of the RF front end is shown in the following diagram:



3.2 RF Power Amplifiers

PA_HF and PA_LF are high efficiency amplifiers capable of yielding RF power programmable in 1 dB steps from -4 to +20dBm directly into a 50 ohm load with low current consumption. PA_LF covers the lower bands (433-510MHz).

The output power is sensitive to the power supply voltage, and typically their performance is expressed at 3.3V. PA_HP(High Power Connected to the PA_BOOST pin , covers all frequency bands that the chip addresses.It permits continuous operation at up to +17dBm and duty cycled operation at up to +18.6dBm.

Pa Select	Mode	Power Range	Pout Formula
0	PA_HF or PA_LF on RFO_HF or RFO_LF	-4dBm to +15dBm	$P_{out} = P_{max} - (15 - \text{OutputPower})$ $P_{max} = 10.8 + 0.6 \times \text{MaxPower [dBm]}$
1	PA_HP on PA_BOOST,Any Frequency	+2dBm to +17dBm	$P_{out} = 17 - (15 - \text{OutputPower}) \text{ [dBm]}$

Table 9 Power Amplifier Mode Slection Truth Table

Notes

- For +18.6dBm restrictions on operation please consult the following .
- To ensure correct operation at the highest power levels ensure that the current limiter OcpTrim is adjusted to permit delivery of the requisite supply current.
- If the PA_BOOST pin is not used it may be left floating.

4. Receiver Description

4.1 Overview

LF7811 features a digital receiver with the analog to digital conversion process being performed directly following the LNA-Mixers block. The receiver also has automatic gain calibration, this improves the precision of RSSI measurement and enhances image rejection.

4.2 Receiver Enabled and Receiver Active States

In the receiver operating mode two states of functionality are defined. Upon initial transition to receiver operating mode the receiver is in the 'receiver-enabled' state. In this state the receiver awaits for either the user defined valid preamble or RSSI detection criterion to be fulfilled. Once met the receiver enters 'receiver-active' state. In this second state the received signal is processed by the packet engine and top level sequencer.

4.3 Automatic Gain Control In FSK/OOK Mode

The AGC feature allows receiver to handle a wide Rx input dynamic range from the sensitivity level up to maximum input level of 0dBm or more, whilst optimizing the system linearity.

RX input level (Pin	Gain Setting	LnaGain	Relative LNA Gain [dB]	NF Lower/Higher Band [dB]	IIP3 Lower/Higher band [dBm]
Pin <= AgcThresh1	G1	'001'	0 dB	4/5.5/7	-15/-22/-11
AgcThresh1 < Pin <= AgcThresh2	G2	'010'	-6 dB	6.5/8/12	-11/-15/-6
AgcThresh2 < Pin <= AgcThresh3	G3	'011'	-12 dB	11/12/17	-11/-12/0
AgcThresh3 < Pin <= AgcThresh4	G4	'100'	-24 dB	20/21/27	2/3/9
AgcThresh4 < Pin <= AgcThresh5	G5	'110'	-26 dB	32/33/35	10/10/14
AgcThresh5 < Pin	G6	'111'	-48 dB	44/45/43	11/12/14

Table 10 LNA Gain Control and Performances

4.4 RSSI in LoRa® Mode

The RSSI values reported by the LoRa® modem differ from those expressed by the FSK/OOK modem. The following formula shows the method used to interpret the LoRa® RSSI values:

$$\text{RSSI[dBm]} = -137 + \text{RSSI}$$

5. Package

Module	Package			Article number
	Form	QTY	Size	
LF7811	Tape&Reel	As required	As required	Undetermined
	Trays	As required	As required	Undetermined

Table 11 Packing Information

6. Contact Us

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