Features

- Upto 16KM Range
- Integrated LoRa™ Modem Semtech SX1272
- Highly Efficient Integral Impedance Matching Network
- Provides Full Functionality of the RFIC:
- 157 dB maximum link budget
- +20 dBm at 100 mW constant RF output vs. V supply
- +14 dBm high efficiency PA
- Built in RF switch
- High sensitivity: down to -130 dBm
- Bullet-proof front end: IIP3 = -12.5 dBm
- 89 dB blocking immunity
- Small Form Factor: 23mm x 20mm
- Programmable bit rate up to 300 kbps
- Low RX current of 10 mA, 100nA register retention
- FSK, GFSK, MSK, GMSK, LoRaTM and OOK modulation
- Built-in bit synchronizer for clock recovery
- Preamble detection
- 127 dB Dynamic Range RSSI
- Automatic RF Sense and CAD with ultra-fast AFC
- Packet engine up to 256 bytes with CRC
- Built-in temperature sensor and low battery indicator

Applications

- Home Automation
- RF Alarms
- Sensor networks
- Long Range Telemetry
- Meter Reading
- Irrigation Systems
- Wireless Applications
- Alarms

Introduction

The RF-LoRa module is an extremely high performance, cost effective radio module featuring the Semtech SX1272 LoRa™ long range providing ultra-long range, spread spectrum communication and high interference immunity within minimal current consumption.

This module including crystal, RF Changeover switch, impedance matching network and track layout provide a simple digital interface and direct antenna connection. This enables a plug in RF solution with maximum efficiency. Programming of the module is via SPI interface.

Using the RF-LoRa enables a fast and easy to market solution with cost effective license exempt hardware.

The RF-LoRa Module is CE compliant. Providing that certain procedures are followed. (please refer to application schematic later in this datasheet).
RF LoRa Transceiver

Part Numbers

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>RF-LoRa-868-50</td>
<td>FM Transceiver Module, pre set to 868MHz (SMT package)</td>
</tr>
<tr>
<td>RF-LoRa-868</td>
<td>FM Transceiver Module, pre set to 868MHz (DIP package)</td>
</tr>
<tr>
<td>RF-LoRa-915-50</td>
<td>FM Transceiver Module, pre set to 915MHz</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PIN</th>
<th>Definition</th>
<th>Direction</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Antenna</td>
<td>In/Out</td>
<td>Antenna pin connection. Keep short (50ohms Impedance)</td>
</tr>
<tr>
<td>2</td>
<td>GND</td>
<td>-</td>
<td>Ground connection</td>
</tr>
<tr>
<td>3</td>
<td>Vcc</td>
<td>In</td>
<td>Power connection</td>
</tr>
<tr>
<td>4</td>
<td>RX_SWITCH</td>
<td>In</td>
<td>Enable RX RF Path Active High</td>
</tr>
<tr>
<td>5</td>
<td>TX_SWITCH</td>
<td>In</td>
<td>Enable TX RF Path Active High</td>
</tr>
<tr>
<td>6</td>
<td>DIO0</td>
<td>In/Out</td>
<td>Digital I/O software configured</td>
</tr>
<tr>
<td>7</td>
<td>DIO1</td>
<td>In/Out</td>
<td>Digital I/O software configured</td>
</tr>
<tr>
<td>8</td>
<td>DIO2</td>
<td>In/Out</td>
<td>Digital I/O software configured</td>
</tr>
<tr>
<td>9</td>
<td>DIO3</td>
<td>In/Out</td>
<td>Serial Interface Select Input (0 – VDD V): Provides select/enable function for 4-line serial data bus.</td>
</tr>
<tr>
<td>10</td>
<td>DIO4</td>
<td>In/Out</td>
<td>Digital I/O software configured</td>
</tr>
<tr>
<td>11</td>
<td>DIO5</td>
<td>In/Out</td>
<td>Digital I/O software configured</td>
</tr>
<tr>
<td>12</td>
<td>RESET</td>
<td>In</td>
<td>Reset Trigger Input</td>
</tr>
<tr>
<td>13</td>
<td>Serial Clock</td>
<td>In</td>
<td>SPI Serial Clock Input</td>
</tr>
<tr>
<td>14</td>
<td>Serial Data Out</td>
<td>Out</td>
<td>SPI Serial Data Output</td>
</tr>
<tr>
<td>15</td>
<td>Serial Data In</td>
<td>In</td>
<td>SPI Serial Data Input</td>
</tr>
<tr>
<td>16</td>
<td>nSEL</td>
<td>In</td>
<td>Device Select Active Low</td>
</tr>
</tbody>
</table>
RF LoRa Transceiver

Pin Description

Mechanical Dimensions

SMT Version

DIP Version

Suggested Layout

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RF LoRa Transceiver

Block Diagram

Application Resources

The RF-LoRa is a ready to use application of the Semtech SX1272.
Access to the programming and configuration of Semtech 1272 Transceiver are via the modules interface SPI line.

The RF-LoRa has been developed with Semtech to provide a low cost platform application of the 1272 transceiver. This offers optimal design realisation and easy integration within the end application.
The most important aspect of any RF Module is to maximise the performance of the transceiver at the external module pads.
In particular the impedance matching network which is the most sensitive section of the RF module design.
In order to maximise signal propagation to the external pad of the module, a specific layout is required which is not (usually) the smallest physical size (beware of small RF modules!).
Many RF Module manufacturers simply reproduce the IC manufacturers data characteristics where in practice the Module RF performance is considerably lower.

To ensure that the latest details in programming this device are offered, we have not included the 1272s programming information in this document.

Programming, configuration and further resource data is available from Semtech at the below links:

SX1272 Datasheet

LoRa Calculator: fast evaluation of link budget, time on air and energy consumption


Packet Error Rate Firmware User Guide

LoRa Modem Designer's Guide
The above schematic shows an easy interface to a PIC Microcontroller

This is the same application circuit that we used for range testing (please see our range test information later in the document).

We also have application source code available for download on our website. This configures the RF LoRa Module for maximum range.

**Walk Test application**

Also available is the source code used to carry out a simple range test.

In order to use this two application boards are required, one acts as a beacon transmitter, the other as the beacon receiver. The TX board will illuminate the GREEN LED when transmitting and the Receiver will illuminate the RED LED when RECEIVING.

The Transmitter board transmits an RF beacon every second (Green LED flashes to indicate transmission). This enables a one man range test, by placing either board in a fixed location and monitoring the beacon signals.
**RF LoRa Transceiver**

**Electrical Specifications**

### Absolute Maximums

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{dd}$</td>
<td>Positive power supply</td>
<td>-0.3</td>
<td>+3.9</td>
<td>V</td>
</tr>
<tr>
<td>$V_{in}$</td>
<td>Voltage on Digital Inputs</td>
<td>-0.3</td>
<td>$V_{dd}$+0.3</td>
<td>V</td>
</tr>
<tr>
<td>$V_{in}$</td>
<td>Voltage on Analogue Inputs</td>
<td>-0.3</td>
<td>$V_{dd}$+0.3</td>
<td>V</td>
</tr>
<tr>
<td>RX</td>
<td>Max Rx input power</td>
<td></td>
<td>+10 dBm</td>
<td></td>
</tr>
<tr>
<td>$T_{op}$</td>
<td>Operating temperature</td>
<td>-40</td>
<td>+85</td>
<td>°C</td>
</tr>
<tr>
<td>$T_{st}$</td>
<td>Storage temperature</td>
<td>-55</td>
<td>115</td>
<td>°C</td>
</tr>
</tbody>
</table>

### Recommended Operating Conditions

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{dd}$</td>
<td>Positive power supply</td>
<td>2.2</td>
<td>3.7</td>
<td>V</td>
</tr>
<tr>
<td>$T_{op}$</td>
<td>Working temperature</td>
<td>0</td>
<td>55</td>
<td>°C</td>
</tr>
</tbody>
</table>

### DC Characteristics

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Test Condition</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply Voltage Range</td>
<td>$V_{dd}$</td>
<td>RC oscillator, main digital regulator, and low power digital regulator OFF.</td>
<td>1.8</td>
<td>3.3</td>
<td>3.6</td>
<td>V</td>
</tr>
<tr>
<td>Power Saving Modes</td>
<td>$I_{	ext{shut}}$</td>
<td>Register values maintained.</td>
<td></td>
<td>30</td>
<td></td>
<td>nA</td>
</tr>
<tr>
<td></td>
<td>$I_{	ext{sleep}}$</td>
<td>Crystal Oscillator and Main Digital Regulator ON, all other blocks OFF.</td>
<td></td>
<td>50</td>
<td></td>
<td>nA</td>
</tr>
<tr>
<td></td>
<td>$I_{	ext{spi}}$</td>
<td>SPI active state</td>
<td>1.35</td>
<td></td>
<td></td>
<td>mA</td>
</tr>
<tr>
<td>TUNE Mode Current</td>
<td>$I_{	ext{tune,RX}}$</td>
<td>RX Tune</td>
<td></td>
<td>6.5</td>
<td></td>
<td>mA</td>
</tr>
<tr>
<td></td>
<td>$I_{	ext{tune,TX}}$</td>
<td>TX Tune</td>
<td></td>
<td>6.9</td>
<td></td>
<td>mA</td>
</tr>
<tr>
<td>RX Mode Current</td>
<td>$I_{\text{RX}}$</td>
<td></td>
<td></td>
<td>10</td>
<td></td>
<td>mA</td>
</tr>
<tr>
<td>TX Mode Current</td>
<td>$I_{\text{TX}}$</td>
<td>RFOP = +20dBm on PA Boost, RFOP = +17dBm on PA Boost, RFOP = +13dBm on PA Boost, RFOP = +7dBm on PA Boost</td>
<td></td>
<td>125</td>
<td>90</td>
<td>mA</td>
</tr>
</tbody>
</table>
### Power Consumption FSK Modulation

The table below gives power consumption figures based on the following parameters:

- $V_{BAT1} = V_{BAT2} = V_{cc} = 3.3\text{V}$
- Temp $= 25\text{degC}$
- $F_{osc} = 32\text{MHz}$, $F_{rf} = 915\text{MHz}$, $P_{out} = +13\text{dBm}$.
- 2 level FSK modulation without pre-filtering, FDA = 5KHz, Bit Rate = 4.8kbps

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
<th>Conditions</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>IDDSL</td>
<td>Supply Current Sleep Mode</td>
<td></td>
<td>0.1</td>
<td>1</td>
<td>uA</td>
</tr>
<tr>
<td>IDDIDLE</td>
<td>Supply Current Idle Mode</td>
<td>RC Oscillator enabled</td>
<td>1.5</td>
<td></td>
<td>uA</td>
</tr>
<tr>
<td>IDDST</td>
<td>Supply Current Standby Mode</td>
<td>XTAL Oscillator enabled</td>
<td>1.4</td>
<td>1.6</td>
<td>mA</td>
</tr>
<tr>
<td>IDDFS</td>
<td>Supply Current Synthesizer Mode</td>
<td>FSRx</td>
<td>4.5</td>
<td></td>
<td>mA</td>
</tr>
<tr>
<td>IDDR</td>
<td>Supply Current Receive Mode</td>
<td>LnaBoost off, LnaBoost on</td>
<td>10.5</td>
<td>11.2</td>
<td>mA</td>
</tr>
<tr>
<td>IDDT</td>
<td>Supply Current Transmit Mode</td>
<td>RFOP=$+20\text{dBm}$ on PA_BOOST, RFOP=$+20\text{dBm}$ on PA_BOOST, RFOP=$+20\text{dBm}$ on RFO pin, RFOP=$+20\text{dBm}$ on RFO pin</td>
<td>125</td>
<td>90</td>
<td>mA</td>
</tr>
</tbody>
</table>

### Power Consumption LORA Modulation

The table below gives power consumption figures based on the following parameters:

- $V_{cc} = 3.3\text{V}$
- Temp $= 25\text{degC}$
- $F_{osc} = 32\text{MHz}$, $F_{rf} = 915\text{MHz}$, Bandwidth $= 125\text{KHz}$, Spreading Factor $= 12$, Error Correction $= 4/6$
- Packet Error Rate $= 1\%$ with CRC on Payload enabled
- $P_{out} = +13\text{dBm}$.
- Payload length $= 10\text{bytes}$, Preamble $= 12$ symbols (programmed register Preamble length $= 8$)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
<th>Conditions</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>IDDR_L</td>
<td>Supply current in receiver LoRa Mode</td>
<td>LnaBoost off, BW=$125\text{KHz}$, LnaBoost off, BW=$250\text{KHz}$, LnaBoost off, BW=$500\text{KHz}$</td>
<td>9.7</td>
<td>10.5</td>
<td>mA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>LnaBoost on, BW=$125\text{KHz}$, LnaBoost on, BW=$250\text{KHz}$, LnaBoost on, BW=$500\text{KHz}$</td>
<td>10.8</td>
<td>11.6</td>
<td>mA</td>
</tr>
<tr>
<td>IDDT_L</td>
<td>Supply Current Transmitter Mode</td>
<td>RFOP=$+13\text{dBm}$, RFOP=$+7\text{dBm}$</td>
<td>28</td>
<td>18</td>
<td>mA</td>
</tr>
<tr>
<td>IDDT_H_L</td>
<td>Supply Current Transmitter Mode</td>
<td>Using PA_BOOST pin, RFOP=$+17\text{dBm}$</td>
<td>90</td>
<td></td>
<td>mA</td>
</tr>
</tbody>
</table>
RF LoRa Transceiver

Range Test Notes

Transmitter and Receiver boards were built using simple Vero board and a PIC microcontroller (16F886). The transmitter sent a beacon signal at 1 second intervals. The receiver acknowledges this signal back to the transmitter.

A simple piece of wire was used as antenna for both transmitter and receiver.

This test was designed to represent a real life application. It is often difficult to design an application with all RF features to an optimum potential i.e. the antenna was not 100% ideal as there was no antenna ground plane, and the motherboard was rudimentary.

Our Range Testing was conducted on Brighton to Shoreham Seafront providing an open Line of Sight Test.

1. The Transmitter was mounted on a plastic wheelie bin 4ft from the ground.
2. The Receiver was carried on the dashboard of a vehicle (5ft above ground) along the seafront. Line of sight was not achieved until the receiver was at least 9km distance
3. As the receiver travelled away from the transmitter Line of sight was lost. A Reliable signal was observed to about 3K range, thereafter the signal became intermittent. When the Transmitter and Receiver regained Line of sight a reliable signal was again observed. This continued for the available distance (about 12KM) at which point the terrain prevented further testing. At the longest available range the signal was 100% reliable.

Test conditions

- $T_a = +25 \, ^\circ C$
- $V_{dd} = 3.3 \, \text{Vdc}$
- Dry, Broken Sunshine, Relative Humidity 45%
  - RF input and output levels can typically be achieved at the antenna port after filtering components.

Conclusion

The product performed as expected. Unfortunately we ran out of land to test a LOS beyond 12Km, so the maximum range is further than tested here.

It is also clear that the product performs considerably better when in LOS.
RF LoRa Transceiver

Range Test Results (Line of Sight)

Range Test Results (Non Line of Sight)

This is subjective as the buildings were random!
RF LoRa Transceiver

RF LoRa module re-flow guide

Profile feature | Value (lead free)
---|---
Ramp up rate | 3°C/s
Pre-heat Temperature
- Temperature Min ($T_{Smin}$) | 150°C
- Temperature Max ($T_{Smax}$) | 200°C
- Pre-heat time | 60-100s
Peak Temperature ($T_p$) | 240°C
Time at $T_p$ | 10-20sec
Ramp down rate | 6°C/s
Time from 25°C to peak | 8 mins max.

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DO NOT
Discard with normal waste, please recycle.

ROHS Directive 2002/95/EC
Specifies certain limits for hazardous substances.

WEEE Directive 2002/96/EC
Waste electrical & electronic equipment
must be disposed of through a licensed point. RF Solutions Ltd., fulfills its WEEE membership of an approved compliance.

This product WEEE collection obligations by scheme.

Waste Batteries and Accumulators
Directive 2006/66/EC
Where batteries are fitted, before recycling the product, the batteries must be removed and disposed of at a licensed collection point.

Environment Agency producer registration number: WEEE/JB0104WV.

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