



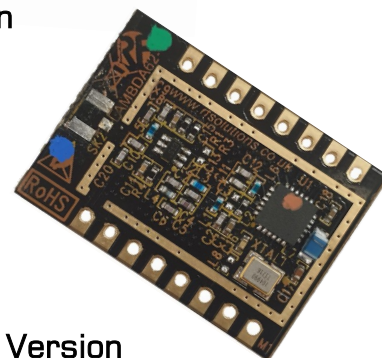
## +22dBm LoRa 868/918MHz Transceiver

### Features

- 20KM+ Range
- Integrated LoRa™ Modem **Semtech SX1262**
- Highly Efficient Integral Impedance Matching Network
- Provides Full Functionality of the RFIC:
- High Rx sensitivity: down to -148 dBm
- Tx +22 dBm @118mA constant RF output
- +14 dBm high efficiency PA
- 170 dB maximum link budget
- Built in RF switch
- 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 4.6 mA, (Lora Operating Mode)
- LoRa,FSK,GFSK,MSK,GMSK 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
- 868MHz CE Compliant
- 918MHz "Modular" FCC Certified for use in USA
- Australia Certification Pending



C Version



Open Version

### Applications

- RF Alarms
- Sensor networks
- Long Range Telemetry
- Meter Reading
- Environmental Sensors
- Building Control & Automation
- Agricultural Applications

### Description

The LAMBDA62 RF module is a class leading, cost effective radio module featuring the Semtech SX1262 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.

The LAMBDA62 Module is CE compliant. Providing that certain procedures are followed. (Please refer to application schematic later in this datasheet).

# LAMBDA62 LoRa Transceiver



## Part Numbers

Open module (no shield can, antenna output on Pin 1)

| Part Number | Description                   | Package |
|-------------|-------------------------------|---------|
| LAMBDA62-8S | FM Transceiver Module, 868MHz | SMT     |
| LAMBDA62-8D | FM Transceiver Module, 868MHz | DIP     |

| Part Number | Description                        | Package |
|-------------|------------------------------------|---------|
| LAMBDA62-9S | FM Transceiver Open Module, 918MHz | SMT     |
| LAMBDA62-9D | FM Transceiver Open Module, 918MHz | DIP     |

Shielded Module (with shield can, antenna output ufl connector)

| Part Number  | Description                            | Package |
|--------------|----------------------------------------|---------|
| LAMBDA62C-9S | FM Transceiver Shielded Module 918MHz  | SMT     |
| LAMBDA62C-9D | FM Transceiver Shielded Module, 918MHz | DIP     |

## FCC / CE Certification

LAMBDA62C-9S and D have the benefit of being an FCC part15 certified RF Module.

This enables the Lambda module to be incorporated within an product and rely on the Lambda module FCC certification for the end product without further testing or FCC certification with the following conditions.

1. The antenna to be used is FLEXI-SMARP-918
2. The finished product will display a label which is directly visible as follows:

**Contains FCC ID: P90LAMBDA62**

Please note that although The radio characteristics are covered by the Lambda62 modular FCC ID of the grant, it is still the responsibility of the manufacturer to perform final checks on the product, such as ensuring the radiated transmitted power is within limits, and to assess the worst case spurious emission is within the FCC requirements of CFR47 Part 15.

In keeping with the requirements of FCC the chosen antenna for any application must be is a non standard connector type to ensure that the antenna used is part of a fixed installation i.e. cannot be changed e.g. a Reverse Polarity Connector type.

## Operational Description in the 900MHz Band

A 32MHz crystal oscillator drives the Semtech SX1262. The RF output goes an RF SPDT switch enabling the TX output to be switched on. There is no external ground to the module other than the circuit board and the screen can. The supply voltage is 2.2 to 3.7 volts dc.

In order to comply with the Modular FCC certification (so as to avoid full FCC certification tests on the finished product) and approved antenna must be used which it type FLEXI-SMARP-918 (Antenna Flexi 1/4 Wave 918MHz SMA Male Reverse Polarity unity gain of +2dBi,).

A stock UFL to reverse SMA cable is available (part no CBA-UFLSMAFRP10IP - UFL to waterproof SMA RP, 100mm long).

The centre operating frequency of the transmitter is 918MHz (917.5MHz – 918.5MHz) which is in the license free band of 902 to 928MHz, and within the license free band of 915 to 928MHz for Australia) The module operates on a single frequency only.

### Feature:

Frequency range: 918MHz (917.5MHz – 918.5MHz)

Modulation Type: CSS

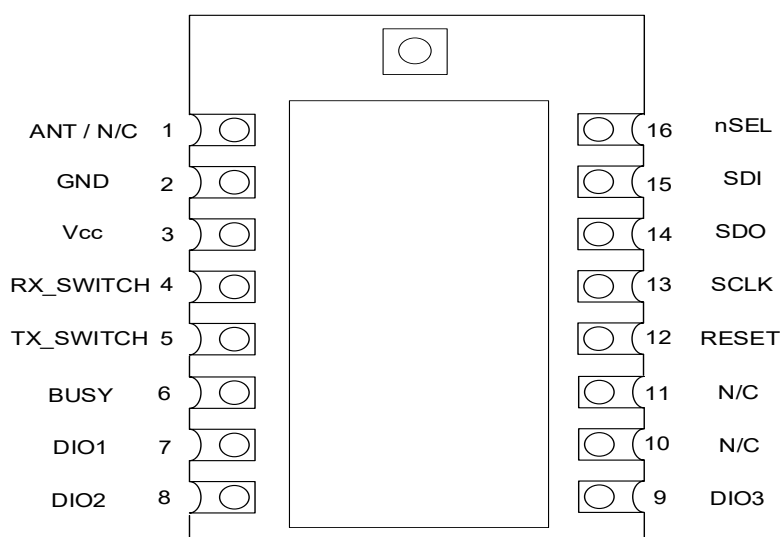
Antenna gain: 2dBi

Crystal: 32MHz

# LAMBDA62 LoRa Transceiver



## Pin Description



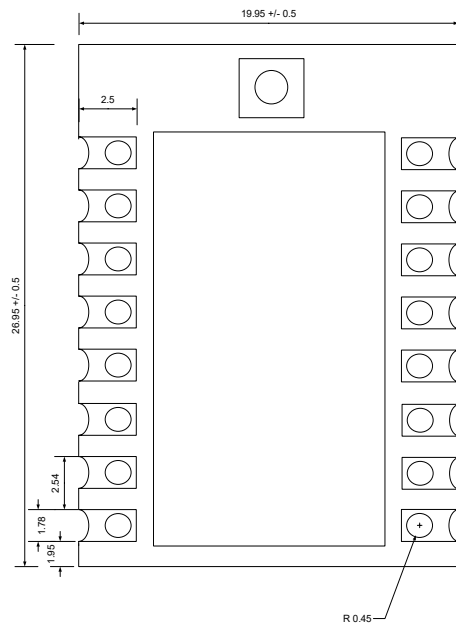
| PIN     | Definition      | Direction | Function                                                                                                                                        |  |         |         |         |   |   |
|---------|-----------------|-----------|-------------------------------------------------------------------------------------------------------------------------------------------------|--|---------|---------|---------|---|---|
| 1       | Antenna         | In/Out    | Versions without Screen can: Antenna connection<br>“C” Versions with screen can: No Connect                                                     |  |         |         |         |   |   |
| 2       | GND             | -         | Ground connection                                                                                                                               |  |         |         |         |   |   |
| 3       | Vcc             | In        | Power connection                                                                                                                                |  |         |         |         |   |   |
| 4       | RX_SWITCH       | In        | Enable RX RF Path Active High<br><table><tr><td></td><td>TX PIN5</td><td>RX PIN4</td></tr><tr><td>RX Mode</td><td>0</td><td>1</td></tr></table> |  | TX PIN5 | RX PIN4 | RX Mode | 0 | 1 |
|         | TX PIN5         | RX PIN4   |                                                                                                                                                 |  |         |         |         |   |   |
| RX Mode | 0               | 1         |                                                                                                                                                 |  |         |         |         |   |   |
| 5       | TX_SWITCH       | In        | Enable TX RF Path Active High<br><table><tr><td></td><td>TX PIN5</td><td>RX PIN4</td></tr><tr><td>TX Mode</td><td>1</td><td>0</td></tr></table> |  | TX PIN5 | RX PIN4 | TX Mode | 1 | 0 |
|         | TX PIN5         | RX PIN4   |                                                                                                                                                 |  |         |         |         |   |   |
| TX Mode | 1               | 0         |                                                                                                                                                 |  |         |         |         |   |   |
| 6       | Busy            | Out       | Indicates LAMBDA Module/EX1262 is Busy                                                                                                          |  |         |         |         |   |   |
| 7       | DIO1            | In/Out    | Digital I/O software configured                                                                                                                 |  |         |         |         |   |   |
| 8       | DIO2            | In/Out    | Digital I/O software configured                                                                                                                 |  |         |         |         |   |   |
| 9       | DIO3            | In/Out    | Digital I/O Software configured                                                                                                                 |  |         |         |         |   |   |
| 10      | N/C             |           | No Connect                                                                                                                                      |  |         |         |         |   |   |
| 11      | N/C             |           | No Connect                                                                                                                                      |  |         |         |         |   |   |
| 12      | RESET           | In        | Reset Trigger Input                                                                                                                             |  |         |         |         |   |   |
| 13      | Serial Clock    | In        | SPI Serial Clock Input                                                                                                                          |  |         |         |         |   |   |
| 14      | Serial Data Out | Out       | SPI Serial Data Output                                                                                                                          |  |         |         |         |   |   |
| 15      | Serial Data In  | In        | SPI Serial Data Input                                                                                                                           |  |         |         |         |   |   |
| 16      | nSEL            | In        | Device Select Active Low                                                                                                                        |  |         |         |         |   |   |

# LAMBDA62 LoRa Transceiver

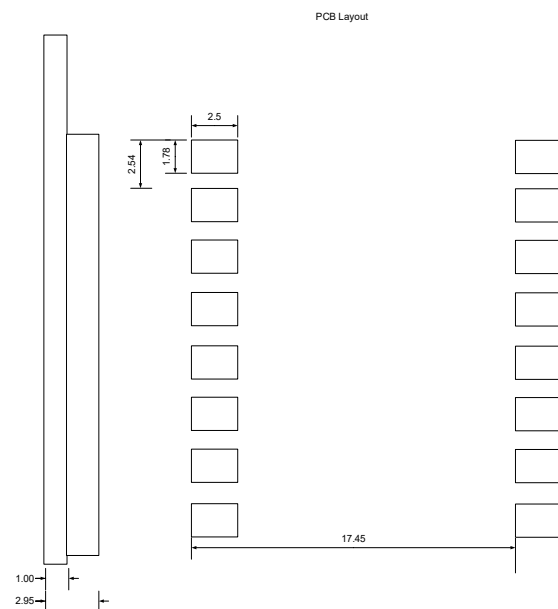


## Mechanical Dimensions

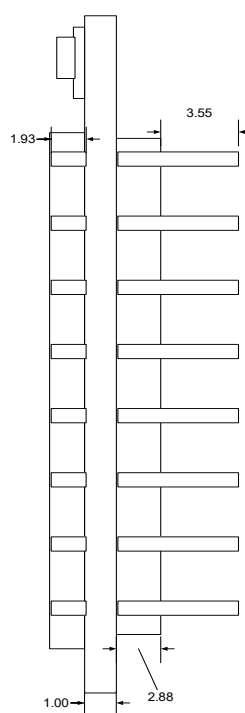
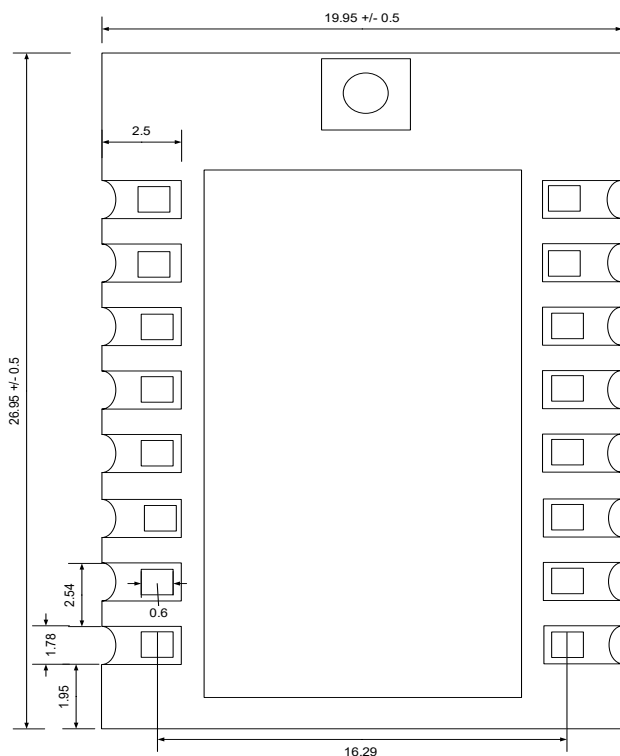
### SMT Version



### Suggested Layout

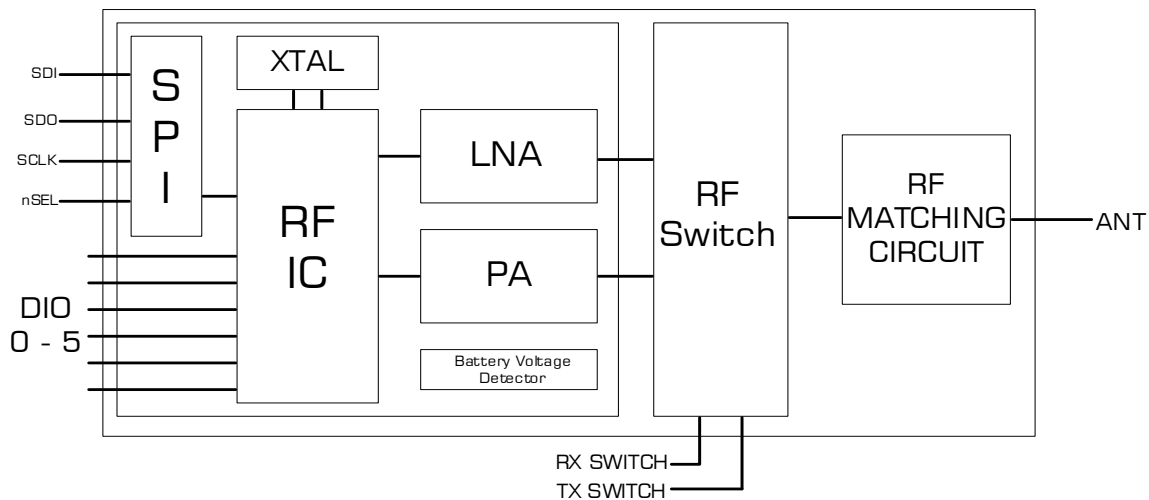


### DIP Version



All dimensions in mm

## Block Diagram



## Application Resources

The LAMBDA62 is a ready to use application of the Semtech SX1262.

Access to the programming and configuration of Semtech 1262 Transceiver are via the modules interface SPI line.

The LAMBDA62 has been developed with Semtech to provide a low cost platform application of the SX1262 transceiver, providing 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.

We have measured the conducted power transmitted from the LAMBDA62 ufl connector at +22.4dBm, which demonstrates the efficiency of the LAMBDA62 module.

RF Solutions has some example firmware (in assembler) which is freely available.

To ensure that the latest details in programming this device are offered, we have not included the 1262s programming information in this document.

The datasheet is readily available online along with additional resource material :

Programming, configuration and further resource data including;

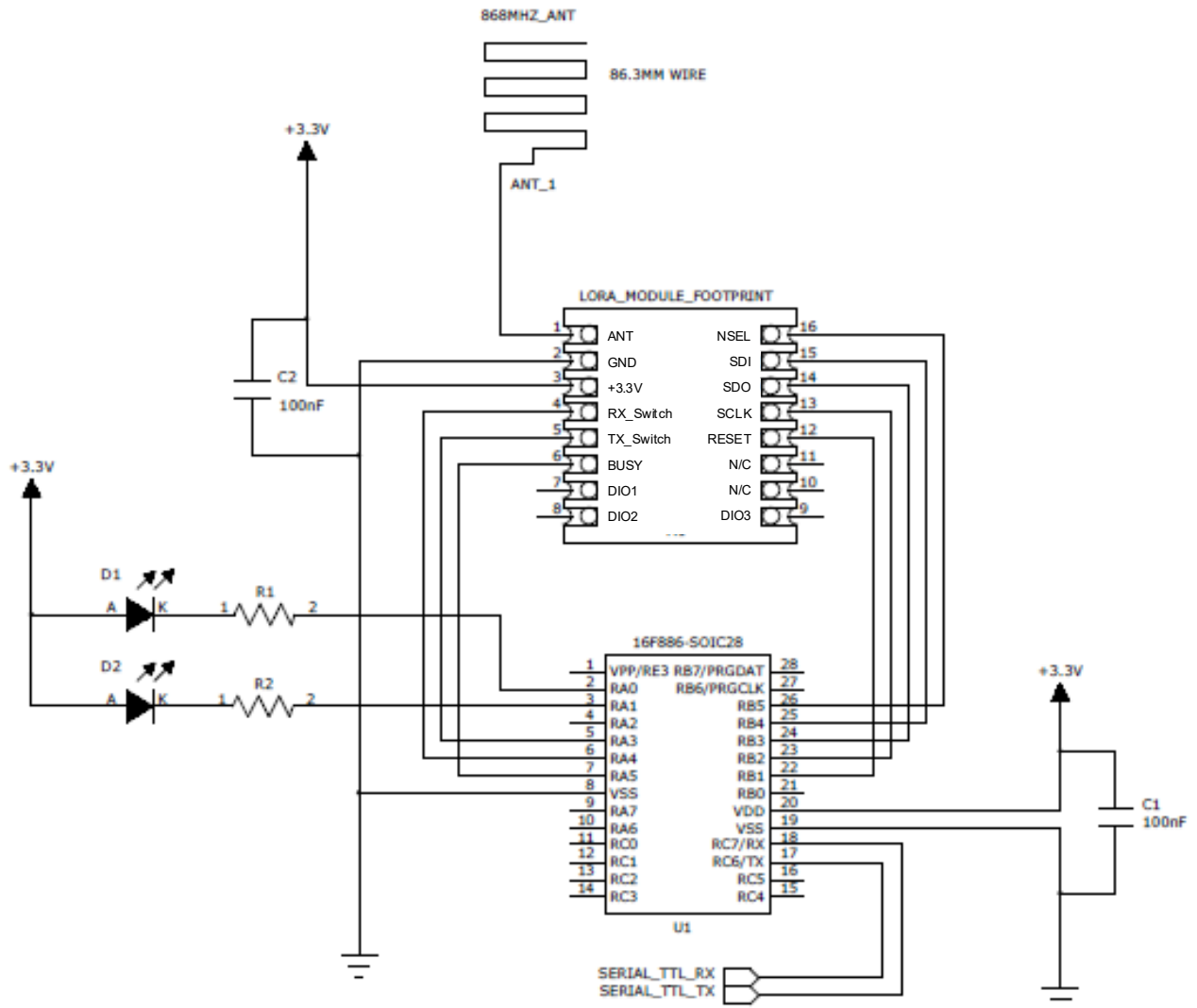
LoRa Calculator: fast evaluation of link budget, time on air and energy consumption.

Packet Error Rate Firmware User Guide.

LoRa Modem Designer's Guide.

is available from Semtech Inc Website

## Application schematic Interfacing a PIC™ Micro Controller



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.

## Controlling the Transmit / Receive RF Switch

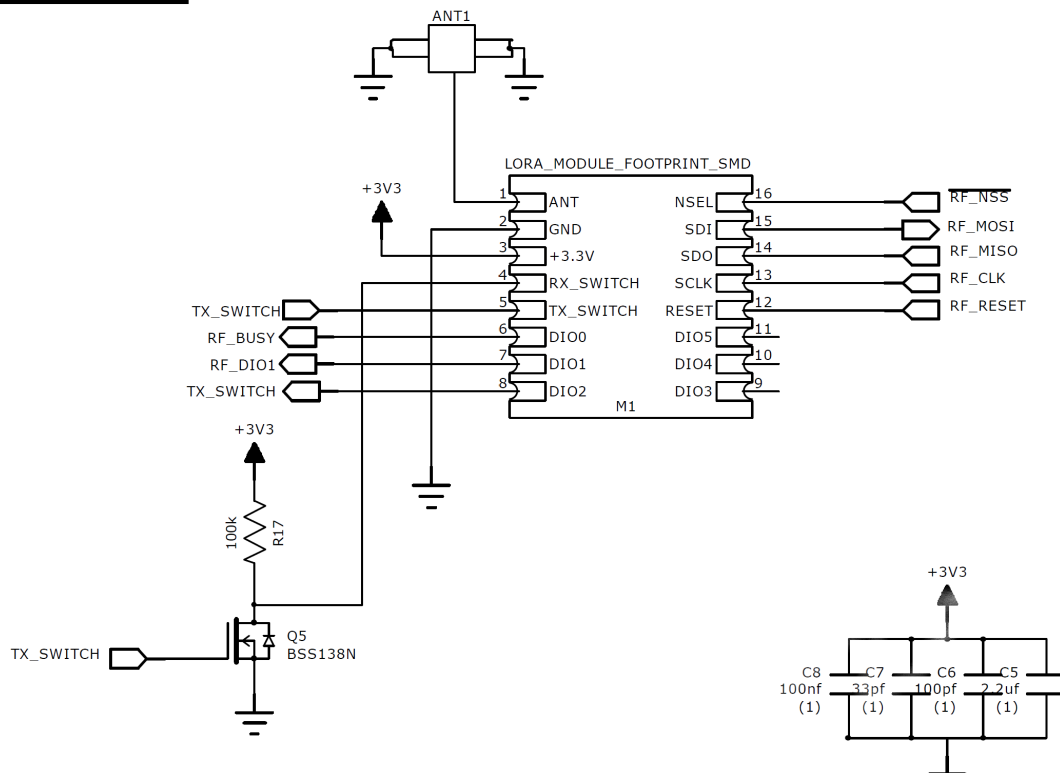
The LAMBDA62 has two inputs to control the onboard RF Switch which connects the impedance matching network / antenna to the Transmit / Receive circuit.

There are two connections in order to provide three states (TX, RX, Disconnected)

Although this requires two I/O Lines this can be reduced to one by using a simple inverting Transistor as shown below,

The TX Switch input can be controlled from the host Micro or, as in the example below by using one of the DIO lines from the LAMBDA62 module as an output to control.

### **RF SECTION**



## Electrical Specifications

### Absolute Maximums

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

### Recommended Operating Conditions

| Symbol   | Parameter             | Minimum | Maximum | Unit |
|----------|-----------------------|---------|---------|------|
| $V_{dd}$ | Positive power supply | 1.8     | 3.7     | V    |
| $T_{op}$ | Working temperature   | -40     | 85      | °C   |

### DC Characteristics

| Parameter            | Symbol         | Test Condition                                                                 | Min | Typ                    | Max | Unit |
|----------------------|----------------|--------------------------------------------------------------------------------|-----|------------------------|-----|------|
| Supply Voltage Range | $V_{DD}$       |                                                                                | 1.8 | 3.3                    | 3.7 | V    |
| Power Saving Modes   | $I_{Shutdown}$ | All blocks of IC OFF.                                                          | —   | 160                    | —   | nA   |
|                      | $I_{Standby}$  | Register values maintained.                                                    | —   | 600                    | —   | nA   |
|                      | $I_{Ready}$    | Crystal Oscillator and Main Digital Regulator ON, all other blocks OFF.        | —   | 0.6                    | —   | mA   |
| TX Mode Current      | $I_{TX}$       | RFOP = +22dBm @ 868/915MHz<br>RFOP = +20dBm<br>RFOP = +17dBm<br>RFOP = + 14dBm | —   | 118<br>102<br>95<br>90 |     | mA   |

#### Note:

#### Set Regulator Mode should be set to 0 (LDO Mode)

The hardware design uses the internal LDO regulator (not the SMPS DC-DC), we chose not to implement the internal BUCK regulator because in our experience, when a battery is reaching end of life the voltage it provides starts to drop and then avalanches in a non linear curve in a short time.

It is only at this stage that the SMPS provides a benefit over and above the LDO regulator, and considering the cost of the large inductor the SMPS requires its not justified for a marginal extension in time the circuit obtains.

If the SMPS is required please contact our Sales Dept.

## Power Consumption in Transmit mode

| Symbol | Frequency Band | Conditions                                                                                             | Power Output | Typical | Unit |
|--------|----------------|--------------------------------------------------------------------------------------------------------|--------------|---------|------|
| IDDTX  | 868/918MHz     | +22dBm                                                                                                 | +22dBm       | 118     | mA   |
|        |                | +20dBm                                                                                                 | +20dBm       | 102     | mA   |
|        |                | +17dBm                                                                                                 | +17dBm       | 95      | mA   |
|        |                | +14dBm                                                                                                 | +14dBm       | 90      | mA   |
|        |                | Optimal Settings for low current and output power. Please see SX1262 PA optimal settings in Datasheet. | +20dBm       | 84      | mA   |
|        |                |                                                                                                        | +17dBm       | 58      |      |
|        |                |                                                                                                        | +14dBm       | 45      |      |

## Receive Mode Specifications

| Symbol  | Description                          | Conditions                            | Typ  | Max | Unit |
|---------|--------------------------------------|---------------------------------------|------|-----|------|
| RXS_2FB | Sensitivity 2-FSK<br>RX boosted gain | BR_F=0.6 kb/s FDA=0.8 KHz BW_F=4KHz   | -125 |     | dBm  |
|         |                                      | BR_F=1.2 kb/s FDA=5 KHz BW_F=20KHz    | -123 |     | dBm  |
|         |                                      | BR_F=4.8 kb/s FDA=5 KHz BW_F=20KHz    | -118 |     | dBm  |
|         |                                      | BR_F=38.4 kb/s FDA=40 KHz BW_F=160KHz | -109 |     | dBm  |
|         |                                      | BR_F=250 kb/s FDA=125 KHz BW_F=500KHz | -104 |     | dBm  |
| RXZ_LB  | Sensitivity LoRa<br>RX boosted gain  | BW_L=10.4 KHz SF=7                    | -134 |     | dBm  |
|         |                                      | BW_L=10.4 KHz SF=12                   | -148 |     | dBm  |
|         |                                      | BW_L=125 KHz SF=7                     | -124 |     | dBm  |
|         |                                      | BW_L=125 KHz SF=12                    | -137 |     | dBm  |
|         |                                      | BW_L=250 KHz SF=7                     | -121 |     | dBm  |
|         |                                      | BW_L=250 KHz SF=12                    | -134 |     | dBm  |
|         |                                      | BW_L=500 KHz SF=7                     | -117 |     | dBm  |
|         |                                      | BW_L=500 KHz SF=12                    | -129 |     | dBm  |
| CCR_F   | Co-channel<br>Rejection FSK          |                                       | 133  |     | dB   |
| CCR_L   | Co-channel<br>Rejection LoRa         | SF=7                                  | 5    |     | dB   |
|         |                                      | SF=12                                 | 19   |     | dB   |
| ACR_f   | Adjacent channel<br>Rejection FSK    | Offset = +/- 50KHz                    | 45   |     | dB   |
| ACR_L   | Adjacent channel<br>Rejection LoRa   | Offset = +/- 1.5 x BW_L               |      |     |      |
|         |                                      | BW_L=125 KHz SF=7                     | 60   |     | dB   |
|         |                                      | BW_L=125 KHz SF=12                    | 72   |     | dB   |

# LAMBDA62 LoRa Transceiver



## General Specifications

| Symbol      | Description                                                                | Conditions                                                                       | Min       | Typ                                | Max      | Unit       |
|-------------|----------------------------------------------------------------------------|----------------------------------------------------------------------------------|-----------|------------------------------------|----------|------------|
| FR          | Synthesizer Frequency Range                                                | SX1261**                                                                         | 150       |                                    | 960      | MHz        |
| FSTEP       | Synthesizer Frequency Step                                                 |                                                                                  |           | 0.95                               |          | MHz        |
| PHN         | Synthesizer Phase Noise<br>868/918MHz                                      | 1 KHz offset<br>10 KHz offset<br>100 KHz offset<br>1 MHz offset<br>10 MHz offset |           | -75<br>-95<br>-100<br>-120<br>-135 |          | dBc/<br>Hz |
| TS_FS       | Synthesizer wakeup time                                                    | From standby to XOSC Mode                                                        |           | 40                                 |          | uS         |
| TS_HOP      | Synthesizer hop time                                                       | 10MHz step                                                                       |           | 30                                 |          | uS         |
| TS_OSC      | Crystal Oscillator Wakeup time                                             | From Standby_RC                                                                  |           | 150                                |          | uS         |
| OSC_TR<br>M | Crystal Oscillator trimming range for crystal frequency error compensation | Min/max specification                                                            | +/-<br>15 | +/-<br>30                          |          | Ppm        |
| BR_F        | Bit Rate FSK                                                               | Programmable Min Modulation index is 0.5                                         | 0.6       |                                    | 300      | Kb/s       |
| FDA         | Frequency Deviation FSK                                                    | Programmable<br>$FDA + BR\_F/2 \leq 250\text{KHz}$                               | 0.6       |                                    | 200      | KHz        |
| BR_L        | Bit Rate LoRa                                                              | Min for SF12 BW_L=7.8KHz<br>Min for SF12 BW_L=500KHz                             | 0.01<br>8 |                                    | 62.<br>5 | Kb/s       |
| BW_L        | Signal BW, LoRa                                                            | Programmable                                                                     | 7.8       |                                    | 500      | KHz        |
| SF          | Spreading Factor for LoRa                                                  | Programmable chips/<br>symbol= $2^{SF}$                                          | 5         |                                    | 12       |            |
| VTCXO       | Regulated voltage range for TCXO voltage supply                            |                                                                                  | 1.6       | 1.7                                | 3.3      | V          |
| ILTCXO      | Load current for TCXO regulator                                            |                                                                                  |           |                                    |          | mA         |
| TSVTCXO     | Startup time for TCXO regulator                                            | From enable to regulated voltage within 25mV from target                         |           |                                    |          | uS         |
| IDDTXO      | Current Consumption for TCXO regulator                                     | Quiescent current<br>Relative to load current                                    |           | 1                                  | 70<br>2  | uA<br>%    |
| ATCXO       | Amplitude voltage for external TCXO applied to XTA pin                     | Provided through a 220ohm resistor in series with 10pF Cap                       | 0.4       | 0.6                                | 1.2      | Vpk-pk     |

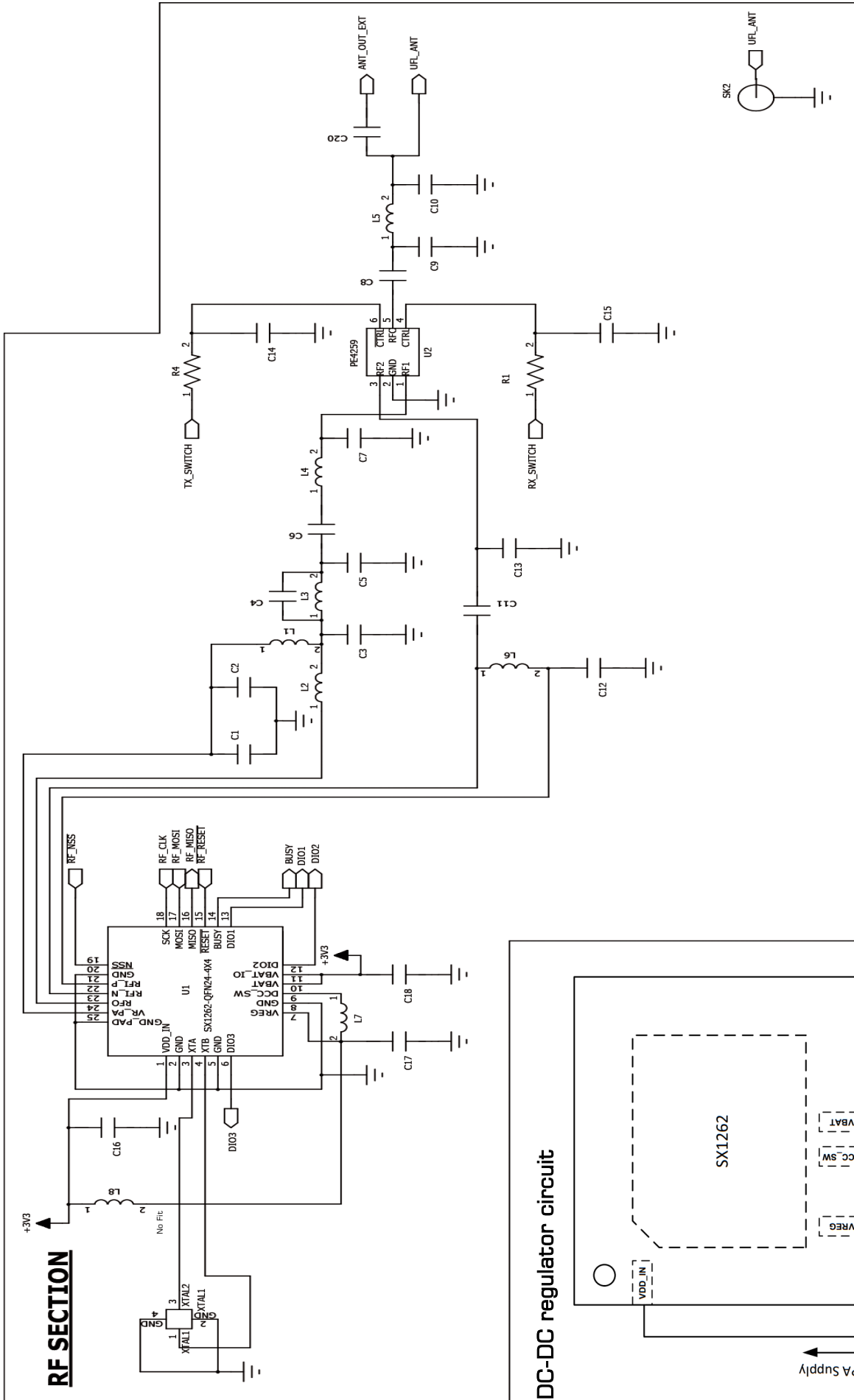
The module contains the Semtech SX1262 which is capable of these operating frequencies however the module contains an impedance matching network which is optimised for operation at 868/915, operating at other frequencies will be impractical.

# LAMBDA62 LoRa Transceiver



## Module Schematic

### RF SECTION



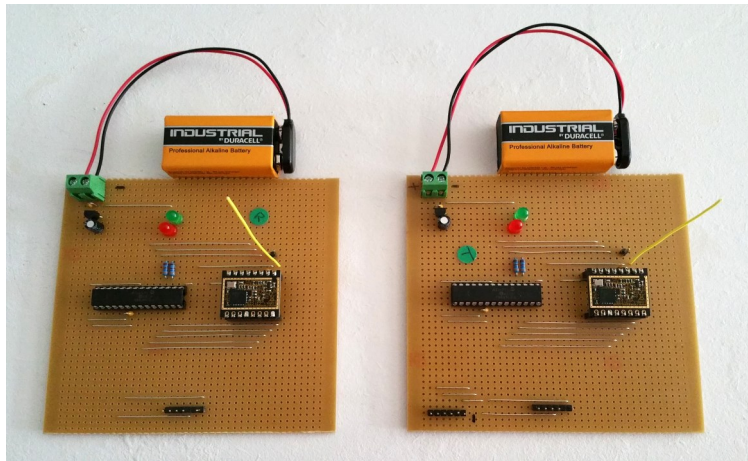
See 5.1.3 of the SX1262 Datasheet Figure 5-3 for further details.

## 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

- $T_A = +25\text{ }^{\circ}\text{C}$
- $V_{DD} = +3.3\text{ Vdc}$
- Dry, Broken Sunshine, Relative Humidity 45%

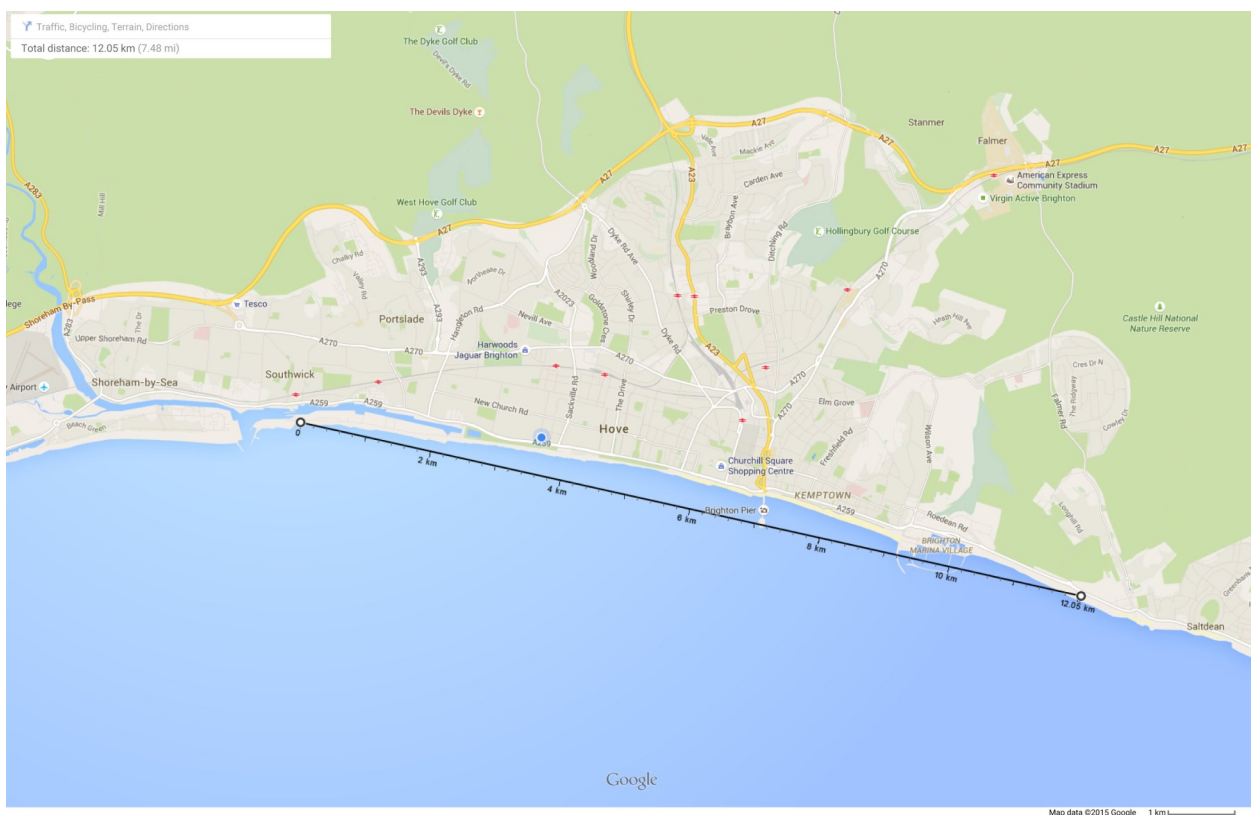
RF input and output levels can typically be achieved at the antenna port after filtering components.

## 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.

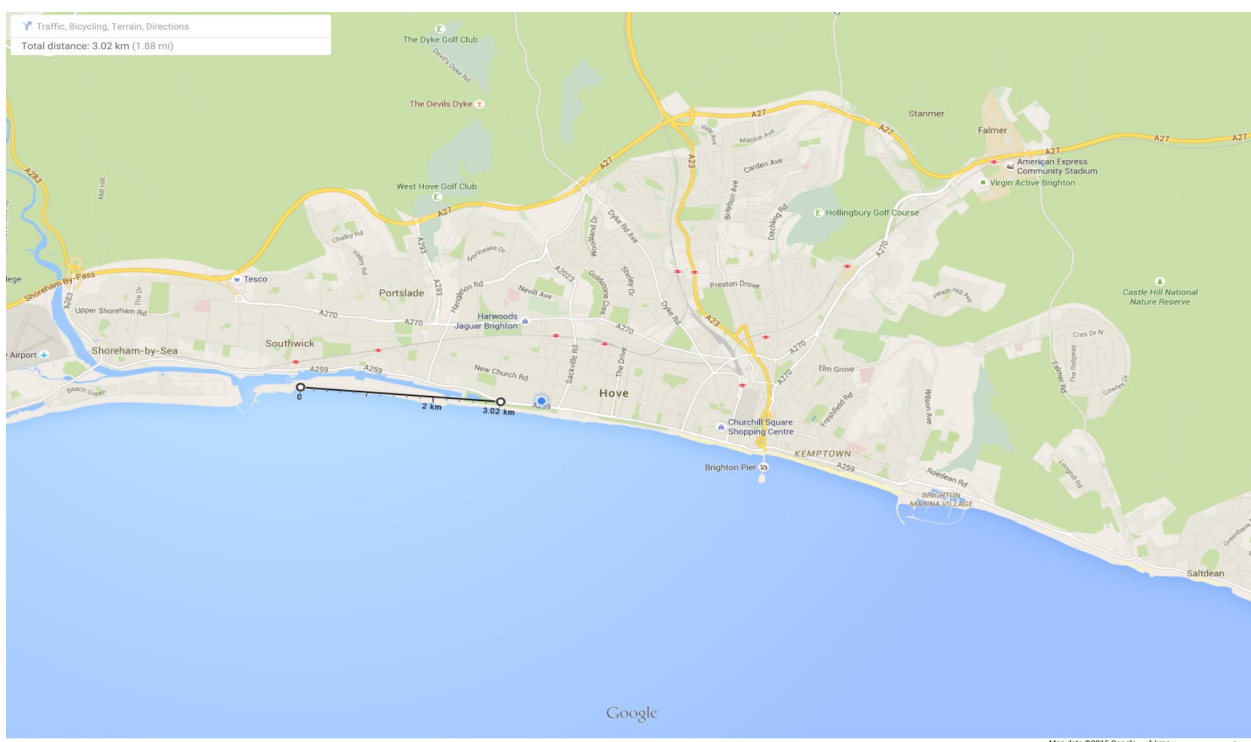
It is also clear that the product performs considerably better when in LOS.

## Range Test Results (Line of Sight)



## Range Test Results (Non Line of Sight)

This is subjective as the buildings were random!



# LAMBDA62 LoRa Transceiver



## LAMBDA62 Types and Device Marking

The LAMBDA62 RF module is available at 868 and 915MHz in the following types:

LAMBDA module is CE Compliant and at the time of writing is being submitted for modular FCC part 15 certification.

### Note:

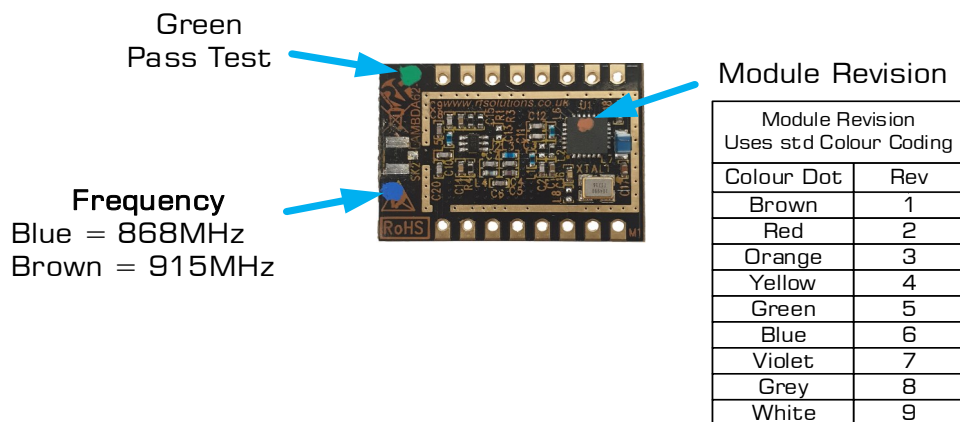
**868MHz:** Open module with antenna connection via pin 1 of the module. This provides the lowest cost whilst achieving CE Compliance

**915MHz:** With Screen Can fitted and antenna connection via ufl. This is in order to achieve Fcc Certification.

## Module with Screen Can & UFL



## Open Module

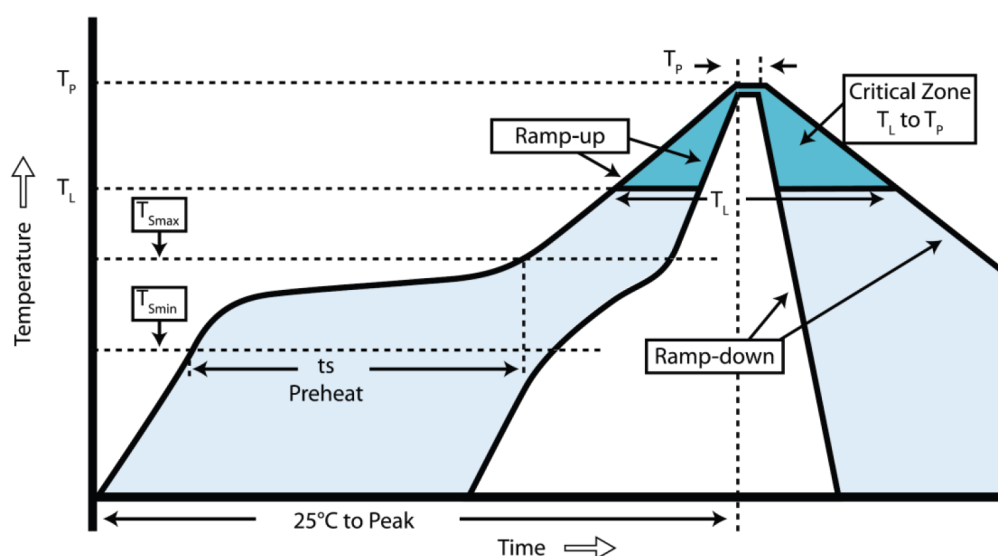


## REVISION CHANGE HISTORY

| Part         | New Revision | Date   | Change / Fix                                                                                      |
|--------------|--------------|--------|---------------------------------------------------------------------------------------------------|
| All versions | 2            | 9/1/20 | Because of Long Leadtime the internal RF switch has been changed to an alternative component part |
| All versions | 3            | 2/2/21 | Update to the Impedance matching network to improve ERP which is now +22dBm                       |

## Module Re-flow Guide

LAMBDA62 is a 4 layer PCB, re-flow is based on IPC/JEDEC JSTD020C July 2004.



| Profile feature                                                                                                                                                                     | Value (lead free)         |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|
| Ramp up rate                                                                                                                                                                        | 3°C /s                    |
| Pre-heat Temperature <ul style="list-style-type: none"> <li>- Temperature Min (T<sub>smmin</sub>)</li> <li>- Temperature Max (T<sub>smax</sub>)</li> <li>- Pre-heat time</li> </ul> | 150°C<br>200°C<br>60-100s |
| Peak Temperature (T <sub>p</sub> )                                                                                                                                                  | 240°C                     |
| Time at T <sub>p</sub>                                                                                                                                                              | 10-20sec                  |
| Ramp down rate                                                                                                                                                                      | 6°C/s                     |
| Time from 25°C to peak                                                                                                                                                              | 8 mins max.               |

## Additional FCC requirements when using the P90LAMBDA62

Provided the installation requirements are followed, further radio performance testing is not required when using this FCC modular approved product. The complete product that the module is used in requires the wording on the finished product label to include "Contains FCC Module ID: P90LAMBDA62". Unintentional radiated spurious emissions must be performed on the finished product in accordance with FCC Part 15.109 requirements, the limits as for a Class B product. The antenna cable assembly CBA-UFLSMARP-10 must be used to provide a non-standard reverse SMA bulkhead connector. It is recommended that the FLEXI-SMA-918 (reverse SMA connector) antenna is used, which is available from RF Solutions. The antenna must not have a maximum gain greater than 2dBi. Colocation of transmitters is not recommended without further radio testing to ensure the maximum declared EMF is not exceeded. It is recommended not to operate the transceiver with persons closer than 20cm to the antenna. Refer to FCC KDB996369 D04, Module Integration Guide for additional information.

# LAMBDA62 LoRa Transceiver



## Simplified Declaration of Conformity (RED)

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