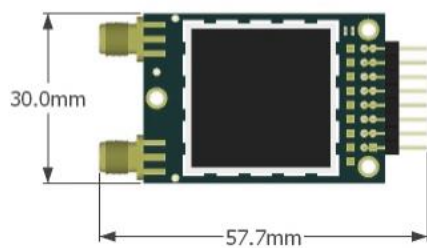




RFD900x Radio Modem Data Sheet

902-928MHz frequency band

Product Specifications and Performance
Flash Programmer User Manual



Features

- Out of the box RF communications.
- Air data rate speeds of up to 500kbps
- Diversity antenna support
- Weight of 14g
- Outdoor RF line-of-site range of 40km or more depending on antenna configuration

Operational

- Operating voltage: 5V, I/O Voltage (3.3V)
- Temperature range: -40°C to +85°C
- Dimensions of 30mm x 57.7mm x 12.8mm
- Current consumption:
 - TX mode: ~1A peak at +30dBm,
 - RX mode: 60mA (typical)

Applications

- Telemetry data
- UAV control
- Remote weather station
- House automation
- Long range RC

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1 Key features

RFD900x provides compact and yet powerful data communication. The key features are:

- No configuration required for out of the box RF communications.
- Operating frequency range of 902 – 928MHz
- Outdoor RF line-of-site range of 40km or more depending on antennas
- Air data rate speeds of up to 500kbps
- Diversity antenna support
- Operating temperature of -40 to +85 degrees Celsius
- Dimensions of 30mm x 57mm x 12.8mm
- Weight of 14g

Compliances and Worldwide Acceptances:

The RFD900x is designed to be compliant to AS4268:2012, and FCC 15.247. It has not been certified as a standalone modem and should be compliance tested in the final product.

2 Specifications

Performance	
Supported RF Data Rates	4 to 750 kbps dependent on type and version of firmware
Indoor Range	500m – 1km
Line-Of-Sight Range	40km or more depending on antennas and settings
Transmit Power	0 to 30dBm in 1dBm steps
Receiver Sensitivity	>121dBm at low data rates
Low Noise Amplifier	>20dB

Features	
Serial Data Interface	+3.3V nominal, 3.3V tolerant
Configuration Method	AT Commands, APM Planner, RF Design Modem Tools
Frequency Band	902MHz - 928MHz
Interference Immunity	FHSS (Frequency Hopping Spread Spectrum)
Serial Interface Data Rate	2400 to 1000000 bps dependent on type and version of firmware
Antenna Connection	2 x RPSMA diversity switched ports
GPIO	6 pins (Digital, PPM capable)
Compliance Standards	FCC Part 15.247, AS/NZS 4268:2012

Networking and Security	
Addressing Options	Network ID: 0 –255
Channels	Up to 50 Frequency Hopping Channels
Supported Network Topologies	Point-to-point and asynchronous mesh ¹ and multipoint synchronous mesh ¹

¹ Only available in separate firmware versions available on the RFD website

Power Requirements	
Supply Voltage	+5V nominal (+5V min, +5.5V Max, +6V ABS Max),
Transmit Current	~1A peak at max power
Receive Current	~60mA

3 Output power levels

Many countries have different legal power levels. Be sure to operate within the legal power limits of the country that you are operating in. The RFD900x modem can support the power levels between 0dBm and 30dBm in 1dBm steps. Formula 2-1 can be used to convert the power in dBm into milliwatts.

$$P_{mW} = 10^{(P_{dBm}/10)}$$

Formula 2-1

To calculate Effective Isotropic Radiated Power (EIRP) you can use the formula 2-2 below:

$$EIRP(dBm) = Transmitpower(dBm) - Cableloss(dB) + AntennaGain(dBi)$$

Formula 2-2

The FCC limit for EIRP is 4 Watts, or 36dBm for frequency hopping radios in the ISM 900 MHz band. The Australian EIRP limit is 30dBm as defined by ACMA.

4 Performance characteristics

Figure 4-1 shows how the output power of the RFD900x varies with supply voltage when the output power is set to +30dBm.

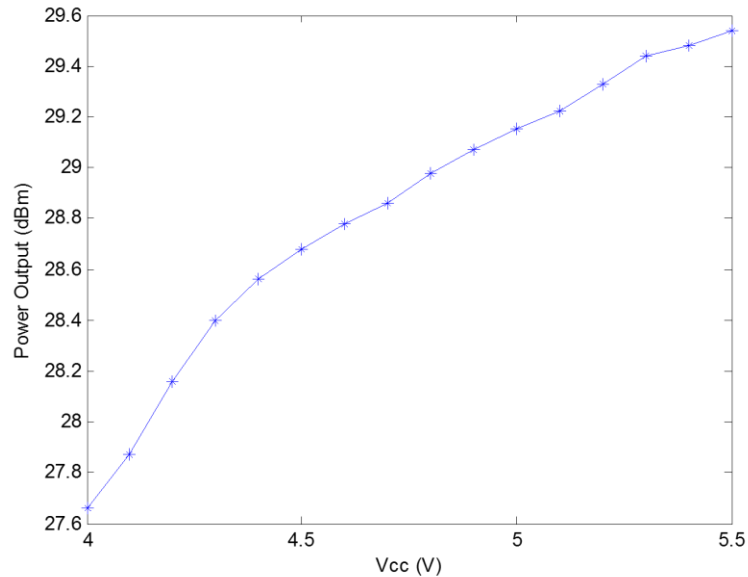


Figure 4-1: Output power vs. input supply voltage

Figure 4-2 shows how the current through the RFD900x varies with the transmit power level. The current during transmission is shown by the 'High Level' plot and that during receive mode is shown by the 'Low Level' plot.

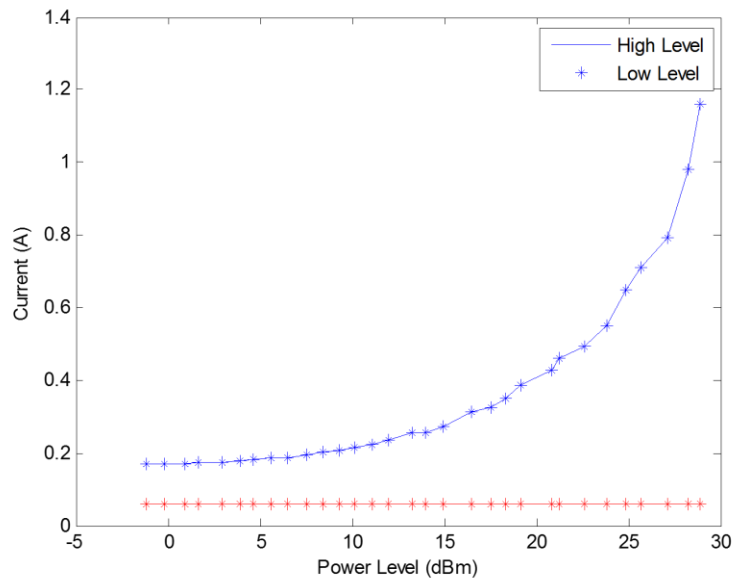


Figure 4-2: Current consumption vs. TX power level

5 Pin signals and layout

Pin #	Name	Direction	Description	Max Voltage
1	GND	-	Ground	0V
2	GND	-	Ground	0V
3	CTS	Either	Clear to send	3.3V
4	Vcc	-	Power supply	5V
5	Vusb	-	Power supply from USB	5V
6	Vusb	-	Power supply from USB	5V
7	RX	Input	UART Data In	3.3V
8	GPIO5/P3.4	Either	Digital I/O	3.3V
9	TX	Output	UART Data Out	3.3V
10	GPIO4/P3.3	Either	Digital I/O	3.3V
11	RTS	Either	Request to send	3.3V
12	GPIO3/P1.3	Either	Digital I/O	3.3V
13	GPIO0/P1.0	Either	Digital I/O	3.3V
14	GPIO2/P1.2	Either	Digital I/O	3.3V
15	GPIO1/P1.1	Either	Digital I/O, PPM I/O	3.3V
16	GND	-	Ground	0V

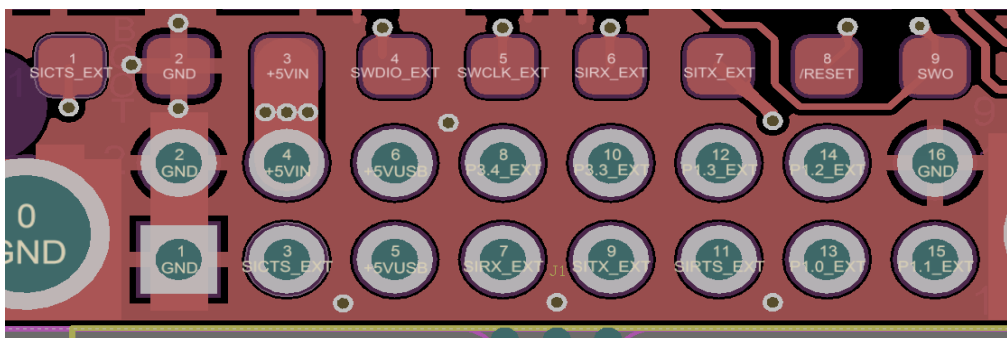


Figure 5-1: Physical pin layout of the RFD900x Radio Modem

GPIO pins will configure for 40kOhm pull down or pull up based on setting as input or output. They can sink or source approximately 5 mA each.

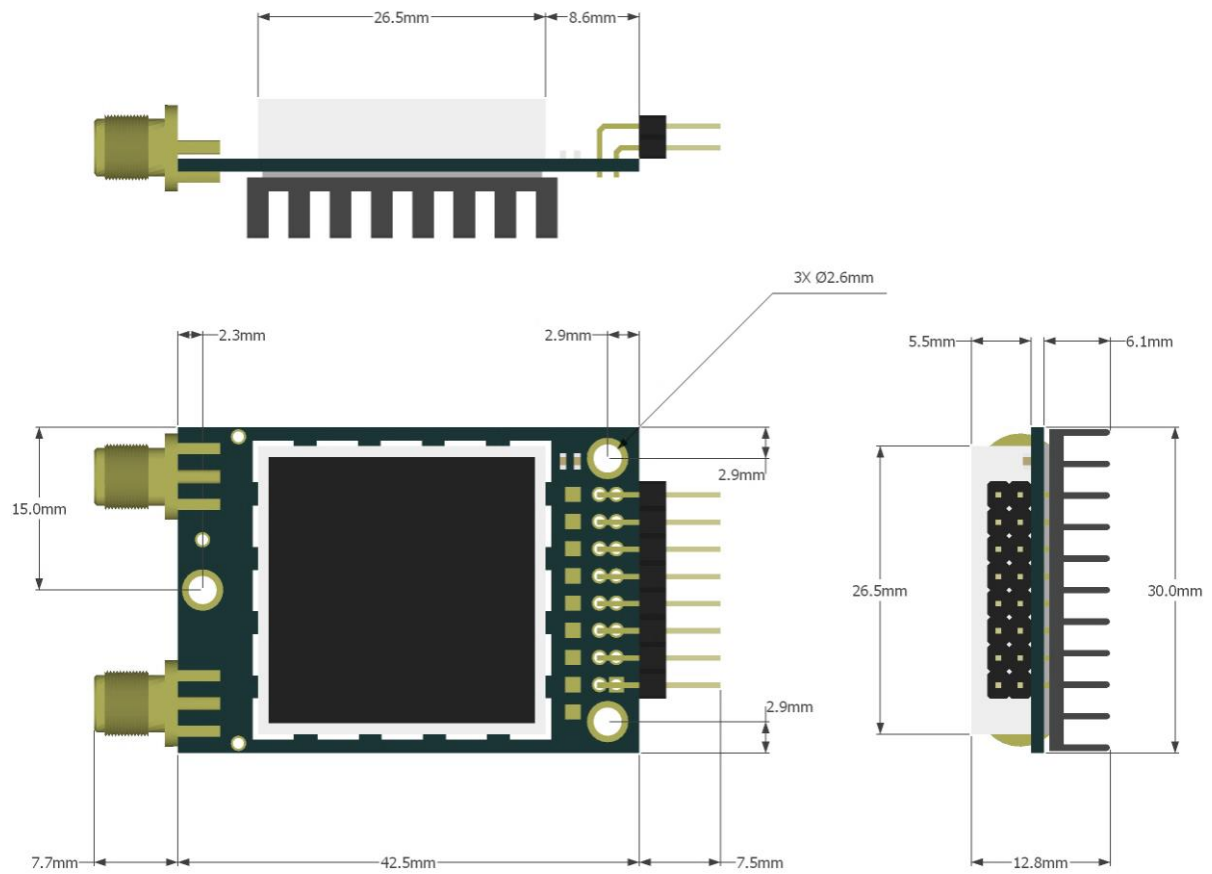
The FTDI cable (see “Useful Links”) is compatible with the RFD900x modem.

Pin 1 of the FTDI cable (black wire) should connect to pin 1 of the RFD900x header. To power the modem from the +5V USB power, a jumper is needed to connect pins 4 and 6.

To power the modem from an external +5V supply, connect the power to pins 2 and 4 as per figure 5-1

To force the modem into bootload mode short pad 9 (the right most of the row of pads in front of the pin header) to the shield or other ground on the modem as the modem is powered up. The on-board LED will become solid red when in boot mode at this point the short can be removed. The modem is then in a state ready to accept firmware.

6 Physical dimensions



7 Software/GCS Support

The default firmware (see “Useful Links”) is a development of the open source project called “SiK” and was created by Mike Smith. It has been further developed and modified by Andrew Tridgell and RFDesign.

The modems feature a boot loader to facilitate field upgrade of the modem firmware via the serial port. This is most easily performed by using the latest version RFD Modem tools (see “Useful links”)

Parameters such as power levels, air data rates, serial speeds, GPIO pins etc can all be custom set by the user using the AT Command set, the RFD Modem Tools V2 or later and APM Planner.

Default serial port settings are as follows:

- 57600 baud rate
- No parity
- 8 data bits
- 1 stop bit

The RFD900x Radio Modem has many software features including:

- Frequency Hopping Spread Spectrum
- Transparent Serial Link
- Configuration by AT commands for local radio, RT Commands for remote radio
- User configurable serial data rates and air data rates
- Error correction routines
- 128-bit AES hardware encryption with user settable key
- MAVLink protocol framing (user selectable)
- MAVLink radio status reporting (Local RSSI, Remote RSSI, Local Noise, Remote Noise)
- Automatic antenna diversity switching on a packet basis in real-time
- Automatic duty cycle throttling based on radio temperature to avoid overheating
- PPM (R/C signal) pass through (Control vehicle across radio).
- GPIO pin mirroring

8 Diversity

The RFD900x has two antenna ports and firmware which supports diversity operation of antennas. During the receive sequence the modem will check both antennas and select the antenna with the best receive signal. The antenna selected during receive is then also used for subsequent transmission. In the case of only one antenna connected, it will automatically select the port with the antenna connected. Testing by Silicon Labs has shown that link budgets can be improved up to the order of 8dB by employing a diversity scheme.

8.1 Spatial diversity

Spatial diversity is the case where the antennas are separated by some distance from one another. It is recommended that two antennas connected to the RFD900 modem be separated by at least 25cm, more if possible.

8.2 Polarisation diversity

Polarisation diversity is the case where the antennas are perpendicular to each other. i.e. one vertical, and one horizontal. This is effective in reducing multipath effects which affect one or the other polarisation. This scheme also helps to maintain the link between non-static objects such as aircraft performing acrobatics by increasing the likelihood that one antenna will maintain the same polarisation as an antenna on the other side of the link. Figure 8-1 depicts how two right-angle monopole antennas can be positioned to achieve polarisation diversity.



Figure 8-1: Antenna configuration to achieve polarisation diversity

9 Network options

RFD900x support firmware for simple pair (peer to peer), asynchronous mesh network and multipoint network. Available for download from the website (see “Useful Links”).

9.1 Simple pair (P2P)

The out-of-the-box firmware of the RFD900x radio modem is set to work in simple pair mode. If you purchased a bundle, you are only required to connect the antennas and supply to initiate the link. As soon as the pair synchronises, the on-board LED will become solid green.

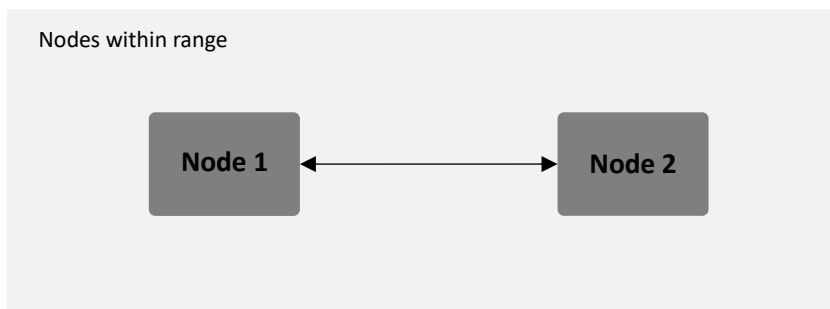


Figure 9-1 Peer to peer modem pair network

9.2 Asynchronous non-hopping mesh

The asynchronous non-forwarding mesh firmware offers a straight forward communication option that allows the user to quickly transmit and receive data across a great distance between two or more nodes. Figure 9-2 depicts this communication topology. If all the nodes are within range and have compatible parameters, communication between them will succeed.

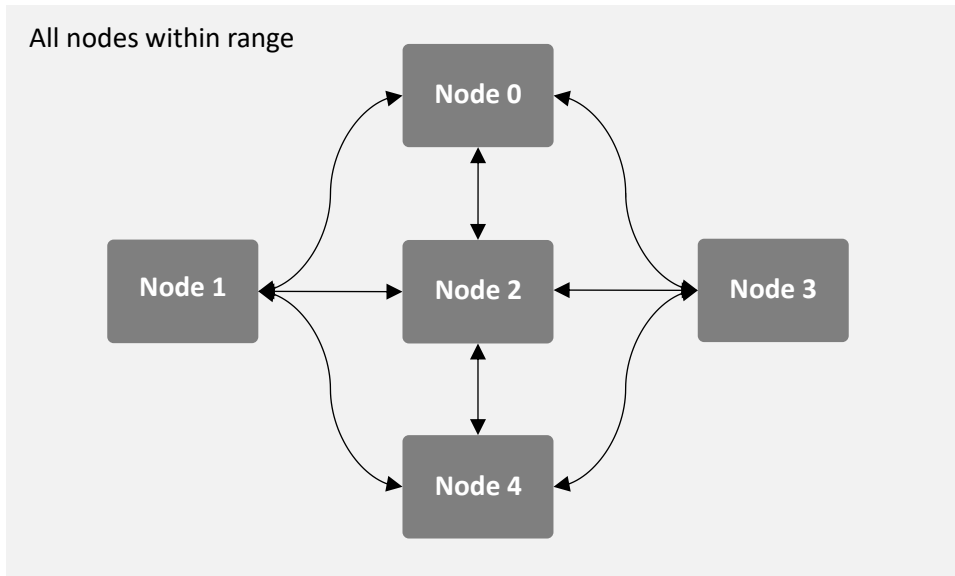


Figure 9-2 Asynchronous mesh topology

It is also possible to establish forwarding between nodes in the network. (See the asynchronous firmware datasheet for details)

9.3 Multipoint synchronised mesh

The network requires that one of the devices assumes a *base* role to control the timeslot distribution of the surrounding radios. If one of the nodes is out of the base's range, communication is still possible if the parameter *SyncAny* is properly set.

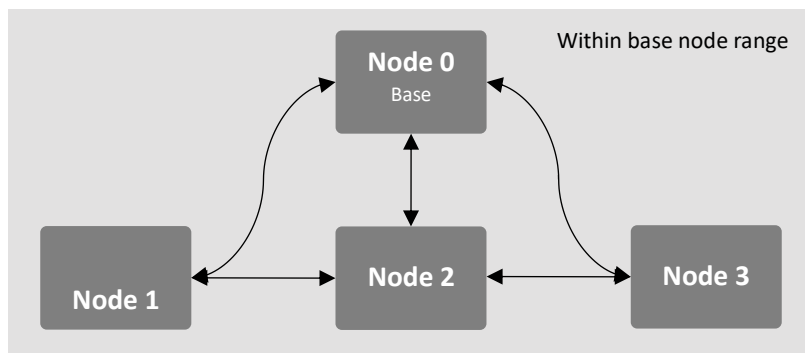


Figure 9-3 Multipoint mesh topology

10 Frequently asked questions (FAQ)

10.1 How many antennas do I need to use?

One is the minimum. Two is recommended.

10.2 How do I connect the FTDI cable to the modem?

The black cable of the FTDI (pin 1) should connect to pin 1 on the modem as shown in Figure 10-1.

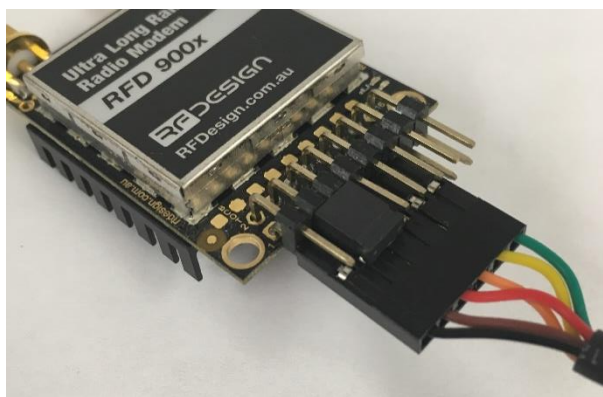


Figure 10-1: An FTDI cable connected to the RFD900x modem

10.3 What do I need to upload the firmware or to change the modem configuration?

Download the latest firmware (see “Useful Links”). Download the RFD900x Modem Tools (see “Useful Links”). Connect the FTDI cable to the modem and to a computer. Use the RFD900x Modem Tools to upload the latest firmware or to change the modem configuration (see “RFD900x Modem Tools User Manual”).

10.4 I upgraded to asynchronous firmware and the modems don't connect anymore?

The default setting for a modem is to have a NODEID set to 1 and DESTID set to 2. As communication is addressed NODEID must be different for all units and DESTID will set the modems to connect to.

10.5 How do I configure 2 base stations and one Airborne platform with 3 modems? (Asynchronous)

Set the Airborne platform as follows:


```
NODEID = 1
DESTID = 65535, (32768 from version 2.45F)
MAVLINK = 1
```

Set the ground station as follows:

```
NODEID = 2 or 3
DESTID = 1
MAVLINK = 1
```

This will allow the airborne modem to handover to multiple ground stations as it flies from the coverage area of one ground station, to another. Both ground stations can be connected and can control the Airborne platform simultaneously. (APM Planner using MAVLink)

11 Useful links

RFD900x Firmware

<http://rfdesign.com.au/firmware/>

RFD SiK firmware is standard SiK (open source)

RFD Asynchronous firmware

RFD Multipoint firmware

RFD900x Flash Programmer

<http://rfdesign.com.au/downloads/>

FTDI Cable documentation

http://www.ftdichip.com/Support/Documents/DataSheets/Cables/DS_TTL-232R_CABLES.pdf

12 Document revision history

Version	Date	Changes
1.0	22/09/17	Release document
1.1	22/05/18	Updated to correct typos, mistakes and changes in new versions