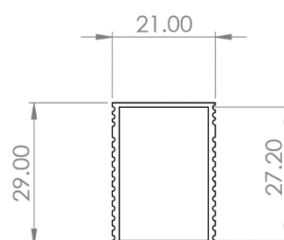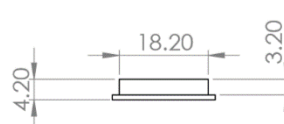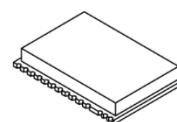# RFDESIGN

RFD900ux Data Sheet

Long-Range Surface-mount Radio Module operating in the 902-928MHz frequency band

TOP VIEW

SIDE VIEW

Features

- Out of the box RF communications.
- Air data rate speeds of up to 224kbps
- Diversity antenna support
- Weight of 3.5g
- Outdoor RF line-of-site range of 40km or more depending on antenna configuration
- USB interface

Applications

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

Operational

- Operating voltage: 5V, I/O Voltage (3.3V)
- Temperature range: -40°C to +85°C
- Dimensions of 21mm x 29mm x 4.2mm
- Current consumption:
  TX mode: ~1A peak at +30dBm,
  RX mode: 60mA (typical)

RFDESIGN

Table of contents

RFDESIGN

1   Key features

RFD900ux 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 224kbps
- Diversity antenna support
- Operating temperature of -40 to +85 degrees Celsius
- Dimensions of 21mm x 29mm x 4.2mm
- Weight of 3.5g

Compliances and Worldwide Acceptances:

The RFD900ux 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	12, 56, 64, 100, 125, 200, 224, 500[1] and 750kbps[1]
Indoor Range	500m – 1km
Line-Of-Sight Range	40km or more depending on antennas
Transmit Power	0 to 30dBm in 1dBm steps
Receiver Sensitivity	113dBm @ 10^{-5} BER 12Kbps

[1] High RF data rates are for experimental purposes only

Features		
Serial Data Interface	+3.3V nominal, 3.3V tolerant	
Configuration Method	AT Commands, APM Planner, Customised Configuration Tool	
Frequency Band	Unlocked	902MHz - 928MHz
	AU locked	915MHz - 921MHz
	NZ locked	920.75MHz – 927.25MHz
	US locked	902MHz - 915MHz
Interference Immunity	FHSS (Frequency Hopping Spread Spectrum)	
Serial Interface Data Rate	2400, 4800, 9600, 19200, 38400, 57600, 115200, 460kbps	
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	Unlocked	Up to 50 Frequency Hopping Channels
	AU locked	23
	NZ locked	25
	US locked	51
Supported Network Topologies	Point-to-point, multipoint[2], and asynchronous non-hopping mesh[2]	

[2] Only available in separate firmware versions available in the 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 RFD900ux 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 RFD900ux varies with supply voltage when the output power is set to +30dBm.
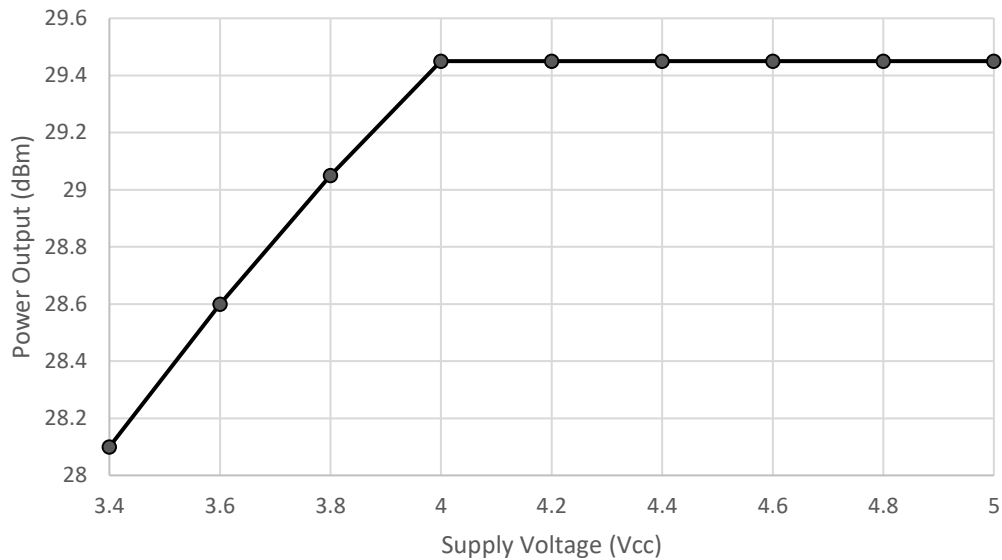

Figure 4-1: Output power vs. input supply voltage

Figure 4-2 shows how the current through the RFD900ux 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.
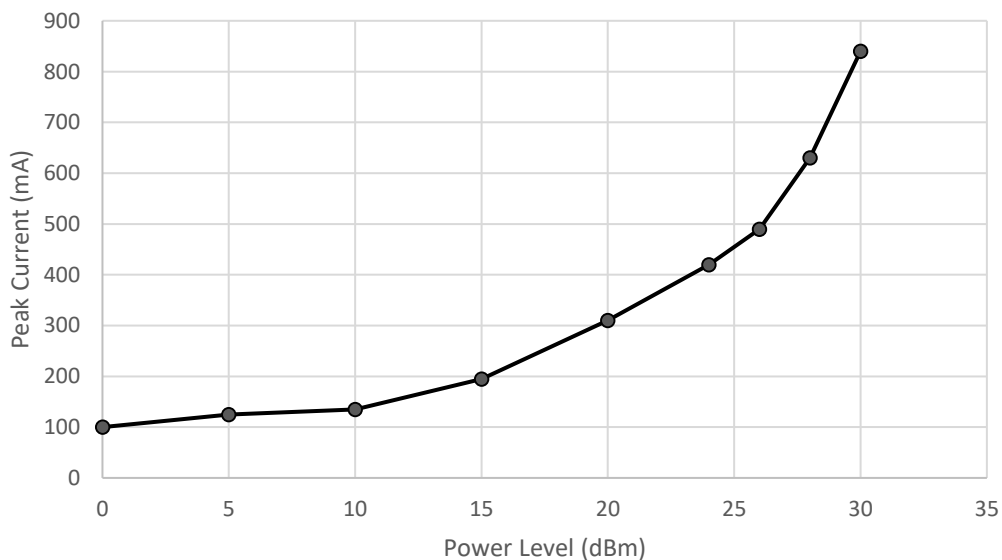

Figure 4-1: Current consumption vs. TX power level

RF DESIGN

The table below is used to determine the sensitivity of the RFD900ux according to the selected air data rate. The link budget is directly affected by the sensitivity, and therefore the communication range also varies. The sensitivity values in the table are based on a 10^{-5} BER.

Air data rate	Sensitivity @ 10-5 BER
12 kbps	-111 dBm
64 kbps	-104 dBm
125 kbps	-102 dBm
224 kbps	-95 dBm
12 kbps	-111 dBm

5   Pin signals and layout
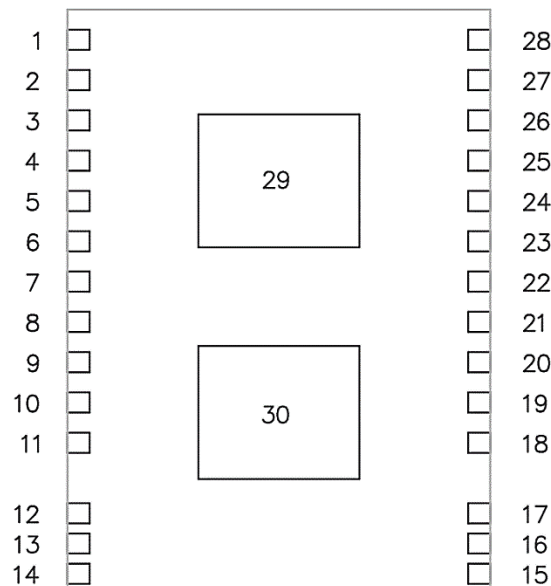
Figure 5-1: Physical pin layout of the RFD900ux Radio Modem

Pin #	Name	Direction	Description	Max Voltage
1	VUSB	Input	Power supply from USB	5V
2	USB_DM		USB Data -	
3	USB_DP		USB Data +	
4	SWO_EXT	Output	SWD debug output	3.3V
5	P3.3_EXT	I/O	Digital I/O	3.3V
6	P3.4_EXT	I/O	Digital I/O	3.3V
7	P3.5_EXT	I/O	Digital I/O	3.3V
8	GND	-	Ground	0V
9	GND	-	Ground	0V
10	+3V3		LDO output	3.3V
11	GND	-	Ground	0V
12	GND	-	Ground	0V

| 13	ANT1	-	Antenna 1	-
14	GND	-	Ground	0V
15	GND	-	Ground	0V
16	ANT2	-	Antenna 2	-
17	GND	-	Ground	0V
18	GND	-	Ground	0V
19	+5V		Power Supply	5V
20	GND	-	Ground	0V
21	P1.0_EXT	I/O	Digital I/O	3.3V
22	P1.1_EXT	I/O	Digital I/O, PPM I/O	3.3V
23	P1.2_EXT	I/O	Digital I/O	3.3V
24	P1.3_EXT	I/O	Digital I/O	3.3V
25	SIRX_EXT	Input	UART Data In	3.3V
26	SITX_EXT	Output	UART Data Out	3.3V
27	SIRTS_EXT	Output	Request to send	3.3V
28	SICTS_EXT	Input	UART Clear to send	3.3V
29	GND	-	Ground	0V
30	GND	-	Ground	0V

In case there is a need to force the modem into boot mode, pull the SWO pin to the ground while applying power. The on-board LED will become solid red when in bootloader mode.

RFDESIGN

6   Recommended PCB Design

LAND PATTERN
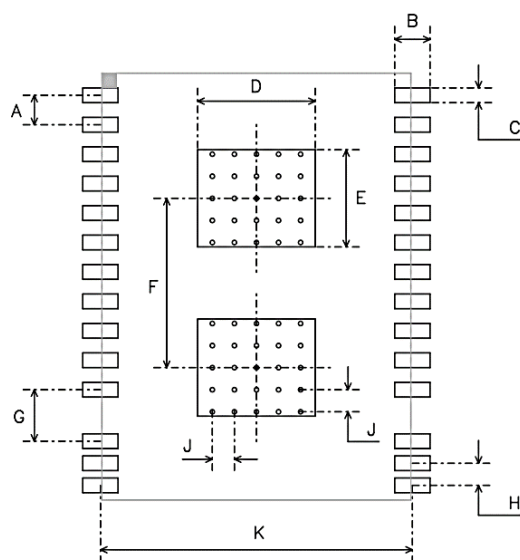
STENCIL DESIGN
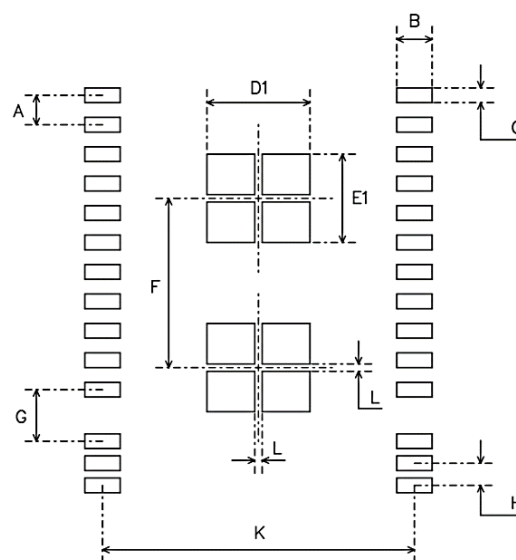
Symbol	Dimension (mm)	Symbol	Dimension (mm)
A	2	F	11.5
B	2.4	G	3.5
C	1	H	1.5
D	8	J	1.5
D1	7	K	21.2
E	6.6	L	0.5
E1	6		

7   Physical dimensions
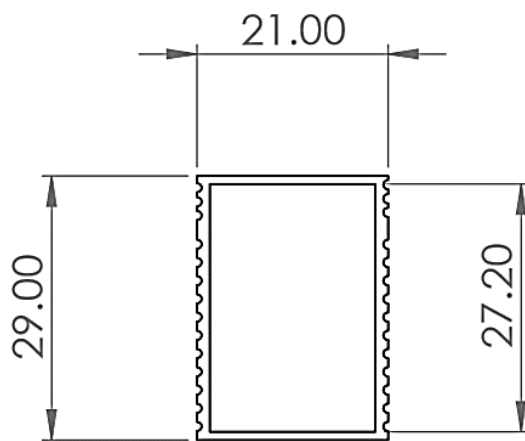
TOP VIEW
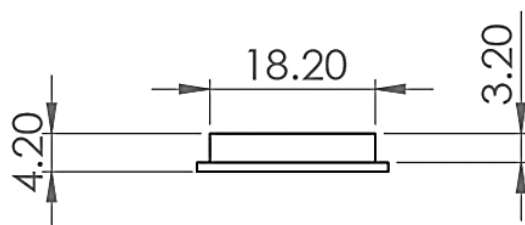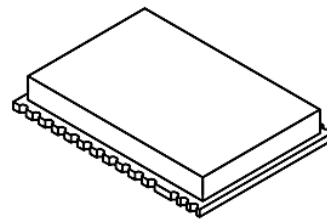
SIDE VIEW

8   Software/GCS Support

The software solution (see "Useful Links") is an open source development which is called "SiK" and was created by Mike Smith and improved on by Andrew Tridgell and RFDesign.

A boot loader and interface are available using RFD900x Flash Programmer and field upgrade of the modem firmware via the serial port. The RFD900ux modem features a boot loader which allows for the uploading of the various modem firmware via the serial port. This firmware upload is supported using the RFD900x Flash Programmer tool, current version of Mission Planner.

The RFD900ux Radio Modem is compatible with many configuration methods like the AT Commands and APM Planner. The AT Commands can be used to change parameters such as power levels, air data rates, serial speeds, GPIO pins etc. Terminal programs such as Hyperterminal or Coolterm are useful for direct configuration of the modem via AT commands.

Integrated support for configuring the RFD900ux Radio Modem is supported by the APM Planner, with other GCS solutions in development. Its default serial port settings are as follows:

- 57600bps baudrate
- No parity
- 8 data bits
- 1 stop bit

The RFD900ux Radio Modem has many software features including:

- Frequency Hopping Spread Spectrum
- Transparent Serial Link
- Configuration by simple AT commands for local radio, RT Commands for remote radio
- User configurable serial data rates and air data rates
- Error correction routines, 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 in order to avoid overheating
- PPM (R/C signal) pass through (Control vehicle across radio).

9   Diversity

The RFD900ux 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.

9.1   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 RDF900ux modem be separated by at least 25cm, more if possible.

9.2   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.

10   Network options

RFD900x can be implemented in either simple pair (P2P), multipoint network (MP Firmware Only), or asynchronous non-hopping mesh. The latter two are available for download in the website (see "Useful Links").

10.1 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.
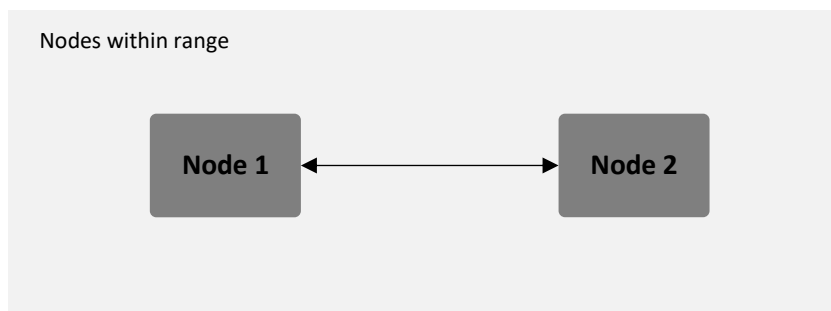

Figure 9-1:Simple pair mode

10.2 Multipoint network

This mode requires the Multipoint firmware to be loaded into the all network radios. Check section "Useful links" for the download link, and refer to section "RFD900x Flash Programmer tool" to flash the multipoint firmware. Refer to the "Multipoint user manual" for setup and usage instructions.
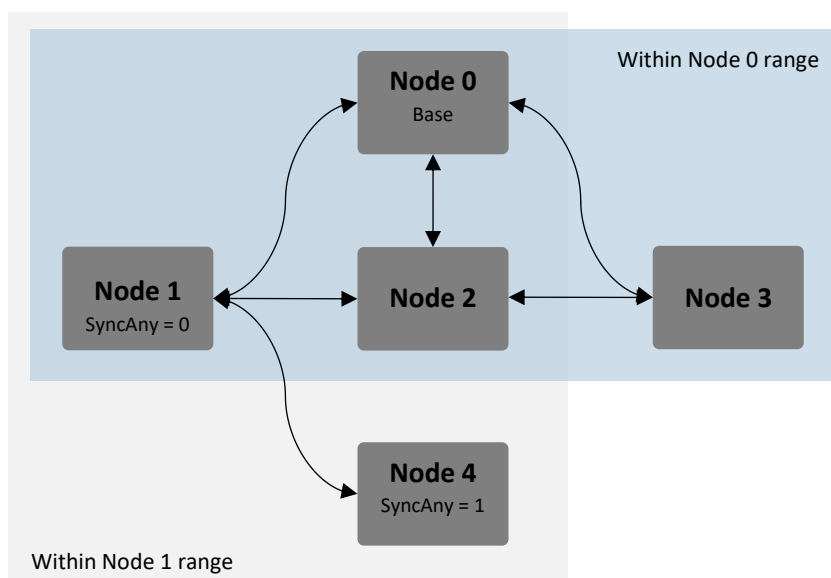

Figure 9-2: example of multipoint network diagram

Last update 12/09/2019

10.3 Asynchronous non-hopping mesh

The asynchronous non-hopping mesh firmware offers a straight forward communication option that allows the user to quickly transmit and receive data across a great distance between two nodes or more. Figure 4-2 depicts this communication topology. As long as all the nodes are within range and have compatible parameters, communication between them will succeed.
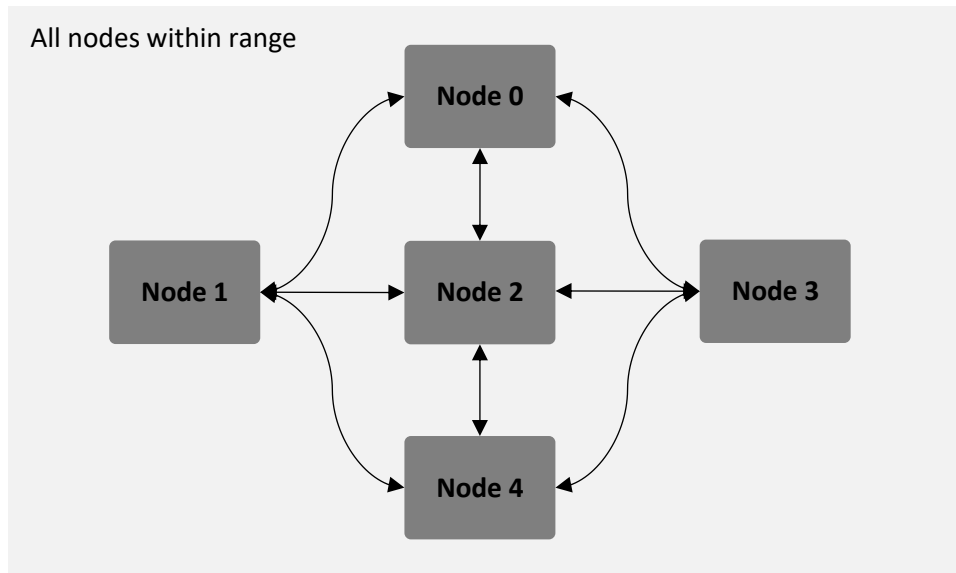

Figure 9-3: Asynchronous non-hopping mesh topology

Last update 12/09/2019

11   PCB Design Guidelines

Some guidelines must be followed as to ensure the PCB design meets the RFD900ux thermal dissipation and electromagnetic compatibility requirements. The proposed layout can be used as a starting point and it is not guaranteed to comply with EM immunity and emissions regulations as is. The PCB designer is expected to calculate the RF antenna track widths to be 50Ω outputs, depending on the host PCB layer stack up and dielectric constant.
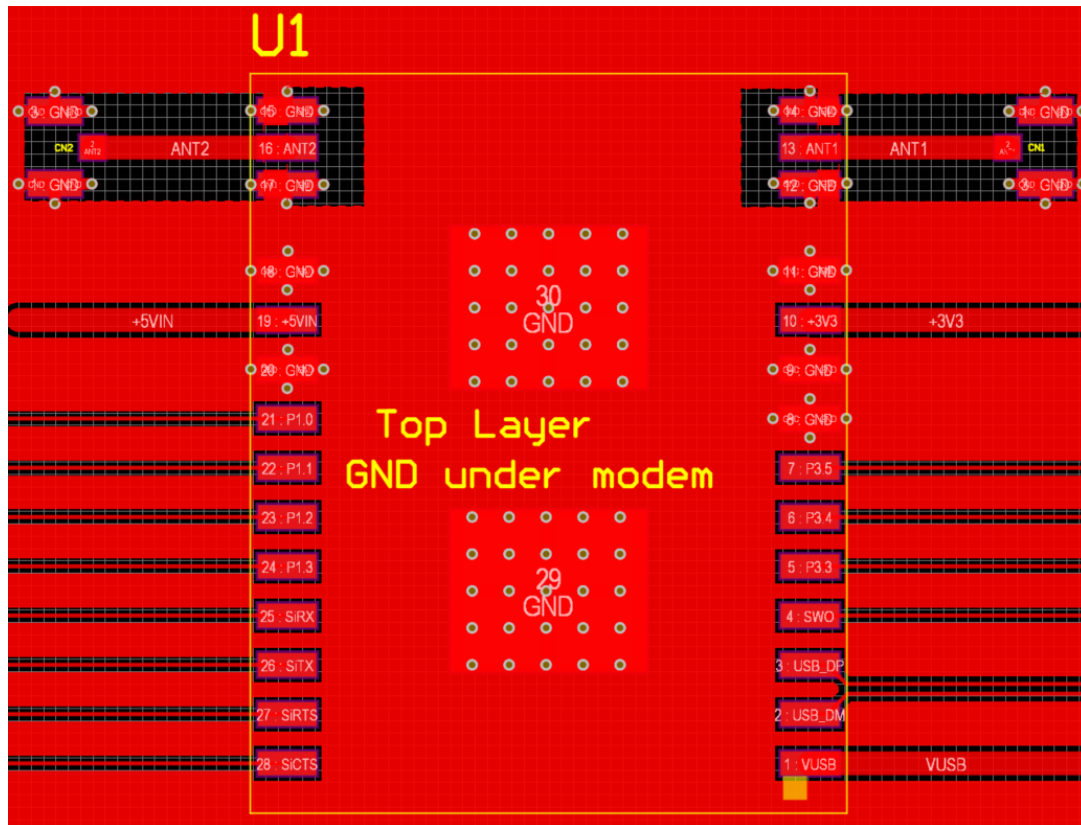
12   Frequently asked questions (FAQ)

How many antennas do I need to use?

One is the minimum. Two is recommended.

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").

What should I do if the Flash Programmer keeps displaying error messages?

Make sure to connect the FTDI cable firmly into the modem. Make sure you choose the correct COM port from the COM dropdown box and the correct baud rate. Try for two more trials and if it still doesn't work, disconnect and reconnect the modem. Should it still fail open a terminal programme and perform a loop back test on the cable. Short the orange and yellow pins of the FTDI cable with something like a paper clip. Then using the terminal programme connect to the COM of the cable then type some text if this text is not returned then it indicates there is likely a fault with the FTDI cable where possible retry the upload process with a new cable.

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

The default setting for a modem is to have a NODEID set to 1. A network must have one node set to 0 to be the base. The base node defines the synchronisation for the whole network of nodes.

How do I configure 2 base stations and one Airborne platform with 3 modems?

Set the Airborne platform as follows:

```
NODEID = 0
NODEDESTINATION = 65535
MAVLINK = 1
```

Set the ground station as follows:

```
NODEID = 1 or 2
NODEDESTINATION = 0
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)

RFDESIGN

13   Useful links

RFD900ux Firmware

The RFD900x runs the same firmware as all other radios from the RFD900x family.

http://files.rfdesign.com.au/firmware/

RFD SiK firmware is standard SiK (open source)

RFD Multipoint firmware is multipoint SiK (MP SiK)

RFD900x Flash Programmer

http://files.rfdesign.com.au/tools/

FTDI Cable documentation

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

14   Document revision history

Version	Date	Changes
1.0	20/08/2019	Release document
1.1	12/09/2019	Amended VBUS pin voltage