RFD900u Radio Modem Data Sheet

RFD900u Product Specifications and Performance

RFD900u Configuration

RFD900u Modem Tools User Manual

Contents

1. Key Features

RFD900u provides compact and yet powerful data communication. The key features are:

- Compatible with RFD900/3DR/Hope RF based modules
- No configuration required for out of the box RF communications.
- Operating frequency range of 902 – 928MHz
- Outdoor RF line-of-site range of 10km or more depending on antennas
- Air data rate speeds of up to 250kbps
- Supports AES128 encryption and hardware acceleration
- Diversity antenna support
- All I/O ESD protected and RF filtered
- Operating temperature of -40 to +85 degrees Celsius
- Dimensions of 18.5 x 29 x 4mm
- Weight of 2.7g

Compliances and Worldwide Acceptances:

The RFD900u 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, 8, 16, 19, 24, 32, 48, 64, 96, 128, 192 and 250
Indoor Range	300m – 700m
Line-Of-Sight Range	10km or more depending on antennas
Transmit Power	0 to 20dBm
Receiver Sensitivity	>121dBm at low data rates, >TBA at high data rates
Low Noise Amplifier	>24dB

Features	
Serial Data Interface	+3.3V nominal, 5V tolerant
Configuration Method	AT Commands, APM Planner, Customised Configuration Tool
Frequency Band	902MHz - 928MHz
Interference Immunity	FHSS (Frequency Hopping Spread Spectrum)
Serial Interface Data Rate	2400, 4800, 9600, 19200, 38400, 57600, 115200 baud
Antenna Options	Yagi, ½ Wave Dipole, ¼ Wave Monopole Antenna
GPIO	2 pins (Digital, ADC, PWM capable)
Compliance Standards	FCC Part 15.247, AS/NZS 4268:2008

Networking and Security	
Addressing Options	Network ID: 0 –499[1]
Channels	Up to 50 Frequency Hopping Channels
Supported Network Topologies	Point to point, Multipoint[1]
Encryption	AES128 encryption support

[1] Only available in firmware version 2.x and later

Power Requirements	
Supply Voltage	+5V nominal (+4V min, +5.5V max)
Transmit Current	~0.3 A peak at max power
Receive Current	~60mA

3. 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 RFD900u modem can support the power levels between 0dBm and 20dBm. Formula (1) can be used to convert the power in dBm into milliwatts.

$$P_{mW} = 10^{(P_{dBm}/10)} \qquad\qquad (1)$$

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

$$EIRP(dBm) \ = \ Transmit\ power\ (dBm) - Cable\ loss(dB) \ + \ Antenna\ Gain\ (dBi) \ (2)$$

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. Pin Signals and Layout

Pin #	Name	Colour	Direction	Description	Max Voltage
8	GND	Black	-	Ground	0V
7	CTS	White	Either	Clear to send	5V
6	Vcc	Red	-	Power supply	5V
5	RX	White	Input	UART Data In	5V
4	TX	Blue	Output	UART Data Out	5V
3	RTS	White	Either	Request to send	5V
2	P1.0	Blue	Either	Digital I/O	5V
1	P1.1	Black	Either	Digital I/O	5V

Table 4.1 Description on 8 Pin Connector

Pin 1

Pin 8

RTS
TX
RX
+5V
CTS
GND
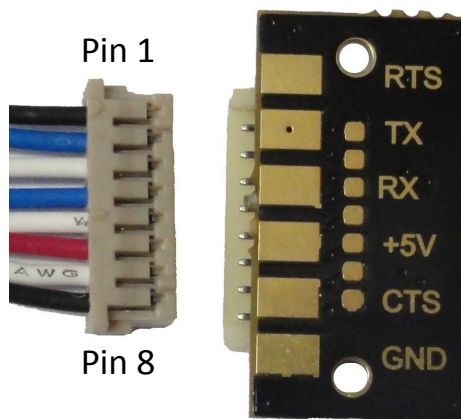
Figure 4.1 Bottom Pin Layout

Pin 8

Pin 1

Figure 4.2 Top Pin Layout

6
SIRTS_EXT

0
GND

RTS
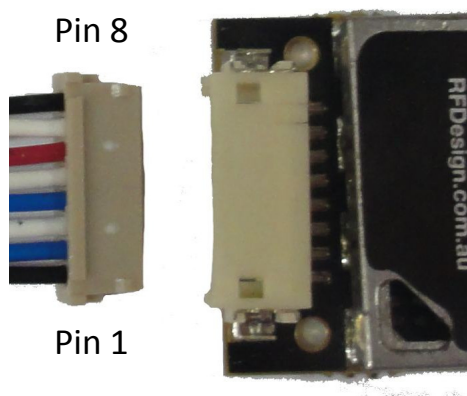
5
SITX_EXT

TX

4
SIRX_EXT

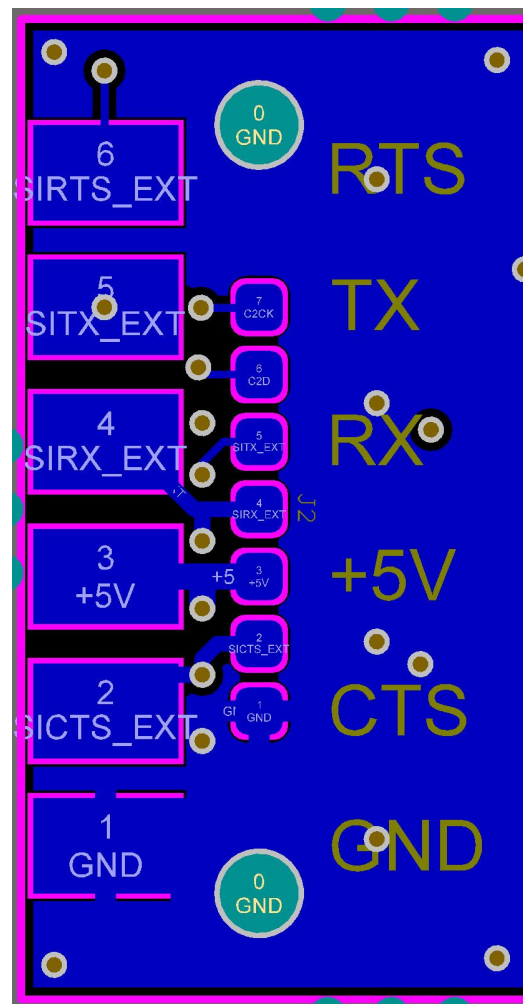RX

3
+5V

+5V

2
SICTS_EXT

CTS

1
GND

0
GND

GND

Figure 4.3 Physical Pin Layout

In case there is need to force the modem into boot mode, short circuit Pins 1 and 2 or Pads labelled CTS and GND on the back of the modem (BIG Pads on edge of board).

5. Software/GCS Support

The software solution (see Useful Links) is an open source development which is also compatible with RFD900u Modem Tools (see Useful Links) and the 3DR Radio Config (see Useful Links) from 3D Robotics. It is called "SiK" and was created by Mike Smith and improved on by Andrew Tridgell and RFDesign.

A boot loader and interface is available using RFD900u Modem Tools and field upgrade of the modem firmware via the serial port.

The RFD900u 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 etc.

Integrated support for configuring the RFD900u Radio Modem is supported by the APM Planner, with other GCS solutions in development. Its default serial port settings are as follows:

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

The RFD900u Radio Modem has many software features which include:

- 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 realtime
- Automatic duty cycle throttling based on radio temperature in order to avoid overheating

6. Antenna Connectivity

6.1. Diversity

The RFD900u 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. 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 in the order of 6-8dB by employing a diversity scheme.

- **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 RDF900u modem be separated by at least 25cm, more if possible.

- **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.

7. AT Commands

The RFD900u modem can support the Hayes 'AT' modem command set for configuration. The AT command mode can be entered by using the '+++' sequence. When doing this, you have to wait for 1 second before and after entering the command mode in order to prevent data being interpreted as data. When you are successfully in the AT command mode, an 'OK' prompt will be displayed on the screen and the RFD900u modem will stop displaying information from the other modem. Whilst in AT mode, you can use the AT commands to control the local RFD900u modem or the RT commands to control the remote modem.

To set certain registers to a particular value, follow these steps:

1. Use the command ATSn=X where n is the register number and X is the actual value.
2. Use the command AT&W to write the new values to the RFD900u modem.
3. Use the command ATZ to reboot the RFD900u modem.

Table 7.1 shows a table that gives a list of AT commands and their description.

AT Command	Description
ATI	Shows the radio version
ATI2	Shows the board type
ATI3	Shows board frequency
ATI4	Shows board version
ATI5	Shows all user settable EEPROM parameters
ATI6	Displays TDM timing report
ATI7	Displays RSSI signal report
ATO	Exits AT command mode
ATSn?	Displays radio parameter number 'n'
ATSn=X	Sets radio parameter number 'n' to 'X'
ATRn=X[,x]	Sets radio parameter number 'n' to 'X'
ATPn=X,Y	Sets radio pin 'X' to setting 'Y' using command 'n'
ATPP	Shows pin settings and values
ATZ	Reboots the radio
AT&W	Writes current parameters to EEPROM
AT&F	Resets all parameters to factory defaults
AT&T=RSSI	Enables RSSI debugging report
AT&T=TDM	Enables TDM debugging report
AT&T	Disables debugging report

Table 7.1 AT Commands and their description

Table 7.2 shows a table that gives a list of RT commands and their description. The x parameter is optional where x is the node ID. For example: use RTI,1 to get RTI value for node 1 or simply use RTI to get the RTI value for the node set in the local NODEDESTINATION (see RFD900u Parameters in Table 7.3).

AT Command	Description
RTI[,x]	Shows the radio version.
RTI2[,x]	Shows the board type
RTI3[,x]	Shows board frequency
RTI4[,x]	Shows board version
RTI5[,x]	Shows all user settable EEPROM parameters
RTI6[,x]	Displays TDM timing report
RTI7[,x]	Displays RSSI signal report
RTO[,x]	Exits AT command mode on the remote node
RTSn? [,x]	Displays radio parameter number 'n'
RTSn=X[,x]	Sets radio parameter number 'n' to 'X'
RTRn=X[,x]	Sets radio parameter number 'n' to 'X'
RTPn=X,Y	Sets radio pin 'X' to setting 'Y' using command 'n'
RTPP	Shows pin settings and values
RTZ[,x]	Reboots the radio
RT&W[,x]	Writes current parameters to EEPROM
RT&F[,x]	Resets all parameters to factory defaults
RT&T=RSSI[,x]	Enables RSSI debugging report
RT&T=TDM[,x]	Enables TDM debugging report
RT&T[,x]	Disables debugging report

Table 7.2 RT Commands and their description

Table 7.3 shows a table with more details about the parameters that can be set in the RFD900u modem.

S Reg #	S Register	Description	Default Val	Max Val	Min Val	Should be the same at both ends of the link for successful communication
0	FORMAT	This is for EEPROM version, it should not be changed	Firmware dependant	N/A	N/A	No
1	SERIAL_SPEED	Serial speed in 'one byte form'	57	115	2	No
2	AIR_SPEED	Air data rate in 'one byte form'	64, 128[1]	250	2	Yes
3	NETID	Network ID. It should be the same on both modems	25	499	0	Yes
4	TXPOWER	Transmit power in dBm. Maximum is 20dBm	20	20	0	No
5	ECC[3]	Golay error correcting code	0	1	0	Yes
6	MAVLINK[4]	MAVLink framing and reporting	0	1	0	No
7	OP_RESEND[5]	Opportunic Resend	0	1	0	No
8	MIN_FREQ	Min freq in KHz	915,000	927,000	902,000	Yes
9	MAX_FREQ	Max freq in KHz	928,000	928,000	903,000	Yes
10	NUM_CHANNELS	Number of frequency hopping channels	50, 20[1]	50	5	Yes
11	DUTY_CYCLE	The percentage of time to allow transmit	100	100	10	No
12	LBT_RSSI	Listen before talk threshold	0	1	0	Yes
13	MANCHESTER	Manchester encoding	0	1	0	Yes
14	RTSCTS	Ready To Send and Clear To Send	0	1	0	No
15	NODEID[2][6]	Node ID - Base node ID is 0	1[1]	29	0	N/A
16	NODEDESTINATION[2][7]	Remote node ID to communicate with	65535[1]	29	0	No
17	SYNCANY[2][8]	Get sync from any node	0[1]	1	0	No
18	NODECOUNT[2]	The total number of nodes.	3[1]	30	2	Yes

Table 7.3 RFD900u parameters

Notes:
[1]Defaults for firmware version 2.* and later
[2]Available only for firmware version 2.* and later
[3]ECC - Software Detection and correction, extra packet information (twice the packet length) is sent to allow the recovery of corrupted packets, unavailable from version 1.8 onward.
[4]Injects RSSI packet when Mavlink protocol used and heartbeat packet detected.
[5]Opportunicresend allows the node to resent packets if it has spare bandwidth.
[6]One node must be acting as a base for a multipoint environment to work. NODECOUNT must be updated first before updating this parameter with bigger number.
[7]Set the value to 65535 to broadcast to all nodes. Cannot be the same as NODEID.
[8]If set to 1, allows the modem to send data to all non-base nodes without finding the base. It is strongly recommended to set the value to 0 to avoid unwanted data communication confusion on a multipoint environment.

8. Air Data Rate

An air speed of 64kps will give a range of about 10km depending on antenna. If the air speed is set to be lower, the range of the wireless link increases but the amount of data that you can send will be limited. Therefore one has to compromise between range and data rate. The data rates that you can choose are only limited to 2, 4, 8, 16, 19, 24, 32, 48, 64, 96, 128, 192 and 250.

The air data rate is chosen depending on:

- the range that you need
- the data rate that you will be sending
- whether you send data in one direction or both
- whether you have enabled ECC or not
- whether you have APM firmware with adaptive flow control

9. Network Options

RFD900u can be implemented in either simple pair (V1.x, V2.x) or multipoint network (V2.x Only).
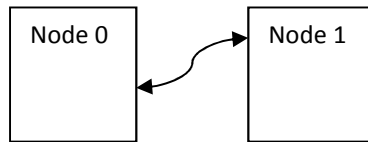
Figure 0.1 Two-node Network Setup
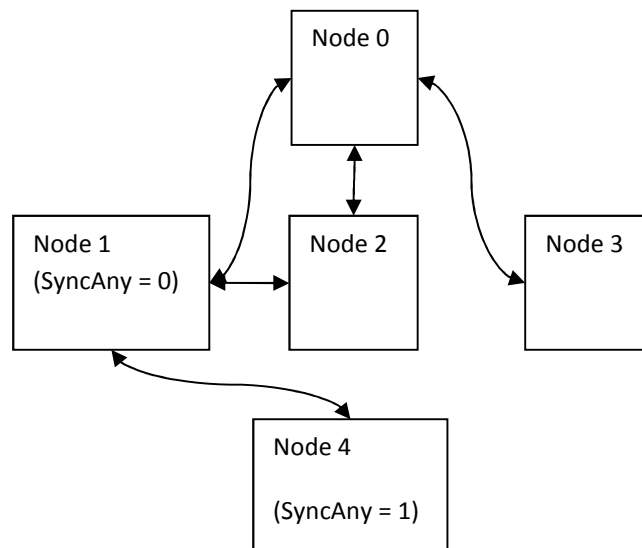
Figure 0.2 Five-node Network Setup

A few notes on the multipoint network (see Figure 10.2):

• In order for Node 1 to communicate with Node 2, it has to be able to see Node 0 (the base) and Node 2

• If Node 4 cannot see Node 0, to communicate with Node 1, it has to be able to see Node 1 and set the SyncAny parameter to 1 (refer to Figure 8.3: RFD900u parameters).

• Please note that there is a maximum number of one node which can have SyncAny = 1 parameter in a network to avoid data corruption.

• More nodes will reduce the bandwidth.

10. RFD900u Modem Tools User Manual

10.1. Introduction

This GUI is for changing RFD900u modem parameters as well as for uploading firmware.

10.2. Requirements – for End Users

Download and copy two files from RFDesign website (see Useful Links) and put them in the same folder:

1. RFD900uModemTools.exe
2. RFD900uModemTools.glade

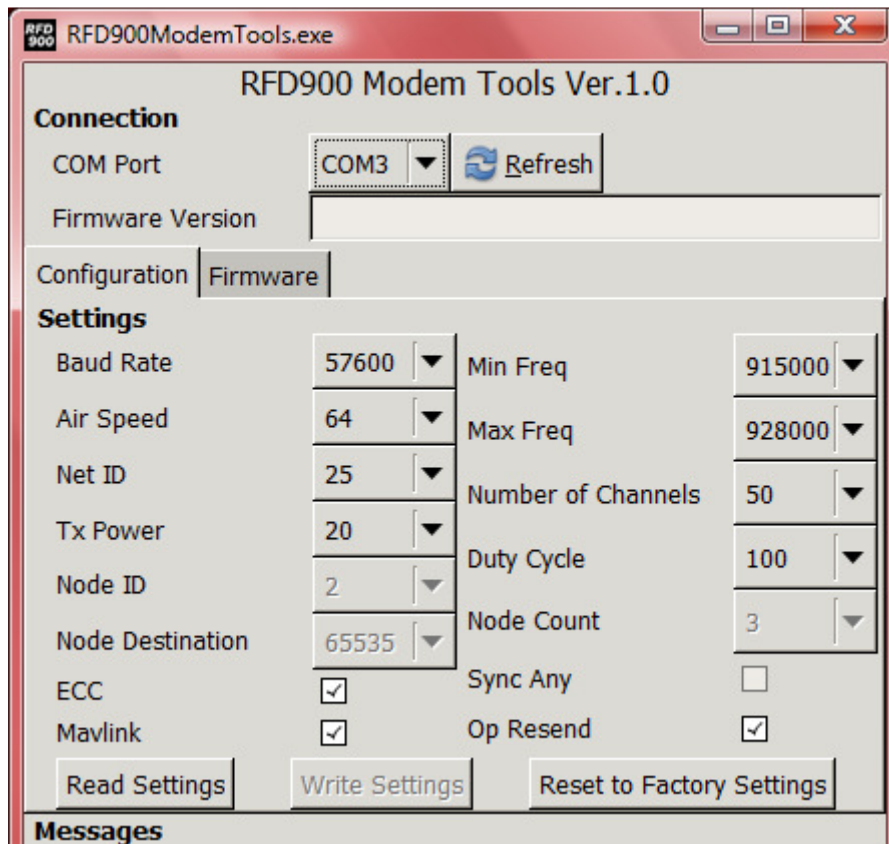**10.3. User Interface**

- **Configuration Tab**

Figure 10.1 Configuration Tab – Modem Tools

To communicate with the modem, make sure you connect the modem to the computer using FTDI cable. Use the COM Port combobox to choose the correct COM port to which the modem is connected.

Use the Refresh button to refresh the COM combobox list after connecting/disconnecting a modem.

Set Node Destination to 65535 to send data to all nodes.

All other comboboxes and checkbuttons are self-explanatory.

Use Update Settings button to write setting changes to the modem. Initially, this button is disabled and will be enabled once the Load Settings button is clicked.

Use the Load Settings button to load settings from the modem.

Use Reset Factory Settings button to reset the current modem settings to the factory settings.
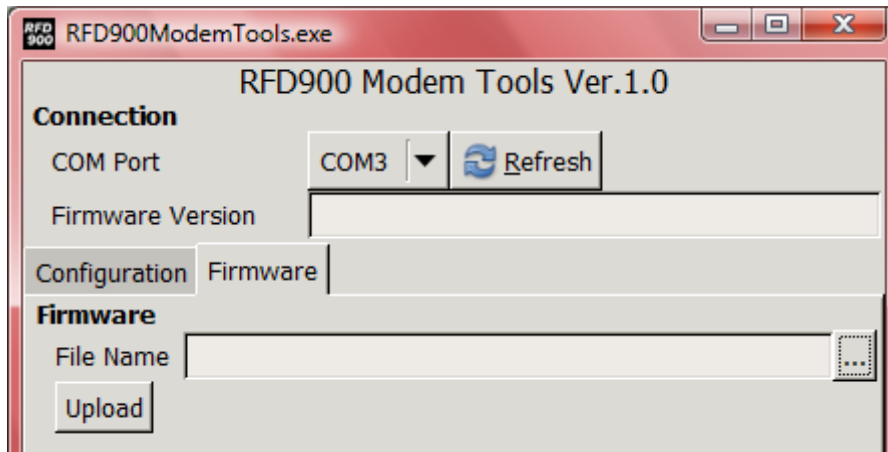
- **Firmware Tab**

Figure 10.2 Configuration Tab – Modem Tools

Use the COM Port combobox to choose the correct COM port to which the modem is connected.

Use the Refresh button to refresh the COM combobox list after connecting/disconnecting a modem.

Download the firmware from the RFDesign website (see Useful Links) and put the file on the same folder as this RFD900u Modem Tools application. Browse for the file using the "..." button then click the Upload button to upload the new firmware to the modem.

11. Frequently Asked Questions (FAQ)

How many antennas do I need to use?

One is the minimum. Two is recommended.

How do I connect the FTDI cable to the modem?

Match the Red Wire from the FTDI cable with the corresponding Red wire on the breakout cable plugged into the modem.
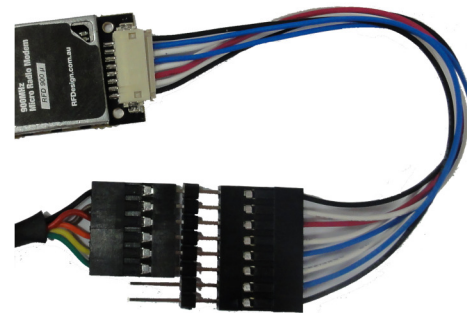
See Figure 11.1 or Table 4.1 for more information

Figure 11.1 FTDI Connection

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

Download the latest firmware (see Useful Links). Download the RFD900u Modem Tools (see Useful Links). Connect the FTDI cable to the modem and to a computer. Use the RFD900u Modem Tools to upload the latest firmware or to change the modem configuration (see RFD900u Modem Tools User Manual).

What should I do if the RFD900u Modem Tools application keeps giving me back 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.

I upgraded to V2.x 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)

12. Useful Links

RFD900u Firmware

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

V1.x firmware is standard SiK (open source)
V2.x firmware is multipoint SiK (MP SiK)

RFD900u Modem Tools

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

FTDI Cable and Drivers

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

Software Solution Sik V1.x

https://github.com/RFDesign/SiK

3DR Radio Configuration Tool

http://vps.oborne.me/3drradioconfig.zip

Index of Figures and Tables