RFD radio modem software manual

For RFD900A, RFD900u, RFD900+ radio modems

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1. Pin Signals and Layout

a) RFD900a

Pin #	Name	Direction	Description	Max Voltage
1	GND	Power	Ground	0V
2	GND	Power	Ground	0V
3	CTS	Either	Clear to send	5V
4	Vcc	Power	Power supply	5V
5	Vusb	Power	Power supply from USB	5V
6	Vusb	Power	Power supply from USB	5V
7	RX	Input	UART Data In	5V
8	P2.3	Either	Digital I/O	5V
9	TX	Output	UART Data Out	5V
10	P2.2	Either	Digital I/O	5V
11	RTS	Either	Request to send	5V
12	P2.1	Either	Digital I/O	5V
13	P0.1	Either	Digital I/O	5V
14	P2.0	Either	Digital I/O	5V
15	P2.6	Either	Digital I/O	5V
16	GND	-	Ground	0V

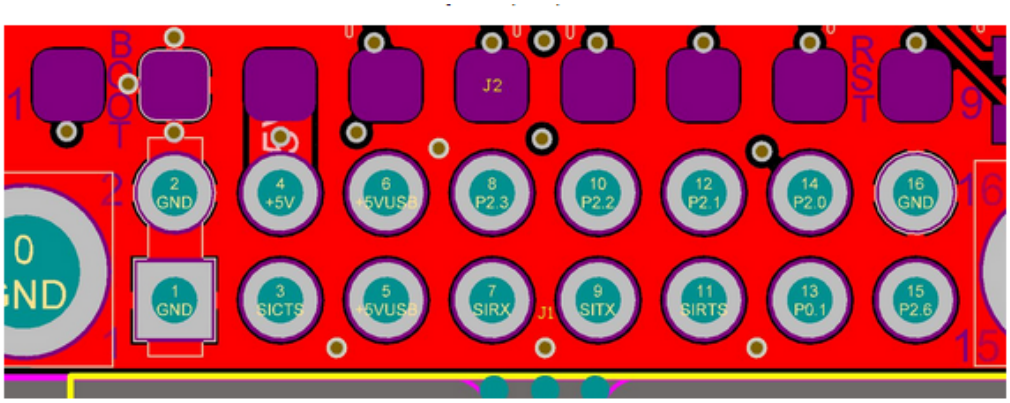


Figure 1.1: Physical Pin Layout of the RFD900 Radio Modem

Pin 1 of the FTDI cable (black wire) should connect to pin 1 of the RFD900 header. In order 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 shown in Figure 1.1.

In case there is need to force the modem into boot mode, short circuit pads 1 and 2 (labelled BOOT) on the 9 way test pads. When in boot mode, the RED LED will be dimly lit.

b) RFD900u

Pin #	Name	Colour	Direction	Description	Max Voltage
8	GND	Black	Power	Ground	0V
7	CTS	White	Either	Clear to send	5V
6	Vcc	Red	Power	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 1:1 Description on 8 Pin Connector

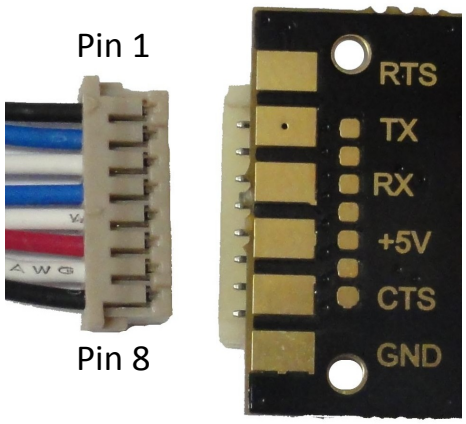


Figure b.1 Bottom Pin Layout

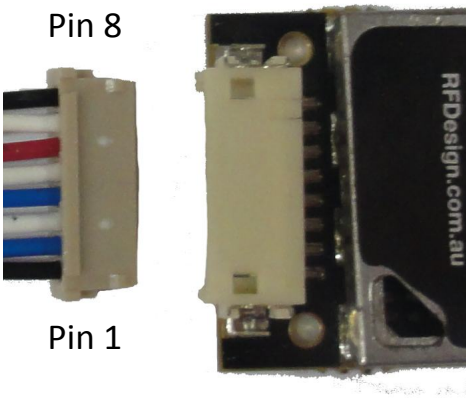


Figure b.2 Top Pin Layout

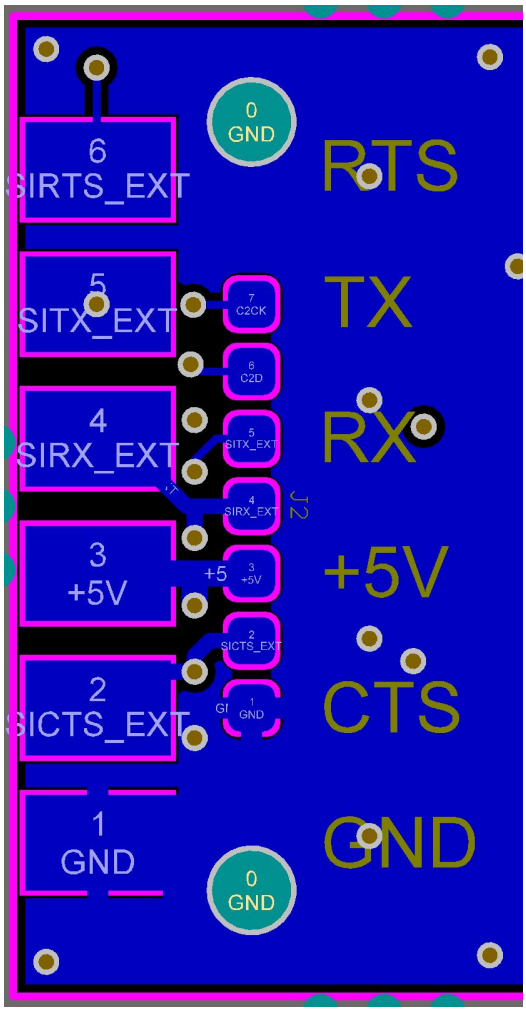


Figure b.3 Physical Pin Layout

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).

2. Software/GCS Support

The software solution (see Useful Links) is an open source development, which is also compatible with RFD900 Modem Tools (see Useful Links) and the 3DR Radio Configuration (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 RFD900 Modem Tools and field upgrade of the modem firmware via the serial port.

The RFD900 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 RFD900 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 RFD900 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 real time
- Automatic duty cycle throttling based on radio temperature in order to avoid overheating

3. AT Commands

The RFD900 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 RFD900 modem will stop displaying information from the other modem. Whilst in AT mode, you can use the AT commands to control the local RFD900 modem or the RT commands to control the remote modem.

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

- Use the command ATn=X where n is the register number including the first character and X is the value you want to set the register to.
- Use the command AT&W to write the new values to the RFD900 modem.
- Use the command ATZ to reboot the RFD900 modem.

a) Status Commands

Table 3:1 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'
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 3:1 AT Status Commands

Table 3:2 shows a table that gives a list of RT commands and their description. The x parameter is optional where x is the node ID when using version 2. 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 RFD900 Parameters in Table 3:5).

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'
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 3:2 RT Commands and their description

b) User Pins

User Pins, this allows the user to control the extra pins on the modem with AT commands or RT through the radio link.

AT Command	Function	Description
PP	Print	Print all Pin Settings
PI=x	Input	Set Pin x to Input
PR=x	Read	Read Pin X value (When set to input)
PO=x	Output	Set Pin x to Output (Default) can only be controlled by ATPC
PC=x,1	Control	Turn pin x on - Output Mode / Set internal pull up resistor - Input Mode
PC=x,0	Control	Turn pin 2 off - Output Mode / Set internal pull down resistor - Input Mode

Table 3:3 RT Commands and their description

Pin	RFD900 Port	RFD900u Port
0	2.3	1.0
1	2.2	1.1
2	2.1	
3	2.0	
4	2.6	
5	0.1	

Table 3:4 Pin to Port Map

c) Dynamic transmit power control.

By setting R0 and R1 in Table 3:5 the modem is able to change its transmit power level automatically to reduce current consumption while maintaining a good RF link. This is done by checking the signal strength of the link and adjusting the transmit power up and down as required. The maximum transmitted power will never exceed the setting in register (S4: transmit power).

By default, register R0 (RSSI target) is 255, which will drive the modem to its maximum permissible power level.

The RSSI target (R0) and RSSI Hysteresis (R1) values need to be tested in the application to determine suitable link margin is maintained.

An initial starting points for dynamic power control are: R0 = 150, R1=20.

Typical ranges of RSSI in a link are: ~40-60 to maintain a link, >60 for data transmission, =217 for maximum reportable RSSI on the RFD900. A target RSSI of 150 will give a good starting point for link tuning.

In the event the modems lose link, they will revert to maximum set power (S4).

d) Parameters

Table 3:5 shows a table with details about the parameters that can be set in the RFD900 modem.

Reg#	S Register	Description	Default Val	Min Val	Max Val	Must be same on all modems in network
S0	FORMAT	This is for EEPROM version, can't be changed	Firmware V	N/A	N/A	No
S1	SERIAL_SPEED	Serial speed in 'one byte form'	57	2	115	No
S2	AIR_SPEED	Air data rate in one byte form	64, 128[1]	2	250	Yes
S3	NETID	Network ID. It should be the same on both modems	25	0	499	Yes
S4	TXPOWER	Transmit power in dBm. Maximum is 30dBm	20, 27[1]	0	30	No
S5	ECC[3]	Enables or disables the golay error correcting code	0	0	1	Yes
S6	MAVLINK[4]	Enables or disables the MAVLink framing and reporting	1, 0[1]	0	1	No
S7	OP_RESEND[5]	Opportunic Resend	0	0	1	No
S8	MIN_FREQ	Min freq in KHz	915,000	902,000	927,000	Yes
S9	MAX_FREQ	Max freq in KHz	928,000	903,000	928,000	Yes
S10	NUM_CHANNELS	Number of frequency hopping channels	50, 20[1]	5	50	Yes
S11	DUTY_CYCLE	The percentage of time to allow transmit	100	10	100	No
S12	LBT_RSSI	Listen before talk threshold (This parameter shouldn't be changed)	0	0	1	Yes
S13	MANCHESTER	Manchester encoding (This parameter shouldn't be changed)	0	0	1	Yes
S14	RTSCTS	Ready To Send and Clear To Send (This parameter shouldn't be changed)	0	0	1	No
S15	NODEID[2]	Node ID. Base node ID is 0. 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.	2[1]	0	29	N/A
S16	NODEDESTINATION[2]	Remote node ID to communicate with. Set the value to 65535 to broadcast to all nodes. Cannot be the same as NODEID. NODECOUNT must be updated first before updating this parameter with bigger number.	65535[1]	0	29	No
S17	SYNCANY[2]	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.	0[1]	0	1	No
S18	NODECOUNT[2]	The total number of nodes.	3[1]	2	30	Yes
R0	TARGET_RSSI	Optimal RSSI value to try to sustain (off = 255)	255	50	255	No
R1	HYSTERESIS_RSSI	Amount of change before power levels altered	50	20	50	No

Table 3:5 RFD900 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.

[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.

4. Air Data Rate

An air speed of 64kps will give a range of about 40km 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

5. Network Options

RFD900 can be implemented in either simple pair (V1.x, V2.x) or multipoint network (V2.x Only).

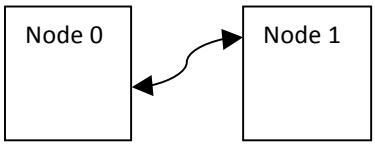


Figure 5.1: Two-node Network Setup

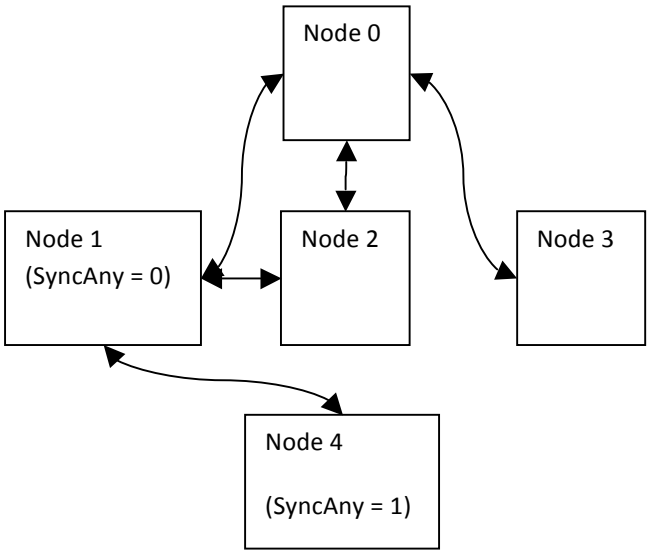


Figure 5.2: Five-node Network Setup

A few notes on the multipoint network (see Figure 5.2):

- 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: RFD900 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.

6. Frequently Asked Questions (FAQ)

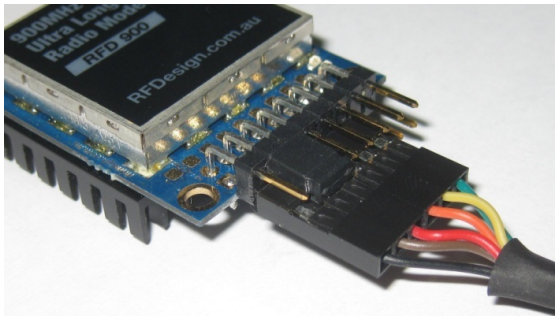
i) What does a solid RED LED mean?

The modem is in bootloader mode, ready to accept firmware. Please use the modem configuration tool to upload the latest version.

ii) How many antennas do I need to use?

One is the minimum. Two is recommended.

iii) 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 (see above)

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

Download the latest firmware (see Useful Links). Download the RFD900 Modem Tools (see Useful Links). Connect the FTDI cable to the modem and to a computer. Use the RFD900 Modem Tools to upload the latest firmware or to change the modem configuration (see RFD900 Modem Tools User Manual).

v) What should I do if the RFD900 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.

vi) 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.

vii) 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)

7. Useful Links

viii) RFD900 Firmware
http://rfdesign.com.au/firmware/

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

ix) RFD900 Modem Tools
http://rfdesign.com.au/downloads/

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

x) Software Solution Sik V1.x
https://github.com/RFDesign/SiK

xi) 3DR Radio Configuration Tool
http://vps.oborne.me/3drradioconfig.zip