RFD900x Asynchronous firmware

User Manual

Configuration and usage guide
Flash Programmer User Manual

RFDesign Pty Ltd
7/1 Stockwell Place
Archerfield, QLD 4108
rfdesign.com.au

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1 Introduction

The RFD900x radio modem can be loaded with three official firmware releases to achieve different communication architectures and node topologies. So far, the available firmware versions are:

- Peer-to-peer (P2P)
- Asynchronous mesh
- Multipoint network

This document describes the configuration of the asynchronous, single hop (or fixed forwarding), mesh network release. This firmware version is not loaded in the RFD900x radio modem by default. This means, you must download the firmware from the RF Design support website and flash it to the radio. Use the latest version of the RF Design modem tools (see Useful Links) to update the firmware.

Figure 1-1 depicts an asynchronous non-forwarding mesh network diagram. In this configuration, all nodes have an equal role. The nodes don't require synchronisation and communicate with other nodes within RF range.

Note: Due to the limited number of channels available on the 868 MHz band this firmware may not operate as intended and is not recommended for 868X modems or reduced band settings less than 915-928MHz on 900X modems

Note: It is not recommended to use the PPM feature with asynchronous firmware. Latency and reliability will vary with number of nodes and data traffic.

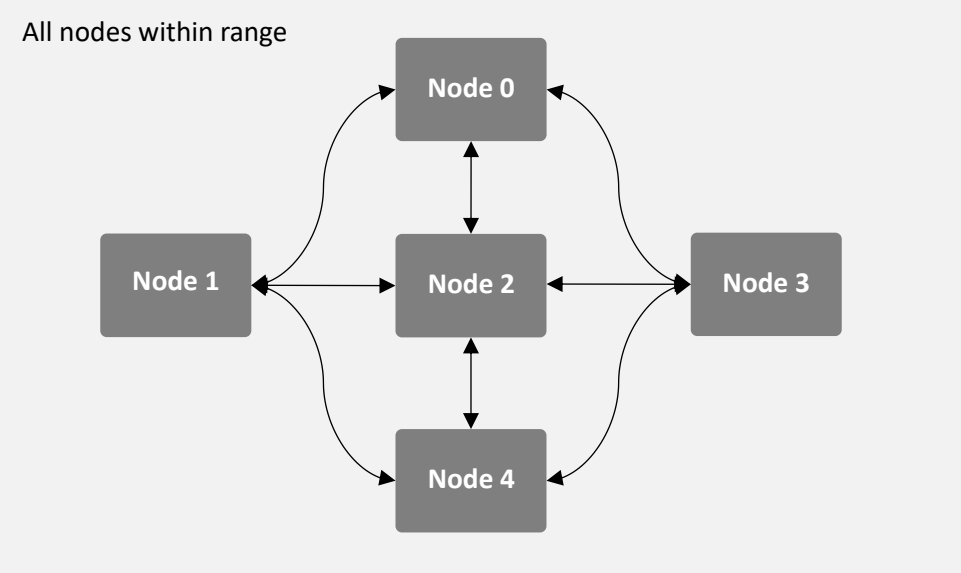

Figure 1-1: Asynchronous non-hopping mesh topology

2 Software/GCS Support

The asynchronous software solution (see “Useful Links”) is multi-node meshing solution for RF Design X series modems.

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 and serial speeds etc can all be custom set by the user using the AT Command set, the RFD Modem Tools V2.6 or later and APM Planner. (Note some parameters are only settable using the AT commands and that RT commands for changing remote settings is not supported)

The default serial settings for the asynchronous firmware is:

- 115200 baud rate
- No parity
- 8 data bits
- 1 stop bit

3 AT commands

The RFD900x modem can supports an AT modem command set for configuration. The AT command mode can be entered by using the '+++' sequence in a serial terminal connected to the radio. You should allow at least one second after the sending of data before entering the sequence to ensure that the modem will correctly enter command mode.

If successful, an 'OK' prompt will be displayed on the screen and the RFD900x modem will stop displaying incoming data from the remote modem. In command mode, you can use the AT commands to control the local RFD900x modem.

Note: RT commands are **not** currently supported in the asynchronous firmware.

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

1. Use the command ATSn=X where *n* is the register number and *X* is the value to assign.
2. Use the command AT&W to save the new values to the RFD900x modem.
3. Use the command ATZ to reboot the RFD900x modem for changes to take effect.

Table 3-1 shows a 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 and their values
ATI5?	Shows all user settable EEPROM parameters and their possible range
ATI6	Displays TDM timing report
ATI7	Displays RSSI signal report
ATI8	Display Device 64-bit unique ID
ATI9	Display node ID [multipoint only]
ATO	Exits AT command mode
ATSn?	Displays radio 'S' parameter number 'n'
ATSn=X	Sets radio 'S' parameter number 'n' to 'X'
ATRn?	Displays radio 'R' parameter number 'n'
ATRn=X	Sets radio 'R' parameter number 'n' to 'X'
ATZ	Reboots the radio
AT&F	Resets all parameters to factory defaults
AT&W	Writes current parameters to EEPROM
AT&UPDATE	Reset and enter boot mode
AT&P	Change TDM phase (debug only)

AT&R	Record default PPM stream for PPM output (vehicle side) (Not recommended. Latency will vary with number of nodes and data traffic)
AT&T	Disables debugging report
AT&T=RSSI	Enables RSSI debugging report
AT&T=TDM	Enables TDM debugging report
AT&E=X	Set new encryption key (128-bit AES in 16 hex bytes e.g. 5A02D5BB...)
AT&E?	Shows current encryption key
ATPP	Shows GPIO configuration and state
ATPO=X	Sets GPIO X to output
ATPI=X	Sets GPIO X to input
ATPM=X	Sets input GPIO pin to mirror on remote radio (local GPIO must be set to input and remote GPIO pin must be set to output)
ATPR=X	Shows GPIO input state
ATPC=X,S	Sets output GPIO X to state S
AT+F?	Show the forwarding table and forwarding buffer size, set MAX_DATA lower to get more forwarding buffer
AT+Fx=?	Show element x of forwarding table
AT+Fx=Src,Dst	Set element x to forward from address Src to Address Dst

Table 3-1: AT Commands and their description

Table 3-2 shows more details about the parameters that can be set in the RFD900x modem.

Reg #	S Register Description	Default Value	Maximum Value	Minimum Value	Must be the same at both ends of the link?
S0	**FORMAT** This is for EEPROM version, it should not be changed. It is set by the firmware	Firmware dependant	N/A	N/A	No
S1	**SERIAL_SPEED** Serial speed in 'one-byte form'. Accepted values are 1, 2, 4, 9, 19, 38, 57, 115, 230, 460, 571 corresponding to 1200bps, 2400bps, 4800bps, 9600bps, 19200bps, 38400bps, 57600bps, 115200bps, 230400bps, 460800bps, 571428bps and 1000000 bps respectively.	115	1000[2]	1	No
S2	**AIR_SPEED** Air data rate in 'one-byte form'. Accepted values are 64,125,250,500,830 corresponding to 64000bps, 125000bps, 25000bps, 500000bps and 830000bps respectively.	64	830[2]	64	Yes
S3	**MAX_DATA** Maximum size of packet data section	4068	4068	1	Yes
S4	**MAX_RETRIES** Maximum number of retries	10	100	1	Yes

S5	**GLOBAL_RETRIES** Maximum number of retries for broadcast messages	10	100	0	Yes
S6	**SER_BREAK_DETECT_MS** Time in ms units for break detection. Set to 0 to turn this feature off	50	500	0	No
S7	**TXENCAP** Transmitted data encapsulation format. 0= none, 1=MAV, 2=SAS	0	2	0	Yes
S8	**RXENCAP** Received data encapsulation format. 0= none, 1=MAV, 2=SAS	0	2	0	Yes
S9	**NETID** Network ID. It should be the same on both modems	25	255	0	Yes
S10	**NODEID** ID used to identify the local node.	1	32767	1	No
S11	**DESTID** ID used to identify the remote node. Set the value to 65535 (32768 from V2.45F)* to broadcast to all nodes. Cannot be the same as NODEID.	2	65535 (32768*)	1	No
S12	**TXPOWER** Transmit power in dBm. Maximum is 30dBm	10	30	0	No
S13	**MAVLINK**[1] Enables or disables the MAVLink framing and reporting	0	1	0	No
S14	**MIN_FREQ** Min frequency in KHz	915000	928000	902000	Yes
S15	**MAX_FREQ** Max frequency in KHz	928000	929000	903000	Yes
S16	**NUM_CHANNELS** Number of frequency hopping channels	20	50	1	Yes
S17	**LBT_RSSI** Listen before talk threshold (This parameter shouldn't be changed)	0	255	0	Yes
S18	**RTSCTS** Enable or disable Ready-to-send and Clear-to-send flow control.	1	1	0	No
S19	**Encryption Level** Encryption level 0=off, 1=128bit AES	0	1	0	Yes
S20	**R/C input GPIO1.1** Set GPIO 1 (Pin 15) as R/C(PPM) input (Not recommended. Latency will vary with number of nodes and data traffic)	0	1	0	No
S21	**R/C output GPIO1.1** Set GPIO 1 (Pin 15) as R/C(PPM) output (Not recommended. Latency will vary with number of nodes and data traffic)	0	1	0	No

S22	**ANTMODE** 0= Antenna 1 1= Antenna 1 TX and antenna 2 RX 2= Diversity	2	2	0	No

Table 3-3: RFD900x parameters

Notes:
[1] Injects RSSI packet when MAVLink protocol used and heartbeat packet detected.

3.1 Setting up data encryption

The 128-bit AES data encryption may be set, enabled and disabled using the AT commands (see Table 3.1). The encryption key can be any 32-character hexadecimal string.

To encrypt a device, the encryption mode must first be enabled by typing 'ATS15=1' in the command terminal. Once the encryption mode is active, an encryption key may be set after typing 'AT&E' into the command terminal. The encryption key may be of any 32-character hexadecimal string of the users choosing. Any devices with different encryption settings will not communicate.

After entering command mode, send the following commands to set encryption on using an arbitrary 32 hexadecimal character key. For example:

```
ATS15=1
AT&E=5AEEF103125C0AA233678909160111CA
AT&E=1234567890ABCDEF1234567890ABCDEF
AT&W
ATZ
```

3.2 Setting the air data rate

An air speed of 64kps will give a maximum range of about 40km in open space depending on antenna configurations, terrain and weather. Reducing the air speed can help to increase the range and link quality limits the data throughput.

Considerations for the air speed setting:

- The desired range
- The amount of data across the link
- Whether you send data in one direction or both
- Whether you have enabled ECC or not
- Whether you have adaptive flow control

It is important to note that when using asynchronous firmware, the air rate should be set to a lower value then the baud rate.

An example of setting the air data rate:

```
ATS2=250
AT&W
ATZ
```

4 Asynchronous Network

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

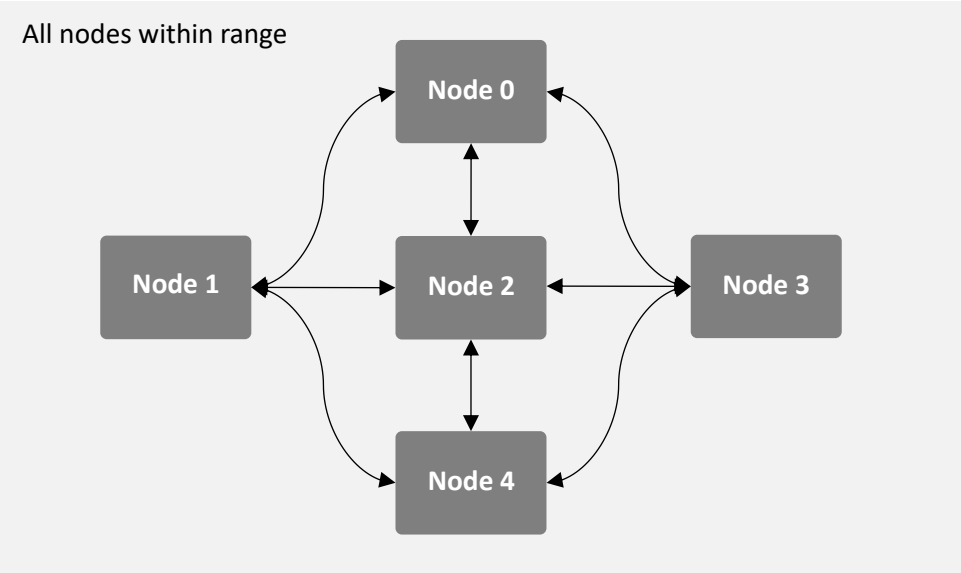

Figure 4-2: Asynchronous non-hopping mesh topology

Each node can only communicate to other nodes within its RF range. Also, it is mandatory to assign a different node id to each node for the network to work properly. An example of setting the NODEID of the modem:

```
ATS10=5
AT&W
ATZ
```

It is possible to address data to a remote node. To do so, set the DESTID parameter to be the same as the node id of the target. For example:

```
ATS11=6
AT&W
ATZ
```

The modem can also be set to send message to the entire network:

```
ATS11=65535 (32768 after V2.45F)
AT&W
ATZ
```

As messages are transmitted asynchronously, whenever a package collision happens, the radio will automatically resend it without user intervention. This behaviour can be disabled by changing the S4 parameter to 1 as follows:

```
ATS4=1
AT&W
ATZ
```

4.1 Forwarding

A fixed forwarding node can be added to relay data from known nodes to known destination nodes. This can be used to communicate without direct link between modems by passing data through an intermediate node.
i.e. 3 nodes located in a straight line all spaced at the maximum transmission range from the next (1,2,3). Data flow is node 1 to node 3 and vice versa using node 2 as a relay node.

Node 1: ATS10 = 1, ATS11 =3 // set node 1, destination 3
Node 3: ATS10 = 3, ATS11 =1 // set node 3, destination 1
Node 2: ATS10 = 2, ATS11 =don't care, AT+F0=1,3, AT+F1=3,1 // forward 1->3, and 3->1

```
(Node 1)
ATS11=3          // sets node 1, destination 3
AT&W
ATZ
(Node 2)
AT+F0=1,3        // sets forwarding table element 0 to forward from node1
                 to node3
AT+F1=3,1        // sets forwarding table element 0 to forward from node1
                 to node3
AT&W
ATZ
```

```
(Node 3)        // sets node 3, destination 1
ATS11=1
AT&W
ATZ
```

You can add up to ten forwarding paths to the array. This would allow up to five nodes to pass data in both directions.

5 FAQ

5.1 How many antennas do I need to use?

One is the minimum. Two is recommended best configured at right angles to each other.

5.2 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 6-2.

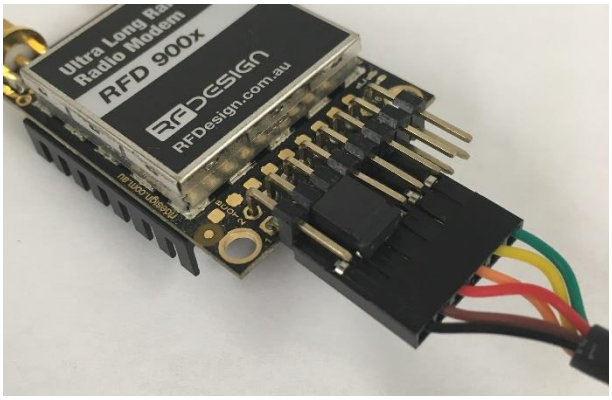

Figure 6-2: An FTDI cable connected to the RFD900x modem

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

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

6 Useful links

RFD900x Firmware
http://rfdesign.com.au/firmware/

RFD SiK (aka peer to peer) firmware is the standard firmware loaded on the modem based on the open source SiK development

RFD Asynchronous the firmware as outlined in this datasheet

RF Design Modem Tools
http://files.rfdesign.com.au/tools/

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

7 Document revision history

Version	Date	Changes
1	22/09/17	Release document
1.1	09/07/18	Updated settings, values and information for current firmware versions and added new forwarding commands and description