RFD V4 BETA Firmware Point to Point Application Note

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Contents

1 Key Features

- Support for SiK point to point like behaviour.
- PPM and SBus signal passthrough
- Raw, MAVLink and SAS data packet support
- GPIO pin state mirroring
- Hardware accelerated AES encryption
- Optional extra listen only nodes

2 Disclaimer and Limitations

The V4 BETA firmware is under active development, there may be significant changes to the operation between firmware releases. Known bugs and issues are listed in the firmware release notes. It is possible that further faults may be found during use. This firmware is to be considered experimental and should be used as such.

Any bugs, issues, general feedback or questions should be addressed to the team via email at beta@rfdesign.com.au

Note: The V4 BETA firmware is currently only configurable by AT Commands. It is not compatible with the modem tools GUI.

Note: The V4 BETA firmware is currently only compatible with the V2 hardware revision of the x series modem. See the x series modem datasheet for details on how to identify the modem hardware version if you are unsure.

3 AT Commands

The BETA firmware is currently **only configurable** by AT Commands.

The AT command mode can be entered by sending '+++', without quotes, sequence in a serial terminal connected to the radio at the correct baud rate, 57600 by default.

If successful, an 'OK' prompt will be displayed on the screen and the modem will stop displaying incoming data from the remote modem, if any.

In command mode, you can use the AT commands to control the local modem settings.

Useful commands for this application note:

AT Command	Description
ATI	Shows the firmware version and country code and hardware revision
ATI5	Shows all user settable EEPROM parameters and their values
ATI5:x:y	An alternate ATI5 command that shows the parameters in the range x to y inclusive. Example usage ATI5:6:11 will print parameters S6 through S11
ATI9	Calibration validation test
ATI10:n	Displays radio S parameter number 'n' and valid settings range.
ATI11	Show information on RC data packets sent or received, if any, depending on if the node is an RC input or RC output.
ATO	Exits AT command mode
ATSn=X	Sets radio 'S' parameter number 'n' to 'X'
ATZ	Reboots the radio
AT&F	Resets all parameters to factory defaults
AT&R	Record default PPM stream for PPM output (vehicle side)

Note: Modem parameters are saved whenever changes are made but modems need to be rebooted after any settings have been modified to activate changes.

4 LED Behaviour

Green LED
This LED indicates the modem link status and has the following patterns:

- A solid green indicates that the link has been established.
- A master unit flashing approximately every two seconds indicates that the unit is unlocked.
- A slave unit flashing approximately every second indicates that the unit is unlocked.
- A slave unit flashing approximately every half second indicates that the unit currently locking/unlocking to/from the network.
- A unit flashing for one second and off for three seconds indicates that the firmware has been installed on an unsupported modem.

Red LED
This LED indicates that data received, and bootloader functions and has the following patterns:

- Flashes indicate an RF data packet received by the modem.
- Solid red indicates that the modem has entered bootloader mode.

5 Application Configuration

5.1 Point to point

This mode is designed to function similarly to the traditional RFD modem SiK firmware. Pairs of modems operate as a wireless serial link.

Point to point operations depend on the configuration of the key parameters:

- P2PAUTO
- SLOTIDS
- NODEID
- SLOTS

The total slot size of a network, in terms of bytes of data is related to the settings of the TOTALUS and BITRATE parameters. Slot BYTES~=TOTALUS*BITRATE/8000

Note that the practical throughput is approximately 85% of the theoretical maximum as represented by the BITRATE parameter.

Note: The radio will not allow settings that result in slots smaller than ~300bytes and not larger than ~1000 bytes.

Modem linking:
Can be configured for automatic or fixed master mode. In automatic master mode a modem will self-configure as a master node if it detects no other master modems on boot. As such the first modem to boot will generally take on the role of master in the network.

In automatic master mode both modems are configured by the following settings:

Setting	AT Command
P2PAUTO=1	ATS6=1
SLOTS=2	ATS8=2
SLOTIDS=2	ATS9=2
NODEID=1	ATS10=1

Fixed master mode is configured by the following settings:

Setting	AT Command
P2PAUTO=0	ATS6=0
SLOTS=2	ATS8=2
SLOTIDS=1	ATS9=1
NODEID=0	ATS10=0

Forcing it to always be the master.

In a fixed master node network, the second modem parameters should be set:

Setting	AT Command
P2PAUTO=0	ATS6=0
SLOTIDS=2	ATS9=2
NODEID=1	ATS10=1

Note: By default, the multifunction firmware is configured for point to point operation with automatic master mode **enabled** therefore radios will attempt link in this mode on boot.

5.2 Remote Control Signal Passthrough

Operates a remote control (RC) signal passthrough in addition to the wireless serial link of standard point to point operation.

RC operations depend on the configuration of the key parameters:

- PIN1TYPE
- PRI
- TOTALUS
- RCDEFS or AT&R (Failsafe modes only)

The RC signals supported include PPM and various SBUS formats.

- PPM
- SBUS:
  - SBUS 1 and 2 signal formats are supported
  - 2 digital channels
  - Modes for 10 or 18 total channels
- Failsafe and no failsafe stream modes
- Support for conversion of input type to different output type e.g. PPM input to SBUS output

Note: In no failsafe mode the output signal will cease valid input signals or lose the modem link.

To configure a node for RC signal input the following parameters should be set:

Setting	AT Command
TOTALUS=20000	ATS7=20000
PRI=3	ATS18=3
PINTYPE(15)=10 (PPM input), or 13 (SBUS input 10 total channels), or 14 (SBUS input 18 total channels)	ATS36=10 or 13 or 14

To configure a node for RC signal output the following parameters should be set:

Setting	AT Command
TOTALUS=20000	ATS7=20000
PINTYPE(15)=11 (PPM output), or 12 (PPM output no failsafe), or 15 (SBUS output), or 16 (SBUS output no failsafe)	ATS36=11 or 12 or 15 or 16

If using fail safe streams, please set the failsafe on the output modem by one of the following methods:

Setting	AT Command
RCDEFS=Channelms counts	**Example** ATS47=1500,1500,1500,1500,1500,1500,1500,1500,1000,1000,

comma separated	

- Ensure that both modems are on and linked
- Set the RC such that the desired failsafe signal is generated
- Issue the AT&R command to the output modem to record the current stream
- Verify the RCDEFS settings with the command ATI10:47
- Restart modem to enable the modified settings

Note: The final two channels of the RCDEFS parameter represent the digital channels of the SBUS outputs. Values of 1500 and above will set a high digital output. These last two channels are ignored if PPM output is set.

Note: The RC signal is sent to/from modem pin 15 with 3.3V logic level. Ensure that any connected devices are compatible with this signal level

Note: For proper operation of the RC signal modem ground also needs to be connected to the signal ground of any connected device. Pin 16 is the nearest ground pin on the modem header.

5.3 Listen Only Nodes

Listen only nodes can be added to networks with a fixed master configuration. The network settings need to match those of the network. Other parameters that should be set are the following:

Setting	AT Command
P2PAUTO=0	ATS6=0
SLOTIDS=2	ATS9=2
NODEID=1	ATS10=1
SLOTTXMODE=0	ATS19=0

5.4 Encryption

The firmware supports hardware accelerated AES encryption with key lengths of 128 or 256 bits. To send and receive valid data all nodes need to have the same encryption level and key. All payload data is encrypted including RC passthrough signals.

Note: Despite being a hardware accelerated process there can be some small latency associated with the encryption and decryption process.

The encryption key (K) should be a string of 32 comma separated values each with a maximum value of 255 and a final trailing comma. This represents the 256 bits of the maximum key length.

For example, the default key is:

6,61,235,16,21,202,113,190,43,115,174,240,133,125,119,129,31,53,44,7,59,97,8,215,45,152,16,163,9,20,223,244,

To enable encryption the following settings should be set:

Setting	AT Command
ENCRYPTLV=1 (128bit key), or 2 (256bit key)	ATS20=1 or 2
ENCRYPTKEY=K	ATS48=K

6 Useful Links

FTDI USB Drivers
https://ftdichip.com/drivers/

RFD Modem Firmware and documentation
https://rfdx.atlassian.net/wiki/spaces/TS/pages/452198432/RFD+x2+Family

RFD Store
https://store.rfdesign.com.au

MAVPROXY Documentation
https://ardupilot.org/mavproxy/

7 Glossary

Term	Description
AES	Advanced Encryption Standard. A data encryption protocol meeting the specifications established in the ISO/IEC 18033-3 standard.
Baud	Unit of measurement of symbol rate. This is an indication of data transfer speed of serial connections
FTDI	Future Technology Devices International, a supplier of electronic components synonymous with their UART to USB converter chips and the cables which use such components.
GPIO	General Purpose Input Output. A microcontroller pin that can be configured for various input and output functions
MAVLink	Micro Air Vehicle Link. A protocol for telemetry data exchange between compatible ground control software and autonomous vehicle controllers.
PPM	Pulse Position Modulation. This is an encoding standard used by radio controller to send data about the position of multiple servo motors.
RC	Remote Control. Wireless control of vehicles using protocols such as PPM and SBUS
RFD	RF Design. The Australian company who designed, build and support the x series modems among other products.
RX	Receive/Receiver of data transfer from an external source.
SAS	A data protocol. This provides an alternative for users not sending MAV data.
SBUS	Serial Bus protocol created by Futaba. This is an encoding standard used by radio controller to send data about the position of multiple servo motors.
SiK	
Serial	A protocol for sending and receiving data in a sequential manner.
TX	Transmit/Transmitter of data to a receiver.
UART	Universal Asychronous Receiver Transmitter. Hardware implementation of a serial data protocol.
USB	Universal Serial Bus. Hardware implementation of a serial data protocol commonly found on PCs and electronic devices. Physical ports can differ based on various type standards such as Type A and Type C.
Logic Level	The voltage level of digital logic signals.
GND (Ground)	The reference level for defining voltages of a circuit or system. May also be called 0 volts.
Latency	The time delay between signal input and output.
Failsafe	A defined signal or behaviour to indicate loss of direct control.

8 Revision History

Version	Date	Changes
1.0	18/10/24	BETA Initial Release Document