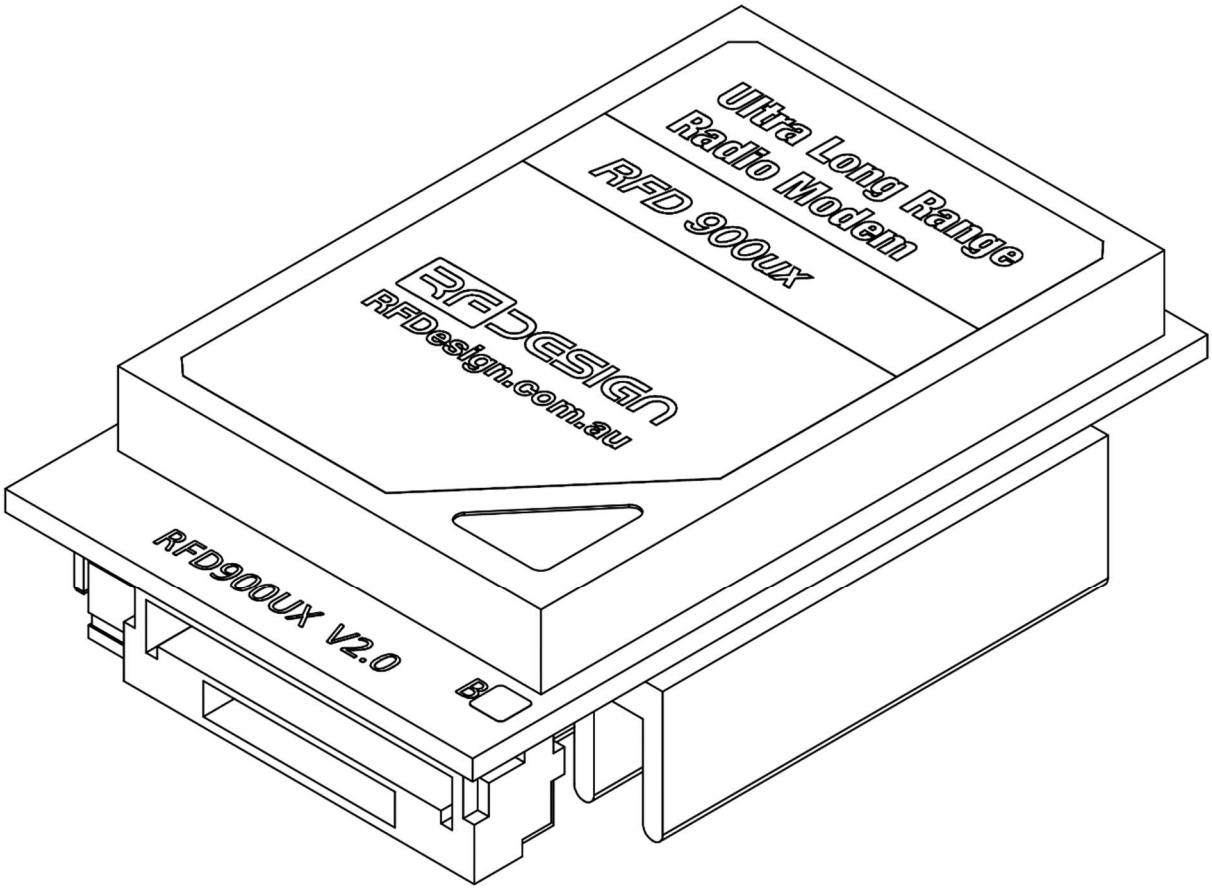
RFD ux Series Radio Data Modem
Technical Datasheet



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1 Key Features

- Supplied ready to use in point to point communication.
- Outdoor RF line-of-site range of 40km or more depending on configuration and antennas.
- MAVLink data packet support.
- Air data rate speeds of up to 224 kbits/s.
- Support for PPM and SBUS remote control signal pass through (SiK firmware only).
- Hardware accelerated AES encryption with up to 256 bit keys.
- Two antenna ports with automatic diversity.
- Operating temperature range of -40 to +85 degrees Celsius.
- Automatic thermal throttling.
- Dimensions of 21 x 33 x 10.65mm (21 x 29 x 4.2mm ux-SMT).
- Weight of 8g (3.5g ux-SMT).

2 Overview

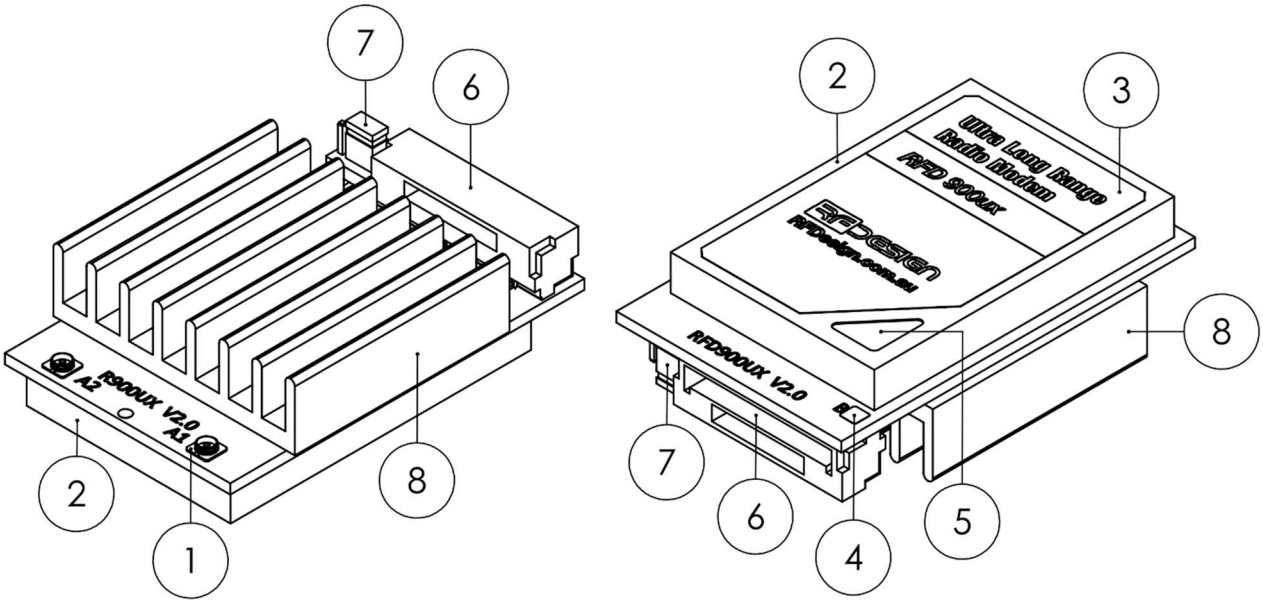

Figure 1: ux series modem feature diagram

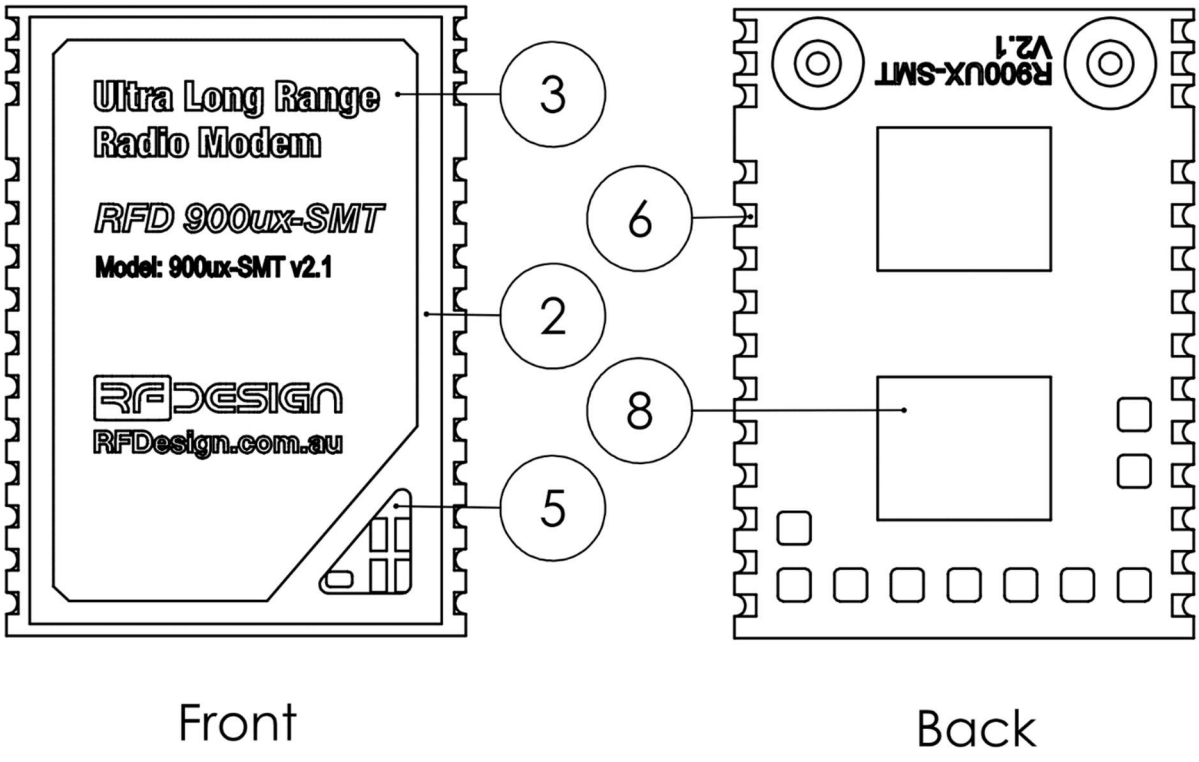

Figure 2: ux series -SMT modem feature diagram

Diagram Feature	Part
1	RF connectors 50ohm male U.FL (castellated pads on SMT variant)
2	RF shield
3	Label
4	Bootloader pad (castellated pad on SMT models)
5	Indicator LED window
6	10 pin JST GH series Socket (castellated pads on SMT variant)
7	Power supply selection jumper (not on SMT variant)
8	Heatsink (through ground pads SMT variant)

2.1 RF Connectors:

The RFD ux series modems are fitted with two with 50 Ohm male U.FL connectors. These are designed to provide compact connection to compatible antennas or RF coaxial extension leads.

Note these connectors are not fitted on SMT variants.

Note that the mechanical strength of these ports is limited and that hanging excessively large antennas from these ports or subjecting them to repeated mechanical/vibrational stresses can damage the ports, solder joints and PCB of the modem.

2.2 RF Shield:

This metal shield is connected to the modem ground rail. It ensures the modems comply with radiated electromagnetic energy and interference requirements under the various certifications, it also provides protection to the main electronic components from physical damage.

Note the shield is made of a thin gauge of metal and can support limited mechanical strain before deformation. Be careful not to bend or depress the lid excessively as it could contact and electrically short circuit the underlying electronic components causing damage.

2.3 Label:

This label indicates the model of modem including, where applicable, the country code designation.

2.4 Bootloader Pad:

This pad can be connected to ground during power up to force the modem to start in bootloader mode.

2.5 Indicator LED Window:

A window to the green and red LEDs mounted under the RF shield. These LEDs provide information on behaviour of the modems. The exact functions are dependent on the firmware that is loaded.

2.6 10 Pin JST Socket:

The main connection to the modem used to supply power, serial and various I/O functions depending on the firmware that is loaded. Compatible with 10 pin JST locking connectors.

Note this connector is not fitted to SMT variants.

2.7 Power supply jumper:

A three pin 0.05” or 1.27mm pitch header is installed to select between two different power supply options. When fitted between pins 1 and 2 of the power select header this connects the power supplied on pin 2 of the JST socket to the modem’s regulator. When connected to pins 2 and 3 this connects the power supplied on pin 5 of the JST socket to the modem’s regulator.

Note this connector is not fitted to SMT variants.

2.8 Heatsink:

This provides cooling to keep the modem within its operating temperatures. The cooling requirement will vary depending on the RF output power settings and the firmware that is loaded. It is possible for this to become hot during extended operation especially when used in limited airflow conditions.

Note this is not fitted to SMT variants. SMT module ground pads should be soldered to the ground plane of the associated PCB to provide thermal dissipation for the module. See later sections for PCB layout guidance.

3 Hardware and Regional Versions

3.1 Hardware Versions:

The ux series modems currently have two major hardware revisions these can be identified by the text on the PCB between the antenna ports, see figure above. This will read V1.# for V1 type hardware and V2.# V2 type hardware. Where # can be any number and is indicative of a minor revision.

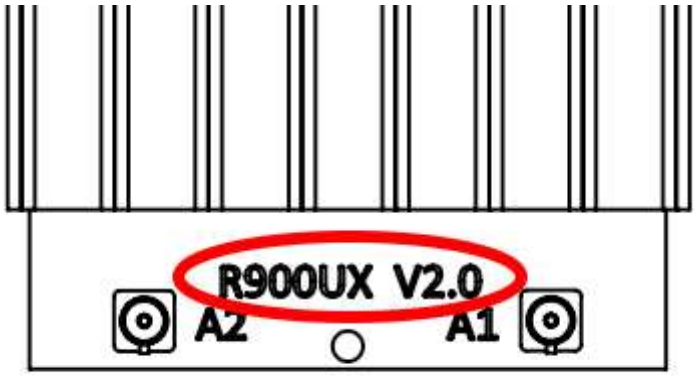

Figure 3: ux series modem hardware version label

Note the different hardware versions are generally compatible with each other with the exception of networks using the asynchronous firmware.

Hardware compatiblity
Peer to Peer (SiK)
and Multipoint

Modem	X (V1)	uX(V1)	X (V2)	uX(V2)
X (V1)				
uX(V1)				
X (V2)				
uX(V2)				

Hardware compatiblity
Ascynchronous

Modem	X (V1)	uX(V1)	X (V2)	uX(V2)
X (V1)				
uX(V1)				
X (V2)				
uX(V2)				

Figure 4: Hardware revision compatibility for different firmware types

3.2 SMT modem:

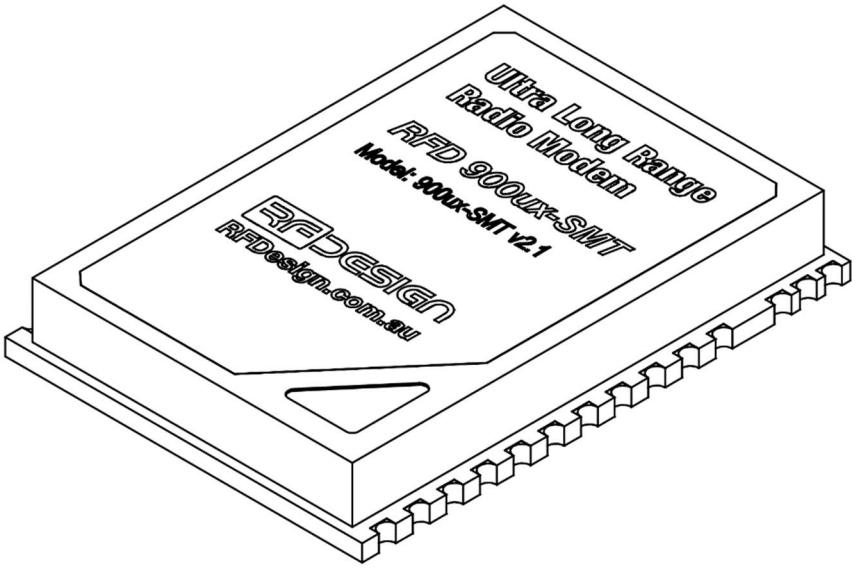

Figure 5: ux-SMT modem variant

For customers seeking to integrate the RFD ux series modems into custom electronics and hardware systems the modems can be supplied in a SMT configuration. This does not have the U.FL connectors, JST pin socket or heatsink fitted. It has a series of castellated pads around the circumference and two large ground pads underneath the module. These provide solderable connections for the RF, supply, and I/O pins. See pinout and physical dimensions sections for more details regarding the connections of the SMT variant.

3.3 Regional Version:

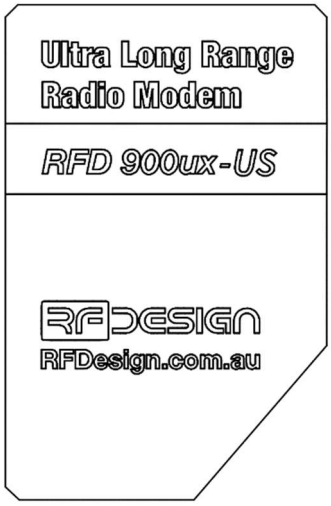

Figure 6: 900ux-US variant label

Modems that feature a product code with a dash and letter code, e.g. RFD900ux-US, are region locked variants. The letters after the dash indicating the region to which that modem is locked.

These codes are:

- AU: Restricted settings and compliance for Australia
- EU: Restricted settings and compliance for European Union
- IND: Restricted settings and compliance for India
- NZ: Restricted settings and compliance for New Zealand
- US: Restricted settings and compliance for United States of America and Canada

Note that not all country complaint variants are available for all models.

Regional variants may satisfy regulations in other areas, for instance the US modem may also suite the regulation in Canada.

Ultimately it is up to the user to identify the radio frequency regulations applicable to their areas of operation and ensure their modems parameters are set correctly.

Modems without these codes are fully user configurable.

3.4 Compliance and Acceptance:

The RFD 900x modems and variants are designed and may be tested for conformity to:

- AS4268:2012
- NZ GURL 2017
- FCC 15.247
- RSS-247 Issue2

The RFD 868x modems and variants are designed and may be tested for conformity to:

- Directive 2014/53/EU on radio equipment
- EN300220
- EN301489
- IEC 62368-1:2014
- EN62311

Equipment type approval of the 865-867MHz band in India

Only the region locked versions of the modems are represented to be compliant in their respective regions.

3.5 Compatibility:

Compatiblity is only guaranteed and tested between modems operating the same firmware version. Backward and forward compatiblity of firmware is not assured.

Asynchronous firmware will not interoperate between V1 and V2 hardware. All other firmware types will interoperate between V1 and V2 hardware provided that firmware version match.

The following table shows modems which can be configured to interoperate with each other.

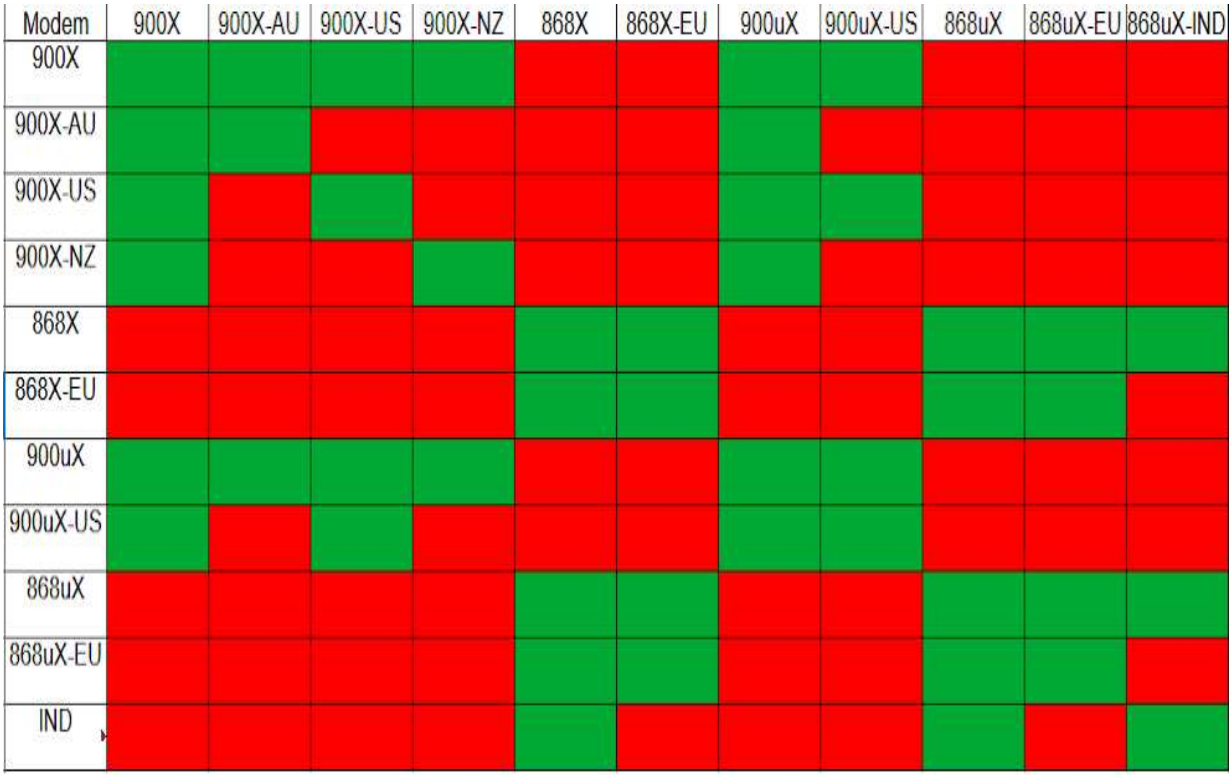

Figure 7: Modem interoperability configurability table.

Interoperable configuration does not convey regional compliance for an unlocked modem.

3.6 Firmware:

Due to bandwidth constraints some versions of the RFD ux series modems are not endorsed for use with some firmware types.

Note the Multipoint (MP) and Asynchronous firmware may be unsuitable for or have limited functionality on 868x/ux and region locked versions thereof.

4 Firmware Support

There are currently three firmware types developed by RF Design.

4.1 SiK (Point to point)

- Factory default firmware.
- MAV telemetry data support.
- PPM or SBUS signals remote control pass through.
- Hardware accelerated AES encryption.

This firmware is the standard for RFD modems. It is installed on all new modems and configured for ready use as a MAV telemetry link out of the box. The SiK firmware user manual covers the various settings and uses of this firmware.

4.2 Multipoint Mesh (MP)

A firmware designed for mesh networks of modems.

- Coordinated transmission to minimises interference and collision and maximises data throughput.
- Support for MAV telemetry and SAS binary data.
- Support for up to approximately 20 nodes. Depending on the available frequency bandwidth and airspeed.
- Hardware accelerated AES encryption.

This firmware is best suited to systems that require regular data transmission and do not have independent transmission coordination such as operating multiple unmanned vehicles simultaneously. The Multipoint firmware user manual covers the various settings and uses of this firmware.

Note that due to bandwidth limitations the Multipoint (MP) firmware is not considered suitable for 868x/ux and region locked versions thereof.

4.3 Asynchronous Mesh (Async)

A firmware designed for mesh networks of modems. There is no transmission coordination or synchronisation of the network.

- Modems will attempt to transmit data as soon as they receive anything from the serial port if an RF channel is free.
- Random back off time to minimise the chance of data collision.
- Optional retries can be used to maximise data integrity.
- Hardware accelerated AES encryption.
- Support for high node counts.

This firmware has a greater maximum number of nodes and no requirement for all nodes to be in range of a master, but generally has lower throughput. It is best suited to systems with independent coordination or low data polling rates and tolerance to data loss/errors, e.g. remotely deployed temperature sensor that reports every ten minutes. The Asynchronous firmware user manual covers the various settings and uses of this firmware.

Note regionally locked version of the modems may restrict or limit the performance and available parameter settings compared to the unlocked modems. Please refer to the appropriate firmware manuals for more details on the configuration and performance.

5 Bootloader

All RFD x series modems have a bootloader that manages the loading of firmware to the modem. This can be entered by:
The AT&UPDATE command from within the firmware command mode.
Or
By using a conductor such as a pin or straightened paperclip to connect the bootloader pad to a ground pin or the metal of the shield while powering up the modem, by for instance sliding the power supply select jumper or the main JST connector into place.

> Note that each bootloader and AT command alike need to be followed by an enter press or other method of sending a newline delimiter (\n).

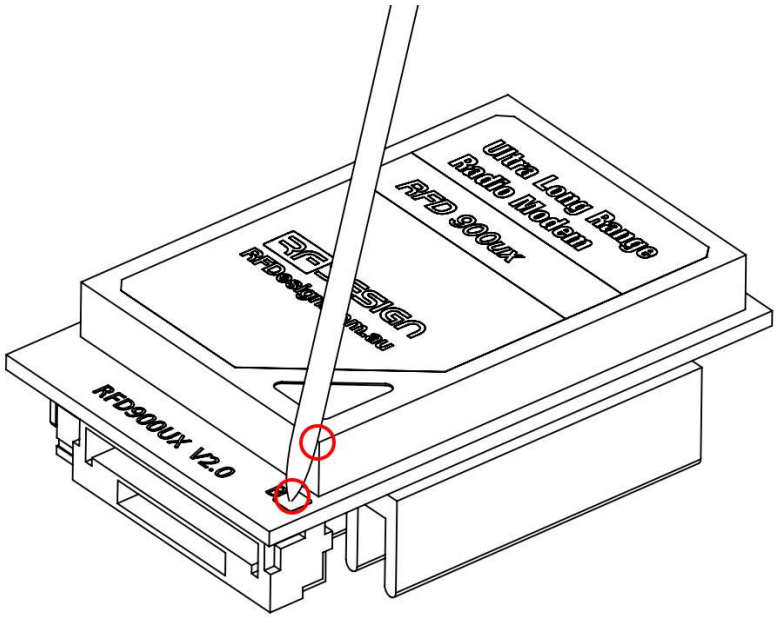

Figure 8: Pin making contact with bootloader pad and RF shield to force bootloader mode

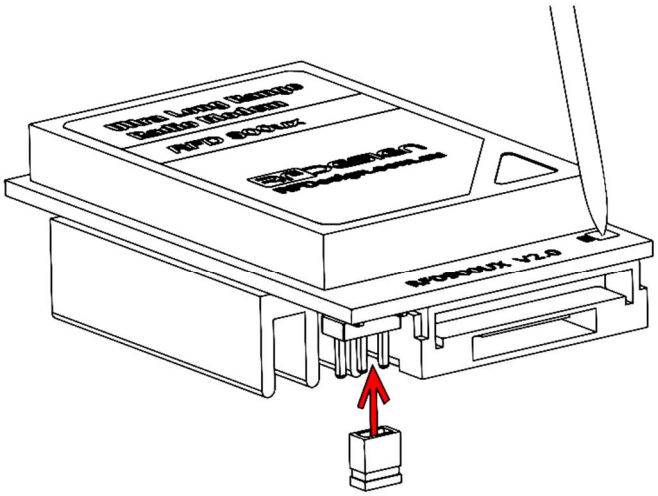

Figure 9: Pin making contact with bootloader pad and RF shield while connecting power supply select jumper

The modem signals that it is in bootloader mode by a solid red LED.

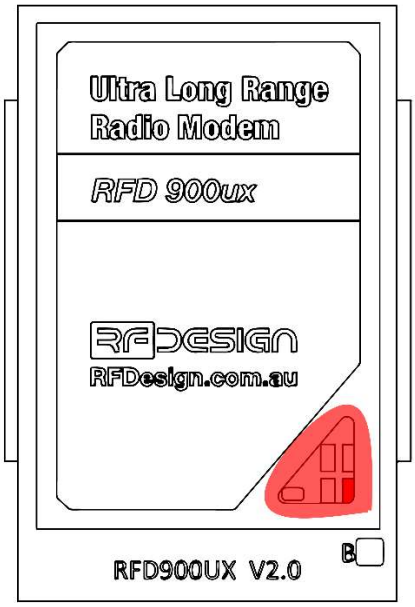

Figure 10: Solid red LED indicating modem in bootloader mode

When entering bootloader mode the serial port will print a string with the modem model, bootloader version and ChipID.
The serial port will be configured to the following defaults.

- 57600 Baud
- No parity bit
- 8 Data bits
- 1 Stop bit
- RTS/CTS flow control OFF

The bootloader has commands for performing basic functions which are as follows:

BAUDHI This command switches the baud rate of the bootloader to 1200000. The modem will reply with and 'OK' to indicate the command has been accepted.

Note this command is not available for some older modems that have an earlier version of the bootloader.

BAUDLO This command switches the baud rate of the bootloader to 57600. The modem will reply with and 'OK' to indicate the command has been accepted.

Note this command is not available for some older modems that have an earlier version of the bootloader.

BOOTNEW This command reboots the modem to the loaded firmware. The modem will reply with and 'OK' to indicate the command has been accepted.

UPLOAD This command tells the modem to expect XMODEM formatted firmware data to install on the modem. The modem will reply with 'Ready' and begin to periodically print 'C' as it waits for data. It will timeout if no data is received within about a minute.

6 Loading firmware

Compatible firmware can be loaded on to the modems by means of:

- The RFD modem tools software.
- MissionPlanner software.

6.1 Programming with RFD modem tools

Requires the user to connect the modem to the PC by means of the FTDI cable. Then you can open the tools programme configure the serial port settings and connect to your modem.

Figure 11: RFD Tools COM port connection

Once connected to the tools select the upload firmware button. This will open a dialogue asking you to select the desired firmware. If you cannot select or upload a file to your modem check that the correct version for your hardware.

Note that the V1 and V2 modems use different firmware packages, the RFD tools will block you from loading the incorrect version.

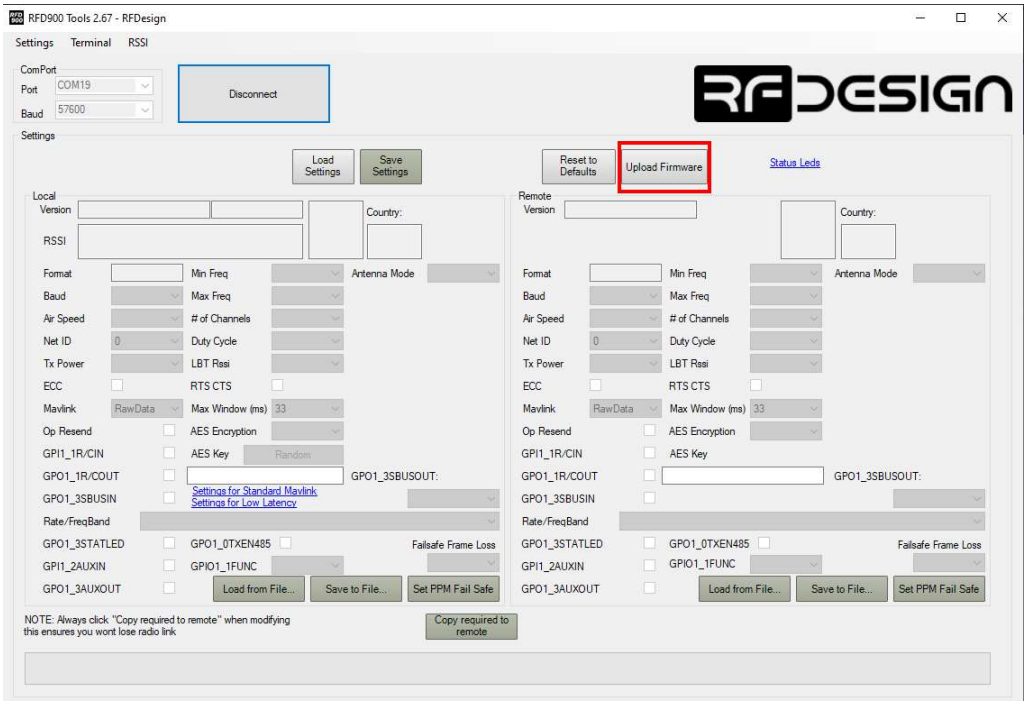

Figure 12: RFD Tools Upload Firmware button

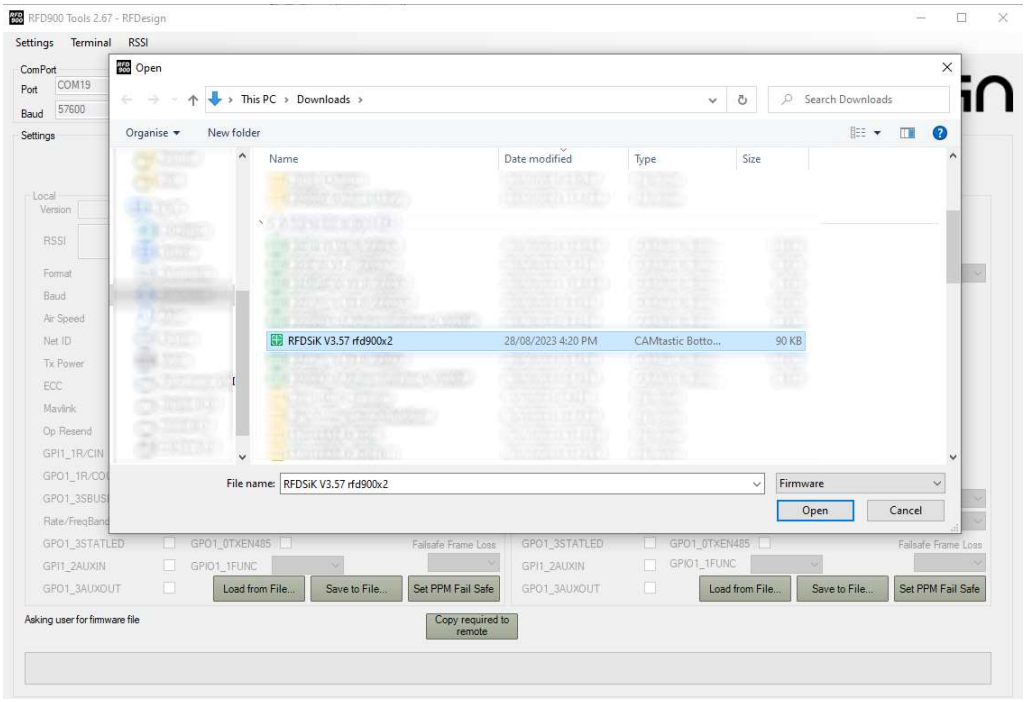

Figure 13: Firmware file selection dialogue box

Once a file has been selected press open and the tools will begin to programme the modem with the firmware. Progress is indicated by the filling green progress bar at the bottom of the screen.

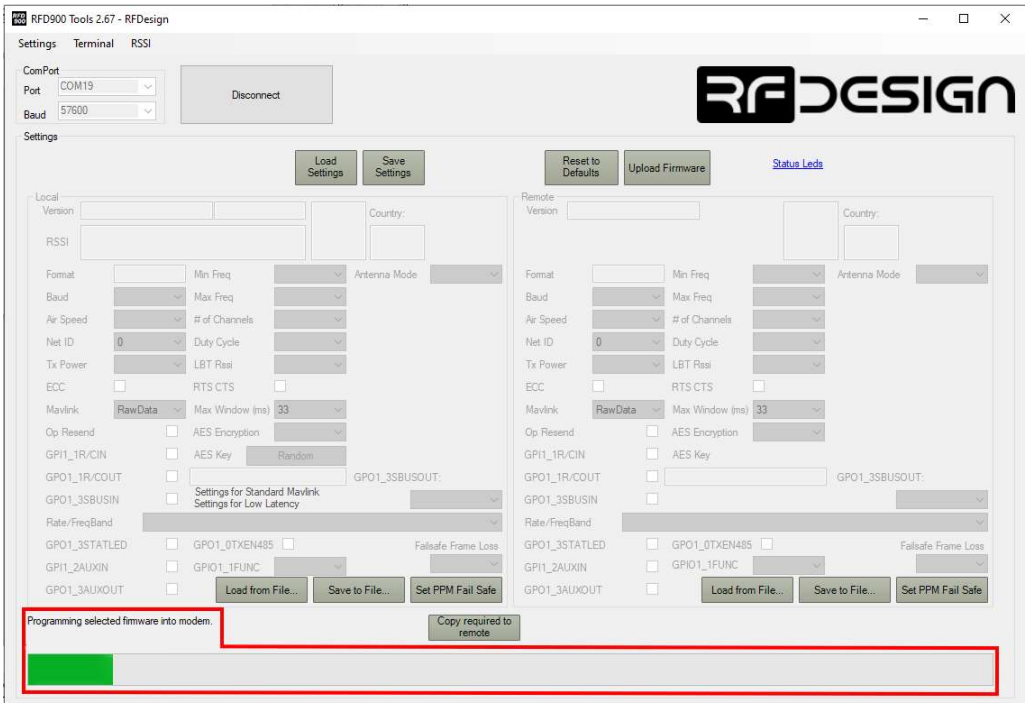

Figure 14: Programming progress bar of the RFD Tools

7 Pinout

7.1 ux series modem

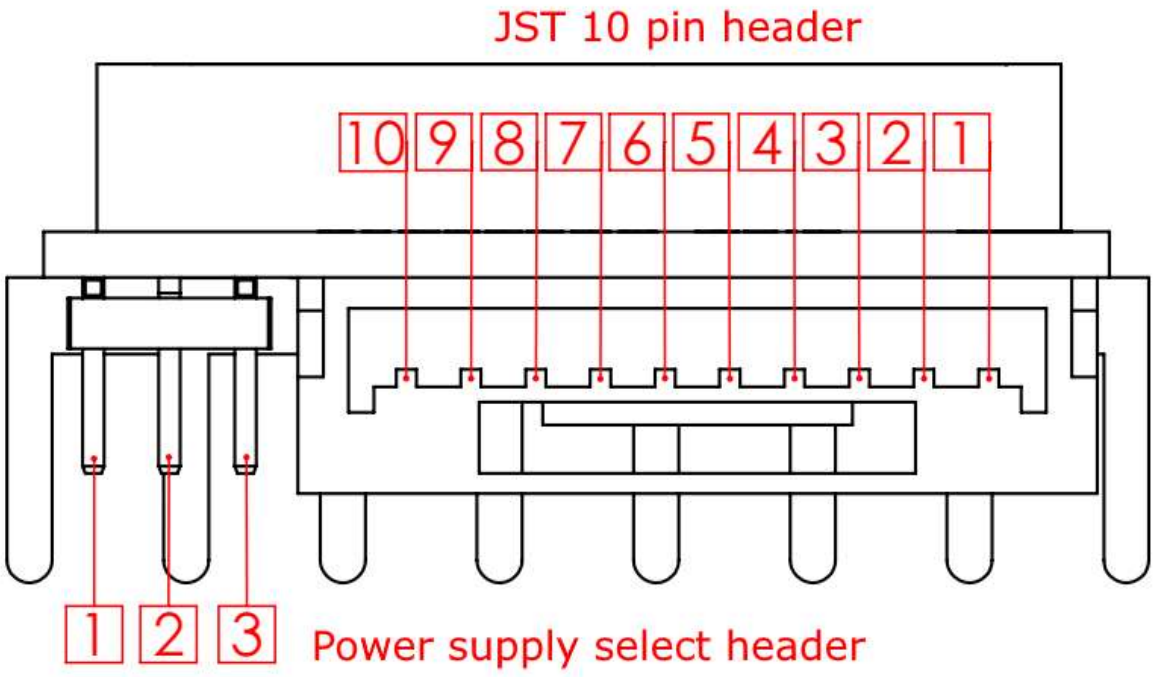

Figure 15: ux series modem pinout

7.2 JST Header

Pin #	Name	Direction	Description	Max. Voltage
1	GND	-	Ground	0V
2	V_External	Input	Positive 5V supply voltage from external source	5.5V
3	GND	-	Ground	3.3V
4	GPIO1	I/O	Digital I/O, PPM I/O, SBUS I/O	3.3V
5	V_Standard	Input	Positive 5V supply voltage from USB	5.5V
6	RX	Input	UART Data Receive	3.3V
7	TX	Output	UART Data Send	3.3V
8	CTS	Input	UART Clear to Send signal	3.3V
9	RTS	Output	UART Ready to Send signal	3.3V
10	GND	-	Ground	0V

7.3 Power Select Header

Pin #	Name	Direction	Description	Max. Voltage
1	V_External	Input	Positive 5V supply voltage from external pins	5.5V
2	V_Supply	Input	Positive 5V supply voltage to modem regulator	5.5V
3	V_Standard	Input	Positive 5V supply voltage from USB	5.5V

7.4 ux-SMT modem

Figure 16: ux-SMT modem pinout

Pin #	Name	Direction	Description	Max Voltage
1	VUSB	Input	5V Power supply from USB	5.5V
2	USB_DM	Input	USB Data - [1]	3.3V
3	USB_DP	Input	USB Data + [1]	3.3V
4	Bootloader	Input	Bootloader mode trigger	3.3V
5	GPIO5	I/O	Digital I/O	3.3V
6	GPIO4	I/O	Digital I/O	3.3V
7	GPIO6	I/O	Digital I/O	3.3V
8	GND	—	Ground	0V
9	GND	—	Ground	0V
10	+3V3	Output	3.3V LDO output	3.3V

Pin #	Name	Direction	Description	Max Voltage
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	—	5V Power Supply	5.5V
20	GND	—	Ground	0V
21	GPIO0	I/O	Digital I/O	3.3V
22	GPIO1	I/O	Digital I/O, PPM I/O, SBUS I/O	3.3V
23	GPIO2	I/O	Digital I/O	3.3V
24	GPIO3	I/O	Digital I/O	3.3V
25	RX	Input	UART Data Receive	3.3V
26	TX	Output	UART Data Transmit	3.3V
27	RTS	Output	UART Request to Send signal	3.3V
28	CTS	Input	UART Clear to Send signal	3.3V

1. Feature not currently supported in any firmware versions

7.5 GPIO Functions:

- GPIO pins may be configured as input or output.
- GPIO pins default to inputs.
- When configured as an output they can sink or source approximately 5 mA each.
- Please refer to the appropriate firmware manual for specific information.

Note that the function/s of each pin may vary depending on the firmware in use.

ux series modem

GPIO #	Possible functions (SiK firmware)
1	Digital I/O pin mirror, PPM/SBUS I/O

ux-SMT modem

GPIO #	Possible functions (SiK firmware)
0	Digital I/O pin mirror
1	Digital I/O pin mirror, PPM/SBUS I/O

2	Digital I/O pin mirror
3	Digital I/O pin mirror, Link status
4	Digital I/O pin mirror
5	Digital I/O pin mirror

7.6 Serial connection:

Note the RFD x series modems support 3.3 volt logic UART connections, higher voltage serial levels risk damaging the pins of the microcontroller. Where different voltage levels are used a level converter should be used to ensure correct operation.

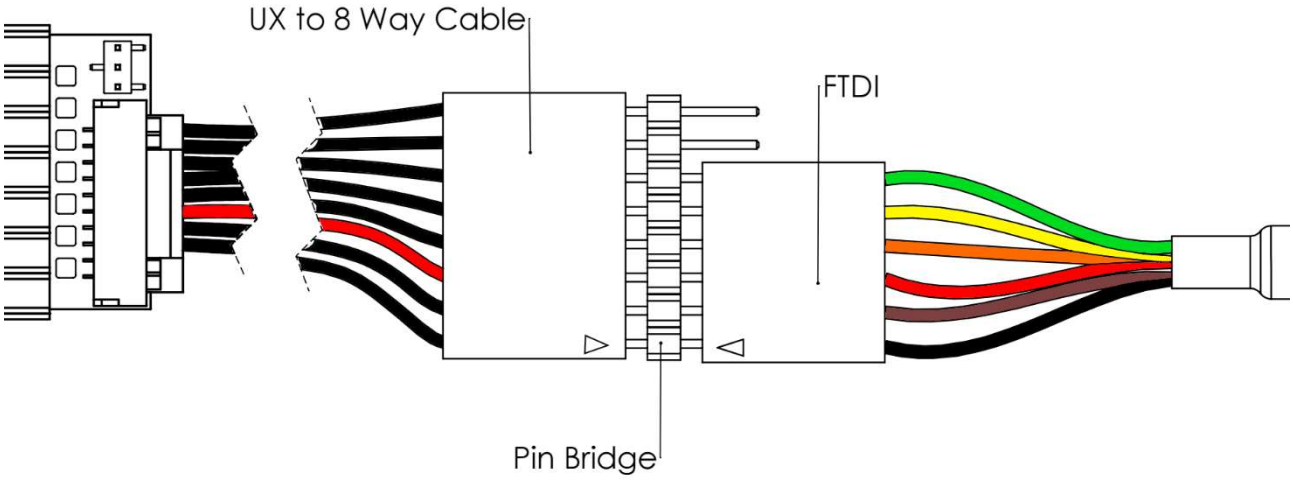

Figure 17: ux series modem connected to 8 way sockect adaptor and FTDI cable

The pin arrangement of the ux to 8way socket cable is designed to be compatible with FTDI cables such as those supplied by RFD on our web store. An FTDI cable by means of pin bridge to the socket of the modem adaptor cable can be connected pin one, as denoted by the arrow marker on the connector, corresponding with modem adapter pin 1.

The RFD x series has support for hardware flow control by use of the RTS and CTS pins.
Default configuration of the modem's serial port with factory SiK firmware is:

- 57600 Baud
- No parity bit
- 8 Data bits
- 1 Stop bit

RTS/CTS flow control OFF

7.7 Remote control signal:

The SiK firmware, loaded on the RFD ux series modems by default, can configure pin 4 (GPIO1) as either an input or output for Remote control signals in PPM or SBUS1/2 formats. The modem can also convert the input format to a different format on the output.
Please see the SiK manual for the details of the supported formats and configurations.

7.8 Cables and Harnesses:

An outline of some cables that support the integration for the RFD X series modems in various applications.

FTDI This cable acts as an interface between the 3.3V serial interface RFD x series modem and a PC or other similar system such as a Single Board Computer (SBC) via a USB port. RFD provides two options for such cables with either a USB type A connector or USB type C connector. When connecting to the FTDI cable should create a virtual COM port. If this port is not correctly established, there may be a requirement for the installation of an appropriate driver from FTDI.

Note the ux series modem requires a breakout cable to adapt the FTDI DuPont connector to the JST connector of the modem.

Figure 18: USB type A connector FTDI cable

RFD900ux multi cable This cable offers a is available in 150mm and 300mm lengths. It breaks out the 10 pin header to three sperate connectors including:
A JST GH series connector suitable for the TELEM port of the Pixhawk Cube standard carrier board.
A two pin, 0.1” (2.54mm) pitch, DuPont style socket for connecting to external power supply.
A three pin, 0.1” (2.54mm) pitch, DuPont style socket for connecting to RC signal.

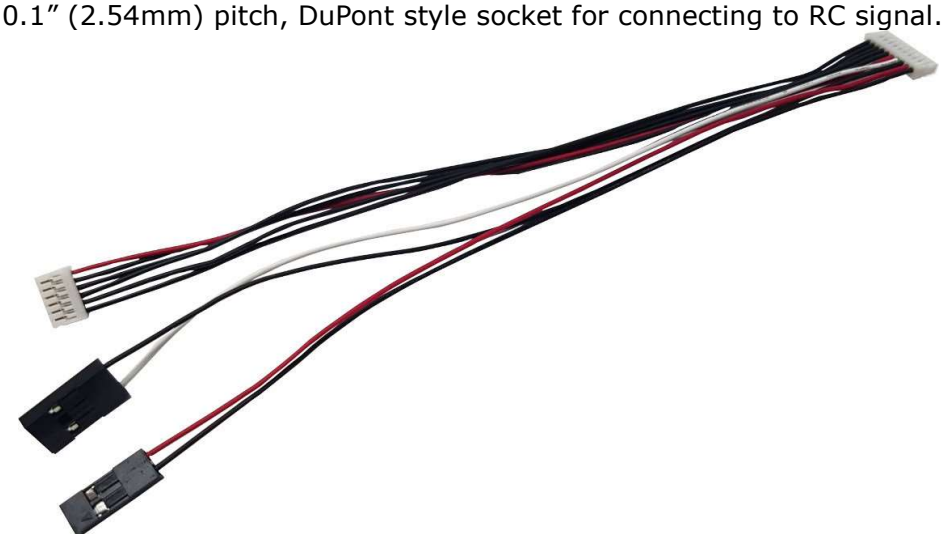

Figure 19: RFD900ux Multi Cable

ux to 8 way socket cable A JST GH series 10 pin connector suitable for the ux series modems connecting pins 3-10 to an 8 pin DuPont socket connector. This cable can be used with a pin adaptor to connect the FTDI cable to the ux modem.

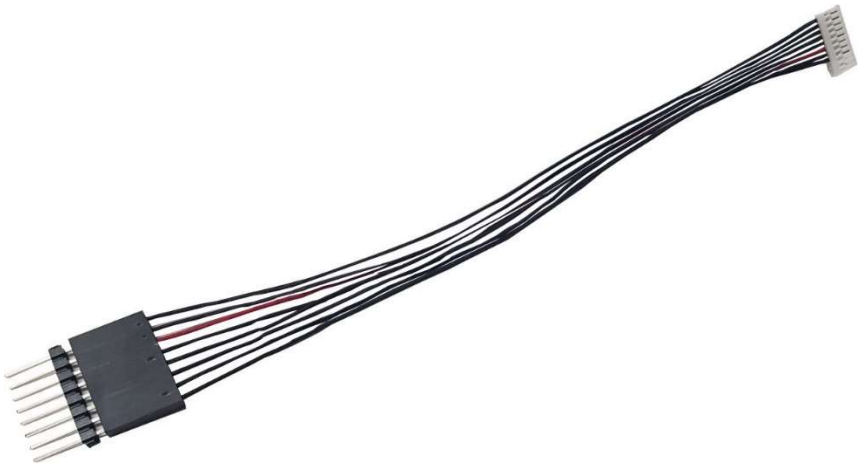

Figure 20: ux to 8 way socket cable

8 Antennas:

The RFD x series modems are designed for 50 Ohm impedance RF connections.
All versions of the ux series modems except the SMT modem are fitted with U.FL connectors on both antenna ports.
Operating without any antennas fitted will not damage the ux series modem RF systems.
Only a single antenna is required for long range operation.
Different antenna modes available including:

- Automatic diversity. (Default for SiK firmware.)
- Single port. (Antenna port 1 or 2 depending on parameter setting)
- Dedicated TX and RX ports.

Settings will vary depending on the firmware installed.

Note antenna diversity can significantly improve performance when orientation of the antennas is variable, e.g. on manoeuvring aircraft.

Note antenna performance can be compromised by mounting against or surrounded by metal or carbon fibre.

8.1 Compatible RFD Antennas:

All antennas supplied by RF Design for use with the x series modems are suitable for both the 900 and 868 MHz bands.

Flex 1 An antenna built on a flexible substrate with an adhesive backing. The antenna performance is optimised for mounting to fibreglass and foam structures. It has a radiation pattern like that of the dipole antenna and a gain of approximately 2.7 dBi. The antenna is polarised along the length of the antenna. It is available with a coaxial cable of 300mm with a male RPSMA connector. It can also be supplied without a cable.

Figure 21: RFD Flex1 antenna with 300mm cable

Flex 2 An antenna built on a flexible substrate with an adhesive backing. The antenna performance is optimised for mounting to fibreglass and foam structures. It has a radiation pattern like that of the dipole antenna and a gain of approximately 2.4 dBi. The antenna is

polarised along the width of the antenna. It is available with a coaxial cable of 300mm with a female U.FL connector. It can also be supplied without a cable.

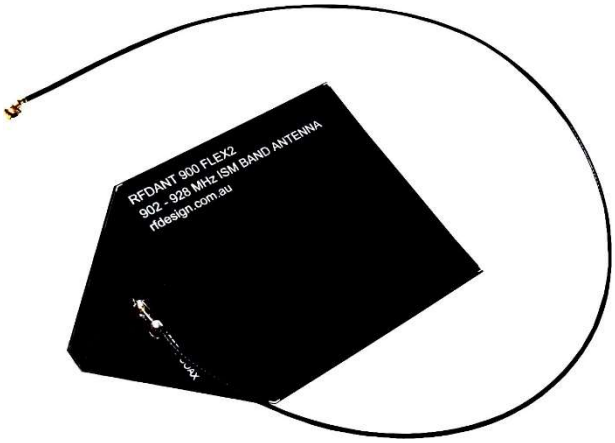

Figure 22: RFD Flex2 antenna with 300mm cable

UFL to RPSMA adapter cable used to interface the RFD ux series modems connectors to the standard RPSMA antennas.

Figure 23: U.FL to RPSMA cable

2dBi Monopole A quarter wave monopole antenna with a male RPSMA connector. Available in a right angle and straight configuration. For optimal performance it should mounted above a suitably sized ground plane.

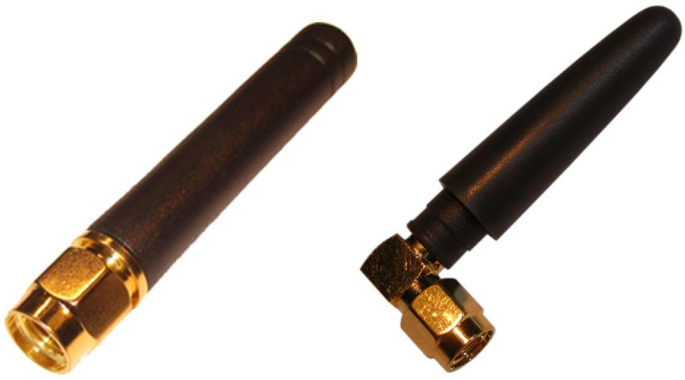

Figure 24: Straight and right angle monopole antennas

3dBi Dipole A half wave dipole antenna with a male RPSMA connector. It has a flexible joint at the base that allows for right angle mounting if required.

Figure 25: Dipole antenna

High Gain Dipoles Dipole antennas available with gains of 5dBi and 8dBi with a male RPSMA connector or N-type connector with adaptor.

Figure 26: 5dBi dipole antenna

6dBi Yagi A Yagi type directional antenna with a peak gain of 6dBi. Has an N-Type connector and is supplied with an adaptor to suit the RFD x series modems.

Figure 27: Yagi antenna

9 Electrical Characteristics

Parameter	Minimum	Typical	Maximum
Operating temperature	-45°C	—	+85°C
Supply Voltage	+5V	+5V	+5.5V (Continuous) +6V(Absolute)
Supply Current (30dBm transmit)	—	—	1A
Receive/Standby Current	—	60mA	—
Voltage on I/O pin (Ref. to GND)	-0.3	—	+3.6V
Input Voltage Low	—	—	+1V
Input Voltage High	+2.3V	—	—
Output Voltage Low (sink 5mA)	—	—	+0.7V
Output Voltage High (source 5mA)	+2.5V	—	—
DC current on I/O pin	—	—	5mA
I/O pull up/down resistance	—	40 kOhm	—
SBUS/SBUS2 channels	—	—	18Ch
PPM channels	2Ch	—	16Ch
PPM Frame Length	—	—	36ms
Channel levels	1000 counts (1ms)	—	2000 counts (2ms)
RF output power	+0 dBm	—	+30 dBm
RF input power	—	—	+5 dBm
RF port impedance (RP-SMA)	—	50 Ohm	—
RF connector torque (RP-SMA)	0.3 Nm	0.5 Nm	0.5 Nm
RF connector rated number of connections (RP-SMA)	—	—	30

10 Performance Characteristics

<table>
<tr><th>Feature</th><th colspan="3">Implementation or Performance</th></tr>
<tr><td>RF Data Rates</td><td colspan="3">12, 56, 64, 100, 125, 200, 224 kbits/sec</td></tr>
<tr><td>Obstructed Line of Sight Range</td><td colspan="3">0.5 – 1 km (depending on antennas, and settings)</td></tr>
<tr><td>Line of Sight Range</td><td colspan="3">40+km (depending on antennas, and settings)</td></tr>
<tr><td>Serial Interface Data Rate</td><td colspan="3">2400, 4800, 9600, 19200, 38400, 57600, 115200, 230400, 460800 and 1200000 baud</td></tr>
<tr><td>Modulation</td><td colspan="3">2GFSK/4GFSK (dependent on air data rate)</td></tr>
<tr><td rowspan="8">Interference Mitigation</td><td colspan="3">Frequency Hopping Spread Spectrum, FHSS, (except RFD868X-EU)</td></tr>
<tr><td>Modem Variant</td><td>Frequency Band/s</td><td>Number of Channels</td></tr>
<tr><td>RFD900X Unlocked</td><td>902 – 928 MHz</td><td>User settable (51 Max)</td></tr>
<tr><td>RFD900X-AU locked</td><td>915 – 921MHz and
922 – 928MHz</td><td>23</td></tr>
<tr><td>RFD900X-NZ locked</td><td>920.75 – 927.25 MHz</td><td>25</td></tr>
<tr><td>RFD900X-US locked</td><td>902 – 915MHz and
915 – 928MHz</td><td>51</td></tr>
<tr><td>RFD868X Unlocked</td><td>865 – 868 MHz</td><td>User settable (7 Max)</td></tr>
<tr><td>RFD868X-EU locked</td><td>869.525MHz and 869.85MHz</td><td>1</td></tr>
</table>

Receiver sensitivity	**Air data rate**	**Sensitivity @ 10-5 BER**
	12 kbits/s	-99 dBm
	56 kbits/s	-99 dBm
	64 kbits/s	-98 dBm
	100 kbits/s	-86 dBm
	125 kbits/s	-98 dBm
	188 kbits/s	-94 dBm
	200 kbits/s	-93 dBm
	224 kbits/s	-90 dBm
Encryption	Hardware accelerated advanced encryption standard, AES, up to 256-bit user settable key	
Error detection	Cyclic redundancy check, CRC	

10.1 Power Supply

Supply voltage fluctuations can cause the modem RF output power to deviate from calibrated levels. Many flight controller telemetry ports are not rated for sufficient current to supply the ux series modems, in such cases a separate supply should be used. This is done by moving the jumper from pins 3 and 2 of the power supply select header to pins 1 and 2 and connecting the external supply ground to the JST connector pin 1 and the positive voltage to pin 2.

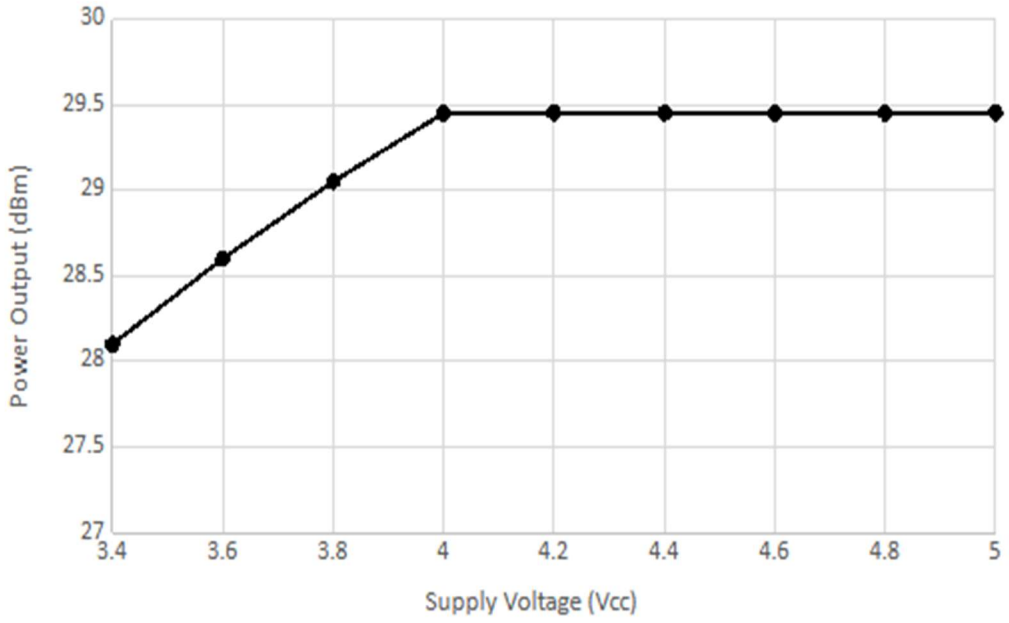

Figure 28: RF output power variation verse input voltage

It should be noted that long power cables, particularly made of thin gauge wire, can cause voltage drop particularly during high current draw. This voltage drop can negatively affect the modem output power and in extreme cases cause brown out events and resets.

Supply current requirement varies with the RF output power setting. It is important that the modem be connected to a supply capable of maintaining 5V under load. A minimum of 1A supply current limit is recommended when operating the modem at 30dBm transmit power.

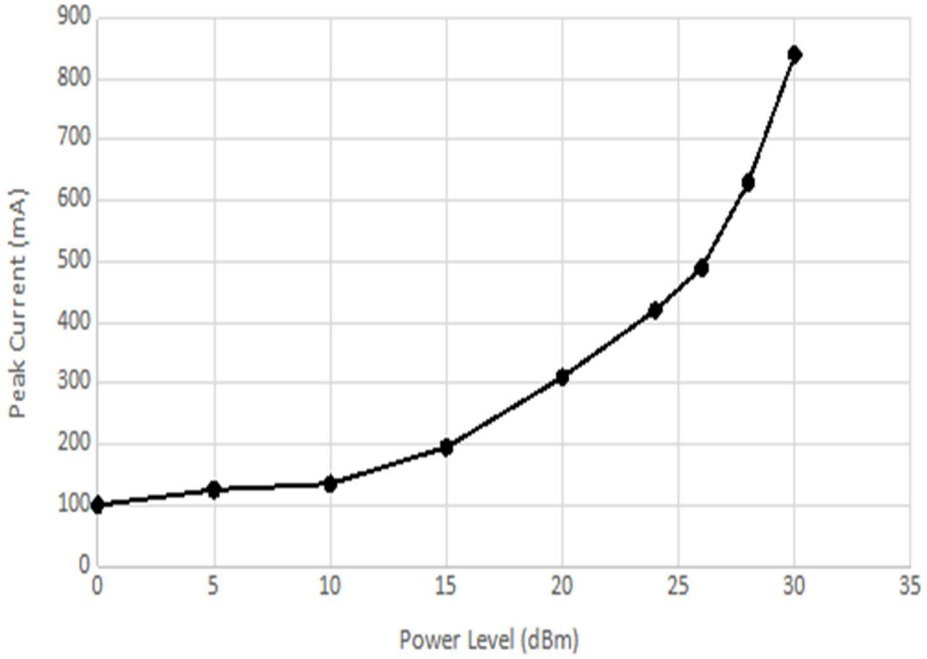

Figure 29: Current draw from 5V supply verses RF transmit power level

10.2 Thermal Management

RFD ux series modems, except for SMT variants, are supplied with a heatsink to improve the cooling of the module. The modems may generate substantial heat whilst operating at full transmitter power. It is advisable to mount the modems in a location where airflow is able to dissipate this heat from the modem.

The ground pads of the ux-SMT modem should be soldered to the ground plane of the associated PCB to provide thermal dissipation for the module. See later sections for PCB layout guidance.

Note that unless transmissions are infrequent, or transmission power levels are low, it is not recommended to operate the ux series modems without a heatsink. Likewise, it is not advisable put the modems in environments where the heat from other components may unduly affect the modems.

The modems have an internal silicon temperature sensor. This sensor is not fully calibrated and therefore could vary by a few degrees from the actual temperature. The temperature reading can be found in the ATI7 RSSI report. If this exceeds a safe operating temperature the modem will reduce the operating duty cycle in order to reduce the heat produced by the system and thus help to protect the components against suffering a thermal failure. Once below a normal operating temperature the system will return to normal function.

Note that the reduction in duty cycle associated with the thermal protection will cause a decrease in transmission throughput of the affected modem.

Note that it is not advised to rapidly cool a hot modem with water, alcohol, electronics freeze spray etc. as this could cause damage to solder joints and other components due to thermal shock.

11 Physical dimensions

11.1 Module dimensions

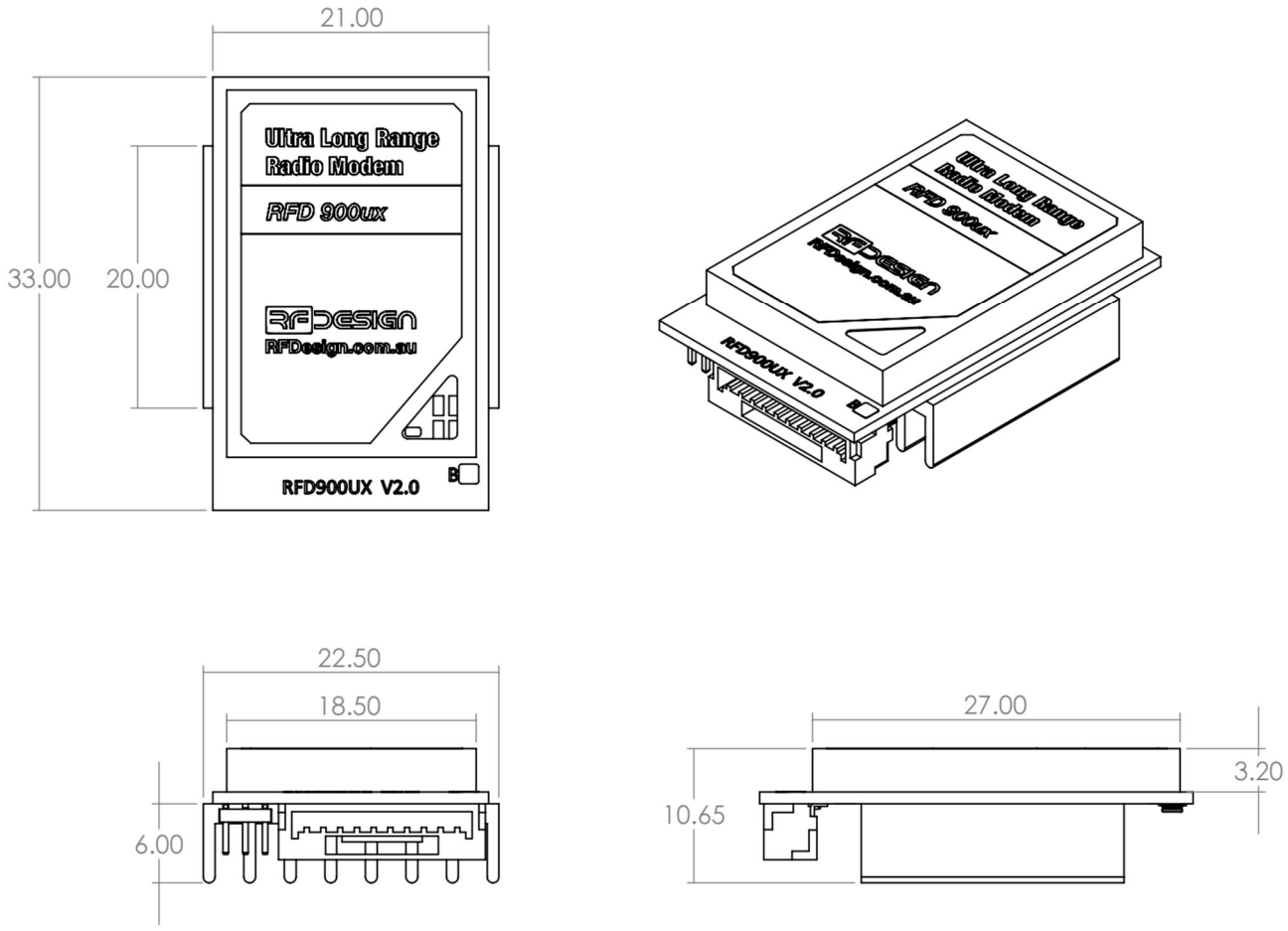

Figure 30: ux series modem dimensions

Note all dimensions have a +/- 0.1mm tolerance.

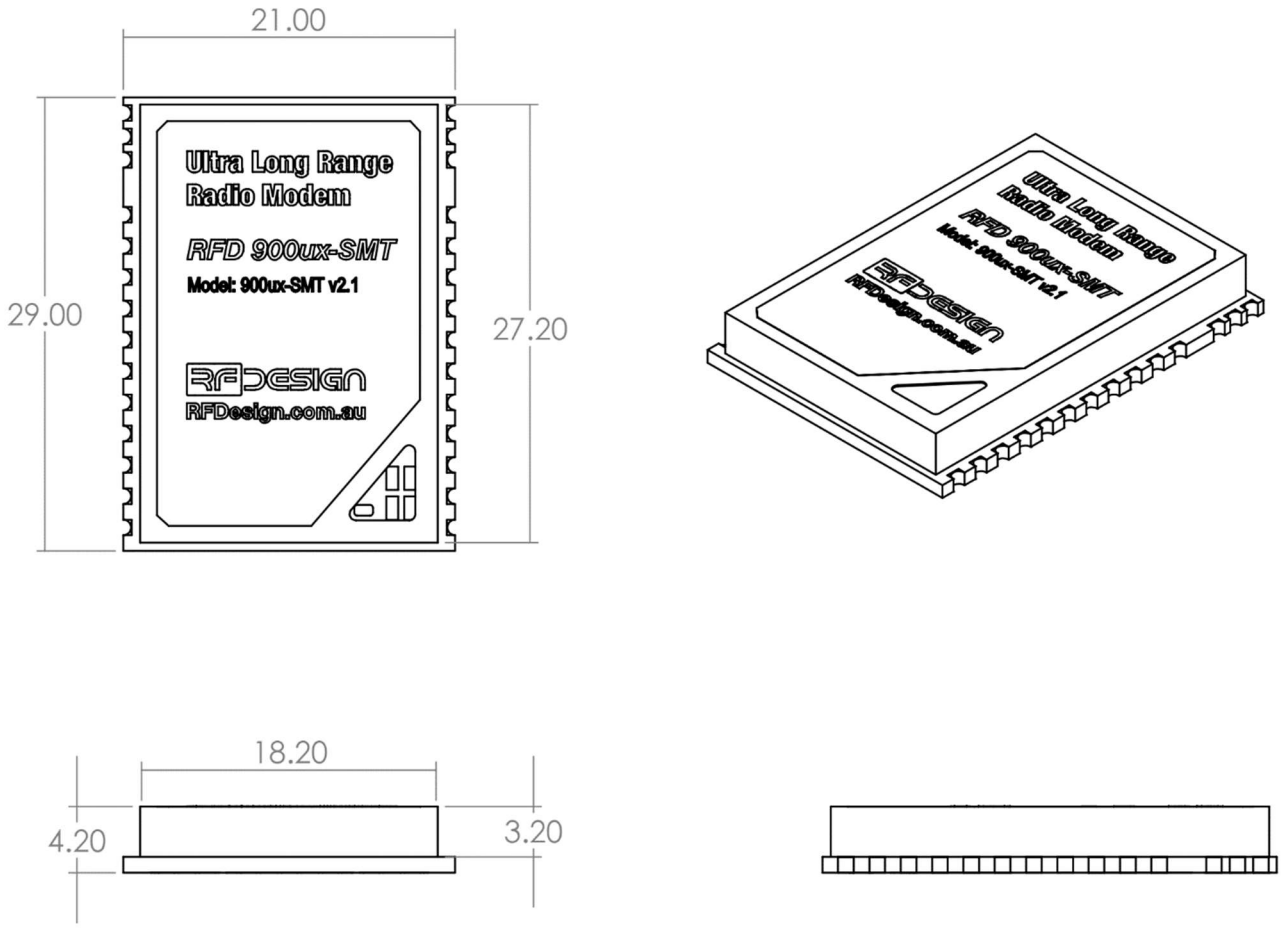

Figure 31:ux-SMT dimensions

Note all dimensions have a +/- 0.1mm tolerance.

11.2 PCB Footprint and Solder Paste Stencil

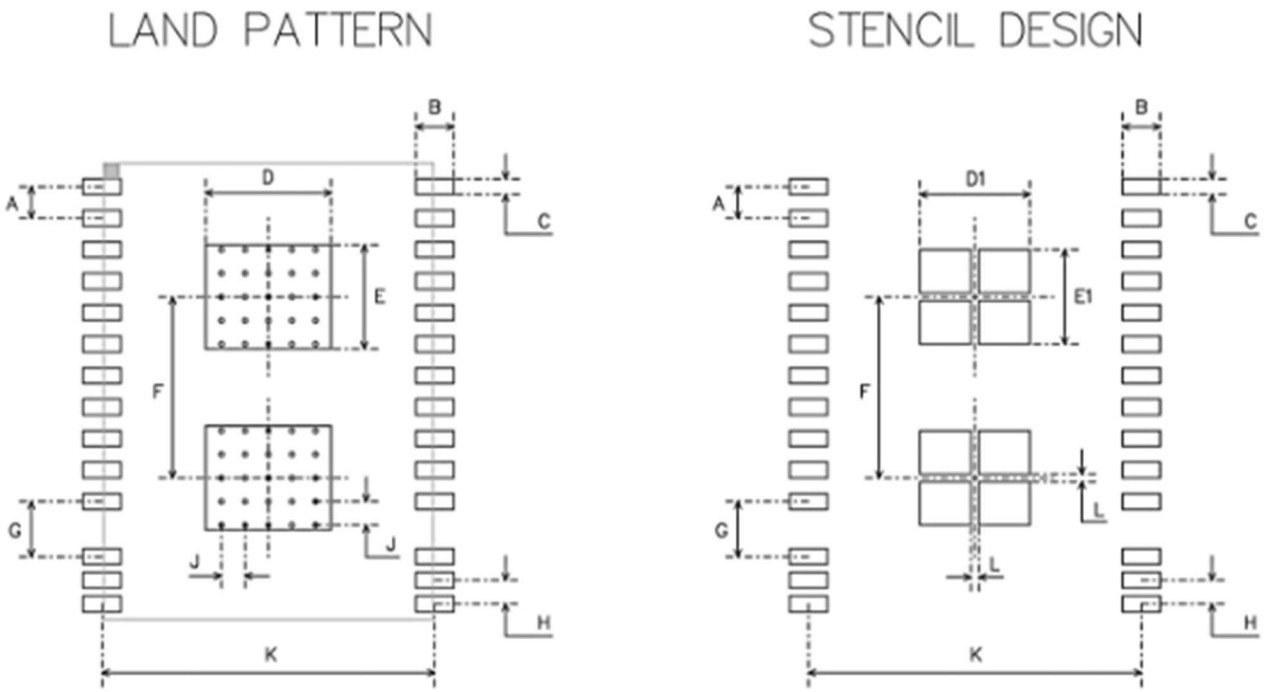

Figure 32: PCB land pattern and solder stencil dimensions

Land Pattern		Stencil Pattern	
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	Vertical A to E	7.0

Note the two large central pads provide for thermal dissipation and should be electrically connected to ground.

An Altium component is available on the RF Design website.

11.3 PCB Layout Guidelines

An example of the ux-SMT modem on a PCB layout is given below. Some key considerations:

- Where possible the under module thermal pads should be fully connected to the ground plane without thermal relief.
- Where possible the ground pad should also be tied to other layers in the PCB to provide thermal dissipation adequate to allow the modem to operate correctly.
- Meeting electromagnetic compatibility requirements are the responsibility of the PCB designer.
- The PCB designer needs to calculate the RF antenna track widths and ground pull back to meet the required 50 Ohm impedance. This will vary depending on the PCB layer stack up and dielectric constant. Tools such as Saturn PCB tool kit can help with this.

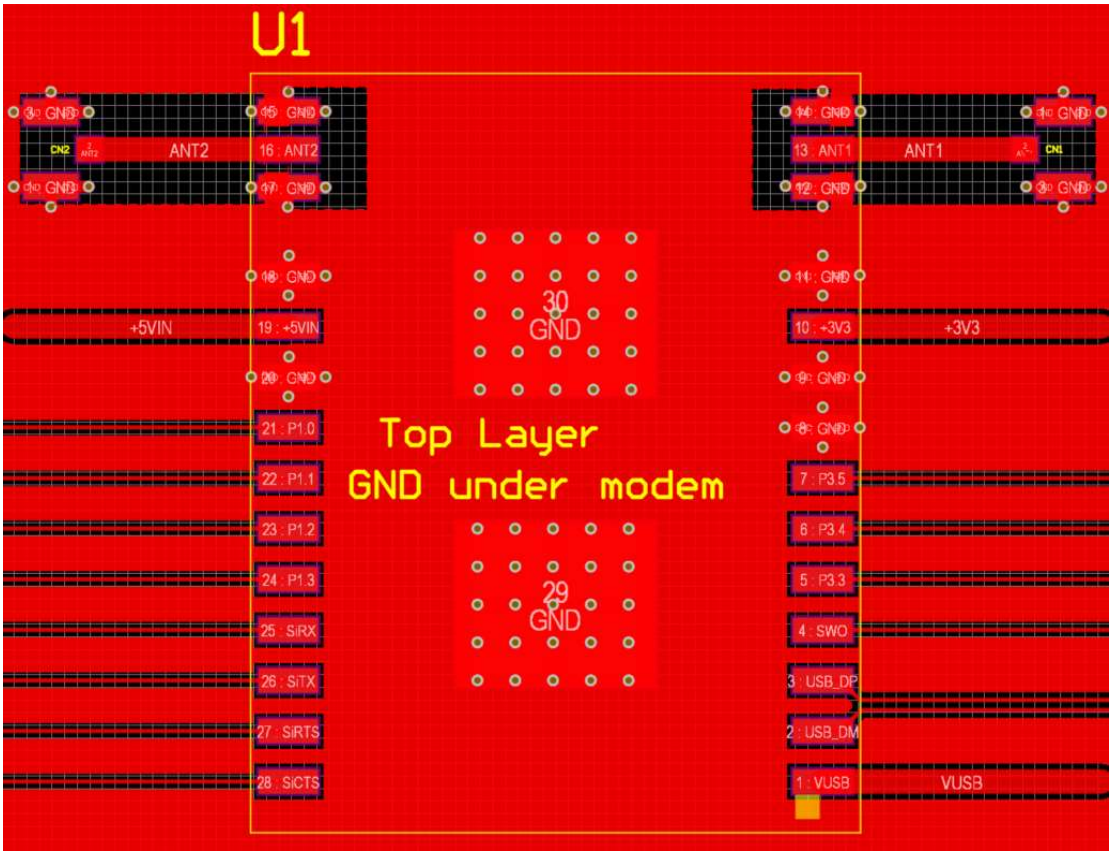

Figure 33: PCB layout example

12 Useful Links

FTDI

https://ftdichip.com/drivers/

RFD Modem Firmware

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

RFD Tools

https://get.support.rfdesign.com.au/servicedesk/customer/portal/1/article/242712577

RFD Store

https://store.rfdesign.com.au

RFD Documentation

https://files.rfdesign.com.au/docs/

Saturn PCB Toolkit

https://saturnpcb.com/saturn-pcb-toolkit/

ux-SMT Altium Component

https://files.rfdesign.com.au/Files/documents/RFD900ux%20Altium%20Library.zip

13 Glossary

RF: Radio Frequency. A term used to describe a portion of the electromagnetic spectrum. Commonly encompassing frequencies between a few tens of kilohertz and a couple of hundred gigahertz.
LOS (aka LoS): Line of Sight. This refers to the distance that a radio signal can reach uninterrupted by obstructions or the radio horizon.
PPM: Pulse Position Modulation. This is an encoding standard used by radio controller to send data about the position of multiple servo motors.
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.
AES: Advanced Encryption Standard. A data encryption protocol meeting the specifications established in the ISO/IEC 18033-3 standard.
RP-SMA: Reverse Pole Subminature type A. A common form of RF connector on consumer electronics. It offers a reasonable compromise between overall size and rated connection cycles.
MAVLink: Micro Air Vehicle Link. A protocol for telemetry data exchange between compatible ground control software and autonomous vehicle controllers.
LED: Light Emitting Diode. A semiconductor device that converts electrical power to light.
Baud: unit of measurement of symbol rate. This is an indication of data transfer speed of serial/UART connections.
Serial: A synonym of UART, a protocol for sending and receiving data in a sequential manner.
TX: Transmit.
RX: Receive.
RTS: Request to Send. UART hardware flow control flag.
CTS: Clear to Send. UART hardware flow control flag.
UART: Universal Asynchronous Receive Transmit. Hardware that manages serial data transfer between connected devices.
XMODEM: An older standard of file transfer protocol which is relatively simple to implement.
GPIO: General Purpose Input Output. A microcontroller pin that can be configured for various input and output functions.
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.
USB: Universal Serial Bus. An industry standard for data communication and power delivery between devices. Most commonly found in type A and C connectors.
FHSS: Frequency Hopping Spread Spectrum. A radio technique used to minimise interference. An RF spectrum allocation into narrow RF channels and the system then hops through those channels.
GFSK: Gaussian Frequency Shift Keying. A form of modulating data onto a carrier frequency by controlling frequency shifts.
CRC: Cyclic Redundancy Check. An error detecting code that uses a small piece extra data to mathematically determine the correctness of a decoded signal.
RFD: RF Design. The Australian company who designed, build and support the x series modems among other products.

14 Revision History

Version	Date	Changes
1.0	20/08/2019	Release document
1.1	12/09/2019	Amended VBUS pin voltage
1.2	19/03/2020	Updated for ux-SMT and compliant versions
1.3	17/12/2020	Updated to reflect changes in compliance and firmware
2.0	18/04/2024	Major revision and update to reflect changes in hardware and software behaviours and provide more technical details.
2.1	17/01/2025	Corrected JST header SMT pad description table errors