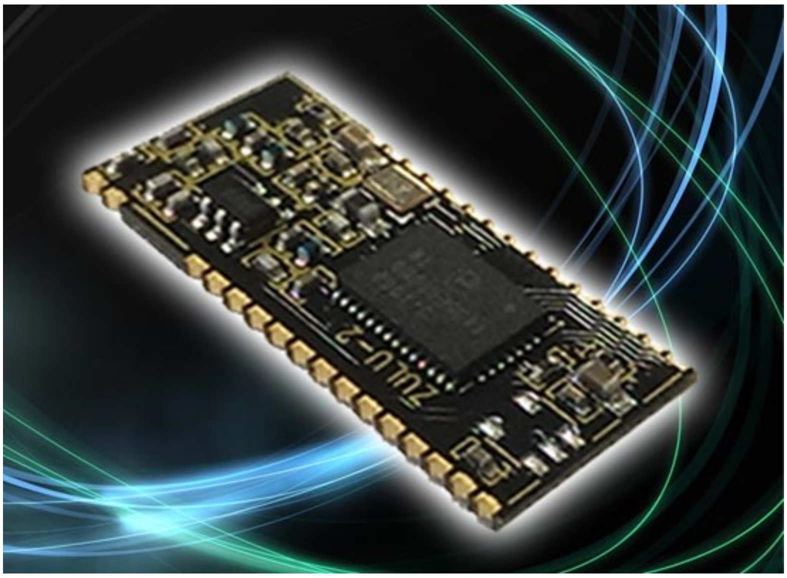
ZULU-2 Radio MODEM Module

Features

- Intelligent RF modem module
- Serial data interface with handshake
- Host data rates up to 57,600 baud
- RF Data Rates to 115Kbps
- On-board XTAL
- Range up to 2Km
- Minimal external components
- Direct LED drive shows data flow
- Secure data protocol
- Ultra low power 2.4 - 3.6V operation
- CE compliant for licence free use
- 868MHz multi channel operation
- 100mW transmit power (+20dBm)
- Receiver sensitivity –121dBm



Applications

- Remote networking
- USB/RS232 cable replacement
- Remote data log
- Meter reading

Description

The ZULU-2 modem module is a highly integrated RF modem and intelligent controller with simple interface. The ZULU-2 modem can achieve a wireless serial data link at up to 38K4bps over a 2Km range. Range may be further extended with suitable antenna. Now includes on board XTAL for simpler integration.

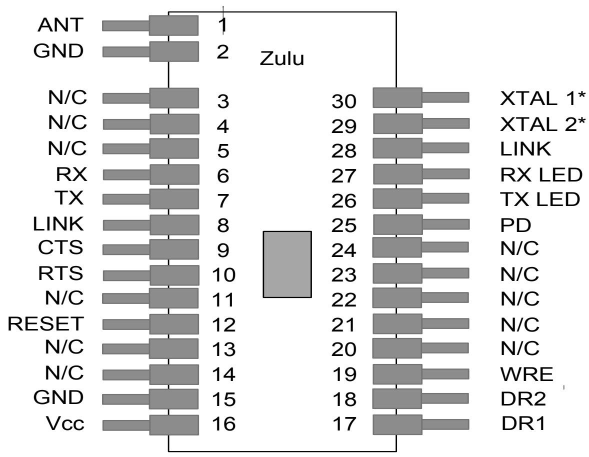
The user interface is standard RS232, operating at low voltage. All RF operation is automatically controlled (with error checking etc) so the ZULU-2 can be treated as a simple communications device. Possible applications include one-to-one and multi-node wireless links in applications including car and building security, EPOS, inventory tracking, remote industrial process monitoring and computer networking. Because of their small size and low power requirements these modules are ideal for use in portable, battery-powered applications such as hand-held terminals.

Ordering Information

Part No	Description
ZULU2-M868	Radio modem module DIP package 868MHz
ZULU2-M868-SO	Radio modem module SMT package 868MHz

ZULU2 Modem

Connections



Pin Description

Pin No	Name	Direction	Description
1	ANT	In	Antenna input / Output 50ohm impedance
2, 15	GND	In	Connect to ground
3-5, 11, 13-14, 20-24	N/C	N/A	Unused leave disconnected.
6	RX	In	(Low Level) RS232 data in
7	TX	Out	(Low Level) RS232 data out
8	LINK	In	Connect to LINK on pin 28
9	CTS	Out	(Low level) RS232 CTS
10	RTS	In	(Low level) RS232 RTS
12	RESET	In	Device reset input (Tie high via 10K resistor)
16	Vcc	In	+2.2 - +3.6v
17-18	DR1-DR2	In	Host data rate selection.
19	WRE	In	Do not connect - unused.
25	PD	In	Power down mode. Take low to enter ‘sleep’ mode
26	TX LED	Out	RF TX LED indicator
27	RX LED	Out	RF RX LED indicator
28	LINK	Out	Connect to LINK on Pin 8
29-30*	XTAL1-2*	In*	These pins are provided as legacy to ensure compatibility with older ZULU modules
31	NC		Leave unconnected

Notes on compatibility with earlier ZULU modules.

ZULU-2 is hardware compatible with all ZULU previous versions, however it cannot communicate with ZULU R1.1 firmware or earlier. The ZULU-2 is 100% backward compatible with ZULU R1.4 and later when Unit ID (R7) is set to the correct value.

If using the ZULU-2 in an existing product designed for ZULU then do so without fitting the external crystal - no other hardware changes are necessary.

Check the configuration set-up for new features and any changes to defaults.

Operational description

Serial Data Format

Baud Rate:	Defined using DR1 and DR2 Pins
Data Bits:	8
Parity:	None
Stop Bits:	1
Flow Control:	Hardware CTS / RTS

RX, TX
These pins are for data input/output. Data is transmitted and received at the low voltage level (dependent on the Vcc being used). Compatible with LCTTL / LVCMOS

CTS, RTS
Clear To Send (CTS) and Request To Send (RTS) are as RS232 standard data flow control used. However they operate at the ZULU-2 modem modules low level Vcc (3V)
If no handshaking is required, RTS may be pulled low. However beware of data overrun errors when transmitting streams of data longer than the data buffer size (55bytes).

RESET
Connection to GND resets the module. The ZULU-2 modem module starts when this input is taken from GND to Vcc. Normal operation: connect to Vcc through a 10Kohm resistor.

DR1 - DR2
These inputs define the host interface baud rate. They are read only when the RESET pin goes high.
It is good practice to operate the host interface at half the speed of the RF data rate.
Note: Baud rate can also be configured in using the in built configuration mode. See page 6.

DR1	DR2	Host Baud Rate
Vcc / Unconnected	Vcc / Unconnected	4,800
Vcc / Unconnected	GND	9,600
GND	Vcc / Unconnected	19,200
GND	GND	38,400

PD
Enables 'Sleep' mode when connected to ground. For normal operation connect to Vcc. No RF packets will be received by the module when in sleep mode.

WRE
No longer used - leave unconnected.

Tx/Rx LED
Direct LED drive which operates whenever there is RF activity.

XTAL1, XTAL2
The ZULU-2 modem module no longer requires a 30MHz drive crystal to be connected between XTAL1-2.
See notes on page 2 for compatibility with older versions.
Crystal spec: 30MHz ,+/-10ppm, ~20pF. Such as FEC 184-2247.

TX LED, RX LED
LED drive pins drive via ~320ohm resistor dependent on Vcc.

Operation Overview

The ZULU-2 modem module provides a simple interface to the host controller. It handles all RF data communications automatically and without any requirement from the user (RF packetising , preamble, encoding, CRC check etc).
With this powerful high-speed radio link, the following networks can be realised:

Networking

One-to-One; For point to point data communication

One-to-Many/Broadcast; A network consisting a master and many slaves (all receivers have the same address)

Many-to-One; Where all transmitters with different addresses send to a single receiver address.

Note: Because each ZULU-2 modem module can be given a unique address, multiple ZULU-2 networks can co-exist in the same area. This type of operation requires clear timing between transmissions or corruption of packets can occur.

Addressing Networks

Each ZULU-2 modem module has a generic pre-configured default address (7F7F7F). This can be modified during configuration. When data received via RF it is examined and the address header embedded within it is compared with its address. Only data received with matching address will be processed and output to the host, all other data will be discarded.

When sending data, the ZULU-2 modem module has a default destination address set to 7F7F7F, this can be user configured.

By setting the two addresses appropriately the above network types can be easily achieved.

Operating Modes

Configuration Mode: In configuration mode the ZULU-2 modem module can receive commands to set internal registers to define its eventual operation. In this mode the ZULU-2 modem module is 'Offline' and cannot send or receive RF data.

Normal Operation: The ZULU-2 modem module is 'Online' automatically transmitting and receiving data from its serial interface across its RF network.

Acknowledge Secure Mode : In this mode each time a ZULU-2 modem module transmits an RF packet, an additional 'packet ID' is added. This ID is a rolling verification counter to receiving ZULU-2 modem modules.

Any correctly addressed receiving ZULU-2 modem module replies with an RF acknowledgment also containing the 'packet ID'. If the transmitting ZULU-2 fails to receive the expected acknowledgement it will transmit the packet again (up to 10 times).

Handshaking

The ZULU2 modem module required the handshaking (RTS/CTS) to communicate with its host interface.

Note: If you do not intend to use handshaking, it is possible to tie the CTS pin to GND and use the modules without. In this configuration the ZULU-2 modem module will send all data in its buffer after a 10ms timeout. Up to 55bytes can be buffered before data is lost. A minimum of 15ms should be allowed before new data is sent to the module after each packet. This is not a recommended method of operation.

Configuration Mode (offline)

Commands can be set using a standard terminal program or by sending the relevant ASCII characters.
Each command must be followed by the Carriage Return <CR> or 'Enter' **except "+++"**

Command	Description	Response from ZULU-2
+++	Enter Configuration Mode Note: This command must be sent as a string with no characters in front or behind. This is to ensure that the +++ is not mistakenly received in mid-data.(<CR> is not to be used with +++).	ZULU-2 responds with status info
?	Retrieve the current register values	ZULU-2 responds with all register values
F	Pre-configured factory defaults; R1=7F7F7F R2=7F7F7F R3 = Ch2 (869.450MHz) R4 = 7 (+20dBm) R5 = 1 (19K2)	'OK'
H	Help	Brief description of commands available
P	Ping Mode This sends a ping request. On receiving, the recipient ZULU-2 Modem will respond with its address and the level of RSSI (Received Signal Strength) The Ping command is continuously repeated every 1 second until any command or character is entered. Please note: R1 and R2 on both devices must be set to the same address for RSSI signal strength to show.	The originating ZULU-2 modem module will respond with the recipient ZULU-2 modems' address. eg. Received from 7F7F7F (D5) Where 7F7F7F = the recipient address D5= RSSI **RSSI** Is a hex value corresponding to the received signal strength Min = 20hex Max =E0hex
S	Save Configuration	'SAVED'
Q	Exit configuration mode and return to online	No response

Note: All commands are entered in upper case

Register Values (Configuration Mode)

Set a register:
To set a register, type 'R#=x' where # is the register number (1-6) and x is the value to set.
For example, to set the RF channel to 3 type : R3=3<CR>
(Where <CR> is carriage return or enter on the keyboard)

Register	Value Range	Description	Example
R1	0000 - FFFFFF (24 bit address) Default: 7F7F7F	Sets the recipient ZULU-2 modem module address	R1=0001 (Data sent to ZULU-2 Modem module with address 0001)
R2	0000 - FFFFFF (24 bit address) Default: 7F7F7F	Set ZULU-2 modem module address	R2=F001 (Data sent is from ZULU-2 modem module with address
R3	CH0 to CH4	Sets the RF channel selection page 7.	R3=2 (Transmit on channel 2)
R4	0 = +1dBm 1 = +2dBm 2 = +5dBm 3 = +8dBm 4 = +11dBm 5 = +14dBm 6 = +17dBm 7 = +20dBm 7 = +20dBm	Set the RF transmit power output*	R4=7 (sets transmit power to max)*
R5	0 = 9,600 1 = 19,200 2 = 28,800 3 = 56,000 4 = 115,200	Set the RF baud rate*	R5=3 (sets the RF data rate to 56Kbps)
R6	0 = Off 1 = On	(Acknowledge) Secure mode enable	R6=1 (Secure Mode on)
R7	0-FF (hex) Default = D4	Unique system identifier	R7=A3 Identifier set to A3.
R8	0 = 4800 1 = 9600 2 = 14400 3 = 19200 4 = 28800 5 = 38400 6 = 56000 7 = 57600	Host baud rate - software over-ride. FF - uses DR1 and DR1 pins.	R8=3 Baud rate set to 19K2
R9	0 or 1	Data whitening enable	R9=1 Enable
R0	00 or 01	OTA Enable Over the air configuration enable	R0=1 Enable

Using Configuration Mode

Baud rates:
It is possible to set both host and RF baud rate via configuration mode. The RF Baud rate should always be twice the host baud rate for best operation.

Secure mode
See “Operating Modes” Page 4

Unique system identifier
Adds a unique identifier at the RF stage. This allows unmatched data packets to be ignored without the need to decode - saving processor time and making a more efficient system when many nodes are present in one location. Systems with the same identifier will operate together. Use for multiple networks in one location. Do not use addresses: FF, AA or 55

OTA - Over the air configuration
It is possible to have a remote node enter configuration mode and change that node’s register settings by sending it the unique code <918273> (including the <>).

After entering OTA mode - all subsequent communications must be sent as macros and will need to include the Line Feed <LF> (do not send “<LF>“ this command must be sent as ASCII code 10 which can vary depending on the software used)

Examples:

Send:	Response:	Send:	Response:	Send:	Response:
<918273>	7F7F7F 7F7F7F 02 00 03 00 D4 01 01 01 01	?<LF>	7F7F7F 7F7F7F 02 00 03 00 D4 01 01 01 01	R4=05<LF> R5=02<LF> Q<LF> S<LF>	OK OK NONE NONE

MPORTANT Notes:
In OTA mode all values are entered in hex and sent as ASCII. Registers must be set in multiples of two characters - ie to set register 6 you must send 06 - as above examples show.

1. Changes made in OTA mode will be lost if not saved.
2. OTA mode cannot be used in conjunction with acknowledge secure mode.

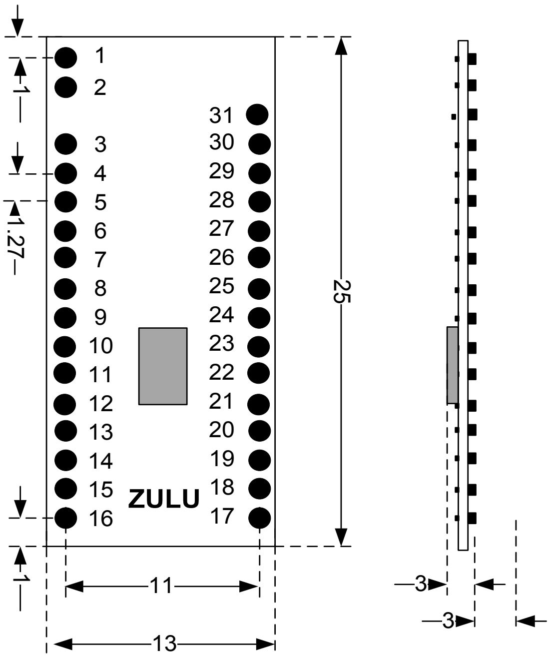
RF Channel Selection

The EU standard sets maximum power transmission limits dependent on frequency, bandwidth and application. Please check the relevant standards are being met when implementing your Application. A rough guidance applicable to the ZULU-2 channel numbers is given below

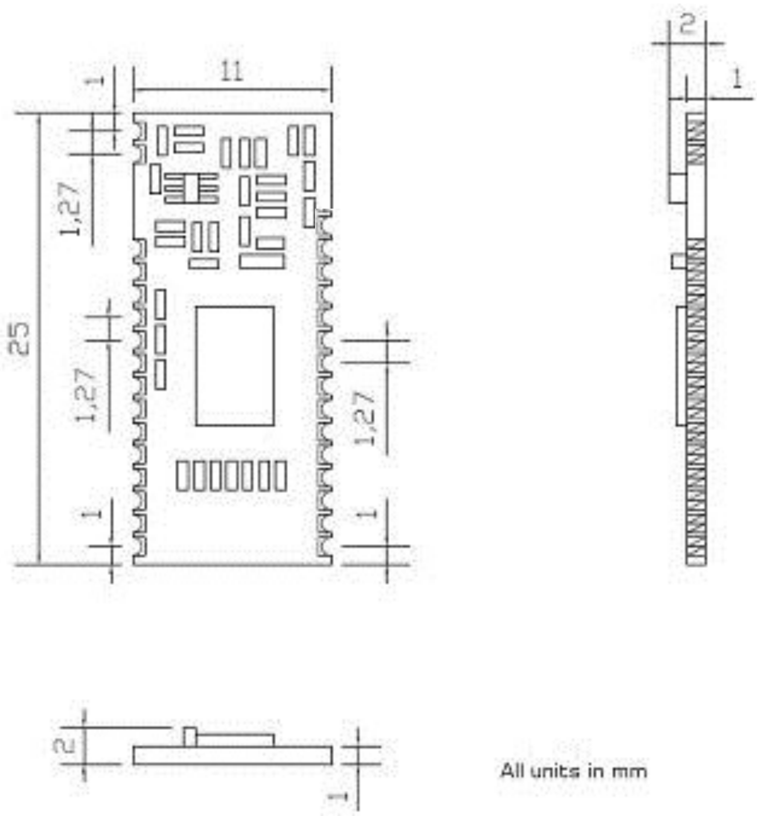
Channel Number	Frequency Centre (MHz)	EU Power Allowance mW / dBm	Notes
0	868.400	25 / 14	Applicable standard - EN300-220
1	868.900	25 / 14	
2	869.450	100 / 20	
3	869.600	100 / 20	
4	869.800	25 / 14	

Mechanical Dimensions

PDIP version **SMT Version**



Notes
1. Pins 1.27mm pitch
2. Pin Dims 0.4mm sq
3. All dims in mm



Range

The antenna choice and position affects controls the system range. Keep the antenna clear of any large metal components in the system. The best position by far, is protruding vertically from the top of the product. This is often not desirable for practical reasons and thus a compromise may be needed. Note that the space around the antenna is as important as the antenna itself. All radio systems are dependent on a radio signal being received through airspace.
The range quoted is the optimal in direct line of sight without obstacles and in good atmospheric conditions. Range is affected by many things, for example local environmental conditions, atmospheric conditions, interference from other radio transmitters. For evaluating the local environment please see our RF meter (DS006)
In the worst case, range quoted may be drastically reduced.

Technical Specifications

Absolute Maximums:
Temperature Range: Storage –50 to +125°C.
Weight: SMT version 7grams, DIP Part 13grams

Parameter	Min	Max	Units
Voltage on any Input Vcc > 2.2 Vcc < 2.2		5.8 Vcc + 3.6	V V
Max Input power (thro Antenna)		+10	dBm

DC Characteristics

Parameter	Min	Typical	Max	Units
Supply voltage	2.4	3	3.6	V
Operating Temperature	-40		+85	°C
ZULU-2 Tx supply current: When transmitting (At max power) When sleeping		 85 1		 mA uA
ZULU-2 Rx Supply Current: When Receiving When sleeping		 18.5 1		 mA uA

RF Characteristics

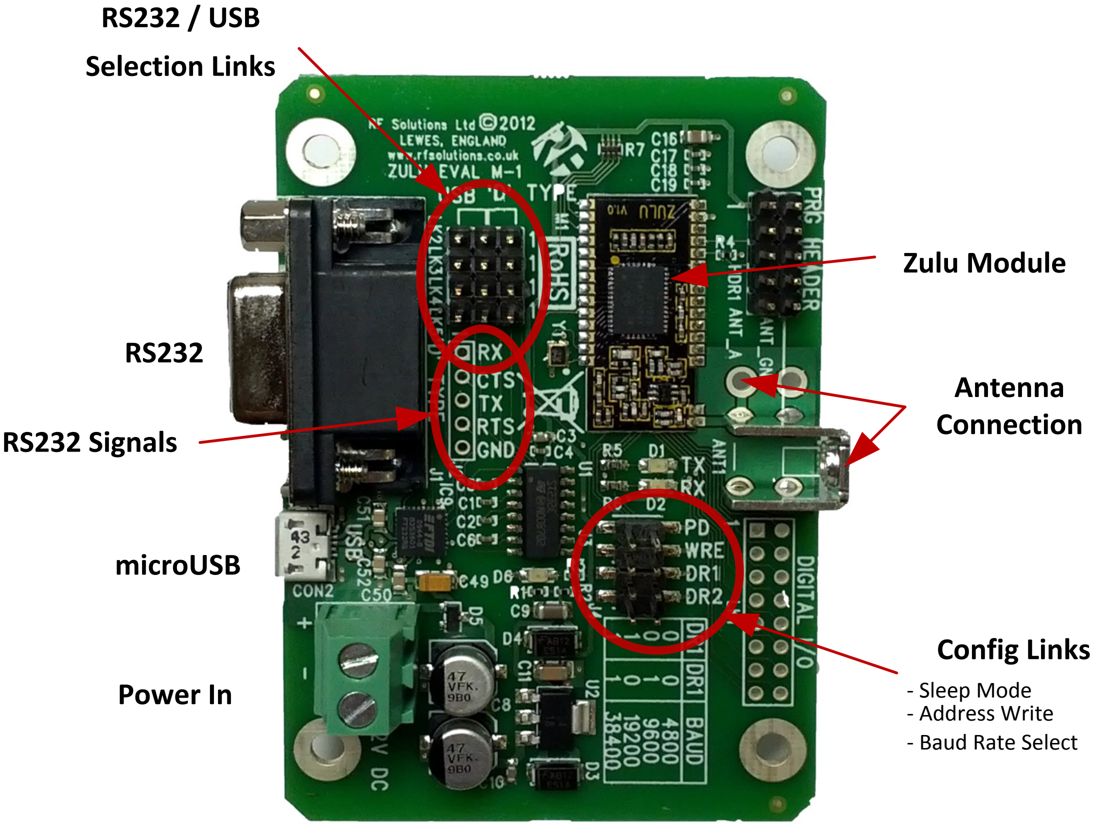
Parameter	Min	Typical	Max	Units
Operating frequency—see freq channel setting	868		870	MHz
Operating temperature	-40		+85	°C
Band width per channel		100		KHz
Deviation		45		KHz
ZULU-2 Tx MAX output power			+20	dBm
ZULU-2 Tx—Rx FSK Raw RF data rate	9.6		115,200	Kbps
ZULU-2 Rx sensitivity	-102 @115K		-109	dBm

ZULU2 Modem Evaluation Board

The ZULU-2 EVAL Board provides a ready made platform which can be used to demonstrate the capabilities of ZULU-2 modem modules providing ready made RS232 and USB modem solutions.

Features

- Direct Connection to RS232 / USB
- 9-12Vdc Power in Screw Terminal
- LED Indication Transmit / Receiver
- User Configuration Links



Ordering Information

Part No	Description
ZULU-2EVAL-M868	ZULU-2 Modem Eval Board 868MHz
PSU-12V100MAUK	Plugtop Power Supply 12V 100mA

EVAL Board Configuration

Power Requirements: 9-15Vdc

Weight: 27grams, Dimensions:

USB / D Links (LK2,3,4,5)
For USB connect all Links from Centre to 'USB' Side
For RS232 connect all Links from Centre to 'RS232' Side
Antenna Connector

Link Ref	Name	When Fitted	When Open
PD	Power Down	Modem is Placed in Sleep Mode	Normal Operation
DR1 DR2	Sets Host Baud	DR1 DR2 Open Open Open Fitted Fitted Open Fitted Fitted	Baud Rate: 4800 9600 19200 38400

The connector is a 4mm Screw Thread (Part NO: SCRTM4RA)

Power Connection

Power is required for RS232 comms, USB connection provides power automatically—note that USB port cannot supply adequate power for full +20dBm transmission! Additional power is needed for maximum range!

Host Terminal Software

Connection to Host is via the micro-USB Cable or RS232 Cable.
Any Terminal emulation program can interface the Eval board, one we have found to be easy to use and powerful is 'Terminal'
This can be downloaded from : https://sites.google.com/site/terminalbpp/

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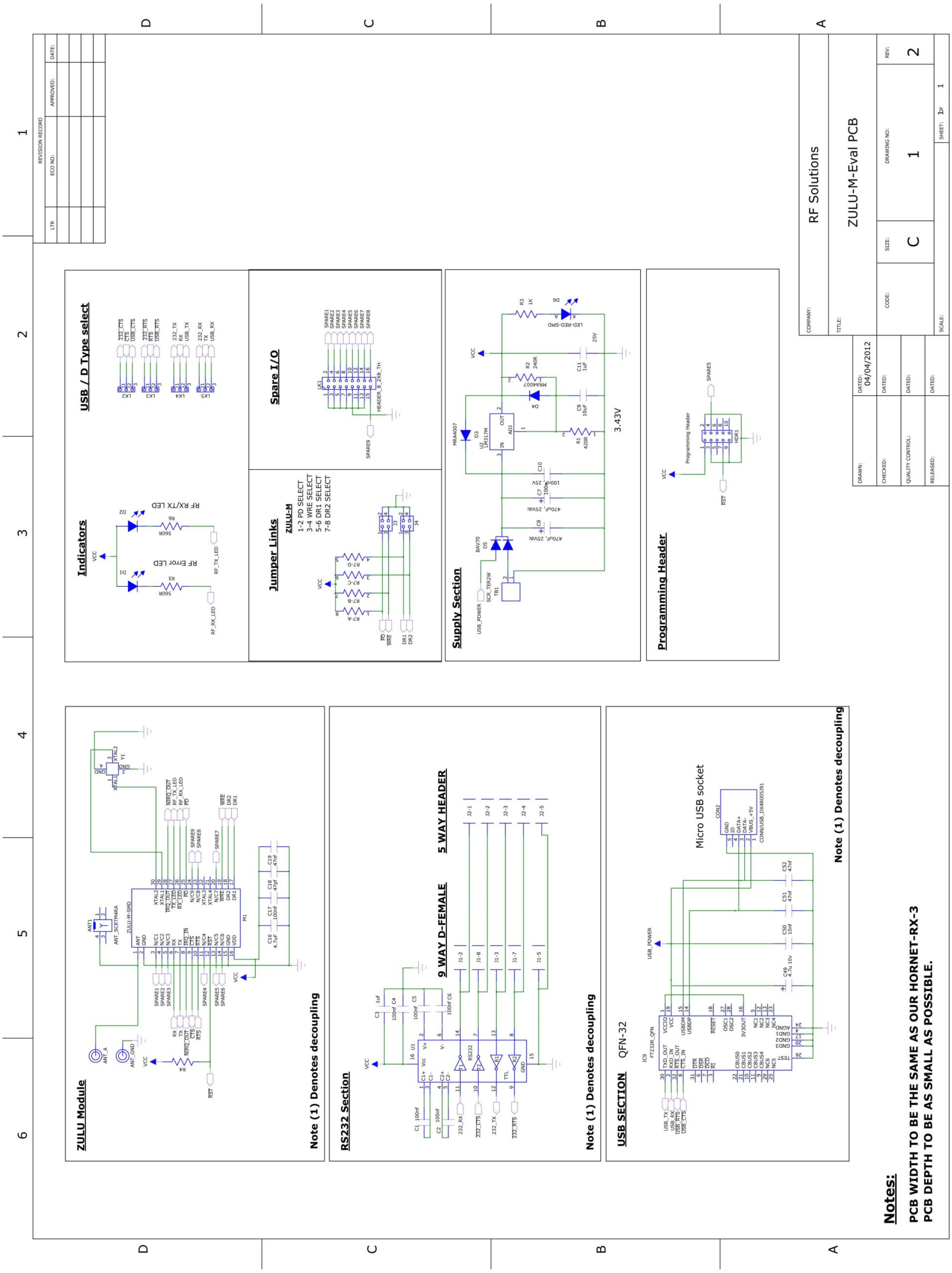
Notes for Optimising Range

1. Use max RF Transmit power (set Register R4 = 7)
2. Use the slowest RF comms Rate (set Register R5 = 0)
3. Power the Eval boards from 12V (don't rely on the USB power)
4. Consider upgrading the antennas to models with gain.
5. Enable data whitening.

ZULU-2 Modem Evaluation Board Schematic



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Application:

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Datasheet: DS-ZULU-2M Rev2

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3. Do you find the organization of this document easy to follow? If not, why?
4. What additions to the document do you think would enhance the structure and subject?
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Environment Agency producer registration number:

WEE/JB0104WV.

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