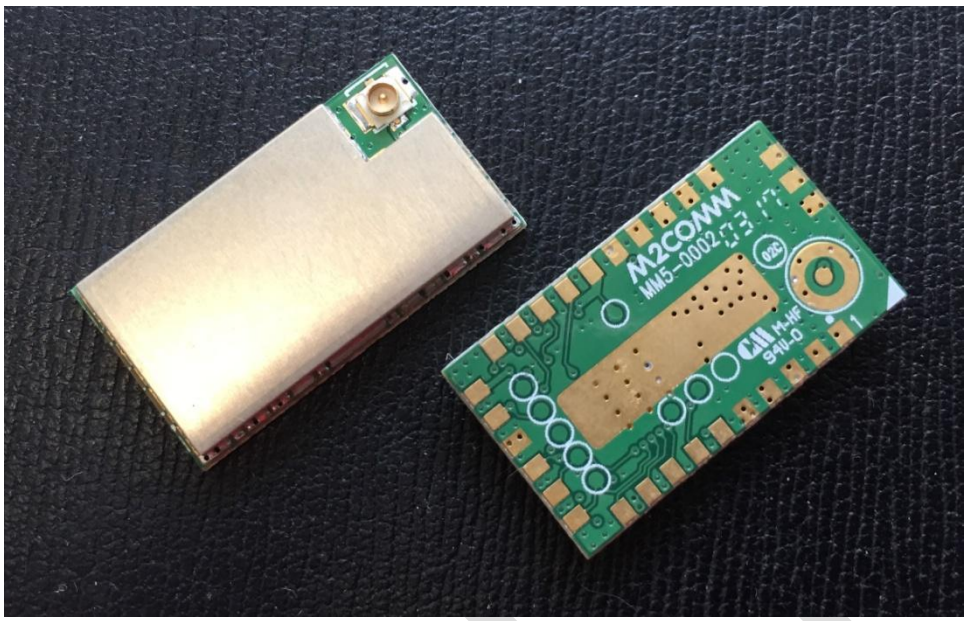

Uplynx-M-RCZ24

Module

Users Manual

M2COMMUNICATION Inc.

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Revision Control

Rev	Date	Description of Change	Approved
1.0	04/20/2017	Released	Charles Lee

Federal Communication Commission Interference Statement

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

FCC Caution: Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate this equipment.

This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

Radiation Exposure Statement:

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20cm between the radiator & your body.

This device is intended only for OEM integrators under the following conditions:

I. The antenna must be installed such that 20 cm is maintained between the antenna and users, and
II. The transmitter module may not be co-located with any other transmitter or antenna.

As long as **2** conditions above are met, further transmitter tests will not be required. However, the OEM integrator is still responsible for testing their end-product for any additional compliance requirements required with this module installed

IMPORTANT NOTE: In the event that these conditions cannot be met (for example certain laptop configurations or co-location with another transmitter), then the FCC authorization is no longer considered valid and the FCC ID cannot be used on the final product. In these circumstances, the OEM integrator will be responsible for re-evaluating the end product (including the transmitter) and obtaining a separate FCC authorization.

End Product Labeling

This transmitter module is authorized only for use in devices where the antenna may be installed such that 20 cm is maintained between the antenna and users. The final end product must be labeled in a visible area with the following:

"Contains FCC ID: 2AFXU8001UX36LDRZ24"

The grantee's FCC ID can be used only when all FCC compliance requirements are met.

Manual Information to the End User

The OEM integrator has to be aware not to provide information to the end user regarding how to install or remove this RF module in the user's manual of the end product which integrates this module.

The end user manual shall include all required regulatory information/warning as show in this manual.

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1 *Product Overview*

The UPLYNX-M-RCZ24 is a Sigfox Verified modem module for the low power wide area network (LPWAN) market. It is designed with M2COMM's Uplynx M2C8001 SOC. The module was designed for high performance, high quality, small form factor and a low cost. The design is fully compliant with FCC part 15.209. The Sigfox application is ported over the Uplynx M2C8001 and executed at high efficiency using its internal 32bit core processor. Every module is preloaded with Sigfox application software and module specific ID/KEY/PAC as specified by the Sigfox network system. The preloaded software also includes a bootloader which allows software updates or future user application development.

2 *Product Features*

- Sigfox Verified™ RF modem (reference design fully certified)
- Frequency range: 902.1375-904.6625 MHz
- Maximum output power: 22dBm typical
- Current consumption: 170mA continuous wave, 130mA AT$SB at 22dBm@902.2MHz
- Operating Voltage: 3.4V to 5.5V (2.5V min for 20dBm+ transmission power)
- Operating Temperature: -40°C to 80°C
- Module enabling pin (POW_EN)
- 0.05µA OFF current
- LGA 29 24mm x 13.5mm (RF IPEX connector) Land Grid Array

3 *Functional Description*

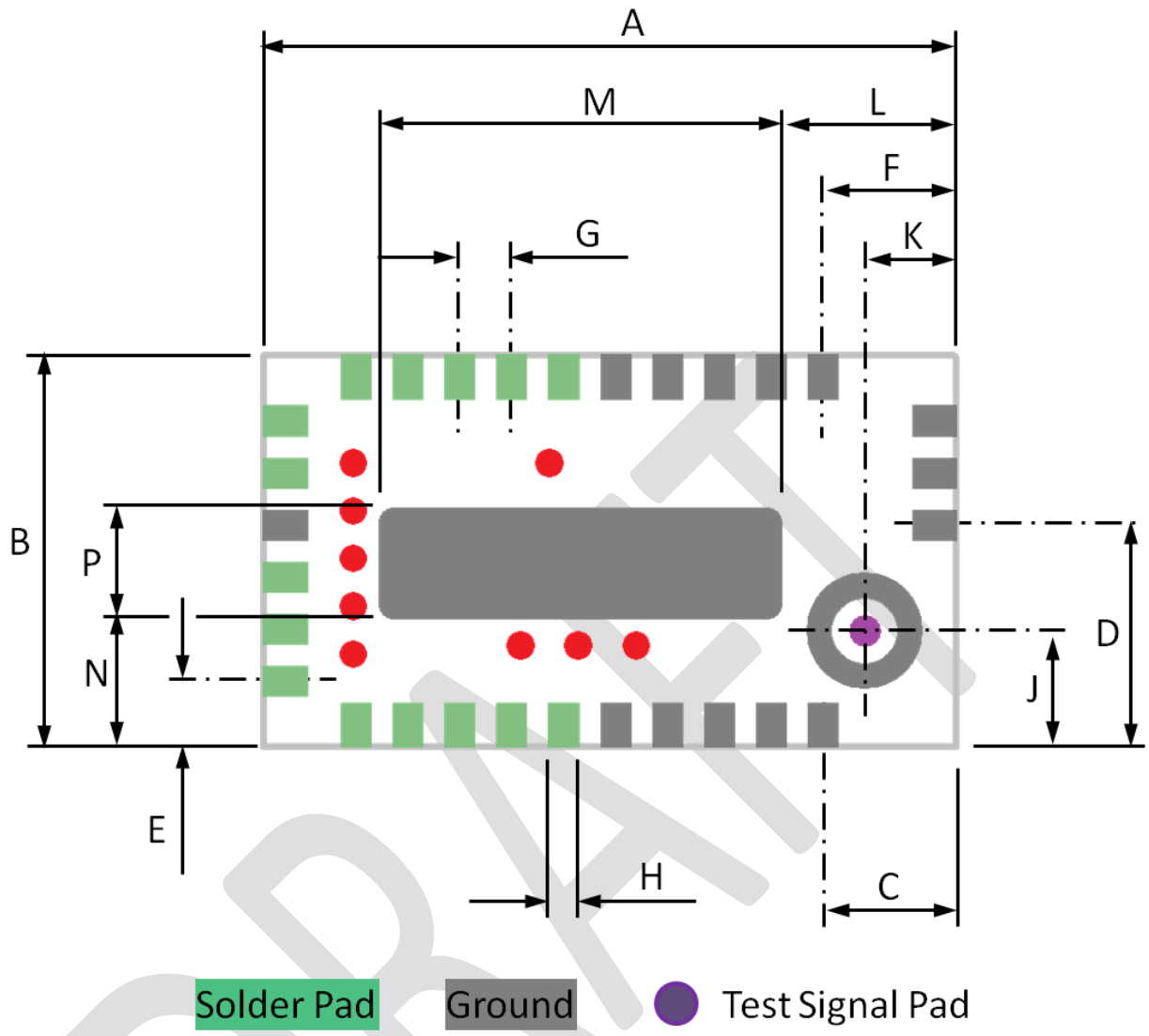
The core of the Uplynx-M-RCZ24 module is the Uplynx M2C8001 SOC. The module design is based on the M2C8001 Sigfox Verified™ reference design. The Uplynx-M-RCZ24 has 6 sets of analogue/digital multi-function pins and digital only multi-function pins. Each multi-function pin can be configured by the user.

The Uplynx-M-RCZ24 communicates with the host MCU over a UART interface. The preloaded UART interface firmware is configured at 9600bps baud rate, 8-bit data, no parity bit, 1 stop bit and no flow control.

The STATUS pin indicates the activity of the Sigfox AT command interface. The module is switched ON and OFF with the POW_EN pin. In OFF mode, the module current consumption can be cut to its minimum (0.05µA) for longer battery operating time, an essential requirement for Sigfox where modem activity is very low.

The RF output is a 50Ω IPEX connector and the whole module is shielded for best spurious containment.

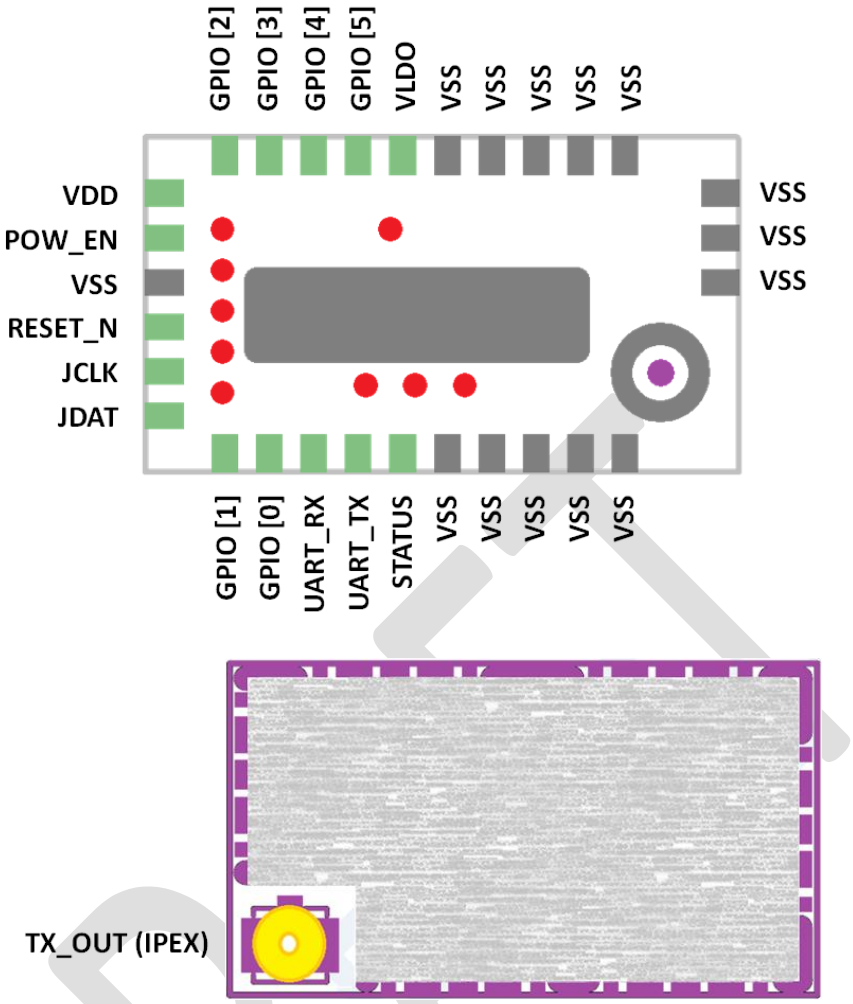
4 *Pin Assignment and Package Mechanicals*



Dimension	A	B	C	D	E	F	G
mm	24	13.5	4.6	7.65	2.25	4.6	1.8 TYP.
Dimension	H	J	K	L	M	N	P
mm	1.0 TYP.	4.1	3.3	5.9	14	4.5	3.9
Pad Length: 1.68 TYP.							
Maximum thickness: 3.0							

Figure 4-1 Bottom view of module

PCB Layout and Gerber files are available upon request



Pad Name	IO	Description
VDD	VDD	Power
VSS	GND	GND
VLDO	O	Operating voltage monitor point
RESET_N	I	Reset: When asserted LOW sets module to INITIAL state
POW_EN	I	Enable: Logic low for Disable; Logic high for Enable
UART_TX	O	UART Tx data (9600bps)
UART_RX	I	UART Rx data (9600bps)
TX_OUT	O	50Ω antenna output
GPIO [0:5]	IO	Reserved
STATUS	O	Logic High: AT Command Interface ready Logic Low: Module busy
JDAT	I	JTAG Interface
JCLK	I	JTAG Interface

Figure 4-2 Module Pinout

5 *Electrical Specifications*

Parameter	Min	Max	Unit
Power (VDD)	-0.3	5.5	V
Voltage on GPIO	-0.3	3.6	V
Storage Temperature	-40	140	°C
Maximum soldering temperature		250	°C

Table 5-1 Absolute Maximum Ratings

Parameter	Min	Max	Unit
VDD	3.4	5.5	V
Operating Temperature	-40	80	°C

Table 5-2 Recommended Operating Conditions

Parameter	Min	Typ.	Max	Unit
Off mode		0.05	1	µA
Sigfox Tx mode 902MHz 22dBm @5V		170		mA

Table 5-3 DC Current Characteristics

Parameter	Min	Typ.	Max	Unit
Output power		22	23	dBm
Harmonics conducted 915MHz 22dBm output			FCC Compatible	dBm
Output Power deviation vs Input voltage (2.6V ~5.5V)			1	dB

Table 5-4 Transmitter RF Performance

Parameter	Min	Typ.	Max	Unit
Reference Frequency		24		MHz
Frequency Range: High band	902.1375		904.6625	MHz
In-Band Phase Noise Floor		-89.77		dBc/Hz
Phase Noise @ 1MHz Offset from Carrier			-104	dBc/Hz
Settling time from power on			100	µs
Lock Time			30	µs

Table 5-5 Synthesizer Specification

Parameter	Note	Min	Typ.	Max	Unit
Calibrated frequency	±5% course calibration		32.768		kHz
Frequency accuracy after calibration	With software offset adjustment routine			±1	%
Supply voltage coefficient	Frequency drift when supply voltage changes after calibration		+10		%/V
Initial calibration time			2.5		ms

Table 5-6 32kHz RC Oscillator Specification

Parameter	Condition/Note	Min	Typ.	Max	Unit
Crystal Frequency			24		MHz
Crystal Frequency accuracy requirement	This is the total tolerance including a) initial tolerance b) crystal loading c) aging d) temperature dependence The acceptable crystal tolerance depends on RF frequency and channel spacing / bandwidth		±20		ppm
Startup time				2	ms

Table 5-7 24MHz Crystal Oscillator Specification

Parameter	Min	Typ.	Max	Unit
Input Low Voltage	-0.3		0.8	V
Input High Voltage	2		3.6	V
Threshold point	1.36	1.45	1.55	V
Output High Voltage	2.4			V
Output Low Voltage			0.4	V
Schmitt Trigger Low to High Threshold Point	1.56	1.66	1.76	V
Schmitt Trigger High to Low Threshold Point	1.1	1.19	1.27	V
Input Leakage Current			±10	µA
Pull up resistor	42k	59k	88k	Ω
Pull down resistor	34k	54k	92k	Ω
Output current drive			20	mA

Table 5-8 Pin IO Voltage

6 *Preloaded Software*

The Uplynx-M-RCZ24 is loaded with the following software prior shipping:

1. Sigfox Verified™ Application
2. Bootloader
3. Device ID, KEY and Portable Access Code (PAC)

More detailed information can be found in document "RM-UPLYNX-E001: Uplynx AT Command GUI and EasyAT User Guide"

6.1 *Sigfox Verified AT command*

The Uplynx-M-RCZ24 is designed to be compliant with the Sigfox uplink specification. The Sigfox Verified™ AT command set is a standard deliverable and is used to access the network. For API interface request, please contact our sales representatives.

The Uplynx-M-RCZ24 communicates with the host MCU over a UART interface. The UART interface is configured at 9600bps baud rate, 8-bit data, no parity bit, 1 stop bit and no flow control. When the AT command interface is running at startup, the pin STATUS will be pulled high.

The following AT commands are supported.

Command	Description	Value
AT$302=pwr	Set Tx power	Pwr = Tx power [14 to 22]
AT$302?	Get current TX power	Return Current transmission power setting
AT$400=v1,v2,v3,v4	Set Sigfox configuration word for RCZ2 and RCZ4 settings	v1 = config_words_0 v2 = config_words_1 v3 = config_words_2 v4 = default FCC Channel
AT$400?	Inquire the Sigfox configuration words	
AT$410=mode	Enable Public Key for emulator mode	Mode: 0-normal mode; 1- Public key enabled (emulator mode)
AT$SB=bitvalue	Send a bit value of 0 or 1	Bitvalue = 0/1
AT$SF=frame	Send payload data, 1 to 12 bytes	Frame: data bytes (0,1,2,3…C,D,E,F) to be sent, 12 byte maximum
AT$RC	SIGFOX_API_reset	
AT$ID?	Get device ID	return ID
AT$PAC?	Get device PAC	return PAC
AT$IF=freq	Set transmission frequency in Hz	e.g. 868000000
AT$IF?	Inquire current frequency setting	Return frequency in Hz
AT$CW= freq, mode	Test mode with continuous wave emission	Freq: 868000000 mode: 0-disable; 1-enable

AT$CM= packetlength	Test mode with random data packet at fixed frequency	Packet length = number of bytes to be transmitted (1~26)
AT$V?	Read firmware information	
AT$O=mode, standard	Open Sigfox API library	Mode: 1 to load Sigfox library Standard: 1-RCZ1; 2-RCZ2; 4-RCZ4
AT$RCZ=standard	Sigfox library regional setting	Standard: 1-RCZ1; 2-RCZ2; 4-RCZ4
AT$RCZ?	Inquire Sigfox library regional setting	Standard: 1-RCZ1; 2-RCZ2; 4-RCZ4
AT$O?	Inquire Sigfox API library open or not	Mode: 1 to load Sigfox library standard: 0(EU)/1(US)
AT$OOB?	Get operation condition	Return values: [Battery voltage before active transmission in mV] [Battery voltage during active transmission in mV] [10x silicon temperature] e.g. 2650 [battery voltage 2.65V before transmission] 2550 [battery voltage 2.55V during transmission] 270 [27C silicon temperature]
AT$FW=mode	Firmware update mode	0: normal mode 1: update firmware with UART at 115200 After asserting the command, the device needs to be rebooted into XMODEM mode with UART speed of 115200bps. New binary can be loaded via XMODEM protocol over UART.
AT$GPIODIR=gpio, val	Set GPIO pin direction.	gpio = 1-GPIO0; 2-GPIO1; … , 6-GPIO5 val: 0-input (weak pull high); 1-output (input float)
AT$GPI=gpio	Return GPIO value	gpio = 1-GPIO0; 2-GPIO1; … , 6-GPIO5
AT$GPO=gpio, val	Set GPIO output high or output low	gpio = 1-GPIO0; 2-GPIO1; … , 6-GPIO5 val: 0(output low)/1(output high)
AT$FEAT=page	Erase flash page	Page: 0 ~ 13 [EasyAT Commander related]
AT$SIO=port	Scan GPIO input values and execute relevant flash	Port: 6-bit input for GPIO0 to GPIO5. A “1” represents the relevant GPIO

	page	input will be scanned. [EasyAT Commander related] e.g. port = "100000", GPIO0 value is scanned and either GPIO0_Input(High) or GPIO0_input(Low) flash page will be executed [EasyAT Commander related]
AT$IFVTH=voltage	Set battery detection voltage threshold	Voltage supply is measured and the AT command on page 12 or page 13 will be executed if the voltage is lower and higher than the threshold respectively [EasyAT Commander related]
AT$DLY=count	No operation delay	Count: number of 100ms delays

Table 6-1 AT Command Set

6.2 *Special Notes for Sigfox AT command interface*

- To load the Sigfox library for specific region X, one should set (AT$RCZ) and confirm (AT$RCZ?) the value stored for RCZ then execute AT$O=1,X
- The configuration set by the following AT commands will be stored on flash and the value will be retained even after power off
    - Transmitting frequency (i.e. AT$IF)
    - Transmitting power (i.e. AT$302)
    - Sigfox configuration word (i.e. AT$400)
    - The following setting **must be loaded** to ensure normal Sigfox network activity:
        - **RCZ2: AT$IF=902200000, AT$400=1,0,0,1**
        -
    - Set RCZ region by AT$RCZ

6.3 *Bootloader*

The preloaded bootloader allows the user to reprogram the flash in the SOC. To enter the firmware update mode, user can

I. Pull pin 16 low at startup (i.e. the STATUS pin of module)
On start up, the bootloader polls the module "STATUS" pin which is pin 16 of the SOC. If the pin is logically low, the UART on the SOC is configured as 115200bps and the bootloader is waiting for firmware via XMODEM. User can then upload the application binary file to the SOC via XMODEM. Details can be found in "RM-UPLYNX-E001: Uplynx AT Command GUI and EasyAT User Guide". The application will be stored at the application startup address and be uploaded after the system is rebooted. Details can be found in the "Uplynx Software Development Kit User Guide". Since the "STATUS" pin is an output pin at normal operation, it is important to ensure the pin is NOT pulled down by the application circuit during normal startup.

II. Enter AT$FW=1 when the Sigfox verified AT command interface is uploaded, the module enters XMODEM mode after the AT$FW command is asserted. The speed of UART is

configurable to 115200bps. The new firmware is to be transmitted via XMODEM protocol over UART and will be installed automatically. Upon successful update, the new firmware will be uploaded on the next reboot. Details can be found in "RM-UPLYNX-E001: Uplynx AT Command GUI and EasyAT User Guide"

6.4 *Device ID, KEY and Portable access code*

As part of the Sigfox operation requirements, each Sigfox device must be assigned a unique identification number (ID), encryption key (KEY) and portable access code (PAC). This information is preloaded in the module and only the ID and PAC can be read via AT command.

7 *Transmission Power and Current Consumption*

7.1 *Transmission Power vs. Input Voltage*

902.2MHz		
VDD	**Power**	**Current (Continuous Wave)**
5	22.3	170.6
4.5	22.3	170.6
4	22.3	170.6
3.9	22.3	170.6
3.8	22.3	170.6
3.7	22.3	170.6
3.6	22.3	170.6
3.5	22.3	170.6
3.4	22.3	170.6
3.3	22.16	167.5
3.2	21.96	163.4
3.1	21.75	159.6
3	21.53	155.9
2.9	20.31	152.5
2.8	21.06	149.3
2.7	20.8	146.1
2.6	20.5	142
2.5	20.1	135.8

Table 7-1 Recommended Pin Connections

The current consumption of the Uplynx-M-RCZ24 is measured and data is presented as a reference. The current is measured using the evaluation kit for Uplynx-M-RCZ24. Current through J2 is measured by a Tektronix MDO3104 and a TCPA300. The module is configured for RCZ2 and AT$SB=1 is executed to send a bit.

7.2 *Current Profile and Measurement*

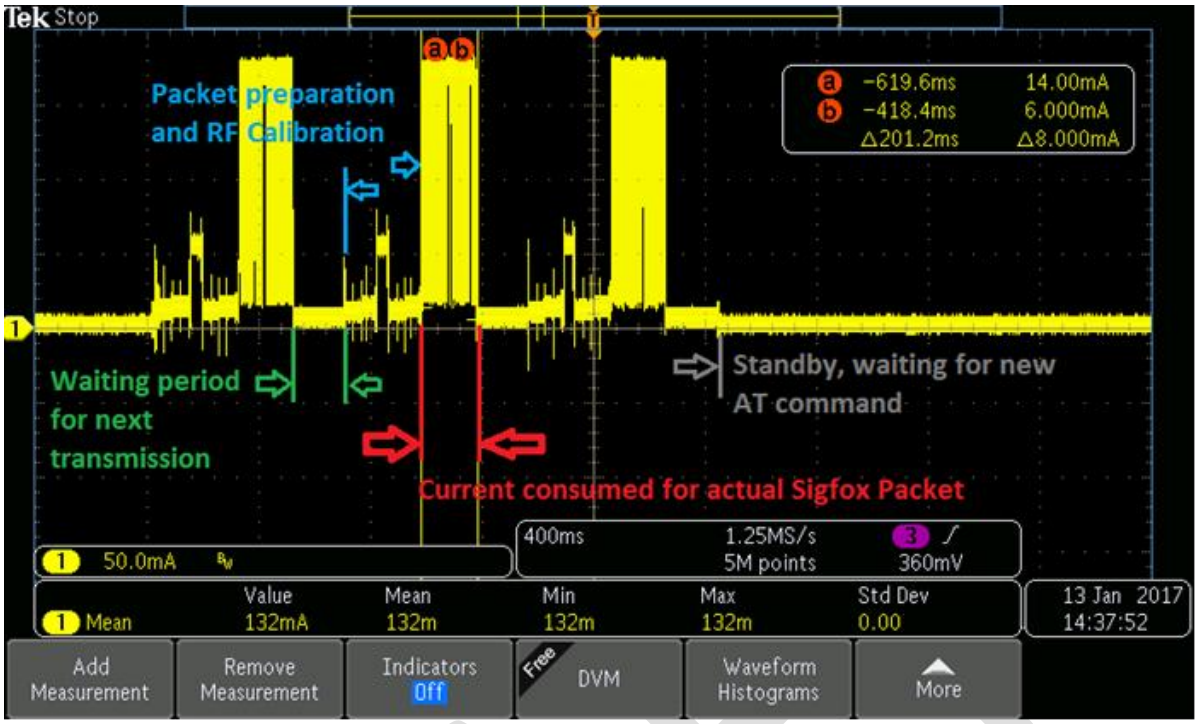


Figure 7-1 Current Profile

VDD @ 5V, 902.2MHz	
Output Power	**Current**
AT$302 to give	Average Current consumption AT$SB=1
14dBm	59.3mA
16dBm	70.6mA
18dBm	83mA
20dBm	124mA
22dBm	132mA
Standby Current (waiting for AT command)	2.5mA
Average current between packets (waiting period + calibration + packet preparation)	14.5mA

8 *Application Information*

8.1 *Mounting Considerations*

Please note this module is designed for inclusion in an embedded design. If you need an off-the-shelf solution you can purchase one of the Uplynx-M-RCZx Evaluation boards.

Surface mount board layout is a critical portion of the total design. The footprint for the module must be the correct size to ensure proper solder connection interface between the board and the module. With the correct pad geometry, the module will self align when subjected to a solder reflow process.

User should surface mount the module onto their hosting PCB with all pads soldered properly. All the control signal and ground pads must be connected properly to ensure correct operation.

8.2 *Recommended connection to essential pins*

PIN	Recommendation
TX_OUT	The 50Ω RF output should be connected to a pi/T antenna matching circuit for potential antenna tuning. An ESD diode could be placed at the antenna port to protect the product against an ESD event induced due to human activity.
VSS	The RF performance relies strongly on a good quality ground. It is recommended to use a ground plane if possible or thick and close ground traces are required to minimize radiation and ensure the best RF performance
STATUS	Can be connected to the host processor to detect module status or the pin can lead to a status LED for displaying purposes
VDD	The voltage supply can come directly from a cell, ac adapter or USB. A decoupling capacitor of size 10µF placed close to the 5V input is recommended. The allowable voltage at this power input is below 5.5V and above 2.6V.
POW_EN	It is connected to a host processor to switch on and off the modem module.
RST_N	This can be tied to a universal reset pin or the host processor. It is internally pulled high to VLDO. In other words, RST_N only works when POW_EN is set high. A 10µF capacitor would be recommended in place close to the module pin in case the supply voltage to the module. The pull high resistance onto pin RESET_N from the system must be smaller than 50k Ω to ensure proper module startup.
VLDO	This is the output of the internal LDO of the module. This voltage supply is used by the module RF system and it is highly recommended to leave this pin unconnected. In case this supply is used by another part of the system, a 1µF capacitor is recommended to be put close to the module.

Table 8-1 Recommended Pin Connections

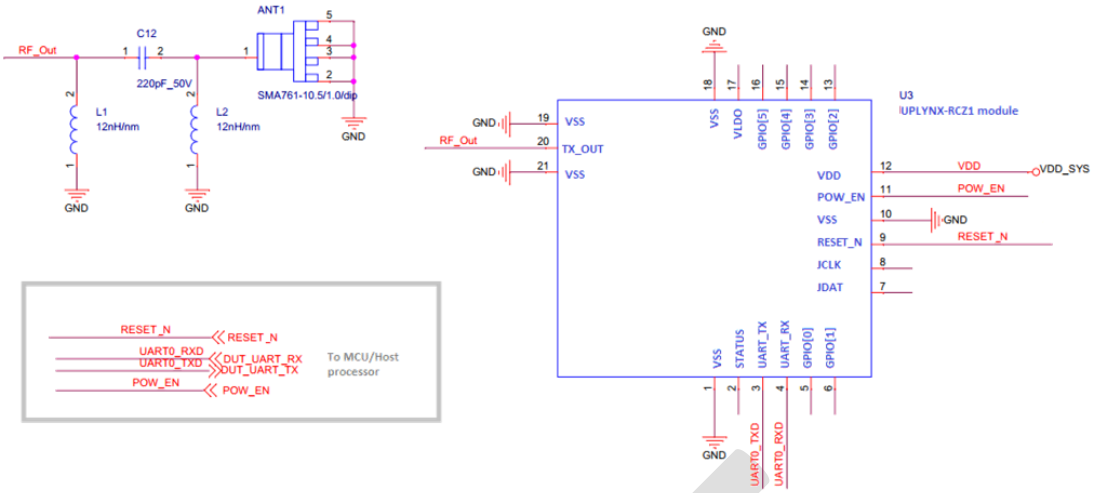


Figure 8-1 Typical Application Circuit

8.3 *Switch ON and OFF procedure*

To ensure proper operation, POW_EN must be asserted high after 5V has settled then wait for 5ms before AT commands can be passed down the UART interface. The settling time is required for the LDO and crystal oscillator to settle to their operating conditions. A software routine can be used to poll the status of STATUS pin before any actual payload is passed to the module.

After switching the module OFF, by pulling POW_EN low, it is highly recommended that the system should wait for at least 10ms before another attempt to power ON.

8.4 *RF power and current measurement.*

The Uplynx M2C8001 operates from 1.8V to 3.6V and the module is designed to leave enough headroom for battery voltage variation and also provide maximum RF transmission power.

3.6V is selected.

With AT$302, the module transmission power is configured within the range of 14 to 22.

The transmission power and current consumption are measured and are shown below. The user can select an appropriate power level setting to accommodate losses.

8.5 *RF Grounding for FCC compliance*

The Uplynx-M-RCZ24 is designed to deliver ~22dBm and is compliant to FCC emission regulations. To achieve the tight emission limitation of the restricted bands, the grounding of the module must be maintained by connecting all the ground pads to a large ground plan in the PCB stack. It is highly recommended that the mother board be designed with dedicated ground plane which connect to all the VSS pins on the module. The VSS pads must be connected to the ground plane with a minimum of 3 vias. Decoupling capacitors must be located close to the module supply voltage. To maximize heat dissipation, the large ground pad must be connected

to the “mother” PCB. Special care must be paid to the solder mask on the mother board to ensure highest yield.

8.6 *Recommended Antenna*

Vendor	Part number	Type
Taoglas	TI.09.B.0151	Dipole antenna
Antenova	SRF2I019	ISM Flat Patch RF Antenna

9 *Certification*

- Sigfox RCZ24 reference design certification
- FCC

10 *Order Information*

Part Number	Description
UPLYNX-M-RCZ24	Uplynx Sigfox Verified RCZ24 modem module 3.3V
UPLYNX-M-RCZ24-1.5V*	Uplynx Sigfox Verified RCZ24 modem module 1.5V

*Please contact our sales representatives for detail information.

Related products

Part Number	Description
UPLYNX-M-RCZ24-EVB	Uplynx Sigfox Verified RCZ24 modem Evaluation Kit