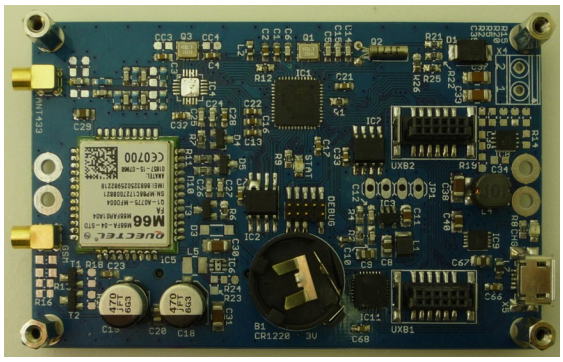

plumpot-cellular

A plumpot series base board with a sub-1GHz radio and a GPRS/EDGE cellular modem

Features:

- half-length, half-width form factor (80x50mm)
- mounting holes for half-length half-width and half-length quarter-width extension boards
- two extension bus connectors (UXB1 compatible - multidrop half-duplex SPI bus, I2C bus, wakeup request, interrupt request and 5V power)
- AX5243 sub-1GHz radio module with a 50ohm MMCX antenna connector
- Quectel M66 2.5G GPRS/EDGE cellular modem with a 50ohm MMCX antenna connector and network activity LED indicators
- 6-60V Vin power supply step down regulator for providing system and bus power (5V, 0.2A)
- micro-B USB port with a CP2101 serial to USB bridge (console access and power input)
- RTC with a CR1220 lithium coin cell backup

The board is developed as an open source hardware using tools freely available for non-commercial usage. It is able to run free and non-free commercial software without any restrictions. It is not locked to a specific firmware and contains a standard 10-pin Cortex Debug connector. A multitude of free and commercial development tools exist to develop and modify the firmware for the board.

For additional information see the licensing section.

Table of Contents

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List of drawings

1. Versions of the board

Name, version	Date released	License and contributors	Comments
plumpot-cellular-0.1.0 (old name unodex-connect-42)	2017-05-04	CC-BY-SA, Marek Koza <qyx@krtko.org>	Initial revision
plumpot-cellular-1.0.0	planned 2018		

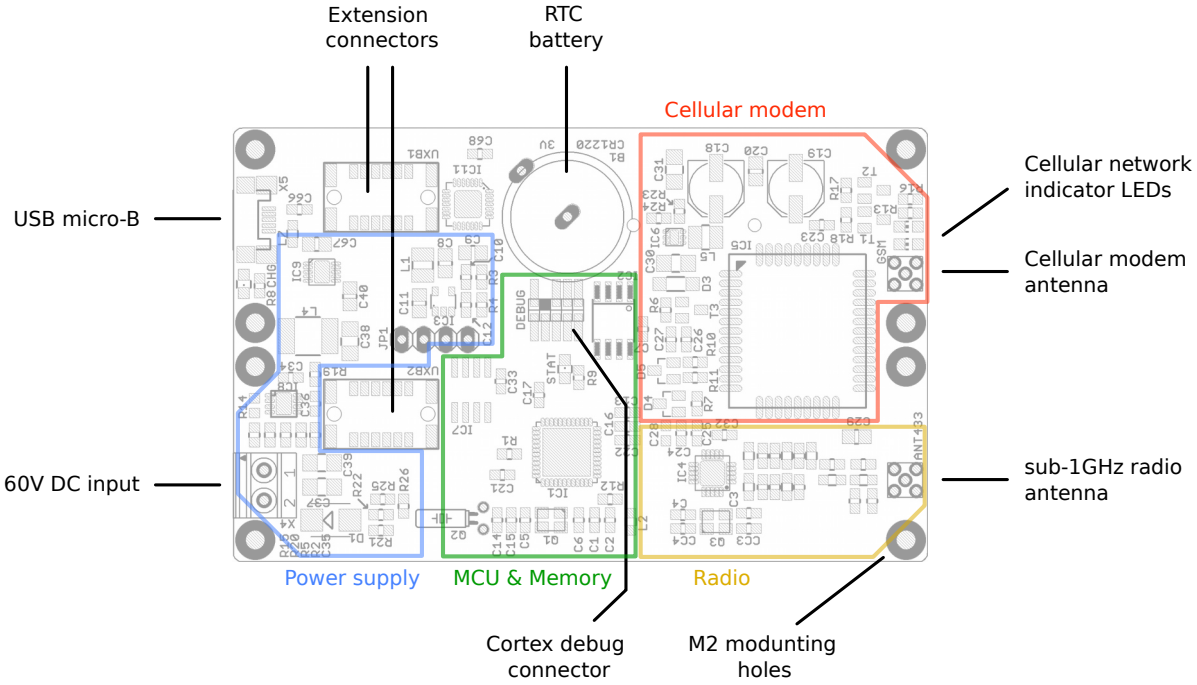
2. Document revisions

Date	Name	Comments
2017-10-30	Marek Koza	Initial revision

3. Changes and issues (errata)

Version	Change/issue
0.1.0	SPI Flash HOLD input issue (reported by Marek Koza) The SPI NOR flash memory was unusable as a result of an undefined HOLD input state. The issue will be resolved in the next revision. You can patch the board by making a solder bridge between pins 7 and 8 on the SPI flash chip.
	Cellular modem step-down regulator unavailable (reported by Marek Koza) The regulator used for the cellular modem (NCP1521) in the DFN6 package is not available anymore from the common distributors. The issue will be resolved in the next revision by changing the step-down regulator IC.
	I2C bus is unstable (reported by Marek Koza) I2C bus on the board uses only the internal STM32 pull-up resistors. External resistors with a value around 4.7K should be added.
	60V power suplly is insufficient to power the cellular modem (reported by Marek Koza) The 200mA output power supply TPS54061 is unable to power the cellular modem during high power peaks and the modem ocassionaly powers off on undervoltage. This can be resolved by a software patch to restart the modem on undervoltage or using an extension board with a power supply capable of delivering at least 0.5A current.

4. Board layout and connections



Drawing 1: Layout of the base board with description

5. System components

5.1 CPU

The board contains an ARM Cortex-M4 MCU running at 84MHz (max), 16MHz (idle). The STM32F401CCU7 microcontroller was selected because of its good availability, low cost, good documentation, development tool availability and a great community being built around the STM32 series of microcontrollers.

The processor contains 64kB of internal SRAM and 512kB of internal Flash for the bootloader and the plumCore firmware.

5.2 Memories

There is also a 32kB I2C EEPROM memory on the base board together with a 1MB SPI NOR flash memory sharing the SPI bus with the radio modem. Those memories may be used to store configuration and log data.

5.3 Interfaces

The CP2102 USB to serial interface bridge was selected to provide a console access for the bootloader and plumCore command line interface. It can also be used to power the board during development and configuration. It is not recommended to power the board using the USB connector in the field as there is no overvoltage or overcurrent protection included.

There is also a 4 pin 2.54mm male header with I2C bus signals for small sensors and modules.

5.4 Extension bus

There are two extension bus connectors included on the base board designed to be compatible with a range of other extension boards for data acquisition, power delivery and communication. The bus contains lines required for half-duplex multidrop (multiple slaves) SPI communication with fast extension boards, I2C lines for slower and simpler extension boards, wakeup signal to wake the boards before an actual data transmission occurs, interrupt request signal to notify the master than a new data is available and a 5V/2A power provided by at least one power board. Multiple boards can provide power as the power OR-ing feature is mandatory on them.

6. Electrical characteristics and power consumption

6.1 Power supply

Parameter	Conditions	Min	Typical	Max	Unit
USB power supply voltage		4.50	5.00	5.50	V
External 5V power supply voltage	Voltage supplied over the extension bus connector	4.50	5.00	5.50	V
5V current consumption idle	No extension boards populated, all onboard peripherals idle, cellular modem off, radio modem off, LEDs off, CPU in the running mode, idle (16MHz), T=25°C		20		mA
5V current consumption max	LEDs on, cellular modem connected to the network, PDP context active, transmitting data, radio modem transmitting data, CPU in the running mode, performance (84MHz), T=25°C	80	120	150	mA
Vin power supply voltage		10.00	24.00	60.00	V
Vin current consumption max	Vin=60V	15	20	40	mA

Table 1: Power supply input characteristics

6.2 Cellular modem

Parameter	Conditions	Min	Typical	Max	Unit

Table 2: Cellular modem parameters

6.3 Radio modem

Parameter	Conditions	Min	Typical	Max	Unit
Modulation type			FSK, MSK, 4FSK, GFSK, GMSK, ASK, AFSK,		

			FM, PSK		
Frequency range		27	433	1050	MHz
Data rate		0.1		125	kbps
Sensitivity	0.1kbps, FSK, 868MHz	-135			dBm
	100kbps, FSK, 868MHz	-107			dBm
Antenna input power				0	dBm
Maximum output power				16	dBm
XTAL frequency			16		MHz
XTAL frequency tolerance			20		ppm

Table 3: Sub-1GHz radio modem parameters

6.4 Extension bus

Parameter	Conditions	Min	Typical	Max	Unit
Output voltage	No other power source on the bus	4.90	5.00	5.10	V
I2C interface speed				400	kHz
I2C interface level			3.0		V
SPI interface speed	CPU in the running state, performance mode	1	21	42	MHz
	CPU in the running state, idle mode	1	1	1	MHz
SPI interface level			3.0		V
wake-up and irq pin level			3.0		V

Table 4: UXB extension bus parameters

7. CE conformity

8. Licensing and contributing

Author of the original design is Marek Koza <qyx@krtko.org>. Resources for the board can be found on the following locations:

- http://qyx.krtko.org/projects/plumpot-cellular/
- http://github.com/iqyx/plumpot-cellular

Everyone is free to use, create and modify the design under the mentioned licensing terms. If you find a bug, you can submit a report on the GitHub project page.

List of contributors:

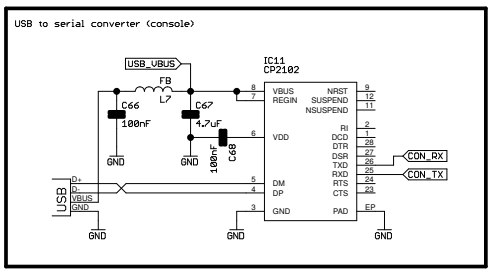
- empty

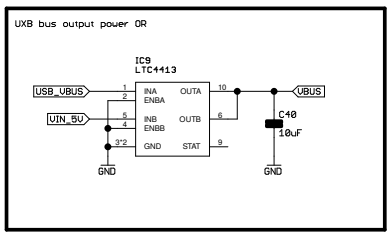
This is a list of software you can use to open and modify files provided in the board repository:

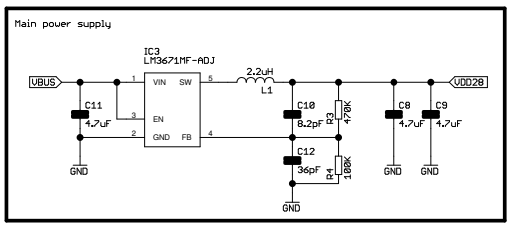
- Cadsoft Eagle (free version is enough), or Autodesk Eagle to open and modify schematic and board layout files. If you do not have this software installed or cannot use it, you can find PDF exports of the schematic and board layout layers in the repository. Gerber exports are available too. You can use them to submit the board for manufacturing.
- Any text editor to view and edit README, BOM and other text files and write/modify your firmware files. BOM files are used to find and order components required for the board.
- GCC to compile the bootloader and firmware files. There are also many commercial compilers and IDE tools to compile your code provided for free (with some restrictions).
- OpenOCD to upload your compiled files to the board using the 10 pin Cortex Debug connector and a compatible debugger (such as STLink on all Discovery and Nucleo boards from ST).

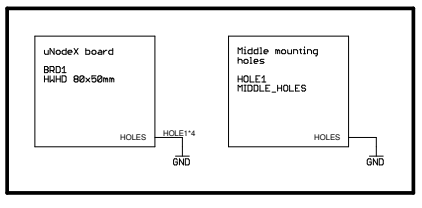
9. Schematic

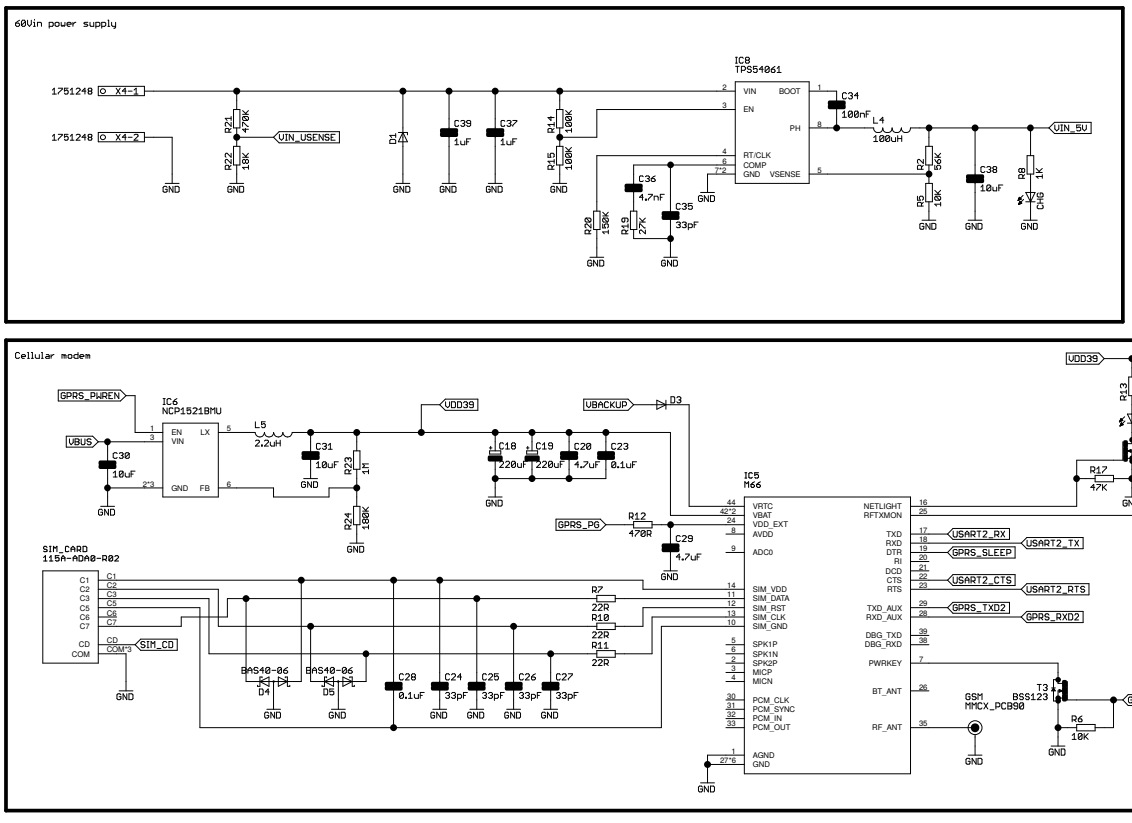
The schematic is included for a quick reference only. The original version is included in the repository.

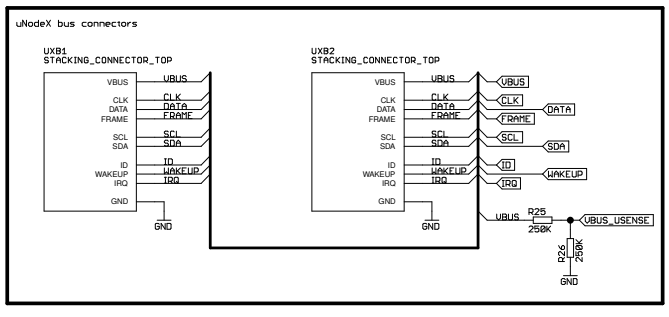


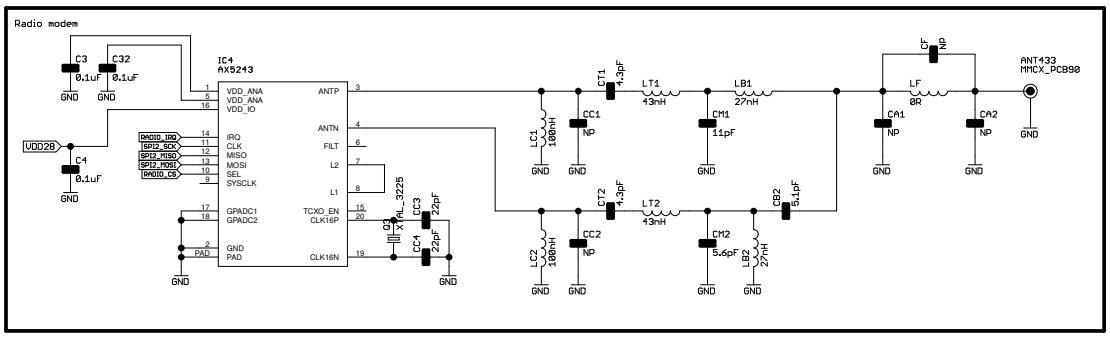


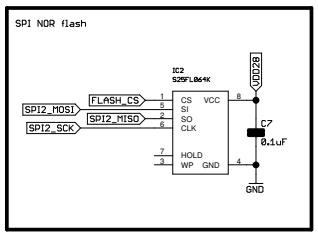


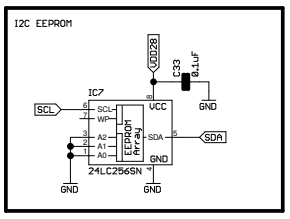


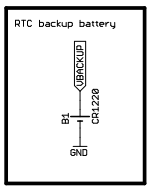


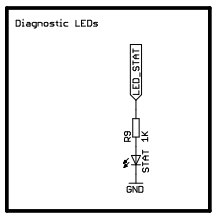


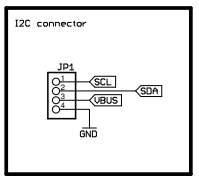


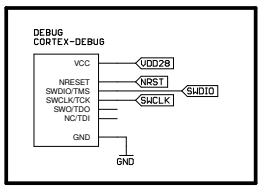


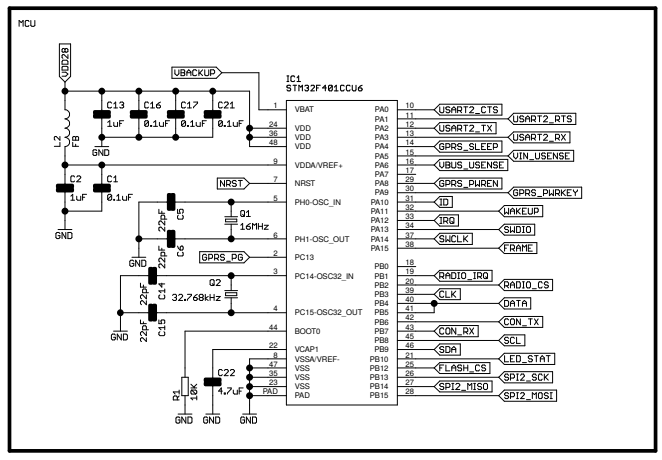












TODO:

testing pads
move the console USART to PA9/PA10 to enable bootloader over USART
add PTC to VIN
replace VIN sensing resistor (bigger package)
replace NCP1521