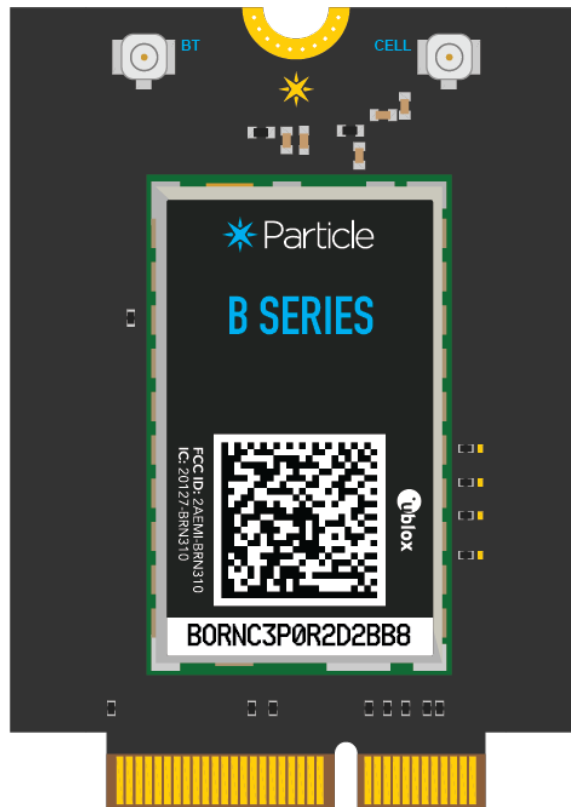


# B404X/B404/B402 Datasheet (014)

PRE-RELEASE DRAFT 2021-10-27



# Functional description

## OVERVIEW

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The B Series System-on-a-Module (SoM) is a cellular device with support for BLE (Bluetooth LE). It is based on the Nordic nRF52840 micro-controller.

The B Series is designed to be integrated into your circuit board design, plugging into a M.2 NGFF connector on your board, allowing the module to be changed or upgraded easily.

## FEATURES

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### Features - B402, B404

- u-blox SARA-R410M-02B or R410M-03 LTE modem (B402, B404)
- LTE Cat M1 module
- Support for United States, Canada, and Mexico only
- 3GPP Release 13 LTE Cat M1
- Cat M1 bands: 2, 3, 4, 5, 8, 12, 13, 20, 28
- Embedded Particle EtherSIM (B404)
- Embedded Particle SIM (B402)

### Features - B404X

- u-blox SARA-R510S-01B LTE modem (B404X)
- LTE Cat M1 module
- Support for United States, Canada, and Mexico only
- 3GPP Release 14 LTE Cat M1
- Cat M1 bands: 1, 2, 3, 4, 5, 8, 12, 13, 18, 19, 20, 25, 26, 28, 66, 71, 85<sup>1</sup>
- Embedded Particle EtherSIM (B404X)

<sup>1</sup> Not all bands enabled in software by default

### Features - All Models

- Nordic Semiconductor nRF52840 SoC
- ARM Cortex-M4F 32-bit processor @ 64MHz
- 1MB flash, 256KB RAM
- Bluetooth 5: 2 Mbps, 1 Mbps, 500 Kbps, 125 Kbps
- Supports DSP instructions, HW accelerated Floating Point Unit (FPU) calculations
- ARM TrustZone CryptoCell-310 Cryptographic and security module
- Up to +8 dBm TX power (down to -20 dBm in 4 dB steps)
- NFC-A tag
- On-module additional 4MB SPI flash
- 24 mixed signal GPIO (8 x Analog, 4 x PWM), UART, I2C, SPI
- USB 2.0 full speed (12 Mbps)
- JTAG (SWD) pins
- RGB status pins for LED
- Reset and Mode pins for buttons
- On-module MFF2 Particle SIM
- Two on-module U.FL connectors for external antennas
- M.2 interface
- FCC and PTCRB certified
- RoHS compliant (lead-free)

# Interfaces

## BLOCK DIAGRAM



## POWER

### VCC

VCC is used to supply power to the u-blox SARA-R410M/R410S cellular module. The recommended input voltage range on this pin is between 3.6V to 4.2V DC. Make sure that the supply can handle currents of at least 2 A.

### 3V3

3V3 is used to supply power to nRF52840, logic ICs, memory, etc. and 3.3v is recommended. VCC input voltage range is between 3V to 3.6V DC. Make sure that the supply can handle currents of at least 150mA.

### VBUS

VBUS is connected to the USB detect pin of nRF52840 to enables the USB interface. The recommended input voltage range is between 4.35V to 5.5V DC.

## ANTENNA

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There are two radios on the B402 module. A BLE radio (nRF52840) and a cellular radio (u-blox). We have provided two u.FL connectors to plug in the cellular and BLE antenna. These are required if you wish to use the cellular and BLE. If you do not need BLE, you do not need to connect the BLE antenna.

### Certified Cellular Antenna

| SKU      | Description   |
|----------|---|
| ANTCW2EA | Particle Cellular Flex Antenna 2G/3G/LTE [x1]             |
| ANTCW2TY | Particle Cellular Flex Antenna 2G/3G/LTE Tray of 50 [x50] |

- Type: LTE Ultra Wide Band Flex Antenna
- Frequency/band: 698 MHz-2690 MHz
- RoHS Compliant
- Mechanical Specs:
  - Dimensions: 97 x 21 x 0.2 mm
  - Mounting: 3M adhesive backed for application on non-metallic surfaces
  - Connector type: FPC + IPEX connector
  - Cable length: 210 mm
  - Gain: 4.71 dBi

### General Antenna Guidance

- The antenna placement needs to follow some basic rules, as any antenna is sensitive to its environment. Mount the antenna at least 10mm from metal components or surfaces, ideally 20mm for best radiation efficiency, and try to maintain a minimum of three directions free from obstructions to be able to operate effectively.
- Needs tuning with actual product enclosure and all components.
- For the BLE antenna, it is recommended to use a 2.4 GHz single-frequency antenna and not a 2.4 GHz + 5 GHz antenna, so as to avoid large gain at the frequency twice of 2.4 GHz which can cause the second harmonic radiation of 2.4 GHz to exceed standards.

## PERIPHERALS AND GPIO

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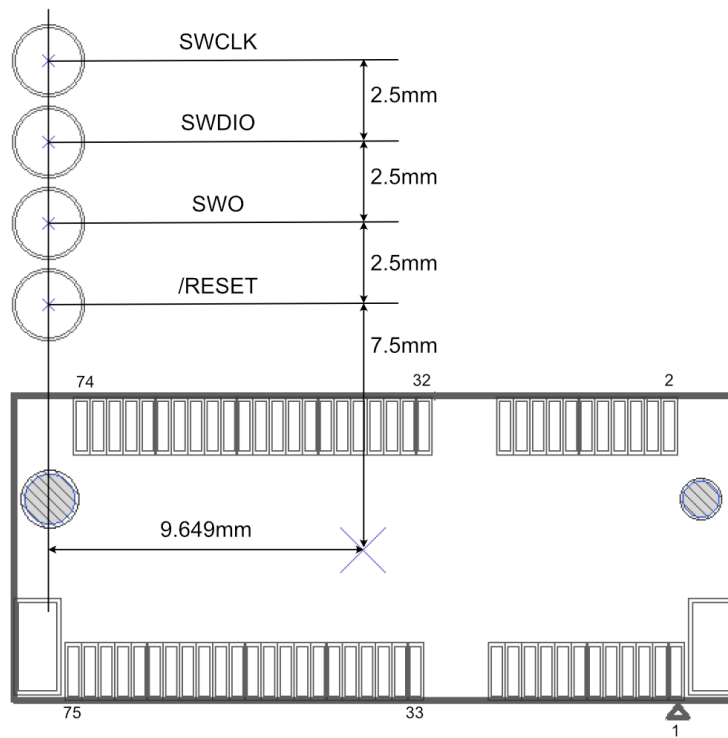
| Peripheral Type | Qty      | Input(I) / Output(O) |
|-----------------|----------|----------------------|
| Digital         | 24 (max) | I/O                  |
| Analog (ADC)    | 8 (max)  | I                    |
| UART            | 1        | I/O                  |
| SPI             | 2        | I/O                  |
| I2C             | 2        | I/O                  |
| USB             | 1        | I/O                  |
| PWM             | 7 (max)  | O                    |
| NFC             | 1        | O                    |

There are some optional B402 module specific I/O:

- u-blox USB and VBUS (for u-blox firmware upgrades)

**Note:** All GPIOs are only rated at 3.3VDC max.

The B402 module has 4 pads at the bottom exposing the SWD interface of the nRF52840. This interface can be used to debug your code or reprogram your B402 bootloader, device OS, or the user firmware. We use 4 pogo-pins connecting to these pads during production for firmware flashing.



# Memory map

## **NRF52840 FLASH LAYOUT OVERVIEW**

---

- Bootloader (48KB, @0xF4000)
- User Application
- 256KB @ 0xB4000 (Device OS 3.1 and later)
- 128KB @ 0xD4000 (Device OS 3.0 and earlier)
- System (656KB, @0x30000)
- SoftDevice (192KB)

## **EXTERNAL SPI FLASH LAYOUT OVERVIEW (DFU OFFSET: 0X80000000)**

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- OTA (1500KB, @0x00289000)
- Reserved (420KB, @0x00220000)
- FAC (128KB, @0x00200000)
- LittleFS (2M, @0x00000000)

# Pins and button definitions

## PINOUT DIAGRAM

|             |     |    |          |
|-------------|-----|----|----------|
|             | H1  | H3 |          |
|             | H5  |    |          |
| VCC         | 2   | 1  | GND      |
| VCC         | 4   | 3  | GND      |
| VCC         | 6   | 5  | GND      |
| VCC         | 8   | 7  | GND      |
| 3V3         | 10  | 9  | GND      |
| 3V3         | 12  | 11 | USB D+   |
| RESERVED    | 14  | 13 | USB D-   |
| VUSB        | 16  | 15 | GND      |
| RESERVED    | 18  | 17 | NFC1     |
| SCL         | 20  | 19 | NFC2     |
| SDA         | 22  | 21 | GND      |
|             | KEY | 23 | ADC0     |
| MODE        | 32  | 33 | ADC1     |
| RESET       | 34  | 35 | ADC2     |
| TX          | 36  | 37 | ADC3     |
| RX          | 38  | 39 | AGND     |
| CTS         | 40  | 41 | ADC4     |
| RTS         | 42  | 43 | ADC5     |
| u-blox USB+ | 44  | 45 | ADC6     |
| u-blox USB- | 46  | 47 | ADC7     |
| CS          | 48  | 49 | AGND     |
| MISO        | 50  | 51 | RESERVED |
| MOSI        | 52  | 53 | RESERVED |
| SCK         | 54  | 55 | RESERVED |
| GND         | 56  | 57 | RESERVED |
| RESERVED    | 58  | 59 | RESERVED |
| RESERVED    | 60  | 61 | RED      |
| GPIO0       | 62  | 63 | GREEN    |
| GPIO1       | 64  | 65 | BLUE     |
| PWM0        | 66  | 67 | SIM_VCC  |
| PWM1        | 68  | 69 | SIM_RST  |
| PWM2        | 70  | 71 | SIM_CLK  |
| PWM3        | 72  | 73 | SIM_DATA |
| u-blox VBUS | 74  | 75 | NC       |
|             | H2  | H4 |          |

Pins SOM0 to SOM9 will vary across various SoM modules. For example, cellular-specific pins exists in this range.

Additionally there are RESERVED<sup>3</sup> pins, whose functions vary depending on the SoM. For example, nRF52 MCU-based modules use some of these pins for additional ADC and GPIO. They are able to be used as described on the B402, but their function may be different on future modules.

For maximum cross-module flexibility, you should try to use only the common pins when possible.

## PIN DESCRIPTION

| #  | Pin    | Common | Function | nRF52 | Description   |
|----|--------|--------|----------|-------|---|
| 1  | GND    | GND    | POWER    |       | System ground.  |
| 2  | VCC    | VCC    | POWER    |       | System power in, connect to the +LiPo or supply a fixed 3.6-4.2v power. |
| 3  | GND    | GND    | POWER    |       | System ground.  |
| 4  | VCC    | VCC    | POWER    |       | System power in, connect to the +LiPo or supply a fixed 3.6-4.2v power. |
| 5  | GND    | GND    | POWER    |       | System ground.  |
| 6  | VCC    | VCC    | POWER    |       | System power in, connect to the +LiPo or supply a fixed 3.6-4.2v power. |
| 7  | GND    | GND    | POWER    |       | System ground.  |
| 8  | VCC    | VCC    | POWER    |       | System power in, connect to the +LiPo or supply a fixed 3.6-4.2v power. |
| 9  | GND    | GND    | POWER    |       | System ground.  |
| 10 | 3V3    | 3V3    | POWER    |       | System power in, supply a fixed 3.0-3.6v power.                         |
| 11 | USB D+ | USB D+ | IO       |       | Data+ pin of the NRF52840 USB port.                                     |

|    |               |                       |           |       |   |
|----|---------------|-----------------------|-----------|-------|---|
| 12 | 3V3           | 3V3                   | POWER     |       | System power in, supply a fixed 3.0-3.6v power.   |
| 13 | USB D-        | USB D-                | IO        |       | Data- pin of the NRF52840 USB port.   |
| 14 | NC            | RESERVED <sup>3</sup> | NC        |       | Leave unconnected.  |
| 15 | GND           | GND                   | POWER     |       | System ground.  |
| 16 | VUSB          | VUSB                  | POWER     |       | System power in, USB detect pin for nRF52840. 5V on this pin enables the USB interface. |
| 17 | NFC1          | SOM3 <sup>3</sup>     | NFC input | P0.9  | NFC antenna connection.   |
| 18 | NC            | RESERVED <sup>3</sup> | NC        |       | Leave unconnected.  |
| 19 | NFC2          | SOM4 <sup>3</sup>     | NFC input | P0.10 | NFC antenna connection.   |
| 20 | D1            | SCL                   | IO        | P0.27 | I2C SCL, and digital only GPIO.   |
| 21 | GND           | GND                   | POWER     |       | System ground.  |
| 22 | D0            | SDA                   | IO        | P0.26 | I2C SDA, and digital only GPIO.   |
| 23 | A0            | ADC0                  | IO        | P0.3  | Analog input ADC0 <sup>2</sup> , and digital GPIO.                                      |
| 32 | MODE          | MODE                  | IO        | P0.11 | Connected to the MODE button input, and digital only GPIO.                              |
| 33 | A1            | ADC1                  | IO        | P0.4  | Analog input ADC1 <sup>2</sup> , and digital GPIO.                                      |
| 34 | RESET         | RESET                 | I         |       | Active-low reset input.   |
| 35 | A2            | ADC2                  | IO        | P0.28 | Analog input ADC2 <sup>2</sup> , and digital GPIO.                                      |
| 36 | D9            | TX                    | IO        | P0.6  | Primarily used as UART TX, but can also be used as a digital GPIO.                      |
| 37 | A3            | ADC3                  | IO        | P0.29 | Analog input ADC3 <sup>2</sup> , and digital GPIO.                                      |
| 38 | D10           | RX                    | IO        | P0.08 | Primarily used as UART RX, but can also be used as a digital GPIO.                      |
| 39 | AGND          | AGND                  | POWER     |       | System analog ground.   |
| 40 | D3            | RESERVED <sup>3</sup> | IO        | P1.1  | UART flow control CTS, SCL1 (Wire1), SPI1 MOSI, digital only GPIO.                      |
| 41 | A4            | RESERVED <sup>3</sup> | IO        | P0.30 | Analog input ADC4 <sup>2</sup> , and digital GPIO.                                      |
| 42 | D2            | RESERVED <sup>3</sup> | IO        | P1.2  | UART flow control RTS, SDA1 (Wire1), SPI1 SCK, digital only GPIO.                       |
| 43 | A5            | RESERVED <sup>3</sup> | IO        | P0.31 | Analog input ADC5 <sup>2</sup> , and digital GPIO.                                      |
| 44 | u-blox USB D+ | SOM0                  | IO        |       | Data+ pin of the cellular modem USB port.   |
| 45 | A6            | RESERVED <sup>3</sup> | IO        | P0.5  | Analog input ADC6 <sup>2</sup> , and digital GPIO.                                      |
| 46 | u-blox USB D- | SOM1                  | IO        |       | Data- pin of the cellular modem USB port.   |
| 47 | A7            | RESERVED <sup>3</sup> | IO        | P0.2  | Analog input ADC7 <sup>2</sup> , and digital GPIO.                                      |
| 48 | D8            | CS                    | IO        | P1.3  | SPI interface CS, and digital only GPIO.  |
| 49 | AGND          | AGND                  | POWER     |       | System analog ground.   |
| 50 | D11           | MISO                  | IO        | P1.14 | SPI interface MISO, and digital only GPIO.  |
| 51 | NC            | RESERVED <sup>3</sup> | NC        |       | Leave unconnected.  |
| 52 | D12           | MOSI                  | IO        | P1.13 | SPI interface MOSI, and digital only GPIO.  |
| 53 | NC            | RESERVED <sup>3</sup> | NC        |       | Leave unconnected.  |
| 54 | D13           | SCK                   | IO        | P1.15 | SPI interface SCK, and digital only GPIO.   |
| 55 | NC            | RESERVED <sup>3</sup> | NC        |       | Leave unconnected.  |
| 56 | GND           | GND                   | POWER     |       | System analog ground.   |
| 57 | NC            | RESERVED <sup>3</sup> | NC        |       | Leave unconnected.  |
| 58 | NC            | RESERVED <sup>3</sup> | NC        |       | Leave unconnected.  |



|    |                       |                       |       |       |  |
|----|-----------------------|-----------------------|-------|-------|--|
| 59 | NC                    | RESERVED <sup>3</sup> | NC    |       | Leave unconnected.   |
| 60 | NC                    | RESERVED <sup>3</sup> | NC    |       | Leave unconnected.   |
| 61 | RGBR                  | RED                   | IO    | P0.13 | Red pin of the RGB LED.  |
| 62 | D22                   | GPIO0                 | IO    | P0.24 | GPIO0, digital only.   |
| 63 | RGBG                  | GREEN                 | IO    | P0.14 | Green pin of the RGB LED.  |
| 64 | D23                   | GPIO1                 | IO    | P1.9  | GPIO1, digital only.   |
| 65 | RGBB                  | BLUE                  | IO    | P0.15 | Blue pin of the RGB LED.   |
| 66 | D4                    | PWM0                  | IO    | P1.8  | SPI1 MISO, Digital only GPIO, and PWM0.  |
| 67 | SIM_VCC <sup>1</sup>  | SOM5 <sup>3</sup>     | POWER |       | Leave unconnected, 1.8V/3V SIM Supply Output from cellular modem.                      |
| 68 | D5                    | PWM1                  | IO    | P1.10 | Digital only GPIO, and PWM1.   |
| 69 | SIM_RST <sup>1</sup>  | SOM6 <sup>3</sup>     | IO    |       | Leave unconnected, 1.8V/3V SIM Reset Output from cellular modem.                       |
| 70 | D6                    | PWM2                  | IO    | P1.11 | Digital only GPIO, and PWM2.   |
| 71 | SIM_CLK <sup>1</sup>  | SOM7 <sup>3</sup>     | IO    |       | Leave unconnected, 1.8V/3V SIM Clock Output from cellular modem.                       |
| 72 | D7                    | PWM3                  | IO    | P1.12 | Digital only GPIO, and PWM3.   |
| 73 | SIM_DATA <sup>1</sup> | SOM8 <sup>3</sup>     | IO    |       | Leave unconnected, 1.8V/3V SIM Data I/O of cellular modem with internal 4.7 k pull-up. |
| 74 | u-blox VBUS           | SOM2 <sup>3</sup>     | IO    |       | USB detect pin for cellular modem. 5V on this pin enables the u-blox USB interface.    |
| 75 | NC                    | SOM9 <sup>3</sup>     | NC    |       | Leave unconnected.   |

<sup>1</sup>These pins are connected to the internal MFF2 SIM and should be left open.

<sup>2</sup>A0-A7 are 12-bit Analog-to-Digital (A/D) inputs (0-4095).

<sup>3</sup>SoM-specific and Reserved pins will vary depending on module. They are able to be used on the B402, but their function may be different on future modules.

By default, the Tinker application firmware enables the use of the bq24195 PMIC and MAX17043 fuel gauge. This in turn uses I2C (D0 and D1) and pin A6 (PM\_INT). If you are not using the PMIC and fuel gauge and wish to use these pins for other purposes, be sure to disable system power configuration. This setting is persistent, so you may want to disable it with your manufacturing firmware only.

```
System.setPowerConfiguration(SystemPowerConfiguration());
```

If you are using Ethernet with the B Series SoM, the following pins are used by Ethernet:

| Device | OS Pin | M.2 Pin | Ethernet Pin |
|--------|--------|---------|--------------|
| MISO   |        | 50      | SPI MISO     |
| MOSI   |        | 52      | SPI MOSI     |
| SCK    |        | 54      | SPI SCK      |
| A7     |        | 47      | nRESET       |
| D22    |        | 62      | nINTERRUPT   |
| D8     |        | 48      | nCHIP SELECT |

## LED STATUS

### System RGB LED

Unlike the Boron, the B402 module does not have an on-module RGB system status LED. We have provided its individual control pins for you to connect an LED of your liking. This will allow greater flexibility in the end design of your products.

A detailed explanation of different color codes of the RGB system LED can be found [here](#).

# Technical specifications

## ABSOLUTE MAXIMUM RATINGS <sup>[1]</sup>

### Supply voltages

| Parameter                      | Symbol    | Min  | Typ | Max       | Unit |
|--------------------------------|-----------|------|-----|-----------|------|
| <b>Supply voltages</b>         |           |      |     |           |      |
| Supply Input Voltage           | VCC       | -0.3 |     | +6.0      | V    |
| Supply Input Voltage           | 3V3       | -0.3 |     | +3.9      | V    |
| VBUS USB supply voltage        | VUSB      | -0.3 |     | +5.8      | V    |
| <b>I/O pin voltage</b>         |           |      |     |           |      |
| VI/O, VDD ≤ 3.6 V              | IO        | -0.3 |     | VDD + 0.3 | V    |
| VI/O, VDD > 3.6 V              | IO        | -0.3 |     | +3.9      | V    |
| <b>NFC antenna pin current</b> |           |      |     |           |      |
| I <sub>NFC1/2</sub>            | NFC1/NFC2 |      |     | 80        | mA   |
| <b>Radio</b>                   |           |      |     |           |      |
| BT RF input level (52840)      |           |      |     | 10        | dBm  |
| <b>Environmental</b>           |           |      |     |           |      |
| Storage temperature            |           | -40  |     | +85       | °C   |

<sup>[1]</sup> Stresses beyond those listed under absolute maximum ratings may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under recommended operating conditions is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

## RECOMMENDED OPERATING CONDITIONS

| Parameter  | Symbol | Min   | Typ  | Max  | Unit |
|--|--------|-------|------|------|------|
| <b>Supply voltages</b>                           |        |       |      |      |      |
| Supply Input Voltage                             | VCC    | +3.6  | +3.8 | +4.2 | V    |
| Supply Input Voltage                             | 3V3    | +3.0  | +3.3 | +3.6 | V    |
| VBUS USB supply voltage                          | VUSB   | +4.35 | +5.0 | +5.5 | V    |
| <b>Environmental</b>                             |        |       |      |      |      |
| Normal operating temperature <sup>1</sup>        |        | -20   | +25  | +65  | °C   |
| Extended operating temperature <sup>2</sup>      |        | -40   |      | +85  | °C   |
| Humidity Range Non condensing, relative humidity |        |       |      | 95   | %    |

### Notes:

<sup>1</sup> Normal operating temperature range (fully functional and meet 3GPP specifications).

<sup>2</sup> Extended operating temperature range (RF performance may be affected outside normal operating range, though module is fully functional)

## POWER CONSUMPTION

| Parameter  | Symbol                  | Min  | Typ  | Peak | Unit |
|--|-------------------------|------|------|------|------|
| Operating Current (uC on, peripherals and radio disabled)      | $I_{idle}$              | 4.48 | 4.71 | 5.17 | mA   |
| Operating Current (uC on, cellular on but not connected)       | $I_{cell\_idle}$        | 5.1  | 45.2 | 166  | mA   |
| Operating Current (uC on, cellular connecting to tower)        | $I_{cell\_conn\_twr}$   | 13.7 | 56.0 | 192  | mA   |
| Operating Current (uC on, cellular connecting to cloud)        | $I_{cell\_conn\_cloud}$ |      | 63.2 | 185  | mA   |
| Operating Current (uC on, cellular connected but idle)         | $I_{cell\_cloud\_idle}$ | 13.4 | 15.5 | 98.3 | mA   |
| Operating Current (uC on, cellular connected and transmitting) | $I_{cell\_cloud\_tx}$   | 9.47 | 66.3 | 192  | mA   |
| STOP mode sleep, GPIO wake-up                                  | $I_{stop\_gpio}$        | 552  | 555  | 559  | uA   |
| STOP mode sleep, analog wake-up                                | $I_{stop\_analog}$      | 554  | 557  | 559  | uA   |
| STOP mode sleep, RTC wake-up                                   | $I_{stop\_intrtc}$      | 553  | 556  | 558  | uA   |
| STOP mode sleep, BLE wake-up, advertising                      | $I_{stop\_ble\_adv}$    |      | 631  | 2650 | uA   |
| STOP mode sleep, BLE wake-up, connected                        | $I_{stop\_ble\_conn}$   | 47.3 | 630  | 1540 | uA   |
| STOP mode sleep, serial wake-up                                | $I_{stop\_usart}$       | 553  | 556  | 558  | uA   |
| STOP mode sleep, cellular wake-up                              | $I_{stop\_cell}$        | 8.87 | 9.65 | 63.6 | mA   |
| ULP mode sleep, GPIO wake-up                                   | $I_{ulp\_gpio}$         | 44.7 | 47.6 | 49.6 | uA   |
| ULP mode sleep, analog wake-up                                 | $I_{ulp\_analog}$       | 45.0 | 47.8 | 49.5 | uA   |
| ULP mode sleep, RTC wake-up                                    | $I_{ulp\_intrtc}$       | 43.4 | 46.4 | 47.9 | uA   |
| ULP mode sleep, BLE wake-up, advertising                       | $I_{ulp\_ble\_adv}$     |      | 130  | 2560 | uA   |
| ULP mode sleep, BLE wake-up, connected                         | $I_{ulp\_ble\_conn}$    |      | 121  | 1010 | uA   |
| ULP mode sleep, serial wake-up                                 | $I_{ulp\_usart}$        | 554  | 557  | 559  | uA   |
| ULP mode sleep, cellular wake-up                               | $I_{ulp\_cell}$         | 0.37 | 9.47 | 53.7 | mA   |
| HIBERNATE mode sleep, GPIO wake-up                             | $I_{hib\_gpio}$         | 23.6 | 26.0 | 29.7 | uA   |
| HIBERNATE mode sleep, analog wake-up                           | $I_{hib\_analog}$       | 23.9 | 26.5 | 30.5 | uA   |

<sup>1</sup>The min, and particularly peak, values may consist of very short transients. The typical (typ) values are the best indicator of overall power consumption over time. The peak values indicate the absolute minimum capacity of the power supply necessary, not overall consumption.

## RADIO SPECIFICATIONS

The B Series SoM has two radio modules.

### nRF52840

- Bluetooth® 5, 2.4 GHz
  - 95 dBm sensitivity in 1 Mbps Bluetooth® low energy mode
  - 103 dBm sensitivity in 125 kbps Bluetooth® low energy mode (long range)
  - 20 to +8 dBm TX power, configurable in 4 dB steps

### u-blox SARA-R410M-02B or R410M-03

| Parameter      | Value                  |
|----------------|------------------------|
| Protocol stack | 3GPP Release 13        |
| RAT            | LTE Cat M1 Half-Duplex |
| LTE FDD Bands  | Band 12 (700 MHz)      |
|                | Band 28 (700 MHz)      |
|                | Band 13 (750 MHz)      |
|                | Band 20 (800 MHz)      |
|                | Band 5 (850 MHz)       |
|                | Band 8 (900 MHz)       |
|                | Band 4 (1700 MHz)      |
|                | Band 3 (1800 MHz)      |
|                | Band 2 (1900 MHz)      |
| Power class    | Class 3 (23 dBm)       |

- LTE Cat M1 for United States, Canada, and Mexico.
- Not all bands are enabled in software by default.
- Particle LTE Cat M1 devices are not certified for use in Europe or other countries that follow EU certification requirements.

### u-blox SARA-R510S-01B

| Parameter      | Value                  | FCC Certified |
|----------------|------------------------|---------------|
| Protocol stack | 3GPP Release 14        |               |
| RAT            | LTE Cat M1 Half-Duplex |               |
| LTE FDD Bands  | Band 71 (600 MHz)      |               |
|                | Band 12 (700 MHz)      | ✓             |
|                | Band 28 (700 MHz)      | ✓             |
|                | Band 85 (700 MHz)      |               |
|                | Band 13 (750 MHz)      | ✓             |
|                | Band 20 (800 MHz)      | ✓             |
|                | Band 5 (850 MHz)       | ✓             |
|                | Band 18 (850 MHz)      |               |
|                | Band 19 (850 MHz)      |               |
|                | Band 26 (850 MHz)      |               |
|                | Band 8 (900 MHz)       | ✓             |
|                | Band 4 (1700 MHz)      | ✓             |

|             |                    |   |
|-------------|--------------------|---|
|             | Band 3 (1800 MHz)  | ✓ |
|             | Band 2 (1900 MHz)  | ✓ |
|             | Band 25 (1900 MHz) |   |
|             | Band 1 (2100 MHz)  |   |
| Power class | Class 3 (23 dBm)   |   |

- LTE Cat M1 for United States, Canada, and Mexico
- Not all bands are enabled in software by default.
- FCC Certification in the United States only tests bands in use in the United States.
- Particle LTE Cat M1 devices are not certified for use in Europe or other countries that follow EU certification requirements.

## I/O CHARACTERISTICS

These specifications are based on the nRF52840 datasheet.

| Symbol    | Parameter  | Min       | Typ | Max       | Unit |
|-----------|--|-----------|-----|-----------|------|
| VIH       | Input high voltage   | 0.7 xVDD  |     | VDD       | V    |
| VIL       | Input low voltage  | VSS       |     | 0.3 xVDD  | V    |
| VOH,SD    | Output high voltage, standard drive, 0.5 mA, VDD ≥1.7                | VDD - 0.4 |     | VDD       | V    |
| VOH,HDH   | Output high voltage, high drive, 5 mA, VDD ≥ 2.7 V                   | VDD - 0.4 |     | VDD       | V    |
| VOH,HDL   | Output high voltage, high drive, 3 mA, VDD ≥ 1.7 V                   | VDD - 0.4 |     | VDD       | V    |
| VOL,SD    | Output low voltage, standard drive, 0.5 mA, VDD ≥1.7                 | VSS       |     | VSS + 0.4 | V    |
| VOL,HDH   | Output low voltage, high drive, 5 mA, VDD ≥ 2.7 V                    | VSS       |     | VSS + 0.4 | V    |
| VOL,HDL   | Output low voltage, high drive, 3 mA, VDD ≥ 1.7 V                    | VSS       |     | VSS + 0.4 | V    |
| IOL,SD    | Current at VSS+0.4 V, output set low, standard drive, VDD ≥1.7       | 1         | 2   | 4         | mA   |
| IOL,HDH   | Current at VSS+0.4 V, output set low, high drive, VDD ≥ 2.7V         | 6         | 10  | 15        | mA   |
| IOL,HDL   | Current at VSS+0.4 V, output set low, high drive, VDD ≥ 1.7V         | 3         |     |           | mA   |
| IOH,SD    | Current at VDD-0.4 V, output set high, standard drive, VDD ≥1.7      | 1         | 2   | 4         | mA   |
| IOH,HDH   | Current at VDD-0.4 V, output set high, high drive, VDD ≥ 2.7V        | 6         | 9   | 14        | mA   |
| IOH,HDL   | Current at VDD-0.4 V, output set high, high drive, VDD ≥ 1.7V        | 3         |     |           | mA   |
| tRF,15pF  | Rise/fall time, standard drivemode, 10-90%, 15 pF load <sup>1</sup>  |           | 9   |           | ns   |
| tRF,25pF  | Rise/fall time, standard drive mode, 10-90%, 25 pF load <sup>1</sup> |           | 13  |           | ns   |
| tRF,50pF  | Rise/fall time, standard drive mode, 10-90%, 50 pF load <sup>1</sup> |           | 25  |           | ns   |
| tHRF,15pF | Rise/Fall time, high drive mode, 10-90%, 15 pF load <sup>1</sup>     |           | 4   |           | ns   |
| tHRF,25pF | Rise/Fall time, high drive mode, 10-90%, 25 pF load <sup>1</sup>     |           | 5   |           | ns   |
| tHRF,50pF | Rise/Fall time, high drive mode, 10-90%, 50 pF load <sup>1</sup>     |           | 8   |           | ns   |
| RPU       | Pull-up resistance   | 11        | 13  | 16        | kΩ   |
| RPD       | Pull-down resistance   | 11        | 13  | 16        | kΩ   |
| CPAD      | Pad capacitance  |           | 3   |           | pF   |
| CPAD_NFC  | Pad capacitance on NFC pads  |           | 4   |           | pF   |
| INFC_LEAK | Leakage current between NFC pads when driven to different states     |           | 1   | 10        | μA   |

- Rise and fall times based on simulations
- GPIO default to standard drive (2mA) but can be reconfigured to high drive (9mA) in Device OS 2.0.0 and later using the `pinSetDriveStrength()` function.

# Mechanical specifications

## DIMENSIONS AND WEIGHT

| Parameters | Value | Unit  |
|------------|-------|-------|
| Width      | 30    | mm    |
| Height     | 42    | mm    |
| Thickness  | 5.5   | mm    |
| Weight     | 6.2   | grams |

## MECHANICAL DRAWING



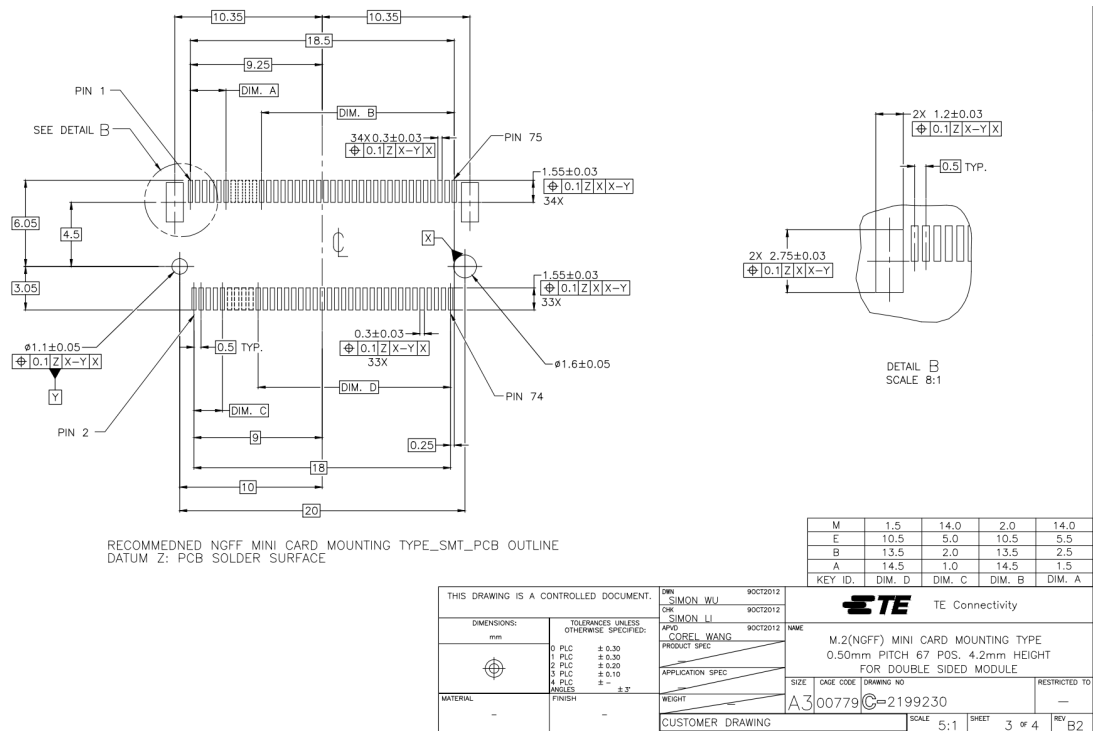
Dimensions are in millimeters.



MATING CONNECTOR AND LAND PATTERN

The mating connector is a an M.2 (NGFF) type 4. Note that there are several different key configurations for the M.2, and type 4 is different than is commonly used on SSDs.

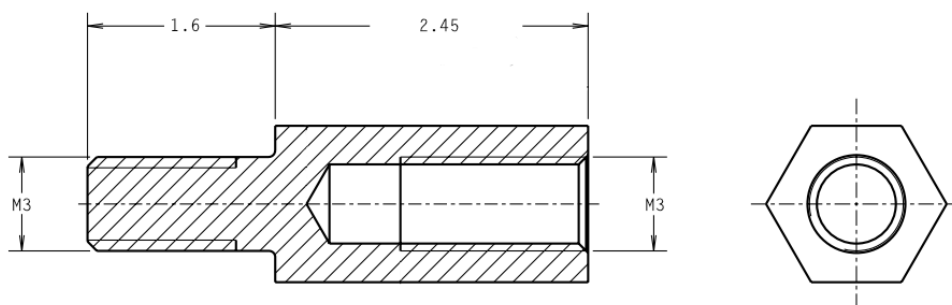
One compatible connector is the [TE 2199230-4](#). It is widely available including at suppliers such as [DigiKey](#).





We recommend this screw assembly to securely affix the B series SoM to your circuit board. From top to bottom:

- M3 screw, 3mm long
- M3 washer
- M3 standoff, 2.45mm



- Mounting hole, 2.6 mm metal hole, 3.1mm metal ring diameter (picture is of the bottom side of the circuit board)



- An [alternative design](#) uses a [JAE SM3ZS067U410-NUTI-R1200](#) standoff. It's reflow soldered to your base board and has a threaded hole for a M2\*3 screw to hold down the SoM. This may be easier to obtain.
- Note that a hold-down screw is required because the M.2 connector does not have integrated locks and the SoM will pop up if not attached to the base board.

#### **DESIGN CONSIDERATIONS**

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We strongly recommend against placing components under the SOM board because there is not enough height.



# Product Handling

## **ESD PRECAUTIONS**

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The B series contains highly sensitive electronic circuitry and is an Electrostatic Sensitive Device (ESD). Handling an B series without proper ESD protection may destroy or damage it permanently. Proper ESD handling and packaging procedures must be applied throughout the processing, handling and operation of any application that incorporates the B series module. ESD precautions should be implemented on the application board where the B series is mounted. Failure to observe these precautions can result in severe damage to the B series!

## **CONNECTORS**

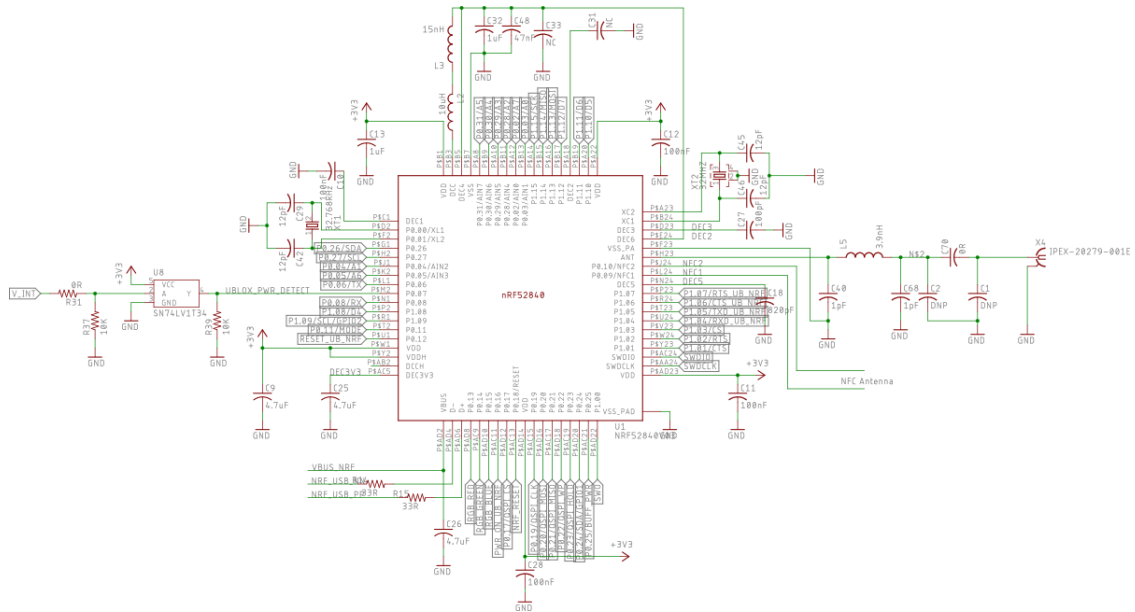
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The U.FL antenna connector is not designed to be constantly plugged and unplugged. The antenna pin is static sensitive and you can destroy the radio with improper handling. A tiny dab of glue (epoxy, rubber cement, liquid tape or hot glue) on the connector can be used securely hold the plug in place.

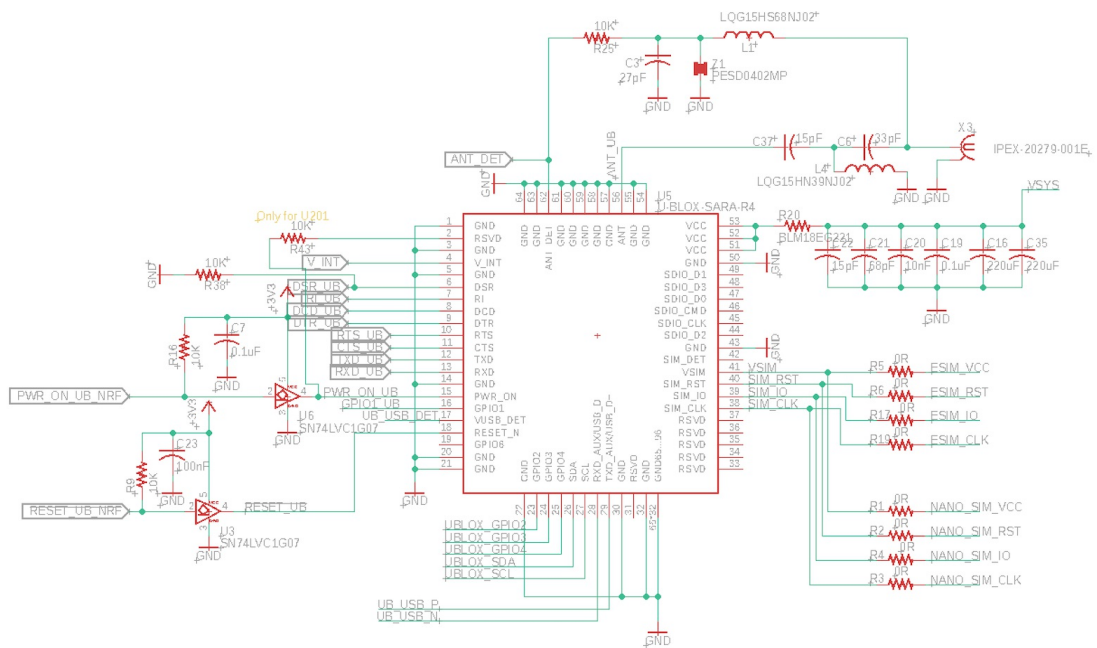
The M.2 edge connector is static sensitive and should be handled carefully. The M.2 connector is not designed for repeated removal and insertion of the module.

# Schematics

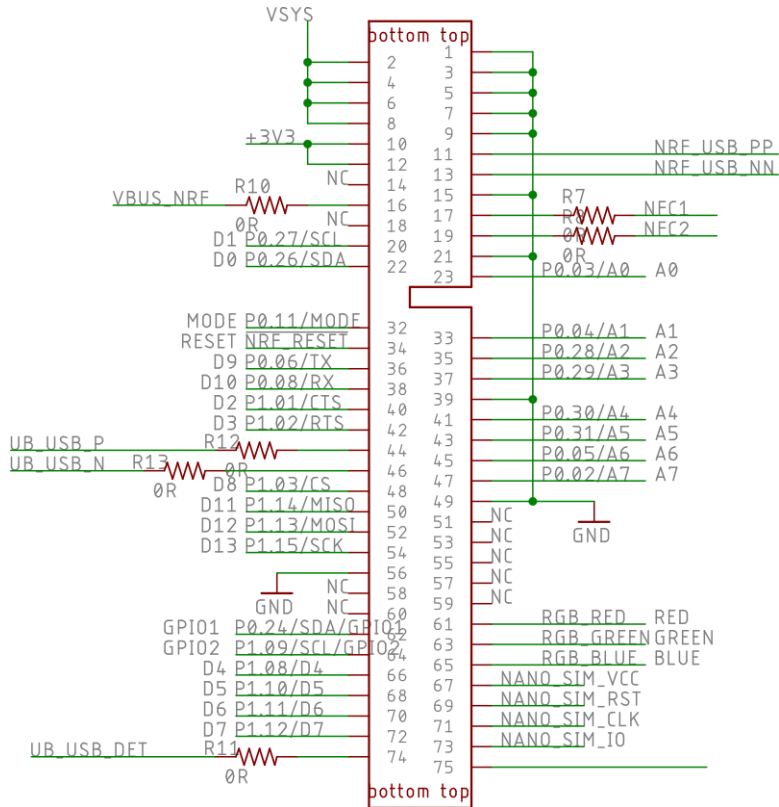
## MICROCONTROLLER



## U-BLOX CELLULAR MODEM

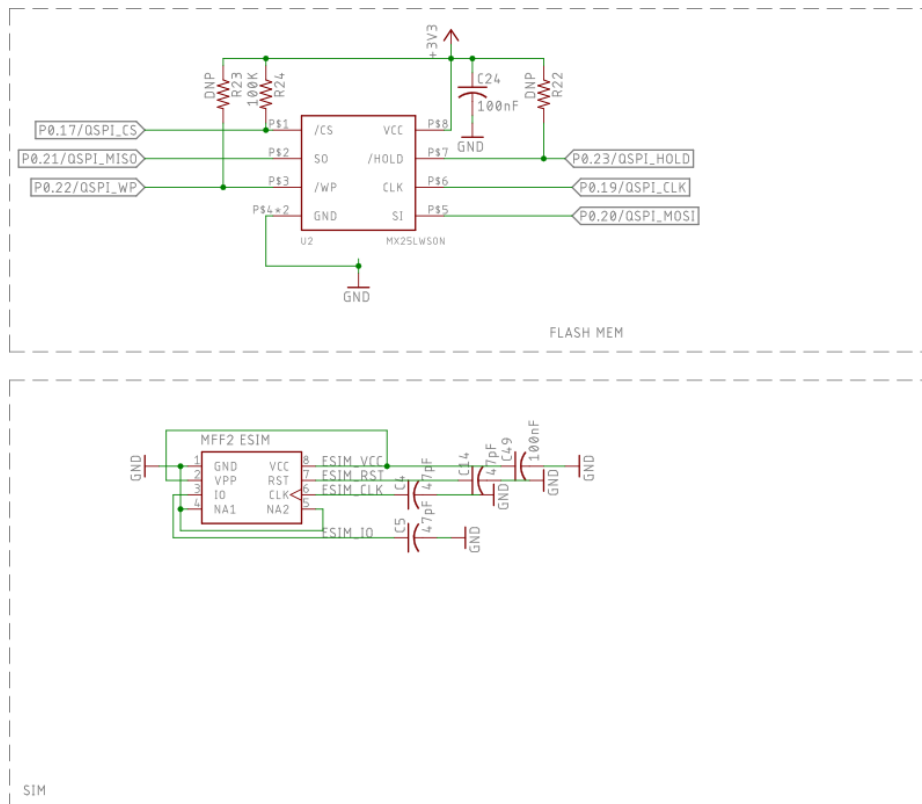


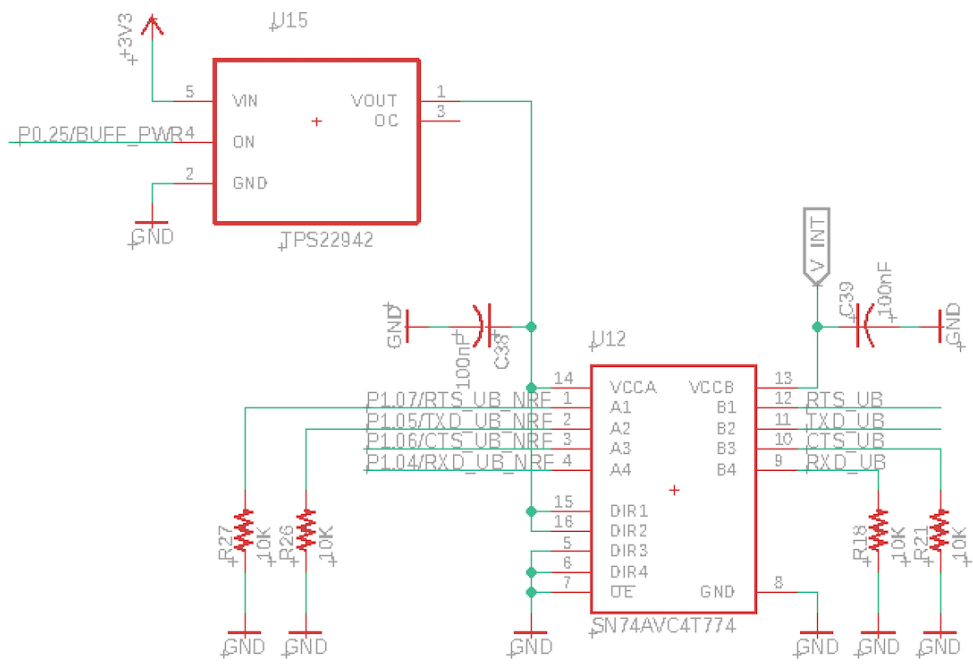
## M.2 CONNECTOR



Note: The labels for CTS and RTS are reversed in this schematic.

## SIM AND FLASH







## Default settings

The B series comes pre-programmed with a bootloader and a user application called Tinker. This application works with an iOS and Android app also named Tinker that allows you to very easily toggle digital pins, take analog and digital readings and drive variable PWM outputs.

The bootloader allows you to easily update the user application via several different methods, USB, OTA, Serial Y-Modem, and also internally via the Factory Reset procedure. All of these methods have multiple tools associated with them as well.

# Country compatibility

| Country       | Model | Technologies | Carriers                              |
|---------------|-------|--------------|---------------------------------------|
| Canada        | B404  | M1           | Bell Mobility, Rogers Wireless, Telus |
| Mexico        | B404  | M1           | AT&T                                  |
| United States | B404  | M1           | AT&T                                  |

# Ordering information

| SKU      | Description                             | Region | Modem | EtherSIM | Lifecycle | Replacement |
|----------|---|--------|-------|----------|-----------|-------------|
| B404MEA  | B Series LTE CAT-M1 (NorAm), [x1]       | NORAM  | R410  | ✓        | GA        |             |
| B404MTY  | B Series LTE CAT-M1 (NorAm), Tray [x50] | NORAM  | R410  | ✓        | GA        |             |
| B404XMEA | B Series LTE CAT-M1 (NorAm), [x1]       | NORAM  | R510  | ✓        | GA        |             |
| B404XMTY | B Series LTE CAT-M1 (NorAm), Tray [x50] | NORAM  | R510  | ✓        | GA        |             |
| B402MEA  | B Series LTE CAT-M1 (NorAm), [x1]       | NORAM  | R410  |          | NRND      | B404MEA     |
| B402MTY  | B Series LTE CAT-M1 (NorAm), Tray [x50] | NORAM  | R410  |          | NRND      | B404MTY     |

## Revision history

| Revision | Date        | Author | Comments                                       |
|----------|-------------|--------|--|
| 001      | 29 Apr 2019 | RK     | Initial Release                                |
| 002      | 03 Feb 2020 | RK     | Fixed number of I2C, SPI, and PWM              |
| 003      | 18 Feb 2020 | RK     | Keep-out diagram M.2 connector was upside-down |
| 004      | 16-Sep-2020 | RK     | Added power consumption information            |
| 005      | 16-Dec-2020 | RK     | Added missing TBD power consumption values     |
| 006      | 04-Jan-2021 | RK     | Fix incorrect pin number on pogo pin diagram   |
| 007      | 03-Feb-2021 | RK     | Split u-blox schematics into two images        |
| 008      | 15-Mar-2021 | RK     | Updated model, carrier, ordering information   |
| 009      | 23-Mar-2021 | RK     | Pins 40 and 42 functions were reversed         |
| 010      | 26-Apr-2021 | RK     | Added B404 model number                        |
| 011      | 14-May-2021 | RK     | Pins 40 and 42 were not actually reversed      |
| 012      | 19-May-2021 | RK     | List Ethernet reserved pins                    |
| 013      | 28-Jun-2021 | RK     | Added Device OS 3.1 memory map information     |
| 014      | 10-Sep-2021 | RK     | Changed wording of peak vs. max current        |