M SoM datasheet

This is a preliminary datasheet and changes may occur prior to release.

Overview

The M SoM module contains the following functional units:

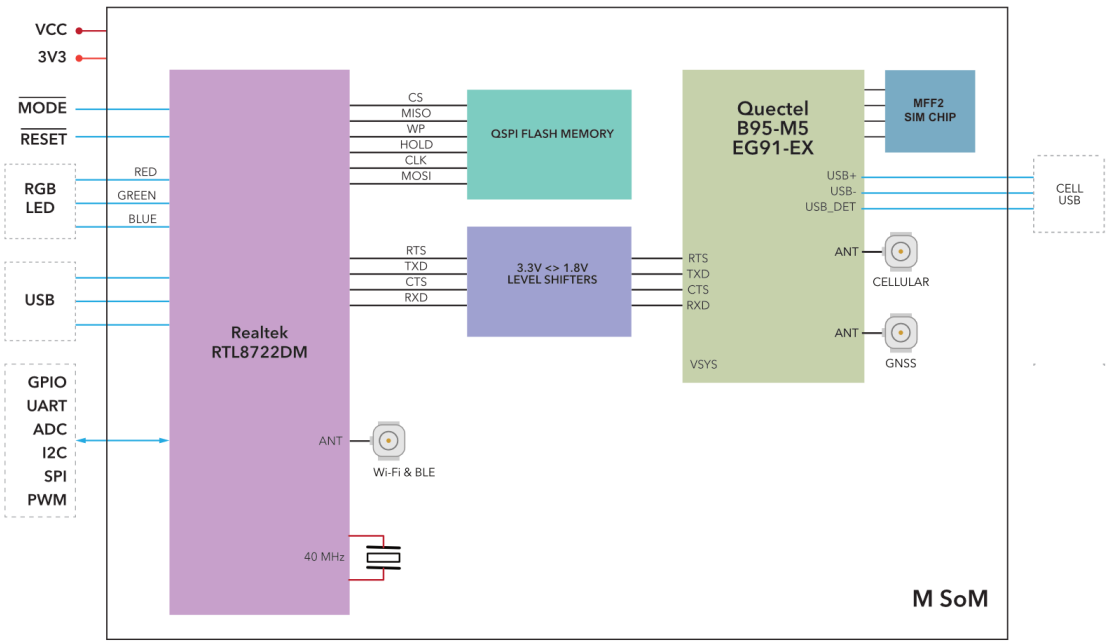
- M.2 SoM form-factor, like the B Series SoM
- Can use cellular or Wi-Fi (2.4 GHz or 5 GHz) for the cloud connection
- Realtek RTL8722DM MCU (BLE and Wi-Fi)
- Cellular modem
  - Quectel BG95-M5 LTE Cat M1 (North America)
  - Quectel EG91-EX LTE Cat 1 with 2G/3G fallback (EMEAA)

MCU

The Realtek RTL8722DM is in the same family as the P2 and Photon 2 modules (RTL8721DM), but has additional GPIO.

- 802.11a/b/g/n Wi-Fi, 2.4 GHz and 5 GHz
  - U.FL connector for external antenna
- BLE 5 using same antenna as Wi-Fi
- Realtek RTL8722DM MCU
  - ARM Cortex M33 CPU, 200 MHz
- 2048 KB (2 MB) user application maximum size
- 3072 KB (3 MB) of RAM available to user applications
- 2 MB flash file system
- FCC (United States), ISED (Canada), and CE (European Union) certified

BLOCK DIAGRAM



DEVICE FAMILIES

	Cellular Only	Cellular & Wi-Fi	Wi-Fi Only
Developer devices	Boron		Photon 2

Production module	B SoM	M SoM	P2

MIGRATION GUIDES

If you are migrating to the M SoM from another Particle device, see also the following migration guides:

- M SoM from B SoM
- M SoM from Boron or Argon
- M SoM from E Series
- M SoM from P2

POWER

VCC

VCC is used to supply power to the cellular module. The recommended input voltage range on this pin is between 3.6V to 4.2V DC. This can be connected directly to a 3.7V LiPo battery. Make sure that the supply can handle currents of at least 2 A.

If you are not using a battery, or using a battery of a different voltage, you should use a regulator to supply 3.7V to 4.2V at 2A. You may want to add additional bulk capacitors to handle the short, high current peak usage when the cellular modem is transmitting.

3V3

3V3 is used to supply power to RTL8722 MCU, logic ICs, memory, etc.. Make sure that the supply can handle a minimum of 500 mA.

These limits do not include any 3.3V peripherals on your base board, so that may increase the current requirements.

Power supply requirements:

- 3.3V output
- Maximum 5% voltage drop
- 100 mV peak-to-peak ripple maximum
- 500 mA minimum output current at 3.3V recommended for future compatibility
- Maintain these values at no-load as well as maximum load

RF

- The M SoM includes three U.FL connectors for external antennas:
  - Cellular
  - Wi-Fi (2.4 GHz and 5 GHz) and BLE
  - GNSS (GPS)
- Wi-Fi operation in the 5150-5250 MHz band is only for indoor use to reduce the potential for harmful interference to co-channel mobile satellite systems.
- GNSS features are limited M404 as the cellular modem cannot do cellular communication and GNSS at the same time.

APPROVED ANTENNAS

To be provided at a later date.

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.

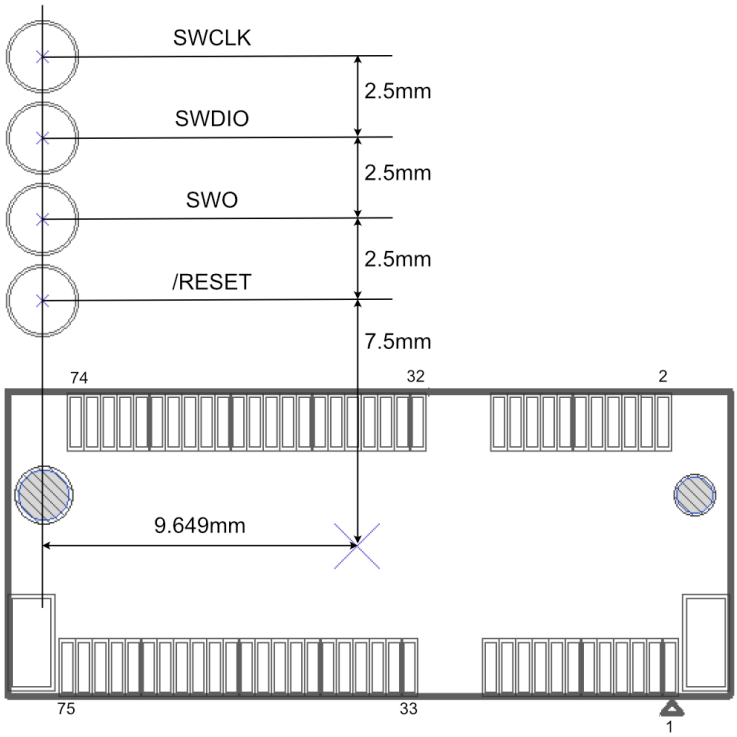
PERIPHERALS AND GPIO

Peripheral Type	Qty	Input(I) / Output(O)
Digital	30 (max)	I/O
Analog (ADC)	8 (max)	I
UART	2	I/O
SPI	2	I/O
I2C	1	I/O
USB	1	I/O
PWM	11 (max)	O

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

JTAG AND SWD

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



Additionally, SWD is supported on pins on the M.2 connector:

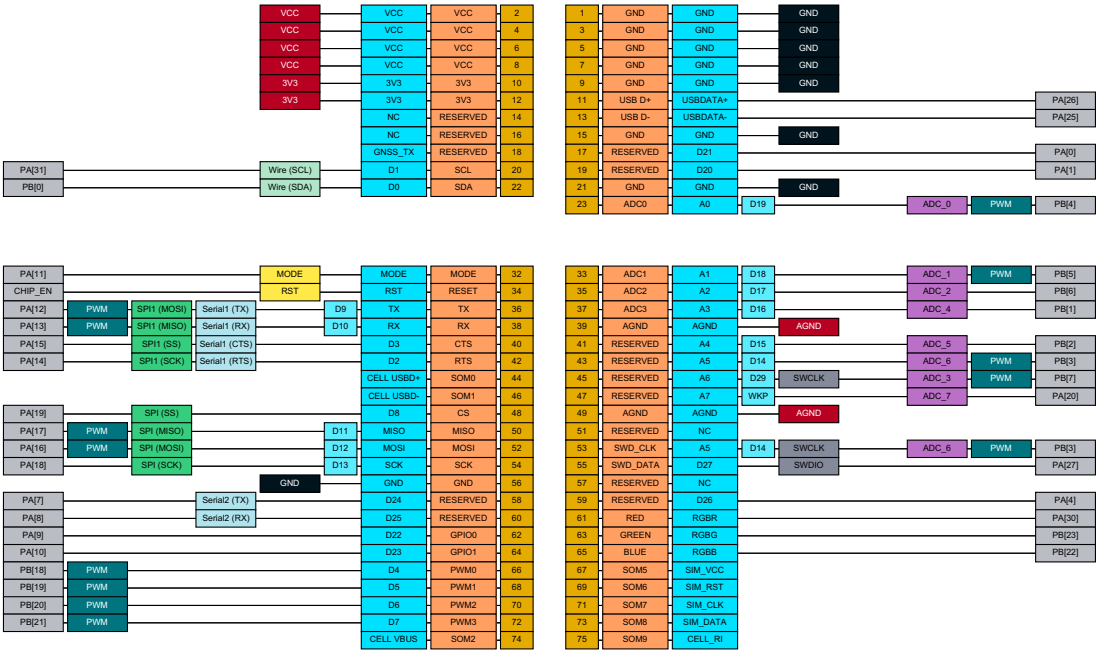
Pin	Pin Name	Description	Interface	MCU
45	A6 / D29	A6 Analog in, GPIO, PWM, SWCLK, M.2 eval PMIC INT, shared with pin 53	SWCLK	PB[7]
53	A5 / D14	A5 Analog in, PWM, GPIO, SWCLK, shared with pin 45	SWCLK	PB[3]

55	D27	D27 GPIO, SWDIO (SWD_DATA), do not pull down at boot	SWDIO	PA[27]

- SWD is on the same pins as GPIO, so by default once user firmware boots, SWD is no longer available. This is the same as Gen 2 (STM32) but different than Gen 3 (nRF52840).
- SWO (Serial Wire Output) is not supported on the RTL8722DM.
- Pins 45 and 53 are shared

Pin information

PINOUT DIAGRAM



PIN FUNCTION BY PIN NAME

Pin Name	Module Pin					MCU
A0 / D19	23	ADC_0				PB[4]
A1 / D18	33	ADC_1				PB[5]
A2 / D17	35	ADC_2				PB[6]
A3 / D16	37	ADC_4				PB[1]
A4 / D15	41	ADC_5				PB[2]
A5 / D14	43	ADC_6				PB[3]
A5 / D14	53	ADC_6	SWCLK			PB[3]
A6 / D29	45	ADC_3	SWCLK			PB[7]
A7 / WKP	47	ADC_7				PA[20]
CELL USBD-	46					
CELL USBD+	44					
CELL VBUS	74					
CELL_RI	75					
D0	22		Wire (SDA)			PB[0]
D1	20		Wire (SCL)			PA[31]
D2	42			SPI1 (SCK)	Serial1 (RTS)	PA[14]
D20	19					PA[1]
D21	17					PA[0]
D22	62					PA[9]
D23	64					PA[10]
D24	58				Serial2 (TX)	PA[7]
D25	60				Serial2 (RX)	PA[8]
D26	59					PA[4]

D27	55		SWDIO			PA[27]
D3	40			SPI1 (SS)	Serial1 (CTS)	PA[15]
D4	66					PB[18]
D5	68					PB[19]
D6	70					PB[20]
D7	72					PB[21]
D8	48			SPI (SS)		PA[19]
GNSS_TX	18					
MISO / D11	50			SPI (MISO)		PA[17]
MOSI / D12	52			SPI (MOSI)		PA[16]
NC	14					
RGBB	65					PB[22]
RGBG	63					PB[23]
RGBR	61					PA[30]
RX / D10	38			SPI1 (MISO)	Serial1 (RX)	PA[13]
SCK / D13	54			SPI (SCK)		PA[18]
SIM_CLK	71					
SIM_DATA	73					
SIM_RST	69					
SIM_VCC	67					
TX / D9	36			SPI1 (MOSI)	Serial1 (TX)	PA[12]
USBDATA-	13					PA[25]
USBDATA+	11					PA[26]

PIN FUCTION BY M.2 PIN

Module Pin	Pin Name					MCU
11	USBDATA+					PA[26]
13	USBDATA-					PA[25]
14	NC					
17	D21					PA[0]
18	GNSS_TX					
19	D20					PA[1]
20	D1		Wire (SCL)			PA[31]
22	D0		Wire (SDA)			PB[0]
23	A0 / D19	ADC_0				PB[4]
33	A1 / D18	ADC_1				PB[5]
35	A2 / D17	ADC_2				PB[6]
36	TX / D9			SPI1 (MOSI)	Serial1 (TX)	PA[12]
37	A3 / D16	ADC_4				PB[1]
38	RX / D10			SPI1 (MISO)	Serial1 (RX)	PA[13]
40	D3			SPI1 (SS)	Serial1 (CTS)	PA[15]
41	A4 / D15	ADC_5				PB[2]
42	D2			SPI1 (SCK)	Serial1 (RTS)	PA[14]
43	A5 / D14	ADC_6				PB[3]
44	CELL USBD+					

45	A6 / D29	ADC_3	SWCLK			PB[7]
46	CELL USBD-					
47	A7 / WKP	ADC_7				PA[20]
48	D8			SPI (SS)		PA[19]
50	MISO / D11			SPI (MISO)		PA[17]
52	MOSI / D12			SPI (MOSI)		PA[16]
53	A5 / D14	ADC_6	SWCLK			PB[3]
54	SCK / D13			SPI (SCK)		PA[18]
55	D27		SWDIO			PA[27]
58	D24				Serial2 (TX)	PA[7]
59	D26					PA[4]
60	D25				Serial2 (RX)	PA[8]
61	RGBR					PA[30]
62	D22					PA[9]
63	RGBG					PB[23]
64	D23					PA[10]
65	RGBB					PB[22]
66	D4					PB[18]
67	SIM_VCC					
68	D5					PB[19]
69	SIM_RST					
70	D6					PB[20]
71	SIM_CLK					
72	D7					PB[21]
73	SIM_DATA					
74	CELL VBUS					
75	CELL_RI					

GPIO (DIGITAL I/O)

Pin	M SoM Pin Name	M SoM GPIO	MCU	Special boot function
17	D21	✓	PA[0]	
19	D20	✓	PA[1]	
20	D1	✓	PA[31]	
22	D0	✓	PB[0]	
23	A0 / D19	✓	PB[4]	
33	A1 / D18	✓	PB[5]	
35	A2 / D17	✓	PB[6]	
36	TX / D9	✓	PA[12]	
37	A3 / D16	✓	PB[1]	
38	RX / D10	✓	PA[13]	
40	D3	✓	PA[15]	
41	A4 / D15	✓	PB[2]	
42	D2	✓	PA[14]	
43	A5 / D14	✓	PB[3]	
45	A6 / D29	✓	PB[7]	SWCLK. 40K pull-down at boot.

47	A7 / WKP	✓	PA[20]	
48	D8	✓	PA[19]	
50	MISO / D11	✓	PA[17]	
52	MOSI / D12	✓	PA[16]	
53	A5 / D14	✓	PB[3]	SWCLK. 40K pull-down at boot.
54	SCK / D13	✓	PA[18]	
55	D27	✓	PA[27]	SWDIO. 40K pull-up at boot. Low at boot triggers MCU test mode.
58	D24	✓	PA[7]	Low at boot triggers ISP flash download
59	D26	✓	PA[4]	
60	D25	✓	PA[8]	Goes high at boot
62	D22	✓	PA[9]	
64	D23	✓	PA[10]	
66	D4	✓	PB[18]	
68	D5	✓	PB[19]	
70	D6	✓	PB[20]	
72	D7	✓	PB[21]	

- All GPIO are 3.3V only and are not 5V tolerant

Certain GPIO will change state at boot, or cause the MCU to enter a special mode. See the boot mode pins section, below, for more information.

ADC (ANALOG TO DIGITAL CONVERTER)

Pin	Pin Name	Description	Interface	MCU
23	A0 / D19	A0 Analog in, GPIO, PWM	ADC_0	PB[4]
33	A1 / D18	A1 Analog in, GPIO, PWM	ADC_1	PB[5]
35	A2 / D17	A2 Analog in, GPIO	ADC_2	PB[6]
37	A3 / D16	A3 Analog in, GPIO	ADC_4	PB[1]
41	A4 / D15	A4 Analog in, GPIO	ADC_5	PB[2]
43	A5 / D14	A5 Analog in, PWM, GPIO, shared with pin 53	ADC_6	PB[3]
45	A6 / D29	A6 Analog in, GPIO, PWM, SWCLK, M.2 eval PMIC INT, shared with pin 53	ADC_3	PB[7]
47	A7 / WKP	A7 Analog In, WKP, GPIO D28	ADC_7	PA[20]
53	A5 / D14	A5 Analog in, PWM, GPIO, SWCLK, shared with pin 45	ADC_6	PB[3]

- ADC inputs are single-ended and limited to 0 to 3.3V
- Resolution is 12 bits
- SoM pin 45 (A6) on the M SoM is shared with SoM pin 53 (SWD_CLK). You cannot use A6 and SWD at the same time. If you implement SWD on your base board, driving pin A6 will prevent SWD from functioning. The SWD_CLK will be driven at hoot by the MCU.

The ADCs on the M SoM (RTL872x) have a lower impedance than other Particle device MCUs (nRF52, STM32F2xx). They require a stronger drive and this may cause issues when used with a voltage divider. This is particularly true for A7, which has an even lower impedance than other ADC inputs.

For signals that change slowly, such as NTC thermocouple resistance, you can add a 2.2 uF capacitor to the signal. For rapidly changing signals, a voltage follower IC can be used.

UART SERIAL

Pin	Pin Name	Description	Interface	MCU
36	TX / D9	Serial TX, PWM, GPIO, SPI1 MOSI	Serial1 (TX)	PA[12]
38	RX / D10	Serial RX, PWM, GPIO, SPI1 MISO	Serial1 (RX)	PA[13]
40	D3	D3 GPIO, Serial1 CTS flow control (optional), SPI1 SS	Serial1 (CTS)	PA[15]
42	D2	D2 GPIO, Serial RTS flow control (optional), SPI1 SCK	Serial1 (RTS)	PA[14]
58	D24	D24 GPIO, Serial2 TX, do not pull down at boot	Serial2 (TX)	PA[7]
60	D25	GPIO25, Serial2 RX	Serial2 (RX)	PA[8]

- The UART pins are 3.3V and must not be connected directly to a RS-232C port or to a 5V TTL serial port
- Hardware flow control is optional; if not used then the RTS and CTS pins can be used as regular GPIO
- Serial1 uses the RTL872x UART_LOG peripheral
- Serial2 uses the RTL872x HS_UART0 peripheral
- Supported baud rates: 110, 300, 600, 1200, 9600, 14400, 19200, 28800, 38400, 57600, 76800, 115200, 128000, 153600, 230400, 500000, 921600, 1000000, 1382400, 1444400, 1500000, 1843200, 2000000, 2100000, 2764800, 3000000, 3250000, 3692300, 3750000, 4000000, 6000000

SPI

Pin	Pin Name	Description	Interface	MCU
36	TX / D9	Serial TX, PWM, GPIO, SPI1 MOSI	SPI1 (MOSI)	PA[12]
38	RX / D10	Serial RX, PWM, GPIO, SPI1 MISO	SPI1 (MISO)	PA[13]
40	D3	D3 GPIO, Serial1 CTS flow control (optional), SPI1 SS	SPI1 (SS)	PA[15]
42	D2	D2 GPIO, Serial RTS flow control (optional), SPI1 SCK	SPI1 (SCK)	PA[14]
48	D8	D8 GPIO, SPI SS	SPI (SS)	PA[19]
50	MISO / D11	D11 GPIO, PWM, SPI MISO	SPI (MISO)	PA[17]
52	MOSI / D12	D12 GPIO, PWM, SPI MOSI	SPI (MOSI)	PA[16]
54	SCK / D13	D13 GPIO, SPI SCK	SPI (SCK)	PA[18]

- The SPI port is 3.3V and must not be connected directly to devices that drive MISO at 5V
- If not using a SPI port, its pins can be used as GPIO
- Any pins can be used as the SPI chip select
- Multiple devices can generally share a single SPI port
- SPI uses the RTL872x SPI1 peripheral (25 MHz maximum speed)
- SPI1 uses the RTL872x SPI0 peripheral (50 MHz maximum speed)

Even though the B SoM and M SoM both have two SPI interfaces, note that the M SoM SPI1 is on different pins.

Pin	B SoM Pin Name	B SoM SPI	M SoM Pin Name	M SoM SPI
36	TX / D9		TX / D9	SPI1 (MOSI)
38	RX / D10		RX / D10	SPI1 (MISO)
40	D3	SPI1 (MOSI)	D3	SPI1 (SS)
42	D2	SPI1 (SCK)	D2	SPI1 (SCK)
48	D8	SPI (SS)	D8	SPI (SS)
50	MISO / D11	SPI (MISO)	MISO / D11	SPI (MISO)
52	MOSI / D12	SPI (MOSI)	MOSI / D12	SPI (MOSI)

54	SCK / D13	SPI (SCK)	SCK / D13	SPI (SCK)
66	D4	SPI1 (MISO)	D4	

I2C

Pin	Pin Name	Description	Interface	MCU
20	D1	D1 GPIO, I2C SCL	Wire (SCL)	PA[31]
22	D0	D0 GPIO, I2C SDA	Wire (SDA)	PB[0]

- The I2C port is 3.3V and must not be connected directly a 5V I2C bus
- Maximum bus speed is 400 kHz
- External pull-up resistors are required for I2C

PWM

Pin	Pin Name	Description	MCU
23	A0 / D19	A0 Analog in, GPIO, PWM	PB[4]
33	A1 / D18	A1 Analog in, GPIO, PWM	PB[5]
36	TX / D9	Serial TX, PWM, GPIO, SPI1 MOSI	PA[12]
38	RX / D10	Serial RX, PWM, GPIO, SPI1 MISO	PA[13]
43	A5 / D14	A5 Analog in, PWM, GPIO, shared with pin 53	PB[3]
45	A6 / D29	A6 Analog in, GPIO, PWM, SWCLK, M.2 eval PMIC INT, shared with pin 53	PB[7]
50	MISO / D11	D11 GPIO, PWM, SPI MISO	PA[17]
52	MOSI / D12	D12 GPIO, PWM, SPI MOSI	PA[16]
53	A5 / D14	A5 Analog in, PWM, GPIO, SWCLK, shared with pin 45	PB[3]
66	D4	D4 GPIO, PWM	PB[18]
68	D5	D5 GPIO, PWM	PB[19]
70	D6	D6 GPIO, PWM	PB[20]
72	D7	D7 GPIO, PWM	PB[21]

- All available PWM pins on the M SoM share a single timer. This means that they must all share a single frequency, but can have different duty cycles.

USB

The M SoM supports a USB interface for programming the device and for USB serial (CDC) communications. The module itself does not contain a USB connector; you typically add a micro USB or USB C connector on your base board. It is optional but recommended.

Pin	Pin Name	Description	MCU
11	USBDATA+	USB Data+	PA[26]
13	USBDATA-	USB Data-	PA[25]
44	CELL USBD+	Cellular Modem USB Data+	
46	CELL USBD-	Cellular Modem USB Data-	

- The CELL USB connector does not need to be populated on your board. It is used for reprogramming the cellular modem firmware, which is rarely done as it often requires recertification of the device.

RGB LED

The M SoM supports an external common anode RGB LED.

One common LED that meets the requirements is the Cree CLMVC-FKA-CL1D1L71BB7C3C3 which is inexpensive and easily procured. You need to add three current limiting resistors. With this LED, we typically use 1K ohm current limiting resistors. These are much larger than necessary. They make the LED less blinding but still provide sufficient current to light the LEDs. If you want maximum brightness you should use the calculated values - 33 ohm on red, and 66 ohm on green and blue.

A detailed explanation of different color codes of the RGB system LED can be found here.

The use of the RGB LED is optional, however it is highly recommended as troubleshooting the device without the LED is very difficult.

Pin	Pin Name	Description	MCU
61	RGBR	RGB LED Red	PA[30]
63	RGBG	RGB LED Green	PB[23]
65	RGBB	RGB LED Blue	PB[22]

- On the M SoM, Pin RGBR (PA[30]) has a 10K hardware pull-up in the module because it's a trap pin that controls the behavior of the internal 1.1V regulator. This does not affect the RGB LED but could affect your design if you are repurposing this pin as GPIO. You must not hold this pin low at boot.

BOOT MODE PINS

These pins have a special function at boot. Beware when using these pins as input as they can trigger special modes in the MCU.

Pin	Pin Name	Description	MCU
45	A6 / D29	SWCLK. 40K pull-down at boot.	PB[7]
53	A5 / D14	SWCLK. 40K pull-down at boot.	PB[3]
55	D27	SWDIO. 40K pull-up at boot. Low at boot triggers MCU test mode.	PA[27]
58	D24	Low at boot triggers ISP flash download	PA[7]
60	D25	Goes high at boot	PA[8]
61	RGBR	Low at boot triggers trap mode	PA[30]

SETUP AND RESET BUTTON

It is highly recommended that you add MODE (SETUP) and RESET buttons to your base board using momentary switches that connect to GND. These are necessary to change the operating mode of the device, for example to enter listening or DFU mode.

Pin	Pin Name	Description	MCU
34	RST	Hardware reset. Pull low to reset; can leave unconnected in normal operation.	CHIP_EN
46	MODE	MODE button. Pin number constant is BTN. External pull-up required!	PA[4]

The MODE button does not have a hardware pull-up on it, so you must add an external pull-up (2.2K to 10K) to 3V3, or connect it to 3V3 if not using a button.

The RST pin does have an internal weak pull-up, but you may want to add external pull-up on that as well, especially if you use an off-board reset button connected by long wires.

BLE (BLUETOOTH LE)

If you wish to use Wi-Fi on the M SoM you will need to provide a way to configure it. Wi-Fi setup works the same as the P2, Photon 2, and Argon, and uses BLE. See Wi-Fi setup options for more information.

BLE 5.3 BLE Central Mode and BLE Peripheral Mode are supported.

Full-speed BLE modes such as A2DP used for BLE audio are not supported.

Wi-Fi and BLE share the same antenna so you do not need to include a separate antenna to use both.

SLEEP

The M SoM can wake from `STOP` or `ULTRA_LOW_POWER` sleep mode on any GPIO, `RISING`, `FALLING`, or `CHANGE`.

The M SoM can only wake from `HIBERNATE` sleep mode on pin A7 (WKP), `RISING`, `FALLING`, or `CHANGE`.

The M SoM preserves the state of outputs during `STOP` or `ULTRA_LOW_POWER` sleep mode. In `HIBERNATE`, outputs are high-impedance.

Most pins can use `INPUT_PULLUP` or `INPUT_PULLDOWN` in sleep modes. The exception is `HIBERNATE` sleep mode where pin D21 can only use an external hardware pull-up or pull down.

Pin	Pin Name	Description	Interface	MCU
17	D21	D21 GPIO	No internal pull up or pull down in HIBERNATE sleep mode.	PA[0]
47	A7 / WKP	A7 Analog In, WKP, GPIO D28	Only this pin can wake from HIBERNATE sleep mode.	PA[20]

PMIC NOTES

When using the M SoM with a bq24195 PMIC, note the following:

By default, the bq24195 sets the input current limit, which affects powering by VIN and VUSB, to 100 mA. This affects the VSYS output of the PMIC, which powers both the cellular modem and 3V3 supply, and is not enough to power the M SoM in normal operation.

If your device has the default firmware (Tinker), it will attempt to connect to the cloud, brown out due to insufficient current, then the device will reset. This may result in what appears to be the status LED blinking white, but is actually rolling reboot caused by brownout.

A factory new M SoM does not enable the PMIC setup. To enable the use of the bq21415, you must enable the system power feature PMIC_DETECTION in your code. This defaults to off because the M SoM can be used without a PMIC, or with a different PMIC, and also requires I2C on D0/D1, and some base boards may use those pins as GPIO.

Because the input current limit does not affect the battery input (Li+), for troubleshooting purposes it can be helpful to attach a battery to help rule out input current limit issues. It's also possible to supply 3.7V via a bench power supply to the battery input, instead of VIN.

The input current limit can result in a situation where you can't bring up a M SoM because it

browns out continuously, but also cannot flash code to it to stop if from browning out. There are two general solutions:

- Attach a battery or supply by Li+ when bringing up a board.
- Use SWD/JTAG and reset halt the MCU. This will prevent it from connecting to the cloud, so you can flash Device OS and firmware to it by SWD.

The input current limit is actually controlled by three factors:

- The power source max current setting in the PMIC. The default is 900 mA. It can be set to 100, 150, 500, 900, 1200, 1500, 2000, or 3000 mA.
- It is also limited by the hardware ILIM resistor. On Particle devices with a built-in PMIC, this is set to 1590 mA, but if you are implementing your own PMIC hardware, you can adjust this higher.
- When connected by USB, it will use DPDM, current negotiation via the USB DP (D+) and DM (D-) lines.

Note that some 2A tablet chargers and multi-port USB power supplies supply 2A but do not implement DPDM; these will be treated as if VIN was used, and you must set the power source current, otherwise the input current will be limited to 900 mA, which is not enough to power a 2G/3G cellular modem without an attached battery.

SIM PINS

- The SIM pins should be left unconnected
- You cannot use these pins for an external SIM card, despite their names

Pin	Pin Name	Description
69	SIM_RST	Leave unconnected, 1.8V/3V SIM Reset Output from cellular modem.
71	SIM_CLK	Leave unconnected, 1.8V/3V SIM Clock Output from cellular modem.
73	SIM_DATA	Leave unconnected, 1.8V/3V SIM Data I/O of cellular modem with internal 4.7 k pull-up.

Technical specification

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RECOMMENDED OPERATING CONDITIONS

Parameter	Symbol	Min	Typ	Max	Unit
Operating Temperature	T_{op}	-20		+70	°C
Humidity Range Non condensing, relative humidity				95	%

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POWER CONSUMPTION (M524)

Parameter	Symbol	Min	Typ	Peak	Unit
Operating Current (uC on, peripherals and radio disabled)	I_{idle}	27.8	28.0	28.4	mA
Operating Current (uC on, cellular on but not connected)	I_{cell_idle}	42.8	45.9	124	mA
Operating Current (uC on, cellular connecting to tower)	$I_{cell\_conn\_twr}$	42.7	46.3	119	mA
Operating Current (uC on, cellular connecting to cloud)	$I_{cell\_conn\_cloud}$	41.4	82.8	751	mA
Operating Current (uC on, cellular connected but idle)	$I_{cell\_cloud\_idle}$	41.3	44.3	126	mA
Operating Current (uC on, cellular connected and transmitting)	$I_{cell\_cloud\_tx}$	42.1	106	766	mA
Operating Current (uC on, Wi-Fi on but not connected)	I_{wifi_idle}	28.5	28.7	29.1	mA
Operating Current (uC on, Wi-Fi connecting to cloud)	$I_{wifi\_conn\_cloud}$	79.3	180	1020	mA
Operating Current (uC on, Wi-Fi connected but idle)	$I_{wifi\_cloud\_idle}$	28.3	28.6	29.0	mA
Operating Current (uC on, Wi-Fi connected and transmitting)	$I_{wifi\_cloud\_tx}$	78.9	84.5	178	mA
STOP mode sleep, GPIO wake-up	I_{stop_gpio}	131	332	704	uA
STOP mode sleep, RTC wake-up	I_{stop_intrtc}	146	344	728	uA
ULP mode sleep, GPIO wake-up	I_{ulp_gpio}	131	332	704	uA
ULP mode sleep, RTC wake-up	I_{ulp_intrtc}	146	344	728	uA
HIBERNATE mode sleep, GPIO wake-up	I_{hib_gpio}		40.8	389	uA
HIBERNATE mode sleep, analog wake-up	I_{hib_analog}		41.1	397	uA

[1]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.

POWER CONSUMPTION (M404)

Parameter	Symbol	Min	Typ	Peak	Unit
Operating Current (uC on, peripherals and radio disabled)	I_{idle}	27.0	27.3	27.5	mA
Operating Current (uC on, cellular on but not connected)	I_{cell_idle}	41.1	45.6	170	mA
Operating Current (uC on, cellular connecting to tower using LTE Cat M1)	$I_{cell\_conn\_twr\_ltem}$	36.5	106	241	mA
Operating Current (uC on, cellular connecting to cloud using LTE Cat M1)	$I_{cell\_conn\_cloud\_ltem}$	40.6	77.1	264	mA
Operating Current (uC on, cellular connected but idle using LTE Cat M1)	$I_{cell\_cloud\_idle\_ltem}$	41.5	48.3	240	mA
Operating Current (uC on, cellular connected and transmitting using LTE Cat M1)	$I_{cell\_cloud\_tx\_ltem}$	41.6	88.7	248	mA

Operating Current (uC on, cellular connecting to tower using 2G)	$I_{cell\_conn\_twr\_2g}$	39.0	87.8	522	mA
Operating Current (uC on, cellular connecting to cloud using 2G)	$I_{cell\_conn\_cloud\_2g}$	36.5	142	963	mA
Operating Current (uC on, cellular connected but idle using 2G)	$I_{cell\_cloud\_idle\_2g}$	38.5	48.5	961	mA
Operating Current (uC on, cellular connected and transmitting using 2G)	$I_{cell\_cloud\_tx\_2g}$	43.6	128	960	mA
Operating Current (uC on, Wi-Fi on but not connected)	I_{wifi_idle}	27.5	27.8	28	mA
Operating Current (uC on, Wi-Fi connecting to cloud)	$I_{wifi\_conn\_cloud}$	61.6	71.0	370	mA
Operating Current (uC on, Wi-Fi connected but idle)	$I_{wifi\_cloud\_idle}$	62.6	65.0	164	mA
Operating Current (uC on, Wi-Fi connected and transmitting)	$I_{wifi\_cloud\_tx}$	20.1	117	305	mA
STOP mode sleep, GPIO wake-up	I_{stop_gpio}	322	329	344	uA
STOP mode sleep, RTC wake-up	I_{stop_intrtc}	323	326	329	uA
ULP mode sleep, GPIO wake-up	I_{ulp_gpio}	322	329	344	uA
ULP mode sleep, RTC wake-up	I_{ulp_intrtc}	323	326	329	uA
HIBERNATE mode sleep, GPIO wake-up	I_{hib_gpio}	40.1	42.3	44.4	uA
HIBERNATE mode sleep, analog wake-up	I_{hib_analog}	40.1	42.2	44.2	uA

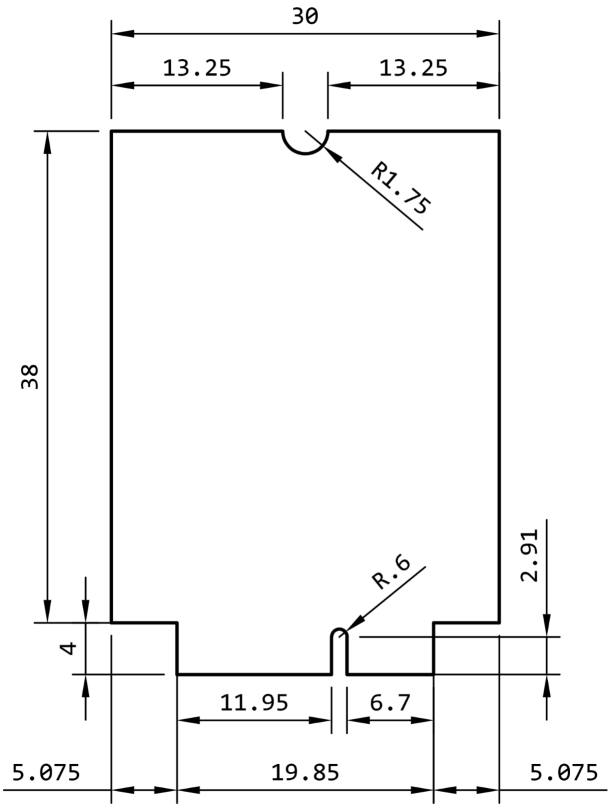
[1]The min, and particularly peak, values may consist of very short transients. The typical (typ) values are the best indicator of overall power consumption over time. The peak values indicate the absolute minimum capacity of the power supply necessary, not overall consumption.

Mechanical specifications

DIMENSIONS AND WEIGHT

To be provided at a later date.

MECHANICAL DRAWING

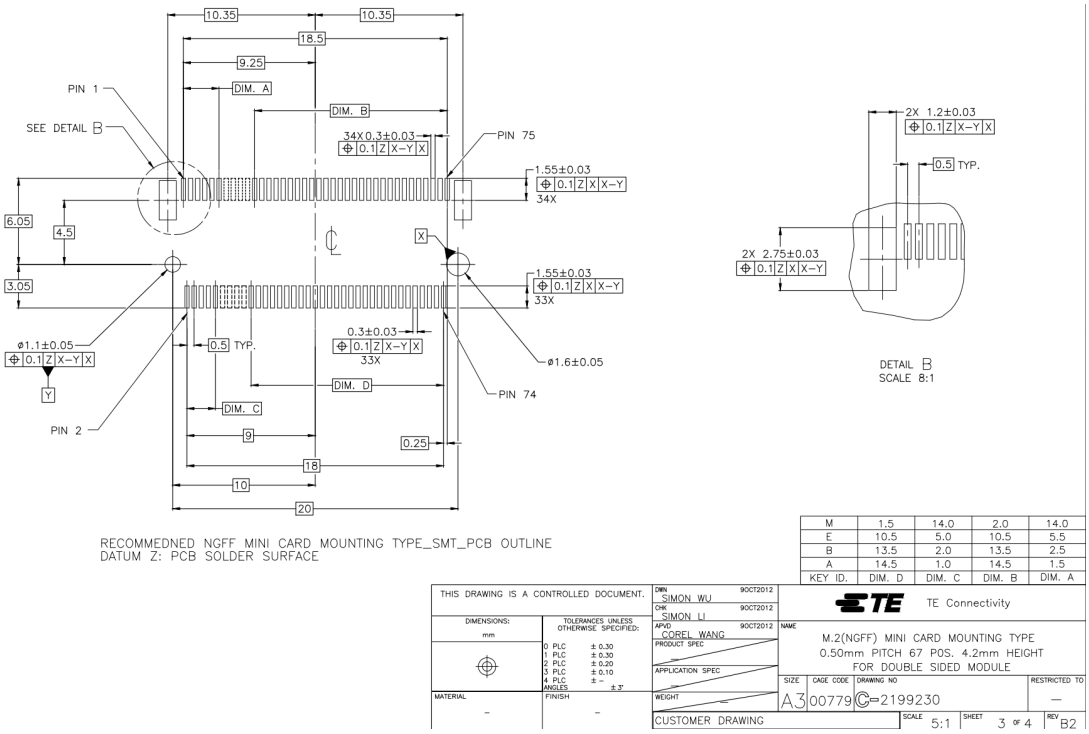


Dimensions are in millimeters.

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.



RECOMMEDNED NGFF MINI CARD MOUNTING TYPE_SMT_PCB OUTLINE
DATUM Z: PCB SOLDER SURFACE

M	1.5	14.0	2.0	14.0
E	10.5	5.0	10.5	5.5
B	13.5	2.0	13.5	2.5
A	14.5	1.0	14.5	1.5
KEY ID.	DIM. D	DIM. C	DIM. B	DIM. A

THIS DRAWING IS A CONTROLLED DOCUMENT.

DIMENSIONS: mm

TOLERANCES UNLESS OTHERWISE SPECIFIED:
0 PLC ± 0.30
1 PLC ± 0.30
2 PLC ± 0.20
3 PLC ± 0.10
4 PLC ± –
ANGLES ± 3°

MATERIAL –
FINISH –

DWN SIMON WU 90CT2012
CHK SIMON LI 90CT2012
APVD COREL WANG 90CT2012
PRODUCT SPEC —
APPLICATION SPEC —
WEIGHT —

TE Connectivity

NAME
M.2(NGFF) MINI CARD MOUNTING TYPE
0.50mm PITCH 67 POS. 4.2mm HEIGHT
FOR DOUBLE SIDED MODULE

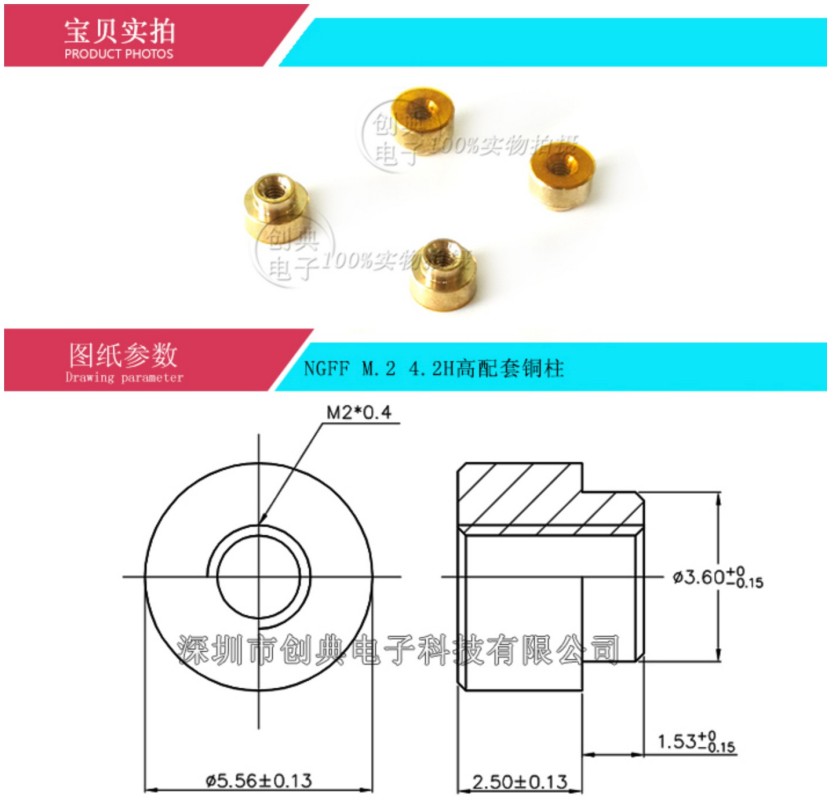
SIZE	CAGE CODE	DRAWING NO	RESTRICTED TO
A3	00779	C-2199230	—

CUSTOMER DRAWING | SCALE 5:1 | SHEET 3 OF 4 | REV B2

SCREW ASSEMBLY

The M.2 SoM requires a screw to hold the SoM in place because the M.2 connector does not have integrated locks and the SoM will pop up if not attached to the base board. The screw also provides better vibration resistance than locking clips.

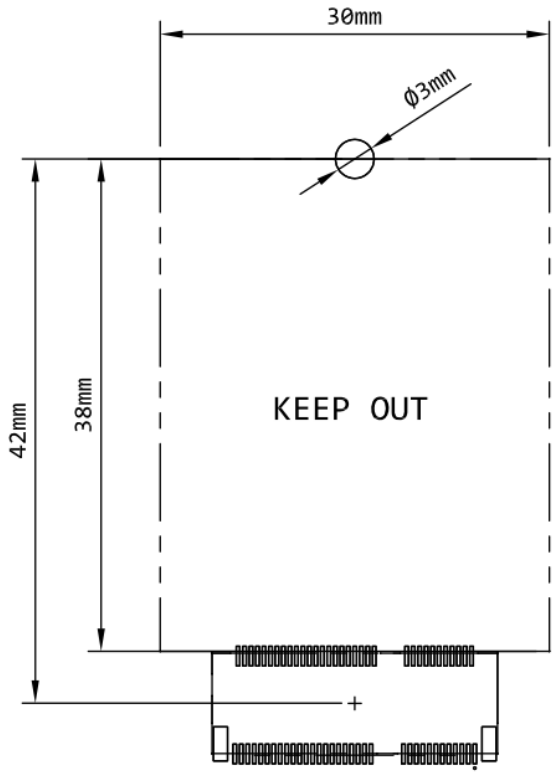
- This is one style of standoff.



- An alternative design uses a JAE SM3ZS067U410-NUT1-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.

DESIGN CONSIDERATIONS

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


30mm
Ø3mm
42mm
38mm
KEEP OUT
+

Product Handling

ESD PRECAUTIONS

The M SoM contains highly sensitive electronic circuitry and is an Electrostatic Sensitive Device (ESD). Handling an M SoM 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 M SoM module. ESD precautions should be implemented on the application board where the M SoM is mounted. Failure to observe these precautions can result in severe damage to the M SoM!

CONNECTORS

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.

Default settings

The M SoM 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.

FCC ISED CE Warnings and End Product Labeling Requirements

Federal Communication Commission Interference Statement 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 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.

FCC Radiation Exposure Statement: This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This transmitter module must not be co-located or operating in conjunction with any other antenna or transmitter. This End equipment should be installed and operated with a minimum distance of 20 centimeters between the radiator and your body.

IMPORTANT NOTE: In the event that these conditions can not 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 can not 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 The final end product must be labeled in a visible area with the following:

- Contains FCC ID: 2AEMI-M404

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.

Outdoor Use (US)

To be compliant to FCC §15.407(a) the EIRP is not allowed to exceed 125 mW (21 dBm) at any elevation angle above 30° (measured from the horizon) when operated as an outdoor access point in U-NII-1 band, 5.150-5.250 GHz.

Canada Statement This device complies with Industry Canada's licence-exempt RSSs. Operation is subject to the following two conditions:

1. This device may not cause interference; and
2. This device must accept any interference, including interference that may cause undesired operation of the device.

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence.

L'exploitation est autorisée aux deux conditions suivantes:

1. l'appareil ne doit pas produire de brouillage;
2. l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Caution Exposure: This device meets the exemption from the routine evaluation limits in section 2.5 of RSS102 and users can obtain Canadian information on RF exposure and compliance. Le dispositif répond à l'exemption des limites d'évaluation de routine dans la section 2.5 de RSS102 et les utilisateurs peuvent obtenir des renseignements canadiens sur l'exposition aux RF et le respect.

The final end product must be labelled in a visible area with the following: The Industry Canada certification label of a module shall be clearly visible at all times when installed in the host device, otherwise the host device must be labelled to display the Industry Canada certification number of the module, preceded by the words "Contains transmitter module", or the word "Contains", or similar wording expressing the same meaning, as follows:

- Contains transmitter module ISED: 20127-M524

This End equipment should be installed and operated with a minimum distance of 20 centimeters between the radiator and your body. Cet équipement devrait être installé et actionné avec une distance minimum de 20 centimètres entre le radiateur et votre corps.

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

Outdoor use (CA)

- Operation in the band 5150–5250 MHz is only for indoor use to reduce the potential for harmful interference to co-channel mobile satellite systems;
- Operation in the 5600-5650 MHz band is not allowed in Canada. High-power radars are allocated as primary users (i.e., priority users) of the bands 5250-5350 MHz and 5650-5850 MHz and that these radars could cause interference and/or damage to LE-LAN devices.

- Le dispositif de fonctionnement dans la bande 5150-5250 MHz est réservé à une utilisation en intérieur pour réduire le risque d'interférences nuisibles à la co-canal systèmes mobiles par satellite
- Opération dans la bande 5600-5650 MHz n'est pas autorisée au Canada. Haute puissance radars sont désignés comme utilisateurs principaux (c.-àutilisateurs prioritaires) des bandes 5250-5350 MHz et 5650-5850 MHz et que ces radars pourraient causer des interférences et / ou des dommages à dispositifs LAN-EL.

EUROPEAN UNION (CE)

We, Particle Industries,Inc, declare under our sole responsibility that the product, P2, to which this declaration relates, is in conformity with RED Directive 2014/53/EU and (EU) 2015/863 RoHS Directive 2011/65/EU (Recast).

The full text of the EU declaration of conformity is available at the followingInternet address: https://www.particle.io/

Radiation Exposure Statement: This equipment complies with radiation exposure limits set forth for an uncontrolled environment.

The operating frequency bands and the maximum transmitted power limit are listed below:

- BLE 2402-2480MHz 10dBm
- Wi-Fi 2.4GHz band 2412-2484MHz 20dBm
- Wi-Fi 5GHz band 5180-5825MHz 23dBm

UNITED KINGDOM

UKCA Conformity:

Radio Equipment Regulations 2017 (S.I. 2017/1206)

OUTDOOR USE (WORLD)

This device is restricted to indoor use when operating in the 5150 to 5350 MHz frequency range. This restriction applies in: AT, BE, BG, CH, CY, CZ, DE, DK, EE, EL, ES, FI, FR, HR, HU, IE, IS, IT, LI, LT, LU, LV, MT, NL, NO, PL, PT, RO, SE, SI, SK, TR, UA, UK(NI).

Country compatibility

Ordering information

Model	Quantity	Region
M404MEA	1	United States, Canada, and Mexico
M404MTY	50	United States, Canada, and Mexico
M524MEA	1	EMEAA (Europe, and parts of the Middle East, Africa, and Asia)
M524MTY	50	EMEAA (Europe, and parts of the Middle East, Africa, and Asia)

Revision history

Revision	Date	Author	Comments
pre	2023-10-03	RK	Initial version
	2023-12-20	RK	Added FCC and IC IDs. Additional notes for ADCs, D24, and D25
	2024-02-07	RK	Added power consumption information