

```
void setup() {  
    Spark.publish("my-event", "The internet just got smarter!");  
}
```

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## Functional description

### Overview

Particle's Internet of Things hardware development kit, the Photon, provides everything you need to build a connected product. Particle combines a powerful ARM Cortex M3 micro-controller with a Broadcom Wi-Fi chip in a tiny thumbnail-sized module called the P0 (P-zero).

To get you started quickly, Particle adds a rock solid 3.3VDC SMPS power supply, RF and user interface components to the P0 on a small single-sided PCB called the Photon. The design is open source, so when you're ready to integrate the Photon into your product, you can.

The Photon comes in two physical forms: with headers and without. Prototyping is easy with headers as the Photon plugs directly into standard breadboards and perfboards, and may also be mounted with 0.1" pitch female headers on a PCB. To minimize space required, the Photon form factor without headers has castellated edges. These make it possible to surface mount the Photon directly onto your PCB.

### Features

Particle P0 Wi-Fi module

Broadcom BCM43362 Wi-Fi chip

802.11b/g/n Wi-Fi

STM32F205 120Mhz ARM Cortex M3

1MB flash, 128KB RAM

On-board RGB status LED (ext. drive provided)

18 Mixed-signal GPIO and advanced peripherals

Open source design

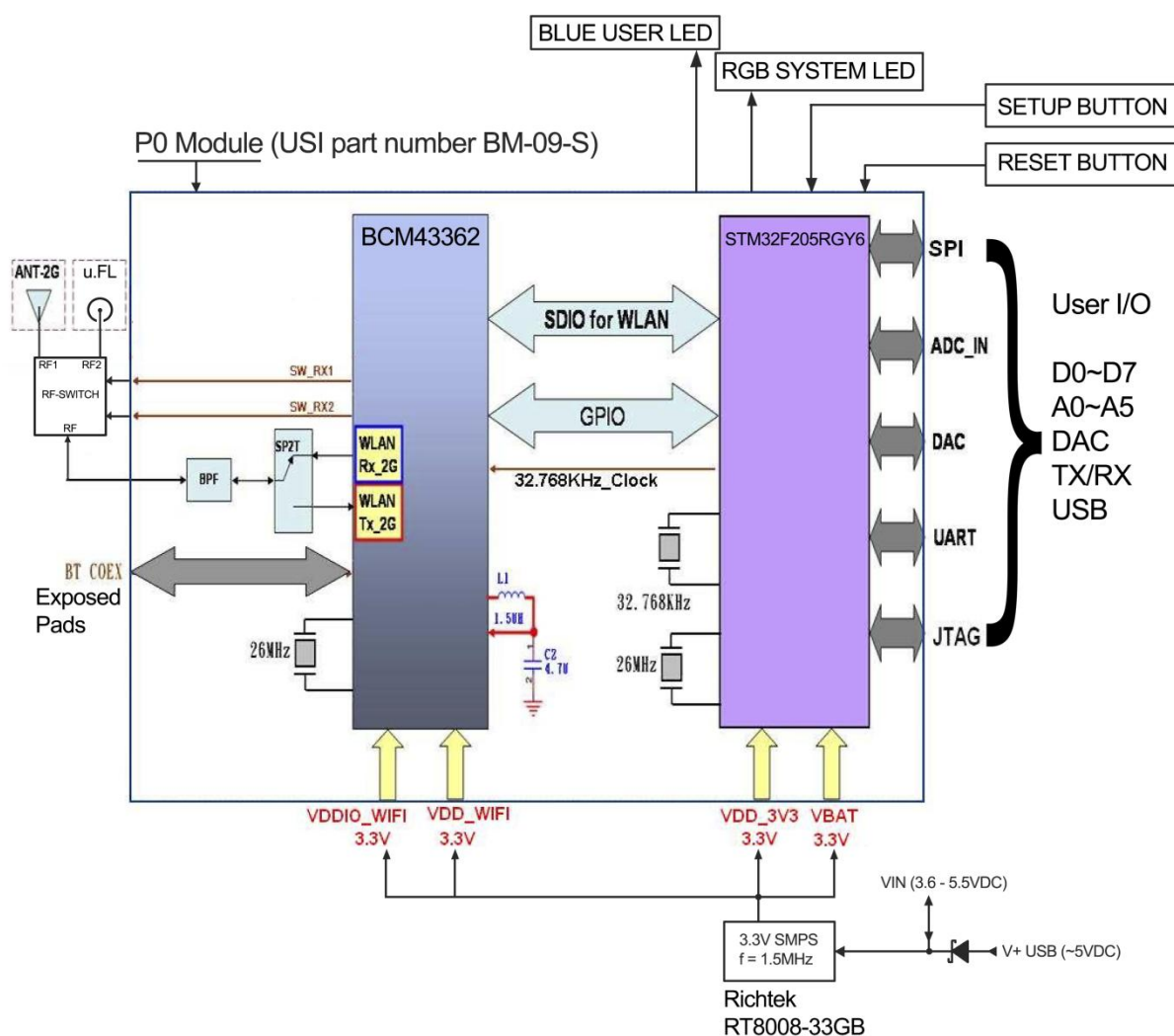
Real-time operating system (FreeRTOS)

Soft AP setup

FCC, CE and IC certified

## Interfaces

### Block Diagram



## Power

Power to the Photon is supplied via the on-board USB Micro B connector or directly via the VIN pin. If power is supplied directly to the VIN pin, the voltage should be regulated between 3.6VDC and 5.5VDC. When the Photon is powered via

the USB port, VIN will output a voltage of approximately 4.8VDC due to a reverse polarity protection series schottky diode between V+ of USB and VIN. When used as an output, the max load on VIN is 1A.

Typical current consumption is 80mA with a 5V input. Deep sleep quiescent current is 160uA. When powering the Photon from the USB connector, make sure to use a quality cable to minimize IR drops (current x resistance = voltage) in the wiring. If a high resistance cable (i.e., low current) is used, peak currents drawn from the Photon when transmitting and receiving will result in voltage sag at the input which may cause a system brown out or intermittent operation. Likewise, the power source should be sufficient enough to source 1A of current to be on the safe side.

## RF

The RF section of the Photon is a finely tuned impedance controlled network of components that optimize the efficiency and sensitivity of the Wi-Fi communications.

An RF feed line runs from the PØ module into a SPDT RF-switch. Logic level control lines on the PØ module select which of the two ports of the RF-switch is connected to the RF feed line. A 100pF decoupling capacitor is located on each control line. One port is connected to a PCB ceramic chip antenna, and the other is connected to a u.FL connector for external antenna adaptation. The default port will be set to the chip antenna.

Additionally, a user API is available to switch between internal, external and even an automatic mode which continuously switches between each antenna and selects the best signal. All three RF ports on the RF-switch have a 10pF RF quality DC-blocking capacitor in series with them. These effectively pass 2.4GHz frequencies freely while blocking unwanted DC voltages from damaging the RF-switch. All RF traces are considered as tiny transmission lines that have a controlled 50 ohm impedance.

The chip antenna is impedance matched to the 50 ohm RF feed line via a Pi network comprised of three RF inductors (1 series, 2 shunt). These values are quite specific to the Photon due to the PCB construction and layout of the RF section. Even if the Photon's layout design is copied exactly, to achieve the best performance it would be worth re-examining the Pi network values on actual samples of the PCB in question.

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## FCC Approved Antennas

| Antenna Type   | Manufacturer       | MFG. Part #    | Gain    |
|----------------|--------------------|----------------|---------|
| Dipole antenna | LumenRadio         | 104-1001       | 2.15dBi |
| Chip antenna   | Advanced Ceramic X | AT7020-E3R0HBA | 1.3dBi  |

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## Peripherals and GPIO

The Photon has ton of capability in a small footprint, with analog, digital and communication interfaces.

| Peripheral Type | Qty | Input(I) / Output(O) | FT[1] / 3V3[2] |
|-----------------|-----|----------------------|----------------|
| Digital         | 18  | I/O                  | FT/3V3         |
| Analog (ADC)    | 8   | I                    | 3V3            |

Peripheral Type Qty Input(I) / Output(O) FT[1] / 3V3[2]

|              |    |     |     |
|--------------|----|-----|-----|
| Analog (DAC) | 2  | O   | 3V3 |
| SPI          | 2  | I/O | 3V3 |
| I2S          | 1  | I/O | 3V3 |
| I2C          | 1  | I/O | FT  |
| CAN          | 1  | I/O | FT  |
| USB          | 1  | I/O | 3V3 |
| PWM          | 93 | O   | 3V3 |

#### Notes:

[1] FT = 5.0V tolerant pins. All pins except A3 and DAC are 5V tolerant (when not in analog mode). If used as a 5V input the pull-up/pull-down resistor must be disabled.

[2] 3V3 = 3.3V max pins.

[3] PWM is available on D0, D1, D2, D3, A4, A5, WKP, RX, TX with a caveat: PWM timer peripheral is duplicated on two pins (A5/D2) and (A4/D3) for 7 total independent PWM outputs. For example: PWM may be used on A5 while D2 is used as a GPIO, or D2 as a PWM while A5 is used as an analog input. However A5 and D2 cannot be used as independently controlled PWM outputs at the same time.

#### JTAG

Pin D3 through D7 are JTAG interface pins. These can be used to reprogram your Photon bootloader or user firmware image with standard JTAG tools such as the ST-Link v2, J-Link, R-Link, OLIMEX ARM-USB-TINI-H, and also the FTDI-based Particle JTAG Programmer.

| Photon Pin | Description | STM32 Pin | PØ Pin # | PØ Pin Name      | Default Internal[1] |
|------------|-------------|-----------|----------|------------------|---------------------|
| D7         | JTAG_TMS    | PA13      | 44       | MICRO_JTAG_TMS   | ~40k pull-up        |
| D6         | JTAG_TCK    | PA14      | 40       | MICRO_JTAG_TCK   | ~40k pull-down      |
| D5         | JTAG_TDI    | PA15      | 43       | MICRO_JTAG_TDI   | ~40k pull-up        |
| D4         | JTAG_TDO    | PB3       | 41       | MICRO_JTAG_TDO   | Floating            |
| D3         | JTAG_TRST   | PB4       | 42       | MICRO_JTAG_TRSTN | ~40k pull-up        |

| Photon Pin | Description | STM32 Pin | PØ Pin # | PØ Pin Name | Default Internal[1] |
|------------|-------------|-----------|----------|-------------|---------------------|
|------------|-------------|-----------|----------|-------------|---------------------|

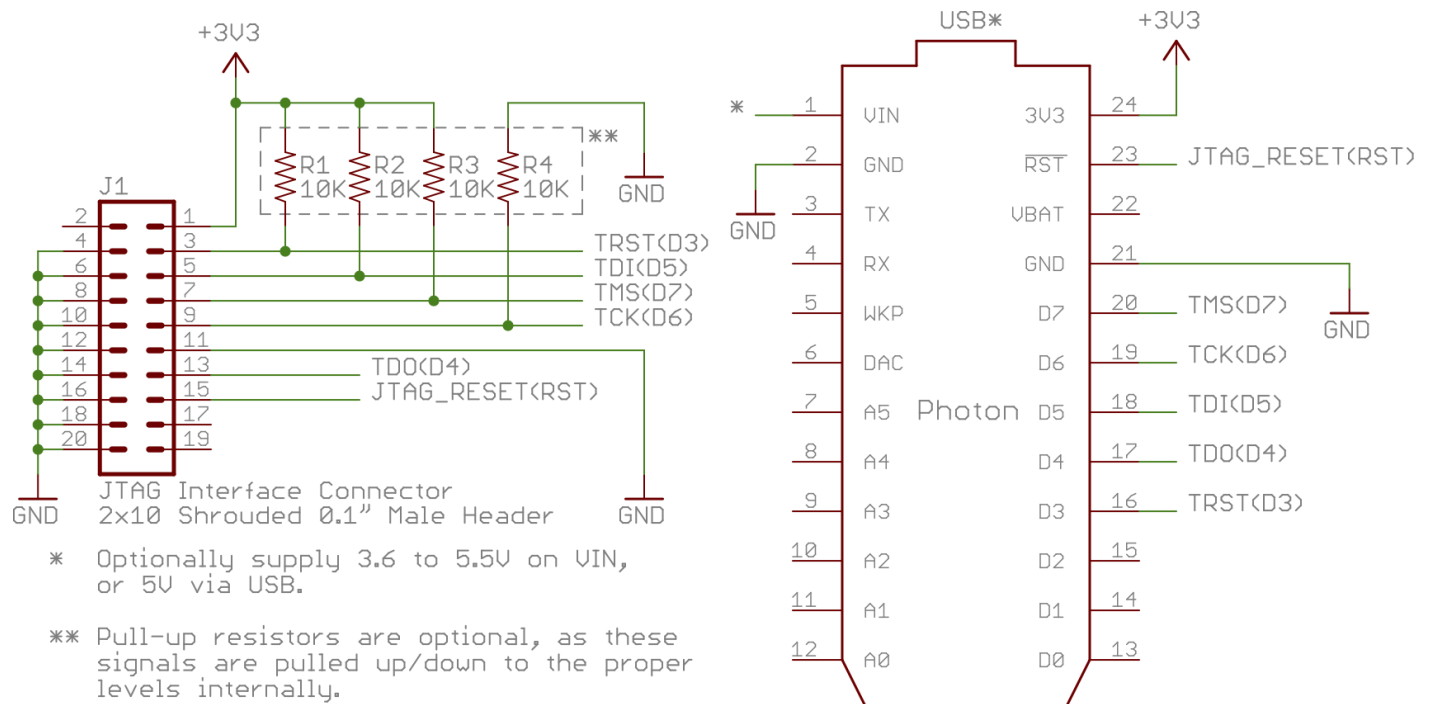
|     |       |  |  |  |  |
|-----|-------|--|--|--|--|
| 3V3 | Power |  |  |  |  |
|-----|-------|--|--|--|--|

|     |        |  |  |  |  |
|-----|--------|--|--|--|--|
| GND | Ground |  |  |  |  |
|-----|--------|--|--|--|--|

|     |       |  |  |  |  |
|-----|-------|--|--|--|--|
| RST | Reset |  |  |  |  |
|-----|-------|--|--|--|--|

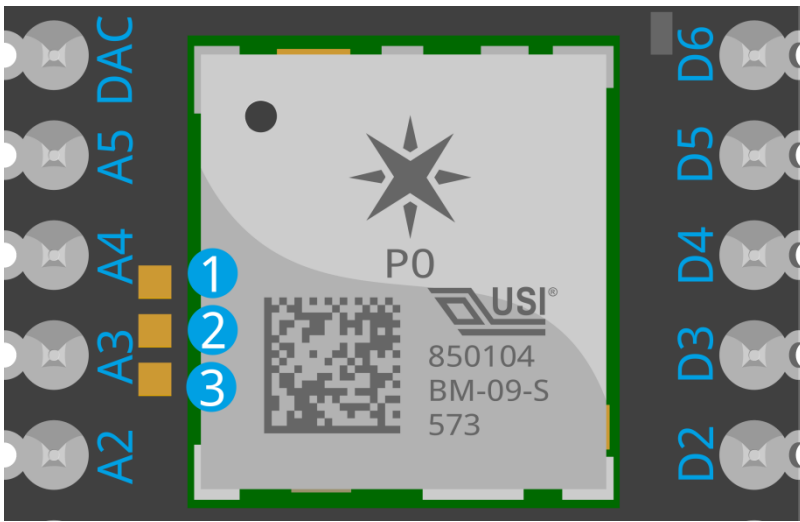
Notes: [1] Default state after reset for a short period of time before these pins are restored to GPIO (if JTAG debugging is not required, i.e. USE\_SWD\_JTAG=y is not specified on the command line.)

A standard 20-pin 0.1" shrouded male JTAG interface connector should be wired as follows:



## External Coexistence Interface

The Photon supports coexistence with Bluetooth and other external radios via the three gold pads on the top side of the PCB near pin A3. These pads are 0.035" square, spaced 0.049" apart. This spacing supports the possibility of tacking on a small 1.25mm - 1.27mm pitch 3-pin male header to make it somewhat easier to interface with.



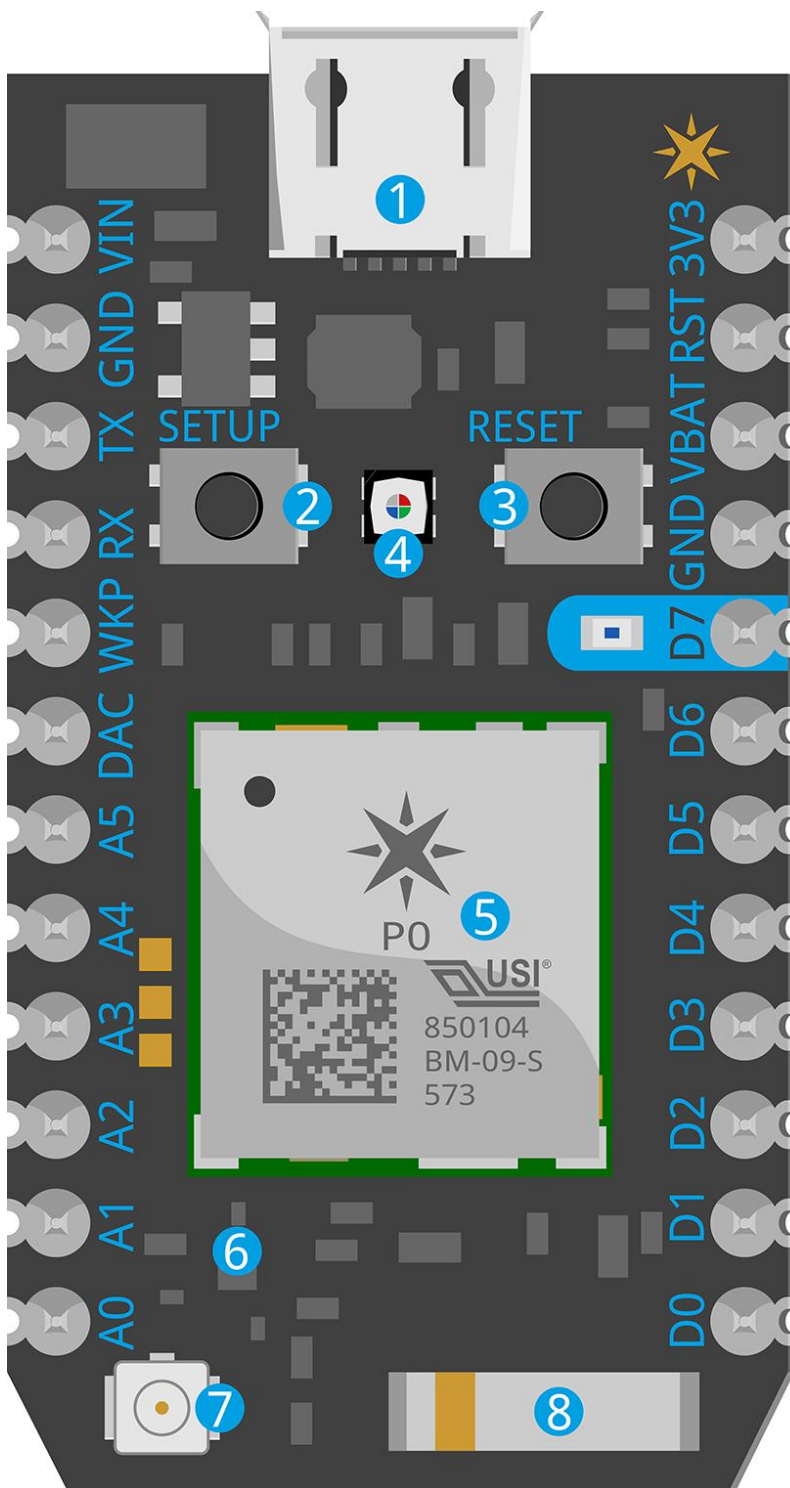
When two radios occupying the same frequency band are used in the same system, such as Wi-Fi and Bluetooth, a coexistence interface can be used to coordinate transmit activity, to ensure optimal performance by arbitrating conflicts between the two radios.

| Pad # | P0 Pin Name    | P0 Pin # | I/O | Description   |
|-------|----------------|----------|-----|---|
| 1     | BTCX_RF_ACTIVE | 9        | I   | Signals Bluetooth is active                           |
| 2     | BTCX_STATUS    | 10       | I   | Signals Bluetooth priority status and TX/RX direction |
| 3     | BTCX_TXCONF    | 11       | O   | Output giving Bluetooth permission to TX              |

When these pads are programmed to be used as a Bluetooth coexistence interface, they're set as high impedance on power up and reset. Alternatively, they can be individually programmed to be used as GPIOs through software control. They can also be programmed to have an internal pull-up or pull-down resistor.

#### Pin and button definition

#### Pin markings



- 1 USB
- 2 SETUP BUTTON
- 3 RESET BUTTON
- 4 RGB LED
- 5 P0 Wi-Fi MODULE
- 6 RF SWITCH
- 7 u.FL ANT CONN.
- 8 CHIP ANTENNA

#### Pin description

| Pin | Description |
|-----|-------------|
|-----|-------------|

|     |  |
|-----|--|
| VIN | This pin can be used as an input or output. As an input, supply 3.6 to 5.5VDC to power the Photon. When the Photon is powered via the USB port, this pin will output a voltage of approximately 4.8VDC due to a reverse polarity protection series schottky diode between VUSB and VIN. When used as an output, the max load on VIN is 1A. |
|-----|--|

|     |  |
|-----|--|
| RST | Active-low reset input. On-board circuitry contains a 1k ohm pull-up resistor between RST and 3V3, and 0.1uF |
|-----|--|

Pin Description

capacitor between RST and GND.

**VBAT** Supply to the internal RTC, backup registers and SRAM when 3V3 is not present (1.65 to 3.6VDC).

**3V3** This pin is the output of the on-board regulator and is internally connected to the VDD of the WiFi module. When powering the Photon via VIN or the USB port, this pin will output a voltage of 3.3VDC. This pin can also be used to power the Photon directly (max input 3.3VDC). When used as an output, the max load on 3V3 is 100mA. NOTE: When powering the Photon via this pin, ensure power is disconnected from VIN and USB.

**WKP** Active-high wakeup pin, wakes the module from sleep/standby modes. When not used as a WAKEUP, this pin can also be used as a digital GPIO, ADC input or PWM.

**D0~D7** Digital only GPIO pins.

**A0~A7** 12-bit Analog-to-Digital (A/D) inputs (0-4095), and also digital GPIOs. A6 and A7 are code convenience mappings, which means pins are not actually labeled as such but you may use code like analogRead(A7). A6 maps to the DAC pin and A7 maps to the WKP pin.

**DAC** 12-bit Digital-to-Analog (D/A) output (0-4095), and also a digital GPIO. DAC is used as DAC or DAC1 in software, and A3 is a second DAC output used as DAC2 in software.

**RX** Primarily used as UART RX, but can also be used as a digital GPIO or PWM.

**TX** Primarily used as UART TX, but can also be used as a digital GPIO or PWM.

### Pin out diagrams

| USB                        | Pin  | Exposed Functions |           | STM32 Pin | PØ Pin # | PØ Pin Name    |                  |   |              |
|----------------------------|------|-------------------|-----------|-----------|----------|----------------|------------------|---|--------------|
| P<br>H<br>O<br>T<br>O<br>N | 3V3  | 3V3               |           |           |          |                |                  |   |              |
|                            | RST  | RST               |           | E8        | 26       | MICRO_RST_N    |                  |   |              |
|                            | VBAT | VBAT              |           | A9        | 28       | VBAT           |                  |   |              |
|                            | GND  | GND               |           |           |          |                |                  |   |              |
|                            | D7   | JTAG_TMS          |           | PA13      | 44       | MICRO_JTAG_TMS |                  |   |              |
|                            | D6   | JTAG_TCK          |           | PA14      | 40       | MICRO_JTAG_TCK |                  |   |              |
|                            | D5   | JTAG_TDI          | SPI3_SS   | I2S3_WS   | PA15     | 43             | MICRO_JTAG_TDI   |   |              |
|                            | D4   | JTAG_TDO          | SPI3_SCK  | I2S3_SCK  | PB3      | 41             | MICRO_JTAG_TDO   |   |              |
|                            | D3   | JTAG_TRST         | SPI3_MISO | TIM3_CH1  | PB4      | 42             | MICRO_JTAG_TRSTN |   |              |
|                            | D2   |                   | SPI3_MOSI | CAN2_RX   | TIM3_CH2 | I2S3_SD        | PB5              | 3 | MICRO_GPIO_5 |
|                            | D1   | SCL               |           | CAN2_TX   | TIM4_CH1 |                | PB6              | 5 | MICRO_GPIO_3 |
|                            | D0   | SDA               |           | TIM4_CH2  |          |                | PB7              | 4 | MICRO_GPIO_4 |

<="">



| Pin | USB                        | Exposed Functions |           |          | STM32 Pin | PØ Pin # | PØ Pin Name   |                |               |
|-----|----------------------------|-------------------|-----------|----------|-----------|----------|---------------|----------------|---------------|
| VIN |                            | VIN               |           |          |           |          |               |                |               |
| GND |                            | GND               |           |          |           |          |               |                |               |
| TX  | P<br>H<br>O<br>T<br>O<br>N |                   | USART1_TX | TIM1_CH2 | PA9       | 39       | MICRO_UART_TX |                |               |
| RX  |                            |                   | USART1_RX | TIM1_CH3 | PA10      | 38       | MICRO_UART_RX |                |               |
| WKP |                            |                   |           | TIM5_CH1 | PA0       | 27       | MICRO_WKUP    |                |               |
| DAC |                            | ADC4              |           |          | DAC1      | PA4      | 22            | MICRO_SPI_SSN  |               |
| A5  |                            | ADC7              | SPI1_MOSI |          | TIM3_CH2  | PA7      | 23            | MICRO_SPI_MOSI |               |
| A4  |                            | ADC6              | SPI1_MISO |          | TIM3_CH1  | PA6      | 25            | MICRO_SPI_MISO |               |
| A3  |                            | ADC5              | SPI1_SCK  |          |           | DAC2     | PA5           | 24             | MICRO_SPI_SCK |
| A2  |                            | ADC12             | SPI1_SS   |          |           |          | PC2           | 2              | MICRO_GPIO_6  |
| A1  |                            | ADC13             |           |          |           |          | PC3           | 1              | MICRO_GPIO_7  |
| A0  |                            | ADC15             |           |          |           |          | PC5           | 54             | MICRO_GPIO_8  |

| User I/O                   |                 | Photon Pin # | Exposed Functions |          | STM32 Pin      | PØ Pin # | PØ Pin Name     |              |
|----------------------------|-----------------|--------------|-------------------|----------|----------------|----------|-----------------|--------------|
| P<br>H<br>O<br>T<br>O<br>N | RGB LED - RED   | 27           |                   | TIM2_CH2 | PA1            | 8        | MICRO_GPIO_0    |              |
|                            | RGB LED - GREEN | 28           |                   | TIM2_CH3 | PA2            | 7        | MICRO_GPIO_1    |              |
|                            | RGB LED - BLUE  | 29           |                   | TIM2_CH4 | PA3            | 6        | MICRO_GPIO_2    |              |
|                            | Setup Button    | 26           |                   | TIM3_CH2 | I2S3_MCK       | PC7      | 53              | MICRO_GPIO_9 |
|                            | Reset Button    | 23           |                   |          | E8             | 26       | MICRO_RST_N     |              |
|                            | USB Data+       | 31           |                   |          | PB15           | 51       | MICRO_USB_HS_DP |              |
|                            | USB Data-       | 30           |                   |          | PB14           | 52       | MICRO_USB_HS_DM |              |
|                            | SMPS Enable     | 25           |                   |          |                |          |                 |              |
|                            | Peripheral Key  |              | ADC               | SPI      | PWM/Servo/Tone |          |                 |              |
|                            |                 |              | JTAG              | SPI1     | I2S            | DAC      |                 |              |
|                            |                 | I2C/Wire     | Serial1           | CAN      |                |          |                 |              |

## Technical specification

### Absolute maximum ratings

| Parameter                                | Symbol     | Min | Typ | Max     | Unit |
|--|------------|-----|-----|---------|------|
| Supply Input Voltage                     | VIN-MAX    |     |     | +6.5    | V    |
| Supply Output Current                    | IIN-MAX-L  |     |     | 1       | A    |
| Supply Output Current                    | I3V3-MAX-L |     |     | 100     | mA   |
| Storage Temperature                      | Tstg       | -40 |     | +85     | °C   |
| Enable Voltage                           | VEN        |     |     | VIN+0.6 | V    |
| ESD Susceptibility HBM (Human Body Mode) | VESD       |     |     | 2       | kV   |

### Recommended operating conditions

| Parameter  | Symbol  | Min    | Typ  | Max    | Unit |
|--|---------|--------|------|--------|------|
| Supply Input Voltage                             | VIN     | +3.6   |      | +5.5   | V    |
| Supply Input Voltage                             | V3V3    | +3.0   | +3.3 | +3.6   | V    |
| Supply Output Voltage                            | VIN     |        | +4.8 |        | V    |
| Supply Output Voltage                            | V3V3    |        | +3.3 |        | V    |
| Supply Input Voltage                             | VVBAT   | +1.65  |      | +3.6   | V    |
| Supply Input Current (VBAT)                      | IVBAT   |        |      | 19     | uA   |
| Operating Current (Wi-Fi on)                     | IIN avg |        | 80   | 100    | mA   |
| Operating Current (Wi-Fi on)                     | IIN pk  | 235[1] |      | 430[1] | mA   |
| Operating Current (Wi-Fi on, w/powersave)        | IIN avg |        | 18   | 100[2] | mA   |
| Operating Current (Wi-Fi off)                    | IIN avg |        | 30   | 40     | mA   |
| Sleep Current (5V @ VIN)                         | IQs     |        | 1    | 2      | mA   |
| Deep Sleep Current (5V @ VIN)                    | IQds    |        | 80   | 100    | uA   |
| Operating Temperature                            | Top     | -20    |      | +60    | °C   |
| Humidity Range Non condensing, relative humidity |         |        |      | 95     | %    |

#### Notes:

[1] These numbers represent the extreme range of short peak current bursts when transmitting and receiving in 802.11b/g/n modes at different power levels. Average TX current consumption in will be 80-100mA.

[2] These are very short average current bursts when transmitting and receiving. On average if minimizing frequency of TX/RX events, current consumption in powersave mode will be 18mA

#### Wi-Fi Specifications

| Feature | Description |
|---------|-------------|
|---------|-------------|

|                |                  |
|----------------|------------------|
| WLAN Standards | IEEE 802 11b/g/n |
|----------------|------------------|

| Feature        | Description  |
|----------------|--|
| Antenna Port   | Single Antenna   |
| Frequency Band | 2.412GHz -- 2.462GHz (United States of America and Canada) |
|                | 2.412GHz -- 2.472GHz (EU)                                  |
| Sub Channels   | 1 -- 11 (United States of America and Canada)              |
|                | 1 -- 13 (EU)   |
| Modulation     | DSSS, CCK, OFDM, BPSK, QPSK, 16QAM, 64QAM                  |

| Ø module Wi-Fi output power                |      | Typ.                | Tol.    | Unit |
|--|------|---------------------|---------|------|
| RF Average Output Power, 802.11b CCK Mode  | 1M   | Avail. upon request | +/- 1.5 | dBm  |
|  | 11M  | -                   | +/- 1.5 | dBm  |
| RF Average Output Power, 802.11g OFDM Mode | 6M   | -                   | +/- 1.5 | dBm  |
|  | 54M  | -                   | +/- 1.5 | dBm  |
| RF Average Output Power, 802.11n OFDM Mode | MCS0 | -                   | +/- 1.5 | dBm  |
|  | MCS7 | -                   | +/- 1.5 | dBm  |

#### I/O Characteristics

These specifications are based on the STM32F205RG datasheet, with reference to Photon pin nomenclature.

| Parameter                             | Symbol | Conditions | Min               | Typ | Max                | Unit |
|---------------------------------------|--------|------------|-------------------|-----|--------------------|------|
| Standard I/O input low level voltage  | VIL    |            | -0.3              |     | 0.28*(V3V3-2)+0.8  | V    |
| I/O FT[1] input low level voltage     | VIL    |            | -0.3              |     | 0.32*(V3V3-2)+0.75 | V    |
| Standard I/O input high level voltage | VIH    |            | 0.41*(V3V3-2)+1.3 |     | V3V3+0.3           | V    |

| Parameter  | Symbol           | Conditions                            | Min                          | Typ | Max | Unit |
|--|------------------|---------------------------------------|------------------------------|-----|-----|------|
| I/O FT[1] input high level voltage                 | VIH              | V3V3 > 2V                             | $0.42 \cdot (V3V3 - 2) + 1$  |     | 5.5 | V    |
|  | VIH              | V3V3 ≤ 2V                             | $0.42 \cdot (V3V3 - 2) + 1$  |     | 5.2 | V    |
| Standard I/O Schmitt trigger voltage hysteresis[2] | Vhys             |                                       | 200                          |     |     | mV   |
| I/O FT Schmitt trigger voltage hysteresis[2]       | Vhys             |                                       | 5% V3V3[3]                   |     |     | mV   |
| Input leakage current[4]                           | I <sub>lkg</sub> | GND ≤ V <sub>io</sub> ≤ V3V3<br>GPIOs |                              |     | ±1  | μA   |
| Input leakage current[4]                           | I <sub>lkg</sub> | RPU                                   | V <sub>io</sub> = 5V, I/O FT |     | 3   | μA   |
| Weak pull-up equivalent resistor[5]                | RPU              | V <sub>io</sub> = GND                 | 30                           | 40  | 50  | k Ω  |
| Weak pull-down equivalent resistor[5]              | RPD              | V <sub>io</sub> = V3V3                | 30                           | 40  | 50  | k Ω  |
| I/O pin capacitance                                | CIO              |                                       |                              | 5   |     | pF   |

#### Notes:

[1] FT = Five-volt tolerant. In order to sustain a voltage higher than V3V3+0.3 the internal pull-up/pull-down resistors must be disabled.

[2] Hysteresis voltage between Schmitt trigger switching levels. Based on characterization, not tested in production.

[3] With a minimum of 100mV.

[4] Leakage could be higher than max. if negative current is injected on adjacent pins.

[5] Pull-up and pull-down resistors are designed with a true resistance in series with switchable PMOS/NMOS. This PMOS/NMOS contribution to the series resistance is minimum (~10% order).

#### Mechanical specifications

##### Dimensions and Weight

| Headers | Dimensions in inches (mm)                | Weight  |
|---------|--|---------|
| With    | 1.44 x 0.8 x 0.27 (36.58 x 20.32 x 6.86) | 5 grams |

Headers    Dimensions in inches (mm)                      Weight

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Without    1.44 x 0.8 x 0.17 (36.58 x 20.32 x 4.32)    3.7 grams

#### Mating connectors

The Photon (with headers) can be mounted with (qty 2) 12-pin single row 0.1" female headers. Typically these are 0.335" (8.5mm) tall, but you may pick a taller one if desired. When you search for parts like these it can be difficult to navigate the thousands of parts available.

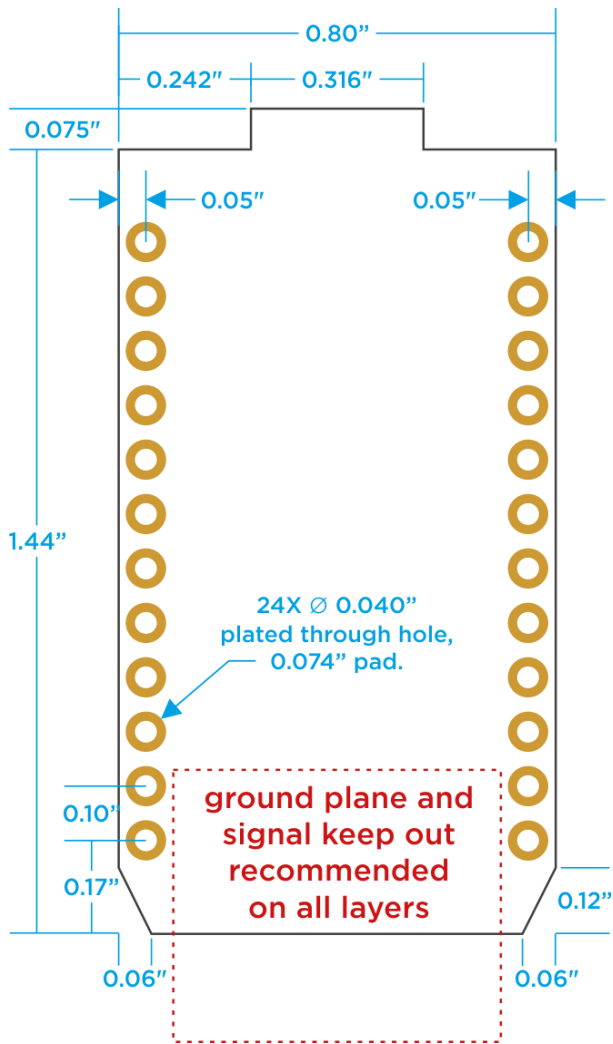
On Digikey.com, this section Rectangular Connectors - Headers, Receptacles, Female Sockets contains 36,000 of them. Narrow the search with: 12 positions, 1 row, 0.1" (2.54mm) pitch, Through Hole mounting types (unless you want SMT), and sort by Price Ascending. You may find something like this:

| Description                      | MFG                         | MFG Part Number |
|----------------------------------|-----------------------------|-----------------|
| 12-pin 0.1" Female Header (Tin)  | Sullins Connector Solutions | PPTC121LFBN-RC  |
| 12-pin 0.1" Female Header (Gold) | Sullins Connector Solutions | PPPC121LFBN-RC  |

You may also search for other types, such as reverse mounted (bottom side SMT) female headers, low profile types, machine pin, etc..

#### Recommended pcb land pattern (Photon with headers)

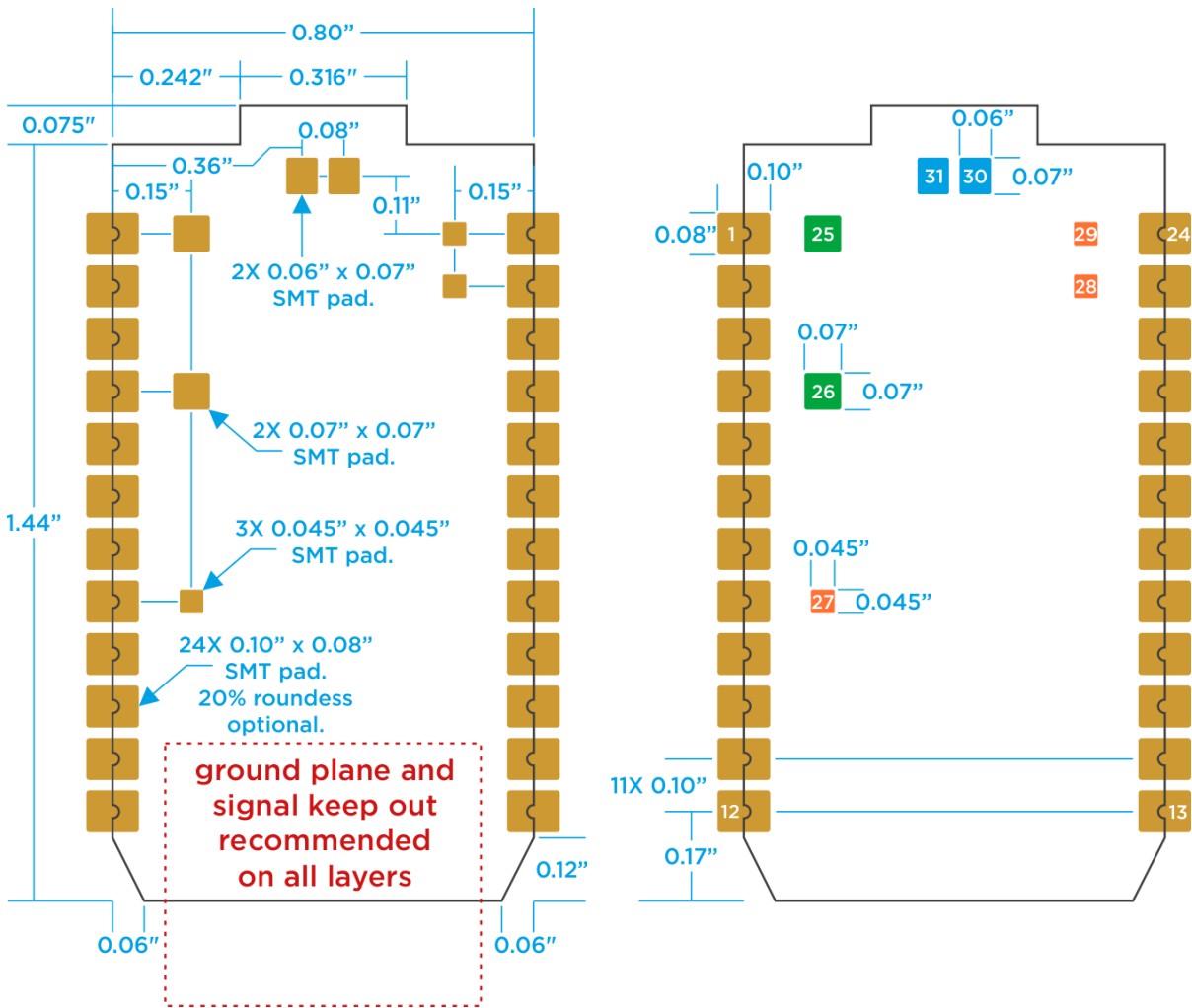
The Photon (with headers) can be mounted with 0.1" 12-pin female header receptacles using the following PCB land pattern:



This land pattern can be found in the Spark.lbr Eagle library, as a Device named PHOTON. Note: Clone or Download the complete repository as a ZIP file to avoid corrupted data in Eagle files.

Recommended pcb land pattern (Photon without headers)

The Photon (without headers) can be surface mounted directly in an end application PCB using the following PCB land pattern:



Photon Pin #25-31 are described in the Pin Out Diagrams.

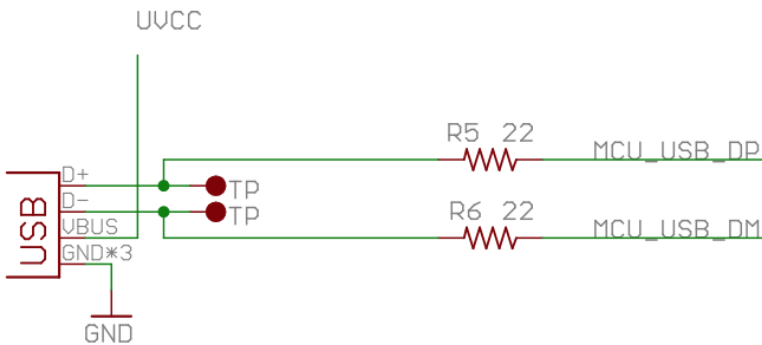
Photon Pin #25-31 are described in the Pin Out Diagrams.

Solder mask around exposed copper pads should be 0.1mm (4 mils) larger in all directions. E.g., a 0.08" x 0.10" pad would have a 0.088" x 0.108" solder mask.

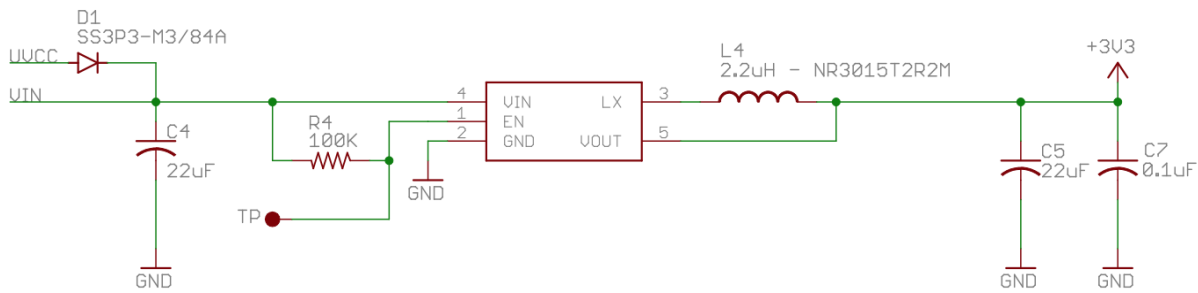
This land pattern can be found in the Spark.lbr Eagle library, as a Device named PHOTON\_SMD. Note: Clone or Download the complete repository as a ZIP file to avoid corrupted data in Eagle files.

Schematic

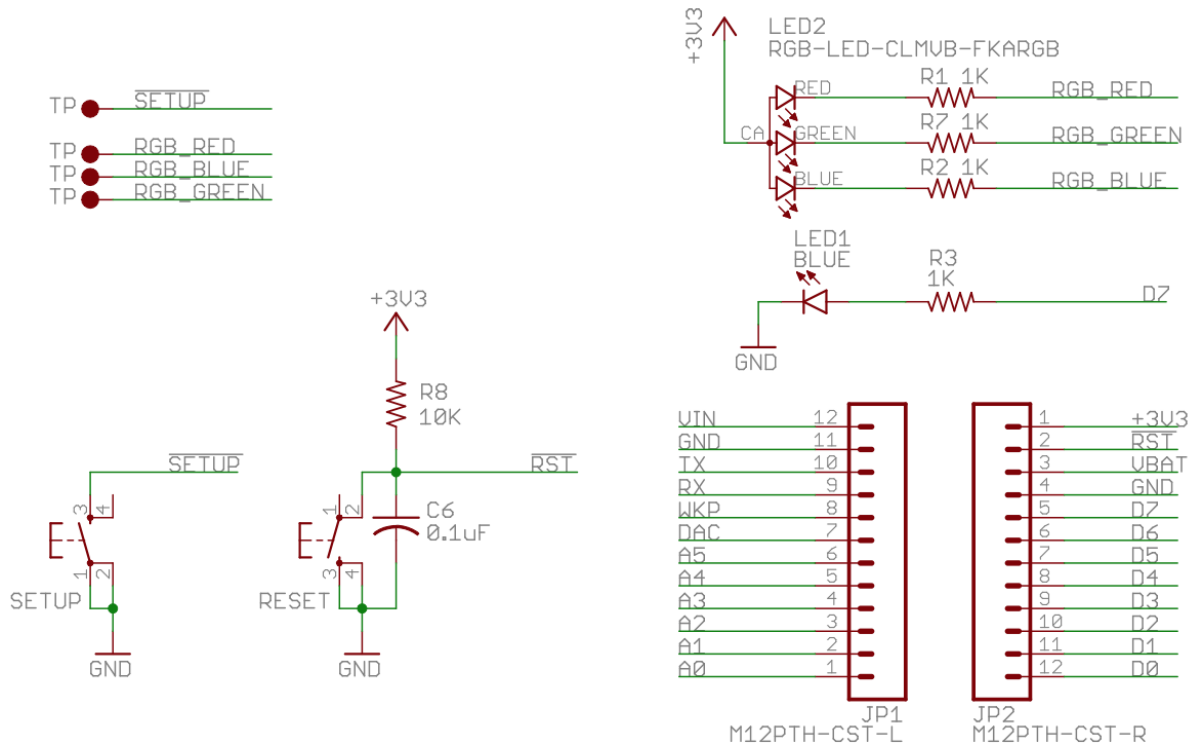
Schematic - USB



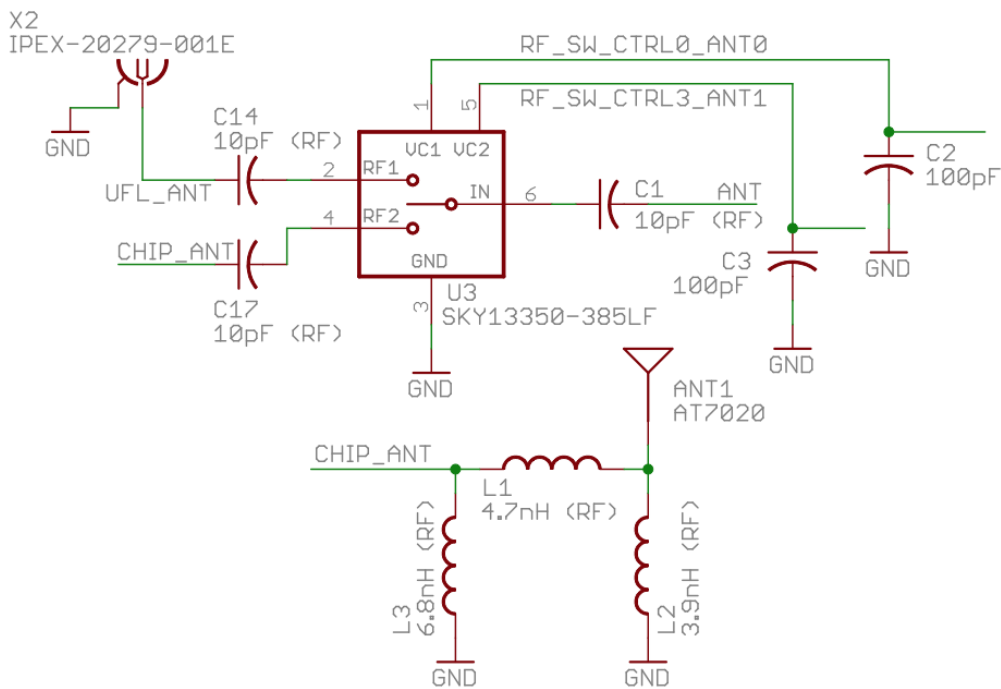
Schematic - Power



Schematic - User I/O

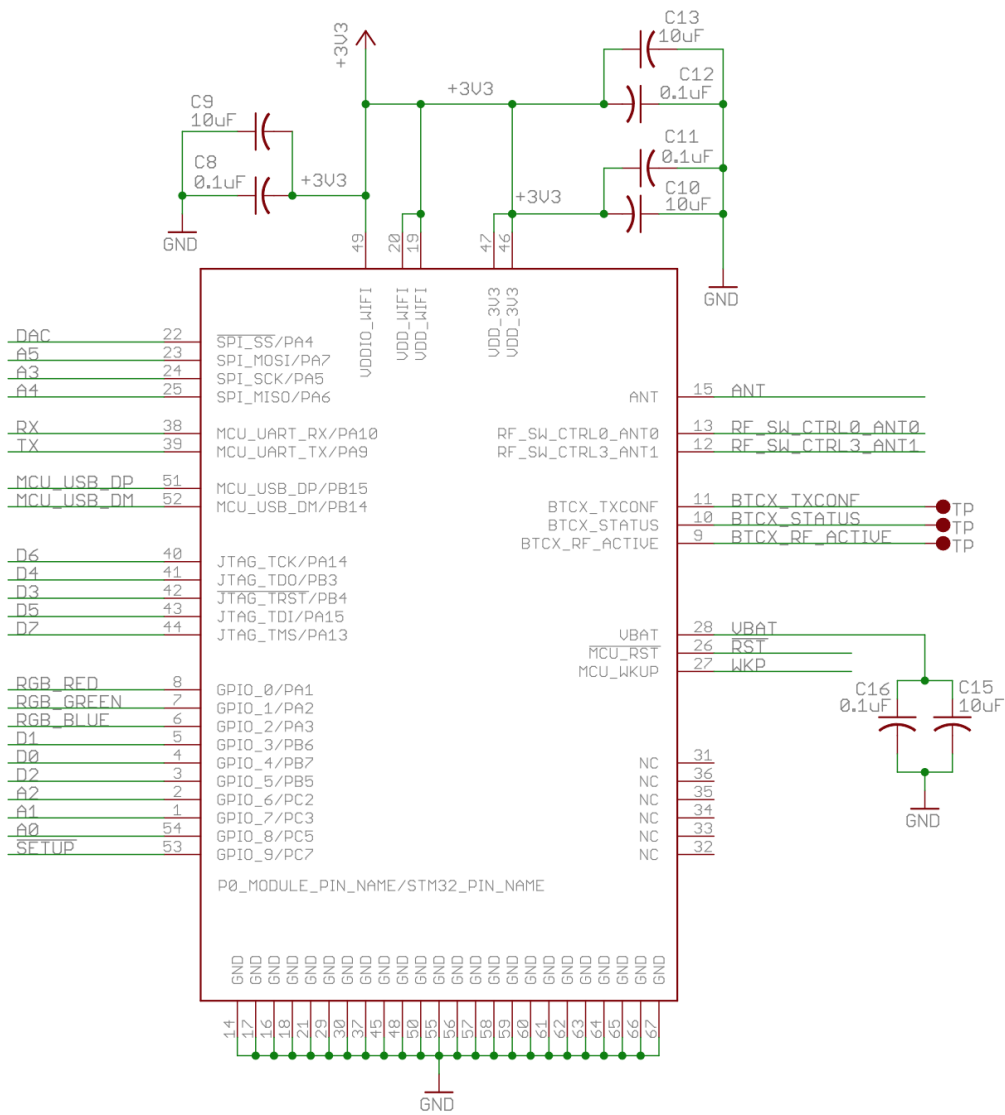


Schematic - RF



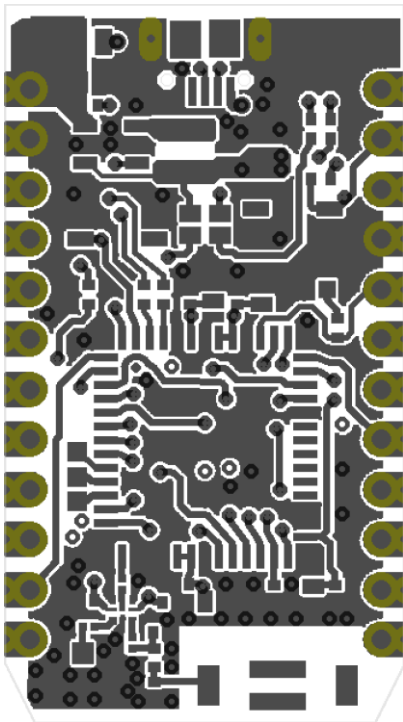
Schematic - P0 Wi-Fi Module



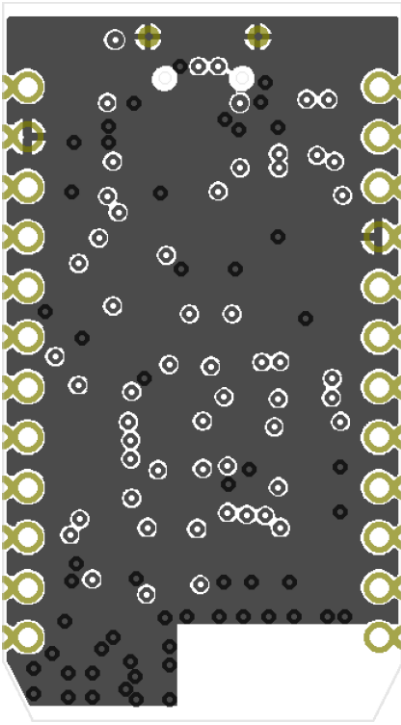


## Layout

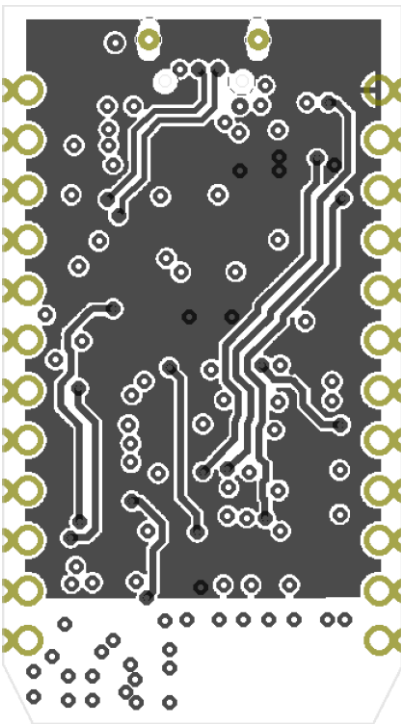
### Photon v1.0.0 Top Layer (GTL)



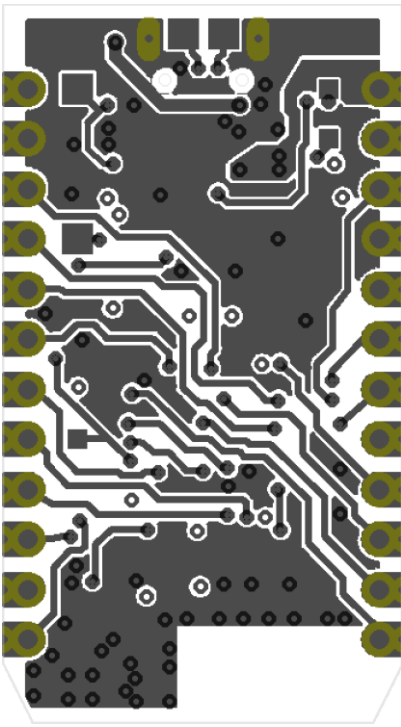
### Photon v1.0.0 GND Layer (G2L)



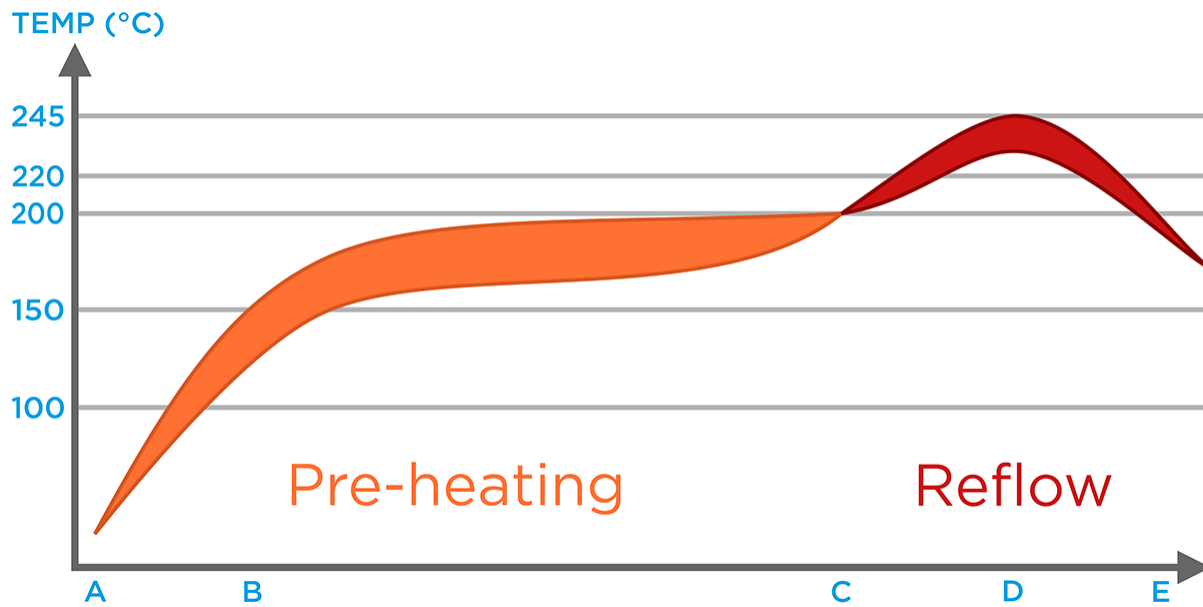
Photon v1.0.0 3V3 Layer (G15L)



Photon v1.0.0 Bottom Layer (GBL)



Recommended solder reflow profile



Phase Temperatures and Rates

A-B. Ambient~150°C, Heating rate: < 3°C/s

B-C. 150~200°C, soak time: 60~120 s

C-D. 200~245°C, Heating rate: < 3°C/s

D. Peak temp.: 235~245°C, Time above 220°C: 40~90 s

D-E. 245~220°C, Cooling rate: < 1°C/s

Bill of Materials

Build your own design based on the Photon!

| Qty | Device                       | Minimum Specification                   | Package/Case                 | Part Designator      | MFG.                  | MFG. PN                      |
|-----|------------------------------|---|------------------------------|----------------------|-----------------------|------------------------------|
| 1   | ANTENNA                      | 2.4GHz Ceramic                          | 5.0mm x<br>2.0mm x<br>2.6mm  | ANT1                 | Advanced<br>Ceramic X | AT7020-E3R0HBA               |
| 2   | CERAMIC<br>CAPACITOR         | 22uF Ceramic<br>6.3V 10% X5R            | 0603                         | C4,C5                | Samsung               | CL10A226MQ8NRNC              |
| 6   | CERAMIC<br>CAPACITOR         | 0.1uF Ceramic<br>6.3V 10% X5R           | 0402                         | C6,C7,C8,C11,C12,C16 | RongFu                | 0402B104K01A                 |
| 2   | CERAMIC<br>CAPACITOR         | 100pF Ceramic<br>6.3V 10% X5R           | 0402                         | C2,C3                | Fenghua               | 0402CG101J500NT              |
| 4   | CERAMIC<br>CAPACITOR         | 10uF Ceramic<br>6.3V 10% X5R            | 0603                         | C9,C11,C13,C15       | Sumsung               | CL10A106MQ8NNNC              |
| 3   | CERAMIC<br>CAPACITOR<br>(RF) | 10pF Ceramic<br>6.3V 10% X5R            | 0402                         | C1,C14,C17           | Murata                | GJM1555C1HR80BB01D           |
| 1   | CONNECTOR                    | USB Micro-B<br>w/tabs & slots           | USB-MICROB                   | X1                   | Kaweei                | CMCUSB-5BFM2G-01-D           |
| 1   | CONNECTOR                    | uFL Connector                           | SMD                          | X2                   | Kaweei                | P1163-0140R                  |
| 2   | HEADER                       | Single String 1.2"<br>Mating Length     | 0.1" 12-pin                  | JP1,JP2              | Kaweei                | CP25411-12G-S116-A           |
| 1   | DIODE                        | Diode Schottky<br>30V 3A                | DO-220AA                     | D1                   | Vishay                | SS3P3-M3/84A                 |
| 1   | DIODE (LED)                  | Blue                                    | SMD 0603                     | LED1                 | Everlight             | 19-217/BHC-<br>ZL1M2RY/3T    |
| 1   | DIODE (LED)                  | LED RGB<br>Common Anode<br>Diffused SMD | 4-PLCC<br>(2.0mm x<br>2.0mm) | LED2                 | Cree                  | CLMVB-FKA-<br>CFHEHLCBB7A363 |
| 1   | INDUCTOR                     | 2.2uH 1.5A                              | 3mm x 3mm                    | L4                   | Taiyo<br>Yuden        | NR3015T2R2M                  |

| Qty | Device          | Minimum Specification   | Package/Case   | Part Designator | MFG.     | MFG. PN        |
|-----|-----------------|---|----------------|-----------------|----------|----------------|
| 1   | INDUCTOR (RF)   | 3.9nH RF inductor   | 0402           | L3              | Johanson | L-07C3N9SV6T   |
| 1   | INDUCTOR (RF)   | 4.7nH RF inductor   | 0402           | L1              | Johanson | L-07C4N7SV6T   |
| 1   | INDUCTOR (RF)   | 6.8nH RF inductor   | 0402           | L2              | Johanson | L-07C6N8JV6T   |
| 1   | WI-FI + MCU     | Broadcom Wi-Fi + STM32 MCU                                      | Custom USI SMD | U1              | USI      | WM-N-BM-09-S   |
| 1   | RF SWITCH       | RF Switch SPDT  | UQFN-6 (1x1mm) | U3              | Skyworks | SKY13350-385LF |
| 1   | POWER REGULATOR | 3.3V 1.5MHz 600mA High Efficiency PWM Step-Down DC/DC Converter | SOT23-5        | U2              | Richtek  | RT8008-33GB    |
| 1   | RESISTOR        | 100k 5%   | 0402           | R4              | Fenghua  | RC-02W104FT    |
| 2   | RESISTOR        | 22R 5%  | 0402           | R5,R6           | Fenghua  | RC-02W220JT    |
| 1   | RESISTOR        | 10k 5%  | 0402           | R8              | Fenghua  | RC-02W103JT    |
| 4   | RESISTOR        | 1k 5%   | 0402           | R1,R2,R3,R7     | Fenghua  | RC-02W102JT    |
| 2   | SWITCH          | Button 160gf  | 3.6mm x 3.1mm  | SETUP,RESET     | Haoyu    | TS-1185A-C     |

#### Ordering information

Photons are available from store.particle.io in single quantities with and without headers, and also included in different maker kits.

#### Qualification and approvals



Model number: PHOTONH

RoHS

CE

FCC ID: 2AEMI-PHOTON

IC: 20127-PHOTON

Product handling

Packaging

The Photon comes in two primary styles of packaging: Matchbox and Kit Box. The Matchbox contains the bare essentials to get you started, while the kit box contains a breadboard, Micro B USB cable, sticker, prototyping card and a couple sensors to build your first internet connected project!



Photons without headers are also available in JEDEC style trays for automated pick and place machines. Request more details from us on this in the Contact section below.

Moisture sensitivity levels

The Moisture Sensitivity Level (MSL) relates to the packaging and handling precautions required. The PØ module on the Photons dominate the MSL requirements and are rated level 3. In general, this precaution applies for Photons without headers. If reflowing a Photon directly onto an application PCB, increased moisture levels prior to reflow can damage sensitive electronics on the Photon. A bake process to reduce moisture may be required.

For more information regarding moisture sensitivity levels, labeling, storage and drying see the MSL standard see IPC/JEDEC J-STD-020 (can be downloaded from [www.jedec.org](http://www.jedec.org)).

ESD Precautions

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

Default settings

The Photon comes preprogrammed 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.

You may use the online Web IDE Particle Build to code, compile and flash a user application OTA (Over The Air). Particle Dev is a local tool that uses the Cloud to compile and flash OTA as well. There is also a package Spark DFU-UTIL for Particle Dev that allows for Cloud compiling and local flashing via DFU over USB. This requires dfu-util to be installed on your system. 'dfu-util' can also be used with Particle CLI for Cloud compiling and local flashing via the command line. Finally the lowest level of development is available via the GNU GCC toolchain for ARM, which offers local compile and flash via dfu-util. This gives the user complete control of all source code and flashing methods. This is an extensive list, however not exhaustive.

## Glossary

### SMPS

Switched-Mode Power Supply

### RF

Radio Frequency

### Castellated

The edge of the PCB has plated holes that are cut in half which resemble the top of a castle. These make it easy to solder the Photon down to another PCB with a SMT reflow process.

### SMT

Surface Mount Technology (often associated with SMD which is a surface mount device).

### AP

Access Point

### LED

Light-Emitting Diode

### RGB LED

Red green and blue LEDs combined and diffused in one package.

### USB

Universal Serial Bus

### Quiescent current

Current consumed in the deepest sleep state

### FT

Five-tolerant; Refers to a pin being tolerant to 5V.

3V3

+3.3V; The regulated +3.3V supply rail. Also used to note a pin is only 3.3V tolerant.

RTC

Real Time Clock

OTA

Over The Air; describing how firmware is transferred to the device.

FCC IC 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:

This device may not cause harmful interference, and

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-PHOTON

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.

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

This device may not cause interference; and

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:

l'appareil ne doit pas produire de brouillage;

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 IC: 20127-PHOTON

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.