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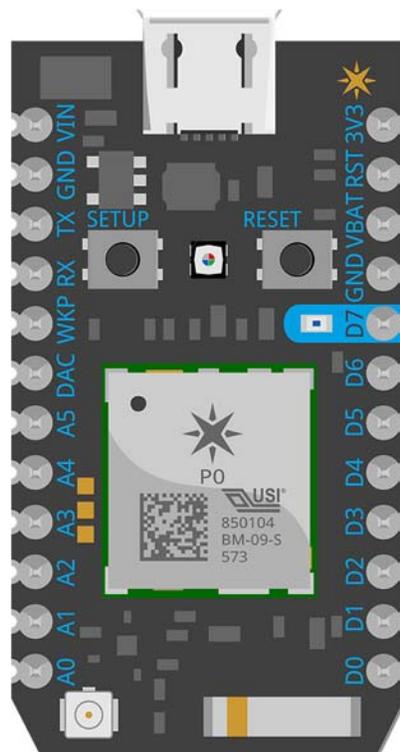
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## Photon Datasheet (v015)

**Model number:** PHOTONH, PHOTONNOH



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

## 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 PØ (P-zero).

To get you started quickly, Particle adds a rock solid 3.3VDC SMPS power supply, RF and user interface components to the PØ 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.

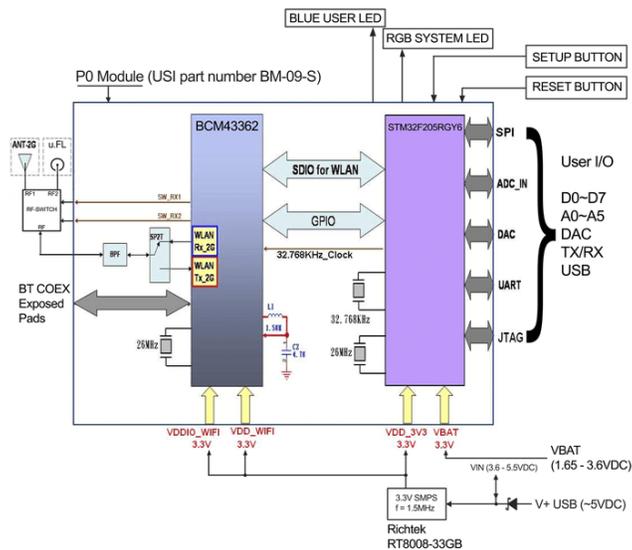
The Photon comes in two physical forms: with headers and without. Prototyping is easy with headers as the Photon plugs directly into standard breadboards and perfboards, and may also be mounted with 0.1" pitch female headers on a PCB. To minimize space required, the Photon form factor without headers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

## Features

- Particle PØ Wi-Fi module
  - Broadcom BCM43362 Wi-Fi chip
  - 802.11b/g/n Wi-Fi
  - STM32F205RGY6 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



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## 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. 3V3 can also be used as an output, but has a limited overhead of only 100mA available. (Please refer to Absolute Maximum Ratings for more info).

Typical average current consumption is 80mA with 5V @ VIN with Wi-Fi on. Deep sleep quiescent current is typically 80uA (Please refer to Recommended Operating Conditions for more info). 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 provide an adequate amount of current overhead (especially if powering additional circuitry off of VIN).

**Warning:** When powering the Photon from long wires on USB and VIN, care should be taken to protect against damaging voltage transients. **From the Richtek datasheet:**

*When a ceramic capacitor is used at the input and the power is supplied by a wall adapter through long wires, a load step at the output can induce ringing at the input, VIN. At best, this ringing can couple to the output and be mistaken as loop instability. At worst, a sudden inrush of current through the long wires can potentially cause a voltage spike at VIN large enough to damage the part.*

To avoid these voltage spikes, keep input wiring as short as possible. If long wires are unavoidable, it is advisable to add a 5.1V zener diode or similar transient suppression device from VIN to GND. Another technique is adding more capacitance to the input using an electrolytic capacitor. Please refer to AN-88 by Linear for a good discussion on this topic.

## 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.

## 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

## 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 <sup>(1)</sup> / 3V3 <sup>(2)</sup>
Digital	18	I/O	FT/3V3
Analog (ADC)	8	I	3V3
Analog (DAC)	2	O	3V3
SPI	2	I/O	3V3
I2S	1	I/O	3V3

Peripheral Type	Qty	Input(I) / Output(O)	FT <sup>[1]</sup> / 3V3 <sup>[2]</sup>
I2C	1	I/O	FT
CAN	1	I/O	3V3 <sup>[4]</sup>
USB	1	I/O	3V3
PWM	9 <sup>[3]</sup>	O	3V3

### Notes:

<sup>[1]</sup> 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.

<sup>[2]</sup> 3V3 = 3.3V max pins.

<sup>[3]</sup> 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.

<sup>[4]</sup> Technically these pins are 5.0V tolerant, but since you wouldn't operate them with a 5.0V transceiver it's proper to classify them as 3.3V.

## JTAG and SWD

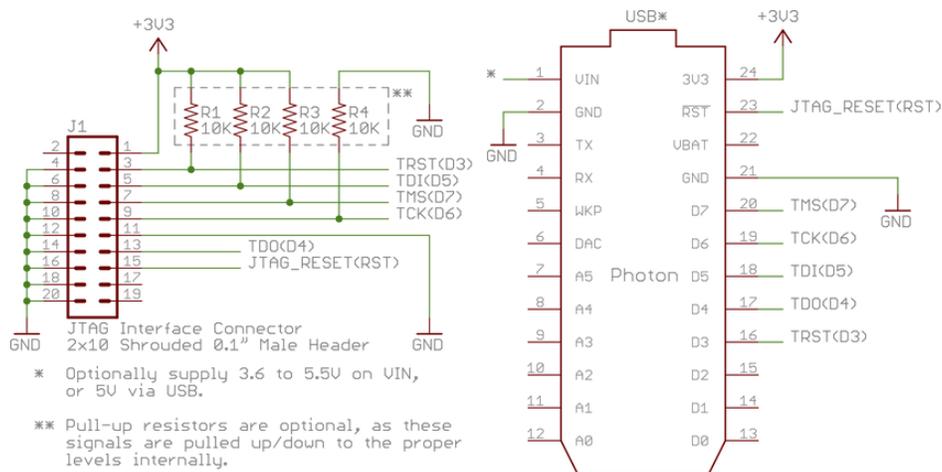
Pin D3 through D7 are JTAG interface pins. These can be used to reprogram your Photon bootloader or user firmware image with standard JTAG tools such as the ST-Link v2, J-Link, R-Link, OLIMEX ARM-USB-TINI-H, and also the FTDI-based Particle JTAG Programmer. If you are short on available pins, you may also use SWD mode which requires less connections.

Photon Pin	JTAG	SWD	STM32F205RGY6 Pin	PØ Pin #	PØ Pin Name	Default Internal <sup>[1]</sup>
D7	JTAG_TMS	SWD/SWDIO	PA13	44	MICRO_JTAG_TMS	~40k pull-up
D6	JTAG_TCK	CLK/SWCLK	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	JTAG	SWD	STM32F205RGY6 Pin	PØ Pin #	PØ Pin Name	Default Internal <sup>[1]</sup>
3V3	Power	Power				
GND	Ground	Ground				
RST	Reset	Reset				

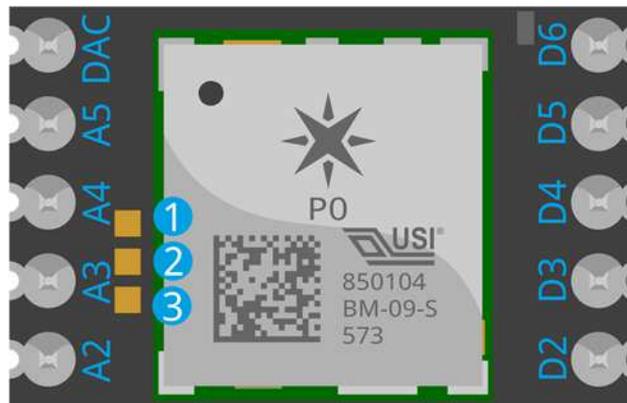
**Notes:** <sup>[1]</sup> Default state after reset for a short period of time before these pins are restored to GPIO (if JTAG debugging is not required, i.e. USE\_SWD\_JTAG=y is not specified on the command line.)

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 #	PØ Pin Name	PØ 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.

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## Memory Map

### STM32F205RGY6 Flash Layout Overview

- Bootloader (16 KB)
- DCT1 (16 KB), stores Wi-Fi credentials, keys, mfg info, system flags, etc..
- DCT2 (16 KB), swap area for DCT1
- EEPROM emulation bank 1 (16 KB)
- EEPROM emulation bank 2 (64 KB)
- System firmware (512 KB) [256 KB Wi-Fi/comms + 256 KB hal/platform/services]
- Factory backup, OTA backup and user application (384 KB) [3 x 128 KB]

### DCT Layout

The DCT area of flash memory has been mapped to a separate DFU media device so that we can incrementally update the application data. This allows one item (say, server public key) to be updated without erasing the other items.

*DCT layout in release/stable* found here in firmware.

[https://github.com/spark/firmware/blob/release/stable/platform/MCU/STM32F2xx/SPARK\\_Firmware\\_Driver/inc/dct.h](https://github.com/spark/firmware/blob/release/stable/platform/MCU/STM32F2xx/SPARK_Firmware_Driver/inc/dct.h)

<b>Region</b>	<b>Offset</b>	<b>Size</b>
system flags	0	32
version	32	2
device private key	34	1216
device public key	1250	384
ip config	1634	120
feature flags	1754	4
country code	1758	4
claim code	1762	63
claimed	1825	1
ssid prefix	1826	26
device code	1852	6
version string	1858	32
dns resolve	1890	128
reserved1	2018	64
server public key	2082	768
padding	2850	2
flash modules	2852	100
product store	2952	24
antenna selection	2976	1
cloud transport	2977	1
alt device public key	2978	128
alt device private key	3106	192
alt server public key	3298	192
alt server address	3490	128
device id	3618	12
radio flags	3630	1
mode button mirror	3631	32
led mirror	3663	96
led theme	3759	64
reserved2	3823	435

**Note:** Writing 0xFF to offset 34 (DEFAULT) or 3106 (ALTERNATE) will cause the device to re-generate a new private key on the next boot. Alternate keys are currently unsupported on the Photon but are used on the Electron as UDP/ECC keys. You should not need to use this feature unless your keys are corrupted.

```
// Regenerate Default Keys
echo -e "\xFF" > fillbyte && dfu-util -d 2b04:d006 -a 1 -s 34 -D fillbyte
// Regenerate Alternate Keys
echo -e "\xFF" > fillbyte && dfu-util -d 2b04:d006 -a 1 -s 3106 -D fillbyte
```

### Memory Map (Common)

Region	Start Address	End Address	Size
Bootloader	0x8000000	0x8004000	16 KB
DCT1	0x8004000	0x8008000	16 KB
DCT2	0x8008000	0x800C000	16 KB
EEPROM1	0x800C000	0x8010000	16 KB
EEPROM2	0x8010000	0x8020000	64 KB

### Memory Map (Modular Firmware - default)

Region	Start Address	End Address	Size
System Part 1	0x8020000	0x8060000	256 KB
System Part 2	0x8060000	0x80A0000	256 KB
User Part	0x80A0000	0x80C0000	128 KB
OTA Backup	0x80C0000	0x80E0000	128 KB
Factory Backup	0x80E0000	0x8100000	128 KB

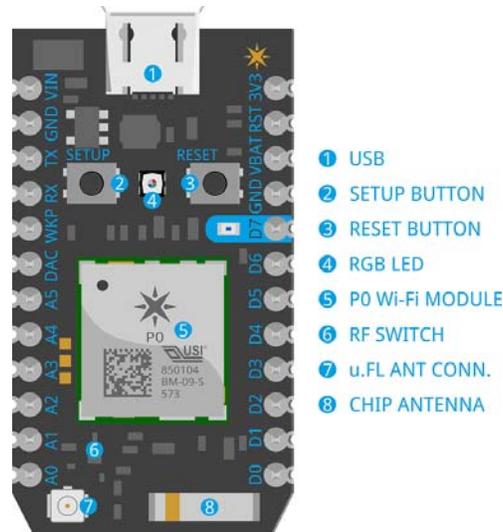
### Memory Map (Monolithic Firmware - optional)

Region	Start Address	End Address	Size
Firmware	0x8020000	0x8080000	384 KB
Factory Reset	0x8080000	0x80E0000	384 KB
Unused (factory reset modular)	0x80E0000	0x8100000	128 KB

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# Pin and button definition

## Pin markings



## 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 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 Wi-Fi 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.
RX	Primarily used as UART RX, but can also be used as a digital GPIO or PWM <sup>[2]</sup> .
TX	Primarily used as UART TX, but can also be used as a digital GPIO or PWM <sup>[2]</sup> .
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 <sup>[2]</sup> . Can be referred to as A7 when used as an ADC.
DAC	12-bit Digital-to-Analog (D/A) output (0-4095), referred to as DAC or DAC1 in software. Can also be used as a digital GPIO or ADC. Can be referred to as A6 when used as an ADC. A3 is a second DAC output used as DAC2 in software.
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 <code>analogRead(A7)</code> . A6 maps to the DAC pin and A7 maps to the WKP pin. A4,A5,A7 may also be used as a PWM <sup>[2]</sup> output.
D0~D7	Digital only GPIO pins. D0~D3 may also be used as a PWM <sup>[2]</sup> output.

**Notes:** <sup>[1]</sup> In addition to the 24 pins around the outside of the Photon, there are 7 pads on the bottom the Photon PCB that can be used to connect to extra signals: RGB LED outputs, SETUP button, SMPS enable line and USB D+/D-. Photon Pins #25-31 are described in the Pin out diagrams. Also refer to the Recommended PCB land pattern photon without headers section for their location on the bottom of the Photon.

<sup>[2]</sup> 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.

## Pinout diagrams

Pin	USB	Exposed Functions		STM32 Pin	PØ Pin #	PØ Pin Name	
VIN	VIN						
GND	GND						
TX	P H O T O N	USART1_TX	TIM1_CH2	PA9	39	MICRO_UART_TX	
RX		USART1_RX	TIM1_CH3	PA10	38	MICRO_UART_RX	
WKP		ADC0	TIM5_CH1	PA0	27	MICRO_WKUP	
DAC		ADC4	DAC1	PA4	22	MICRO_SPI_SSN <sup>[1]</sup>	
A5		ADC7	SPI (MOSI)	TIM3_CH2	PA7	23	MICRO_SPI_MOSI
A4		ADC6	SPI (MISO)	TIM3_CH1	PA6	25	MICRO_SPI_MISO
A3		ADC5	SPI (SCK)	DAC2	PA5	24	MICRO_SPI_SCK
A2		ADC12	SPI (SS)		PC2	2	MICRO_GPIO_6
A1		ADC13			PC3	1	MICRO_GPIO_7
A0		ADC15			PC5	54	MICRO_GPIO_8

USB	Pin	Exposed Functions		STM32 Pin	PØ Pin #	PØ Pin Name			
P H O T O 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	SPI1 (SS)	I2S3_WS	PA15	43	MICRO_JTAG_TDI		
	D4	JTAG_TDO	SPI1 (SCK)	I2S3_SCK	PB3	41	MICRO_JTAG_TDO		
	D3	JTAG_TRST	SPI1 (MISO)	TIM3_CH1	PB4	42	MICRO_JTAG_TRSTN		
	D2		SPI1 (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	

	User I/O	Photon Pin #	Exposed Functions	STM32 Pin	PØ Pin #	PØ Pin Name
P H O T O 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			

### Notes:

<sup>(1)</sup> MICRO\_SPI\_SSN is only for reference as a PØ module pin name. It is technically speaking the STM32 pin PA4 which is the SS pin in an hardware SPI driven sense, however in the Particle API SPI SS is only user controlled as a GPIO. The hardware SS pin is not implemented. The default SS pin for the Particle SPI API is A2 (STM32 pin PC2), but any GPIO can be used for this function with `SPI.begin(pin)`.

## Technical specification

### Absolute maximum ratings

Parameter	Symbol	Min	Typ	Max	Unit
Supply Input Voltage	V <sub>VIN-MAX</sub>			+6.5	V
Supply Output Current	I <sub>VIN-MAX-L</sub>			1	A
Supply Output Current	I <sub>V3-MAX-L</sub>			100	mA
Storage Temperature	T <sub>stg</sub>	-40		+85	°C
Enable Voltage	V <sub>EN</sub>			V <sub>VIN</sub> +0.6	V
ESD Susceptibility HBM (Human Body Mode)	V <sub>ESD</sub>			2	kV

## Recommended operating conditions

Parameter	Symbol	Min	Typ	Max	Unit
Supply Input Voltage	V <sub>VIN</sub>	+3.6		+5.5	V
Supply Input Voltage	V <sub>3V3</sub>	+3.0	+3.3	+3.6	V
Supply Output Voltage	V <sub>VIN</sub>		+4.8		V
Supply Output Voltage	V <sub>3V3</sub>		+3.3		V
Supply Input Voltage	V <sub>VBAT</sub>	+1.65		+3.6	V
Supply Input Current (VBAT)	I <sub>VBAT</sub>			19	uA
Operating Current (Wi-Fi on)	I <sub>VIN avg</sub>		80	100	mA
Operating Current (Wi-Fi on)	I <sub>VIN pk</sub>	235 <sup>[1]</sup>		430 <sup>[1]</sup>	mA
Operating Current (Wi-Fi on, w/powersave)	I <sub>VIN avg</sub>		18	100 <sup>[2]</sup>	mA
Operating Current (Wi-Fi off)	I <sub>VIN avg</sub>		30	40	mA
Sleep Current (5V @ VIN)	I <sub>Qs</sub>		1	2	mA
Deep Sleep Current (5V @ VIN)	I <sub>Qds</sub>		80	100	uA
Operating Temperature	T <sub>op</sub>	-20		+60	°C
Humidity Range Non condensing, relative humidity				95	%

### Notes:

<sup>[1]</sup> 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.

<sup>[2]</sup> 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
Antenna Port	Single Antenna
Frequency Band	2.412GHz -- 2.462GHz (United States of America and Canada)
	2.412GHz -- 2.472GHz (EU/Japan)
Sub Channels	1 -- 11 (United States of America and Canada)

Feature	Description
	1 -- 13 (EU/Japan)
Modulation	DSSS, CCK, OFDM, BPSK, QPSK, 16QAM, 64QAM

#### PO 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 STM32F205RGY6 datasheet, with reference to Photon pin nomenclature.

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Standard I/O input low level voltage	$V_{IL}$		-0.3		$0.28*(V_{3V3}-2)+0.8$	V
I/O FT <sup>[1]</sup> input low level voltage	$V_{IL}$		-0.3		$0.32*(V_{3V3}-2)+0.75$	V
Standard I/O input high level voltage	$V_{IH}$		$0.41*(V_{3V3}-2)+1.3$		$V_{3V3}+0.3$	V
I/O FT <sup>[1]</sup> input high level voltage	$V_{IH}$	$V_{3V3} > 2V$	$0.42*(V_{3V3}-2)+1$		5.5	V
	$V_{IH}$	$V_{3V3} \leq 2V$	$0.42*(V_{3V3}-2)+1$		5.2	V
Standard I/O Schmitt trigger voltage hysteresis <sup>[2]</sup>	$V_{hys}$		200			mV
I/O FT Schmitt trigger voltage hysteresis <sup>[2]</sup>	$V_{hys}$		5% $V_{3V3}$ <sup>[3]</sup>			mV
Input/Output current max	$I_{io}$				±25	mA
Input/Output current total	$I_{io\ total}$				±120	mA
Input leakage current <sup>[4]</sup>	$I_{lkg}$	$GND \leq V_{io} \leq V_{3V3}$ GPIOs			±1	µA

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Input leakage current <sup>[4]</sup>	$I_{lk}$	$R_{PU}$	$V_{io} = 5V, I/O$ FT		3	$\mu A$
Weak pull-up equivalent resistor <sup>[5]</sup>	$R_{PU}$	$V_{io} = GND$	30	40	50	k $\Omega$
Weak pull-down equivalent resistor <sup>[5]</sup>	$R_{PD}$	$V_{io} = V_{3V3}$	30	40	50	k $\Omega$
I/O pin capacitance	$C_{IO}$			5		pF
DAC output voltage (buffers enabled by default)	$V_{DAC}$		0.2		$V_{3V3}-0.2$	V
DAC output resistive load (buffers enabled by default)	$R_{DAC}$		5			k $\Omega$
DAC output capacitive load (buffers enabled by default)	$C_{DAC}$				50	pF

### Notes:

[1] FT = Five-volt tolerant. In order to sustain a voltage higher than  $V_{3V3}+0.3$  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
Without	1.44 x 0.8 x 0.17 (36.58 x 20.32 x 4.32)	3.7 grams

## Mating connectors

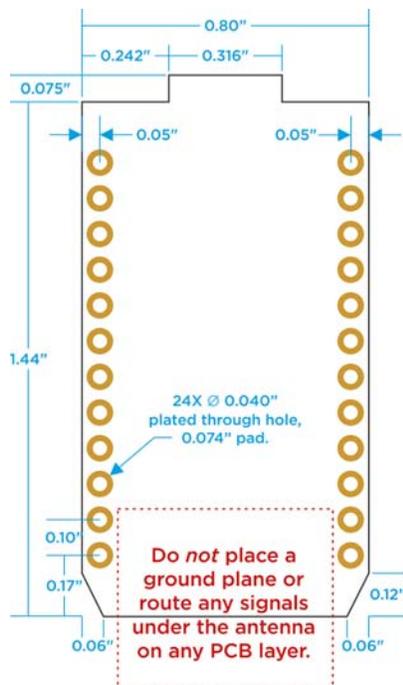
The Photon (with headers) can be mounted with (qty 2) 12-pin single row 0.1" female headers. Typically these are 0.335" (8.5mm) tall, but you may pick a taller one if desired. When you search for parts like these it can be difficult to navigate the thousands of parts available online so here are a few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

Description	MFG	MFG Part Number	Distributor
12-pin 0.1" Female Header (Tin)	Sullins Connector Solutions	<a href="#">PPTC121LFBN-RC</a>	Digikey
12-pin 0.1" Female Header (Gold)	Sullins Connector Solutions	<a href="#">PPPC121LFBN-RC</a>	Digikey
12-pin 0.1" Female Header (Tin)	Harwin	<a href="#">M20-7821246</a>	Mouser

You may also use other types, such as reverse mounted (bottom side SMT) female headers, low profile types, 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:

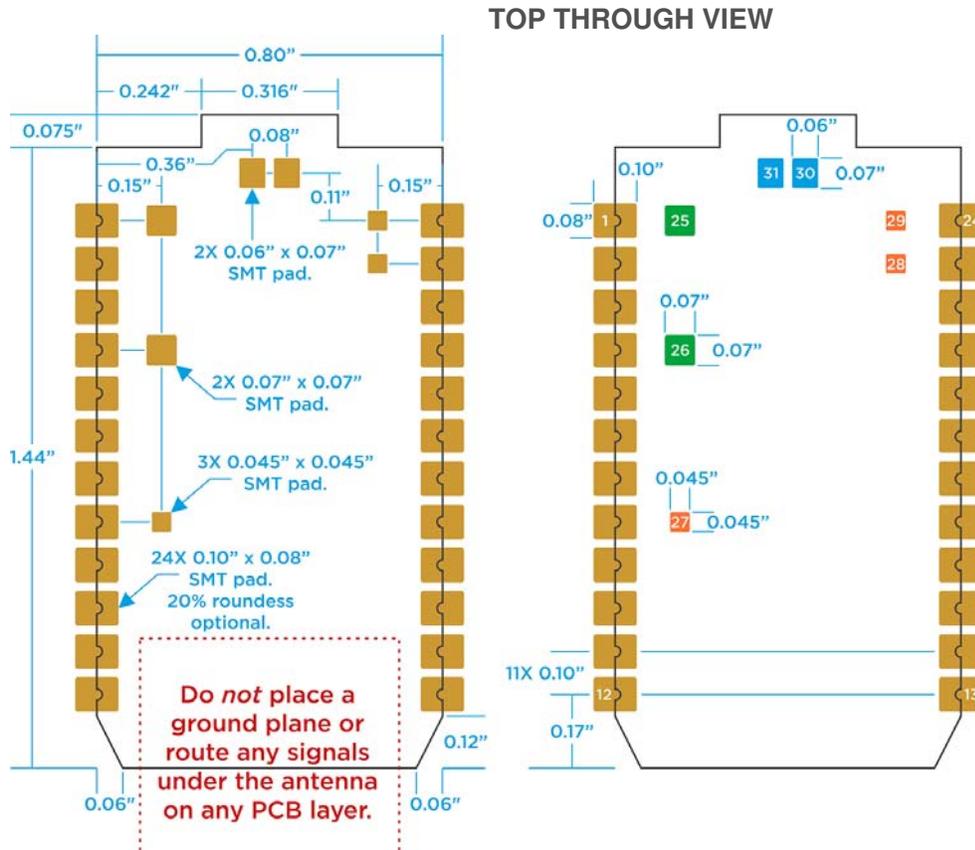


A Photon with headers part for EAGLE can be found in the Particle EAGLE library

<https://github.com/spark/hardware-libraries#pcb-footprints-land-pattern>

## 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:



In addition to the 24 pins around the outside of the Photon, there are 7 pads on the bottom the Photon PCB that can be used to connect to extra signals: RGB LED outputs, SETUP button, SMPS enable line and USB D+/D-. Photon Pins #25-31 are described in the Pin out diagrams.

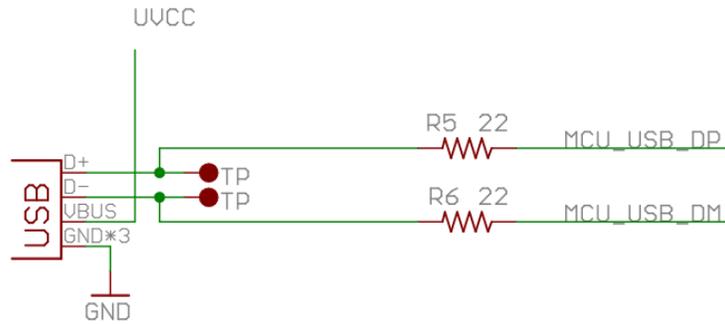
Solder mask around exposed copper pads should be 0.1mm (4 mils) larger in all directions. E.g., a 0.08" x 0.10" pad would have a 0.088" x 0.108" solder mask.

A Photon without headers part for EAGLE can be found in the Particle EAGLE library

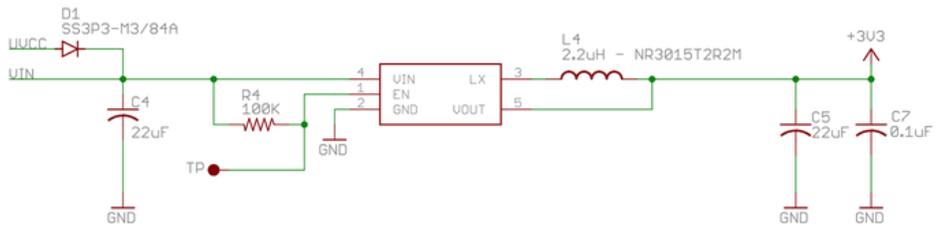
<https://github.com/spark/hardware-libraries#pcb-footprints-land-patter>

# Schematic

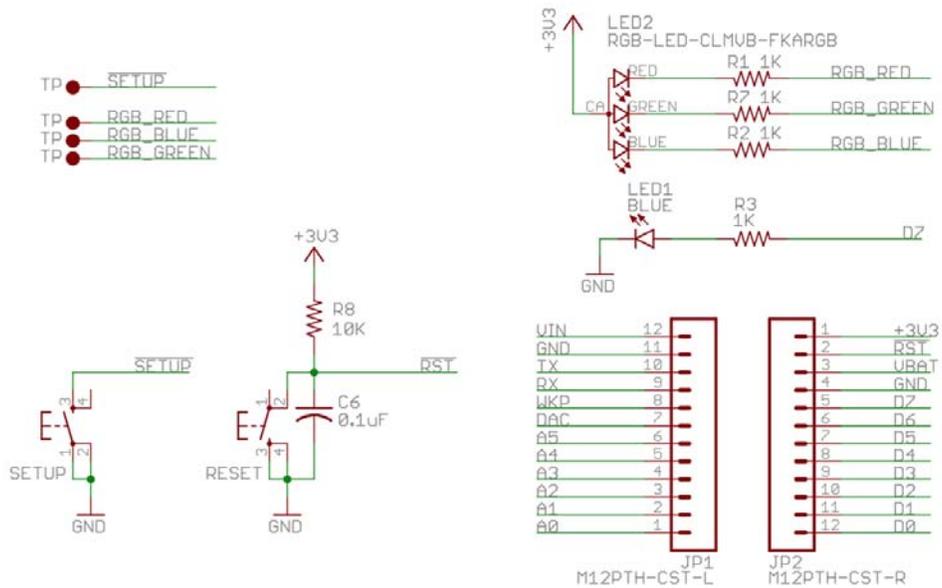
## Schematic - USB



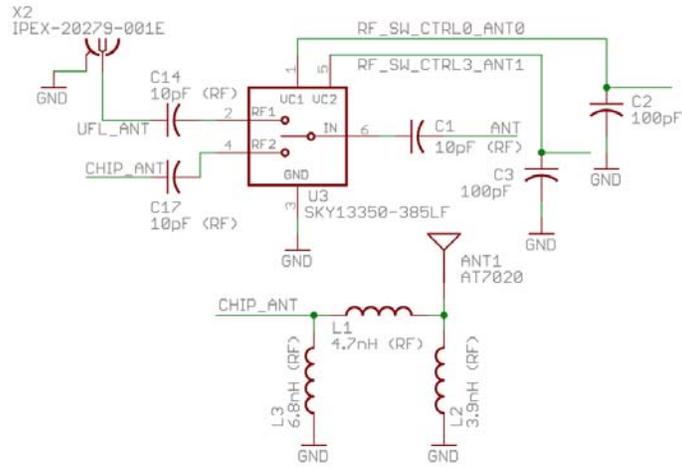
## Schematic - Power



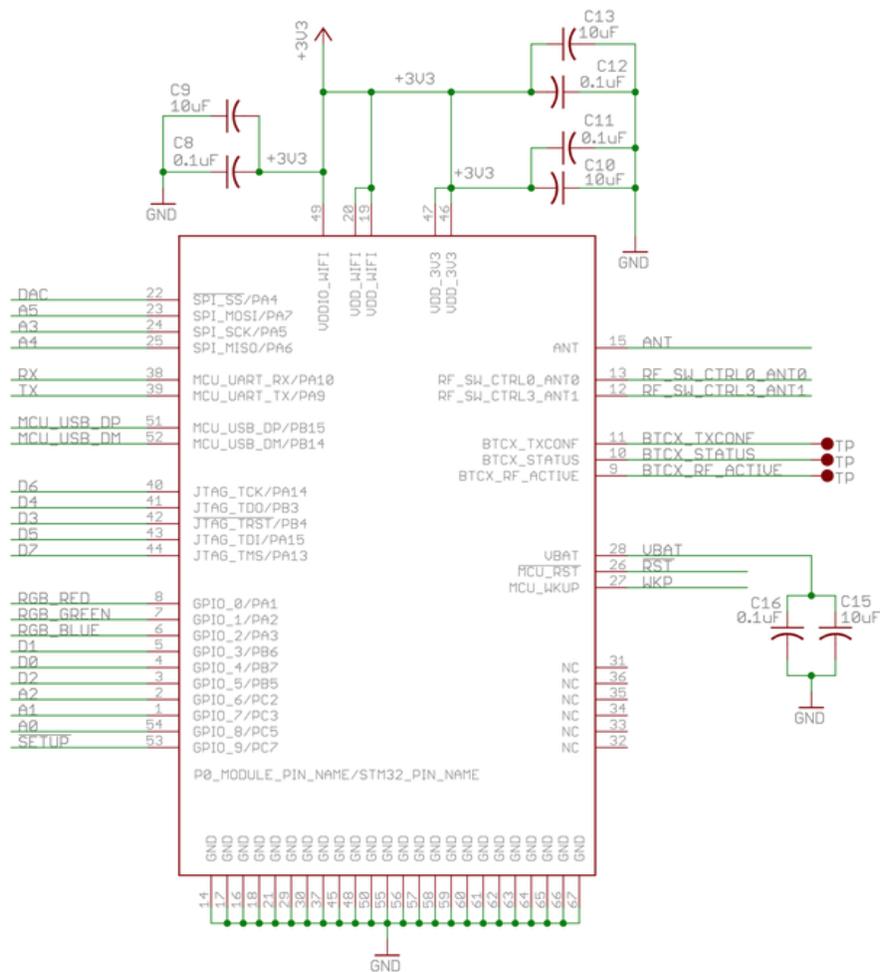
## Schematic - User I/O



## Schematic - RF

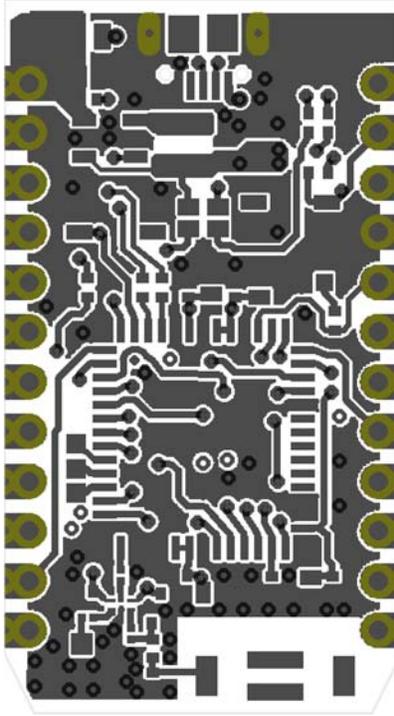


## Schematic - PØ Wi-Fi Module

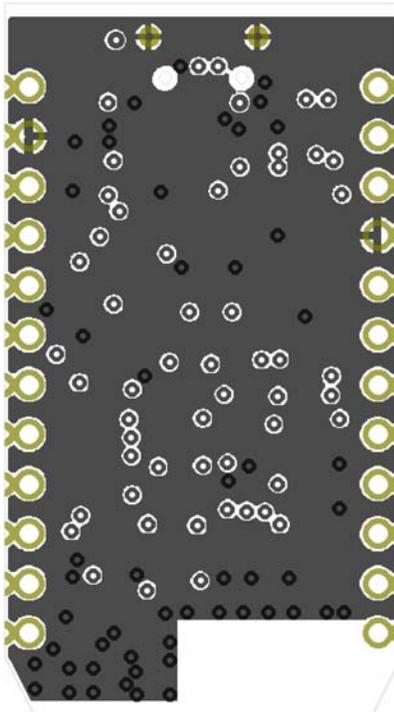


# Layout

Photon v1.0.0 Top Layer (GTL)

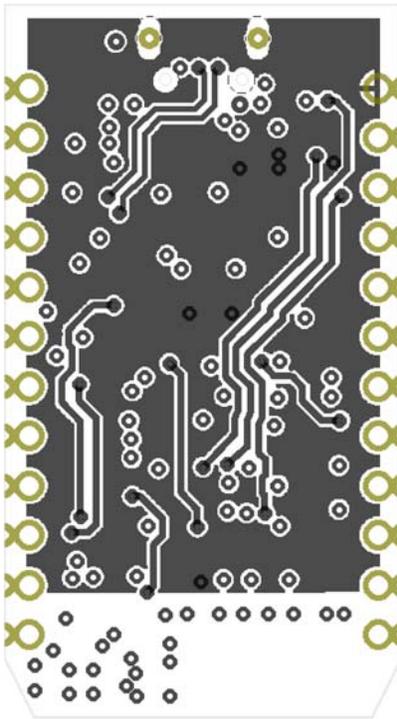


Photon v1.0.0 GND Layer (G2L)

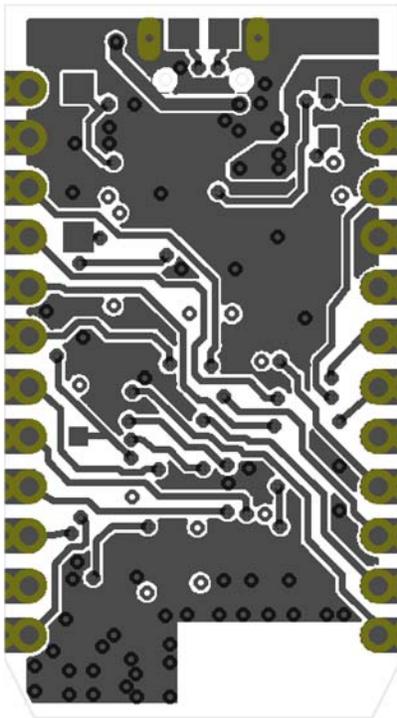


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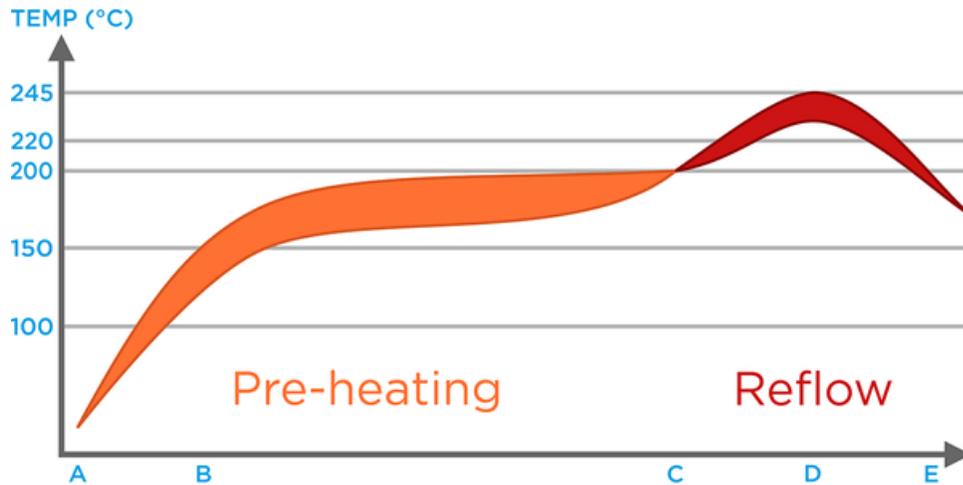
Photon v1.0.0 3V3 Layer (G15L)



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 × 2.0mm x 2.6mm	ANT1	Advanced Ceramic X	AT7020-E3R0HBA
2	CERAMIC CAPACITOR	22uF Ceramic 6.3V 10% X5R	0603	C4,C5	Samsung	CL10A226MQ8NRNC
6	CERAMIC CAPACITOR	0.1uF Ceramic 6.3V 10% X5R	0402	C6,C7,C8,C11,C12,C16	RongFu	0402B104K01A
2	CERAMIC CAPACITOR	100pF Ceramic 6.3V 10% X5R	0402	C2,C3	Fenghua	0402CG101J500NT
4	CERAMIC CAPACITOR	10uF Ceramic 6.3V 10% X5R	0603	C9,C11,C13,C15	Sumsung	CL10A106MQ8NNNC
3	CERAMIC	10pF Ceramic 6.3V	0402	C1,C14,C17	Murata	GJM1555C1HR80BB01D

Qty	Device	Minimum Specification	Package/Case	Part Designator	MFG.	MFG. PN
	CAPACITOR (RF)	10% X5R				
1	CONNECTOR	USB Micro-B 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" Mating Length	0.1" 12-pin	JP1,JP2	Kaweei	CP25411-12G-S116-A
1	DIODE	Diode Schottky 30V 3A	DO-220AA	D1	Vishay	SS3P3-M3/84A
1	DIODE (LED)	Blue	SMD 0603	LED1	Everlight	19-217/BHC-ZL1M2RY/3T
1	DIODE (LED)	LED RGB Common Anode Diffused SMD	4-PLCC (2.0mm x 2.0mm)	LED2	Cree	CLMVB-FKA-CFHEHLCBB7A363
1	INDUCTOR	2.2uH 1.5A	3mm x 3mm	L4	Taiyo Yuden	NR3015T2R2M
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 + STM32F205RGY6 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](http://store.particle.io) in single quantities with and without headers, and also included in different maker kits.

## Qualification and approvals



### Photon with Headers

- Model Number: PHOTONH
- RoHS
- CE
- FCC ID: 2AEMI-PHOTON
- IC: 20127-PHOTON

### Photon without Headers

- Model Number: PHOTONNOH
- 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 packaging contains the bare essentials to get you started, while the Photon Kit contains a breadboard, Micro B USB cable, sticker, prototyping card and a couple sensors to build your first Internet connected project!



Photons without headers in matchbox packaging 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!