Functional description

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

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[1] / 3V3[2]
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
I2C	1	I/O	FT
CAN	1	I/O	3V3[4]
USB	1	I/O	3V3
PWM	9[3]	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.

[4] 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.

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[1]
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
3V3	Power	Power				
GND	Ground	Ground				
RST	Reset	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:
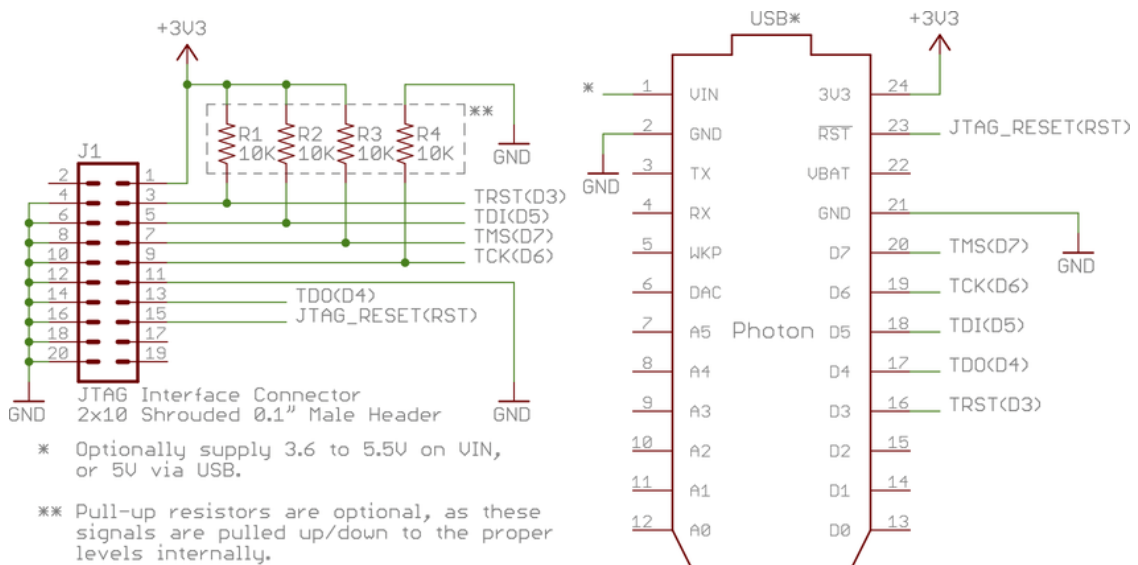
Note: This interface is not supported by the P0 module and cannot be used.

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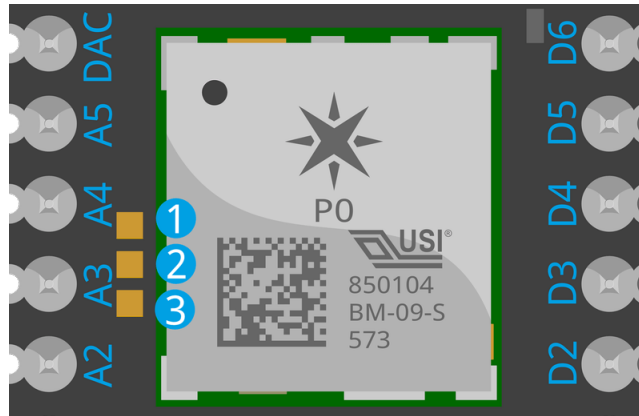
When two radios occupying the same frequency band are used in the same system, such as Wi-Fi and Bluetooth, a coexistence interface can be used to coordinate transmit activity, to ensure optimal performance by arbitrating conflicts between the two radios.

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.

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)
- Device OS (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.](#)

Region	Offset	Size
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 -en "\xFF" > fillbyte && dfu-util -d 2b04:d006 -a 1 -s 34 -D fillbyte
// Regenerate Alternate Keys
echo -en "\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

Pin and button definition

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 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[2].
TX	Primarily used as UART TX, but can also be used as a digital GPIO or PWM[2].
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[2]. 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 `analogRead(A7)`. `A6` maps to the DAC pin and `A7` maps to the WKP pin. A4,A5,A7 may also be used as a PWM[2] output.
D0~D7	Digital only GPIO pins. D0~D3 may also be used as a PWM[2] output.

Notes: [1] 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.

[2] 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			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 [1]
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
	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
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:

[1] 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	$V_{VIN-MAX}$			+6.5	V
Supply Output Current	$I_{VIN-MAX-L}$			1	A
Supply Output Current	$I_{3V3-MAX-L}$			100	mA
Storage Temperature	T_{stg}	-40		+85	°C
Enable Voltage	V_{EN}			$V_{VIN}+0.6$	V
ESD Susceptibility HBM (Human Body Mode)	V_{ESD}			2	kV

RECOMMENDED OPERATING CONDITIONS

Parameter	Symbol	Min	Typ	Max	Unit
Supply Input Voltage	V_{VIN}	+3.6		+5.5	V
Supply Input Voltage	V_{3V3}	+3.0	+3.3	+3.6	V
Supply Output Voltage	V_{VIN}		+4.8		V
Supply Output Voltage	V_{3V3}		+3.3		V
Supply Input Voltage	V_{VBAT}	+1.65		+3.6	V
Supply Input Current (VBAT)	I_{VBAT}			19	uA
Operating Current (Wi-Fi on)	$I_{VIN\ avg}$		80	100	mA
Operating Current (Wi-Fi on)	$I_{VIN\ pk}$	235[1]		430[1]	mA
Operating Current (Wi-Fi on, w/powersave)	$I_{VIN\ avg}$		18	100[2]	mA
Operating Current (Wi-Fi off)	$I_{VIN\ avg}$		30	40	mA
Sleep Current (5V @ VIN)	I_{Qs}		1	2	mA
Deep Sleep Current (5V @ VIN)	I_{Qds}		80	100	uA
Operating Temperature	T_{op}	-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
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)
	1 -- 13 (EU/Japan)

Modulation	DSSS, CCK, OFDM, BPSK, QPSK, 16QAM, 64QAM

PØ 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[1] 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[1] 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[2]	V_{hys}		200			mV
I/O FT Schmitt trigger voltage hysteresis[2]	V_{hys}		5% V_{3V3}[3]			mV
Input/Output current max	I_{io}				±25	mA
Input/Output current total	$I_{io\ total}$				±120	mA
Input leakage current[4]	I_{lkg}	$GND \leq V_{io} \leq V_{3V3}$ GPIOs			±1	μA
Input leakage current[4]	I_{lkg}	R_{PU}	V_{io} = 5V, I/O FT		3	μA
Weak pull-up equivalent resistor[5]	R_{PU}	V_{io} = GND	30	40	50	k Ω
Weak pull-down equivalent resistor[5]	R_{PD}	$V_{io} = V_{3V3}$	30	40	50	k Ω
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 Ω
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

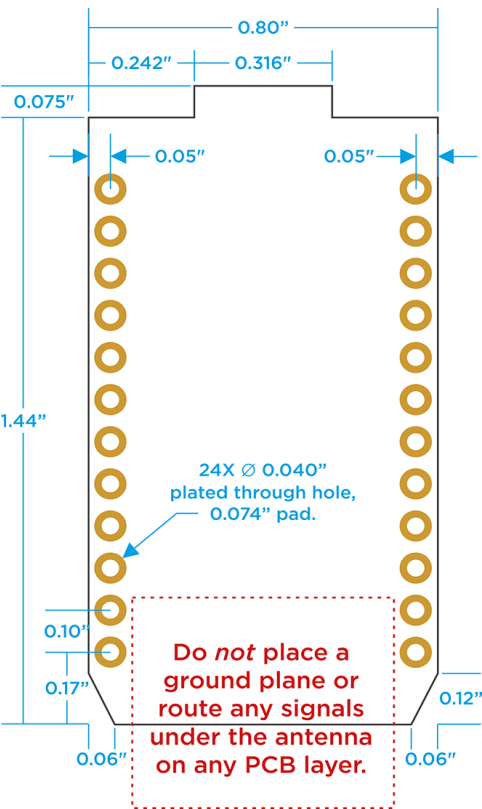| Headers	Dimensions in inches (mm)	Weight
With	1.44 x 0.8 x 0.27 (36.58 x 20.32 x 6.86)	5 grams
Without	1.44 x 0.8 x 0.17 (36.58 x 20.32 x 4.32)	3.7 grams

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	PPTC121LFBN-RC	Digi-Key
12-pin 0.1" Female Header (Gold)	Sullins Connector Solutions	PPPC121LFBN-RC	Digi-Key
12-pin 0.1" Female Header (Tin)	Harwin	M20-7821246	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:
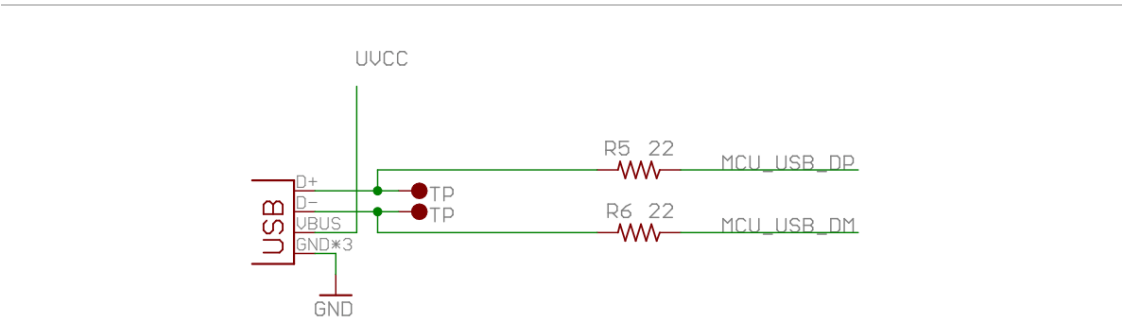

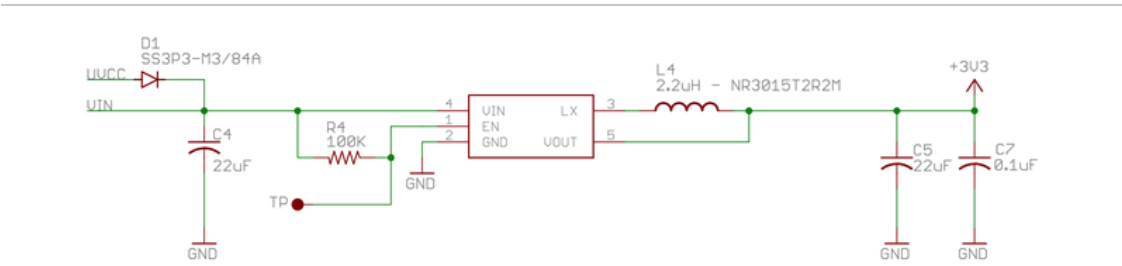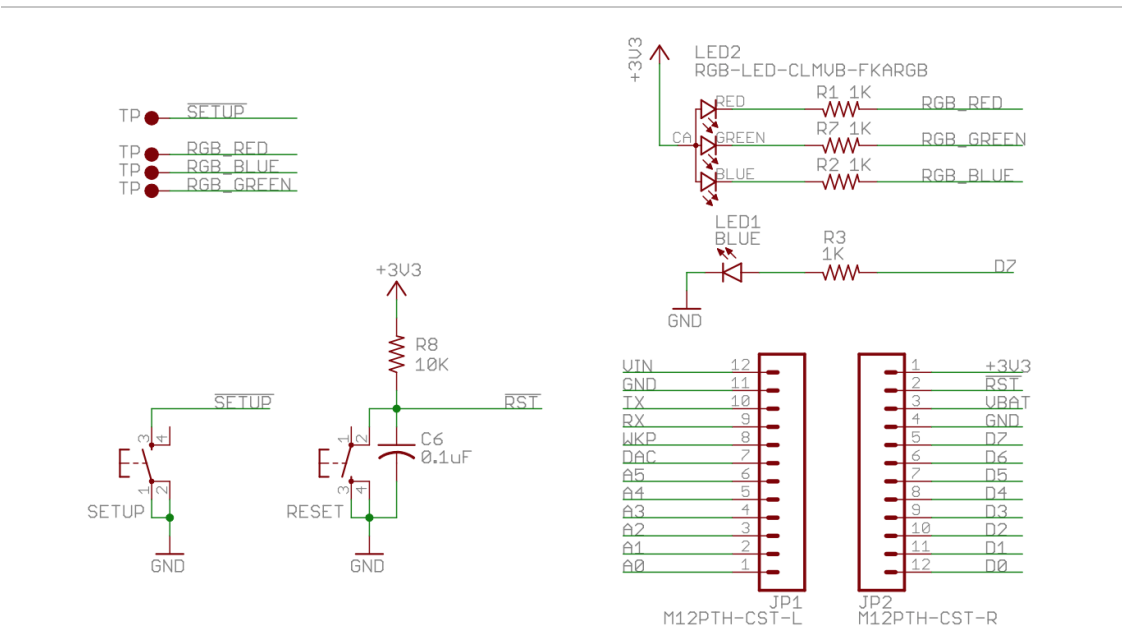A Photon with headers part for EAGLE can be found in the Particle EAGLE library

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

TOP THROUGH VIEW

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

Schematic

SCHEMATIC - USB

UVCC

USB
D+
D-
VBUS
GND*3

TP
TP

R5 22
MCU_USB_DP

R6 22
MCU_USB_DM

GND

SCHEMATIC - POWER

D1
SS3P3-M3/84A

UVCC
VIN

C4
22uF

R4
100K

TP

GND

VIN   LX
EN
GND   VOUT

4
1
2

3

5

L4
2.2uH - NR3015T2R2M

+3V3

C5
22uF

C7
0.1uF

GND   GND

SCHEMATIC - USER I/O

+3V3

LED2
RGB-LED-CLMVB-FKARGB

RED
CA   GREEN
BLUE

R1 1K
RGB_RED
R7 1K
RGB_GREEN
R2 1K
RGB_BLUE

TP   SETUP

TP   RGB_RED
TP   RGB_BLUE
TP   RGB_GREEN

LED1
BLUE

R3
1K
D7

GND

+3V3

R8
10K

SETUP

RST

C6
0.1uF

SETUP

RESET

GND   GND

VIN	12		1	+3V3
GND	11		2	RST
TX	10		3	VBAT
RX	9		4	GND
WKP	8		5	D7
DAC	7		6	D6
A5	6		7	D5
A4	5		8	D4
A3	4		9	D3
A2	3		10	D2
A1	2		11	D1
A0	1		12	D0

JP1
M12PTH-CST-L

JP2
M12PTH-CST-R

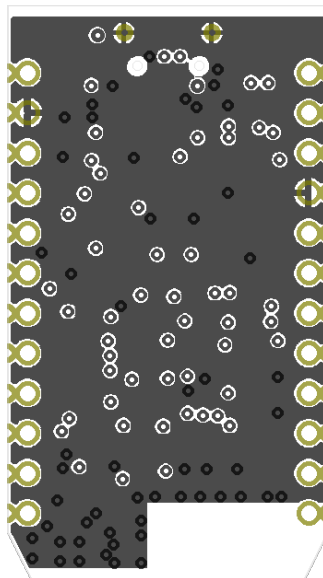## SCHEMATIC - RF

SCHEMATIC - PØ WI-FI MODULE
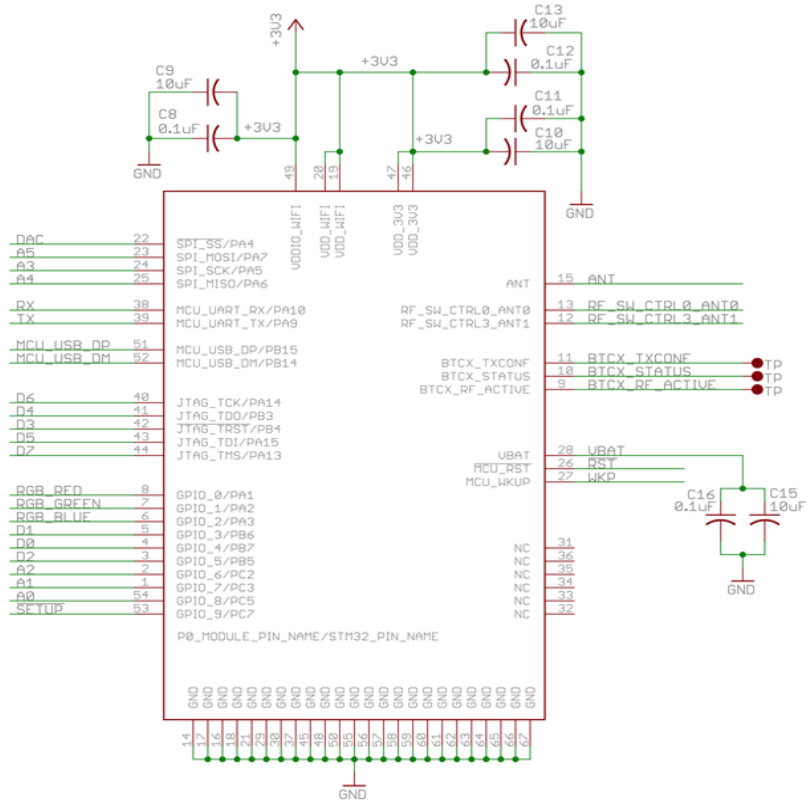
Layout

PHOTON V1.0.0 TOP LAYER (GTL)
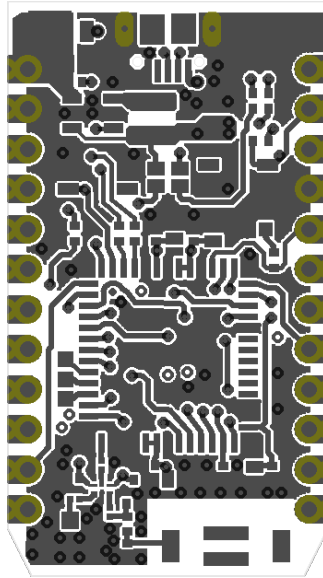
PHOTON V1.0.0 GND LAYER (G2L)

PHOTON V1.0.0 3V3 LAYER (G15L)
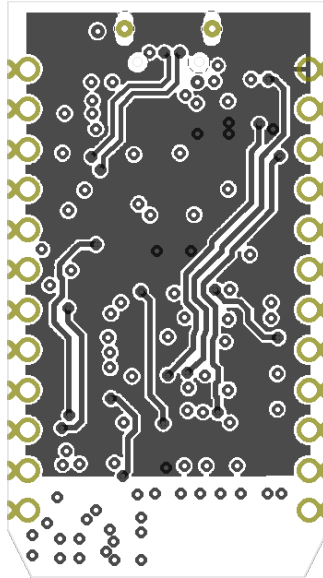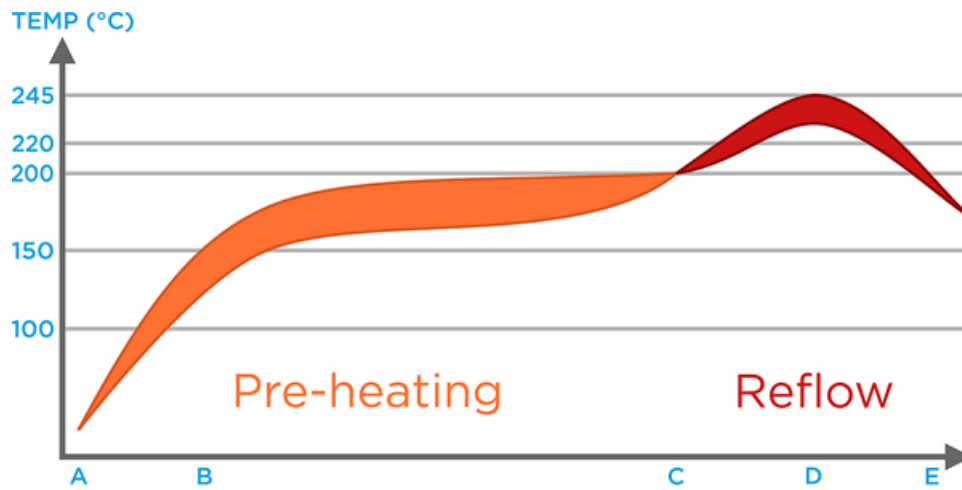

PHOTON V1.0.0 BOTTOM LAYER (GBL)
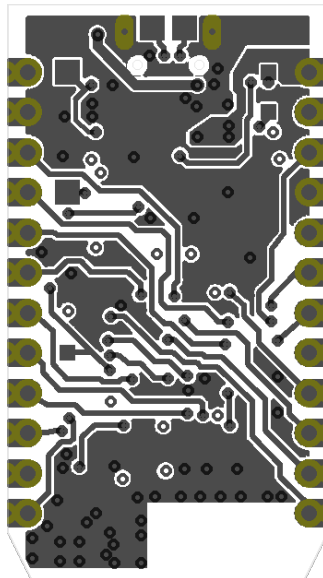
Recommended solder reflow profile

TEMP (°C)

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 CAPACITOR (RF)	10pF Ceramic 6.3V 10% X5R	0402	C1,C14,C17	Murata	GJM1555C1HR80BB01D
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 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).

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 Workbench is a full-featured desktop IDE for Windows, Mac, and Linux based on VSCode and supports both cloud-based and local gcc-arm compiles. The Particle CLI provides a command-line interface for cloud-based compiles and flashing code over USB.

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:

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-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.

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 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.

Revision history

Revision	Date	Author	Comments
-	30-March-2015	BW	Initial release
v003	7-April-2015	BW	Updated template
v004	8-April-2015	BW	Updated Overview, Block diagram, Power, RF, and Pin markings sections
v005	9-April-2015	BW	Updated BOM
v006	21-April-2015	BW	Added JTAG, BT CO-EX, I/O Characteristics, Schematic, Layout, Reflow Profile, Glossary, Updated Operating Conditions
v007	28-April-2015	BW	Added Layout, Updated analog pins, Land patterns, Packaging, Mating Connectors
v008	11-May-2015	BW	Updated BT CO-EX, PWM info, Qualifications
v009	31-May-2015	BW	Updated Pinouts, DAC info, Height dimensions, Solder mask info, Recommended operating conditions
v010	1-June-2015	BW	Updated VBAT info
v011	24-July-2015	BW	Added FCC IC CE Warnings and End Product Labeling Requirements, Updated power output, added approved antennas, Corrected DAC2 as A3, Added pin numbers to PCB Land Pattern for Photon without headers.
v012	15-January-2016	WH	Added TELEC Certification information and expanded explanation of Photons with and without headers.
v013	7-April-2016	BW	Added: full STM32 part number, Memory map, DAC limits, SWD pin locations, max source/sink current, more descriptive info about bottom side pads, known errata URL. Updated: BT COEX info, pin diagram, block diagram, operating conditions, pin descriptions, land-pattern image signal keepout note.
v014	13-September-2016	BW	Updated Mating connectors section.
v015	25-July-2017	BW	Updated the Pin Description section and added high resolution pinout PDF, PWM notes and DCT layout, added warning to power section
v016	31-May-2018	BW	Updated External Coexistence Interface section (unsupported)

Known Errata

We are tracking known errata with this datasheet here. These issues/errors in the datasheet will be resolved in subsequent revisions.

Contact

Web

https://www.particle.io

Community Forums

https://community.particle.io

Email

https://support.particle.io