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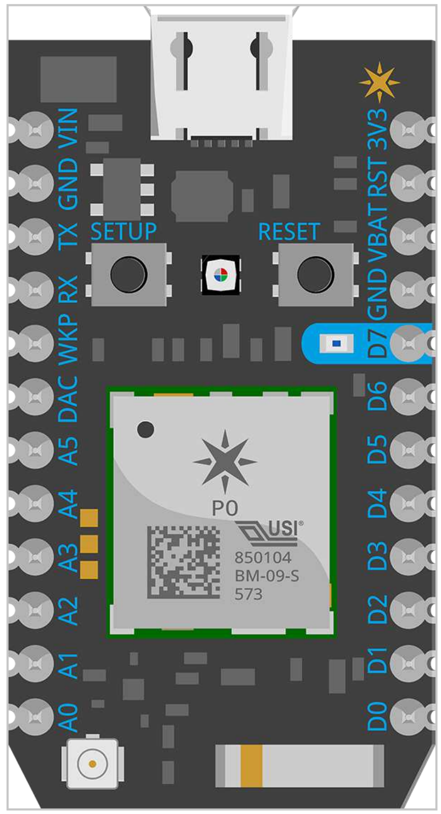
Photon Datasheet (v011)

Model number: PHOTONH




```
void setup() {
    Spark.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.

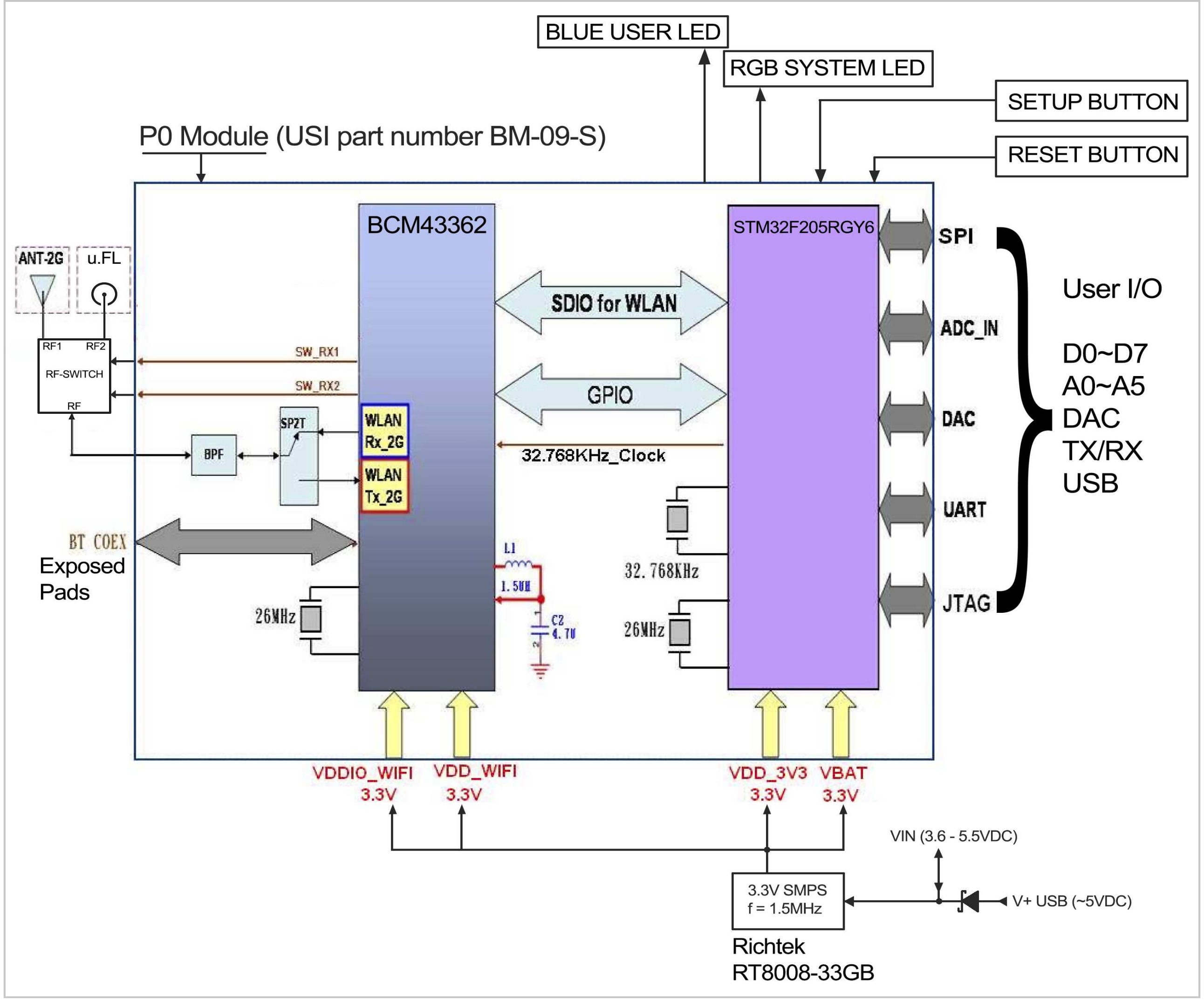
The Photon comes in two physical forms: with headers and without. Prototyping is easy with headers as the Photon plugs directly into standard breadboards and perfboards, and may also be mounted with 0.1" pitch female headers on a PCB. To minimize space required, the Photon form factor without headers 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
  - 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.

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	FT
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.

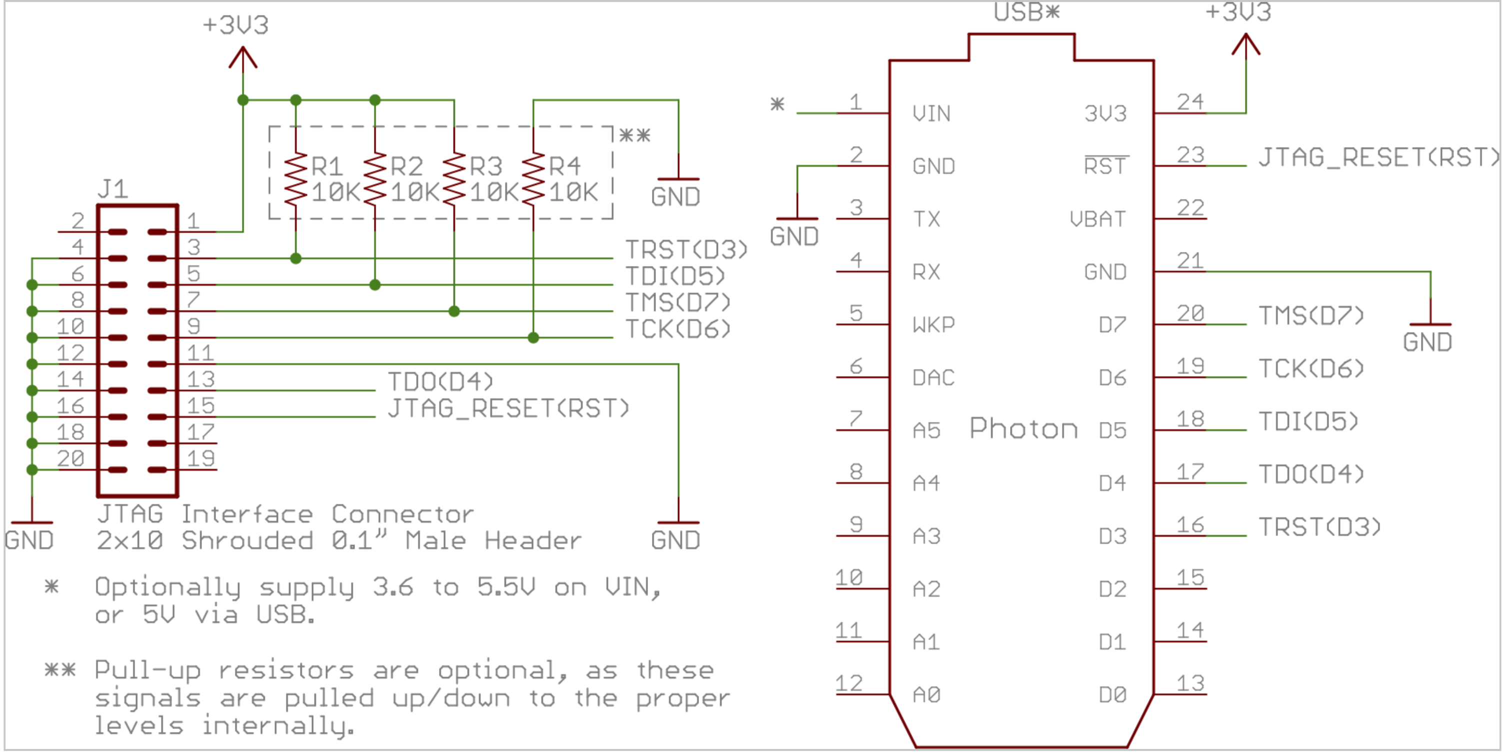
JTAG

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
3V3	Power				
GND	Ground				
RST	Reset				

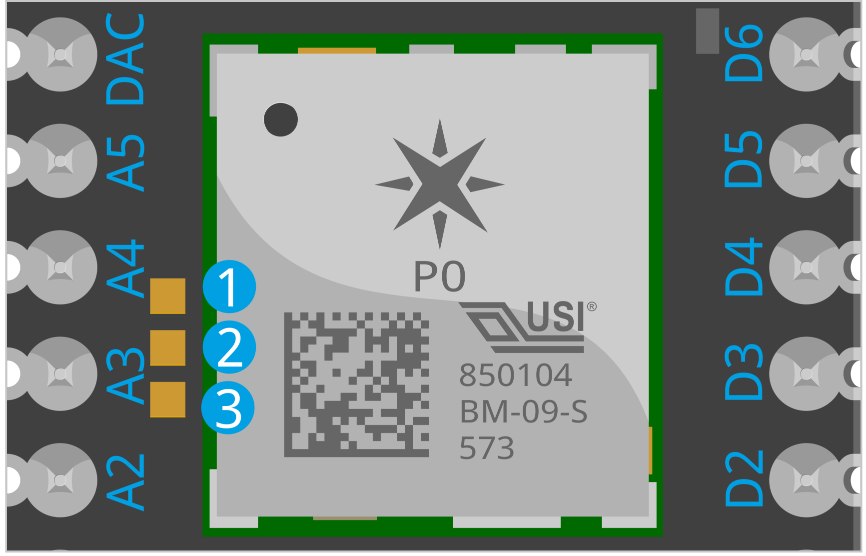
Notes: [1] Default state after reset for a short period of time before these pins are restored to GPIO (if JTAG debugging is not required, i.e. `USE_SWD_JTAG=y` is not specified on the command line.)

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.



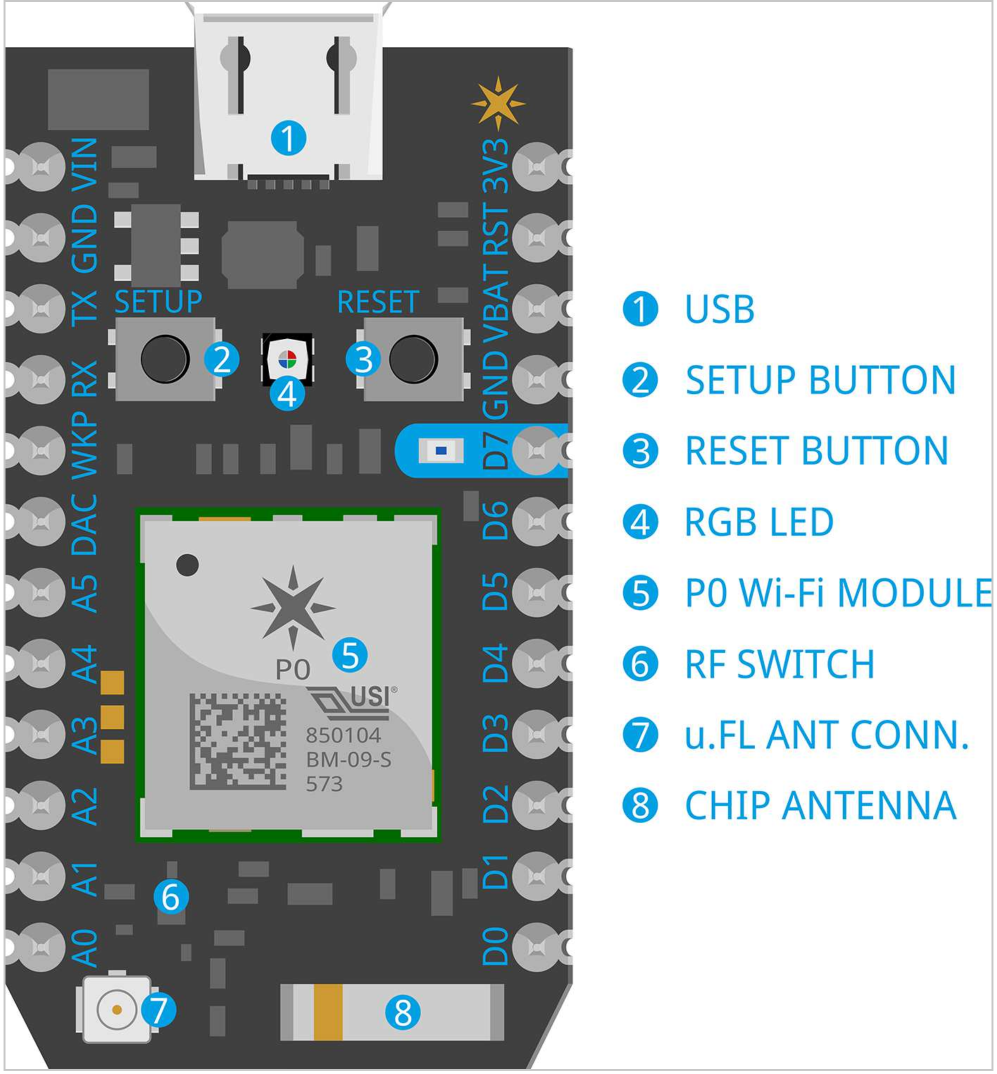
When two radios occupying the same frequency band are used in the same system, such as Wi-Fi and Bluetooth, a coexistence interface can be used to coordinate transmit activity, to ensure optimal performance by arbitrating conflicts between the two radios.

Pad #	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. 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



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 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
PHOTON	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	PHOTON	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
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
PHOTON	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	$V_{IN\text{-}MAX}$			+6.5	V
Supply Output Current	$I_{IN\text{-}MAX\text{-}L}$			1	A
Supply Output Current	$I_{3V3\text{-}MAX\text{-}L}$			100	mA
Storage Temperature	T_{stg}	-40		+85	°C
Enable Voltage	V_{EN}			V_{IN}+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_{IN}	+3.6		+5.5	V
Supply Input Voltage	V_{3V3}	+3.0	+3.3	+3.6	V
Supply Output Voltage	V_{IN}		+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)	$I_{IN\ avg}$		80	100	mA
Operating Current (Wi-Fi on)	$I_{IN\ pk}$	235[1]		430[1]	mA
Operating Current (Wi-Fi on, w/powersave)	$I_{IN\ avg}$		18	100[2]	mA
Operating Current (Wi-Fi off)	$I_{IN\ avg}$		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)
Sub Channels	1 -- 11 (United States of America and Canada)
	1 -- 13 (EU)
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 STM32F205RG 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 leakage current[4]	I_{lkg}	GND ≤ V_{io} ≤ 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

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.

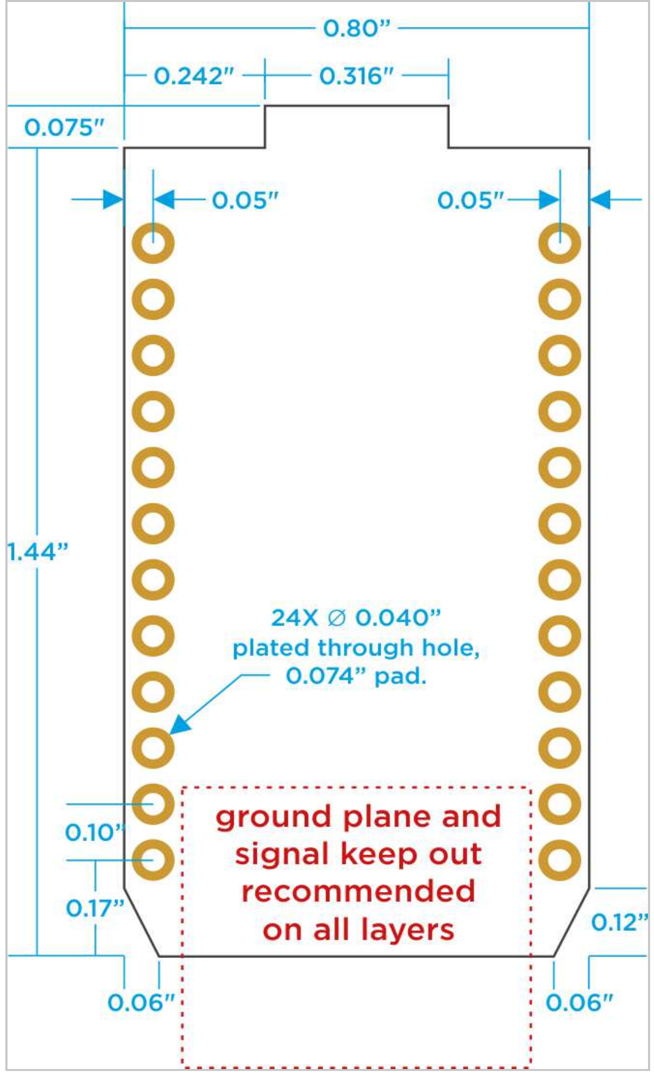
On Digikey.com, this section Rectangular Connectors - Headers, Receptacles, Female Sockets contains 36,000 of them. Narrow the search with: 12 positions, 1 row, 0.1" (2.54mm) pitch, Through Hole mounting types (unless you want SMT), and sort by Price Ascending. You may find something like this:

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)

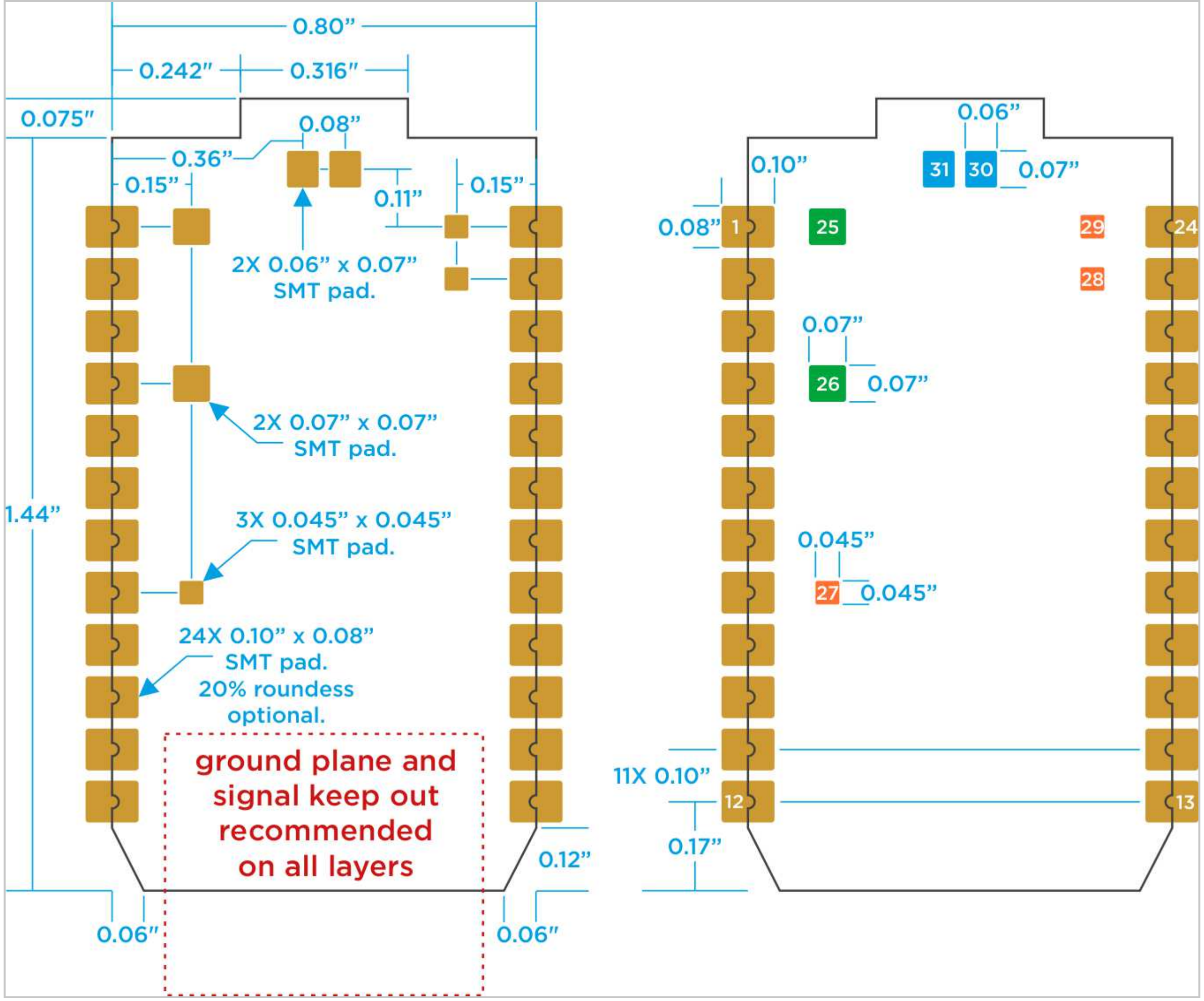
The Photon (with headers) can be mounted with 0.1" 12-pin female header receptacles using the following PCB land pattern:



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:



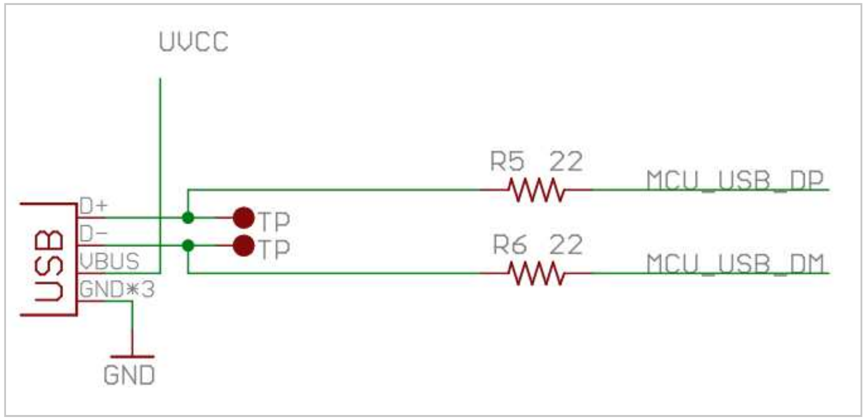
Photon Pin #25-31 are described in the Pin Out Diagrams.

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.

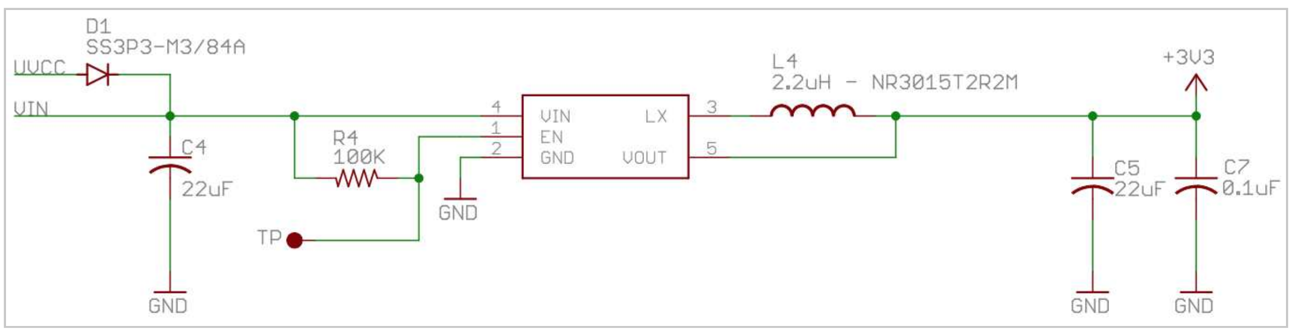
This land pattern can be found in the Spark.lbr Eagle library, as a Device named `PHOTON_SMD`. **Note: Clone or Download the complete repository as a ZIP file to avoid corrupted data in Eagle files.**

Schematic

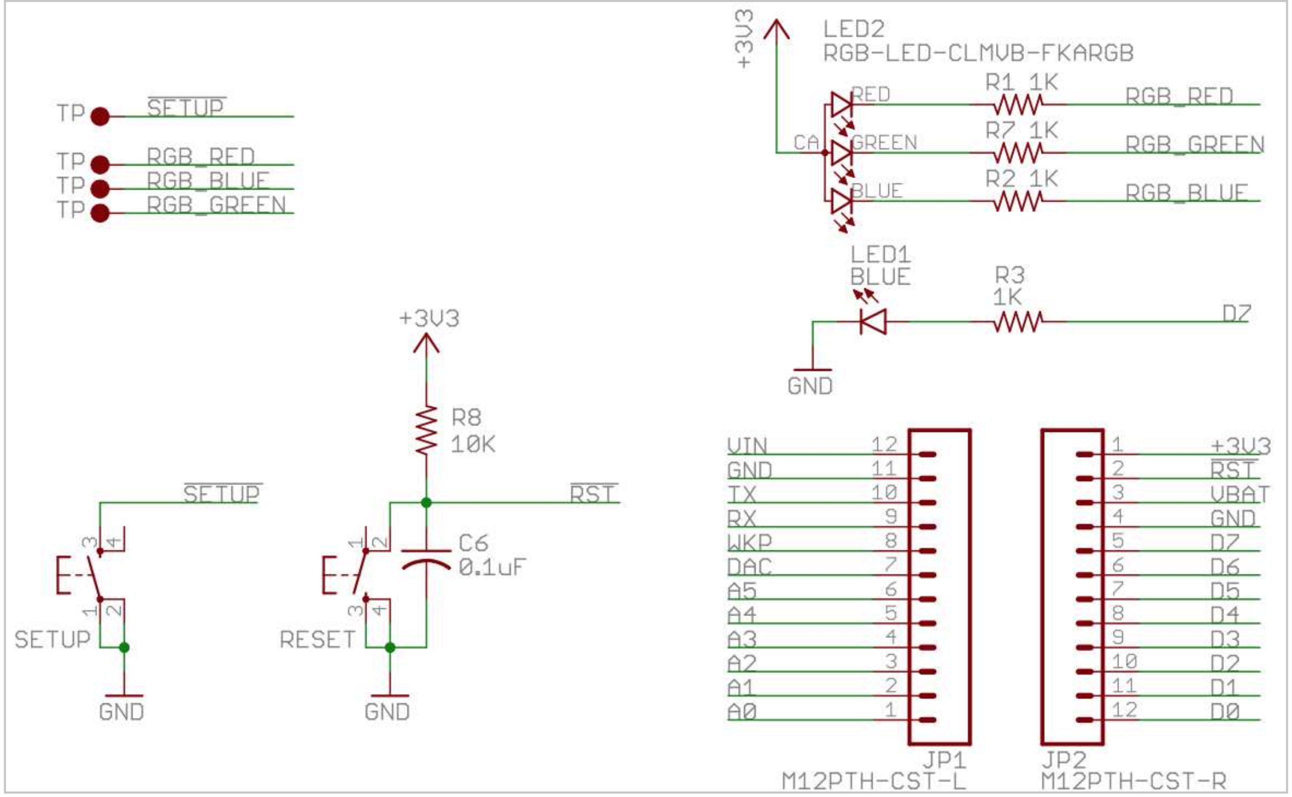
SCHEMATIC - USB



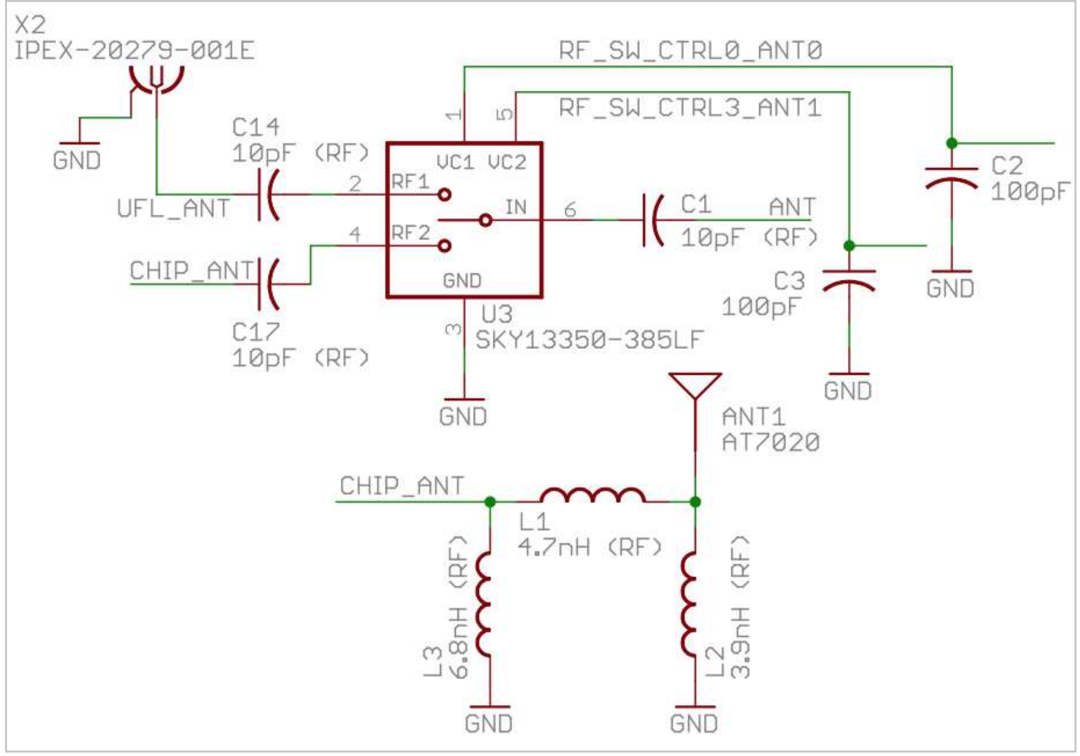
SCHEMATIC - POWER



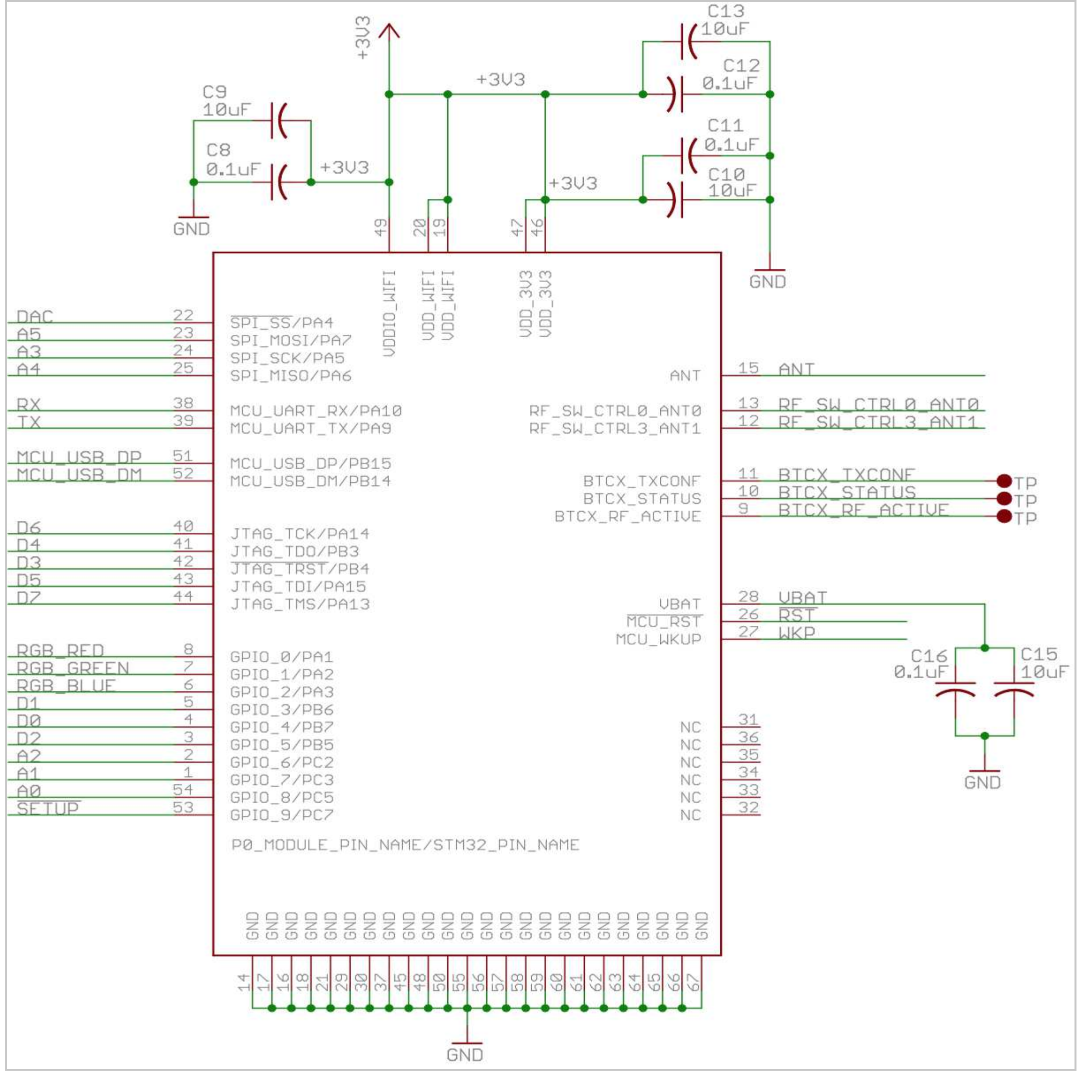
SCHEMATIC - USER I/O



SCHEMATIC - RF

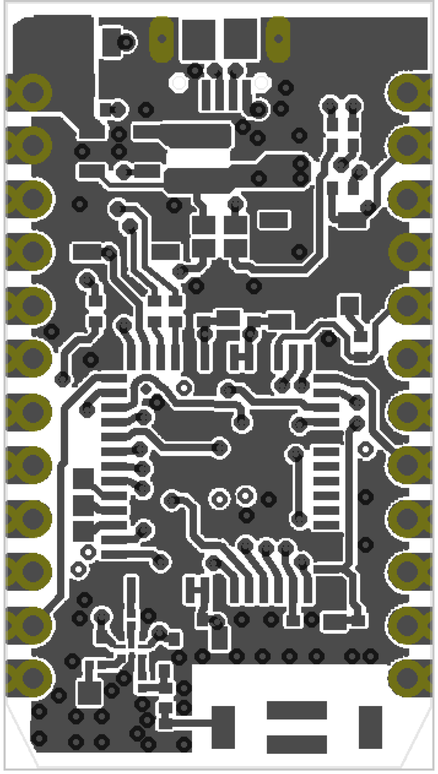


SCHEMATIC - PØ WI-FI MODULE

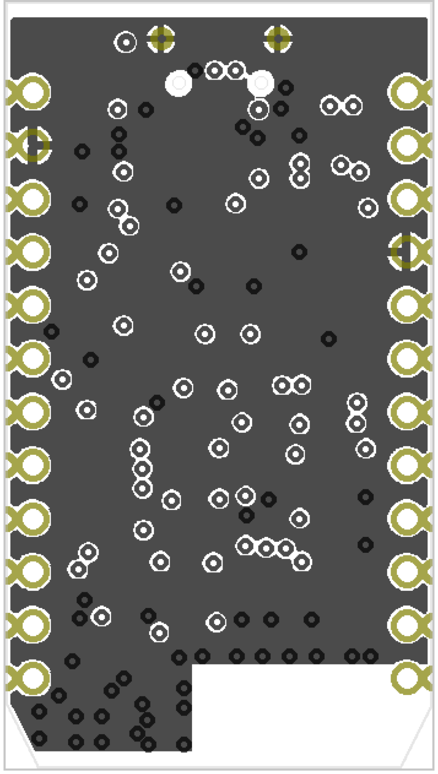


Layout

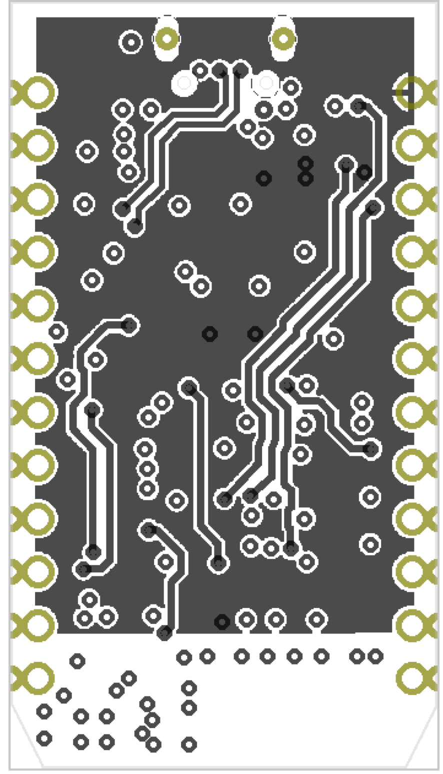
PHOTON V1.0.0 TOP LAYER (GTL)



PHOTON V1.0.0 GND LAYER (G2L)



PHOTON V1.0.0 3V3 LAYER (G15L)



PHOTON V1.0.0 BOTTOM LAYER (GBL)