

# P2 Datasheet (pre)

**Preliminary pre-release version 2022-01-20**

# Functional description

## OVERVIEW

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The P2 is a SMD module with a microcontroller and Wi-Fi networking. The form-factor is the same as the P1, but the P2 supports 2.4 GHz and 5 GHz Wi-Fi, BLE, and has much larger RAM and flash that can support larger applications.

## FEATURES

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- 802.11a/b/g/n Wi-Fi, 2.4 GHz and 5 GHz
  - Integrated PCB antenna
  - Integrated U.FL connector for external antenna
  - Integrated RF switch
- BLE 5 using same antenna as Wi-Fi
- Realtek RTL8721DM MCU
  - ARM Cortex M4F CPU, 200 MHz
- 1024 KB (1 MB) user application maximum size
- 2 MB flash file system
- FCC, IC, and CE certified

# Interfaces

## BLOCK DIAGRAM

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[To be provided at a later date.]

## POWER

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[To be provided at a later date.]

## RF

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- The P2 includes an on-module PCB trace antenna and a U.FL connector that allows the user to connect an external antenna.
- The antenna is selected in software. The default is the PCB trace antenna.
- The area surrounding the PCB antenna on the carrier PCB should be free of ground planes and signal traces for maximum Wi-Fi performance when using the trace antenna.

## FCC APPROVED ANTENNAS

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Antenna Type	Manufacturer	MFG. Part #	Gain
Dipole antenna	LumenRadio	104-1001	2.15dBi
PCB Antenna	Included	-	-

The P2 module supports programming and debugging use SWD (Serial Wire Debug) on pins D6 and D7.

Pin	JTAG	SWD	P2 Pin #	Pull at boot
D7	SWDIO	PA[27]	54	Pull-up
D6	SWCLK	PB[3]	55	Pull-down
3V3	Power			
GND	Ground			
RST	Reset			

When the bootloader starts, for a brief period of time a weak pull-up is applied to pin D7 and pull-down to pin D6 to detect whether a SWD debugger is attached. After boot, you can use these things for regular GPIO, but beware of a possible GPIO state change caused by the pull-up or pull-down when using these pins as output.

# Memory Map

## FLASH LAYOUT OVERVIEW

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[To be provided at a later date.]

## DCT LAYOUT

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[This information is from the P1, and is likely to remain the same, but is subject to change.]

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 P1 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:d00a -a 1 -s 34 -D fillbyte
// Regenerate Alternate Keys
echo -en "\xFF" > fillbyte && dfu-util -d 2b04:d00a -a 1 -s 3106 -D
fillbyte
```

## MEMORY MAP

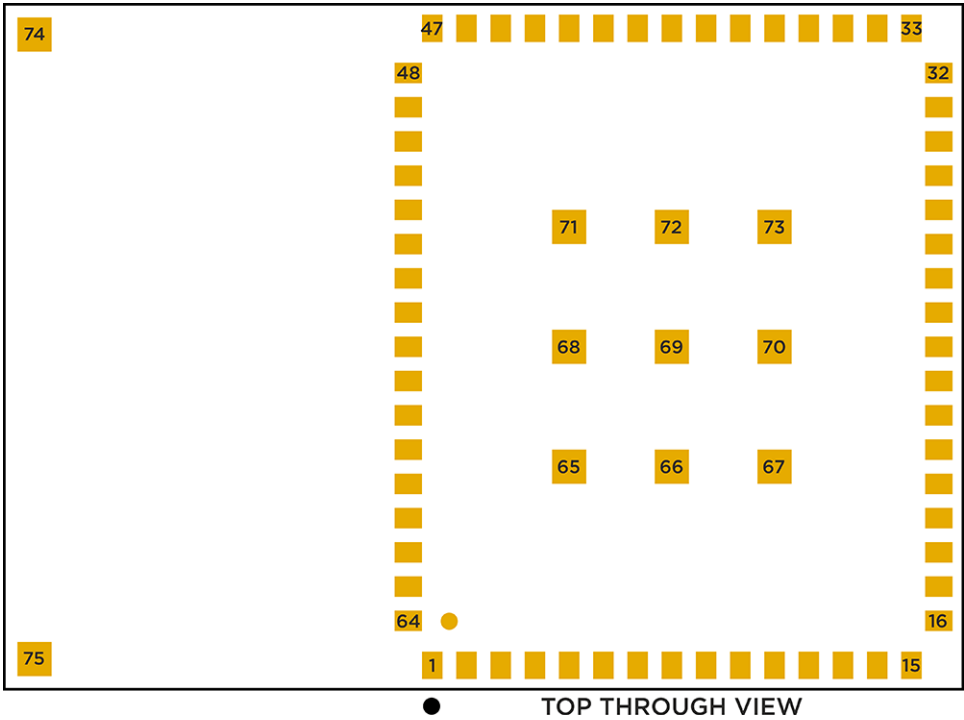
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[To be provided at a later date.]

# Pin and button definition

Peripheral Type	Qty	Input(I) / Output(O)
Digital	23	I/O
Analog (ADC)	6	I
SPI	2	I/O
I2C	1	I/O
USB	1	I/O
PWM	7	O

## PIN MARKINGS



## GPIO AND PORT LISTING

Pin Name	Module Pin		MCU
A0 / D12	50	ADC_4	PB[1]
A1 / D13	43	ADC_5	PB[2]
A2 / D14	49	ADC_3	PB[7]
A5 / D17	23	ADC_0	SPI (MOSI) PB[4]
D0 / A3	36	ADC_2	Wire (SDA) PB[6]
D1 / A4	35	ADC_1	Wire (SCL) PB[5]
D11 / WKP	30		PA[15]
D2	45		SPI1 (MOSI) Serial2 (RTS) PA[16]
D3	51		SPI1 (MISO) Serial2 (CTS) PA[17]
D4	52		SPI1 (SCK) Serial2 (RX) PA[18]
D5	53		SPI1 (SS) Serial2 (TX) PA[19]
D6	55	SWCLK	PB[3]
D7	54	SWDIO	PA[27]
RGBB	31		PB[22]
RGBG	32		PB[23]

RGBR	29		PA[30]
RST	34		CHIP_EN
RX / D10	63	Serial1 (RX)	PA[8]
S0 / D18	40	SPI (MOSI)	PA[12]
S1 / D19	41	SPI (MISO)	PA[13]
S2 / D20	42	SPI (SCK)	PA[14]
S3 / D21	44		PB[26]
S4 / D22	47		PA[0]
S5 / D23	48		PB[29]
S6 / D24	33		PB[31]
SETUP	46		PA[4]
TX / D9	64	Serial1 (TX)	PA[7]
USBDATA-	62		PA[25]
USBDATA+	61		PA[26]

## ADC (ANALOG TO DIGITAL CONVERTER)

The P2 supports four ADC inputs.

Pin	Pin Name	Description	Interface	MCU
23	A5 / D17	A5 Analog in, GPIO, PWM, SPI.	ADC_0	PB[4]
35	D1 / A4	D1 GPIO, PWM, I2C, A4 Analog In	ADC_1	PB[5]
36	D0 / A3	D0 GPIO, PWM, I2C, A3 Analog In	ADC_2	PB[6]
43	A1 / D13	A1 Analog in, GPIO	ADC_5	PB[2]
49	A2 / D14	A2 Analog in, PWM, GPIO	ADC_3	PB[7]
50	A0 / D12	A0 Analog in, GPIO	ADC_4	PB[1]

- ADC inputs are single-ended and limited to 0 to 3.3V
- Resolution is 12 bits

## UART SERIAL

The P2 supports two UART serial interfaces.

Pin	Pin Name	Description	Interface	MCU
45	D2	D2 GPIO, Serial2, SPI1	Serial2 (RTS)	PA[16]
51	D3	D3 GPIO, Serial2, SPI1	Serial2 (CTS)	PA[17]
52	D4	D4 GPIO, Serial2, SPI1	Serial2 (RX)	PA[18]
53	D5	D5 GPIO, Serial2, SPI1	Serial2 (TX)	PA[19]
63	RX / D10	Serial1 RX (received data), GPIO	Serial1 (RX)	PA[8]
64	TX / D9	Serial1 TX (transmitted data), GPIO	Serial1 (TX)	PA[7]

- The UART pins are 3.3V and must not be connected directly to a RS-232C port or to a 5V TTL serial port
- Hardware flow control is optional; if not used then the RTS and CTS pins can be used as regular GPIO
- Serial1 uses the RTL872x UART\_LOG peripheral
- Serial2 uses the RTL872x HS\_UART0 peripheral



## SPI

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The P2 supports two SPI (serial peripheral interconnect) ports.

Pin	Pin Name	Description	Interface	MCU
23	A5 / D17	A5 Analog in, GPIO, PWM, SPI.	SPI (MOSI)	PB[4]
40	S0 / D18	S0 GPIO, PWM, SPI. (Was P1S0 on P1.)	SPI (MOSI)	PA[12]
41	S1 / D19	S1 GPIO, PWM, SPI. (Was P1S1 on P1.)	SPI (MISO)	PA[13]
42	S2 / D20	S2 GPIO, SPI. (Was P1S2 on P1.)	SPI (SCK)	PA[14]
45	D2	D2 GPIO, Serial2, SPI1	SPI1 (MOSI)	PA[16]
51	D3	D3 GPIO, Serial2, SPI1	SPI1 (MISO)	PA[17]
52	D4	D4 GPIO, Serial2, SPI1	SPI1 (SCK)	PA[18]
53	D5	D5 GPIO, Serial2, SPI1	SPI1 (SS)	PA[19]

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

## I2C

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The P2 supports one I2C (two-wire serial interface) port.

Pin	Pin Name	Description	Interface	MCU
35	D1 / A4	D1 GPIO, PWM, I2C, A4 Analog In	Wire (SCL)	PB[5]
36	D0 / A3	D0 GPIO, PWM, I2C, A3 Analog In	Wire (SDA)	PB[6]

- The I2C port is 3.3V and must not be connected directly a 5V I2C bus
- Maximum bus speed is 400 kHz
- External pull-up resistors are required for I2C
- If not using I2C, pins D0 and D1 can be used as GPIO

## USB

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The P2 supports a USB interface for programming the device and for USB serial (CDC) communications. The module itself does not contain a USB connector; you typically add a micro USB or USB C connector on your base board. It is optional but recommended.

Pin	Pin Name	Description	MCU
61	USBDATA+	USB Data+	PA[26]
62	USBDATA-	USB Data-	PA[25]

## RGB LED

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The P2 supports an external common anode RGB LED.

One common LED that meets the requirements is the [Cree CLMVC-FKA-CL1D1L71BB7C3C3](#) which is inexpensive and easily procured. You need to add three current limiting resistors. With this LED, we typically use 1K ohm current limiting resistors. These are much larger than necessary. They make the LED less blinding but still provide sufficient current to light the LEDs. If you want

maximum brightness you should use the calculated values - 33 ohm on red, and 66 ohm on green and blue.

A detailed explanation of different color codes of the RGB system LED can be found [here](#).

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

Pin	Pin Name	Description	MCU
29	RGBR	RGB LED Red	PA[30]
31	RGBB	RGB LED Blue	PB[22]
32	RGBG	RGB LED Green	PB[23]

## SETUP AND RESET BUTTON

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

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

## COMPLETE MODULE PIN LISTING

Pin	Pin Name	Description	MCU
1	GND	Ground. Be sure you connect all P1 ground pins.	
2	3V3_RF	3.3V power to RF module	
3	3V3_RF	3.3V power to RF module	
4	GND	Ground. Be sure you connect all P1 ground pins.	
5	3V3_IO	3.3V power to MCU IO.	
6	GND	Ground. Be sure you connect all P1 ground pins.	
7	NC	No connection. Do not connect anything to this pin.	
8	NC	No connection. Do not connect anything to this pin.	
9	NC	No connection. Do not connect anything to this pin.	
10	NC	No connection. Do not connect anything to this pin.	
11	NC	No connection. Do not connect anything to this pin.	
12	VBAT_MEAS	Battery voltage measurement (optional).	
13	GND	Ground. Be sure you connect all P1 ground pins.	
14	NC	No connection. Do not connect anything to this pin.	
15	GND	Ground. Be sure you connect all P1 ground pins.	
16	NC	No connection. Do not connect anything to this pin.	
17	NC	No connection. Do not connect anything to this pin.	
18	NC	No connection. Do not connect anything to this pin.	
19	NC	No connection. Do not connect anything to this pin.	
20	NC	No connection. Do not connect anything to this pin.	
21	NC	No connection. Do not connect anything to this pin.	
22	NC	No connection. Do not connect anything to this pin.	

23	A5 / D17	A5 Analog in, GPIO, PWM, SPI.	PB[4]
24	NC	No connection. Do not connect anything to this pin.	
25	GND	Ground. Be sure you connect all P1 ground pins.	
26	3V3	3.3V power to MCU	
27	3V3	3.3V power to MCU	
28	GND	Ground. Be sure you connect all P1 ground pins.	
29	RGBR	RGB LED Red	PA[30]
30	D11 / WKP	GPIO. (Was WKP/A7 on P1.)	PA[15]
31	RGBB	RGB LED Blue	PB[22]
32	RGBG	RGB LED Green	PB[23]
33	S6 / D24	S6 GPIO. (Was P1S6/TESTMODE on P1.)	PB[31]
34	RST	Hardware reset. Pull low to reset; can leave unconnected in normal operation.	CHIP_EN
35	D1 / A4	D1 GPIO, PWM, I2C, A4 Analog In	PB[5]
36	D0 / A3	D0 GPIO, PWM, I2C, A3 Analog In	PB[6]
37	GND	Ground. Be sure you connect all P1 ground pins.	
38	NC	No connection. Do not connect anything to this pin.	
39	GND	Ground. Be sure you connect all P1 ground pins.	
40	S0 / D18	S0 GPIO, PWM, SPI. (Was P1S0 on P1.)	PA[12]
41	S1 / D19	S1 GPIO, PWM, SPI. (Was P1S1 on P1.)	PA[13]
42	S2 / D20	S2 GPIO, SPI. (Was P1S2 on P1.)	PA[14]
43	A1 / D13	A1 Analog in, GPIO	PB[2]
44	S3 / D21	S3 GPIO. (Was P1S3 on P1.)	PB[26]
45	D2	D2 GPIO, Serial2, SPI1	PA[16]
46	SETUP	SETUP button, has internal pull-up. Pin number constant is BTN.	PA[4]
47	S4 / D22	S4 GPIO. (Was P1S4 on P1.)	PA[0]
48	S5 / D23	S5 GPIO. (Was P1S5 on P1.)	PB[29]
49	A2 / D14	A2 Analog in, PWM, GPIO	PB[7]
50	A0 / D12	A0 Analog in, GPIO	PB[1]
51	D3	D3 GPIO, Serial2, SPI1	PA[17]
52	D4	D4 GPIO, Serial2, SPI1	PA[18]
53	D5	D5 GPIO, Serial2, SPI1	PA[19]
54	D7	D7 GPIO	PA[27]
55	D6	D6 GPIO	PB[3]
56	NC	No connection. Do not connect anything to this pin.	
57	NC	No connection. Do not connect anything to this pin.	
58	NC	No connection. Do not connect anything to this pin.	
59	GND	Ground. Be sure you connect all P1 ground pins.	
60	NC	No connection. Do not connect anything to this pin.	
61	USBDATA+	USB Data+	PA[26]
62	USBDATA-	USB Data-	PA[25]
63	RX / D10	Serial1 RX (received data), GPIO	PA[8]
64	TX / D9	Serial1 TX (transmitted data), GPIO	PA[7]
65	GND	Ground. Be sure you connect all P1 ground pins.	
66	GND	Ground. Be sure you connect all P1 ground pins.	
67	GND	Ground. Be sure you connect all P1 ground pins.	

68	GND	Ground. Be sure you connect all P1 ground pins.
69	GND	Ground. Be sure you connect all P1 ground pins.
70	GND	Ground. Be sure you connect all P1 ground pins.
71	GND	Ground. Be sure you connect all P1 ground pins.
72	GND	Ground. Be sure you connect all P1 ground pins.
73	GND	Ground. Be sure you connect all P1 ground pins.
74	NC	No connection. Do not connect anything to this pin.
75	NC	No connection. Do not connect anything to this pin.

# Technical specification

## ABSOLUTE MAXIMUM RATINGS

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[To be provided at a later date.]

## RECOMMENDED OPERATING CONDITIONS

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[To be provided at a later date.]

## WI-FI SPECIFICATIONS

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[To be provided at a later date.]

## I/O CHARACTERISTICS

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[To be provided at a later date.]

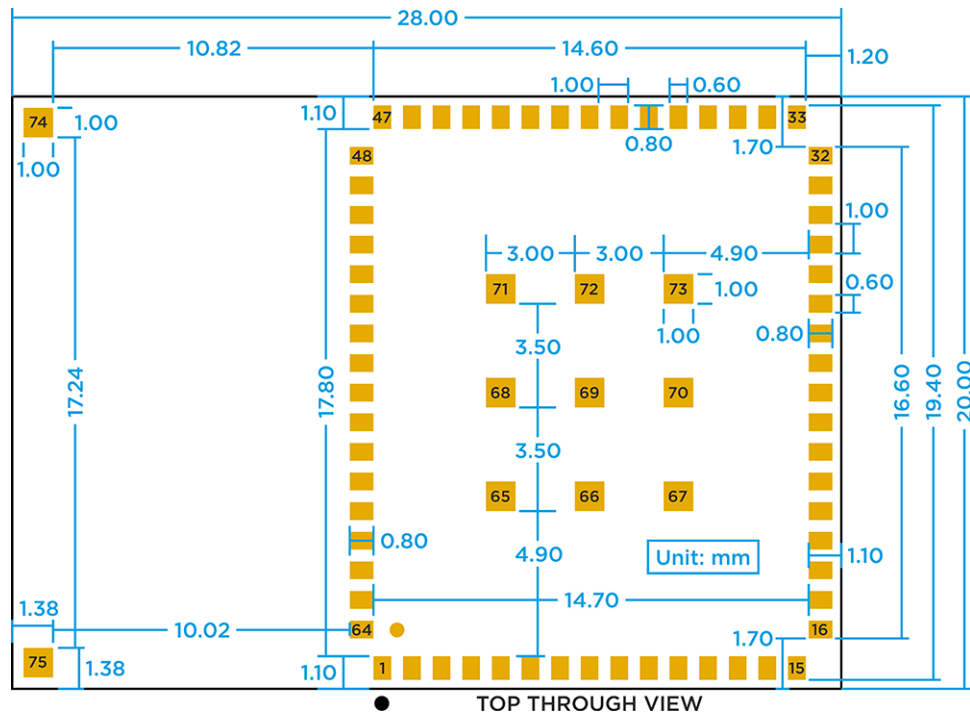
# Mechanical specifications

## OVERALL DIMENSIONS

[To be provided at a later date.]

## MODULE DIMENSIONS

- P1 module dimensions are: 0.787"(28mm) (W) x 1.102"(20mm) (L) x 0.0787"(2.0mm) (H) +/-0.0039" (0.1mm) (includes metal shielding)
- The P2 should have the same width and length but the height may be slightly different as it has different metal shielding



## RECOMMENDED PCB LAND PATTERN

The P2 can be mounted directly on a carrier PCB with following PCB land pattern:



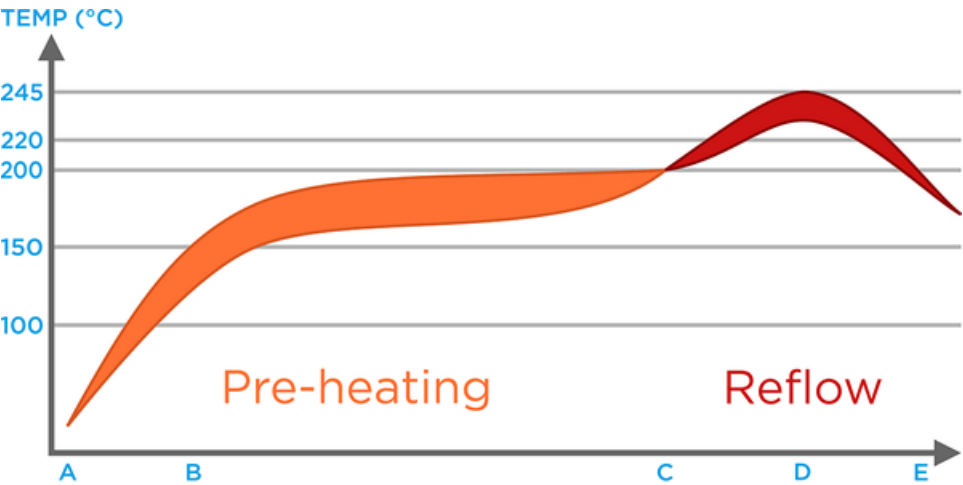
# Reference Design Schematic

[To be provided at a later date.]



# Recommended solder reflow profile

[This information is from the P1, and is likely to remain the same, but is subject to change.]



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: 4~9 s
D-E.	245~220°C, Cooling rate: < 1°C/s

## Ordering information

[To be provided at a later date.]

P2 modules are available from [store.particle.io](https://store.particle.io) as cut tape in quantities of 10 each.

SKU	Description	Region	Lifecycle	Replacement
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## Qualification and approvals



- RoHS
- CE
- FCC ID: [To be provided at a later date.]
- IC: [To be provided at a later date.]

# Product handling

## **TAPE AND REEL INFO**

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[To be provided at a later date.]

## **MOISTURE SENSITIVITY LEVELS**

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The Moisture Sensitivity Level (MSL) relates to the packaging and handling precautions required. The P1 module is rated level 3. In general, this precaution applies for Photons without headers. When reflowing a P1 directly onto an application PCB, increased moisture levels prior to reflow can damage sensitive electronics on the P1. 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**

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The P1 module contains highly sensitive electronic circuitry and is an Electrostatic Sensitive Device (ESD). Handling a P1 module 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 P1 modules. ESD precautions should be implemented on the application board where the P1 module is mounted. Failure to observe these precautions can result in severe damage to the P1 module!

## Default settings

The P2 module comes pre-programmed with a bootloader and a user application called Tinker. This application works with an iOS and Android app also named Tinker that allows you to very easily toggle digital pins, take analog and digital readings and drive variable PWM outputs.

The bootloader allows you to easily update the user application via several different methods, USB, OTA, Serial Y-Modem, and also internally via the Factory Reset procedure. All of these methods have multiple tools associated with them as well.

You may use the [Particle Web IDE](#) 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

Radio Frequency

## **SMT**

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

## **AP**

Access Point

## **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: [To be provided at a later date]

**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: [To be provided at a later date]

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
pre	2021-11-04	RK	Pre-release

## Known Errata

# Contact

## Web

<https://www.particle.io>

## Community Forums

<https://community.particle.io>

## Email

<https://support.particle.io>