

Flairmesh Technologies FMB120 Bluetooth V5.4 Dual Mode Owner's Manual

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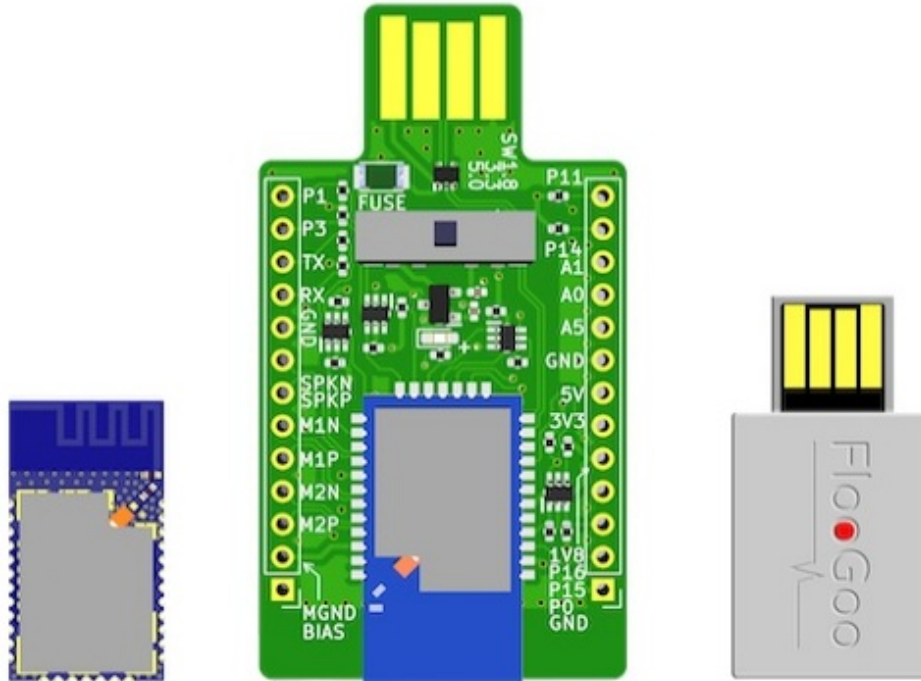


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Flairmesh Technologies FMB120 Bluetooth V5.4 Dual Mode



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Release Record

Version	Release Date	Comments
1.0	Aug. 31, 2023	The first release.

Description

FMB120 is a dual-mode class 1 Bluetooth® V5.4 module. It supports both the classic BT A2DP and the new low-energy audio TMAP and PBP source role in a single module. With its internal DSP and Bluetooth stack processor, it can be used to stream USB or analog stereo audio to classic and new LE audio headsets/speakers/earbuds. All these functions are built into a small form factor castellated hole footprint module, with an on-board PCB antenna. In addition to the standard SBC and LC3 encoder for A2DP and LE audio respectively, it also supports aptX®, aptX HD, and aptX adaptive encoder for high-quality music streaming. Super low latency gaming mode is also supported. With its ASCII command-based control interface, fully qualified Bluetooth stack, and modular approvals for major markets such as FCC/CE, it helps customers integrate Bluetooth audio source functionality into their host system with minimal effort.

Typical Bluetooth & LE audio applications:

- Analog Bluetooth audio source dongle
- USB audio source dongle
- Wireless microphone
- Home entertainment equipment

Features

- Dual mode Bluetooth® v5.4
- Support BLE 2M PHY
- +15dBm BR TX power, -97dBm BR RX sensitivity
- +15dBm BLE TX power, -100.5dBm BLE 1Mb/s RX sensitivity
- PCB antenna with 2.7dBi gain
- Qualified profiles: TMAP (CG, UMS, BMS), PBP (PBS, Auracast®), A2DP (SRC), AVRCP (TG).
- Profiles supported with customized firmware: HFP, HID, SPP, OPP, etc.
- UART/I2C/SPI master multiplexed with PIOs
- 11 digital PIOs, 2 LED outputs multiplexed with AIOs
- SBC, aptX, aptX HD, aptX adaptive, and LC3 encoder
- 22mm x 12mm x 2.2mm
- Weight: approximately 1g
- Plated half-hole SMT pads for easy and reliable PCB mounting
- Bluetooth QDID:
- FCC ID: 2A22WFMB120
- CE
- RCM
- RoHS compliant

Ordering Number	Package	Items in One Package	Comments
FMB120-P	Plastic tray	80	
FMB120-T	Tape	TBD	

Please also supply the customer firmware code issued by Flairmesh Technologies when you place the order.

Pinout and Description

Pin Assignments

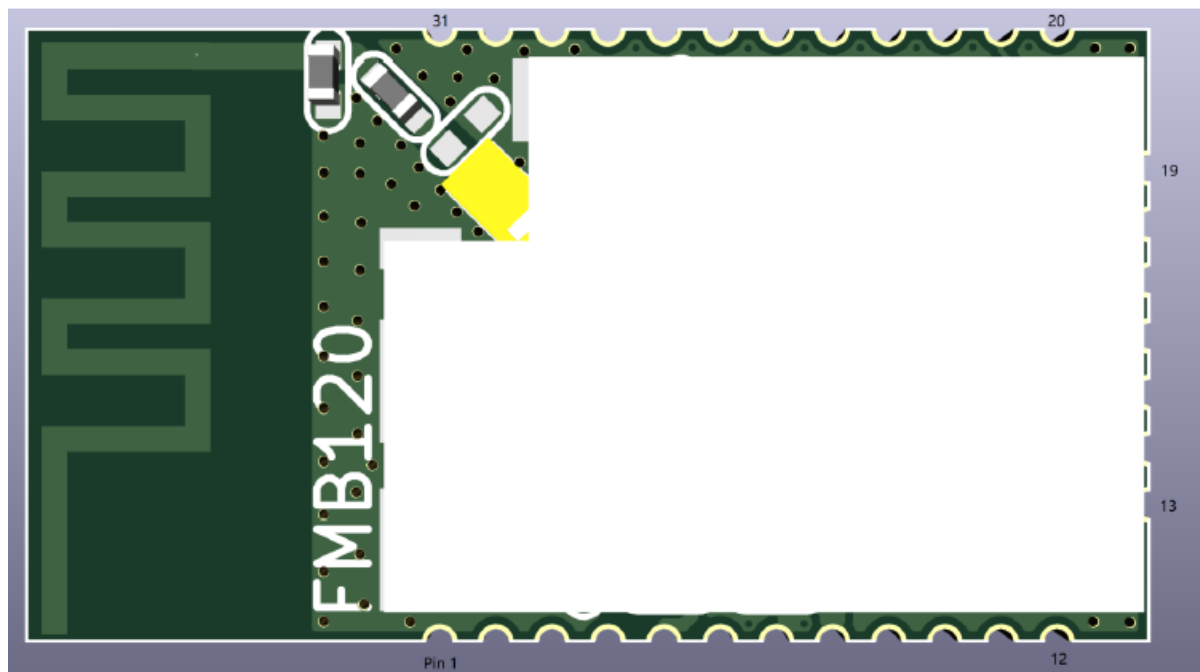


Figure 1: Pinout of FMB120

Pinout Descriptions

Pin	Symbol	I/O Type	Description
1	GND	Ground	Ground
2	3V3/VBAT	Power input	Battery voltage input
3	PIO0/VREG_EN	Digital input	<p>Typically connected to an ON/OFF push button. If power is present from the battery and/or charger, and software has placed the device in the OFF or DORMANT state, a button press boots the device. Also usable as a digital input in normal operation. No pull. Additional function:</p> <p>■ PIO[0] input only</p>
4	PIO8	Digital bidirectional with programmable strength internal pull-up/pull-down	Programmable IO 8, weak pull down when reset
5	VDD_IO	Power input	PIO supply, 1.8V or 3.3V, needs to be powered at the same time as VBAT or VBUS
6	1V8_OUT	Power output	Can provide 100mA for external circuits
7	GND	Ground	Ground

8	VBUS	Power input	5V input
9	PIO1/RESETB	Digital bidirectional with programable strength internal pull-up/pull-down	<p>Automatically defaults to RESET# mode when the device is unpowered, or in off modes.</p> <p>Reconfigurable as a PIO after boot.</p> <p>Programmable IO 1, strong pull-up when reset</p>
10	PIO2	Digital bidirectional with programable strength internal pull-up/pull-down	Programmable IO 2, weak pull down when reset
11	USB_DP	Digital	<p>USB Full Speed device D- I/O. IEC- 61000-4-2 (device level) ESD Protection</p>
12	USB_DN	Digital	<p>USB Full Speed device D- I/O.</p> <p>IEC-61000-4-2 (device level) ESD Protection</p>
13	PIO4	Analog or digital input/open-drain output	Programmable IO 4, weak pull down when reset
14	AIO1/LED1	Analog or digital input/open-drain output	General purpose analog/digital input or open drain LED output 1
15	AIO0/LED0	Analog or digital input/open-drain output	General purpose analog/digital input or open drain LED output 0
16	PIO34	Digital bidirectional with programable strength internal pull-up/pull-down	Programmable IO 34, weak pull-down when reset
17	PIO21	Digital bidirectional with programable strength internal pull-up/pull-down	Programmable IO 21, weak pull-down when reset
18	PIO36	Digital bidirectional with programable strength internal pull-up/pull-down	Programmable IO 36, strong pull-up when reset
19	PIO7	Digital bidirectional with programable strength internal pull-up/pull-down	Programmable IO 7, strong pull-up when reset

20	PIO5/UART_RX	Digital bidirectional with programable strength internal pull-up/pull-down	<p>Programmable IO 5, weak pull down when resetting,</p> <p>Additional function:</p> <p>■ UART RX</p>
21	PIO15/UART_TX	Digital bidirectional with programable strength internal pull-up/pull-down	Programmable IO 15, strong pull-up when reset,

5	VDD_IO	Power input	PIO supply, 1.8V or 3.3V, needs to be powered at the same time as VBAT or VBUS
6	1V8_OUT	Power output	Can provide 100mA for external circuits
7	GND	Ground	Ground
8	VBUS	Power input	5V input
9	PIO1/RESETB	Digital bidirectional with programable strength internal pull-up/pull-down	<p>Automatically defaults to RESET# mode when the device is unpowered, or in off modes.</p> <p>Reconfigurable as a PIO after boot.</p> <p>Programmable IO 1, strong pull-up when reset</p>
10	PIO2	Digital bidirectional with programable strength internal pull-up/pull-down	Programmable IO 2, weak pull down when reset
11	USB_DP	Digital	<p>USB Full Speed device D- I/O. IEC- 61000-4-2 (device level) ESD Protection</p>
12	USB_DN	Digital	<p>USB Full Speed device D- I/O.</p> <p>IEC-61000-4-2 (device level) ESD Protection</p>
13	PIO4	Analog or digital input/open-drain output	Programmable IO 4, weak pull down when reset
14	AIO1/LED1	Analog or digital input/open-drain output	General purpose analog/digital input or open drain LED output 1

15	AIO0/LED0	Analog or digital input/open-drain output	General purpose analog/digital input or open drain LED output 0
16	PIO34	Digital bidirectional with programmable strength internal pull-up/pull-down	Programmable IO 34, weak pull-down when reset
17	PIO21	Digital bidirectional with programmable strength internal pull-up/pull-down	Programmable IO 21, weak pull-down when reset
18	PIO36	Digital bidirectional with programmable strength internal pull-up/pull-down	Programmable IO 36, strong pull-up when reset
19	PIO7	Digital bidirectional with programmable strength internal pull-up/pull-down	Programmable IO 7, strong pull-up when reset
20	PIO5/UART_RX	Digital bidirectional with programmable strength internal pull-up/pull-down	Programmable IO 5, weak pull down when resetting, Additional function: ■ UART RX
21	PIO15/UART_TX	Digital bidirectional with programmable strength internal pull-up/pull-down	Programmable IO 15, strong pull-up when reset,

Electrical Characteristics

Absolute Maximum Rating

Rating	Min	Max	Unit
Storage Temperature	-40	+85	°C
VBUS Voltage	-0.4	6.5	V
USB_DP/USB_DN Voltage	-0.4	3.8	V
VBAT Voltage	-0.4	4.8	V
PIO Voltage	-0.4	3.8	V
LED Voltage	-0.4	7.0	V
AIO Voltage	-0.4	2.1	V
MIC Voltage	-0.4	2.1	V

Recommended Operating Conditions

Operating Condition	Min	Typ	Max	Unit
Operating Temperature Range*	-40	—	+85	°C
VBUS	4.75	5.0	6.5	V
USB_DP/USB_DN Voltage	0	—	3.6	V
VBAT Voltage	2.8	3.7	4.6	V
PIO Voltage	1.7	3.3	3.6	V
LED voltage	0	—	6.5	V
AIO Voltage	0	—	1.95	V

Table 4: Recommended Operating Conditions

Note *: Charger operates in a range from -10 to +85 (not including battery).

Input/output Terminal Characteristics

Digital Terminals

Supply Voltage Levels	Min	Typ	Max	Unit
Input Voltage Levels				
VIL input logic level low	0	—	$0.25 \times VDD_PIO$	V
VIH input logic level high	$0.625 \times VDD_PIO$	—	—	V
Drive current (configurable 2,4,8,12mA)	2	4	12	mA
Output Voltage Levels				
VOL output logic level low, at max, rated drive	—	—	$0.22 \times VDD_PIO$	V
VOH output logic level high, at max rated drive	$0.75 \times VDD_PIO$	—	—	V
Pull Strength				
Strong pull-up/down	50	70	125	kΩ
Weak pull-up/down	729	1050	1350	kΩ

Table 5: Digital Terminal

LED Driver Pads

LED driver pads		Min	Typ	Max	Unit
Open drain current	High impedance state	–	–	5	uA
	Current sink state	–	–	50	mA
LED pad resistance	$V < 0.5V$	–	–	12	Ω
VIL input logic level low		–	–	0.4	V
VIH input logic level high		0.8	–	–	V

10-bit Auxiliary ADC

10-bit auxiliary ADC		Min	Typ	Max	Unit
Resolution		–	–	10	Bits
Internal voltage reference		1.746	1.800	1.854	V
Functional input voltage range		0	–	Internal voltage reference	V
Accuracy (Guaranteed monotonic)	INL	-3	–	3	LSB
	DNL	-1	–	2	LSB
Offset		-1	–	1	LSB
Gain error		-1	–	1	%
Hardware conversion time		–	10	–	μs
LED pad leakage		-1	–	1	uA
External pad capacitance for < 0.5 LSB error		0	40	–	nF

Table 7: LED Driver Pads

High-quality (HQADC) Single-ended Audio Input

Parameter	Conditions	Min	Typ	Max	Unit
Output Sample Width	–	–	–	24	Bits
Output Sample Rate, Fsample	–	8	–	96	kHz
Input Level	–	–	–	2.4	V pk-pk
Input impedance	0dB to 24dB analog gain	–	20	–	k Ω
	27dB to 39dB analog gain	–	10	–	k Ω
Signal Noise Ratio, SNR	Fin=1kHz 48kHz Fsample B/W=20Hz->20kHz A- Weighted THD+N < 0.1% 2.4V p k-pk input (0dB gain)	–	99.4	–	dBA

THD+N	Fin=1kHz 48kHz 2.4V pk-pk input (0dB gain)	–	-91.9	–	dB
Analog Gain	3dB Steps	0	–	39	dB

High-quality (HQADC) Differential Audio Input

Parameter	Conditions	Min	Typ	Max	Unit
Output Sample Width	–	–	–	24	Bits
Output Sample Rate, Fsample	–	8	–	96	kHz
Input Level	–	–	–	2.4	V pk-pk
Input impedance	0dB to 24dB analog gain	–	20	–	k Ω
	27dB to 39dB analog gain	–	10	–	k Ω
Signal Noise Ratio, SNR	Fin=1kHz 48kHz Fsample B/W=20Hz->20kHz A- Weighted THD+N < 0.1% 2.4V p k-pk input (0dB gain)	–	99	–	dBA
THD+N	Fin=1kHz 48kHz 2.4V pk-pk input (0dB gain)	–	-94.9	–	dB
Analog Gain	3dB Steps	0	–	39	dB

Microphone Bias

Parameter	Conditions	Min	Typ	Max	Unit
Output voltage (Tunable, step = 0.1V)	–	1.5	–	2.1	V
Output current capability	–	0.07	–	6.00	mA
DC accuracy	–	-60	–	60	mV
Output noise	B/W=20Hz->20kHz Unweighted	4.5	5.1	7.3	terms
Crosstalk between microphones	Using the recommended application circuit	–	80	–	dB
Load capacitance	From parasitic PCB routing and package	–	–	0.1	nF

VBAT voltage measurement accuracy

Measurement	Min	Typ	Max	Unit
VBAT voltage measurement accuracy	–	+/-1	+/-1.5	%

Power consumptions

Operating Condition	Typical	Unit
Dormant	23	uA
Deep sleep, idle	–	uA
Connected, 495ms BT Sniff sub-rating	–	uA
Connected, 187ms BT Sniff, 2 links, four slots no retry, AFH on	–	mA
Connected, 11.25ms BT Sniff	–	mA
Connected with audio streaming (A2DP), SBC in 192 kbit, SBC Out 192kbit, Output Mono L P_DAC 48 KHz	–	mA

Note:

Power consumption depends on the firmware used. Typical values are shown in the table. Sniff mode — In Sniff mode, the duty cycle of the slave's activity in the piconet may be reduced. If a slave is in active mode on an ACL

logical transport, it shall listen in every ACL slot to the master traffic, unless that link is being treated as a scatternet link or is absent due to hold mode. With sniff mode, the time slots when a slave is listening are reduced, so it benefits the power consumption of the slave and the master shall only transmit to a slave in specified time slots. The sniff anchor points are spaced regularly with an interval of T_{sniff} , which depends on the firmware used.

Antenna Performance and Radiation Patterns

Antenna performance is measured by the evaluation board.

Frequency (MHz)	Efficiency %	Efficiency dB	Gain dB
2400	40%	-4.0	1.1
2410	45%	-3.4	2.2
2420	52%	-2.9	2.2
2430	55%	-2.6	2.0
2440	56%	-2.5	2.1
2450	53%	-2.8	1.4
2460	61%	-2.2	2.7
2470	61%	-2.2	2.1
2480	60%	-2.2	2.7
2490	58%	-2.4	2.1
2500	57%	-2.4	2.3

Table 13: Antenna Efficiencies and Gains

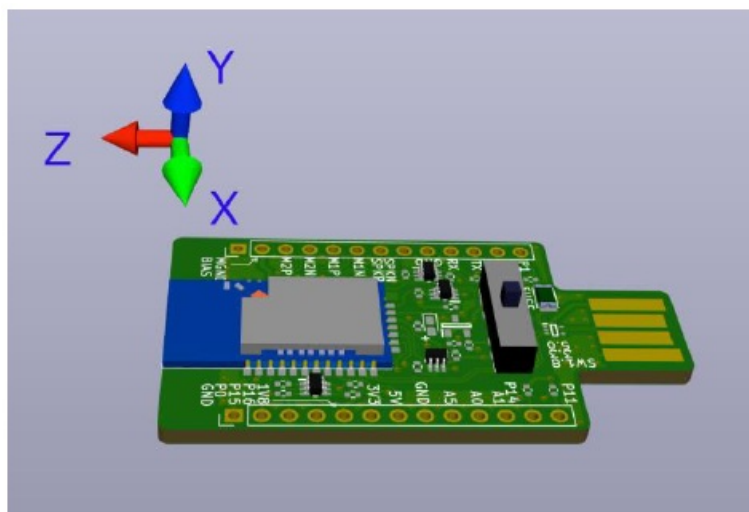


Figure 2: Coordinate System Used in 3D Patterns

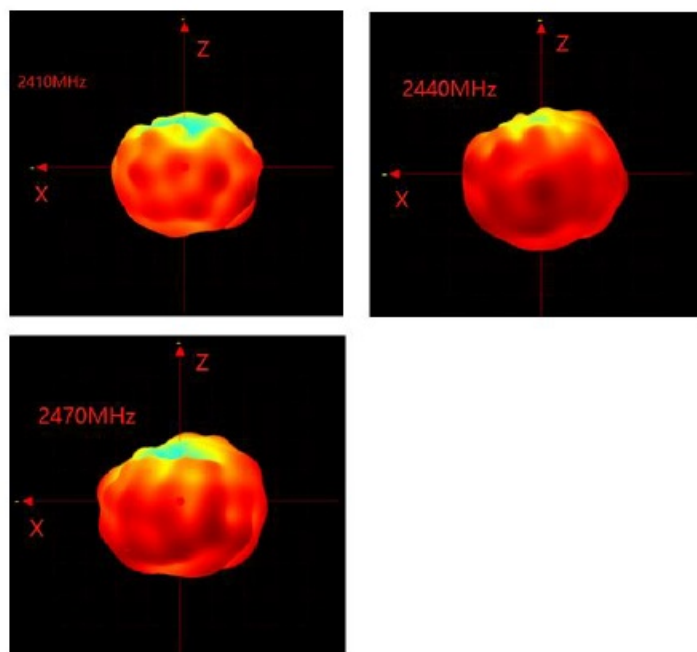
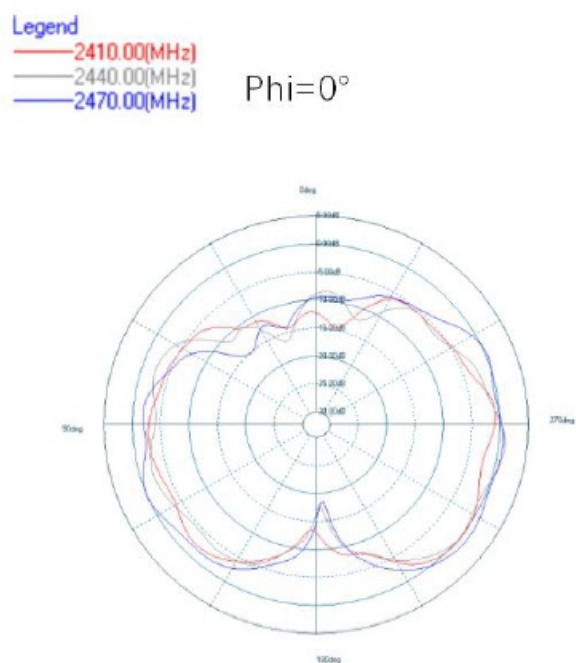


Figure 3: 3D Patterns – XZ Plane

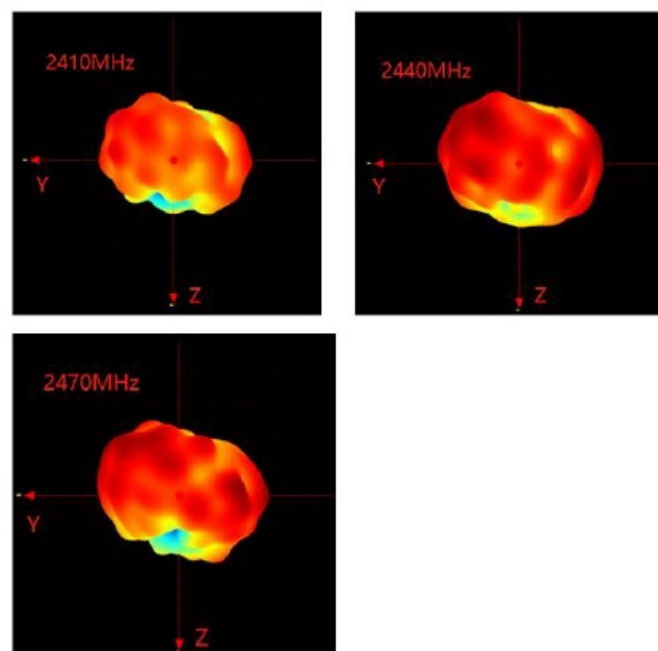
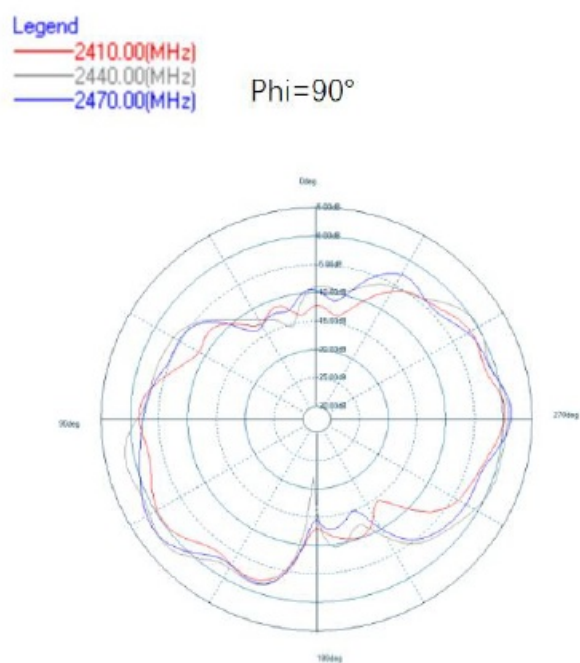


Figure 4: 3D Patterns – YZ Plane

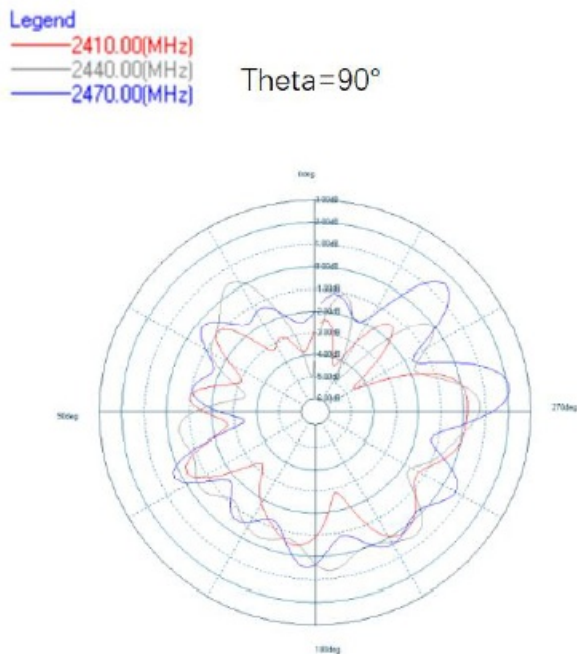


Figure 5: 3D Patterns – XY Plane

Physical Interfaces

Power Supply

There are three power supply schemes available for the module. It can be powered by a Li-poly battery (3.7V), a 3.3V DC on its VBAT, or a 5V DC on its VBUS. Please refer to the reference designs in 5.

Reset

- The module may be reset from several sources: RESET pin, power-on reset, USB charger attaches reset, and software-configured watchdog timer. The RSTB pin is an active low reset. It is recommended that RSTB be applied for a period greater than 120μs. At reset the digital I/O pins are set to inputs for bi-directional pins and outputs are tri-state. The pull-down state is shown below.

Pin Name / Group	Pin Status on Reset
USB_DP	Tristate
USB_DN	Tristate
PIO0	No Pull
PIO[1,7,15,36]	PUS
PIO[2,4,5,8,21,34]	PDW

Note: PUS – Strong pull-up, PDS – Strong pull-down, PUW – Weak pull-up, PDW – Weak pull-down. If RSTB is held low for > 1.8 s and VBUS is not applied, the module turns off. A rising edge on PIO0 or VBUS is then required to power on.

Audio Interfaces

The module has two analog audio inputs configurable as single-ended line inputs, or unbalanced, or balanced analog microphone inputs. Digital microphones are also supported. It also has a unidirectional 24-bit I2S interface and two instances of SPDIF as inputs.

General Purpose Analog IO

The module has two general-purpose analog interface pins multiplexed with LED pads. In a Li-poly battery application, the VBAT pin can measure the battery voltage directly.

LED Drivers

The FMB120 includes a PWM LED driver for driving LEDs. There are 2 open-drain LED outputs multiplexed with AIOs. Any PIOs can also be mapped into LED output by firmware.

Serial Interfaces

CART

The module has a standard UART serial interface that provides a simple mechanism for communicating using the RS232 protocol.

Parameter		Possible Values
Baud Rate	Minimum	2400 baud ($\leq 2\%$ Error)
		19200 baud ($\leq 1\%$ Error)
	Maximum	4M baud ($\leq 1\%$ Error)
Flow control		RTS/CTS or None
Parity		None, Odd or Even
Number of Stop Bits		1 or 2
Bits per Byte		8

Table 15: Possible UART Settings

USB

FMB120 has a full-speed (12 Mbps) USB port and enumerates as a compound device with a hub. The enabled audio source/sink/HID/CDC device appears behind that hub. The DP 1.5k pull-up is integrated internally. No series resistors are required on the USB data lines. The VBUS input is tolerant of a constant 6.5V and transients up to 7.0V. Use an external clamping protection device if extra overvoltage protection is required. FMB120 supports charger detection to the USB BC 1.2 specification. It provides Data Contact Detection (DCD) using an internal current source, and provides:

- Detection of Standard Downstream Ports (SDP)
- Charging Downstream Ports (CDP)
- Dedicated Downstream Ports (DCP)

The 10-bit auxiliary ADC reads the voltage on the USB data lines. This enables the detection of proprietary chargers that bias the voltage on the USB data lines. For USB Type-C® connectors, use the LED pins to detect the voltage on the USB Configuration Channel (CC) line pins (CC1 and CC2) to detect the charge current capabilities of the upstream device.

I2C

- Any two PIOs can be used to form a master I2C interface.

SPI Interface

Any four PIOs can be used to form an SPI interface. Firmware can be customized to connect with variable peripherals.

Firmware Stack

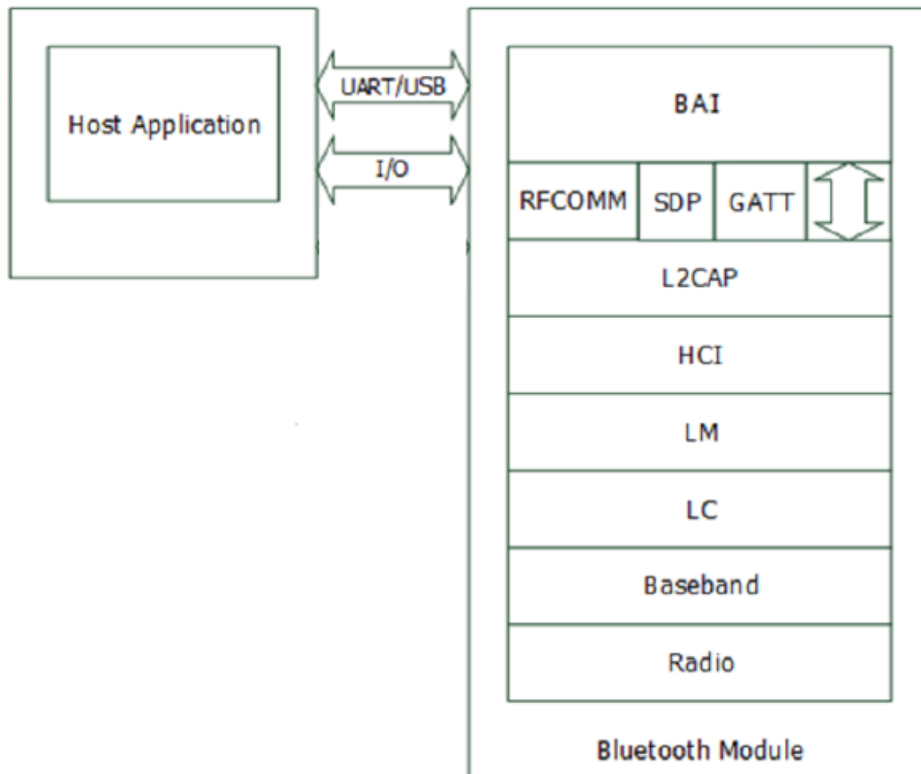


Figure 6: FMB120 Stacks

FMB120 is supplied with qualified Bluetooth 5.4 stack firmware. With Flairmesh's BAI interface, the host MCU can easily control A2DP (SRC role), AVRCP (TG role), HFP (AG role), TMAP (CG, UMS, and BMS role), PBP (PBS role), SPP (A and B), OPP (client), HID (peripheral) profiles running on the module.

Reference Design

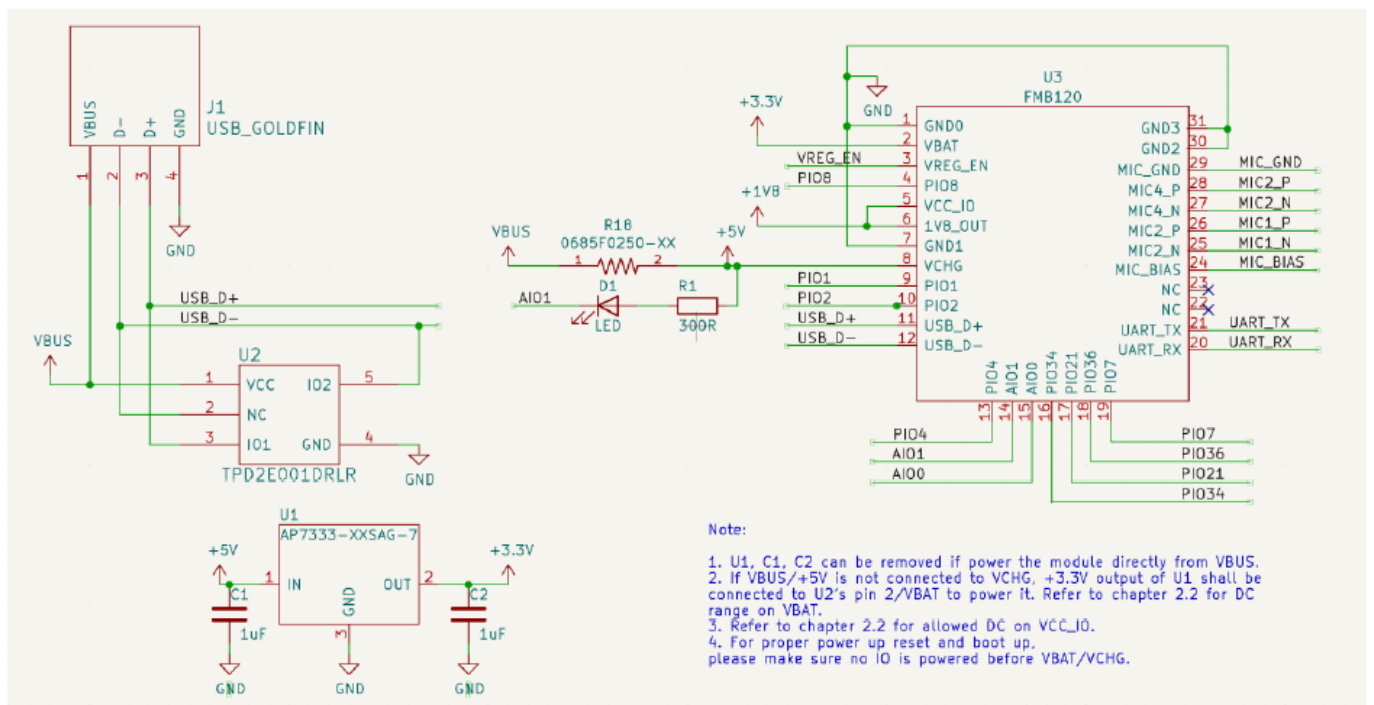


Figure 7: Reference Design Using USB or DC 3.3V

Mechanical Size and Recommended PCB Footprint

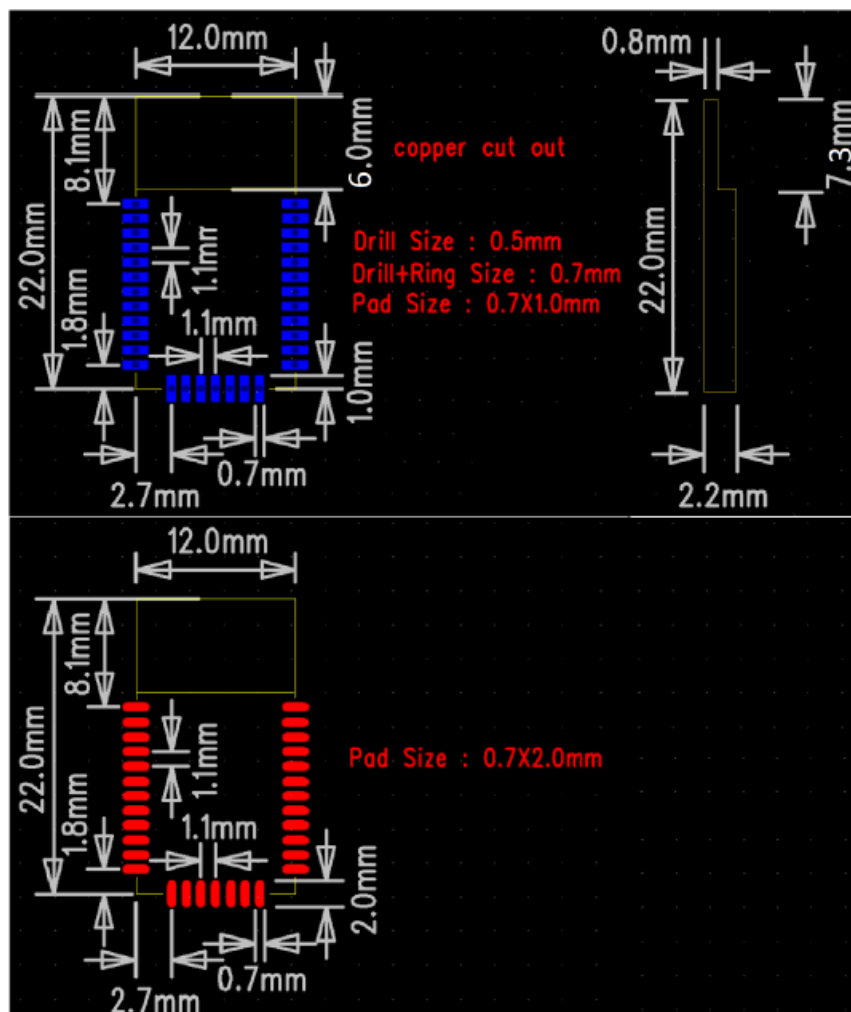


Figure 8: Mechanical Size and Recommended PCB Footprint

RF Layout Guidelines

FMB120 integrates an on-board Meander line antenna to radiate and receive the RF signals. The antenna has been well designed and tuned for common usage but it still needs to have good ground clearance around the antenna to get good RF performance.

1. No ground below the antenna region (copper cut out in Figure 8) of the FMB120.
2. There should also be a good ground panel and clearance on the main PCB board on which the module is mounted. As shown in Figure 9.

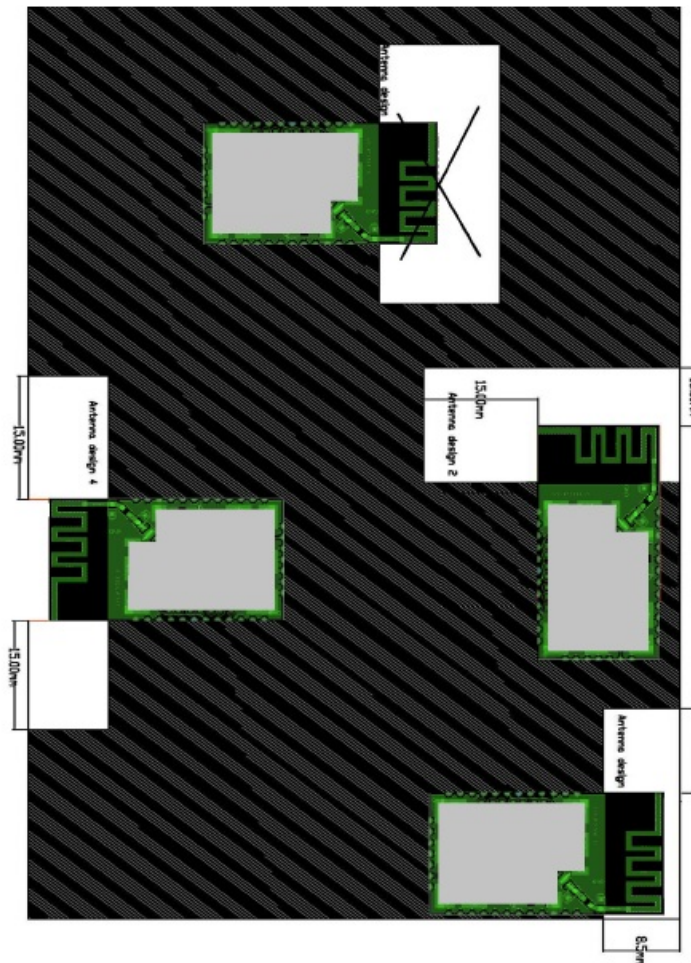


Figure 9 : Placement the module and the ground of main PCB Board

Reflow Profile

FMB120 is compatible with industrial standard reflow profile for Pb-free solders. The soldering profile depends on various parameters necessitating a setup for each application. The data here is given only for guidance on solder re-flow.

There are four zones

- **Preheat Zone** – This zone raises the temperature at a controlled rate, typically 1-2.5°C/s.
- **Equilibrium Zone** – This zone brings the board to a uniform temperature and also activates the flux. The duration in this zone (typically 2-3 minutes) will need to be adjusted to optimize the out-gassing of the flux.
- **Reflow Zone**- The peak temperature should be high enough to achieve good wetting but not so high as to cause component discoloration or damage. Excessive soldering time can lead to intermetallic growth which can result in a brittle joint.
- **Cooling Zone** – The cooling rate should be fast, to keep the solder grains small which will give a longer-lasting joint. Typical rates will be 2-5°C/s.

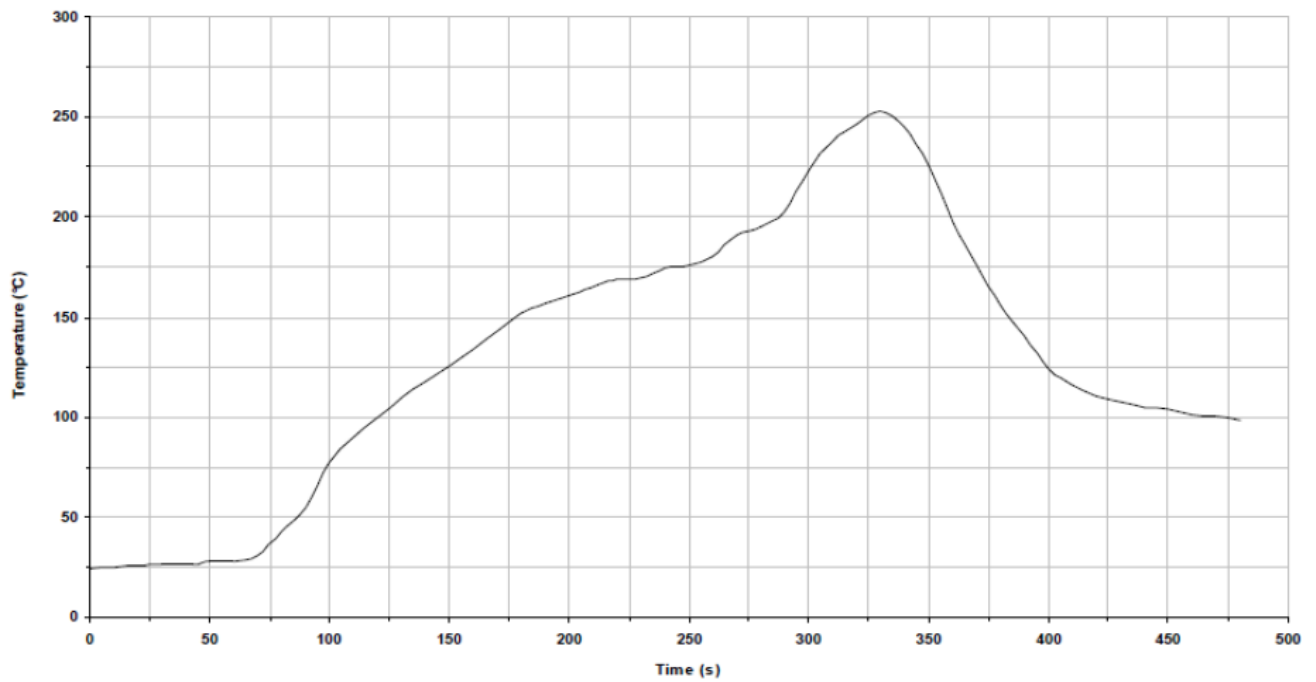


Figure 10: Typical Lead-Free Re-flow Solder Profile for FMB120

Key features of the profile:

- Initial Ramp = 1-2.5°C/sec to 175°C \pm 25°C equilibrium
- Equilibrium time = 60 to 180 seconds
- Ramp to Maximum temperature (250°C) = 3°C/sec max.
- Time above liquidus temperature (217°C): 45-90 seconds
- Device absolute maximum reflow temperature: 255°C

Note: Customer might choose a local 0.2mm thickness solder cream for the module, or use 0.15mm to match other components in the same PCB.

Package

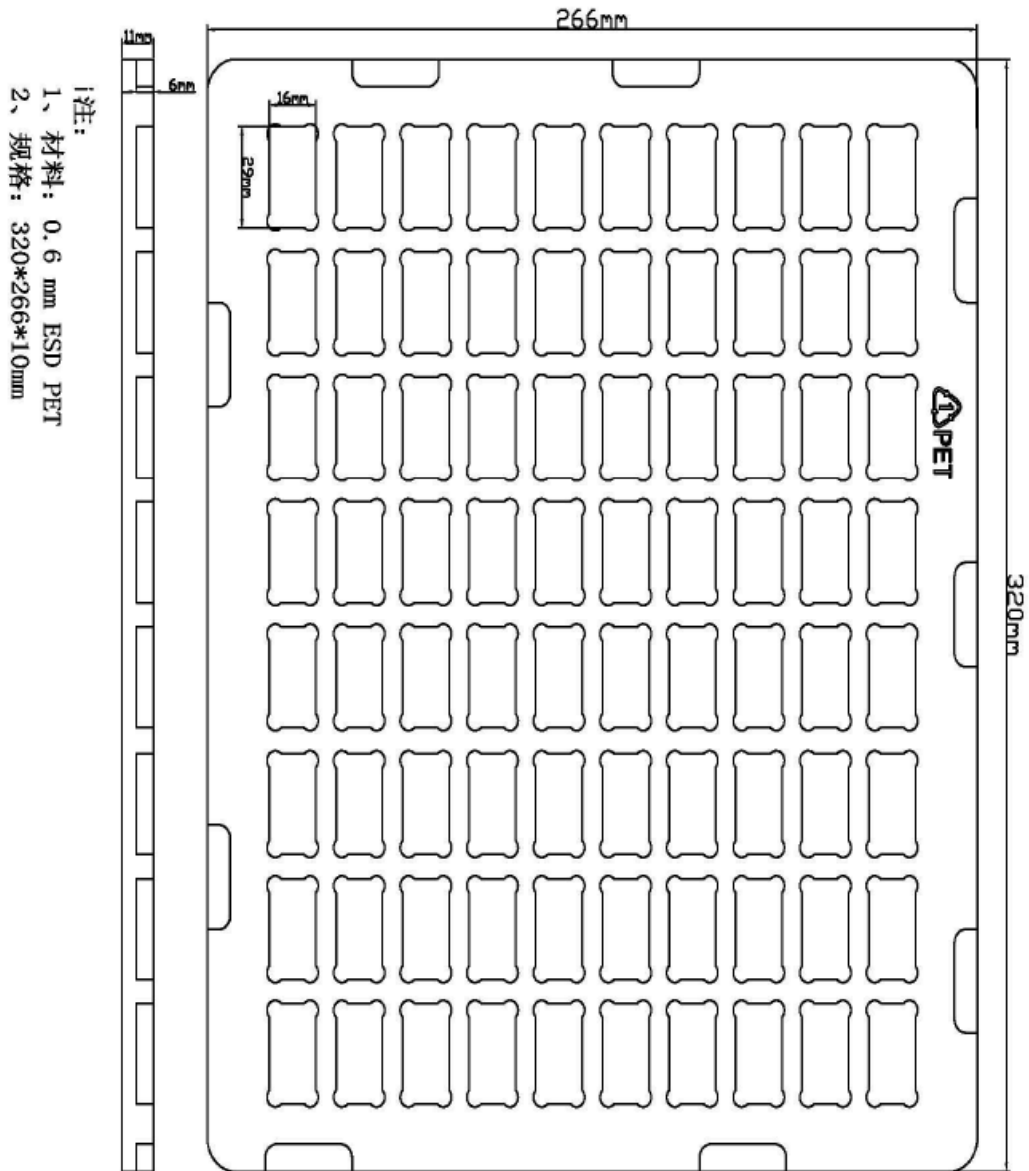


Figure 11: FMB120 Plastic Tray Package

Plastic trays, plus aluminum bags do vacuum packing. Items in One Package number of 80 PCS, external aluminum foil vacuum packaging. The module's Moisture Sensitivity Level is level 3 by JEDEC J-STD-020.

Statement and Contact Information

Radioworks Microelectronics PTY LTD is the business name holder of Flairmesh Technologies.

FCC statements

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.

NOTE: The manufacturer is not responsible for any radio or TV interference caused by unauthorized modifications or changes to this equipment. Such modifications or changes could void the user's authority to operate the equipment.

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, under 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 by 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 or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and the receiver.
- Connect the equipment to 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.

Federal Communication Commission (FCC) Radiation Exposure Statement

When using the product, maintain a distance of 20cm from the body to ensure compliance with RF exposure requirements.

This device is intended only for OEM integrators under the following conditions: 1. The antenna must be installed such that 20 cm is maintained between the antenna and users. 2. The transmitter module may not be co-located with any other transmitter or antenna. As long as the two conditions above are met, additional transmitter testing will not be required. However, the OEM integrator is still responsible for testing their end product for any additional compliance requirements required for the installed module.

Important Note: If these conditions cannot be met (for example certain laptop configurations or co-location with another transmitter), then the Federal Communications Commission of the U.S. Government (FCC) and the Canadian Government authorizations are no longer considered valid and the FCC ID cannot be used on the final product. In these circumstances, the OEM integrator shall be responsible for re-evaluating the end product (including the transmitter) and obtaining a separate FCC authorization in the U.S. OEM Integrators – End Product Labeling Considerations: This transmitter module is authorized only for use in devices where the antenna may be installed such that 20 cm may be maintained between the antenna and users. The end product must be labeled in a visible area with the following: “Contains, FCC ID: 2A22WFMB120”. The grantee’s FCC ID can be used only when all FCC compliance requirements are met.

OEM Integrators – End Product Manual Provided to the End User: The OEM integrator shall not provide information to the end user regarding how to install or remove this RF module in the end product user manual. The end user manual must include all required regulatory information and warnings as outlined in this document. Appropriate measurements (e.g. 15 B compliance) and if applicable additional equipment authorizations (e.g. SDoC) of the host product to be addressed by the integrator/manufacturer. This module is only FCC authorized for the specific rule parts 15.247, and 15.407 listed on the grant, and the host product manufacturer is responsible for compliance with any other FCC rules that apply to the host product as being Part 15 Subpart B compliant.

Documents / Resources

	Flairmesh Technologies FMB120 Bluetooth V5.4 Dual Mode [pdf] Owner's Manual FMB120 Bluetooth V5.4 Dual Mode, FMB120, Bluetooth V5.4 Dual Mode, V5.4 Dual Mode, Dual Mode, Mode
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References

- [User Manual](#)

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