

FSC-BW151

WI-FI6/BT5.0 SOC Module Datasheet

Version 1.5



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Revision History

Version	Date	Notes	
1.0	2021/05/25	Initial Version	Fish
1.1	2021/05/27	Update application circuit diagram	Fish
1.2	2021/07/27	Revision: Extended voltage range 2.3v-3.6v	Devin Wan
1.3	2021/08/04	Update: Figure 2 Block Diagram	Devin Wan
1.4	2022/03/18	Update CPU Features, Storage temperature: -40°C ~+85°C	Devin Wan
1.5	2023/02/14	Add circuit diagram	Devin Wan

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1. INTRODUCTION

Overview

FSC-BW151 module adopts a high-performance SoC, it's an industry's leading dual-band Wi-Fi 6 / BT5.0 dual-mode single chip. While supporting all the indicators of WIFI6, the power consumption is the lowest in the industry. FSC-BW151 integrates Cortex-M4F CPU at the same time, the main frequency can reach 480MHz. With the help of the internal integrated 992KB SRAM, 752KB ROM and up to 128Mbit on-chip SPI flash memory, it provides users with powerful hardware support and can be used for secondary development. FSC-BW151 has a wealth of peripheral interfaces that can be used for control and data transmission through SPI / SDIO / I2C / UART/USB, and can be quickly applied to any microcontroller-based design.

FSC-BW151 module supports the standard IEEE802.11 b/g/n/a/ac/ax protocol and the complete TCP/IP protocol stack. Users can use this module to add networking functions to existing equipment, or build an independent network controller.

FSC-BW151 module provides maximum practicability at the lowest cost, providing unlimited possibilities for Wi-Fi function embedding in other systems.

WiFi Features

- CMOS single-chip fully-integrated RF, Modem and MAC
- Wi-Fi 6 support 2.4GHz/5GHz Frequency band
- The highest data rate is 286.8Mbps@TX and 229.4Mbps@RX, and the bandwidth is 20/40MHz
- RX sensitivity under 11b 1M mode -98dBm
- Tx power up to 20dBm in 11b mode, up to 18dBm in HT/VHT/HE40 MCS7 mode
- Support STA, AP, Wi-Fi Direct mode at the same time
- Support STBC, beamforming
- Support Wi-Fi 6 TWT
- Support two NAVs, buffer report, spatial reuse, Multi-BSSID, intra-PPDU power save

- Support LDPC
- Support MU-MIMO, OFDMA
- Support DCM, Mid-amble, UORA
- Support WEP / WPA / WPA2 / WPA3-SAE Personal, MFP Frequency band

BT 5.0 Features

- Supports all the mandatory and optional features of Bluetooth 2.1+EDR/3.0/4.x/5
- Supports advanced master and slave topologies

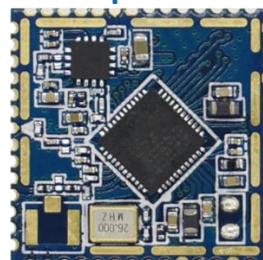
CPU Features

- Integrated Cortex-M4F CPU with MPU and FPU
- CPU speed up to 480Mhz
- On-chip memory includes 992KB SRAM and 752KB ROM
- Supports SDIO/SPI/USB2.0
- Integrated hardware crypto accelerator AES/RSA/HASH/ECC
- Integrated True Random Number Generator (TRNG)
- Support external OPI SDR/DDR PSRAM
- Integrated 128Mbits SPI flash
- Integrated UART/I2S/I2C/PWM/SPI/SDMMC
- Integrated watchdog

Application

- IoT device
- Wireless device

Module picture as below showing



2. General Specification

Table 1: General Specifications

Categories	Features	Implementation
Bluetooth		
Bluetooth Standard		Bluetooth V5.0 LE & BR/EDR
Frequency Band		2402MHz~2480MHz
Interface		UART / USB
WIFI		
WiFi Standard		802.11 a/b/g/n/ac/ax
Frequency Band		2412MHz~2462MHz /5100MHz~5900MHz
Interface		SDIO / USB
General		
Size		17mm × 17 mm × 2.0mm
Operating temperature		-20°C ~+80°C
Storage temperature		-40°C ~+85°C
VDD_3V3		2.3V ~ 3.6V
VDD_IO		1.8V ~ 3.6V
Miscellaneous	Lead Free	Lead-free and RoHS compliant
	Warranty	One Year
Humidity		10% ~ 90% non-condensing
MSL grade:		MSL 3
ESD grade:		Human Body Model: Pass ±2000 V, all pins
		Charge device model: Pass ±400 V, all pins

3. HARDWARE SPECIFICATION

3.1 PIN Definition Descriptions

Table 2: Pin definition *(This content is only applies to modules with PCB version V1.0)*

Pin	Pin Name	Type	Pin Descriptions	Notes
1	WiFi_2.4G	O	WiFi 2.4G radio frequency	
2	GND		Ground	
3	GND		Ground	
4	BT_RF	O	WiFi 2.4G radio frequency	
5	GND		Ground	
6	UART_RX	I	High-Speed UART Data In	
7	UART_TX	O	High-Speed UART Data Out	
8	GND		Ground	
9	UART_CTS	I	High-Speed UART CTS	
10	UART_RTS	O	High-Speed UART RTS	
11	GPIOB13	I/O	General Purpose Input/ Output Pin	
12	NC			
13	PWRKEY	I	Module power-on pin, power-on = 1; power-off = 0; There is a 100K resistor inside the module, which is pulled up to VDD_3V3	
14	GPIOB4	I/O	General Purpose Input/ Output Pin Hang in the air when not in use, no need to connect	
15	DEBUG_TX	I/O	Debug serial port TX Hang in the air when not in use, no need to connect	
16	GPIOB5	I/O	General Purpose Input/ Output Pin Hang in the air when not in use, no need to connect	
17	DEBUG_RX	I/O	Debug serial port RX Hang in the air when not in use, no need to connect	
18	GND		Ground	
19	USB_DM	I/O	USB data D- Hang in the air when not in use, no need to connect	
20	USB_DP	I/O	USB data D+ Hang in the air when not in use, no need to connect	
21	GND		Ground	
22	VDD_3V3	PWR	3.3V Supply Voltage	
23	VDD_3V3	PWR	3.3V Supply Voltage	
24	VDD_3V3	PWR	3.3V Supply Voltage	
25	NC			
26	NC			
27	NC			
28	NC			
29	GPIOB2	I/O	General Purpose Input/ Output Pin Hang in the air when not in use, no need to connect	

30	GPIOB6	I/O	General Purpose Input/ Output Pin Hang in the air when not in use, no need to connect
31	NC		
32	GPIOB7	I/O	General Purpose Input/ Output Pin Hang in the air when not in use, no need to connect
33	GND		Ground
34	VDD_IO	PWR	1.8V~3.3V Supply Voltage
35	VDD_IO	PWR	1.8V~3.3V Supply Voltage
36	GND		Ground
37	SDIO_D0	I/O	SDIO Data Line 0
38	SDIO_D1	I/O	SDIO Data Line 1
39	SDIO_D2	I/O	SDIO Data Line 2
40	SDIO_D3	I/O	SDIO Data Line 3
41	SDIO_CLK	I	SDIO Clock Input
42	SDIO_CMD	I/O	SDIO Command Input
43	GPIOB3	I/O	General Purpose Input/ Output Pin Hang in the air when not in use, no need to connect
44	GND		Ground
45	WiFi_5G	O	WiFi 5G radio frequency
46	GND		Ground
47	GND		Ground
48	GND		Ground
49	GND		Ground
50	GND		Ground
51	GND		Ground
52	GND		Ground
53	GND		Ground
54	GND		Ground
55	GND		Ground
56	GND		Ground

4. ELECTRICAL CHARACTERISTICS

4.1 Recommended Operating Conditions

Table 3: Recommended Operating Conditions

Parameter	Min	Type	Max	Unit
VDD_3V3	2.3	3.3	3.6	V
VDD_IO	1.8		3.3	°C
Operating temperature (T _A)	-20	25	+80	°C
Storage temperature (T _{stg})	-40	25	+85	°C
High-level input voltage	0.7 X VDD_IO		VDD_IO	V
Low-level input voltage	0		0.3 X VDD_IO	V

4.2 Power Consumption

Table 4: Power Consumption:

Internal Pull Resistor	Voltage	Power Consumption(mA)(Max)
VDD_3V3	3.3V	300
VDD_IO	3.3V	100

Testing Condition: 2.4GHz Tx MCS0 6.5Mbps

FSC-BW151 Module Power Consumption:

300mA @ VDD_3V3 (Maximum) and 100mA @ VDD_IO(Maximum)

Suggest customer design power capacity are 500mA@VDD_3V3 and 200mA @ VDD_IO for FSC-BW151 Module.

5. MSL & ESD

Table 5: MSL and ESD

Parameter	Value
MSL grade:	MSL 3
ESD grade	Electrostatic discharge
ESD – Human-body model (HBM) rating, JESD22-A114-F (Total samples from one wafer lot)	Pass ±2000 V, all pins
ESD – Charge-device model (CDM) rating, JESD22-C101-D (Total samples from one wafer lot)	Pass ±400 V, all pins

6. RECOMMENDED TEMPERATURE REFLOW PROFILE

Prior to any reflow, it is important to ensure the modules were packaged to prevent moisture absorption. New packages contain desiccant (to absorb moisture) and a humidity indicator card to display the level maintained during storage and shipment. If directed to bake units on the card, please check the below and follow instructions specified by IPC/JEDEC J-STD-033.

Note: The shipping tray cannot be heated above 65°C. If baking is required at the higher temperatures displayed in the below, the modules must be removed from the shipping tray.

Any modules not manufactured before exceeding their floor life should be re-packaged with fresh desiccant and a new humidity indicator card. Floor life for MSL (Moisture Sensitivity Level) 3 devices is 168 hours in ambient environment 30°C/60%RH.

Notice :

Feascom module must use Step-Stencil, suggestion using the stencil thickness about 0.16-0.2mm, it could be modify with the product.

Table 6: Recommended baking times and temperatures

MSL	125°C Baking Temp.		90°C/≤ 5%RH Baking Temp.		40°C/ ≤ 5%RH Baking Temp.	
	Saturated @	Floor Life Limit	Saturated @	Floor Life Limit	Saturated @	Floor Life Limit
	30°C/85%	+ 72 hours @ 30°C/60%	30°C/85%	+ 72 hours @ 30°C/60%	30°C/85%	+ 72 hours @ 30°C/60%
3	9 hours	7 hours	33 hours	23 hours	13 days	9 days

Feasycom surface mount modules are designed to be easily manufactured, including reflow soldering to a PCB. Ultimately it is the responsibility of the customer to choose the appropriate solder paste and to ensure oven temperatures during reflow meet the requirements of the solder paste. Feasycom surface mount modules conform to J-STD-020D1 standards for reflow temperatures.

The soldering profile depends on various parameters necessitating a set up for each application. The data here is given only for guidance on solder reflow.

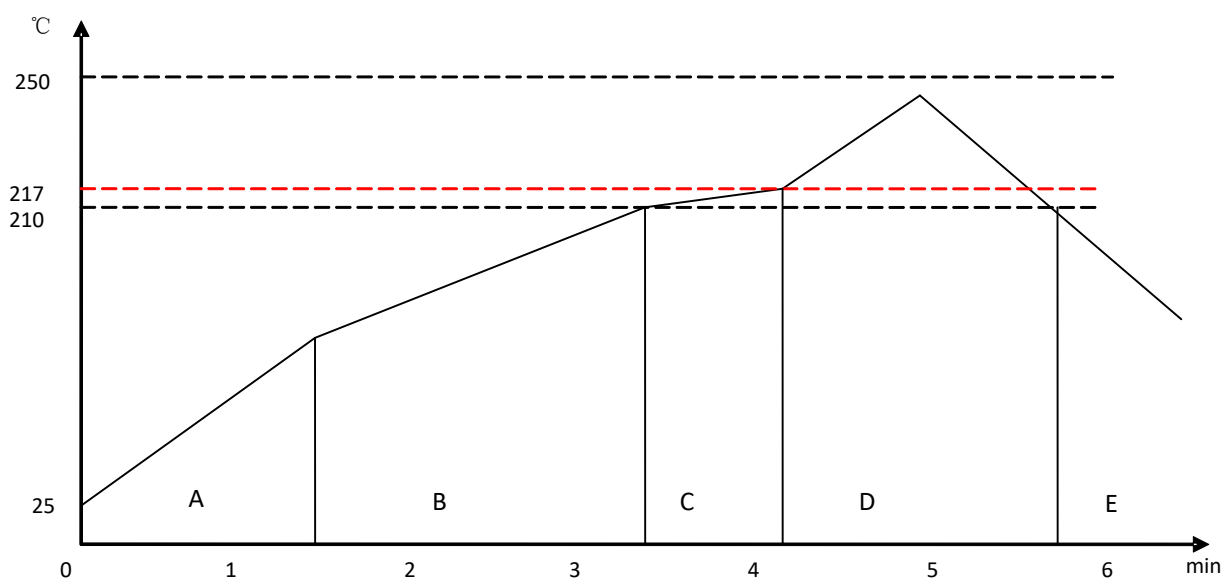


Figure 4: Typical Lead-free Re-flow

Pre-heat zone (A) — This zone raises the temperature at a controlled rate, **typically 0.5 – 2 °C/s**. The purpose of this zone is to preheat the PCB board and components to 120 ~ 150 °C. This stage is required to distribute the heat uniformly to the PCB board and completely remove solvent to reduce the heat shock to components.

Equilibrium Zone 1 (B) — In this stage the flux becomes soft and uniformly encapsulates solder particles and spread over PCB board, preventing them from being re-oxidized. Also with elevation of temperature and liquefaction of flux, each activator and rosin get activated and start eliminating oxide film formed on the surface of each solder particle and PCB board. **The temperature is recommended to be 150° to 210° for 60 to 120 second for this zone.**

Equilibrium Zone 2 (C) (optional) — In order to resolve the upright component issue, it is recommended to keep the temperature in 210 – 217 ° for about 20 to 30 second.

Reflow Zone (D) — The profile in the figure is designed for Sn/Ag3.0/Cu0.5. It can be a reference for other lead-free solder. 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. The recommended peak temperature (Tp) is 230 ~ 250 °C. The soldering time should be 30 to 90 second when the temperature is above 217 °C.

Cooling Zone (E) — The cooling rate should be fast, to keep the solder grains small which will give a longer-lasting joint. **Typical cooling rate should be 4 °C.**

7. MECHANICAL DETAILS

7.1 Mechanical Details

- Dimension: 17mm(W) x 17mm(L) x 2.0mm(H) Tolerance: $\pm 0.1\text{mm}$
- Module size: 17mm x 17mm Tolerance: $\pm 0.2\text{mm}$
- Pad size: 1.5mm x 0.75mm Tolerance: $\pm 0.1\text{mm}$
- Pad pitch: 1.1mm Tolerance: $\pm 0.1\text{mm}$

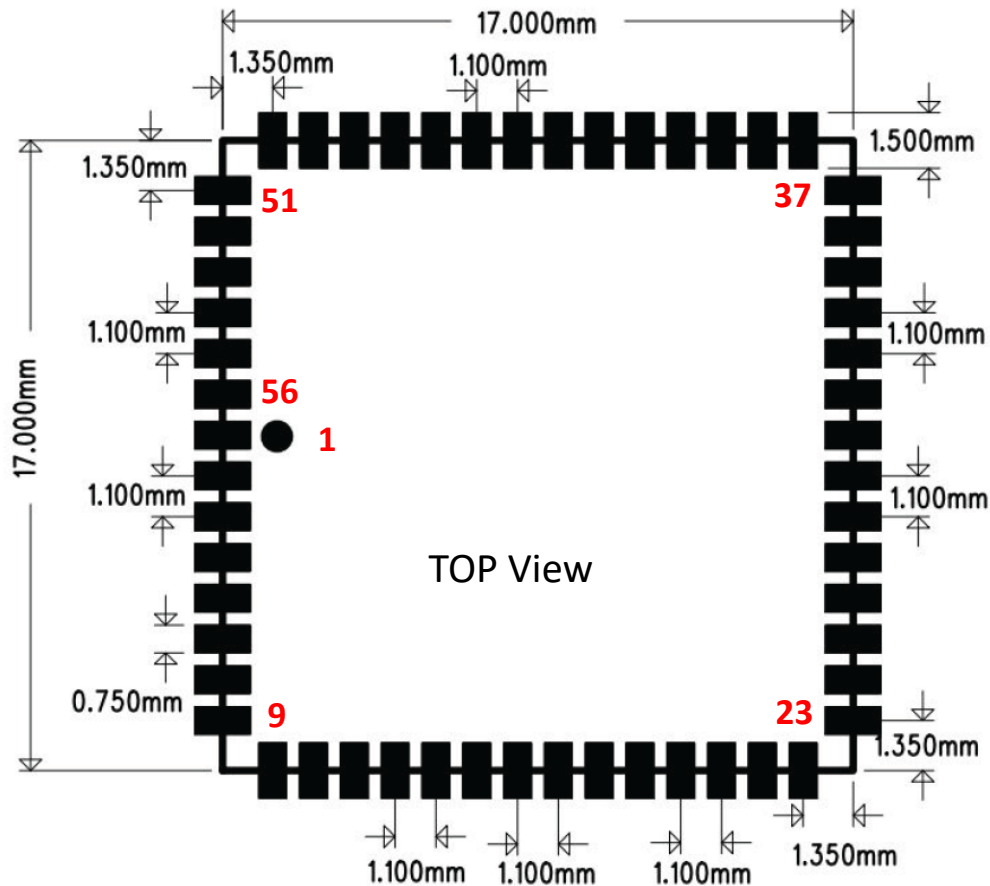


Figure 5: FSC-BW151 footprint Layout Guide (Top View)

8. HARDWARE INTEGRATION SUGGESTIONS

8.1 Soldering Recommendations

FSC-BW151 is compatible with industrial standard reflow profile for Pb-free solders. The reflow profile used is dependent on the thermal mass of the entire populated PCB, heat transfer efficiency of the oven and particular type of solder paste used. Consult the datasheet of particular solder paste for profile configurations.

Feasycom will give following recommendations for soldering the module to ensure reliable solder joint and operation of the module after soldering. Since the profile used is process and layout dependent, the optimum profile should be studied case by case. Thus following recommendation should be taken as a starting point guide.

8.2 Layout Guidelines(Internal Antenna)

Important Note: The antenna for FSC-BW151 is suggested to support both 2.4GHz and 5.8GHz dual frequency bands. We recommend using external FPC dual-band antennas instead of PCB onboard antennas. The following are general instructions for PCB onboard antennas for reference only.

It is strongly recommended to use good layout practices to ensure proper operation of the module. Placing copper or any metal near antenna deteriorates its operation by having effect on the matching properties. Metal shield around the antenna will prevent the radiation and thus metal case should not be used with the module. Use grounding vias separated max 3 mm apart at the edge of grounding areas to prevent RF penetrating inside the PCB and causing an unintentional resonator. Use GND vias all around the PCB edges.

The mother board should have no bare conductors or vias in this restricted area, because it is not covered by stop mask print. Also no copper (planes, traces or vias) are allowed in this area, because of mismatching the on-board antenna.

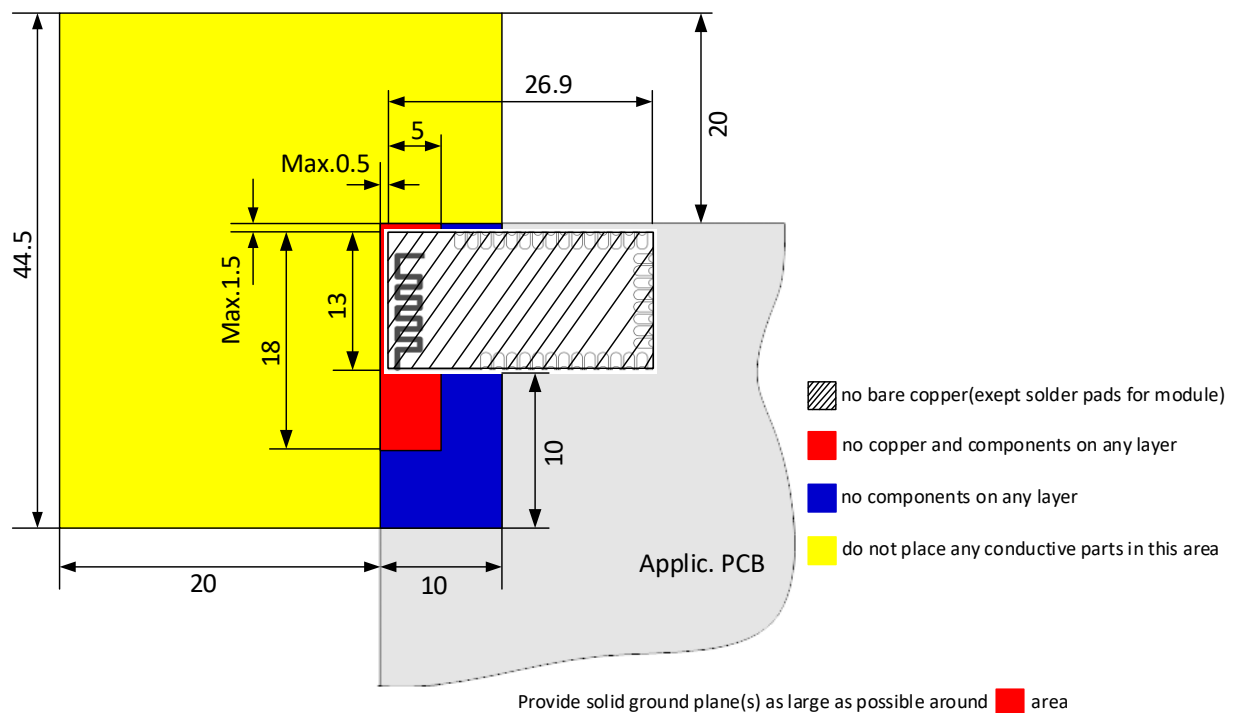


Figure 6: Restricted Area (Design schematic, for reference only. Unit: mm)

Following recommendations helps to avoid EMC problems arising in the design. Note that each design is unique and the following list do not consider all basic design rules such as avoiding capacitive coupling between signal lines. Following list is aimed to avoid EMC problems caused by RF part of the module. Use good consideration to avoid problems arising from digital signals in the design.

Ensure that signal lines have return paths as short as possible. For example if a signal goes to an inner layer through a via, always use ground vias around it. Locate them tightly and symmetrically around the signal vias. Routing of any sensitive signals should be done in the inner layers of the PCB. Sensitive traces should have a ground area above and under the line. If this is not possible, make sure that the return path is short by other means (for example using a ground line next to the signal line).

8.3 Layout Guidelines(External Antenna)

Placement and PCB layout are critical to optimize the performances of a module without on-board antenna designs. The trace from the antenna port of the module to an external antenna should be 50Ω and must be as short as possible to avoid any interference into the transceiver of the module. The location of the external antenna and RF-IN port of the module should be kept away from any noise sources and digital traces. A matching network might be needed in between the external antenna and RF-IN port to better match the impedance to minimize the return loss.

As indicated in below, RF critical circuits of the module should be clearly separated from any digital circuits on the system board. All RF circuits in the module are close to the antenna port. The module, then, should be placed in this way that module digital part towards your digital section of the system PCB.

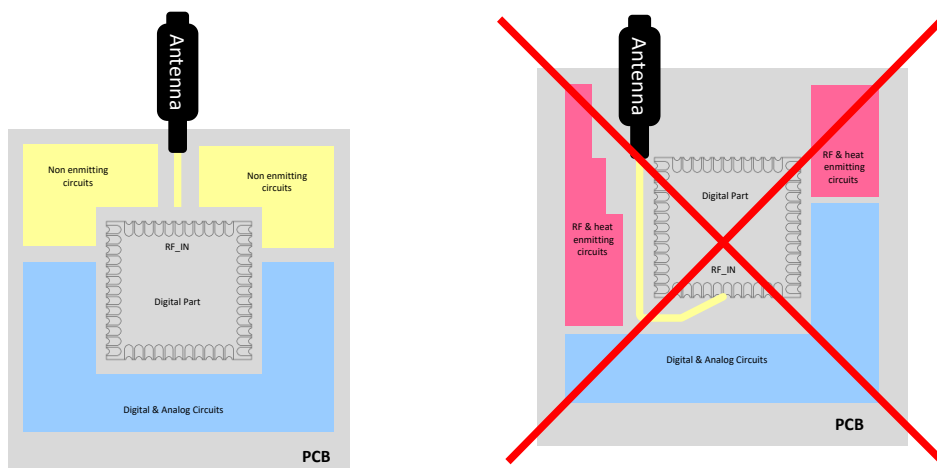


Figure 7: Placement the Module on a System Board

8.3.1 Antenna Connection and Grounding Plane Design

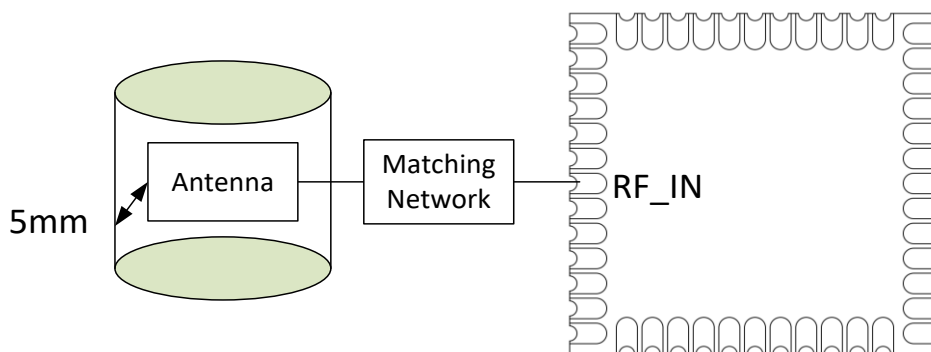


Figure 8: Leave 5mm Clearance Space from the Antenna

General design recommendations are:

- The length of the trace or connection line should be kept as short as possible.
- Distance between connection and ground area on the top layer should at least be as large as the dielectric thickness.
- Routing the RF close to digital sections of the system board should be avoided.

- To reduce signal reflections, sharp angles in the routing of the micro strip line should be avoided. Chamfers or fillets are preferred for rectangular routing; 45-degree routing is preferred over Manhattan style 90-degree routing.

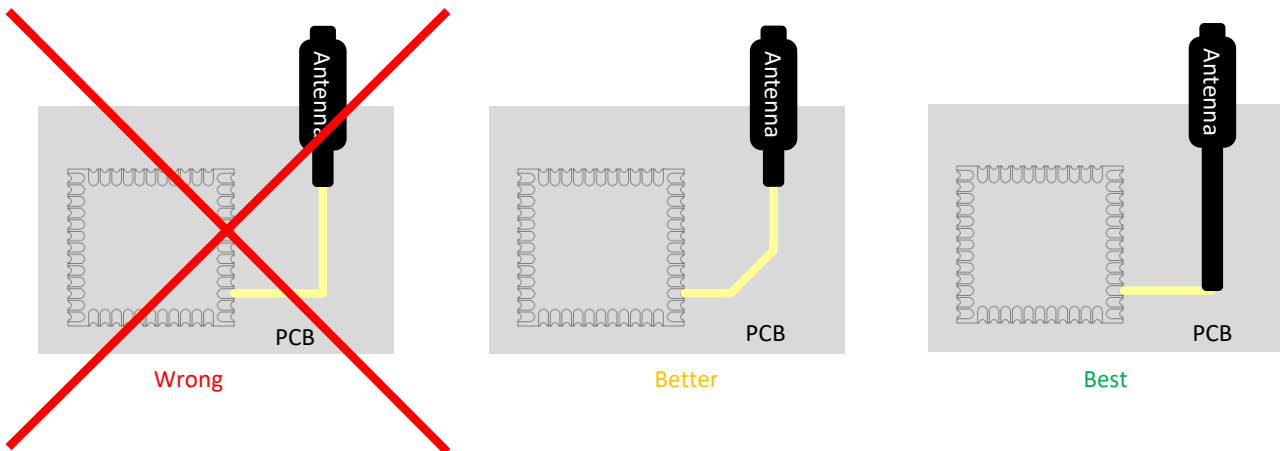


Figure 9: Recommended Trace Connects Antenna and the Module

- Routing of the RF-connection underneath the module should be avoided. The distance of the micro strip line to the ground plane on the bottom side of the receiver is very small and has huge tolerances. Therefore, the impedance of this part of the trace cannot be controlled.
- Use as many vias as possible to connect the ground planes.

8.4 SDIO Lines Layout Guideline

The following SDIO line routing must obey the following rule to prevent overshoot/undershoot, as these lines drive 8mA.

SDIO_CMD_WL

SDIO_CLK_WL

SDIO_D0_WL ~ SDIO_D3_WL

The route length of these signals be less than 15 cm and the line impedance be less than 50Ω

8.5 HCI Lines Layout Guideline

The following HCI line routing must obey the following rule to prevent overshoot/undershoot, as these lines drive 4 ~ 8mA

HCI_RX_BT

HCI_TX_BT

HCI_CTS_BT

HCI_RTS_BT

The route length of these signals be less than 15 cm and the line impedance be less than 50Ω

8.6 Power Trace Lines Layout Guideline

VDD_3V3 Trace Width: 40mil

VDD_IO Trace Width: 20mil

8.7 Ground Lines Layout Guideline

A Complete Ground in Ground Layer.

Add Ground Through Holes to FSC-BW151 Module Ground Pads

Decoupling Capacitors close to FSC-BW151 Module Power and Ground Pads

9. PRODUCT PACKAGING INFORMATION

9.1 Default Packing

a, Tray vacuum

b, Tray Dimension: 140mm * 265mm



Figure 10: Tray vacuum

FCC Warning

Integration instructions for host product manufacturers according to KDB 996369 D03 OEM Manual v01

2.2 List of applicable FCC rules

FCC Part 15.247

2.3 Specific operational use conditions

This transmitter/module and its antenna(s) must not be co-located or operating in conjunction with any transmitter. This information also extends to the host manufacturer's instruction manual.

2.4 Limited module procedures

Not applicable

2.5 Trace antenna designs

It is "not applicable" as trace antenna which is not used on the module.

2.6 RF exposure considerations

This equipment complies with FCC RF radiation exposure limits set forth for an uncontrolled environment. This compliance to FCC radiation exposure limits for an uncontrolled environment, and minimum of 20cm separation between antenna and body.

The host product manufacturer would provide the above information to end users in their end-product manuals.

2.7 Antennas

FPC Antenna; 3.77dBi &.036dBi; 2.400GHz~2500MHz, 5100~5900MHz

2.8 Label and compliance information

The end product must carry a physical label or shall use e-labeling followed KDB784748D01 and KDB 784748 stating "Contains Transmitter Module FCC ID: 2BAWX-FSC-BW151.

2.9 Information on test modes and additional testing requirements

For more information on testing, please contact the manufacturer.

2.10 Additional testing, Part 15 Subpart B disclaimer

The modular transmitter is FCC authorized for the specific rule parts (FCC Part 15.247) listed on the grant, and that the host product manufacturer is responsible for compliance to any other FCC rules that apply to the host not covered by the modular transmitter grant of certification. The final host product still requires Part 15 Subpart B compliance testing with the modular transmitter installed when contains digital circuitry.

FCC Statements

(OEM) Integrator has to assure compliance of the entire end-product incl. the integrated RF Module. For 15 B (§15.107 and if applicable §15.109) compliance, the host manufacturer is required to show compliance with 15 while the module is installed and operating.

Furthermore the module should be transmitting and the evaluation should confirm that the module's intentional emissions (15C) are compliant (fundamental / out-of-band). Finally the integrator has to apply the appropriate equipment authorization (e.g. Verification) for the new host device per definition in §15.101.

Integrator is reminded to assure that these installation instructions will not be made available to the end-user of the final host device.

The final host device, into which this RF Module is integrated has to be labeled with an auxiliary label stating the FCC ID of the RF Module, such as "Contains FCC ID: 2BAWX-FSC-BW151.

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.

Changes or modifications to this unit not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

The Integrator will be responsible to satisfy SAR/ RF Exposure requirements, when the module integrated into the host device.

Module statement

The single-modular transmitter is a self-contained, physically delineated, component for which compliance can be demonstrated independent of the host operating conditions, and which complies with all eight requirements of § 15.212(a)(1) as summarized below.

- 1) The radio elements have the radio frequency circuitry shielded.
- 2) The module has buffered modulation/data inputs to ensure that the device will comply with Part 15 requirements with any type of input signal.
- 3) The module contains power supply regulation on the module.
- 4) The module contains a permanently attached antenna.
- 5) The module demonstrates compliance in a stand-alone configuration.
- 6) The module is labeled with its permanently affixed FCC ID label.
- 7) The module complies with all specific rules applicable to the transmitter, including all the conditions provided in the integration instructions by the grantee.
- 8) The module complies with RF exposure requirements.

NOTE: 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 or more 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

For USA: The frequency stability of all transmission frequencies of U-NII-1, U-NII 2A, U-NII 2C and U-NII-3 meets the requirements of 47 CFR FCC Part15.407(g), and the manufacturer declares that their transmission is maintained at Band U-NII-1, U-NII 2A, U-NII 2C and U-NII-3.