



BP.BBR.V1.XXX Radio Module
Product Manual

Bit Part LLC Confidential



Change History

Date	Ver	Changes	Author
2024-07-31	V1.0	Initial Release	DM
2024-12-20	V1.1	Installation Instructions & Regulatory	DM

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Overview

The BP.BBR.V1.XXX module series are sub-GHz secure ethernet native radio modules. The modules use channel conflict assessment (CCA) and carrier sense multiple access/collision detection (CSMA CD) mechanisms to avoid channel interference. The modules use automatic frequency selection, automatic power control, and other means to optimize network transmission performance. Integration requires connecting the module to SPI flash for firmware and settings storage and retrieval.

Module Parameters

Interfaces: RMII, UART, GPIO, SPI
Radio bandwidth: 1/2/4/8MHz
Radio data rate: Up to 33 Mbps
Radio modulation: BPSK, QPSK, 16-QAM, 64-QAM
Radio coding: 1/2 x 2, 1/2, 2/3, 3/4, 5/6
Radio modes: Base, Remote, Repeater
Radio encryption: AES

Radio Module
BP.BBR.V1.XXX

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Model Numbers

BP.BBR.V1.XXX



Series base model number



Frequency range

Model Number	Frequency Range	RX SAW Filter
BP.BBR.V1.915	902-928MHz	915MHz
BP.BBR.V1.868	859-894MHz	877MHz
BP.BBR.V1.900	860-928MHz	N/A

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Specifications

Power Input Specifications

Pin	Function	Minimum Voltage (V)	Recommended Voltage (V)	Maximum Voltage (V)
VCC0	Module Power	3.0	3.3	3.6
VCC1	RF SW Power	3.0	3.3	3.6
VCC2	RF PA Power	3.0	3.3	3.6
SVCC	IO Power	3.0	3.3	3.6

RF Specifications

Frequency Range			
Model	Minimum	Maximum	
BP.BBR.V1.915	902MHz	928MHz	
BP.BBR.V1.868	859MHz	894MHz	
BP.BBR.V1.900	860MHz	928MHz	
Reception			
Bandwidth	Modulation & Coding	Minimum	Units
8MHz Channel	BPSK 1/2 (Error Rate < 10%)	-95	dBm
	QPSK 3/4 (Error Rate < 10%)	-92	dBm
	64-QAM 5/6 (Error Rate < 10%)	-80	dBm
4MHz Channel	BPSK 1/2 (Error Rate < 10%)	-99	dBm



4MHz Channel	QPSK 3/4 (Error Rate < 10%)	-96	dBm	
	64-QAM 5/6 (Error Rate < 10%)	-82	dBm	
2MHz Channel	BPSK 1/2 (Error Rate < 10%)	-101	dBm	
	QPSK 3/4 (Error Rate < 10%)	-99	dBm	
1MHz Channel	64-QAM 5/6 (Error Rate < 10%)	-87	dBm	
	BPSK 1/2 x 2 (Error Rate < 10%)	-107	dBm	
	BPSK 1/2 (Error Rate < 10%)	-104	dBm	
	QPSK 3/4 (Error Rate < 10%)	-102	dBm	
	64-QAM 5/6 (Error Rate < 10%)	-90	dBm	
Transmission				
Parameter	Minimum	Typical	Maximum	Units
TX Power	18	20	22	dBm
Frequency Drift	-5	0	5	ppm
Spectral Mask (8MHz) @ ±8MHz Offsets			-28	dBc
Spectral Mask (4MHz) @ ±4MHz Offsets			-28	dBc
Spectral Mask (2MHz) @ ±2MHz Offsets			-28	dBc
Spectral Mask (1MHz) @ ±1MHz Offsets			-28	dBc
Modulation Accuracy			-27	dB

Environmental Specifications

Parameter	Specification
Temperature	-20°C ~ 70°C
Humidity	0 ~ 85% (non-condensing)

Module Dimensions

Parameter	Size	Units
Length	17.00±0.10	mm
Width	15.00±0.10	mm
Height	2.40±0.10	mm

Module Pinout

1	GND	13	LED2	25	RMII_RXD1
2	ANT	14	MCLR	26	RMII_TXD0
3	GND	15	RMII_MDIO	27	RMII_TXD1
4	VCC2	16	RMII_MDC	28	RMII_CRSVD
5	VCC2	17	SW_PAIR	29	RMII_TXEN
6	VCC1	18	LEDO	30	RF_PA1
7	VCC0	19	SW_MODE	31	RF_PA2
8	SPI_SO	20	LED1	32	UART_RX
9	SPI_CS	21	SVCC	33	UART_TX
10	SPI_SI	22	RMII_REFCLK	34	N/A
11	SPI_SCK	23	RMII_RXERR	35	N/A
12	LED3	24	RMII_RXD0	36	GND



Designing into End Applications

General Considerations

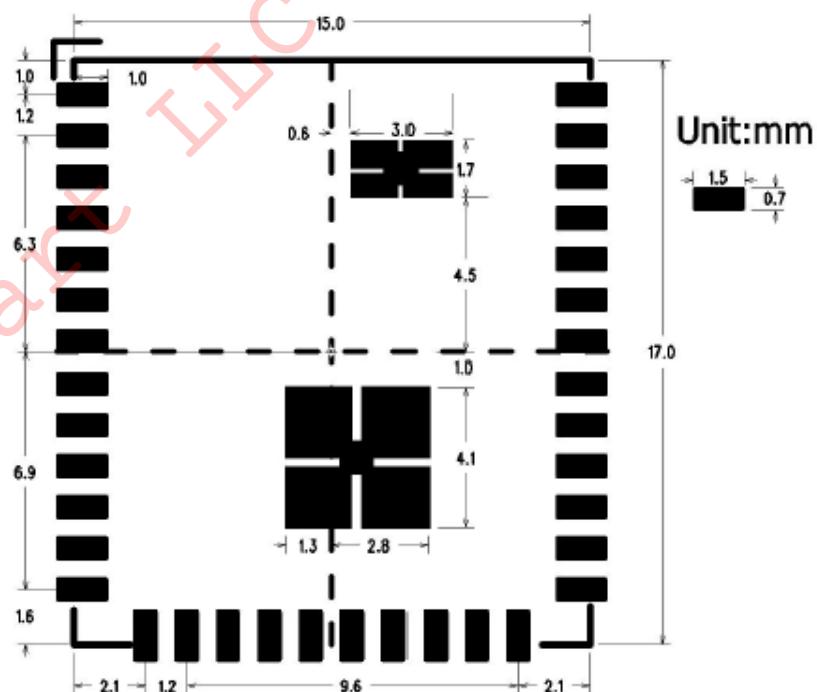
The BP.BBR.V1.XXX module series was designed to be implemented onto impedance controlled multi-layer PCBs. A good ground connection is essential. Routing under the module is allowed.

PCB Considerations

It is recommended to use a four-layer board design, specifically:

- 1) Top layer: mainly used for signal traces and component placement.
- 2) Ground layer: no signal traces, ensuring a complete ground plane.
- 3) Power layer: signal traces can be moderately routed while ensuring a complete ground plane beneath RF signals.
- 4) Bottom layer: component placement is not recommended, power traces should be routed on this layer.

Recommended PCB Layout



Top View – Copper Pad and Paste Dimensions



Module Placement Considerations

When placing the module on the base board, RF traces should be kept far from on-board DCDC power converters, crystals, clock signal lines (e.g. RMII_50M_CLK, etc.), and high-speed digital signal lines (e.g. HDMI, DDR, MIPI, etc.).

Power Supply Considerations

In a four-layer board design route power traces on the bottom layer. Main power traces should be at least 25mil wide, with at least 2 vias at layer transitions. To ensure proper RF performance the peak-to-peak power ripple must be <30mV.

Module power traces require a minimum of one $10\mu\text{F}$ capacitor, used in combination with a $0.1\mu\text{F}$ capacitor. Power traces can then branch out in a star topology to reduce coupling between different power pins. All decoupling capacitors should be placed close to their corresponding power pins. Ground pins of decoupling capacitors should be connected to nearby ground vias to ensure short return paths. For ground pads under the module, at least 9 ground vias connecting to the ground plane are required. The EPAD thermal pad under the chip on the back of the module should be laid out in a grid pattern as illustrated in *Recommended PCB Layout*, with solder mask in the gaps. Ground vias should be placed in the gaps to improve module EPAD soldering when attached to the base board.

RF Considerations

RF traces must have 50Ω single-ended impedance control, with the second layer as reference plane. A pi-type matching network should be used on RF traces, placed as close as possible to the antenna end.

RF trace length should be minimized, with dense ground via shielding around them, spaced 1-2mm apart. RF trace width must remain consistent, with no branch traces. RF traces should be exclusively on the top layer, avoid layer crossing, vias, and preferably use 135° angles or arc traces. RF traces must have complete ground planes in adjacent layers, with minimal traces under RF routes. No high-frequency signal lines should be near RF traces. Antennas must be far from all



high-frequency signal components like crystals, DDR, and other high-frequency clocks. Additionally, USB ports, USB-to-serial chips, Ethernet, UART signal lines (including traces, vias, test points, pin headers, etc.) must be kept as far as possible from the antenna.

Programming

Module firmware provided by Bit Part LLC is initially loaded onto SPI NOR flash memory using standard procedures. It is recommended to provide a programming interface on the module's SPI bus traces. Subsequent firmware updates are performed over-the-air using the RMII Ethernet interface.

Reflow Profile

Parameter	Standard	Limit
Starting Temperature		25°C
Ramp Up Rate		2°C/second max
Pre-Heat Phase		150 - 200°C, 60 - 120 sec
Heat Phase		Above 217°C, 40 - 60 sec
Heating Rate		1-2°C/second max
Peak Temperature	245+0/-5°C	250°C
Ramp Down Rate		2.5°C/second max
Reflow Cycles		1 cycle

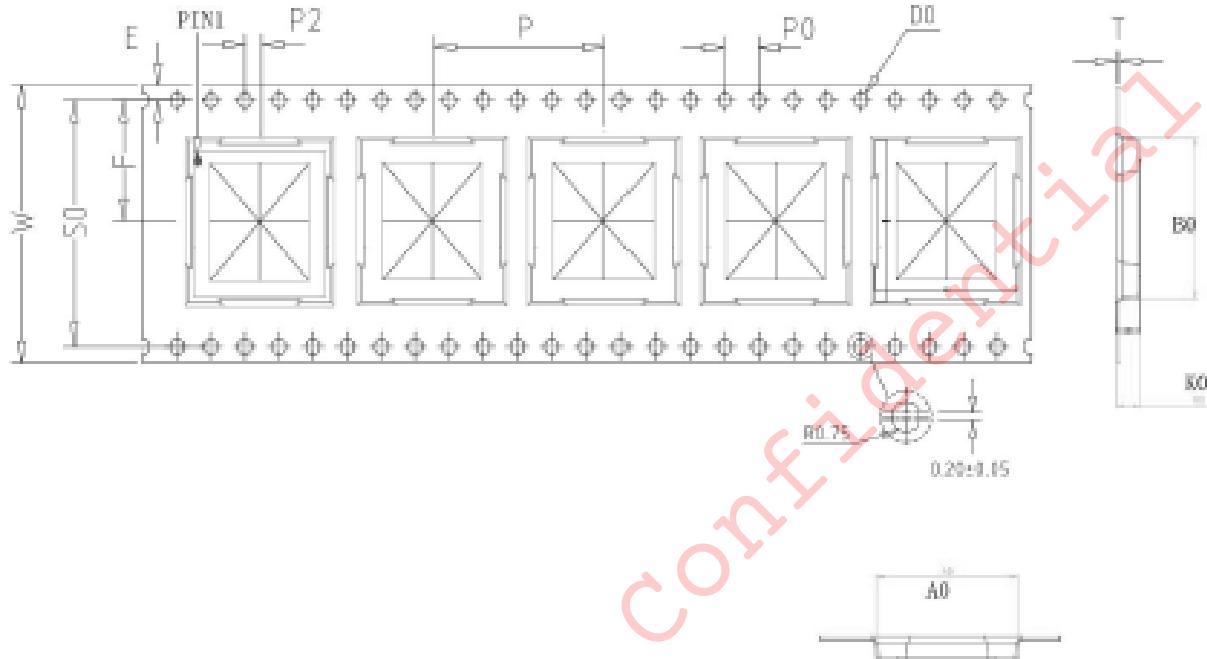
Cleaning

Use "No Clean" solder paste. Washing a BP.BBR.V1.XXX series module or a final assembly incorporating one is not recommended; water may be captured under the module and/or RF shield causing part degradation.



Packaging

BP.BBR.V1.XXX modules come on tape and reel packaging as illustrated.



Unit	W	A0	B0	K0	K1	P	F
mm	32.00 ±0.30	16.20 ±0.15	18.30 ±0.15	2.85 ±0.15	-	20.00 ±0.10	14.20 ±0.15
	E	S0	D0	D1	P0	P2	T
	1.75 ±0.10	28.40 ±0.10	1.50 +0.10	0.00 ±0.00	4.00 ±0.10	2.00 ±0.10	0.30 ±0.05

NOTES:

1. 10 sprocket hole pitch cumulative tolerance ± 0.20 mm.
2. Carrier camber not to exceed 1mm in 250mm.
3. A0 and B0 measured on a plane 0.3mm above the bottom of the packet.
4. K0 measured from a plane on the inside bottom of the packet to the top surface of the carrier.
5. All dimensions meet EIA-481-D requirements.
6. Material: PS. Black(YHD-BK-300).
7. Thickness:0.30+/-0.05mm.



Antenna Information

BP.BBR.V1.915 can be used with antennas meeting the following criteria:

Parameter	Value
Frequency Range	< 902MHz ~ > 928MHz
Impedance	50 Ohm
Standing Wave Ratio	≤ 2.0
Connector	RP-SMA

BP.BBR.V1.915 has been tested with the following antennas:

TE Connectivity ANT-916-CW-HWR-RPS	
Frequency Range	900MHz ~ 930MHz
Wavelength	1/2 Wave
Standing Wave Ratio	≤ 2.0 Typical
Peak Gain	1.2dBi
Impedance	50 Ohm
Connector	RP-SMA
TE Connectivity ANT-916-CW-QW	
Frequency Range	865MHz ~ 965MHz
Wavelength	1/4 Wave
Standing Wave Ratio	≤ 1.9 Typical
Peak Gain	1.8dBi
Impedance	50 Ohm
Connector	RP-SMA

Regulatory

FCC

FCC Part 15 Warning

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: 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.

WARNING: The grantee is not responsible for any changes or modifications not expressly approved by the party responsible for compliance. Such modifications could void the user's authority to operate the equipment.



FCC Radiation Exposure Statement

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. End users must follow the specific operating instructions for satisfying RF exposure compliance.

FCC Modular Usage Statement

This module is certified that it complies with RF exposure requirements under mobile or fixed conditions, this module is to be installed only in mobile or fixed applications.

A mobile device is defined as a transmitting device designed to be used in other than fixed locations and to generally be used in such a way that a separation distance of at least 20 centimeters is normally maintained between the transmitter's radiating structure(s) and the body of the user or nearby persons. Transmitting devices designed to be used by consumers or workers that can be easily relocated, such as wireless devices associated with a personal computer, are considered to be mobile devices if they meet the 20 centimeter separation requirement.

A fixed device is defined as a device that is physically secured at one location and is not able to be easily moved to another location.

Notes

Any modifications made to the module will void the Grant of Certification. This module is limited to integration only and must not be sold to end-users. The end-user shall not receive instructions for removing or installing the module, only software or operating procedures shall be included in the end-user operating manual of final products.

The module may be operated only with the antennas with which it is authorized.

Additional testing and certification may be necessary when multiple modules are used together.

To ensure compliance with all non-transmitter functions the host manufacturer is responsible for ensuring compliance with the module(s) installed and fully operational. For example, if a host was previously authorized as an unintentional radiator under the Declaration



of Conformity procedure without a transmitter certified module and a module is added, the host manufacturer is responsible for ensuring that after the module is installed and operational the host continues to be compliant with the Part 15B unintentional radiator requirements. Since this may depend on the details of how the module is integrated with the host, Bit Part LLC shall provide guidance to the host manufacturer for compliance with the Part 15B requirements.

FCC ID Labeling Requirements

The final system must be labeled with "Contains FCC ID: 2BGOC-BR1X900" or "Contains transmitter module FCC ID: 2BGOC-BR1X900".

ISED Canada

ISED Compliance Statement

This device contains license-exempt transmitter(s)/receiver(s) that comply with Innovation, Science and Economic Development Canada license-exempt RSS(s). Operation is subject to the following two conditions:

- 1) This device may not cause interference.
- 2) This device must accept any interference, including interference that may cause undesired operation of the device.

L'émetteur/récepteur exempt de licence contenu dans le présent appareil est conforme aux CNR d'Innovation, Sciences et Développement économique 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'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

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ISED RF exposure statement

This equipment meets the exemption from the routine evaluation limits in section 2.5 of RSS-102. It should be installed and operated with a minimum distance of 20cm between the radiator and any part of your body.

Cet équipement est conforme à l'exemption des limites d'évaluation habituelle de la section 2.5 de la norme RSS-102. Il doit être installé et utilisé à une distance minimale de 20 cm entre le radiateur et toute partie de votre corps.

ISED Modular Usage Statement

When the ISED certification number is not visible when the module is installed inside another device, then the outside of the device into which the module is installed must also display a label referring to the enclosed module. This exterior label can use the wording "Contains transmitter module IC: 32587-BBR1X900" or "Contains IC: 32587-BBR1X900".

Lorsque le numéro de certification ISED n'est pas visible lorsque le module est installé dans un autre appareil, l'extérieur de l'appareil dans lequel le module est installé doit également afficher une étiquette faisant référence au module inclus. Cette étiquette extérieure peut être libellée Contient le module émetteur IC: 32587-BBR1X900 ou Contient IC: 32587-BBR1X900.

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