General Description

BDE-BDM209B is a Bluetooth 5.1 Basic Rate (BR), Enhanced Data Rate (EDR) and Low Energy (LE) Dual-Mode module.

The module offers a unique combination of Bluetooth Classic and Bluetooth Low Energy radio (CC2564C) from Texas Instruments (TI) and an ultra-low-power Arm® Cortex®-M4 32-bit MCU (STM32L431). It integrates all required external components, including level shifters, clocks, power supply, band-pass filter, and antenna, at an affordable cost.

The module provides best-in-class RF performance with transmit power and receive sensitivity that offer twice the range and higher throughput compared to other Bluetooth Low Energy-only solutions. The power management hardware and software algorithms deliver significant power savings in all commonly used Bluetooth BR/EDR and Low Energy modes of operation.

The module is pre-certified with FCC, ISED, and CE (In-progress), and comes with certified and royalty-free Dual-mode Bluetooth 5.1 protocol stack software. It provides complete Bluetooth BR/EDR and Bluetooth Low Energy sample applications, reducing design effort and ensuring a faster time to market.

Key Features

- Processing and memories
  - Core: Arm® 32-bit Cortex®-M4 CPU with FPU, adaptive real-time accelerator (ART Accelerator™) allowing 0-wait-state execution from Flash memory
  - Frequency up to 80 MHz, MPU, 100DMIPS and DSP instructions
  - Up to 256 KB single bank Flash, proprietary code readout protection
  - 64 KB of SRAM including 16 KB with hardware parity check
- BR and EDR features
  - Up to seven active devices
  - Scatternet: up to three piconets simultaneously, one as master and two as slaves
  - Up to two Synchronous Connection Oriented (SCO) links on the same piconet
  - Support for all voice air-coding - Continuously Variable Slope Delta (CVSD), A-Law, µ-Law, and Transparent (Uncoded)
  - Assisted mode for HFP 1.6 Wideband Speech (WBS) Profile or A2DP Profile to reduce host processing and power
  - Support of multiple Bluetooth profiles with enhanced QoS
- Bluetooth Low Energy features
  - Support of up to 10 simultaneous connections
  - Multiple sniff instances tightly coupled to achieve minimum power consumption
  - Independent buffering for Low Energy allows large numbers of multiple connections without affecting BR or EDR performance
  - Built-In coexistence and prioritization handling for BR, EDR, and Low Energy
- RF performance
  - Class 1.5 TX power up to +10 dBm
  - –93 dBm typical RX sensitivity
  - Internal temperature detection and compensation to ensure minimal variation in RF performance over temperature, no external calibration required
  - Improved Adaptive Frequency Hopping (AFH) algorithm with minimum adaptation time
  - Provides longer range, including twice the range of other Low-Energy-Only solutions
- Ultra-low power consumption
  - MCU
    - 84 µA/MHz run mode
    - 280 nA Standby mode with RTC
    - 28 nA Standby mode (wakeup pins)
    - 8 nA Shutdown mode (wakeup pins)
  - Bluetooth
    - Shutdown: 1 µA
    - Deep sleep mode: 40 µA
    - Continuous TX @ Maximum power @ GFSK: 107 mA

- ✧ Continuous TX @ Maximum power @ BR/EDR: 112.5 mA

- Clocks
  - 26 MHz HFXT for Bluetooth
  - 32.768 KHz crystal oscillator for Bluetooth
  - 12 MHz HFXT for MCU
  - Internal low-power 32 kHz RC (±5%) for MCU
  - External 32.768 KHz LFXT for MCU (Not fitted by default)
- Peripherals and interfaces
  - 11x timers: 1x 16-bit advanced motor-control, 1x 32-bit and 2x 16-bit general purpose, 2x 16- bit basic, 2x low-power 16-bit timers (available in Stop mode), 2x watchdogs, SysTick timer
  - 1x 12-bit ADC 5 Msps, up to 16-bit with hardware oversampling, 200 µA/Msps
  - 2x 12-bit DAC output channels, low-power sample and hold
  - 1x SAI (serial audio interface)
  - 2x USART
  - 1x LPUART
  - 2x I2C
  - 1x SPI
  - 19x GPIOs
- Enhanced system features
  - RTC with HW calendar, alarms and calibration
  - True random number generator
- CRC calculation unit, 96-bit unique ID
- Bluetooth 5.1 Dual-mode stack
  - Dual-mode Bluetooth 5.1 certified and royalty free
  - QDID: 172097
- Classic Bluetooth Profiles available
  - A2DP1.2, AVDTP1.2, AVRCP1.3, HSP1.2, GAP, HID1.0, MAP1.0, PBAP1.0, RFCOMM, SDP, SPP
  - QDID: 185918
- Bluetooth Low Energy Profiles available
  - ANS1.0, BAS1.0, CSCS1.0, DIS1.0, FMP1.0, GAPS1.0, GATT1.0, HTS1.0, HRS1.0, HIDS1.0, IAS1.0, LLS1.0, PASS1.0, PXP1.0, TPS1.0
  - QDID: 185918
- Large variety of sample applications
  - Bluetooth Classic sample applications include: A3DP Sink/Source, HFP, HID, HSP, MAP, PBAP, SPP application demos.
  - BLE sample applications include: ANP, iBeacon, HRP, HTP, PASP, HOGP, PXP, FMP, CSCP application demos.
  - Bluetooth Classic + Bluetooth Low Energy sample applications include: SPP+SPPLE, SPP DMMulti application demos
- MFi Support
  - iAP Protocol (iAP 1/iAP 2) provided as an add-on upon request
- Operating conditions
  - Single power supply: 2.4V to 3.6V
  - Operating temperature range: –40°C to 85°C
- Antenna: Integrated PCB trace antenna
- Package
  - 12 mm x 22 mm x 2.1 mm
  - LCC-29
- Certification (In-progress)
  - Bluetooth DID: D058373
  - FCC ID: 2ABRU-BDM209B
  - IC: 25657-BDM209B
  - CE-RED

Applications

- Mobile accessories
- Sports and fitness applications
- Wireless audio solutions
- Set-Top boxes and remote controls
- Toys
- Test and measurement
- Industrial: cable replacement
- Wireless sensors
- Automotive aftermarket
- Wellness and health

Contents

References

[1]. CC2564C resources: https://www.ti.com/product/CC2564C

[2]. STM32L431 resources: https://www.st.com/en/microcontrollers-microprocessors/stm32l431cc.html

1. Block Diagram

BDE-BDM209B integrates a Bluetooth dual-mode controller, a high-performance Arm® 32-bit Cortex®-M4 MCU, and other required components into a compact form factor, enabling a ready-to-use, cost-effective Bluetooth dual-mode MCU module.

The block diagram of the module is shown in Figure 1.

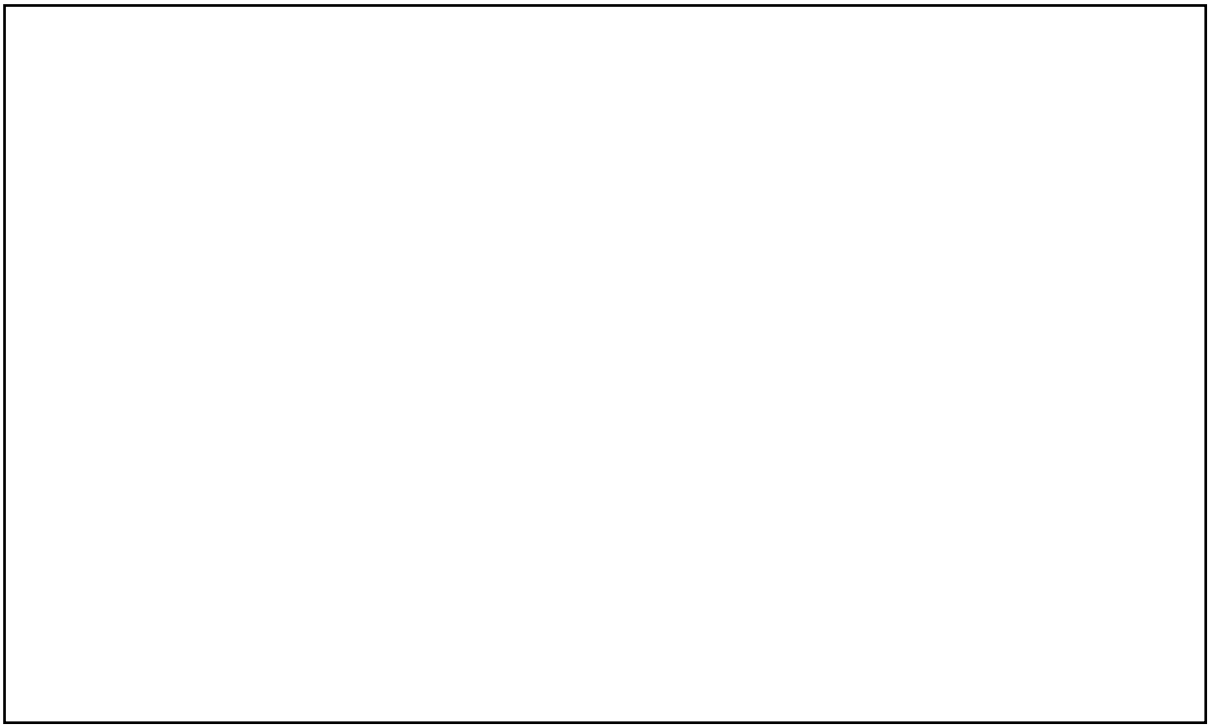

Figure 1. The block diagram of BDE-BDM209B (Confidential)

2. Pinout Functions

The module is with LCC-29 package. 29 pads are exposed for user. This section describes pinout functions of the module in details.

2.1. Pinout Diagram

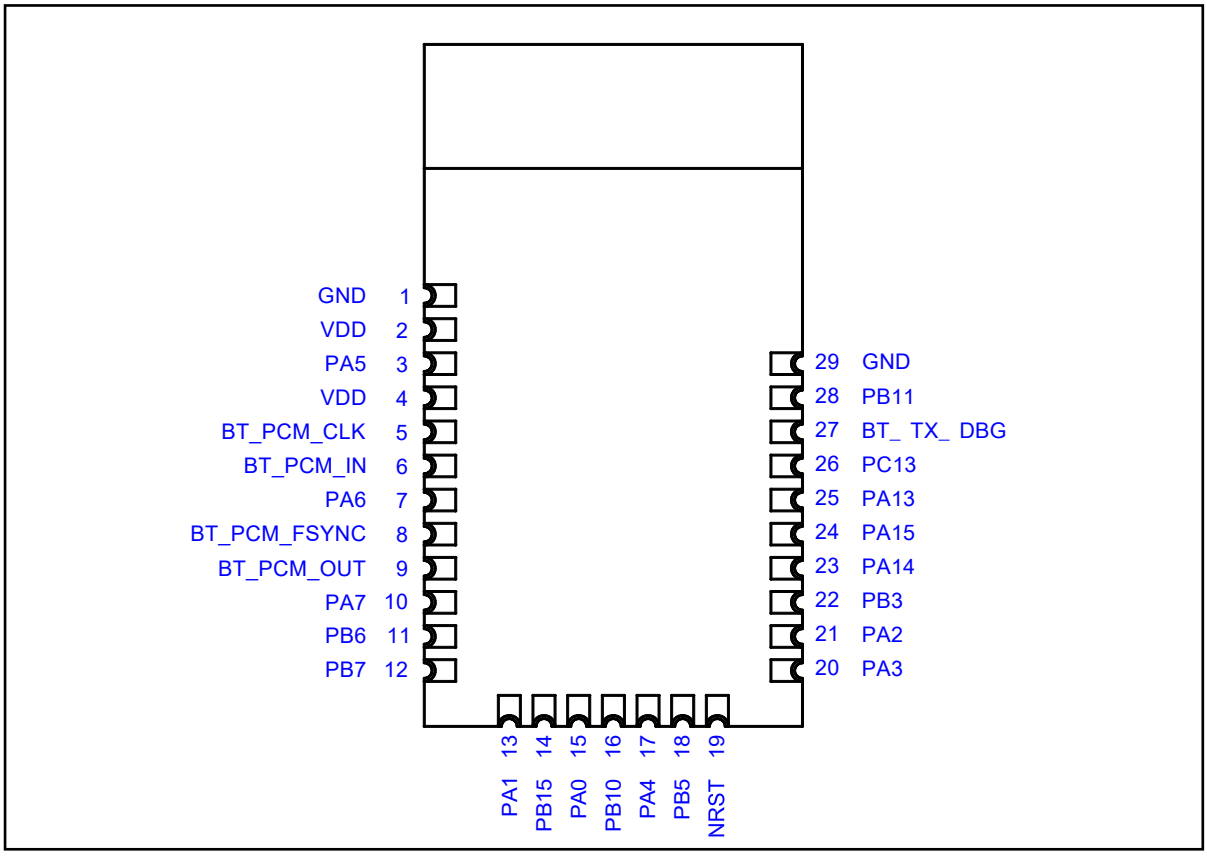

Figure 2. The pinout diagram of BDE-BDM209B (Top View)

2.2. Pinout Description

Table 1. Pinout Description (1)

Module Pin #	Pin Name	Type	Pin Functions		
			Function After Reset	Alternate Functions	Additional Functions
1	GND	GND	Ground	-	-
2	VDD	PWR	Power supply, 2.4V to 3.6V	-	-
3	PA5	I/O	GPIO	TIM2_CH1, TIM2_ETR, SPI1_SCK, LPTIM2_ETR, EVENTOUT	COMP1_INM, COMP2_INM, ADC1_IN10, DAC1_OUT2
4	VDD	PWR	Power supply, 2.4V to 3.6V	-	-
5	BT_PCM_CLK	I/O	PCM clock, from BT controller	-	-
6	BT_PCM_IN	I	PCM data input, from BT controller	-	-
7	PA6	I/O	GPIO	TIM1_BKIN, SPI1_MISO, COMP1_OUT, USART3_CTS, LPUART1_CTS, TIM1_BKIN_COMP2, TIM16_CH1, EVENTOUT	ADC1_IN11

Module Pin #	Pin Name	Type	Pin Functions		
			Function After Reset	Alternate Functions	Additional Functions
8	BT_PCM_FSYNC	I/O	PCM frame sync, from BT controller	-	-
9	BT_PCM_OUT	O	PCM data output, from BT controller	-	-
10	PA7	I/O	GPIO	TIM1_CH1N, SPI1_MOSI, COMP2_OUT, EVENTOUT	ADC1_IN12
11	PB6	I/O	GPIO	LPTIM1_ETR, I2C1_SCL, SAI1_FS_B, TIM16_CH1N, EVENTOUT	COMP2_INP
12	PB7	I/O	GPIO	LPTIM1_IN2, I2C1_SDA, EVENTOUT	COMP2_INM, PVD_IN
13	PA1	I/O	GPIO	TIM2_CH2, I2C1_SMBA, SPI1_SCK, USART2_RTS_DE, TIM15_CH1N, EVENTOUT	OPAMP1_ VINM, COMP1_INP, ADC1_IN6
14	PB15	I/O	GPIO	RTC_REFIN, TIM1_CH3N, SWPMI1_SUSPEND, SAI1_SD_A, TIM15_CH2, EVENTOUT	-
15	PA0	I/O	GPIO	TIM2_CH1, USART2_CTS, COMP1_OUT, SAI1_EXTCLK, TIM2_ETR, EVENTOUT	OPAMP1_ VINP, COMP1_INM, ADC1_IN5, RTC_TAMP2, WKUP1
16	PB10	I/O	GPIO	TIM2_CH3, I2C2_SCL, USART3_TX, LPUART1_RX, COMP1_OUT, SAI1_SCK_A, EVENTOUT	-
17	PA4	I/O	GPIO	SPI1_NSS, USART2_CK, SAI1_FS_B, LPTIM2_OUT, EVENTOUT	COMP1_INM, COMP2_INM, ADC1_IN9, DAC1_OUT1
18	PB5	I/O	GPIO	LPTIM1_IN1, I2C1_SMBA, SPI1_MOSI, COMP2_OUT, SAI1_SD_B, TIM16_BKIN, EVENTOUT	-
19	NRST	I	Reset, internal pull-up, active low	-	-
20	PA3	I/O	GPIO	TIM2_CH4, USART2_RX, LPUART1_RX, SAI1_MCLK_A, TIM15_CH2, EVENTOUT	OPAMP1_ VOUT, COMP2_INP, ADC1_IN8

Module Pin #	Pin Name	Type	Pin Functions		
			Function After Reset	Alternate Functions	Additional Functions
21	PA2	I/O	GPIO	TIM2_CH3, USART2_TX, LPUART1_TX, COMP2_OUT, TIM15_CH1, EVENTOUT	COMP2_INM, ADC1_IN7, WKUP4, LSCO
22	PB3	I/O	GPIO	JTDO-TRACESWO, TIM2_CH2, SPI1_SCK, SAI1_SCK_B, EVENTOUT	COMP2_INM
23	PA14	I/O	GPIO	JTCK-SWCLK, LPTIM1_OUT, I2C1_SMBA, SWPMI1_RX, SAI1_FS_B, EVENTOUT	-
24	PA15	I/O	GPIO	JTDI, TIM2_CH1, TIM2_ETR, USART2_RX, SPI1_NSS, USART3_RTS_DE, SWPMI1_SUSPEND, EVENTOUT	-
25	PA13	I/O	GPIO	JTMS-SWDIO, IR_OUT, SWPMI1_TX, SAI1_SD_B, EVENTOUT	-
26	PC13	I/O	GPIO	EVENTOUT	RTC_TAMP1, RTC_TS, RTC_OUT, WKUP2
27	BT_TX_DBG	O	BT debug message, 1.8V voltage level	-	-
28	PB11	I/O	GPIO	TIM2_CH4, I2C2_SDA, USART3_RX, LPUART1_TX, COMP2_OUT, EVENTOUT	-
29	GND	GND	Ground	-	-

(1) For pin multiplexing details, refer to the datasheet of STM32L431.

Table 2. Connection for Unused Pins (1)

Function	Pin Name	Connection
GPIO	PAx, PBx, PCx	Set to port function in output direction, and leave unconnected
Reset	NRST	Has been internally pulled-up to VDD, require a 0.1µF pulldown
JTDI	PA15	The JTAG TDI pin is shared with general-purpose I/O function (PA15). If not being used, this pin should be set to port function in the output direction. When used as JTAG TDI pin, it should remain open
JTDO	PB3	The JTAG TDO pin is shared with general-purpose I/O function (PB3). If not being used, this pin should be set to port function in the output direction. When used as JTAG TDO pin, it should be pulled down externally
JTMS	PA13	The JTAG TMS pin is shared with general-purpose I/O function (PA13). If not being used, this pin should be set to port function in the output direction. When used as JTAG TMS pin, it should be pulled up externally

Function	Pin Name	Connection
JTCK	PA14	The JTAG TCK pin is shared with general-purpose I/O function (PA14). If not being used, this pin should be set to port function in the output direction. When used as JTAG TCK pin, it should be pulled down externally
TX_DUG	BT_TX_DUG	Remain open

(1) For pin multiplexing details, refer to the datasheet of STM32L431.

3. Characteristics

3.1. Electrical Characteristics

All MIN/MAX specification limits are guaranteed by design, production testing and/or statistical characterization. Typical values are based on characterization results at default measurement conditions and are informative only.
Default measurement conditions (unless otherwise specified): VDD= 3.3 V, TA = 25 °C. All radio measurements are performed with standard RF measurement equipment.

3.1.1. Absolute Maximum Ratings

Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specification is not implied. Exposure to Absolute Maximum Rating conditions for extended periods may affect device reliability.

Table 3. Absolute Maximum Ratings

Parameter	MIN	MAX	Unit
VDD, Supply voltage	-0.3	4	V
T_{STG}, Storage temperature	-40	125	°C

3.1.2. Recommended Operating Conditions

Table 4. Recommended Operating Conditions

Parameter	MIN	MAX	Unit
VDD, Supply voltage	2.4	3.6	V
T_A, Operating temperature	-40	85	°C

3.2. RF Characteristics

Table 5. Transmit (TX) Characteristics

Parameter	Description	Conditions	MIN	TYP	MAX	Unit
TX_{GFSK}	Maximum TX output power -GFSK	GFSK		10		dBm
TX_{EDR}	Maximum TX output power - EDR	EDR		10		dBm

Table 6. Receive (RX) Characteristics

Parameter	Description	Conditions	MIN	TYP	MAX	Unit
RX_{SEN_1}	RX sensitivity - GFSK	GFSK BER = 0.1%		-95		dBm
RX_{SEN_2}	RX sensitivity -π/4-DQPSK	π/4-DQPSK		-94		dBm

		BER = 0.01%				
RX_{SEN_3}	RX sensitivity - DPSK	8DPSK BER = 0.01%		-87		dBm

4. Mechanical Specifications

The following section includes mechanical and footprint drawings of the module.

4.1. Module Dimensions

The module dimensions are presented in the following figure.

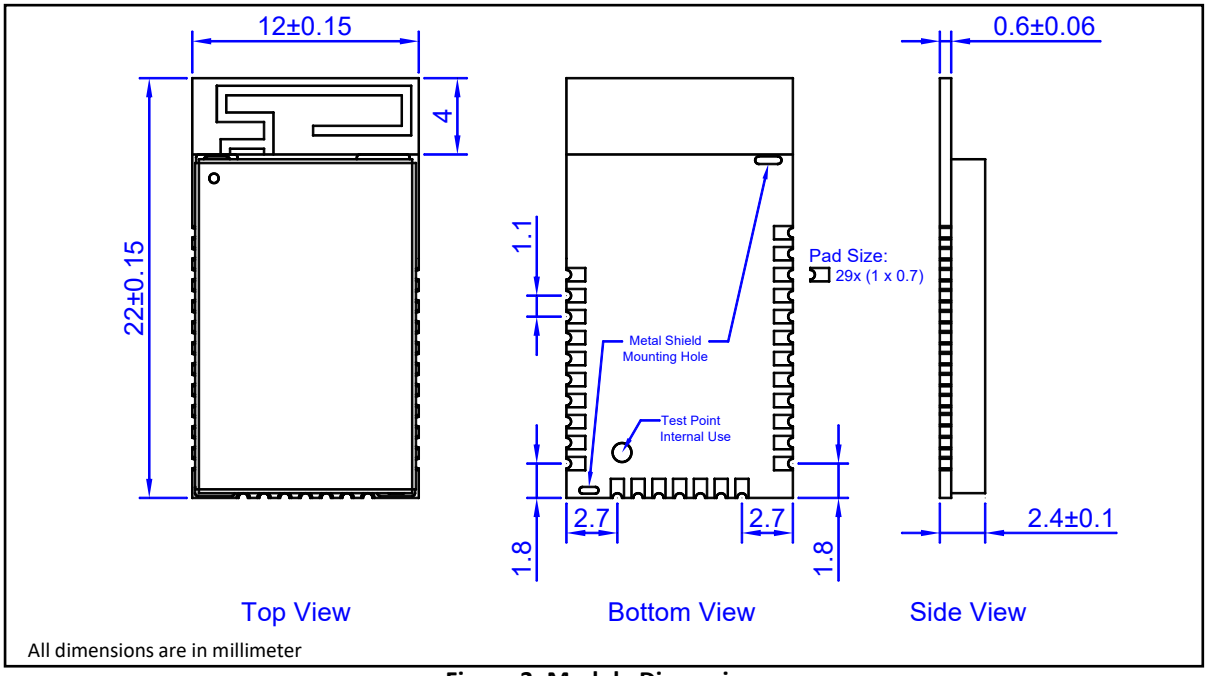

Figure 3. Module Dimensions

4.2. PCB Footprint

The recommended module footprint is presented in the following figure.

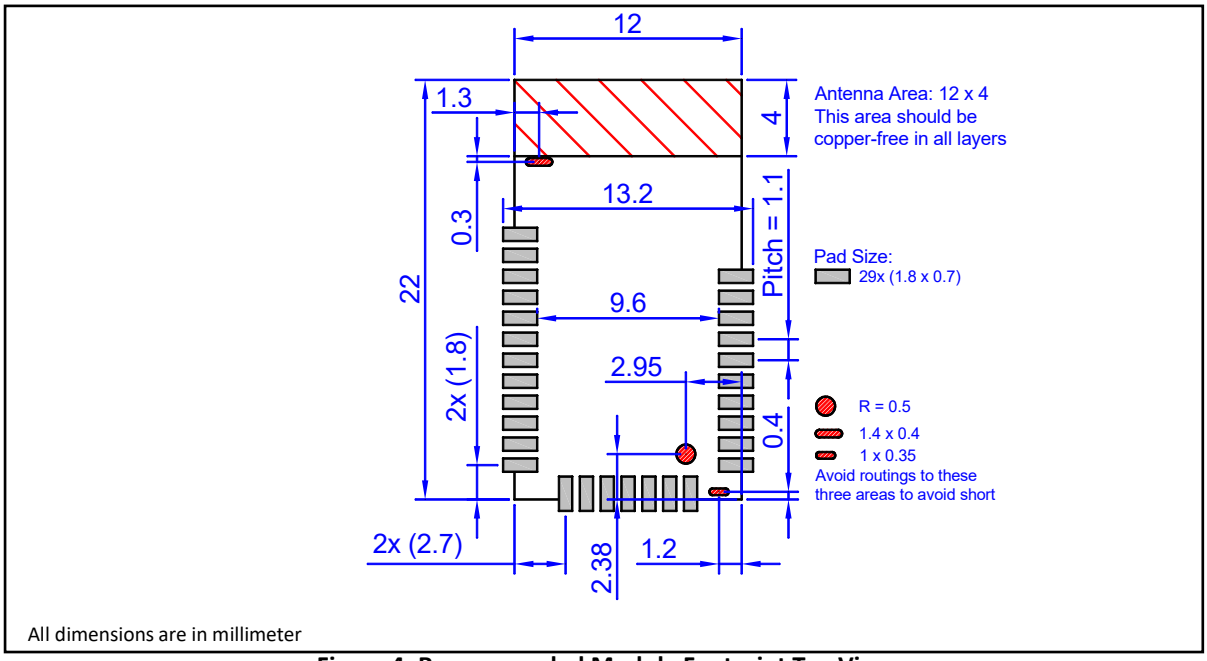

Figure 4: Recommended Module Footprint Top View

5. Ordering Information

Table 7. Ordering Information

Part Number	Size (mm)	Shipping Form	MOQ
BDE-BDM209B	12 x 22 x 2.4	Tape & Reel	1000

6. Revision History

Revision	Date	Description
V0.1	2024-08-02	Preliminary
V0.2	2024-08-19	Corrected some editorial mistakes
V0.3	2024-09-27	Modified pinout and pin functions, modified mechanical and footprint drawings

Important Notice and Disclaimer

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FCC Statement

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 not expressly approved by the party responsible for compliance 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, pursua nt to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful inte rference in a residential installation. This equipment generates uses and can radiate radio frequency energy a nd, if not installed and used in accordance with the instructions, may cause harmful interference to radio com munications. 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 turn ing 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 important announcement

Important Note:

Radiation Exposure Statement

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20cm between the radiator and your body.

This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

Country Code selection feature to be disabled for products marketed to the US/Canada.

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, and
2. The transmitter module may not be co-located with any other transmitter or antenna,
3. For all products market in US, OEM has to limit the operation 2.4G(2402-2480MHz) band by supplied firmware programming tool. OEM shall not supply any tool or info to the end-user regarding to Regulatory Domain change.

As long as the three conditions above are met, further transmitter testing will not be required. However, the OEM integrator is still responsible for testing their end-product for any additional compliance requirements required with this module installed.

Important Note:

In the event that these conditions cannot 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 cannot 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: **2ABRU-209B** "

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.

The end user manual shall include all required regulatory information/warning as show in this manual.

Integration instructions for host product manufacturers according to KDB 996369 D03 OEM Manual v01r01

2.2 List of applicable FCC rules

CFR 47 FCC PART 15 SUBPART C has been investigated. It is applicable to the modular transmitter

2.3 Specific operational use conditions

This module is stand-alone modular. If the end product will involve the Multiple simultaneously transmitting condition or different operational conditions for a stand-alone modular transmitter in a host, host manufacturer have to consult with module manufacturer for the installation method in end system.

2.4 Limited module procedures

Not applicable

2.5 Trace antenna designs

Not applicable

2.6 RF exposure considerations

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20cm between the radiator & your body.

2.7 Antennas

This radio transmitter **FCC ID: 2ABRU-209B** has been approved by Federal Communications Commission to operate with the antenna types listed below, with the maximum permissible gain indicated. Antenna types not included in this list that have a gain greater than the maximum gain indicated for any type listed are strictly prohibited for use with this device.

Antenna No.	Model No. of antenna:	Type of antenna:	Gain of the antenna (Max.)	Frequency range(MHz)
PCB antenna	BDE-BDM209B	PCB	-0.2dBi	2400 - 2450

2.8 Label and compliance information

The final end product must be labeled in a visible area with the following" Contains **FCC ID: 2ABRU-209B**".

2.9 Information on test modes and additional testing requirements

Host manufacturer is strongly recommended to confirm compliance with FCC requirements for the transmitter when the module is installed in the host.

2.10 Additional testing, Part 15 Subpart B disclaimer

Host manufacturer is responsible for compliance of the host system with module installed with all other applicable requirements for the system such as Part 15 B.

2.11 Note EMI Considerations

Host manufacture is recommended to use D04 Module Integration Guide recommending as "best practice" RF design engineering testing and evaluation in case non-linear interactions generate additional non-compliant limits due to module placement to host components or properties.

2.12 How to make changes

This module is stand-alone modular. If the end product will involve the Multiple simultaneously transmitting condition or different operational conditions for a stand-alone modular transmitter in a host, host manufacturer have to consult with module manufacturer for the installation method in end system. According to the KDB 996369 D02 Q&A Q12, that a host manufacture only needs to do an evaluation (i.e., no C2PC required when no emission exceeds the limit of any individual device (including unintentional radiators) as a composite. The host manufacturer must fix any failure.

ISED Statement

- English: This device complies with Industry Canada license-exempt RSS standard(s). Operation is subject to the following two conditions: (1) This device may not cause interference, a nd (2) This device must accept any interference, including interference that may cause undesired operation of the device.

The digital apparatus complies with Canadian CAN ICES-3 (B)/NMB-3(B).

- French: Le présentappareilestconforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitationestautorisée aux deux conditions suivantes: (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareildoit accepter tout brouillageradi oélectriquesubi, mêmesi le brouillageest susceptible d'encompromettre le fonctionnement.

l'appareil numérique du ciem conforme canadien peut - 3 (b) / nmb - 3 (b).

This device meets the exemption from the routine evaluation limits in section 6.3 of RSS 102 and compliance with RSS 102 RF exposure, users can obtain Canadian information on RF exposure and compliance.

cet appareil est conforme à l'exemption des limites d'évaluation courante dans la section 6.3 du cnr - 102 et conformité avec rss 102 de l'exposition aux rf, les utilisateurs peuvent obtenir des données canadiennes sur l'exposition aux champs rf et la conformité.

This equipment complies with Canada radiation exposure limits set forth for an uncontrolled environment.

Cet équipement est conforme Canada limites d'exposition aux radiations dans un environnement non contrôlé.

This equipment should be installed and operated with minimum distance 20cm between the radiator & your body.

Cet équipementdoit être installé et utilisé à une distance minimale de 20 cm entre le radiateur et votre corps.

ISED Modular Usage Statement

NOTE 1: 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: 25657-209B” or “Contains IC: 25657-209B”.

NOTE 1: 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 étiquetteextérieure peut être libellée Contient le module émetteur IC: 25657-209B ou Contient IC: 25657-209B.