

## General Description



The BDE-MP2651R3A is a single-protocol 2.4-GHz wireless module supporting Zigbee®, Bluetooth® 5.0 Low Energy, IEEE 802.15.4g, TI 15.4-Stack (2.4 GHz). The module is based on an Arm® Cortex® M4 main processor and optimized for low-power wireless communication and advanced sensing in grid infrastructure, building automation, retail automation, personal electronics and medical applications.

BDE-MP2651R3A has a software defined radio powered by an Arm® Cortex® M0, which allows support for multiple physical layers and RF standards. The device supports operation in the 2400 to 2480-MHz frequency band. The module supports +5 dBm TX at 9.5 mA in the 2.4-GHz band. It has a receive sensitivity of -103 dBm for 125-kbps Bluetooth® Low Energy Coded PHY.

The module has a low sleep current of 0.8  $\mu$ A with RTC and 32KB RAM retention. Consistent with many customers' 10 to 15 years or longer life cycle requirements.

BDE-MP2651R3A integrates all required system-level hardware components including clocks, passives, and PCB antenna into a QFM package for easy assembly and low-cost PCB design.

## Key Features

- Wireless microcontroller
  - Powerful 48-MHz Arm® Cortex®-M4 processor
  - 352KB flash program memory
  - 32KB of ultra-low leakage SRAM
  - 8KB of Cache SRAM (Alternatively available as general-purpose RAM)
  - Programmable radio includes support for 2-(G)FSK, 4-(G)FSK, MSK, Bluetooth® 5.0 Low Energy, IEEE 802.15.4 PHY and MAC
  - Supports over-the-air upgrade (OTA)
- Low power consumption
  - MCU consumption:
    - ◇ 2.91 mA active mode, CoreMark®
    - ◇ 61  $\mu$ A/MHz running CoreMark
    - ◇ 0.8  $\mu$ A standby mode, RTC, 32KB RAM
    - ◇ 0.1  $\mu$ A shutdown mode, wake-up on pin
  - Radio Consumption:
    - ◇ 6.4 mA RX
    - ◇ 7.1 mA TX at 0 dBm
    - ◇ 9.5 mA TX at +5 dBm
- Wireless protocol support
  - Zigbee®
  - Bluetooth® 5.0 Low Energy
  - SimpleLink™ TI 15.4-stack
  - Proprietary systems
- High performance radio
  - -103 dBm for Bluetooth® Low Energy 125-kbps
  - Output power up to +5 dBm with temperature compensation
- Regulatory compliance (On-going)
  - FCC
  - IC
  - CE-RED
  - Bluetooth SIG
- MCU peripherals
  - Digital peripherals can be routed to any GPIO

- Four 32-bit or eight 16-bit general-purpose timers
- 12-bit ADC, 200 kSamples/s, 8 channels
- 8-bit DAC
- Analog Comparator
- UART, SSI, I2C, I2S
- Real-time clock (RTC)
- Integrated temperature and battery monitor
- Security enablers
  - AES 128-bit cryptographic accelerator
  - True random number generator (TRNG)
  - Additional cryptography drivers available in Software Development Kit (SDK)
- Operating range
  - On-chip buck DC/DC converter
  - 1.8-V to 3.8-V single supply voltage
  - -40 to +85°C
  - -40 to +105°C (BDE-MP2651R3A-IN)
- Antenna: PCB antenna
- Package
  - Dimension: 22.95 mm x 15 mm x 2.15 mm
  - QFM-36 (31 GPIOs)
  - RoHS-compliant package

## Applications

- 2400 to 2480 MHz ISM and SRD systems with down to 4 kHz of receive bandwidth
- Building automation
  - Building security systems – motion detector, electronic smart lock, door and window sensor, garage door system, gateway
  - HVAC – thermostat, wireless environmental sensor, HVAC system controller, gateway
  - Fire safety system – smoke and heat detector, fire alarm control panel (FACP)
  - Video surveillance – IP network camera
  - Elevators and escalators – elevator main control panel for elevators and escalators
- Industrial transport – asset tracking
- Factory automation and control
- Medical
- Electronic point of sale (EPOS) – Electronic Shelf Label (ESL)
- Communication equipment
  - Wired networking – wireless LAN or Wi-Fi access points, edge router, small business router
- Personal electronics
  - Home theater & entertainment – smart speakers, smart display, set-top box
  - Wearables (non-medical) – smart trackers, smart clothing

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## 1. References

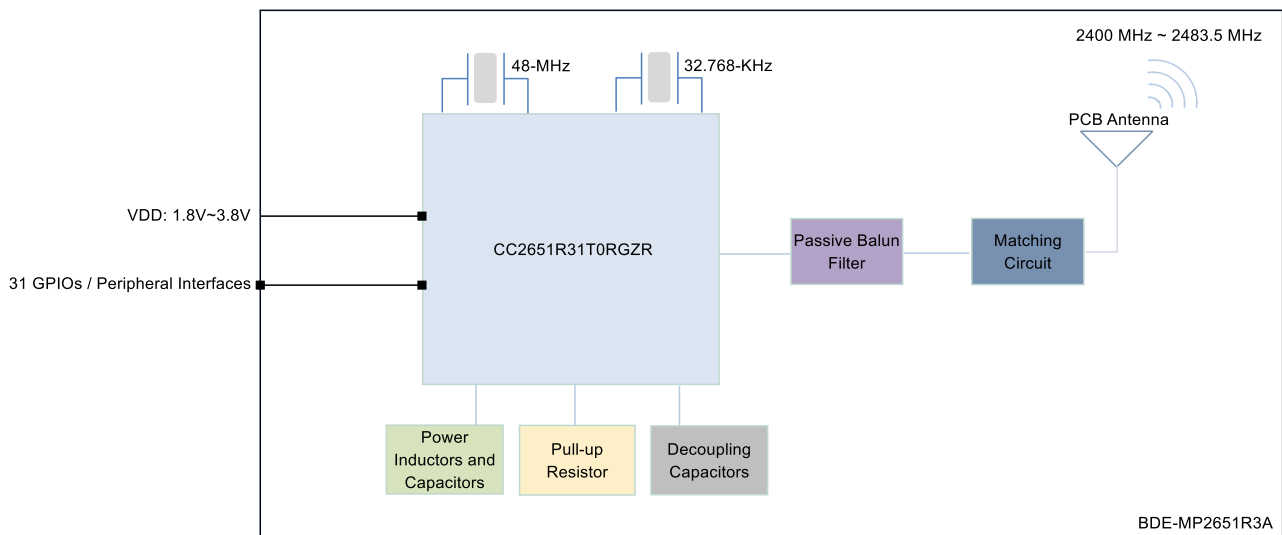
- [1] CC2651R3 resources: <https://www.ti.com/product/CC2651R3>

## 2. Block Diagram

BDE-MP2651R3A module is based on the Texas Instruments CC2651R3 single chip wireless MCU. With integrated clocks, other required passives and antenna, it allows faster time to market at reduced development cost.

The module, as seen in Figure 2-1, comprises of:

- 48-MHz XTAL
- 32.768-kHz XTAL
- Power inductors and capacitors
- Pull-up resistor
- Passive balun filter
- Decoupling capacitors
- Matching circuit PCB trace antenna



**Figure 2-1. BDE-MP2651R3A Module Block Diagram**

### 3. Terminal Configuration and Functions

#### 3.1 Pin Diagram

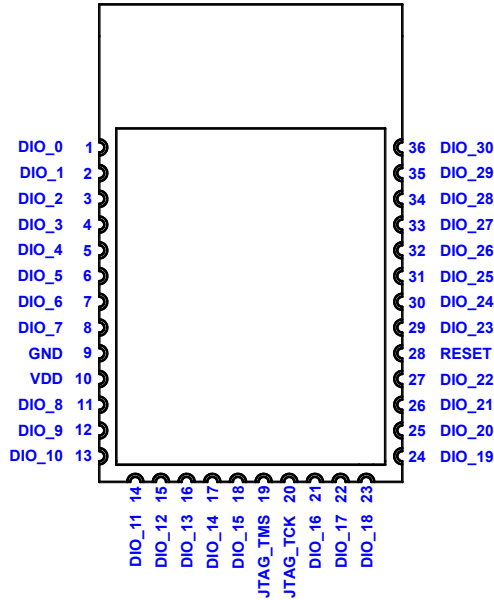


Figure 3-1. Pin Diagram (Top View)

#### 3.2 Pin Attributes and Pin Multiplexing

Table 3-1 describes the definitions of the pins of the module. Pin number of CC2651R3 chip is also stated here, because the VQFN pin is referred to in the software design kit (SDK).

Table 3-1. Pin Description <sup>(1)</sup>

| Module Pin # | Pin Name | Type   | CC2651R3 Pin # | Description                           |
|--------------|----------|--------|----------------|---------------------------------------|
| 1            | DIO_0    | I/O    | 5              | GPIO                                  |
| 2            | DIO_1    | I/O    | 6              | GPIO                                  |
| 3            | DIO_2    | I/O    | 7              | GPIO                                  |
| 4            | DIO_3    | I/O    | 8              | GPIO                                  |
| 5            | DIO_4    | I/O    | 9              | GPIO                                  |
| 6            | DIO_5    | I/O    | 10             | GPIO, high-drive capability           |
| 7            | DIO_6    | I/O    | 11             | GPIO, high-drive capability           |
| 8            | DIO_7    | I/O    | 12             | GPIO, high-drive capability           |
| 9            | GND      | Ground | -              | Power ground                          |
| 10           | VDD      | Power  | -              | Power supply                          |
| 11           | DIO_8    | I/O    | 14             | GPIO                                  |
| 12           | DIO_9    | I/O    | 15             | GPIO                                  |
| 13           | DIO_10   | I/O    | 16             | GPIO                                  |
| 14           | DIO_11   | I/O    | 17             | GPIO                                  |
| 15           | DIO_12   | I/O    | 18             | GPIO                                  |
| 16           | DIO_13   | I/O    | 19             | GPIO                                  |
| 17           | DIO_14   | I/O    | 20             | GPIO                                  |
| 18           | DIO_15   | I/O    | 21             | GPIO                                  |
| 19           | JTAG_TMS | I/O    | 24             | JTAG TMS, high-drive capability       |
| 20           | JTAG_TCK | I      | 25             | JTAG TCK                              |
| 21           | DIO_16   | I/O    | 26             | GPIO, JTAG_TDO, high-drive capability |

| Module Pin # | Pin Name | Type | CC2651R3 Pin # | Description   |
|--------------|----------|------|----------------|---|
| 22           | DIO_17   | I/O  | 27             | GPIO, JTAG_TDI, high-drive capability                 |
| 23           | DIO_18   | I/O  | 28             | GPIO  |
| 24           | DIO_19   | I/O  | 29             | GPIO  |
| 25           | DIO_20   | I/O  | 30             | GPIO  |
| 26           | DIO_21   | I/O  | 31             | GPIO  |
| 27           | DIO_22   | I/O  | 32             | GPIO  |
| 28           | RESET    | I    | 35             | Reset, active-low, 100K ohm internal pull-up resistor |
| 29           | DIO_23   | I/O  | 36             | GPIO, analog capability                               |
| 30           | DIO_24   | I/O  | 37             | GPIO, analog capability                               |
| 31           | DIO_25   | I/O  | 38             | GPIO, analog capability                               |
| 32           | DIO_26   | I/O  | 39             | GPIO, analog capability                               |
| 33           | DIO_27   | I/O  | 40             | GPIO, analog capability                               |
| 34           | DIO_28   | I/O  | 41             | GPIO, analog capability                               |
| 35           | DIO_29   | I/O  | 42             | GPIO, analog capability                               |
| 36           | DIO_30   | I/O  | 43             | GPIO, analog capability                               |

Note <sup>(1)</sup>: For more information, please refer to [CC2651R3](#) datasheet.

## 4. Specifications

### 4.1 Absolute Maximum Ratings

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

| PARAMETER                   | MIN  | MAX         | UNIT | Notes  |
|-----------------------------|------|-------------|------|--|
| VDD                         | -0.3 | 4.1         | V    |  |
| Voltage on any digital pins | -0.3 | VDD+0.3≤4.1 | V    |  |
| Voltage on ADC input        | -0.3 | VDDS        | V    | Voltage scaling enabled                      |
|                             | -0.3 | 1.49        | V    | Voltage scaling disabled, internal reference |
|                             | -0.3 | VDD/2.9     | V    | Voltage scaling disabled, VDD as reference   |
| Storage temperature         | -40  | 125         | °C   |  |

### 4.2 Recommended Operating Conditions

| PARAMETER                        | MIN | TYP | MAX | UNIT  |
|----------------------------------|-----|-----|-----|-------|
| VDDS                             | 1.8 | 3.3 | 3.8 | V     |
| Operating temperature            | -40 | -   | 85  | °C    |
| Rising supply voltage slew rate  | 0   |     | 100 | mV/μs |
| Falling supply voltage slew rate | 0   |     | 20  | mV/μs |



## 5. Mechanical Specifications

### 5.1 Dimensions

The following pages include mechanical, footprint drawings, and marking information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document.

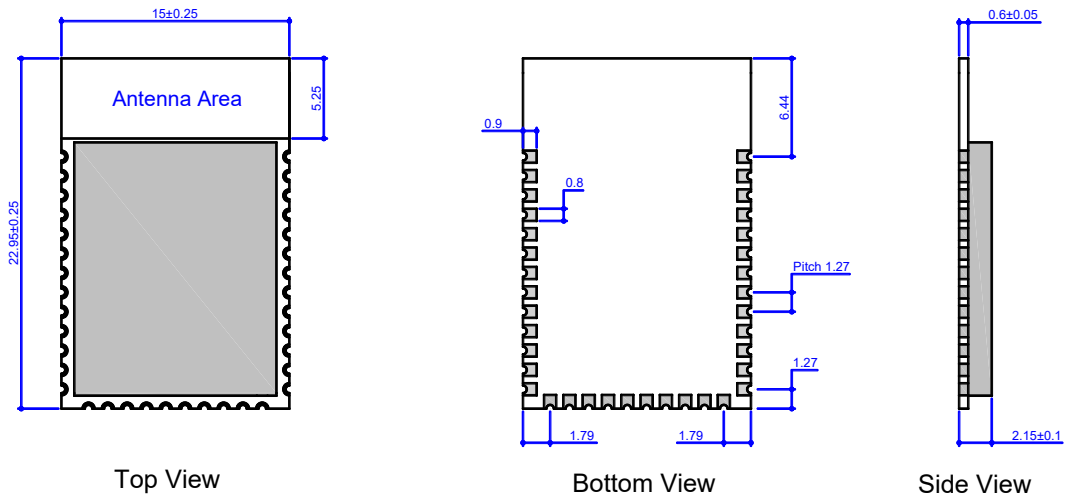
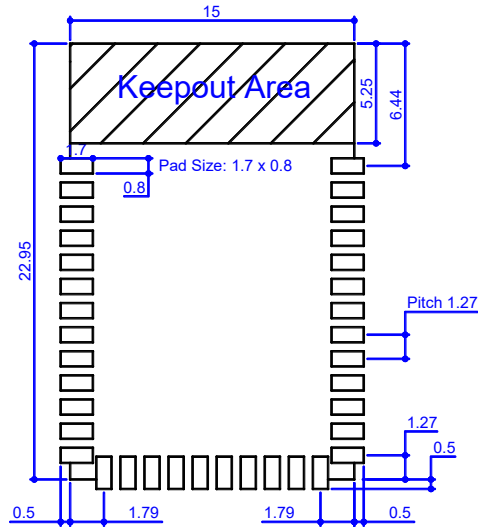


Fig 5-1. Mechanical Drawing

### 5.2 PCB Footprint



Note:

- 1. All dimensions are in millimeter;
- 2. Solder mask should be the same or 5% larger than the dimension of the pad;
- 3. Solder paste must be the same as the pin for all peripheral pads.

Fig 5-2. Module Footprint Top View

### 5.3 Marking



Fig 5-3. Module Marking

## 6. Typical Reflow Profile

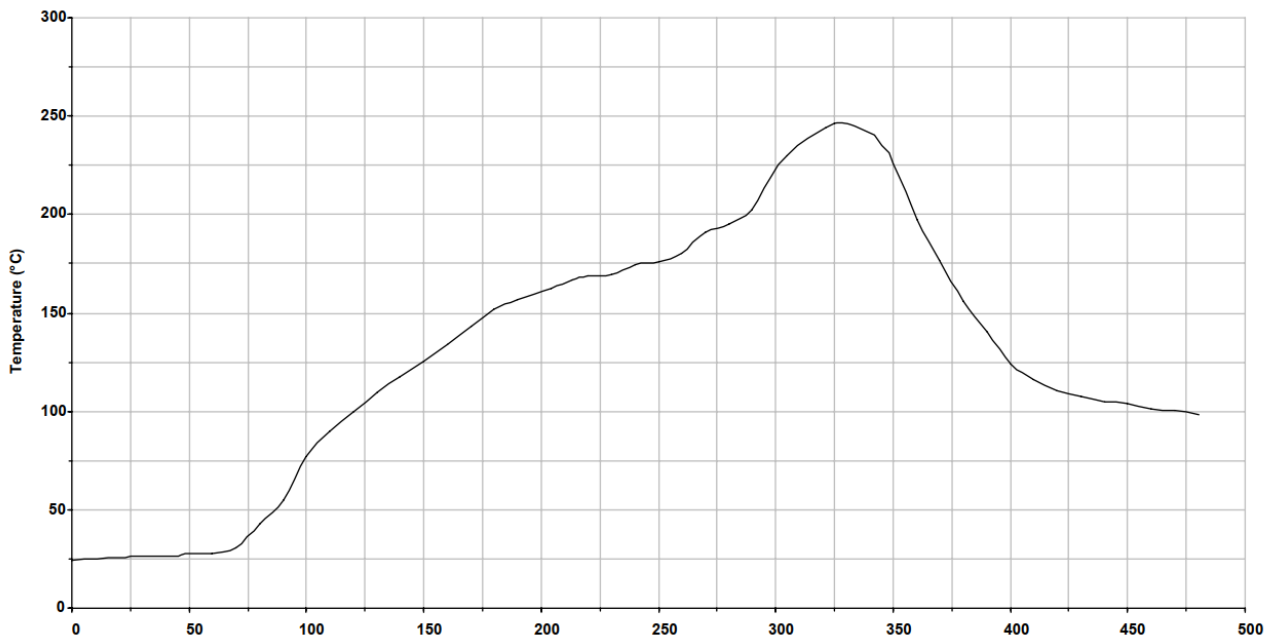


Figure 6-1. Typical Reflow Profile

Key features of the profile:

- Initial ramp = 1-2.5°C/sec to 175°C ±25°C equilibrium
- Equilibrium time = 60 to 180 seconds
- Ramp to maximum temperature (245°C) = 3°C/sec max.
- Time above liquidus temperature (217°C): 45-90 seconds
- Device absolute maximum reflow temperature: 260°C

### 7. Ordering Information

| Part Number   | Size (mm)         | Core Chip | Operating Temperature | Shipping Form | MOQ |
|---------------|-------------------|-----------|-----------------------|---------------|-----|
| BDE-MP2651R3A | 22.95 × 15 × 2.15 | CC2651R3  | -40 to +85°C          | Tape & Reel   | 1K  |
| BDE-MP2651R3A | 22.95 × 15 × 2.15 | CC2651R3  | -40 to +105°C         | Tape & Reel   | 1K  |

### 8. Revision History

| Revision | Date            | Description     |
|----------|-----------------|-----------------|
| V1.0     | 12-October-2022 | Initial Release |

### Contacts

BDE Technology Inc.

USA: 67 E Madison St, #1603A, Chicago, IL 60603, US

Tel: +1-312-379-9589

Website: <http://www.bdecomm.com>

Email: [info@bdecomm.com](mailto:info@bdecomm.com)

China: B2-403, 162 Science Avenue, Huangpu District, Guangzhou 510663, China

Tel: +86-20-28065335

Website: <http://www.bdecomm.com>

Email: [shu@bdecomm.com](mailto:shu@bdecomm.com)