

## General Description



The BDE-SG1312R7 is a multiprotocol Sub-1 GHz wireless microcontroller (MCU) supporting IEEE 802.15.4g, IPv6-enabled smart objects (6LoWPAN), mioty®, Wi-SUN®, proprietary systems, including the TI 15.4-Stack (Sub-1 GHz), and concurrent multiprotocol through a Dynamic Multiprotocol Manager (DMM) driver. The BDE-SG1312R7 is based on an Arm® Cortex® M4F main processor and optimized for low-power wireless communication and advanced sensing in grid infrastructure, building automation, retail automation, personal electronics and medical applications.

The BDE-SG1312R7 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 915-MHz frequency bands. PHY and frequency band switching can be done runtime through a dynamic multiprotocol manager (DMM) driver. The BDE-SG1312R7 has an efficient built-in PA that supports +14 dBm TX at 24.9 mA current consumption. In RX it has -122 dBm sensitivity and 88 dB blocking  $\pm 10$  MHz in SimpleLink™ long-range mode with 2.5-kbps data rate.

The BDE-SG1312R7 has a low sleep current of 0.9  $\mu$ A with RTC and 144KB RAM retention. In addition to the main Cortex® M4F processor, the device also has an autonomous ultra-low power Sensor Controller CPU with fast wake-up capability. As an example, the sensor controller is capable of 1-Hz ADC sampling at 1- $\mu$ A system current. The BDE-SG1312R7 has Low SER (Soft Error Rate) FIT (Failure-in-time) for long operational lifetime. Always-on SRAM parity minimizes risk for corruption due to potential radiation events. Consistent with many customers' 10 to 15 years or longer life cycle requirements.

The module is with dimension of 22 mm x 15 mm x 2.15 mm, it has a U.FL connector for connecting an external antenna or it can be configured to use the RF pad for connecting the antenna in application board.

## Key Features

- Wireless microcontroller
  - Powerful 48-MHz Arm® Cortex®-M4F processor
  - 704KB flash program memory
  - 256KB of ROM for protocols and library functions
  - 8KB of cache SRAM
  - 144KB of ultra-low leakage SRAM with parity for high-reliability operation
  - Dynamic multiprotocol manager (DMM) driver
  - Programmable radio includes support for 2-(G)FSK, 4-(G)FSK, MSK, OOK, IEEE 802.15.4 PHY and MAC
  - Supports over-the-air upgrade (OTA)
- Ultra-low power sensor controller
  - Autonomous MCU with 4KB of SRAM
  - Sample, store, and process sensor data
  - Fast wake-up for low-power operation
  - Software defined peripherals; capacitive touch, flow meter, LCD Low power consumption
  - MCU consumption:
    - ✧ 2.63 mA active mode, CoreMark
    - ✧ 55  $\mu$ A/MHz running CoreMark
    - ✧ 0.8  $\mu$ A standby mode, RTC, 144KB RAM
    - ✧ 0.1  $\mu$ A shutdown mode, wake-up on pin •
  - Ultra low-power sensor controller consumption:
    - ✧ 25.2  $\mu$ A in 2 MHz mode
    - ✧ 701  $\mu$ A in 24 MHz mode

- Radio Consumption:
  - ◇ 5.4 mA RX at 868 MHz
  - ◇ 24.9 mA TX at +14 dBm at 915 MHz
- Wireless protocol support
  - Wi-SUN®
  - mioty®
  - Amazon Sidewalk
  - Wireless M-Bus
  - SimpleLink™ TI 15.4-stack
  - 6LoWPAN
  - Proprietary systems
- High performance radio
  - -121 dBm for 2.5-kbps long-range mode
  - -110 dBm at 50 kbps, 802.15.4, 915 MHz
  - Output power up to +14 dBm with temperature compensation
- Regulatory compliance (On-going)
  - Suitable for systems targeting compliance with these standards:
    - ◇ FCC
    - ◇ IC
    - ◇ CE-RED
- 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
  - Two comparators
  - Programmable current source
  - Two UART, two SSI, I2C, I2S
  - Real-time clock (RTC)
  - Integrated temperature and battery monitor
- Security enablers
  - AES 128- and 256-bit cryptographic accelerator
  - ECC and RSA public key hardware accelerator
  - SHA2 Accelerator (full suite up to SHA-512)
  - True random number generator (TRNG)
- 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 (See ordering information)
- Antenna:
  - U.FL connector or RF pad
- Small Size
  - 22 mm x 15 mm x 2.15 mm

## Applications

- Grid infrastructure
  - Smart Meters – electricity meter, water meter, gas meter, and heat cost allocator
  - Grid communications – wireless communications
  - EV charging infrastructure – AC charging (pile) station
  - Other alternative energy – energy harvesting
- Building automation
  - Building security systems – motion detector, door and window sensor, glass break detector, panic button, electronic smart lock and IP network camera
  - HVAC systems – thermostat, environmental sensor and HVAC controller
  - Fire safety – smoke and head detector, gas detector and fire alarm control panel
  - Retail Automation
  - Retail automation & payment applications – electronic shelf labels and portable POS terminal
- Personal Electronics
  - RF remote controls
  - Smart Speakers and Smart Displays
  - Gaming and electronic and robotic toys
  - Wearables (non-medical) and smart trackers
- Wireless Modules
  - Wireless third party modules including WiSUN®, Amazon Sidewalk, mioty® and multiprotocol
  - Wireless communications modules

## Contents

General Description .....	1
Key Features .....	1
Applications .....	2
Contents .....	3
1. References .....	4
2. Block Diagram .....	5
3. Terminal Configuration and Functions .....	6
3.1 Pin Diagram .....	6
3.2 Pin Attributes and Pin Multiplexing .....	6
4. Specifications .....	8
4.1 Absolute Maximum Ratings .....	8
4.2 ESD Ratings .....	8
5. Dimensions & Marking .....	9
5.1 Dimensions .....	9
5.2 PCB Footprint .....	9
5.3 Marking .....	10
6. Typical Reflow Profile .....	10
7. Ordering Information .....	11
8. Revision History .....	11
Contacts .....	11

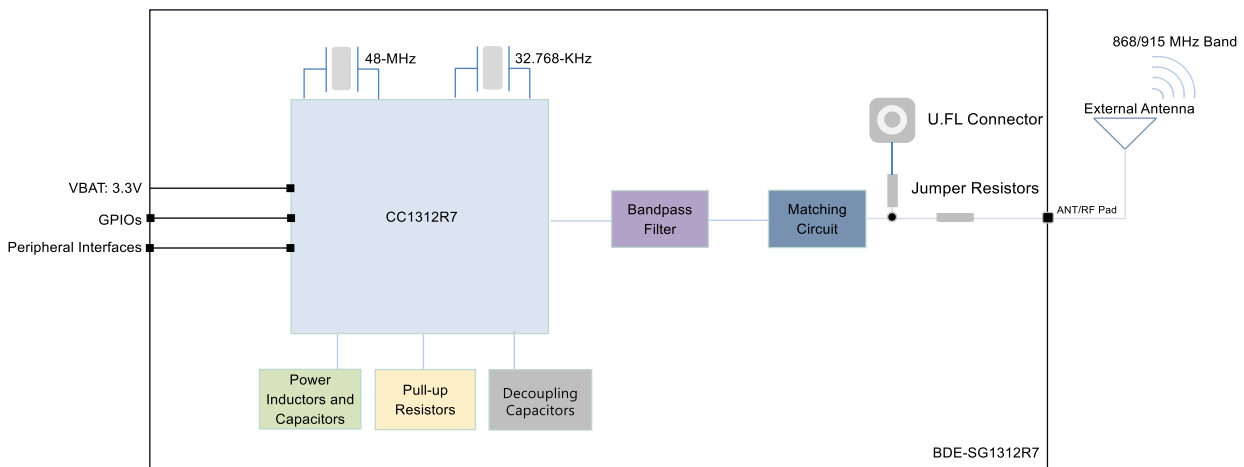
## 1. References

- [1] CC1312R7 resources: <https://www.ti.com/product/CC1312R7>

## 2. Block Diagram

BDE-SG1312R7 module is based on the Texas Instruments CC1312R7 single chip wireless MCU. 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



**Figure 2-1. BDE-SG1312R7 Module Block Diagram**

### 3. Terminal Configuration and Functions

#### 3.1 Pin Diagram

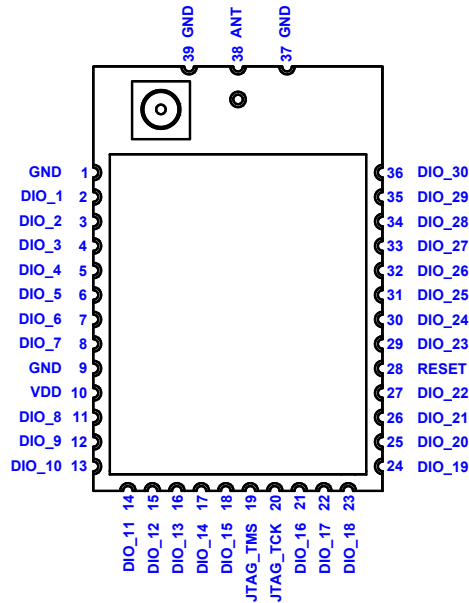


Figure 3-1. Pin Diagram (Top View)

#### 3.2 Pin Attributes and Pin Multiplexing

Table 3-1. Pin Description

Pin Number	Pin Name	Type	Definitions
1	GND	Ground	Power Ground
2	DIO_1	I/O	GPIO, Sensor Controller
3	DIO_2	I/O	GPIO, Sensor Controller
4	DIO_3	I/O	GPIO, Sensor Controller
5	DIO_4	I/O	GPIO, Sensor Controller
6	DIO_5	I/O	GPIO, Sensor Controller, high-drive capability
7	DIO_6	I/O	GPIO, Sensor Controller, high-drive capability
8	DIO_7	I/O	GPIO, Sensor Controller, high-drive capability
9	GND	Ground	Power Ground
10	VDD	Power	Power Supply
11	DIO_8	I/O	GPIO
12	DIO_9	I/O	GPIO
13	DIO_10	I/O	GPIO
14	DIO_11	I/O	GPIO
15	DIO_12	I/O	GPIO

16	DIO_13	I/O	GPIO
17	DIO_14	I/O	GPIO
18	DIO_15	I/O	GPIO
19	JTAG_TMS	I/O	JTAG TMS, high-drive capability
20	JTAG_TCK	I	JTAG TCK
21	DIO_16	I/O	GPIO, JTAG_TDO, high-drive capability
22	DIO_17	I/O	GPIO, JTAG_TDI, high-drive capability
23	DIO_18	I/O	GPIO
24	DIO_19	I/O	GPIO
25	DIO_20	I/O	GPIO
26	DIO_21	I/O	GPIO
27	DIO_22	I/O	GPIO
28	RESET	I	Reset, active-low
29	DIO_23	I/O	GPIO, Sensor Controller, Analog
30	DIO_24	I/O	GPIO, Sensor Controller, Analog
31	DIO_25	I/O	GPIO, Sensor Controller, Analog
32	DIO_26	I/O	GPIO, Sensor Controller, Analog
33	DIO_27	I/O	GPIO, Sensor Controller, Analog
34	DIO_28	I/O	GPIO, Sensor Controller, Analog
35	DIO_29	I/O	GPIO, Sensor Controller, Analog
36	DIO_30	I/O	GPIO, Sensor Controller, Analog
37	GND	Ground	Power Ground
38	ANT	-	Antenna port (When disconnected with UFL, this port can be used)
39	GND	Ground	Power Ground

## 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
VDDS	-0.3	4.1	V	
Other Digital Terminals	-0.3	VDDS+0.3≤4.1	V	
V <sub>in</sub>	-0.3	VDDS	V	VDD IO Voltage
	-0.3	1.49	V	Input Voltage to all digital pins
	-0.3	VDDS/2.9	V	HFXT_P Input Voltage
RF pin		12.5	dBm	
Storage Temperature	-40	150	°C	

### 4.2 ESD Ratings

		VALUE	UNIT
V <sub>(ESD)</sub> Electrostatic discharge	Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001(1)	±2000	V
	Charged device model (CDM), per ANSI/ESDA/JEDEC JS-002(2)	±500	

(1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.

(2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process. .



## 5. Dimensions & Marking

### 5.1 Dimensions

Figure 5-1 shows the overall dimensions of BDE-SG1312R7. The module measures 22 mm long by 15 mm wide by 2.15mm height with the shield.

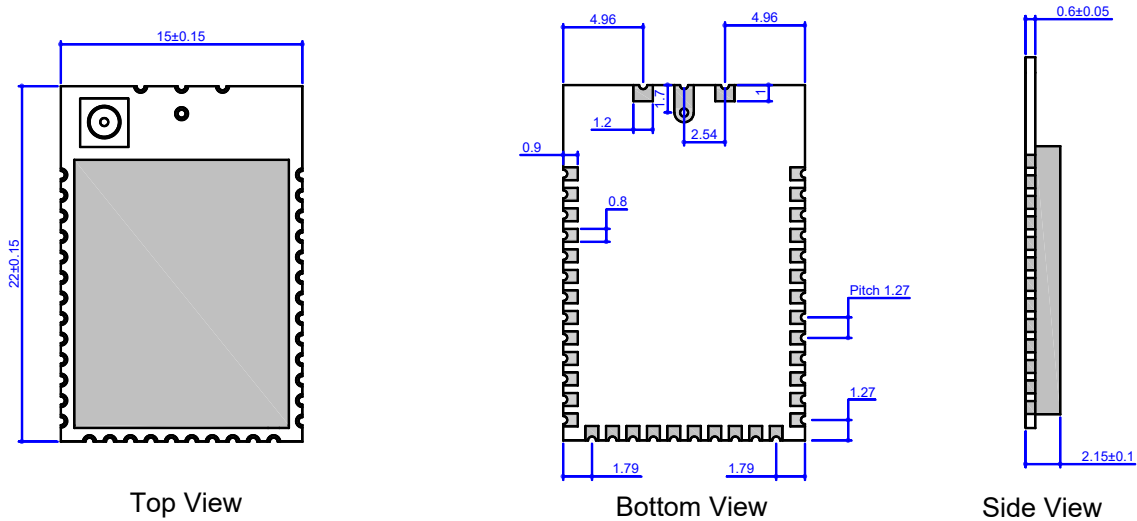
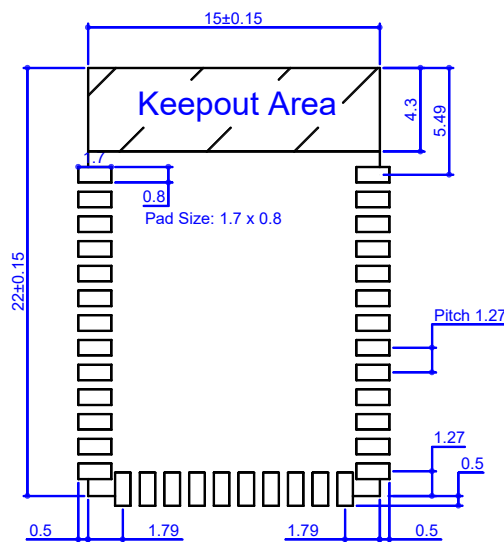


Figure 5-1. Overall Dimensions of BDE-SG1312R7

### 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. For ground pins, make the solder paste 20% smaller than the pad.

Figure 5-2. Module Footprint for BDE-SG1312R7 Top View

### 5.3 Marking

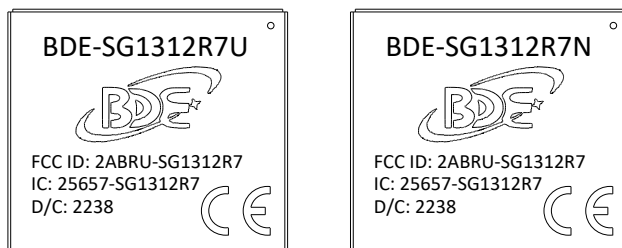


Fig 5-3. Module Marking

## 6. Typical Reflow Profile

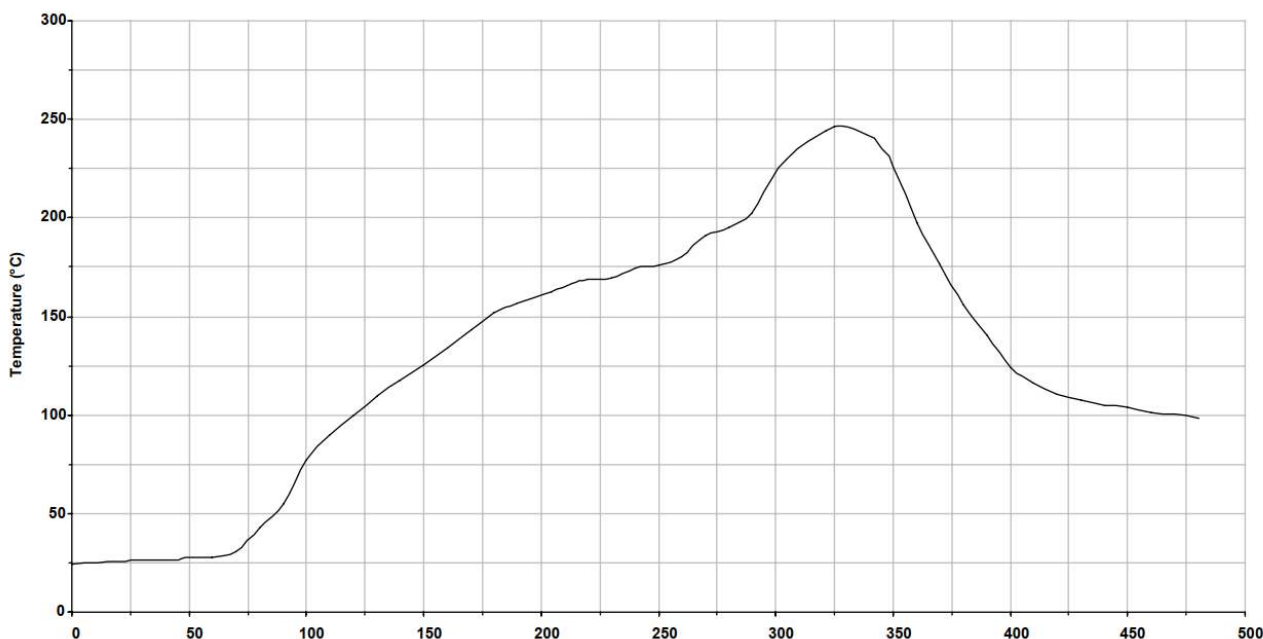


Figure 6-1. Typical Reflow Profile

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	Shipping Form	MOQ
BDE-SG1312R7U	22 × 15 × 2.15	CC1312R7	Tape & Reel	1K
BDE-SG1312R7N	22 × 15 × 2.15	CC1312R7	Tape & Reel	1K

## 8. Revision History

Revision	Date	Description
V1.0	17-Oct-2022	Preliminary, draft

## Contacts

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