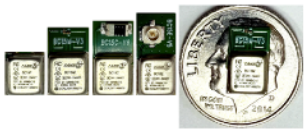
Compact Bluetooth 6.0, 802.15.4 Module BC15C

Ver 1.01 Oct. 2025

BC15C Series are powerful, highly flexible, ultra low power Bluetooth Low Energy (BLE) modules using Nordic nRF54L15 SoC. With an ARM Cortex™ M33 MCU, 1.524MB flash, 256KB RAM, embedded 2.4GHz multi-protocol transceiver, and an integrated chip antenna or an u.FL for an external antenna. It allows faster time to market with reduced development cost.



No external components needed. Both 32MHz, 32KHz crystals and DCDC converter inductors are embedded despite of its 6.0x6.3 mm size.

BC15C Specifications

BLE 5.4, IEEE 802.15.4-2006 Transceiver

- Complete RF solution with integrated antenna
  - BLE: 2Mbps, 1Mbps (-98 dBm sensitivity), 500kbps, 125kbps (-106 dBm sensitivity).
  - IEEE 802.15.4-2006: 250 kbps (-102 dBm sensitivity).
  - Proprietary: 4Mbps, 2Mbps, 1Mbps.
- Programmable TX power, -8 dBm +8 dBm.
- AoA and AoD direction finding using BLE.
- 128 bit AES/ECB/CCM/AAR co-processor (on-the-fly operation).
- 12.0 mW TX current at 0 dBm, 1Mbps, 1.8V VDD.
- 7.5 mW RX current, 1Mbps, 1.8V VDD.
- RSSI, 1 dB resolution

Platform Security

- Secure/non-secure memory protection.
- Symmetric and asymmetric key crypto accelerator.
- Secure key management.
- Tamper detection.
- Immutable boot partition.
- Debug access port protection.
- Two watchdog timers for secure and non-secure context.

MCU

- Nordic nRF54L with ARM Cortex M33, 128 MHz.
- Flash/RAM: 1524KB/256KB.
- 505 EEMAC CoreMark score running from non-volatile memory, 3.95 CoreMark per MHz.
- Single precision floating point unit (FPU).
- Memory protection unit (MPU).
- Digital signal processing (DSP) instructions.
- Data watchpoint and trace (DWT), embedded trace macrocell (ETM), instrumentation trace macrocell (ITM), and cross trigger interface (CTI).
- Serial Wire Debug (SWD)
- Trace port interface unit (TPIU), 4-bit parallel trace of ITM and ETM trace data; Serial wire output (SWO) trace of ITM data.

Peripherals

- Two realtime counters (RTC), and one global RTC (GRTC) that can run in System OFF mode and implement a shared system timer.
- Seven 32-bit timers with counter mode.
- Five fully featured serial interfaces with EasyDMA, supporting I²C, SPI controller/peripheral, and UART.
- Three pulse width modulator (PWM) units with Easy DMA.
- I2S two channel inter-IC sound interface.
- 14-bit at 20KS/s, 12 bit at 250KS/s, or 10-bit at 2MS/s ADC with up to eight programmable gain channels.
- Near field communication (NFC).
- Two quadrature decoders (QDEC).
- 36 LGA pins.
- 31 GPIOs
- Embedded inductors for DCDC converter
- 1.7V to 3.6V supply voltage with up to 2.6V I/O voltage.
- Operation temperature: -40°C to +105°C

Certifications

- FCC ID: X8WBC15 with SAR.
- ISED ID: 4100A-BC15
- TELEC ID: 201-250527
- NCC ID: See below.
- CE and RCM: Compliant
- QDID:

Model Summaries

module	BC15C	BC15E	BC15M	BC15P
Flash/RAM	1524KB/256KB	1524KB/256KB	1524KB/256KB	1524KB/256KB
Embedded crystals	32MHz + 32KHz	32MHz + 32KHz	32MHz + 32KHz	32MHz + 32KHz
Size	6.0x11.0mm	6.0x10.5	6.0x9.6mm	6.0x6.3mm
TX power, max. conducted	+8.01 dBm	+8.01 dBm	+8.01 dBm	+8.01 dBm
TX power, max. radiated	+7.05 dBm	+14.01 dBm (ANT060)	+5.64 dBm	+14.01 dBm (ANT060)
Antenna	Chip	u.FL for external	PCB antenna	Pads for external
Bluetooth range, 1Mbps	90 meters	>1000 meters, est.	90 meters	>1000 meters, est.
NCC ID	CCAL25Y10690T7	CCAL25Y10691T1	CCAL25Y10692T0	CCAL25Y10693T2
Availability	Production	Production	Production	Production

Table Of Contents

1. Introduction

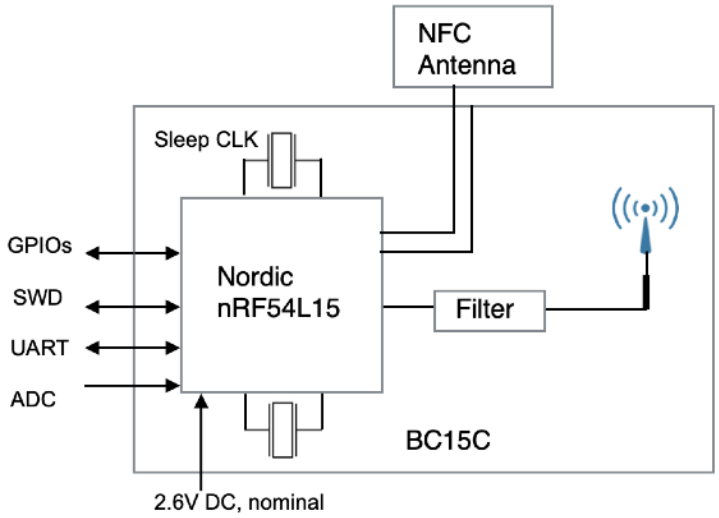
BC15C module is powerful, highly flexible, ultra low power Bluetooth Low Energy (BLE) modules using Nordic nRF54L15 SoCs. With an ARM Cortex™ M33 MCU at 128 MHz, 1.524MB flash, 256KB RAM, embedded 2.4GHz multi-protocol transceiver, and an integrated antenna, it allows faster time to market with reduced development cost.

The following is a block diagram of BC15C. Antenna circuit and main clock are integrated. All 31 GPIOs of nRF54L15 can be accessed from main board. Both 32 MHz and 32.768 kHz crystals are embedded. Connection to an external NFC (Near Field Communication) antenna is provided.

In this data sheets, BC15C, BC15E, BC15M, and BC15P are referred as BC15C.

BC15C Block Diagram

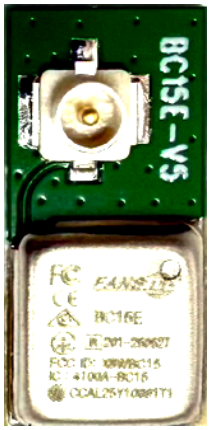
The following is a block diagram of BC15C.



BC15C Series modules have the same features except the followings.

BC15C

- Uses an nRF54L15 SoC.
- Cortex M33 MCU at 128 MHz, 1524KB flash, 256 KB RAM
- Integrated chip antenna
- Size 6.0x11.0mm.



BC15E

- Uses an nRF54L15 SoC.
- Cortex M33 MCU at 128 MHz, 1524KB flash, 256 KB RAM
- An u.FL connector for external antenna.
- Size 6.0x10.5mm.

BC15M

- Uses an nRF54L15 SoC.

- Cortex M33 MCU at 128 MHz, 1524KB flash, 256 KB RAM
- Integrated PCB trace antenna
- Size 6.0x9.6mm.

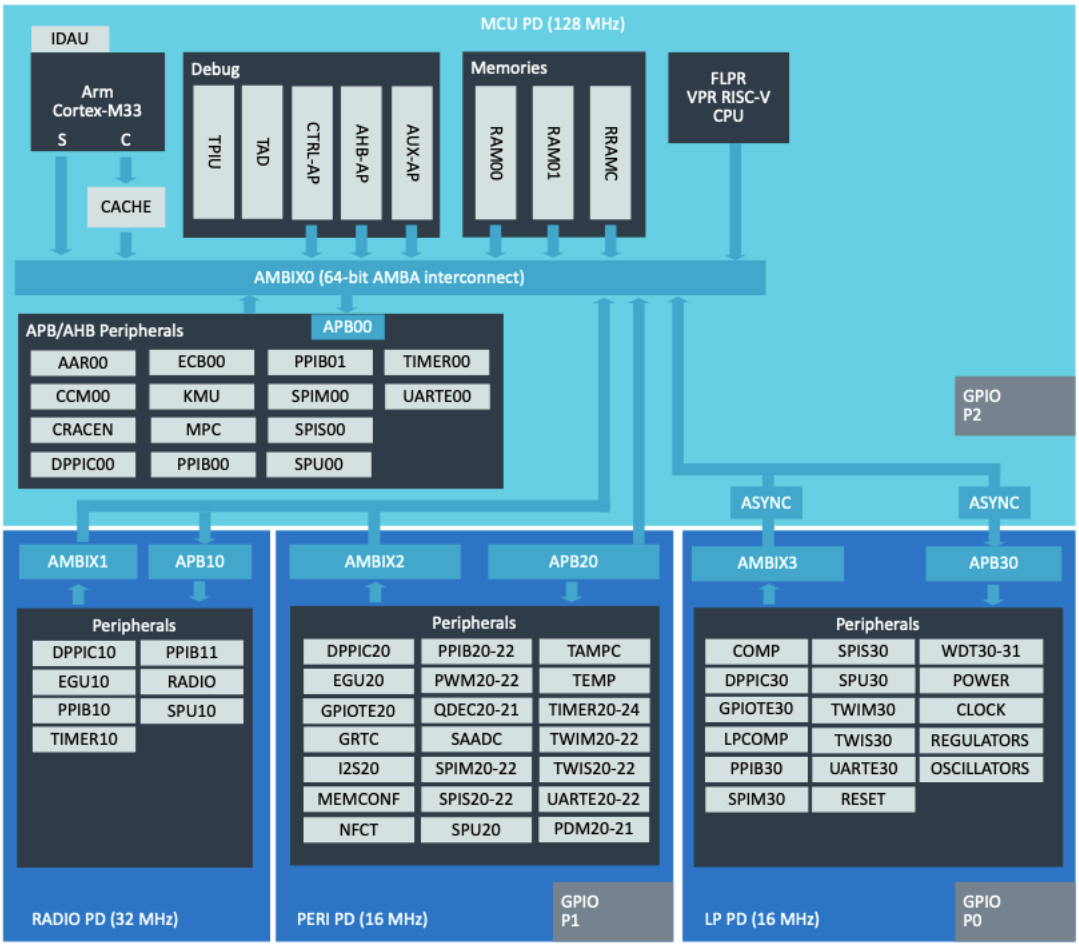
BC15P

- Uses an nRF54L15 SoC.
- Cortex M33 MCU at 128 MHz, 1524KB flash, 256 KB RAM
- Pads for external antenna connection.
- Size: 6.0x6.3 mm

2. BC15M Specifications

Nordic SoCs

A block diagram of nRF54L15 is below. This is an ultra-low power SoC with advanced security features, a range of peripherals, and a multiple protocol 2.4 GHz transceiver. It supports Bluetooth Low Energy (BLE), IEEE 802.15.4 for Thread and Zigbee protocols, and allows for the implementation of proprietary 2.4 GHz protocols.



The main processing unit is an ARM Cortex M33 processor running at up to 128 MHz, supported by nonvolatile RRAM and RAM memory. The ARM Cortex M33 has a full set of digital processing (DSP) instructions and a memory protection unit (MPU) for application security. The full-featured single-precision floating-point unit (FPU) supports all single-precision instructions.

The peripheral set offers a variety of analog and digital functionality enabling single chip implementation of a wide range of applications. Hardware isolation between the secure and non-secure resources, as defined by ARM TrustZone, is implemented in the device. The hardware peripherals can be configured as secure or non-secure.

A key management unit (KMU) provides key storage, that when combined with a cryptographic accelerator (CRACEN), ensures discretion of encryption keys even within the secure world. The cryptographic accelerator has protection against differential power analysis (DPA) attacks.

The device has measures to protect against physical security attacks. It can detect and report fault injection attacks such as voltage glitching or electromagnetic fault injection. An external active shield I/O interface provides PCB or product level security for the detection of a product's encapsulation being opened, or product tampering.

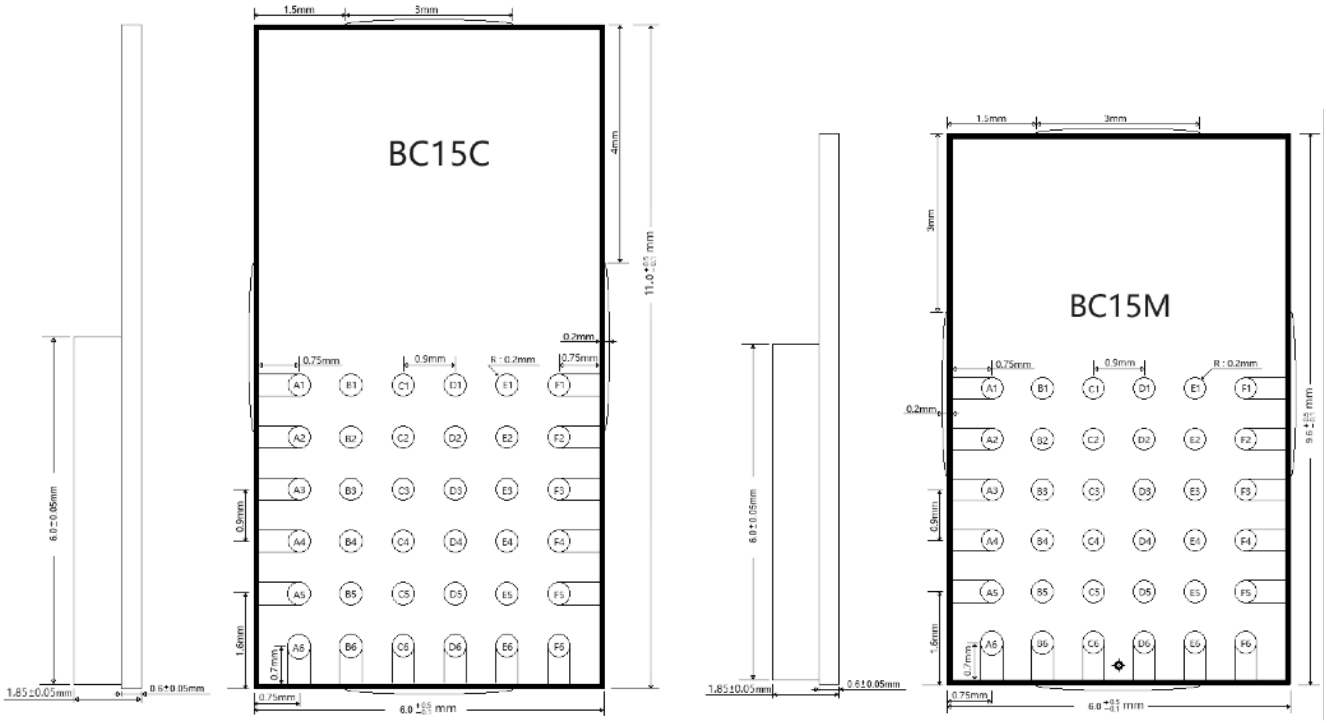
The device non-volatile memory has a boot region that can be made immutable before the CPU starts up. Boot initiated from an immutable source allows subsequent boot steps to be performed by authenticated code.

The debug access port can be enabled or disabled to allow either non-intrusive or intrusive debugging, from secure or non secure worlds. The non volatile memory can be protected against erasing, providing protection from unauthenticated repurposing. Authenticated debug access control, such as facilitating the ARM ADAC architecture, is supported through a hardware mailbox. The mailbox allows on-chip firmware to authenticate the debug host before enabling the device debug interface.

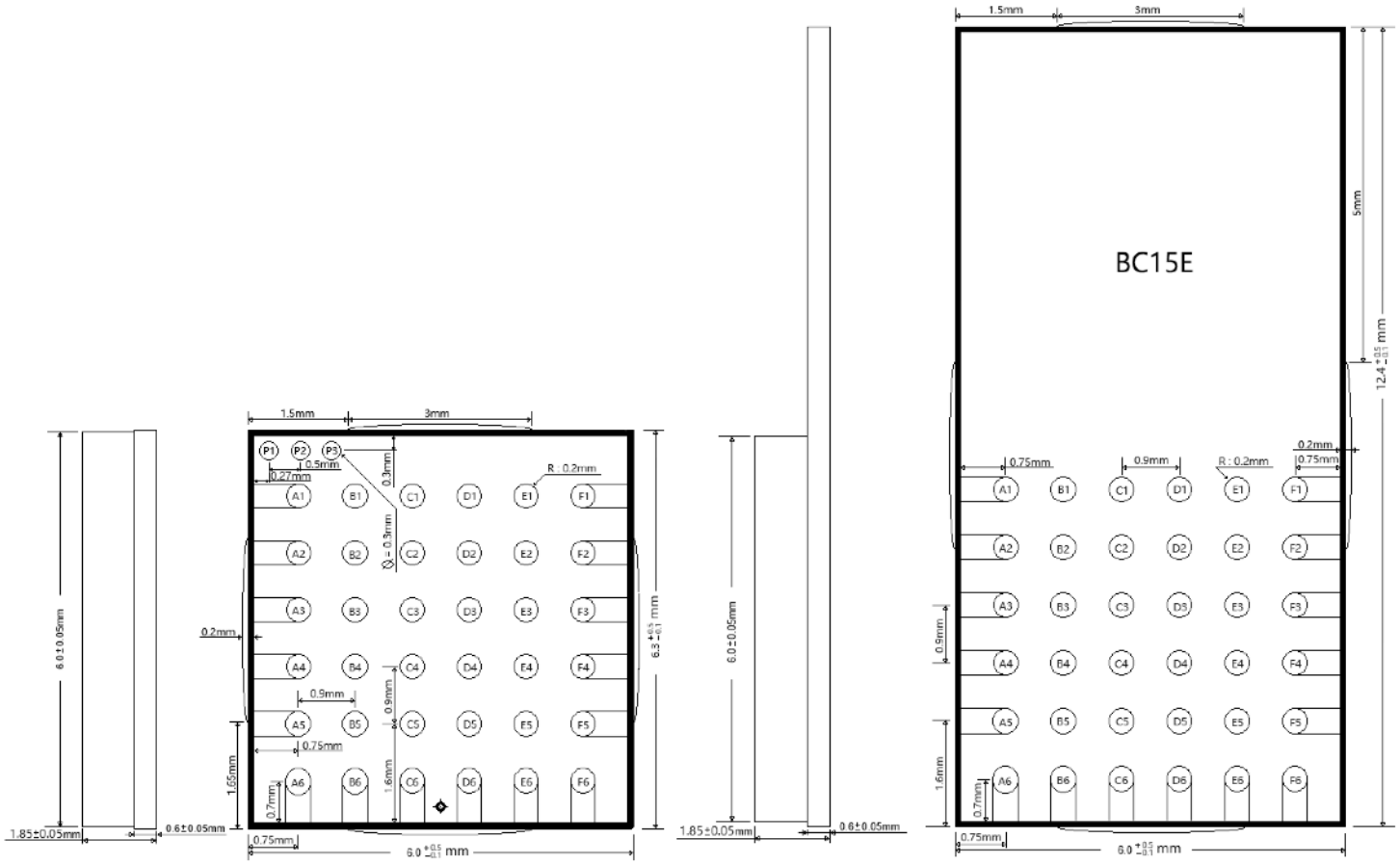
The device has a dedicated RISC-V CPU (VPR), which is a fast, lightweight peripheral processor (FLPR) dedicated for software defined peripherals.

Mechanical Drawings

BC15C and BC15M mechanical drawings, top view.



BC15P and BC15E mechanical drawings, top view.

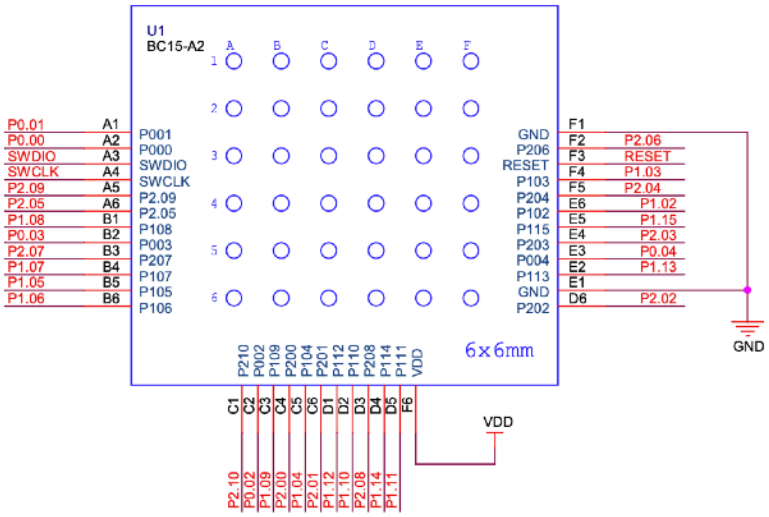


Library components for Altium, PADS and EAGLE can be downloaded from the Fanstel website.

For other PCB layout tools, please download evaluation Gerber files and extract library component.

BC15C Pin Functions

The following is a pin map of BC15C Series modules.

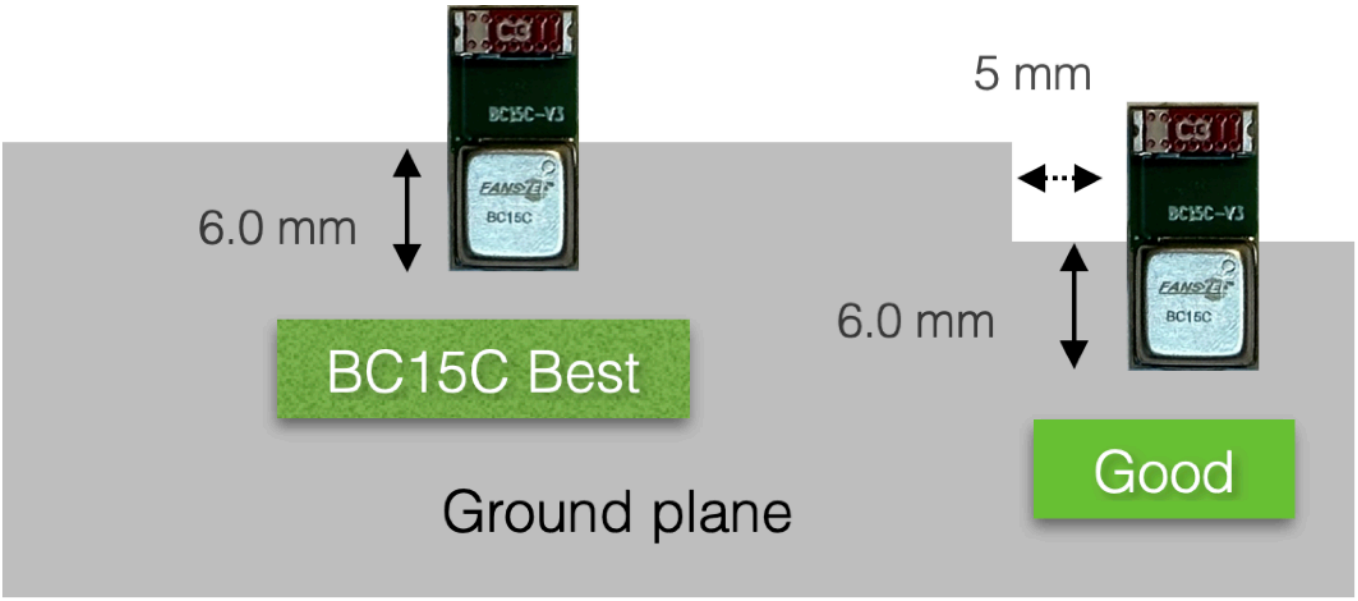


BC15C Pin Functions

Module	BC15C	nRF54L15		
pin#		pin#	Name	Descriptions
A1	P001	F1	P0.01	GPIO
A2	P000	G1	P0.00	GPIO
A3	SWDIO	F2	SWDIO	Serial Wire Debug, Data
A4	SWDCLK	E3	SWDCLK	Serial Wire Debug, Clock
A5	P209	F3	P2.09	GPIO
A6	P205	G5	P2.05	GPIO
B1	P108	F7	P1.08	GPIO
B2	P003	E1	P0.03	GPIO
B3	P207	E4	P2.07	GPIO
B4	P107	E7	P1.07/AIN3	GPIO, Analog input
B5	P105	E6	P1.05/AIN1	GPIO, Analog input
B6	P106	D7	P1.06/AIN2	GPIO, Analog input
C1	P210	G2	P2.10	GPIO
C2	P002	E2	P0.02	GPIO
C3	P109	B3	P1.09	GPIO
C4	P200	G6	P2.00	GPIO
C5	P104	D6	P1.04/AIN0	GPIO, Analog input
C6	P201	G7	P2.01	GPIO
D1	P112	A3	P1.12/AIN5	GPIO, Analog input
D2	P110	C3	P1.10	GPIO
D3	P208	D4	P2.08	GPIO
D4	P114	B5	P1.14/AIN7	GPIO, Analog input
D5	P111	C4	P1.11/AIN4	GPIO, Analog input
D6	P202	F6	P2.02	GPIO
E1	GND	A6	VSS	Ground
E2	P113	B4	P1.13/AIN6	GPIO, Analog input
E3	P004	D3	P0.04	GPIO
E4	P203	E6	P2.03	GPIO
E5	P115	B6	P1.15	GPIO
E6	P102	C7	P1.02/NFC1	GPIO, NFC Connection
F1	GND	G4	GND	Ground
F2	P206	F4	P2.06	GPIO
F3	/RESET	D2	/RESET	/Reset, active low.
F4	P103	D5	P1.03/NFC2	GPIO, NFC Connection
F5	P204	F5	P2.04	GPIO
F6	VDD	G3	VDD	DC power supply, 2.6V for rev A; 1.8 to 3.6V for rev B.

Mounting BC15C on the Host PCB

The following figure shows recommended mounting of BC15C module on the host PCB.



- For the best Bluetooth range performance, the upper edge of the RFI shield shall align with the upper edge of the ground plane on host PCB board, the height of the RFI shield is 6.0mm.
- The next choice is to place a module on a corner of host PCB, the upper edge of the RFI shield shall align with the upper edge of ground plane. Ground plane shall be at least 5 mm from the edge of the antenna area of module.
- We don’t recommend mounting BC15C module in the middle of a host PCB.

For the best Bluetooth range performance, keep all external metal at least 30mm from the antenna area.

3. Evaluation Board

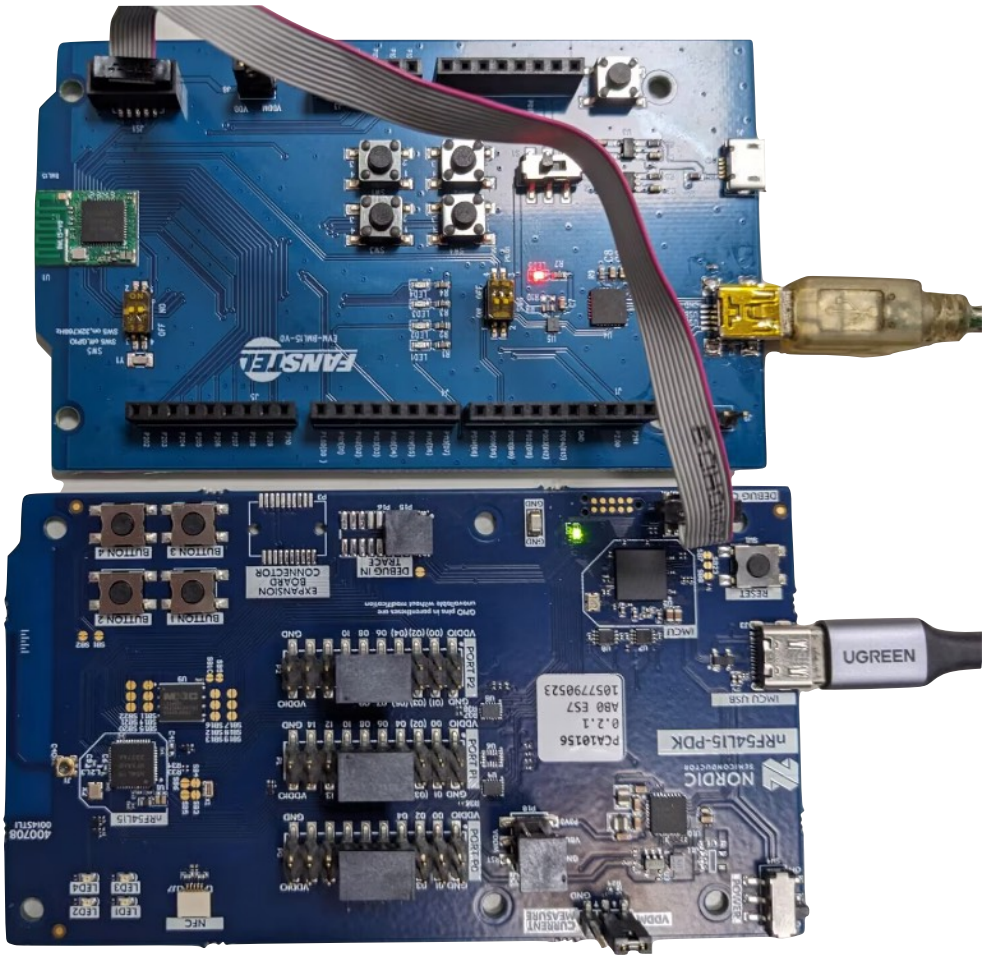
An evaluation board can be used to evaluate performance of module and to develop and test your firmware before an application-specific host board is developed.

Loading Firmware into Evaluation Board Through a Nordic DK

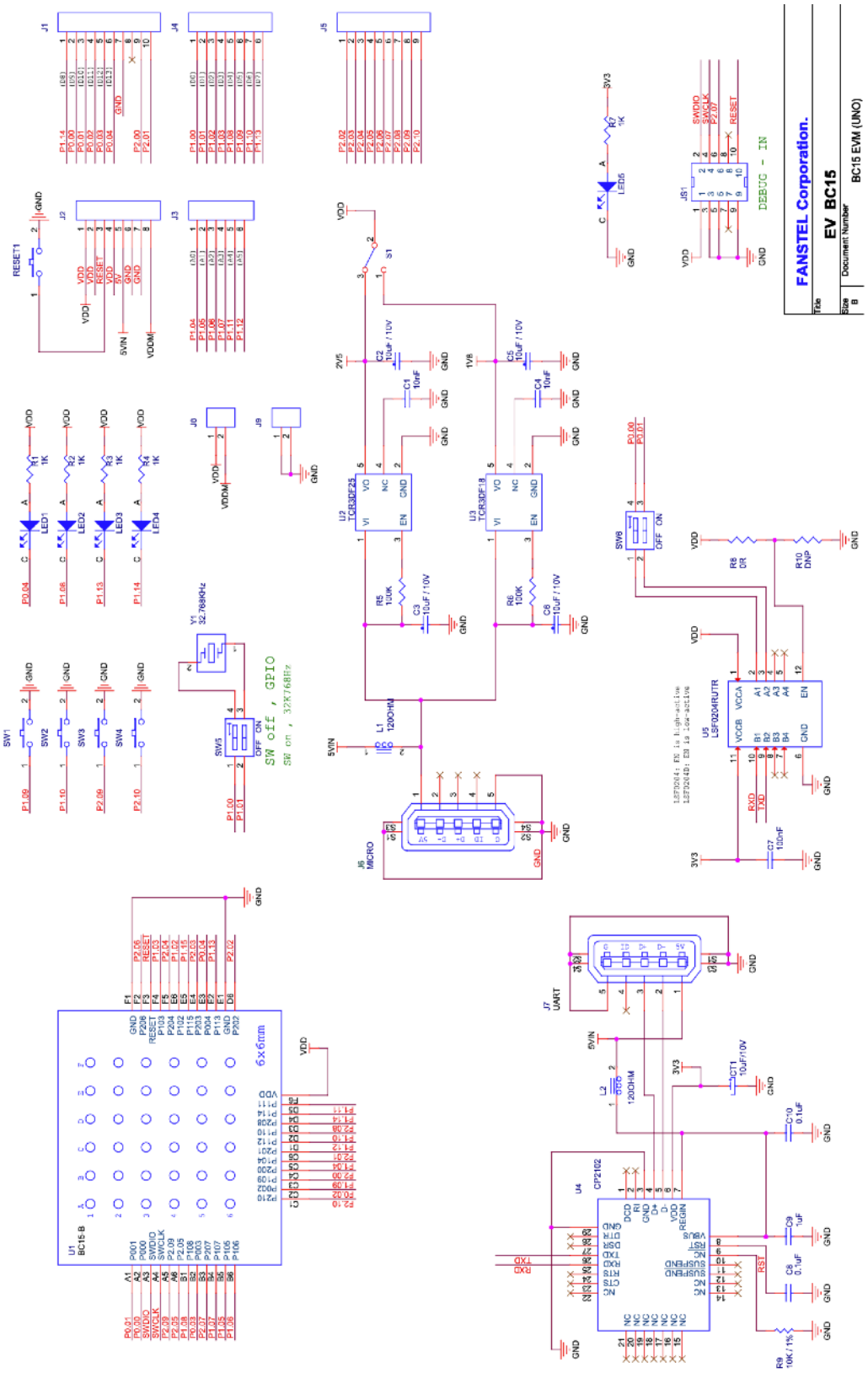
A Nordic nRF54L15 DK is required to load firmware into EV-BC15C.

Procedures to connect a Nordic DK to a Fanstel nRF54 module evaluation board.

- Connect Nordic nRF54L15 DK debug out to Fanstel evaluation board debug in using the 10-pin flat cable as shown below.
- Connect Nordic nRF54L15 DK to PC.
- Connect a DC power source to micro or mini USB port of evaluation board.



EV-BC15C Schematics



4. Firmware Development

Procedures to Load Firmware

EV-BC15C hex codes and source codes can be downloaded from the Fanstel website.

Open command line tool and execute the programming commands.

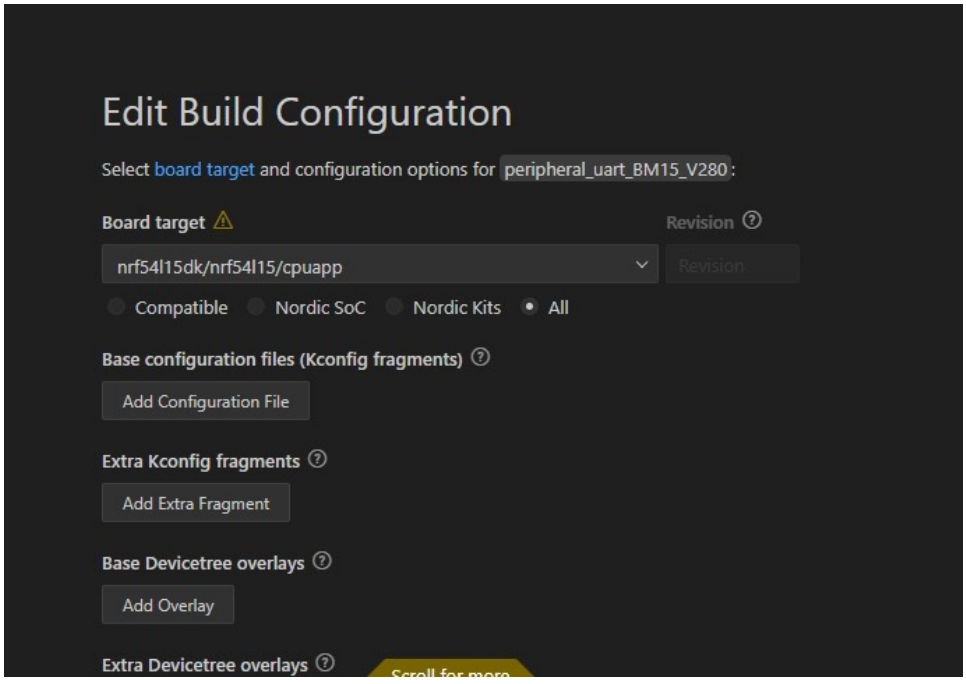
nrfjprog -f NRF54L --recover

nrfjprog -f NRF54L --program BML15_231129.hex --chiperase --verify —reset

```
C:\Users\Leo\Desktop\Nordic_Firmware\BML15_231129\HEX>nrfjprog -f NRF54L --recover
Recovering device. This operation might take 30s.
Erasing user code and UICR flash areas.

C:\Users\Leo\Desktop\Nordic_Firmware\BML15_231129\HEX>nrfjprog -f NRF54L --program BML15_231129.hex --chiperase --verify
 --reset
[ ##################### ]   0.261s | Erase file - Done erasing
[ ##################### ]   3.951s | Program file - Done programming
[ ##################### ]   1.720s | Verify file - Done verifying
Applying system reset.
Run.

C:\Users\Leo\Desktop\Nordic_Firmware\BML15_231129\HEX>
```

Setting Up Firmware Development Environment

Please use nRF Connect SDK version 2.8.0 or newer for development. The previous versions of nRF Connect SDK do not support the BM15C. Please select the board nrf54l15dk/nrf54l15/cupapp. nRF54L15 silicon.



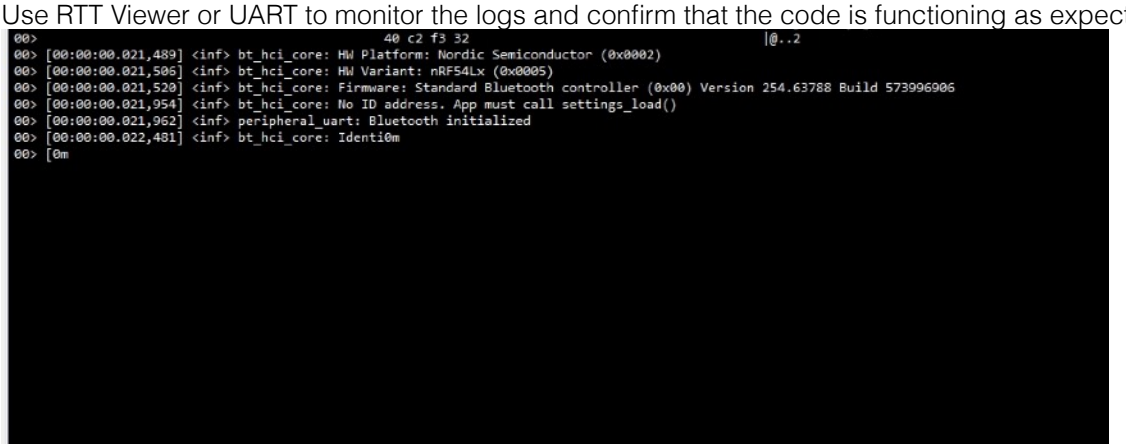
Create an overlay file to configure the hardware peripherals to match your specific hardware. The following is an example setup for the nrf54l15dk/nrf54l15.overlay file.

```
//-----------------------------------------------------------
//OSC32KRC.INTCAP 0x50120904
//"nordic,nrf-lfxo".yaml([4000:18000] ,step 500)
&lfxo {
    load-capacitors = "internal";
    load-capacitance-femtofarad = <15500>;
};

&pinctrl {
    /omit-if-no-ref/ uart20_default: uart20_default {
        group1 {
            psels = <NRF_PSEL(UART_TX, 1, 13)>;
        };
        group2 {
            psels = <NRF_PSEL(UART_RX, 1, 14)>;
            bias-pull-up;
        };
    };

    /omit-if-no-ref/ uart20_sleep: uart20_sleep {
        group1 {
            psels = <NRF_PSEL(UART_TX, 1, 13)>,
                <NRF_PSEL(UART_RX, 1, 14)>;
            low-power-enable;
        };
    };
};

&uart20 {
    status = "okay";
    current-speed = <115200>;
    pinctrl-0 = <&uart20_default>;
    pinctrl-1 = <&uart20_sleep>;
    pinctrl-names = "default", "sleep";
```

After completing the setup, build and flash the code. Ensure that the code is running properly.

```
Restore: CONFIG_MBEDTLS_PSA_CRYPTO_C: True
Restore: CONFIG_MBEDTLS_PSA_CRYPTO_KEY_ID_ENCODES_OWNER: False
Restore: CONFIG_MBEDTLS_PSA_CRYPTO_SPM: False
Restore: CONFIG_MBEDTLS_USE_PSA_CRYPTO: True
Restore: CONFIG_MBEDTLS_PLATFORM_PRINTF_ALT: False
Restore: CONFIG_MBEDTLS_THREADING: False
Restore: CONFIG_MBEDTLS_THREADING_ALT: True
========== End psa_crypto_library_config ==============
CMake Warning at C:/nRF91_241105_V280/v2.8.0/zephyr/CMakeLists.txt:2134 (message):
  __ASSERT() statements are globally ENABLED


-- Configuring done
-- Generating done
-- Build files have been written to: C:/MyNordicTestV280/peripheral_uart_BM15_V280/build/peripheral_uart_BM15_V280
-- Configuring done
-- Generating done
-- Build files have been written to: C:/MyNordicTestV280/peripheral_uart_BM15_V280/build
[68/68] Linking C executable zephyr\zephyr.elf
Memory region         Used Size  Region Size  %age Used
           FLASH:      240056 B      1420 KB     16.51%
             RAM:       37044 B       188 KB     19.24%
       IDT_LIST:          0 GB        32 KB      0.00%
Generating files from C:/MyNordicTestV280/peripheral_uart_BM15_V280/build/peripheral_uart_BM15_V280/zephyr/zephyr.elf for
[5/5] Generating ../merged.hex
 *  Terminal will be reused by tasks, press any key to close it.
```

Use RTT Viewer or UART to monitor the logs and confirm that the code is functioning as expected.



Using Internal Load Capacitors for the High Frequency Oscillator

The external load capacitors for the 32MHz crystal are not mounted. An Epson or equivalent +/-10 PPM crystal is connected to XC1 and XC2 pins. The Bluetooth signal frequencies are within specifications if the internal load capacitors are not enabled. Use the following procedures to set the internal load capacitors to:

The internal load capacitors can be programmed from 4.0 pF to 17pF in 0.5 pF steps. The addresses and description of registers for programming the value of load capacitors are from the nRF54L15 product specifications.

To set up the internal capacitance, please configure it in the overlay file.

XOSC32M.CONFIG.INTCAP step 0.25 pf

```
&hfxo {
        load-capacitors = "internal";
        load-capacitance-femtofarad = <17000>;
};
```

XOSC32KI.INTCAP step 0.5 pf

```
&lfxo {
   load-capacitors = "internal";
   load-capacitance-femtofarad = <7000>;
};
```

Read the memory back to confirm.

nrfjprog --memrd 0x5012071C

The internal load capacitance shall be set to 17 pF for BM15C, BM15E, and BM15M modules.

Suggestion for Battery Power Application

Standby current consumption is important for battery-powered product. You can enable the embedded 32.768 kHz crystal to reduce power consumption. The 32MHz main clock won't be active at idle state to save power.

Two inductors required for DCDC converter are inside BC15C module. You can enable DCDC to lower power consumption.

Preloaded Firmware

Modules are loaded with production test codes. Please erase them before use.

The nRF54L15 SoC is not supported for production in nRF Connect SDK v2.9.0.

Please use version 2.9.1 or later.

Nordic has recently updated the CONFIG_MPSL_HFCLK_LATENCY setting in their SDK.

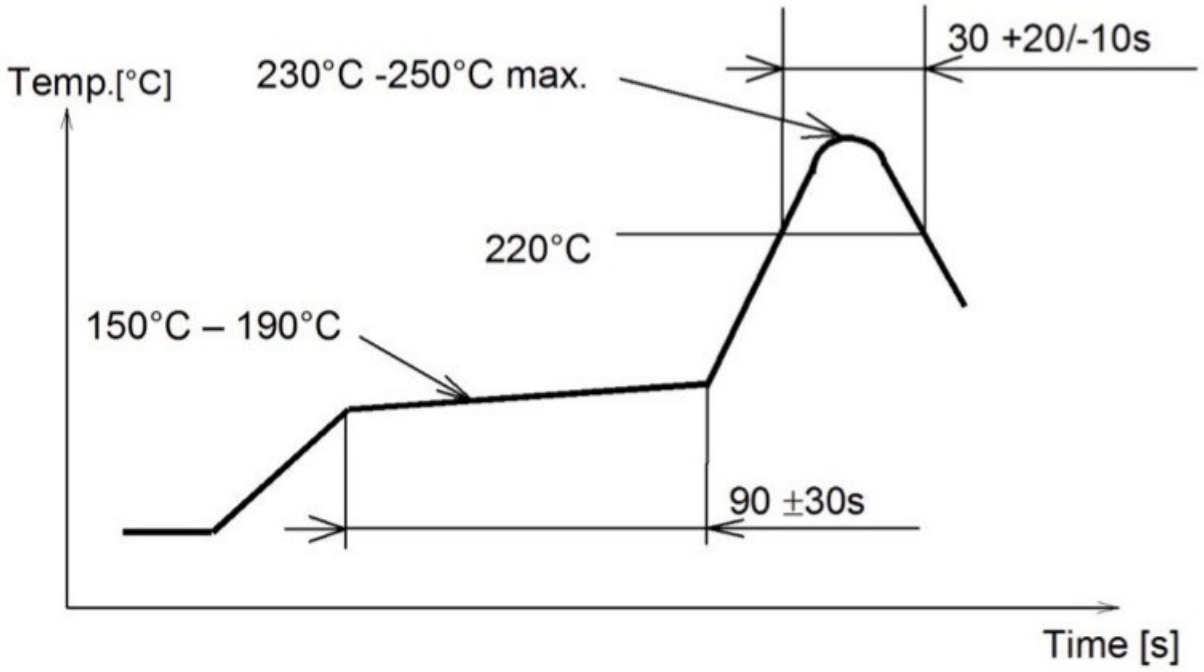
As part of this change, the function mpsl_clock_hfclk_latency_set() was introduced.

The updated SDK reduces latency time. To prevent BLE connection issues, please set `CONFIG_MPSL_HFCLK_LATENCY` to **1400**

5. Miscellaneous

Soldering Temperature-Time Profile for Re-Flow Soldering

Maximum number of cycles for re-flow is 2. No opposite side re-flow is allowed.



Cautions, Design Notes, and Installation Notes

Failure to follow the guidelines set forth in this document may result in degrading of the product's functions and damage to the product.

Design Notes

(1) Follow the conditions written in this specification, especially the control signals of this module.

(2) The supply voltage has to be free of AC ripple voltage (for example from a battery or a low noise regulator output). For noisy supply voltages, provide a decoupling circuit (for example a ferrite in series connection and a bypass capacitor to ground of at least 47uF directly at the module).

(3) This product should not be mechanically stressed when installed.

(4) Keep this product away from heat. Heat is the major cause of decreasing the life of these products.

(5) Avoid assembly and use of the target equipment in conditions where the products' temperature may exceed the maximum tolerance.

(6) The supply voltage should not be exceedingly high or reversed. It should not carry noise and/or spikes.

(7) this product away from other high frequency circuits.

Notes on Antenna and PCB Layout

(1) Don't use a module with internal antenna inside a metal case.

(2) For PCB layout:

- Avoid running any signal line below module whenever possible,
- No ground plane below antenna,
- If possible, cut-off the portion of main board PCB below antenna.

Installation Notes

(1) Reflow soldering is possible twice based on the time-temperature profile in this data sheets. Set up the temperature at the soldering portion of this product according to this reflow profile.

(2) Carefully position the products so that their heat will not burn into printed circuit boards or affect the other components that are susceptible to heat.

(3) Carefully locate these products so that their temperatures will not increase due to the effects of heat generated by neighboring components.

(4) If a vinyl-covered wire comes into contact with the products, then the cover will melt and generate toxic gas, damaging the insulation. Never allow contact between the cover and these products to occur.

(5) This product should not be mechanically stressed or vibrated when reflowed.

(6) If you want to repair your board by hand soldering, please keep the conditions of this chapter.

(7) Do not wash this product.

(8) Refer to the recommended pattern when designing a board.

(9) Pressing on parts of the metal cover or fastening objects to the metal will cause damage to the unit.

(10) For more details on LGA (Land Grid Array) soldering processes refer to the application note.

Usage Condition Notes

(1) Take measures to protect the unit against static electricity. If pulses or other transient loads (a large load applied in a short time) are applied to the products, check and evaluate their operation before assembly on the final products.

(2) Do not use dropped products.

(3) Do not touch, damage or soil the pins.

(4) Follow the recommended condition ratings about the power supply applied to this product.

(5) Electrode peeling strength: Do not add pressure of more than 4.9N when soldered on PCB

(6) Pressing on parts of the metal cover or fastening objects to the metal cover will cause damage.

(7) These products are intended for general purpose and standard use in general electronic equipment, such as home appliances, office equipment, information and communication equipment.

Storage Notes

(1) The module should not be stressed mechanically during storage.

(2) Do not store these products in the following conditions or the performance characteristics of the product, such as RF performance will be adversely affected:

- Storage in salty air or in an environment with a high concentration of corrosive gas.
- Storage in direct sunlight

- Storage in an environment where the temperature may be outside the range specified.
- Storage of the products for more than one year after the date of delivery storage period.

(3) Keep this product away from water, poisonous gas and corrosive gas.

(4) This product should not be stressed or shocked when transported.

(5) Follow the specification when stacking packed crates (max. 10).

Safety Conditions

These specifications are intended to preserve the quality assurance of products and individual components. Before use, check and evaluate the operation when mounted on your products. Abide by these specifications, without deviation when using the products. These products may short-circuit. If electrical shocks, smoke, fire, and/or accidents involving human life are anticipated when a short circuit occurs, then provide the following failsafe functions, as a minimum.

(1)Ensure the safety of the whole system by installing a protection circuit and a protection device.

(2)Ensure the safety of the whole system by installing a redundant circuit or another system to prevent a dual fault causing an unsafe status.

Other Cautions

(1)This specification sheet is copyrighted. Reproduction of this data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices.

(2)Do not use the products for other purposes than those listed.

(3)Be sure to provide an appropriate failsafe function on your product to prevent an additional damage that may be caused by the abnormal function or the failure of the product.

(4)This product has been manufactured without any ozone chemical controlled under the Montreal Protocol.

(5)These products are not intended for other uses, other than under the special conditions shown below. Before using these products under such special conditions, check their performance and reliability under the said special conditions carefully to determine whether or not they can be used in such a manner.

- In liquid, such as water, salt water, oil, alkali, or organic solvent, or in places where liquid may splash.
- In direct sunlight, outdoors, or in a dusty environment
- In an environment where condensation occurs.
- In an environment with a high concentration of harmful gas.

(6) If an abnormal voltage is applied due to a problem occurring in other components or circuits, replace these products with new products because they may not be able to provide normal performance even if their electronic characteristics and appearances appear satisfactory.

(7) When you have any question or uncertainty, contact Fanstel.

Packaging

Production modules are delivered in reel, 1000 modules in each reel.

FCC LABEL

The Original Equipment Manufacturer (OEM) must ensure that the OEM modular transmitter must be labeled with its own FCC ID number. This includes a clearly visible label on the outside of the final product enclosure that displays the contents shown below. If the FCC ID is not visible when the equipment is installed inside another device, then the outside of the device into which the equipment is installed must also display a label referring to the enclosed equipment

The end product with this module may subject to perform FCC part 15 unintentional emission test requirement and be properly authorized.

This device is intended for OEM integrator only.

6. Revision History

- Nov. 2024, Ver. 0.70: The first draft release.
- May 2025, Ver. 0.90: Update module specs.
- July 2025, Ver. 1.00: Initial release.
- Oct.2025, Ver. 1.01:Add product photos.

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