IACT02 Bluetooth Module

DATA SHEET

Contents

1. Product Instruction

IACT02 series is a powerful, highly flexible, ultra low power **Bluetooth® 5** module based on **Nordic® Semiconductor nRF52832 SoC** solution, which has a 32bit Arm® Cortex™-M4 CPU with floating point unit running at 64MHz.

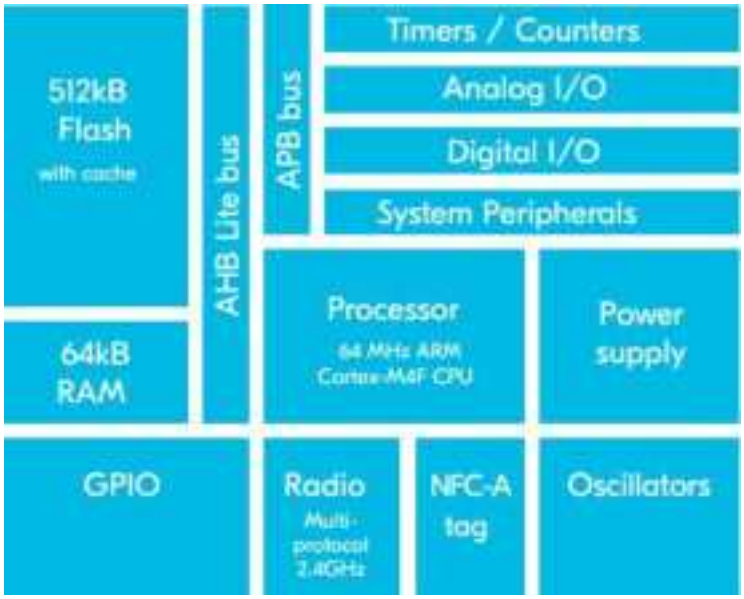
IACT02 module is multiprotocol capable with full protocol concurrency. It supports **BLE®** (Bluetooth Low Energy). Bluetooth mesh can be run concurrently with Bluetooth LE, enabling smartphones to provision, commission, configure and control mesh nodes. NFC, ANT and 2.4GHz proprietary protocols are also supported.

IACT02 module is a device to enable Bluetooth communication of the product to be installed and The product equipped with the module can be monitored and controlled through Bluetooth communication.

Module is limited to OEM installation ONLY and OEM integrators is responsible for ensuring that the end-user has no manual instructions to remove or install module. Module is limited to installation in mobile or fixed applications, according to Part 2.1091(b).)

Separate approval is required for all other operating configurations, including portable configurations with respect to Part 2.1093 and different antenna configuration

1.1. Key Features



- Bluetooth 5
    - CSA#2
    - Advertising Extensions

- 512kB Flash and 64kB RAM
- Supports 1 Mbps Bluetooth LE modes
- Sensitivity of -96 dBm for Bluetooth LE
- Wide supply voltage range: 1.7 V to 3.6 V
- Full set of digital interfaces including: SPI, 2-wire, I²S, UART, PDM, QDEC with EasyDMA
- 12-bit, 200ksps ADC

128-bit AES ECB/CCM/AAR co-processor

- RAM mapped FIFOs using EasyDMA
- Type 2 near field communication (NFC-A) tag with wakeup-on-field and touch-to-pair capabilities (P09 and P10)
- RAM mapped FIFOs using EasyDMA
- Individual power management for all peripherals
- On-chip DC/DC buck converter
- Small size: 18.0 x33 x 4.3mm (with shield)
- 30 GPIOs

1.2. Applications

- **IoT**
  - Home automation
  - Sensor networks
  - Building automation
  - Industrial automation
- **Personal area networks**
  - Health/fitness sensor and monitor devices
  - Medical devices
  - Key fobs and wrist watches
- **Interactive entertainment devices**
  - Remote controls
  - Gaming controllers
  - VR/AR
- **Beacons**
- **A4WP wireless chargers and devices**
- **Remote control toys**
- **Computer peripherals and I/O devices**
  - Mouse
  - Keyboar

1.3. Product Specifications

Detail	Description
Bluetooth	
Features	Bluetooth® Low Energy 1M LE PHY Advertising Extensions CSA #2
Security	AES-128
LE connections	Concurrent central, observer, peripheral, and broadcaster roles with up to twenty concurrent connections along with one observer and one broadcaster
Radio	
Frequency	2402MHz - 2480MHz
Modulations	GFSK at 1 Mbps data rates
Transmit power	+4 dBm maximum Configurable down to -40dBm
Receiver sensitivity	-96 dBm in 1 Mbps Bluetooth® low energy mode -93 dBm in 1 Mbps ANT mode -30 dBm in whisper mode
Antenna	AL931C5-Chip Antenna
Current consumption	
TX only (DCDC enabled, 3V) @ +4dBm / 0dBm / -4dBm/-20dBm/-40dBm	7.5mA / 5.3mA / 4.2mA / 3.2mA / 2.7mA
TX only @ +4dBm / 0dBm / -4dBm / -20dBm / -40dBm	16.6mA / 11.6mA / 9.3mA / 7.0mA / 5.9mA
RX only (DCDC enabled, 3V) @1Msps / 1Msps BLE	5.4mA
RX only @ 1Msps / 1Mbps BLE	11.7mA
RX only (DCDC enabled, 3V) @2Msps / 2Msps BLE	5.8mA
RX only @ 2Msps / 2Mbps BLE	12.9mA
System OFF mode(3V)	0.3uA
System OFF mode with full 64 kB RAM retention(3V)	0.7uA
System ON mode, no RAM retention, wake on RTC(3V)	1.9uA
Mechanical design	
Dimensions	Length: 33mm±0.2mm Width: 18mm±0.2mm Height: 4.3mm+0.1mm/-0.15mm
Package	40 Plated Half-hole pins
PCB material	FR-4
Impedance	50Ω

IACT02 Bluetooth Module

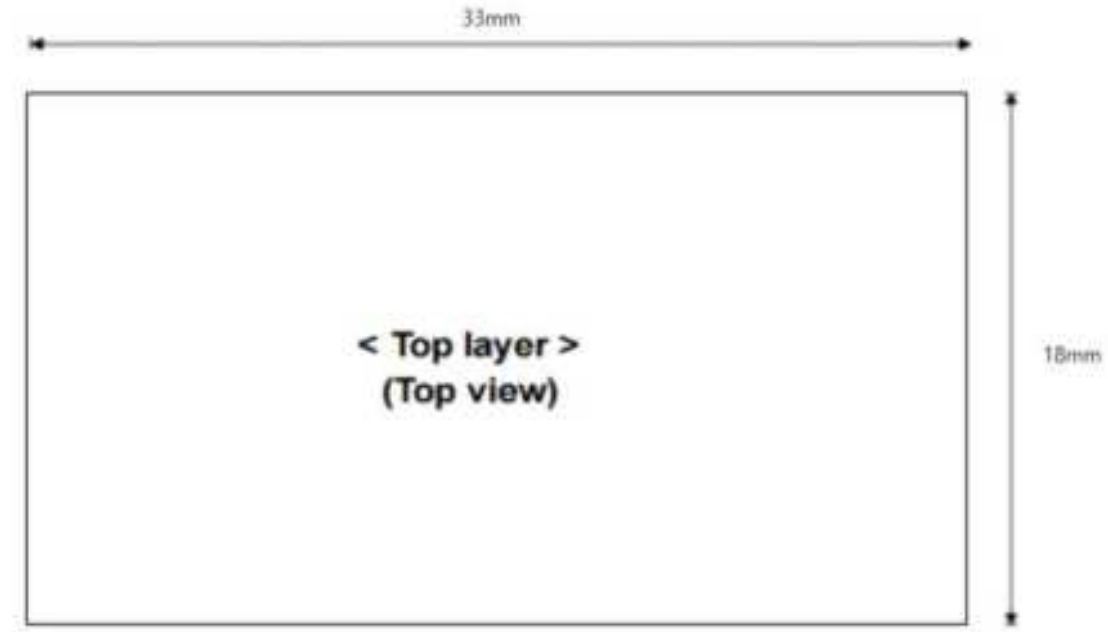
Datasheet

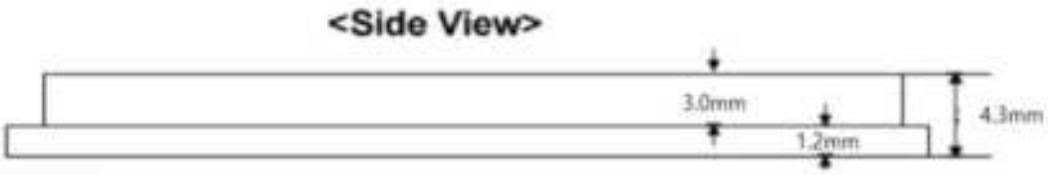
Detail	Description
Hardware	
CPU	ARM® Cortex®-M4 32-bit processor with FPU, 64MHz
Memory	512 kB flash, 64 kB RAM
Interfaces	3x SPI master/slave with EasyDMA 2x I2C compatible 2-wire master/slave 30 GPIOs 8x 12 bit, 200ksps ADC 3x real-time counter (RTC) 3x 4-channel pulse width modulator (PWM) unit with EasyDMA UART (CTS/RTS) with EasyDMA I2S with EasyDMA Digital microphone interface (PDM) Quadrature decoder (QDEC) NFC-A Tag
Power supply	1.7V to 3.6V
Operating temperature range	-40 to 85°C
Clock control	32.768 kHz +/-20 ppm crystal oscillator
Power regulator	DC/DC regulator setup

2. Mechanical Specifications

2.1. Module Mechanical Dimensions

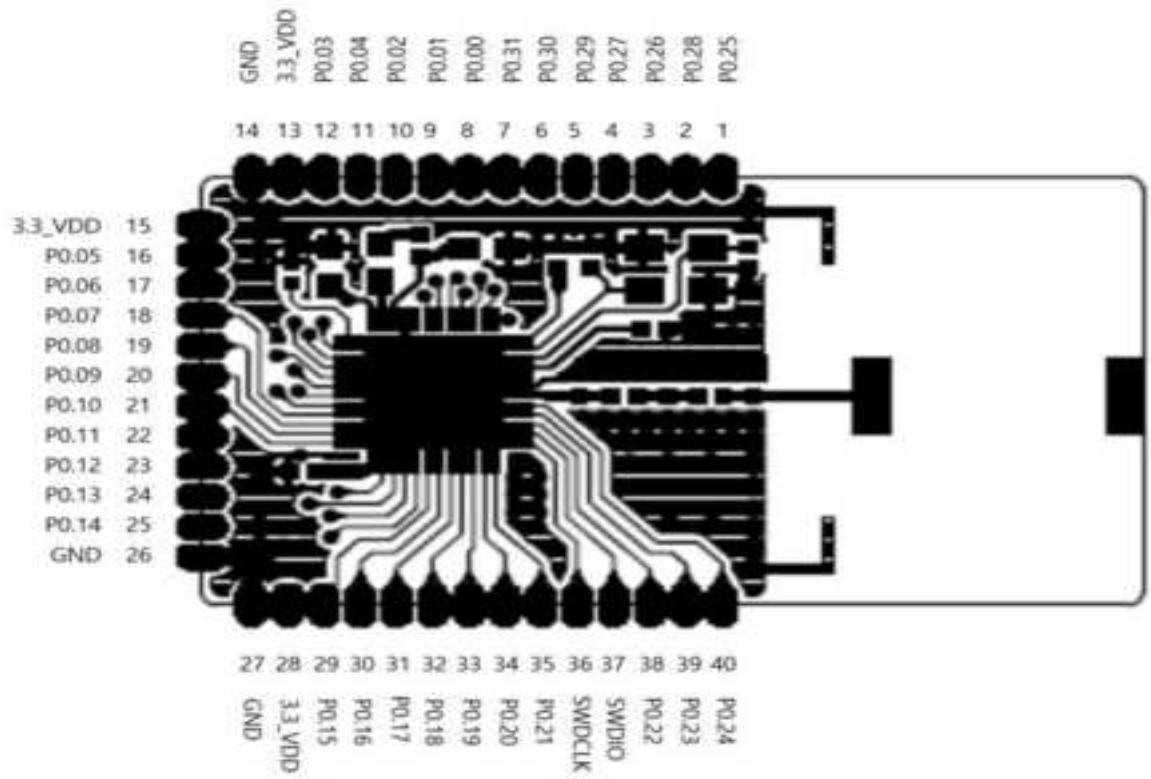
Dimension	18mm(W) x 33mm(L) x Max 4.3mm(H)





(Unit : mm)

3. Pin Assignment



IACT02 module pin diagram

Pin	Pin Name	Pin Type	Description
1	P0.25	Digital I/O	General purpose I/O
2	P0.28	AIN4	SAADC/COMP/LPCOMP input
3	P0.26	Digital I/O	General purpose I/O
4	P0.27	Digital I/O	General purpose I/O
5	P0.29	AIN5	SAADC/COMP/LPCOMP input
6	P0.30	AIN6	SAADC/COMP/LPCOMP input
7	P0.31	AIN7	SAADC/COMP/LPCOMP input
8	P0.00	Digital I/O	General purpose I/O
9	P0.01	Digital I/O	General purpose I/O
10	P0.02	AIN0	SAADC/COMP/LPCOMP input
11	P0.04	AIN2	SAADC/COMP/LPCOMP input
12	P0.03	AIN1	SAADC/COMP/LPCOMP input

Pin	Pin Name	Pin Type	Description
13	3.3_VDD	Power	Power supply
14	GND	GND	Ground
15	3.3_VDD	Power	Power supply
16	P0.05	AIN3	SAADC/COMP/LPCOMP input
17	P0.06	Digital I/O	General purpose I/O
18	P0.07	Digital I/O	General purpose I/O
19	P0.08	Digital I/O	General purpose I/O
20	P0.09	NFC1	NFC antenna connection
21	P0.10	NFC2	NFC antenna connection
22	P0.11	Digital I/O	General purpose I/O
23	P0.12	Digital I/O	General purpose I/O
24	P0.13	Digital I/O	General purpose I/O
25	P0.14	Digital I/O	General purpose I/O
26	GND	GND	Ground
27	GND	GND	Ground
28	3.3_VDD	Power	Power supply
29	P0.15	Digital I/O	General purpose I/O
30	P0.16	Digital I/O	General purpose I/O
31	P0.17	Digital I/O	General purpose I/O
32	P0.18	Digital I/O	General purpose I/O
33	P0.19	Digital I/O	General purpose I/O
34	P0.20	Digital I/O	General purpose I/O
35	P0.21	Digital I/O	General purpose I/O
36	SWDCLK	Digital input	Serial wire debug clock input for debug and programming
37	SWDIO	Digital I/O	Serial wire debug I/O for debug and programming
38	P0.22	Digital I/O	General purpose I/O
39	P0.23	Digital I/O	General purpose I/O
40	P0.24	nRESET	Configurable as pin reset

4. Interfaces

4.1. Power Supply

Regulated power for the **IACT02** is required. The input voltage VCC range should be 1.7V to 3.6V. Suitable decoupling must be provided by external decoupling circuitry (10uF and 0.1uF). It can reduce the noise from power supply and increase power stability.

4.2. System Function Interfaces

4.2.1. GPIO

The general purpose I/O is organized as one port with up to 30 I/Os enabling access and control of up to 30 pins through one port. Each GPIO can be accessed individually with the following user configurable features:

- Input/output direction
- Output drive strength
- Internal pull-up and pull-down resistors
- Wake-up from high or low level triggers on all pins
- Trigger interrupt on all pins
- All pins can be used by the PPI task/event system; the maximum number of pins that can be interfaced through the PPI at the same time is limited by the number of GPIOTE channels
- All pins can be individually configured to carry serial interface or quadrature demodulator signals
- All pins can be configured as PWM signal

4.2.2. Two-wire Interface (I^2C Compatible)

The two-wire interface can communicate with a bi-directional wired-AND bus with two lines (SCL, SDA). The protocol makes it possible to interconnect up to 127 individually addressable devices. The interface is capable of clock stretching, supporting data rates of 100kbps ,250kbps and 400kbps. The module has 2 TWI ports and they properties like following table.

Instance	Master/Slave
TWI 0	Master
TWI 1	Master

4.2.3. Flash Program I/O

The module has two programmer pins, respectively SWDCLK pin and SWDIO pin. The two pin Serial Wire Debug (SWD) interface provided as a part of the Debug Access Port (DAP) offers a flexible and powerful mechanism for non- intrusive debugging of program code. Breakpoints and single

stepping are part of this support.

4.2.4. Serial Peripheral Interface

The SPI interfaces enable full duplex synchronous communication between devices. They support a three-wire (SCK, MISO, MOSI) bi-directional bus with fast data transfers. The SPI Master can communicate with multiple slaves using individual chip select signals for each of the slave devices attached to a bus. Control of chip select signals is left to the application through use of GPIO signals. SPI Master has double buffered I/O data. The SPI Slave includes EasyDMA for data transfer directly to and from RAM allowing Slave data transfers to occur while the CPU is IDLE. The GPIOs are used for each SPI interface line can be chosen from any GPIOs on the device and independently. This enables great flexibility in device pinout and efficient use of printed circuit board space and signal routing.

4.2.5. UART

The Universal Asynchronous Receiver/Transmitter offers fast, full-duplex, asynchronous serial communication with built-in flow control (CTS, RTS), support in hardware up to 1 Mbps baud. Parity checking is supported.

Note: The GPIOs are used for each SPI/TWI/UART interface line can be chosen from any GPIOs on the device and configured independently.

4.2.6. Low Power Comparator (LPCOMP)

In System ON, the block can generate separate events on rising and falling edges of a signal, or sample the current state of the pin as being above or below the threshold. The block can be configured to use any of the analog inputs on the device. Additionally, the low power comparator can be used as an analog wakeup source from System OFF or System ON. The comparator threshold can be programmed to a range of fractions of the supply voltage.

4.2.7. Analog to Digital Converter (ADC)

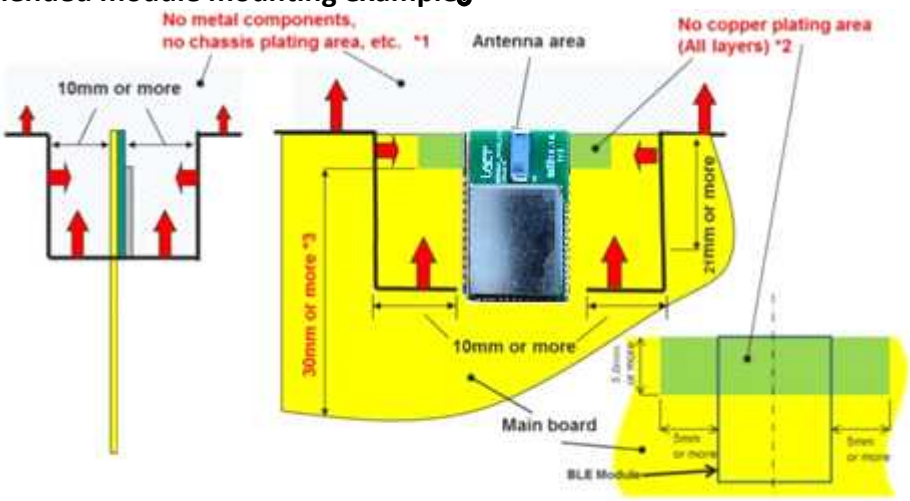
The 12bit incremental Analog to Digital Converter (ADC) enables sampling of up to 8 external signals through a front-end multiplexer. The ADC has configurable input and reference prescaling, and sample resolution (8,10, and 12bit).

- Note: The ADC module uses the same analog inputs as the LPCOMP module. Only one of the modules can be enabled at the same time.

5. Mounting Suggestion

You can refer to the following references for the mounting design of the module with on-board antenna

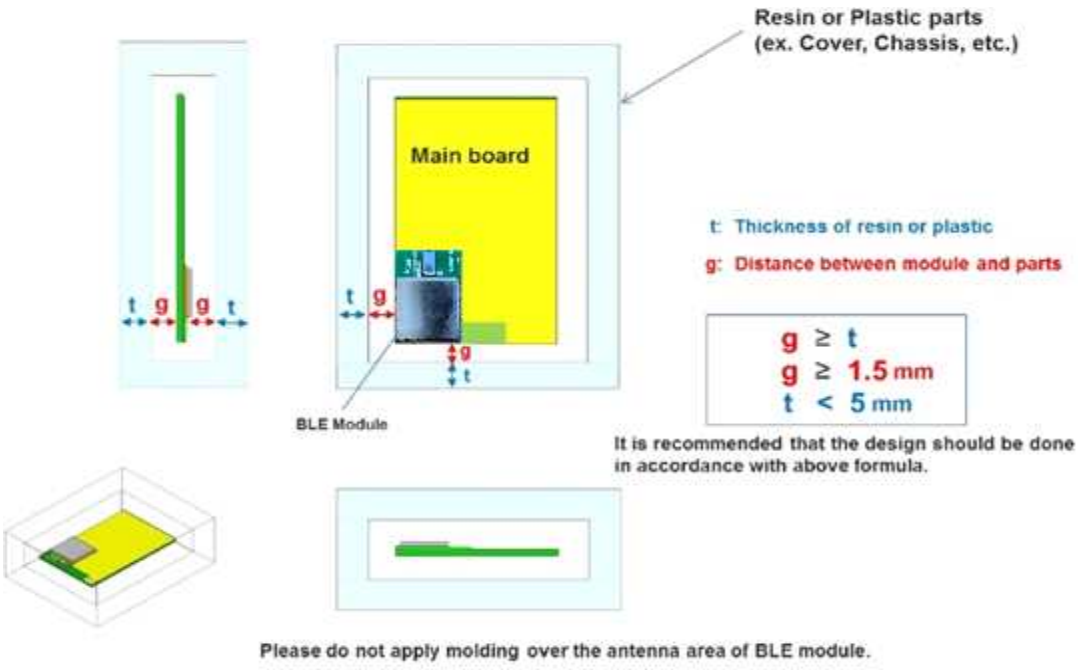
Recommended module mounting example



- Please do not place any metal components in blue shaded space(*1), such as signal line and metal chassis as possible except for main board while mounting the components in *1 space on the main board is allowed except for no copper plating area(*2).
- (*2)This area is routing prohibited area on the main board. Please do not place copper on any layer.
- (*3)Characteristics may deteriorate when GND pattern length is less than 30mm. It should be 30 mm or more as possible.
- For the best Bluetooth range performance, the antenna area of module shall extend 3 mm outside the edge of main board, or 3 mm outside the edge of a ground plane. Ground plane shall be at least 5 mm from the edge of the antenna area of module.
- All module GND pins MUST be connected to main board GND. Place GND vias close to module GND pads as possible. Unused PCB area on surface layer can flooded with copper but place GND vias regularly to connect copper flood to inner GND plane. If GND flood copper underside the module then connect with GND vias to inner GND plane.
- Even when above mentioned condition is satisfied, communication performance may be significantly deteriorated depending on the structure of the product. Bluetooth range performance is degraded if a module is placed in the middle of the main board.
- For main board layout:
  - Avoid running any signal line below module whenever possible.
  - No ground plane below antenna.
  - If possible, cut-off the portion of main board below antenna.

Other module mounting examples:

Placement of resin or plastic parts:



Placement of metal parts

- Minimum safe distance for metal parts without seriously compromising the antenna (tuning) is 40 mm top/bottom and 30 mm left or right.
- Metal close to the module antenna (bottom, top, left, right, any direction) will have degradation on the antenna performance. The amount of that degradation is entirely system dependent, meaning you will need to perform some testing with your host application.
- Any metal closer than 20 mm will begin to significantly degrade performance (S11, gain, radiation efficiency).
- It is best that you test the range with a mock-up (or actual prototype) of the product to assess effects of enclosure height (and materials, whether metal or plastic).

6. Cautions

6.1. Reflow Soldering

Reflow soldering is a vitally important step in the SMT process. The temperature curve associated with the reflow is an essential parameter to control to ensure the correct connection of parts. The parameters of certain components will also directly impact the temperature curve selected for this step in the process.

Temperature-Time Profile for Reflow Soldering:

- The standard reflow profile has four zones: **①preheat, ②soak, ③reflow, ④cooling**. The profile describes the ideal temperature curve of the top layer of the PCB.
- During reflow, modules should not be above 260°C and not for more than 30 seconds.

Specification	Value
Temperature Increase Rate	<2.5°C/s
Temperature Decrease Rate	Free air cooling
Preheat Temperature	0-150°C
Preheat Period (Typical)	40-90s
Soak Temp Increase Rate	0.4-1°C/s
Soak Temperature	150-200°C
Soak Period	60-120s
Liquidus Temperature (SAC305)	220°C
Time Above Liquidous	45-90s
Reflow Temperature	230-250°C
Absolute Peak Temperature	260°C

Example of MOKO SMT reflow soldering:

Note: The module is LGA package. Please be careful of the amount of solder paste. The module may be lifted due to excess solder.

6.2. Usage Condition Notes

- Follow the conditions written in this specification, especially the recommended condition ratings about the power supply applied to this product.
- 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).
- 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.
- The supply voltage should not be exceedingly high or reversed. It should not carry noise and/or spikes.
- This product away from other high frequency circuits.
- Keep this product away from heat. Heat is the major cause of decreasing the life of these products.
- Avoid assembly and use of the target equipment in conditions where the products' temperature may exceed the maximum tolerance.
- This product should not be mechanically stressed when installed.
- Do not use dropped products.
- Do not touch, damage or soil the pins.
- Pressing on parts of the metal shield or fastening objects to the metal shield will cause damage.

6.3. Storage Notes

- The module should not be stressed mechanically during storage.
- 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.
- Keep this product away from water, poisonous gas and corrosive gas.
- This product should not be stressed or shocked when transported.

7. Revision History

Revision	Description of changes	Approved	Revision Date
V1.0	Initial Release	Kenkim	2023.01.03

8. Installation and Precautions

1) The module is a device to enable bluetooth communication of the product to be installed.
2) The product equipped with the module can be monitored and controlled through bluetooth communication.
3) This module is mounted on the body using a SMD PAD.

   (PAD Pin map – Pin Description Note)
4) Module is limited to ODM installation ONLY.
5) ODM integrators is responsible for ensuring that the end-user has no manual instructions to remove or install module.
6) Module is limited to installation in mobile or fixed applications, according to Part 2.1091(b).
7) Separate approval is required for all other operating configurations, including portable configurations with respect to Part 2.1093 and different antenna configuration

Federal Communication Commission (FCC) Radiation Exposure statement

This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter. This modular must be installed and operated with a minimum distance of 20 cm between the radiator and user body.

FCC Caution

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 2.This device must accept any interference received, including interference that may cause undesired operation. Any changes or modifications not expressly approved by the party responsible for compliance could void the authority to operate equipment. The antenna(s) used for this transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

Grantees are responsible for the continued compliance of their modules to the FCC rules. This includes advising host product manufacturers that they need to provide a physical or e-label stating “Contains FCC ID” with their finished product. See Guidelines for Labeling and User Information for RF Devices –KDB Publication 784748.

Additional guidance for testing host products is given in KDB Publication 996369 D04 Module Integration Guide. Test modes should take into consideration different operational conditions for a stand-alone modular transmitter in a host, as well as for multiple simultaneously transmitting modules or other transmitters in a host product.

The grantee should provide information on how to configure test modes for host product evaluation for different operational conditions for a stand-alone modular transmitter in a host, versus with multiple, simultaneously transmitting modules or other transmitters in a host.
Grantees can increase the utility of their modular transmitters by providing special means, modes, or instructions that simulates or characterizes a connection by enabling a transmitter. This can greatly simplify a host manufacturer's determination that a module as installed in a host complies with FCC requirements.

The grantee should include a statement that the modular transmitter is only FCC authorized for the specific rule parts (i.e., FCC transmitter rules) listed on the grant, and that the host product manufacturer is responsible for compliance to any other FCC rules that apply to the host not covered by the modular transmitter grant of certification. If the grantee markets their product as being Part 15 Subpart B compliant (when it also contains unintentional-radiator digital circuity), then the grantee shall provide a notice stating that the final host product still requires Part 15 Subpart B compliance testing with the modular transmitter installed.

Requirements of KDB Publication 996369 D03

List of applicable FCC rules

This module has been granted modular approval as below listed FCC rule parts.

-FCC Rule parts 15C(15.247)

Summarize the specific operational use conditions

-The OEM integrator should use equivalent antennas which is the same type and equal or less gain then an antenna listed in 2.7 in this instruction manual.

RF exposure considerations

The module has been certified for integration into products only by OEM integrators under the following condition:

-The antenna(s) must be installed such that a minimum separation distance of at least 20 cm is maintained between the radiator (antenna) and all persons at all times.

-The transmitter module must not be co-located or operating in conjunction with any other antenna or transmitter except in accordance with FCC multi-transmitter product procedures.

-Mobile use

As long as the three conditions above are met, further transmitter testing will not be required.

OEM integrators should provide the minimum separation distance to end users in their end-product manuals.

Antennas list

This module is certified with the following integrated antenna.

-Type: Chip antenna (Internal Antenna)

-Max. peak Antenna gain: 2 dBi

Any new antenna type, higher gain than listed antenna should be met the requirements of FCC rule 15.203 and 2.1043 as permissive change procedure.

Label and compliance information

End Product Labeling

The module is labeled with its own FCC ID. If the FCC ID are 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. In that case, the final end product must be labeled in a visible area with the following:
“Contains FCC ID: 2BAHPIACTB52”

Information on test modes and additional testing requirements

-OEM integrator is still responsible for testing their end-product for any additional compliance requirements required with this module installed (for example, digital device emissions, PC peripheral requirements, additional transmitter in the host, etc.).

Additional testing, Part 15 Subpart B disclaimer

-The final host product also requires Part 15 subpart B compliance testing with the modular transmitter installed to be properly authorized for operation as a Part 15 digital device.