BLM01

Bluetooth low energy module

Data sheet

Abstract

This technical data sheet describes the BLM01 stand-alone Bluetooth® low energy module. The OEMs can embed their own application on top of the integrated Bluetooth low energy stack using Nordic Semiconductor SDK integrated development environment (IDE).

Contents

1 Functional description

The BLM01 is a powerful, highly flexible, ultra-low power Bluetooth low energy module based on the nRF52832 SoC from Nordic Semiconductor. With an Arm® Cortex®-M4 with FPU 32-bit processor, embedded 2.4GHz transceiver, and integrated antenna, the BLM01 provides a complete RF solution with no additional RF design, allowing faster time to market. Providing full use of the nRF52832's capabilities and peripherals, the BLM01 can power the most demanding applications, all while simplifying designs and reducing BOM costs. With an internal DC-DC converter and intelligent power control, the BLM01 provides class-leading power efficiency, enabling ultra-low power sensitive applications. Regulatory pre-approvals reduce the burden to enter the market.

1.1 Features

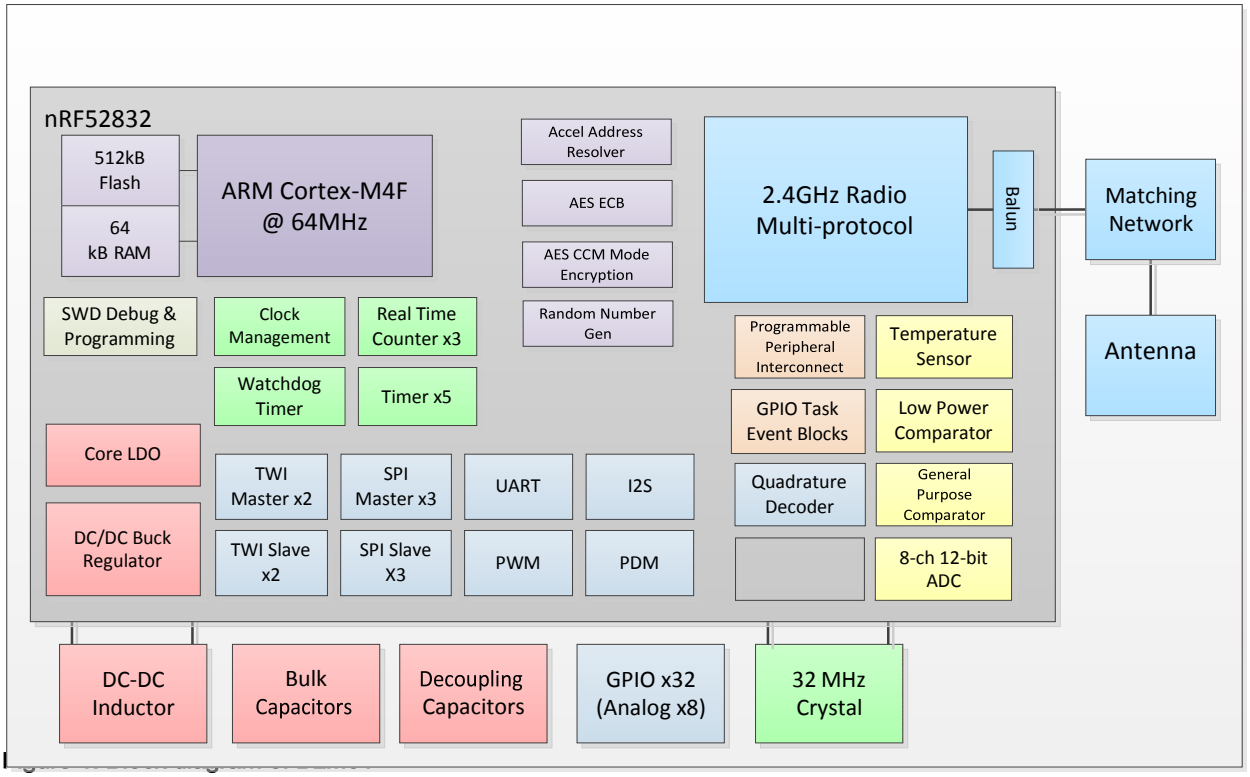
- Based on the Nordic Semiconductor nRF52832 SoC
- Bluetooth 5 PHYs: LE 2M
- Bluetooth 5 features: Advertising Extensions, Channel Selection Algorithm #2
- Bluetooth mesh
- Complete RF solution with an integrated DC-DC converter
- Nordic Semiconductor SoftDevice ready
- Over-the-Air (OTA) firmware updates
- No external components required
- Arm® Cortex®-M4 with FPU 32-bit processor
- 512 kB embedded flash memory
- 64 kB RAM
- –40 °C to +85 °C Temperature range
- 32 General Purpose I/O Pins
- 12-bit/200 KSPS ADC
- Serial Wire Debug (SWD)
- Three SPI Master/Slave (8 Mbps)
- Two 2-wire Master/Slave (I2C compatible)
- Footprint compatible with BMD-301, BMD-330, BMD-360, and BMD-340 (superset)
- UART (w/ CTS/RTS and DMA)
- I2S audio interface
- Low power comparator
- Temperature sensor
- Random number generator
- 20 channel CPU independent Programmable Peripheral Interconnect (PPI)
- Quadrature Demodulator (QDEC)
- 128-bit AES HW encryption
- 5 x 32 bit, 3 x 24 bit Real Timer Counters (RTC)
- Dimensions: 14 x 9.8 x 1.9 mm

1.2 Applications

- Beacons – iBeacon™, Eddystone, AltBeacon, etc.
- Low-power sensors
- Fitness devices
- Wearables

- Climate control
- Lighting
- Safety and security
- Home appliances
- Access control
- Internet of Things
- Home health care
- Advanced remote controls
- Smart energy management
- Low-power sensor networks
- Interactive entertainment
- Key fobs
- Environmental monitoring
- Hotel automation
- Office automation

1.3 Block diagram



1.4 Product specifications

Detail	Description
Bluetooth	
Bluetooth version	Bluetooth 5 low energy, Concurrent Central & Peripheral (S132), 2M LE PHY, Advertising Extensions, CSA #2 Bluetooth Mesh
LE connections	Concurrent central, observer, peripheral, and broadcaster roles with up to twenty concurrent connections along with one Observer and one Broadcaster (S132)
Radio	
Frequency	2.402 GHz to 2.480 GHz
Modulations	GFSK at 2 Mbps data rates
Transmit power	+3 dBm maximum
Receiver sensitivity	–96 dBm (Bluetooth low energy mode)
Antenna	PCB(–0.5dBi peak)
Current consumption	
TX only @ +3 dBm, @ 3V, DCDC enabled	7.5 mA, 5.3 mA
TX only @ +3 dBm	16.6 mA, 11.6 mA
RX only @ 1 Mbps @ 3V, DCDC enabled	5.4 mA
RX only @ 1 Mbps	11.7 mA
CPU @ 64MHz from flash, from RAM	7.4 mA, 6.7 mA
CPU @ 64MHz from flash, from RAM @ 3V, DCDC	3.7 mA, 3.3 mA
System Off, On	0.3 µA, 1.2 µA
Additional current for RAM retention	30 nA / 4KB block
Dimensions	
Length	14.0 mm ± 0.3mm
Width	9.8 mm ± 0.3mm
Height	1.9 mm ± 0.1mm
Hardware	
Interfaces	SPI Master/Slave x 3 UART Two-Wire Master/Slave (I2C) x 2 I2S PWM PDM GPIO x 32
Power supply	1.7 V to 3.6 V
Temperature range	–40 °C to +85 °C
Certifications	

2Pin definition

2.1 Pin assignment

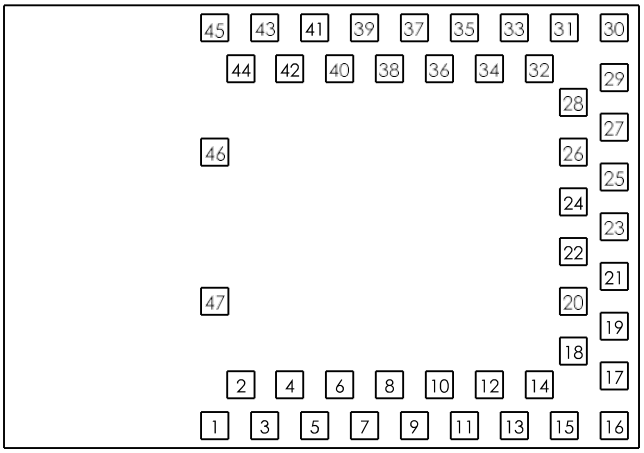


Figure 2: BLM01 Pin assignment (top view)

No.	Name	I/O	Description	nRF52 pin	Remarks
1	GND	Power	Electrical Ground		
2	GND	Power	Electrical Ground		
3	GND	Power	Electrical Ground		
4	GND	Power	Electrical Ground		
5	GND	Power	Electrical Ground		
6	P0.25	I/O	GPIO	P0.25	Use as low drive, low frequency GPIO only
7	P0.26	I/O	GPIO	P0.26	Use as low drive, low frequency GPIO only
8	P0.27	I/O	GPIO	P0.27	Use as low drive, low frequency GPIO only
9	P0.28	I/O	GPIO/AIN4	P0.28	Pin is analog capable, use as low drive, low frequency GPIO only
10	P0.29	I/O	GPIO/AIN5	P0.29	Pin is analog capable, use as low drive, low frequency GPIO only
11	P0.30	I/O	GPIO/AIN6	P0.30	Pin is analog capable, use as low drive, low frequency GPIO only
12	P0.31	I/O	GPIO/AIN7	P0.31	Pin is analog capable, use as low drive, low frequency GPIO only
13	P0.00	I/O	GPIO/XTAL1 (32.768 kHz)	P0.00	
14	P0.01	I/O	GPIO/XTAL2 (32.768 kHz)	P0.01	
15	P0.02	I/O	GPIO/AIN0	P0.02	Pin is analog capable
16	GND	Power	Electrical Ground		
17	VCC	Power	+1.7V to +3.6V		An internal 4.7 µF bulk capacitor is included on the module. However, it is good design practice to add additional bulk capacitance as required for your application, i.e. those with heavy GPIO usage and/or current draw.
18	GND	Power	Electrical Ground		
19	P0.03	I/O	GPIO/AIN1	P0.03	Pin is analog capable
20	P0.04	I/O	GPIO/AIN2	P0.04	Pin is analog capable
21	P0.05	I/O	GPIO/AIN3	P0.05	Pin is analog capable

No.	Name	I/O	Description	nRF52 pin	Remarks
22	P0.06	I/O	GPIO	P0.06	
23	P0.07	I/O	GPIO	P0.07	
24	P0.08	I/O	GPIO	P0.08	
25	P0.09	I/O	GPIO/NFC1	P0.09	NFC pin 1 (default)
26	P0.10	I/O	GPIO/NFC2	P0.10	NFC pin 2 (default)
27	P0.11	I/O	GPIO	P0.11	
28	P0.12	I/O	GPIO	P0.12	
29	GND	Power	Electrical Ground		
30	GND	Power	Electrical Ground		
31	P0.13	I/O	GPIO	P0.13	
32	P0.14	I/O	GPIO/TRACEDATA[3]	P0.14	
33	P0.15	I/O	GPIO/TRACEDATA[2]	P0.15	
34	P0.16	I/O	GPIO/TRACEDATA[1]	P0.16	
35	P0.17	I/O	GPIO	P0.17	
36	P0.18	I/O	GPIO/TRACEDATA[0]/SWO	P0.18	
37	P0.19	I/O	GPIO	P0.19	
38	P0.20	I/O	GPIO/TRACECLK	P0.20	
39	P0.21	I/O	GPIO/RESET_N	P0.21	May be used as active low reset input
40	P0.22	I/O	GPIO	P0.22	Use as low drive, low frequency GPIO only
41	P0.23	I/O	GPIO	P0.23	Use as low drive, low frequency GPIO only
42	P0.24	I/O	GPIO	P0.24	Use as low drive, low frequency GPIO only
43	SWCLK	I	SWD Clock	SWCLK	
44	SWDIO	I/O	SWD IO	SWDIO	
45	GND	Power	Electrical Ground		
46	GND	Power	Electrical Ground		
47	GND	Power	Electrical Ground		

Table 2: BLM01 pin-out

3Electrical specifications

Warning: Stressing the device above one or more of the ratings listed in the Absolute maximum rating section may cause permanent damage. These are stress ratings only. Operating the module at
these or at any conditions other than those specified in the Operating conditions section of this document should be avoided. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Notice: Operating condition ranges define those limits within which the functionality of the device is guaranteed. Where application information is given, it is advisory only and does not form part of
the specification.

3.1 Absolute maximum ratings

Symbol	Description	Min	Max	Unit
V_{CC_MAX}	Voltage on supply pin	–0.3	3.9	V
V_{IO_MAX}	Voltage on GPIO pins (VCC > 3.6 V)	–0.3	3.9	V
V_{IO_MAX}	Voltage on GPIO pins (VCC ≤ 3.6V)	–0.3	VCC+0.3 V	V
T_S	Storage Temperature Range	–40	125	°C

Table 3: Absolute maximum ratings

Warning: The product is not protected against overvoltage or reversed voltages. If necessary, voltage spikes exceeding the power supply voltage specification, given in table above, must be limited to values
within the specified boundaries by using appropriate protection devices.

3.2 Operating conditions

Notice: Unless otherwise specified, all operating condition specifications are at an ambient temperature of 25 °C and a supply voltage of 3.0 V.

Warning: Operation beyond the specified operating conditions is not recommended and extended exposure beyond them may affect device reliability.

Symbol	Parameter	Min	Typ.	Max	Unit
V_{CC}	Operating supply voltage	1.7	3.3	3.6	V
T_{R_VCC}	Supply rise time (0 V to 1.7 V)	-	-	60	ms
T_A	Operating ambient temperature range	–40	25	85	° C

Table 4: Operating conditions

3.3 General purpose I/O

The general purpose I/O is organized as one port enabling access and control of the 32 available GPIO pins via one port, P0. Each GPIO can be accessed 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

Symbol	Parameter	Min	Typ.	Max	Unit
V_{IH}	Input high voltage	0.7 x VCC	-	VCC	V
V_{IL}	Input low voltage	VSS	-	0.3 x VCC	V
V_{OH}	Output high voltage	VCC – 0.4	-	VCC	V
V_{OL}	Output low voltage	VSS	-	VSS +0.4	V
R_{PU}	Pull-up resistance	11	13	16	kΩ
R_{PD}	Pull-down resistance	11	13	16	kΩ

Table 5: GPIO

3.4 Peripheral pin assignments

The peripherals within the BLM01 may be assigned to nearly any of the GPIO pins through the application. There are some restrictions called out by the nRF52832 product specification. See the remarks column of Table 2.

3.5 Module reset

GPIO pin P0.21 may be used for a hardware reset. In order to utilize P0.21 as a hardware reset, the UICR registers PSELRESET[0] and PSELRESET[1] must be set alike, to the value of 0x7FFFFF15. When P0.21 is programmed as RESET, the internal pull-up is automatically enabled. Nordic Semiconductor example applications and development kits program P0.21 as RESET_N.

3.6 Debug and programming

The BLM01 supports the two pin Serial Wire Debug (SWD) interface and offers flexible and powerful mechanism for non-intrusive debugging of program code. Breakpoints, single stepping, and instruction trace capture of code execution flow are part of this support.

The BLM01 also supports ETM and ITM trace. Trace data from the ETM and the ITM is sent to an external debugger via a 4-bit wide parallel trace port. In addition to parallel trace, the TPIU supports serial trace via the Serial Wire Output (SWO) trace protocol.

3.7 Clocks

The BLM01 requires two clocks, a high frequency clock and a low frequency clock.

The high frequency clock is provided on-module by a high-accuracy 32 MHz crystal as required by the nRF52832 for radio operation.

The low frequency clock can be provided internally by an RC oscillator or synthesized from the fast clock, or externally by a 32.768 kHz crystal. An external crystal provides the lowest power consumption and greatest accuracy. Using the internal RC oscillator with calibration provides acceptable performance for Bluetooth low energy applications at a reduced cost and slight increase in power consumption.

Notice: The ANT protocol requires the use of an external crystal.

3.7.1 32.768 kHz crystal (LFXO)

Symbol	Parameter	Typ.	Max.	Unit
F_{NOM_LFXO}	Crystal frequency	32.768	-	kHz
$F_{TOL\_LFXO\_BLE}$	Frequency tolerance, Bluetooth low energy applications[1]	-	±250	ppm
$f_{TOL\_LFXO\_ANT}$	Frequency Tolerance, ANT applications[1]	-	±50	ppm
C_{L_LFXO}	Load capacitance	-	12.5	pF
C_{0_LFXO}	Shunt capacitance	-	2	pF
R_{S_LFXO}	Equivalent series resistance	-	100	kΩ
C_{pin}	Input capacitance on XL1 & XL2 pads	4	-	pF

Notice: 1: $f_{TOL\_LFXO\_BLE}$ and $f_{TOL\_LFXO\_ANT}$ are the maximum allowed for Bluetooth low energy and ANT applications. Actual tolerance depends on the crystal used.

Table 6: 32.768 kHz crystal (LFXO)

3.7.2 32.768 kHz clock source comparison

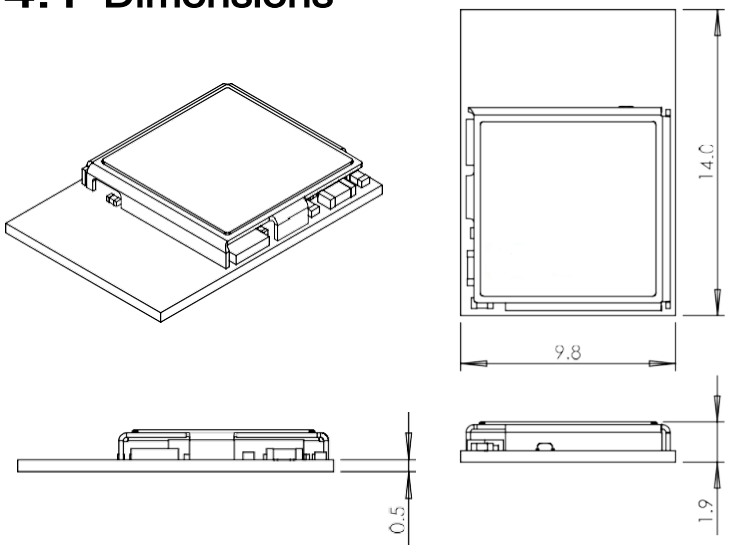
Symbol	Parameter	Min.	Typ.	Max.	Unit
I_{LFXO}	Current for 32.768 kHz Crystal oscillator	-	0.25	-	µA
I_{LFRC}	Current for 32.768 kHz RC oscillator	-	0.6	1	µA
I_{LFSYNT}	Current for 32.768 kHz Synthesized oscillator	-	100	-	µA
$f_{TOL\_LFXO\_BLE}$	Frequency Tolerance, 32.768 kHz Crystal oscillator (Bluetooth low energy Stack)[1]	-	-	±250	ppm
$f_{TOL\_LFXO\_ANT}$	Frequency Tolerance, 32.768 kHz Crystal oscillator (ANT Stack)[1]	-	-	±50	ppm
f_{TOL_LFRC}	Frequency Tolerance, 32.768 kHz RC oscillator	-	-	±2	%
$f_{TOL\_CAL\_LFRC}$	Frequency tolerance, 32.768 kHz RC after calibration	-	-	±250	ppm
f_{TOL_LFSYNT}	Frequency Tolerance, 32.768 kHz Synthesized oscillator	-	-	±48	ppm

Notice: $f_{TOL\_LFXO\_BLE}$ and $f_{TOL\_LFXO\_ANT}$ are the maximum allowed for Bluetooth low energy and ANT applications. Actual tolerance depends on the crystal used.

Table 7: 32.768 kHz clock source comparison

4 Mechanical specifications

4.1 Dimensions



Length: ± 0.3 mm, Width: ± 0.3 mm, Height: ± 0.1 mm

Figure 3: BLM01 mechanical drawing

4.2 Recommended PCB land pads

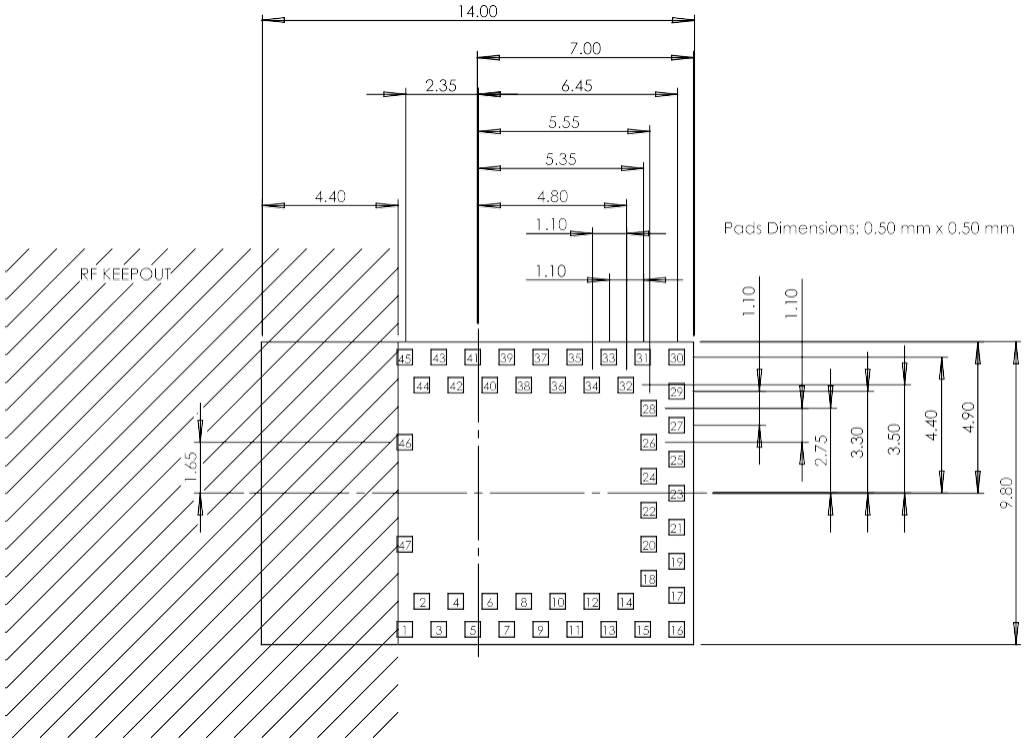


Figure 4: Recommended PCB Land Pads

Notice: The RF Keep-out area extends vertically to the board edge.

FCC Caution:

Any Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

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.

FCC RF Radiation Exposure Statement:

1. This Transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.
2. This equipment complies with RF radiation exposure limits set forth for an uncontrolled environment.

3.This equipment should be installed and operated according to the following antennas:

Antenna Model：	2.4-GHz-antenna
Antenna type:	PCB antenna
Antenna gain:	-0.5dBi

Host product manufacturers that they need to provide a physical or e-label stating, “Contains FCC ID: 2AL7PBLM01 ” with their finished product.

Only those antennas with same type and lesser gain filed under this FCC ID can be used with this device.

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. The final host product still requires Part 15 Subpart B compliance testing with the modular transmitter installed.

The final host integrator must ensure there is no instruction provided in the user manual or customer documentation indicating how to install or remove the transmitter module except such device has implemented two-ways authentication between module and the host system.

The final host manual shall include the following regulatory statement: This equipment has been tested and found to comply with the limits. 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.

This module has been tested and found to comply with part 15.247 requirements for Modular Approval.

This module is intended for OEM integrator. The OEM integrator is responsible for the compliance to all the rules that apply to the product into which this certified RF module is integrated. Additional testing and certification may be necessary when multiple modules are used.

FCC Radiation Exposure sTATENMENT:

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

OEM Guidance

1. Applicable FCC rules

This device complies with part 15.247 of the FCC Rules.

2. The specific operational use conditions

This module can be used in IoT devices. The input voltage to the module is nominally 3.3 V DC. The operational ambient temperature of the module is -40 °C ~ 85 °C. the embedded PCB antenna is allowed. Any other external antenna is prohibited.

3. Limited module procedures

N/A

4. Trace antenna design

N/A

5. RF exposure considerations

The equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment.

6. Antenna

Antenna type: PCB antenna Peak gain : -0.5 dBi

7. Label and compliance information

An exterior label on OEM's end product can use wording such as the following: "Contains Transmitter Module FCC ID: 2AL7PBLM01

8. Information on test modes and additional testing requirements

a)The modular transmitter has been fully tested by the module grantee on the required number of channels,modulation types, and modes, it should not be necessary for the host installer to re-test all the available transmitter modes or settings. It is recommended that the host product manufacturer, installing the modular transmitter,perform some investigative measurements to confirm that the resulting composite system does not exceed the spurious emissions limits or band edge limits (e.g., where a different antenna may be causing additional emissions).

b)The testing should check for emissions that may occur due to the intermixing of emissions with the other transmitters, digital circuitry, or due to physical properties of the host product (enclosure). This investigation is especially important when integrating multiple modular transmitters where the certification is based on testing each of them in a stand-alone configuration. It is important to note that host product manufacturers should not assume that because the modular transmitter is certified that they do not have any responsibility for final product compliance.

c)If the investigation indicates a compliance concern the host product manufacturer is obligated to mitigate the issue. Host products using a modular transmitter are subject to all the applicable individual technical rules as well as to the general conditions of operation in Sections 15.5, 15.15, and 15.29 to not cause interference. The operator of the host product will be obligated to stop operating the device until the interference have been corrected .

9. Additional testing, Part 15 Sub part B disclaimer The final host / module combination need to be evaluated against the FCC Part 15B criteria for unintentional radiators in order to be properly authorized for operation as a Part 15 digital device.

The host integrator installing this module into their product must ensure that the final composite product complies with the FCC requirements by a technical assessment or evaluation to the FCC rules, including the transmitter operation and should refer to guidance in KDB 996369. For host products with certified modular transmitter, the frequency range of investigation of the composite system is specified by rule in Sections 15.33(a)(1) through (a)(3), or the range applicable to the digital device, as shown in Section 15.33(b)(1), whichever is the higher frequency range of investigation

When testing the host product, all the transmitters must be operating.The transmitters can be enabled by using publicly-available drivers and turned on, so the transmitters are active. In certain conditions it might be appropriate to use a technology-specific call box (test set) where accessory 50 devices or drivers are not available. When testing for emissions from the unintentional radiator, the transmitter shall be placed in the receive mode or idle mode, if possible. If receive mode only is not possible then, the radio shall be passive (preferred) and/or active scanning. In these cases, this would need to enable activity on the communication BUS (i.e., PCIe, SDIO, USB) to ensure the unintentional radiator circuitry is enabled. Testing laboratories may need to add attenuation or filters depending on the signal strength of any active beacons (if applicable) from the enabled radio(s). See ANSI C63.4, ANSI C63.10 and ANSI C63.26 for further general testing details.

The product under test is set into a link/association with a partnering device, as per the normal intended use of the product. To ease testing, the product under test is set to transmit at a high duty cycle, such as by sending a file or streaming some media content.