iSenseTek Technology, Inc

Approval Sheet

Model : 1506 Wireless Module (nRF51822)

Part No : ISBLE1506-A51822ACA

Datasheet Version : v1.2

Date : 2017/03/24

Approved	Checked	Designed

Customer Name : _____

Model : _____

P/N : _____

Checked	Received

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1. Overall Introduction

iSenseTek's ISBLE series is a wireless module designed based on Nordic Semiconductor solution. The module include chip antenna, frequency on the 2.4GHz band. And support low energy or BLE function. Please see below of the feature:

- Based on the Nordic nRF51822 SoC
- Multiple protocol of BLE & RF 2.4GHz & ANT+ upon customer preference
- Dimension:

Length	Width	Height
15 ± 0.3mm	6 ± 0.3mm	2 ± 0.2mm

- Low power requirements, Ultra-low peak, Average and idle mode power Consumption
- Compatible with a large installed based of mobiles phones, tablets and computers
- Fully coverage of wireless applications
- BLE & RF transmission switching may help products to fit all operation system
- BLE & RF transmission switching may help products to fit all kinds of hardwares

1.1 Applications

Computer peripherals and I/O devices

- Mouse
- Keyboard
- Multi-touch trackpad

Interactive entertainment devices

- Remote control
- Gaming controller

Beacons

Personal area networks

- Health/fitness sensor and monitor devices
- Medical devices
- Key-fobs + Wrist watch
- Remote control toys

1.2 Features

2.4GHz transceiver

- -93 dBm sensitivity in Bluetooth® low energy mode
- 250 kbps, 1 Mbps, 2 Mbps supported data rates
- TX Power -20 to +4 dBm in 4 dB steps
- TX Power -30 dBm Whisper mode
- RSSI (1 dB resolution)

ARM® Cortex™-M0 32 bit processor

- Serial Wire Debug (SWD)

Memory

- 256 kB embedded flash program memory
- 16 kB RAM

Flexible Power Management

- Supply voltage range 1.8 V to 3.6 V
- 4.2 µs wake-up using 16 MHz RCOSC
- 0.6 µA at 3 V OFF mode
- 1.2 µA at 3 V in OFF mode + 1 region RAM retention
- 2.6 µA at 3 V ON mode, all blocks IDLE

S100 series Soft Device ready
On-air compatibility with nRF24L series
8/9/10 bit ADC - 8 configurable channels
32 General Purpose I/O Pins
One 32 bit and two 16 bit timers with counter mode
SPI Master/Slave
Low power comparator
Temperature sensor
Two-wire Master (I2C compatible)
UART (CTS/RTS)
CPU independent Programmable Peripheral Interconnect (PPI)
Quadrature Decoder (QDEC)
AES HW encryption
Real Timer Counter (RTC)

2. P/N Number Define

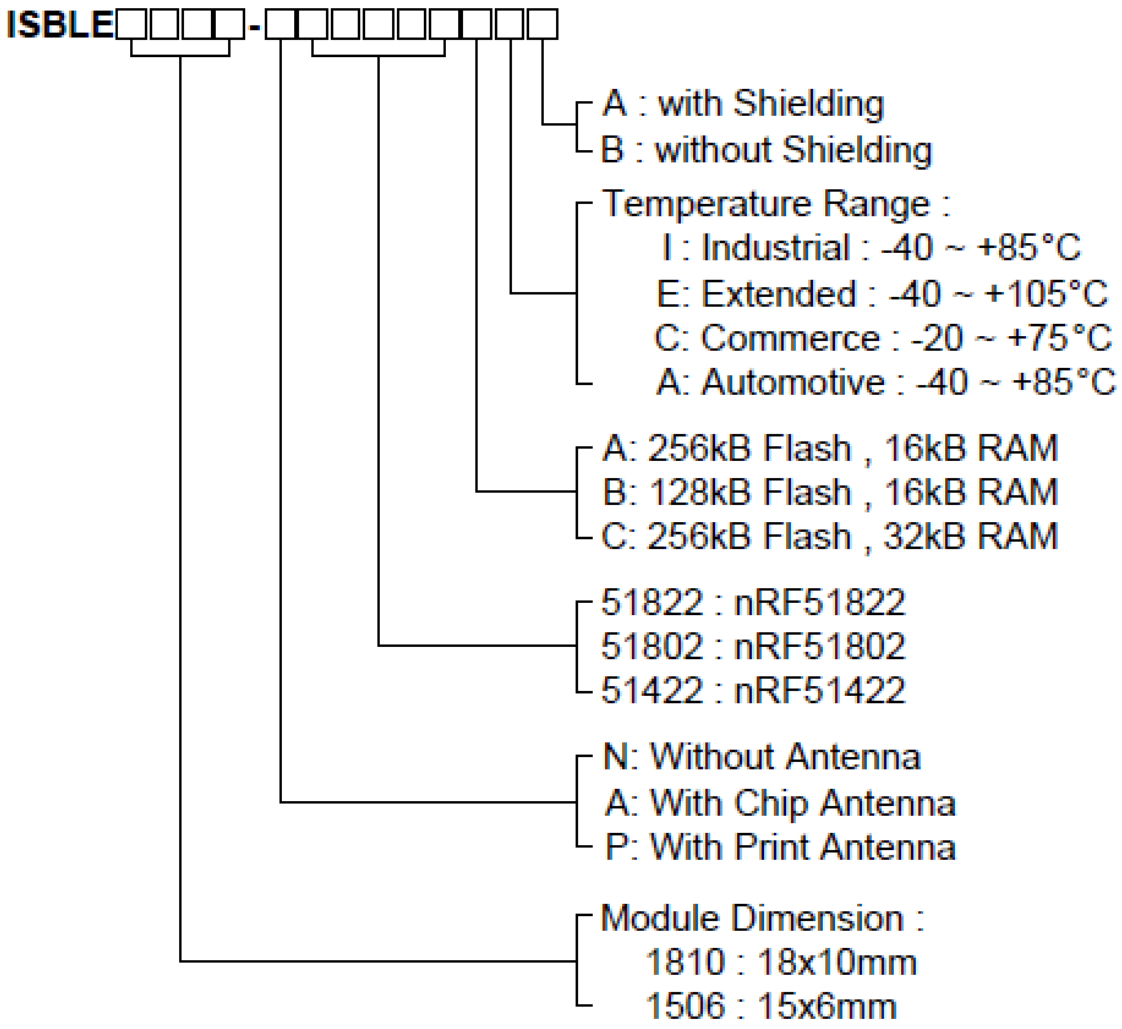

Figure 1 : P/N Number Define

3. Module Descriptions

3.1 Product Dimensions

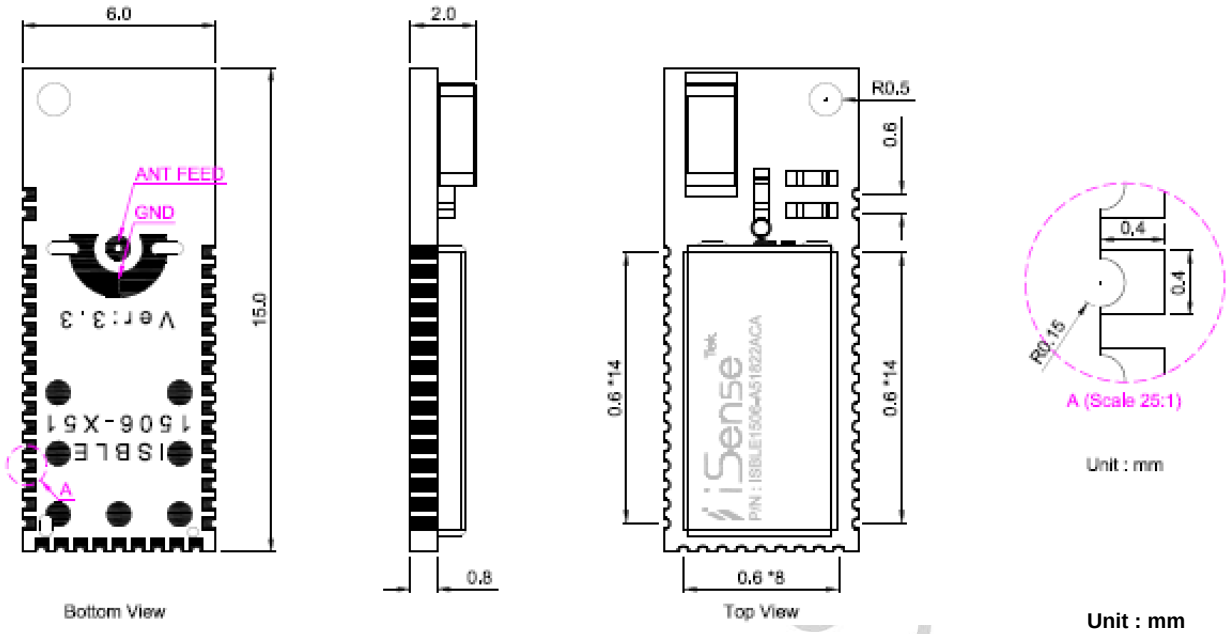

Figure 2 : Product Dimensions

3.2 Pin Descriptions

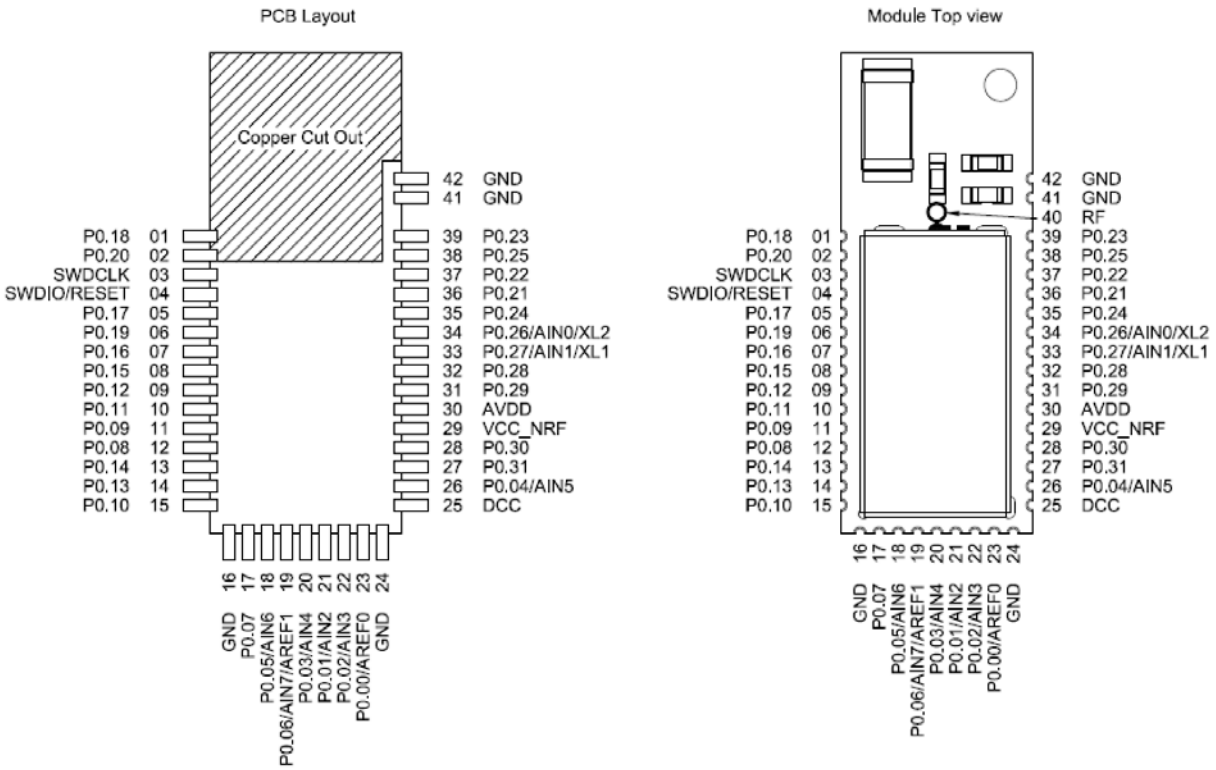

Figure 3 : Module Pin Descriptions

Pin NO.	Name	Pin function	Description
1	P0.18	Digital I/O	General-purpose digital I/O
2	P0.20	Digital I/O	General-purpose digital I/O
3	SWDCLK	Digital input	HW debug and flash programming. Connect a 12K ohm resister to GND for flash programming .
4	SWDIO	Digital I/O	Also HW debug and flash programming I/O
	RESET	Digital I/O	System reset(active low)
5	P0.17	Digital I/O	General-purpose digital I/O
6	P0.19	Digital I/O	General-purpose digital I/O
7	P0.16	Digital I/O	General-purpose digital I/O
8	P0.15	Digital I/O	General-purpose digital I/O
9	P0.12	Digital I/O	General-purpose digital I/O
10	P0.11	Digital I/O	General-purpose digital I/O
11	P0.09	Digital I/O	General-purpose digital I/O
12	P0.08	Digital I/O	General-purpose digital I/O
13	P0.14	Digital I/O	General-purpose digital I/O
14	P0.13	Digital I/O	General-purpose digital I/O
15	P0.10	Digital I/O	General-purpose digital I/O
16	GND	Ground	The pad must be connected to a solid ground plane
17	P0.07	Digital I/O	General-purpose digital I/O
18	P0.05	Digital I/O	General-purpose digital I/O
	AIN6	Analog input	ADC input 6
19	P0.06	Digital I/O	General-purpose digital I/O
	AIN7	Analog input	ADC input 7
	AREF1	Analog input	ADC Reference voltage
20	P0.03	Digital I/O	General-purpose digital I/O
	AIN4	Analog input	ADC input 4
21	P0.01	Digital I/O	General-purpose digital I/O
	AIN2	Analog input	ADC input 2
22	P0.02	Digital I/O	General-purpose digital I/O
	AIN3	Analog input	ADC input 3
23	P0.00	Digital I/O	General-purpose digital I/O
	AREF0	Analog input	ADC Reference voltage
24	GND	Ground	The pad must be connected to a solid ground plane
25	DCC	Power	DC/DC output voltage to external LC filter
26	P0.04	Digital Input	General-purpose digital I/O
	AIN5	Analog input	ADC input 5

Pin NO.	Name	Pin function	Description
27	P0.31	Digital I/O	General-purpose digital I/O
28	P0.30	Digital I/O	General-purpose digital I/O
29	VCC_nRF	Power	Power supply
30	AVDD	Power	Analog power supply
31	P0.29	Digital I/O	General-purpose digital I/O
32	P0.28	Digital I/O	General-purpose digital I/O
33	P0.27	Digital I/O	General-purpose digital I/O
	AIN1	Analog input	ADC input 1
	XL1	Analog input	Connector for 32.768KHz crystal
34	P0.26	Digital I/O	General-purpose digital I/O
	AIN0	Analog input	ADC input 0
	XL2	Analog output	Connector for 32.768KHz crystal
35	P0.24	Digital I/O	General-purpose digital I/O
36	P0.21	Digital I/O	General-purpose digital I/O
37	P0.22	Digital I/O	General-purpose digital I/O
38	P0.25	Digital I/O	General-purpose digital I/O
39	P0.23	Digital I/O	General-purpose digital I/O
40	RF	RFout	2.4GHz 50ohm RF out, not need to mount.
41	GND	Ground	The pad must be connected to a solid ground plane
42	GND	Ground	The pad must be connected to a solid ground plane

1. Digital I/O pad with 5mA source/sink capability.

Table 1 : Pin function

3.3 PCB Layout Guide

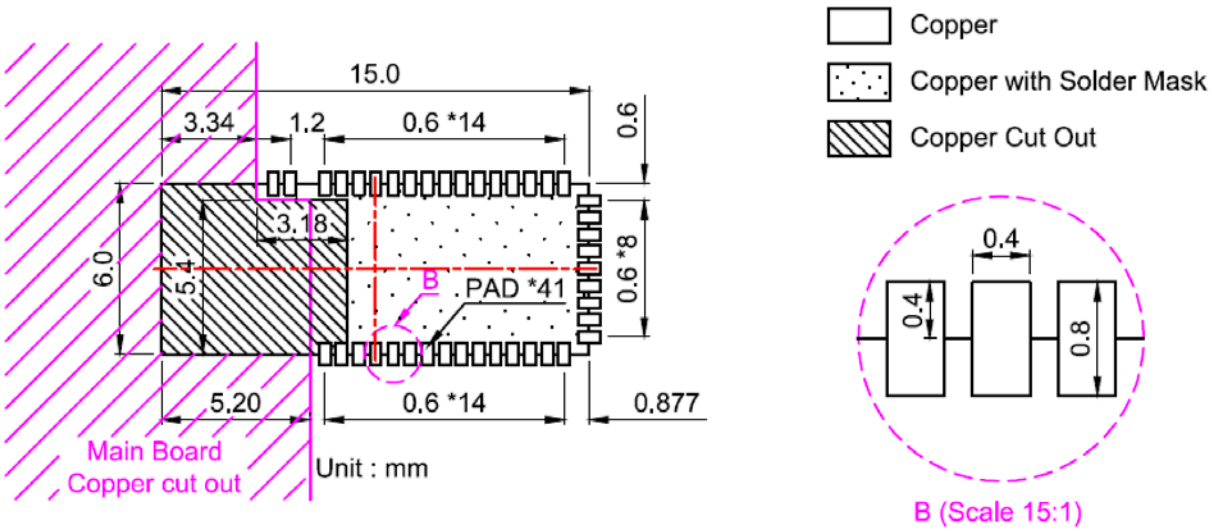

Figure 4 : PCB Layout Guide

4. Main Chip Solution

RF IC	Crystal Frequency
Nordic nRF51822-CEAA	16MHz

Table 2 : Main Chip Solution

5. Shipment Packing Information

Part Number	Package
ISBLE1506-A51822ACA	500 PCS/BOX

Table 3 : Shipment Packing Information

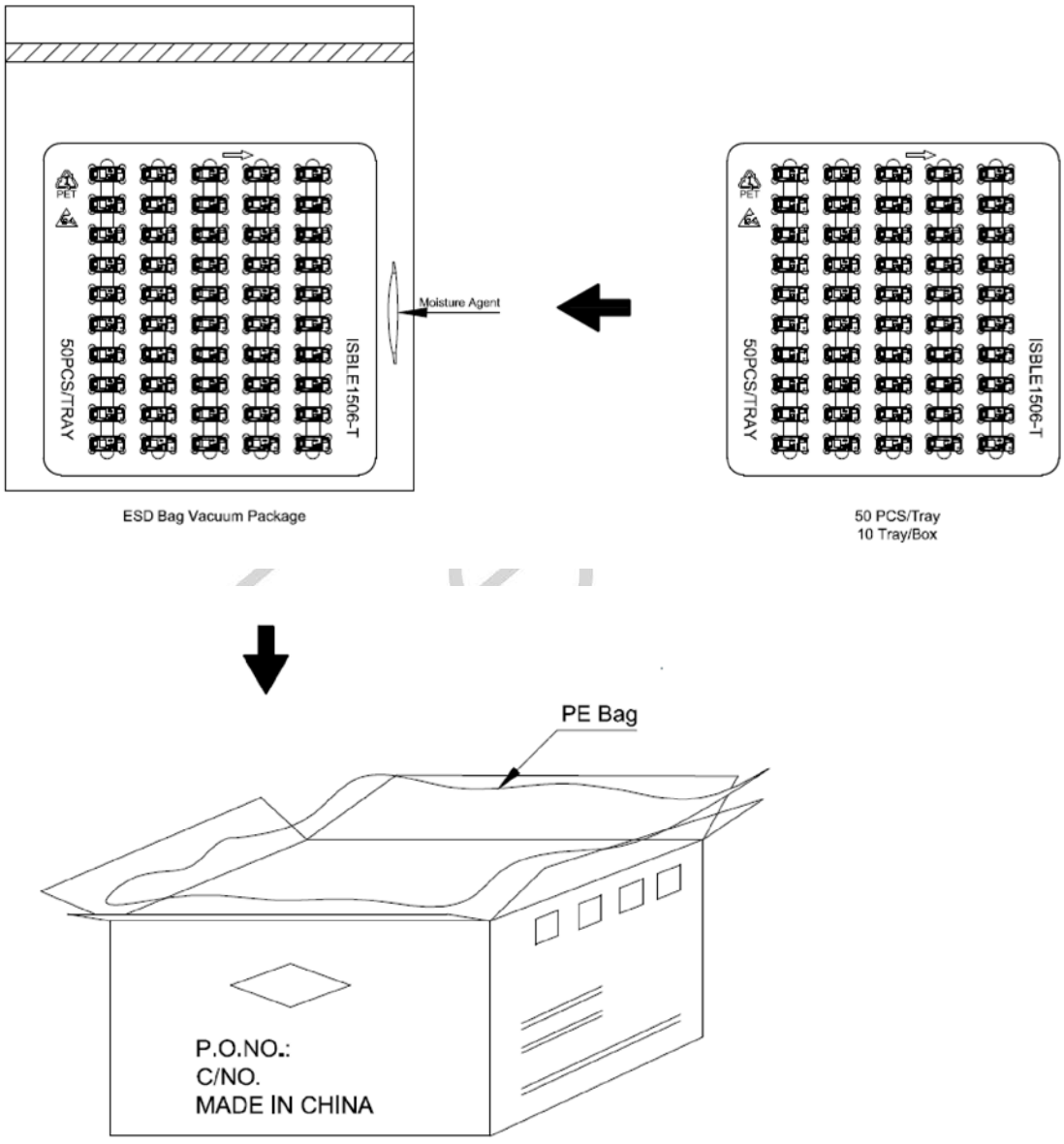

Figure 5 : Packing Information

6. Specification

6.1 Absolute Maximum Ratings

Maximum ratings are the extreme limits the chip can be exposed to without causing permanent damage. Exposure to absolute maximum ratings for prolonged periods of time may affect the reliability of the chip.

Table 5 specifies the absolute maximum ratings.

Symbol	Parameter	Min.	Max.	Units
Supply voltages				
VDD		-0.3	+3.9	V
DEC2			2	V
VSS			0	V
I/O pin voltage				
VIO		-0.3	VDD+0.3	V
Environmental QFN48 package				
Storage temperature		-40	+125	˚C
MSL	Moisture Sensitivity Level		2	
ESD HBM	Human Body Model		3	kV
ESD CDM	Charged Device Model		750	V
Environmental WLCSP package				
Storage temperature		-40	+125	˚C
MSL	Moisture Sensitivity Level		1	
ESD HBM	Human Body Model		4	kV
ESD CDM	Charged Device Model		500	V
Flash memory				
Endurance		20000 [1]		Write / erase cycles
Retention		10 years at 40 °C 50 years at 25 °C		
Number of times an address can be written between erase cycles			2	times

1. Flash endurance is 20,000 erase cycles. The smallest element of flash that can be written is a 32 bit word.

Table 4 : Absolute maximum ratings

6.2 Operation Conditions

The operating conditions are the physical parameters that the chip can operate within as defined in Table 6.

Symbol	Parameter	Notes	Min.	Typ.	Max.	Units
VDD	Supply voltage, internal LDO setup		1.8	3.0	3.6	V
VDD	Supply voltage, DC/DC converter setup		2.1	3.0	3.6	V
VDD	Supply voltage, low voltage mode setup	1	1.75	1.8	1.95	V
t_{R_VDD}	Supply rise time (0 V to VDD)	2			100	ms
T_A	Operating temperature		-25	25	75	˚C

1. DEC2 shall be connected to VDD in this mode.
2. The on-chip power-on reset circuitry may not function properly for rise times outside the specified interval.

Table 5 : Operating conditions

6.3 Electrical Specifications

6.3.1 Radio Transceiver

- **General radio characteristics**

Symbol	Parameter	Notes	Min.	Typ.	Max.	Units	Test Level
f_{OP}	Operating frequencies.	1 MHz channel spacing	2400		2483	MHz	N/A
PLL_{res}	PLL programming resolution.			1		MHz	N/A
Δf_{250}	Frequency deviation at 250 kbps.			±170		kHz	2
Δf_{1M}	Frequency deviation at 1 Mbps.			±170		kHz	2
Δf_{2M}	Frequency deviation at 2 Mbps.			±320		kHz	2
Δf_{BLE}	Frequency deviation at BLE.		±225	±250	±275	kHz	4
bps_{FSK}	On-air data rate.		250		2000	kbps	N/A

Table 6 : General radio characteristics

- **Radio current consumption**

Symbol	Parameter	Notes	Min.	Typ.	Max.	Units	Test Level
$I_{TX,+4dBm}$	TX only run current at P_{OUT} = +4 dBm.	1		16		mA	4
$I_{TX,0dBm}$	TX only run current at P_{OUT} = 0 dBm.	1		10.5		mA	4
$I_{TX,-4dBm}$	TX only run current at P_{OUT} = -4 dBm.	1		8		mA	2
$I_{TX,-8dBm}$	TX only run current at P_{OUT} = -8 dBm.	1		7		mA	2

Symbol	Parameter	Notes	Min.	Typ.	Max.	Units	Test Level
$I_{TX,-12dBm}$	TX only run current at P_{OUT} = -12 dBm.	1		6.5		mA	2
$I_{TX,-16dBm}$	TX only run current at P_{OUT} = -16 dBm.	1		6		mA	2
$I_{TX,-20dBm}$	TX only run current at P_{OUT} = -20 dBm.	1		5.5		mA	2
$I_{TX,-30dBm}$	TX only run current at P_{OUT} = -30 dBm.	1		5.5		mA	2
$I_{START,TX}$	TX startup current.	2		7		mA	1
$I_{RX,250}$	RX only run current at 250 kbps.			12.6		mA	1
$I_{RX,1M}$	RX only run current at 1 Mbps.			13		mA	4
$I_{RX,2M}$	RX only run current at 2 Mbps.			13.4		mA	1
I_{START}	RX startup current.	3		8.7		mA	1

1. Valid for data rates 250 kbps, 1 Mbps, and 2 Mbps.
2. Average current consumption (at 0 dBm TX output power) for TX startup (130 µs), and when changing mode from RX toTX (130 µs).
3. Average current consumption for RX startup (130 µs), and when changing mode from TX to RX (130 µs).

Table 7 : Radio current consumption

6.3.2 Transmitter Specifications

Symbol	Description	Min.	Typ.	Max.	Units	Test Level
P_{RF}	Maximum output power.		4		dBm	4
P_{RFC}	RF power control range.	20	24		dB	2
P_{RFCR}	RF power accuracy.			±4	dB	1
P_{WHISP}	RF power whisper mode.		-30		dBm	2
P_{BW2}	20 dB bandwidth for modulated carrier (2 Mbps).		1800	2000	kHz	2
P_{BW1}	20 dB bandwidth for modulated carrier (1 Mbps).		950	1100	kHz	2
P_{BW250}	20 dB bandwidth for modulated carrier (250 kbps).		700	800	kHz	2
$P_{RF1.2}$	1st Adjacent Channel Transmit Power. ±2 MHz (2 Mbps).			-20	dBc	2
$P_{RF2.2}$	2nd Adjacent Channel Transmit Power. ±4 MHz (2 Mbps).			-45	dBc	2
$P_{RF1.1}$	1st Adjacent Channel Transmit Power. ±1 MHz (1 Mbps).			-20	dBc	2
$P_{RF2.1}$	2nd Adjacent Channel Transmit Power. ±2 MHz (1 Mbps).			-40	dBc	2
$P_{RF1.250}$	1st Adjacent Channel Transmit Power. ±1 MHz (250 kbps).			-25	dBc	2
$P_{RF2.250}$	2nd Adjacent Channel Transmit Power. ±2 MHz (250 kbps).			-40	dBc	2

Symbol	Description	Min.	Typ.	Max.	Units	Test Level
$t_{TX,30}$	Maximum consecutive transmission time, f_{TOL} < ±30 ppm.			16	ms	1
$t_{TX,60}$	Maximum consecutive transmission time, f_{TOL} < ±60 ppm.			4	ms	1

Table 8 : Transmitter specifications

6.3.3 Receiver Specifications

Symbol	Description	Min.	Typ.	Max.	Units	Test Level
Receiver operation						
PRX_{MAX}	Maximum received signal strength at < 0.1% PER.		0		dBm	1
$PRX_{SENS,2M}$	Sensitivity (0.1% BER) at 2 Mbps.		-85		dBm	2
$PRX_{SENS,1M}$	Sensitivity (0.1% BER) at 1 Mbps.		-90		dBm	2
$PRX_{SENS,250k}$	Sensitivity (0.1% BER) at 250 kbps.		-96		dBm	2
P_{SENS} IT 1 Mbps BLE	Receiver sensitivity: Ideal transmitter.		-93		dBm	2
P_{SENS} DT 1 Mbps BLE	Receiver sensitivity: Dirty transmitter.1		-91		dBm	2
RX selectivity - modulated interfering signal[2]						
	2 Mbps					
C/I_{CO}	C/I co-channel.		12		dB	2
C/I_{1ST}	1st ACS, C/I 2 MHz.		-4		dB	2
C/I_{2ND}	2nd ACS, C/I 4 MHz.		-24		dB	2
C/I_{3RD}	3rd ACS, C/I 6 MHz.		-28		dB	2
C/I_{6th}	6th ACS, C/I 12 MHz.		-44		dB	2
C/I_{Nth}	Nth ACS, C/I f_i > 25 MHz.		-50		dB	2
	1 Mbps					
C/I_{CO}	C/I co-channel (1 Mbps).		12		dB	2
C/I_{1ST}	1st ACS, C/I 1 MHz.		4		dB	2
C/I_{2ND}	2nd ACS, C/I 2 MHz.		-24		dB	2
C/I_{3RD}	3rd ACS, C/I 3 MHz.		-30		dB	2
C/I_{6th}	6th ACS, C/I 6 MHz.		-40		dB	2
C/I_{12th}	12th ACS, C/I 12 MHz.		-50		dB	2
C/I_{Nth}	Nth ACS, C/I f_i > 25 MHz.		-53		dB	2

Symbol	Description	Min.	Typ.	Max.	Units	Test Level
	250 kbps					
C/I_{CO}	C/I co-channel.		4		dB	2
C/I_{1ST}	1st ACS, C/I 1 MHz.		-10		dB	2
C/I_{2ND}	2nd ACS, C/I 2 MHz.		-34		dB	2
C/I_{3RD}	3rd ACS, C/I 3 MHz.		-39		dB	2
C/I_{6th}	6th ACS, C/I fi > 6 MHz.		-50		dB	2
C/I_{12th}	12th ACS, C/I 12 MHz.		-55		dB	2
C/I_{Nth}	Nth ACS, C/I f_i > 25 MHz.		-60		dB	2
	***Bluetooth* Low Energy RX selectivity**					
C/I_{CO}	C/I co-channel.		10		dB	2
C/I_{1ST}	1st ACS, C/I 1 MHz.		1		dB	2
C/I_{2ND}	2nd ACS, C/I 2 MHz.		-25		dB	2
C/I3+N	ACS, C/I (3+n) MHz offset [n = 0, 1, 2, . . .].		-51		dB	2
C/IImage	Image blocking level.		-30		dB	2
C/IImage±1MHz	Adjacent channel to image blocking level (±1 MHz).		-31		dB	2
RX intermodulation[3]						
P_IMD_{2Mbps}	IMD performance, 2 Mbps, 3rd, 4th, and 5th offset channel.		-41		dBm	2
P_IMD_{1Mbps}	IMD performance, 1 Mbps, 3rd, 4th, and 5th offset channel.		-40		dBm	2
$P\_IMD_{250kbps}$	IMD performance, 250 kbps, 3rd, 4th, and 5th offset channel.		-36		dBm	2
P_IMD_{BLE}	IMD performance, 1 Mbps BLE, 3rd, 4th, and 5th offset channel.		-39		dBm	2

1. As defined in the Bluetooth Core Specification v4.0 Volume 6: Core System Package (Low Energy Controller Volume).
2. Wanted signal level at PIN = -67 dBm. One interferer is used, having equal modulation as the wanted signal. The input power of the interferer where the sensitivity equals BER = 0.1% is presented.
3. Wanted signal level at PIN = -64 dBm. Two interferers with equal input power are used. The interferer closest in fre-quency is not modulated, the other interferer is modulated equal with the wanted signal. The input power of interferers where the sensitivity equals BER = 0.1% is presented.

Table 9 : Receiver specifications

6.3.4 Radio Timing Parameters

Symbol	Description	250 k	1 M	2 M	BLE	Jitter	Units
t_{TXEN}	Time between TXEN task and READY event.	132	132	132	140	0	µs
$t_{TXDISABLE}$	Time between DISABLE task and DISABLED event when the radio was in TX.	10	4	3	4	1	µs
t_{RXEN}	Time between the RXEN task and READY event.	130	130	130	138	0	µs
$t_{RXDISABLE}$	Time between DISABLE task and DISABLED event when the radio was in RX.	0	0	0	0	1	µs
$t_{TXCHAIN}$	TX chain delay.	5	1	0.5	1	0	µs
$t_{RXCHAIN}$	RX chain delay.	12.5	3	2	3	0	µs

Table 10 : Radio timing

6.3.5 RSSI Specifications

Symbol	Description	Notes	Min.	Typ.	Max.	Units	Test Level
$RSSI_{ACC}$	RSSI accuracy.	Valid range -50 dBm to -80 dBm.			±6	dB	2
$RSSI_{RESOLUTION}$	RSSI resolution.			1		dB	1
$RSSI_{PERIOD}$	Sample period.		8.8			µs	1
$RSSI_{CURRENT}$	Current consumption in addition to IRX.			250		µA	1

Table 11 : RSSI specifications

6.3.6 CPU

Symbol	Description	Min.	Typ.	Max.	Units	Test Level
$I_{CPU, FLASH}$	Run current at 16 MHz (XOSC). Executing code from flash memory.		4.1		mA	2
$I_{CPU, RAM}$	Run current at 16 MHz (XOSC). Executing code from RAM.		2.4		mA	1
$I_{START, CPU}$	CPU startup current.		600		µA	1
$t_{START, CPU}$	IDLE to CPU execute.	0			µs	1

Table 12 : RSSI specifications

6.3.7 Power Management

Symbol	Description	Min.	Typ.	Max.	Units	Test Level
I_{OFF}	Current in SYSTEM OFF, no RAM retention.		0.6 [1]		µA	2
$I_{OFF, RET, 8k}$	Additional current in SYSTEM OFF per retained RAM block (8 kB).		0.6 [1]		µA	2
I_{OFF2ON}	OFF to CPU execute transition current.		400		µA	1
t_{OFF2ON}	OFF to CPU execute.		9.6	10.6	µs	1
$I_{ON,16k}$	SYSTEM-ON base current with 16 kB RAM enabled.		2.6 [1]		µA	2
$I_{ON,32k}$	SYSTEM-ON base current with 32 kB RAM enabled.		3.8 [1]		µA	2
t_{1V2}	Startup time for 1V2 regulator.		2.3		µs	1
$I_{1V2XO16}$	Current drawn by 1V2 regulator and 16 MHz XOSC when both are on at the same time.		810 [2]		µA	1
$I_{1V2XO32}$	Current drawn by 1V2 regulator and 32 MHz XOSC when both are on at the same time.		840 [2]		µA	1
$I_{1V2RC16}$	Current drawn by 1V2 regulator and 16 MHz RCOSC when both are on at the same time.		880 [2]		µA	1
$I_{1V2XO16,1M}$	For HFCLK in 1 MHz mode3. Current drawn by 1V2 regulator and 16 MHz XOSC when both are on at the same time.		520 [2]		µA	1
$I_{1V2XO32,1M}$	For HFCLK in 1 MHz mode3. Current drawn by 1V2 regulator and 32 MHz XOSC when both are on at the same time.		560 [2]		µA	1
$I_{1V2RC16,1M}$	For HFCLK in 1 MHz mode3. Current drawn by 1V2 regulator and 16 MHz RCOSC when both are on at the same time.		630 [2]		µA	1
t_{XO}	Startup time for the clock management system when the XTAL is in standby.		2.3		µs	1
t_{1V7}	Startup time for 1V7 regulator.		2	3.6	µs	1
I_{1V7}	Current drawn by 1V7 regulator.		105		µA	2
F_{DCDC}	DC/DC converter current conversion factor.	0.65 [4]		1.2 [4]		1

1. Add 1 µA to the current value if the device is used in Low voltage mode.
2. This number includes the current used by the automated power and clock management system.
3. For details on 1 MHz mode, see Section 4.2 “Timer/counters (TIMER)” on page 33.
4. FDCDC will vary depending on VDD and internal radio current consumption (IDD). Please refer to the nRF51 Series Refer-ence Manual, v3.0 or later, for a method to calculate IDD,DCDC. See Figure 11 on page 51 for a DC/DC conversion factor chart.

Table 13 : Power management

7. Reference Circuit

7.1 Schematic with Internal LDO

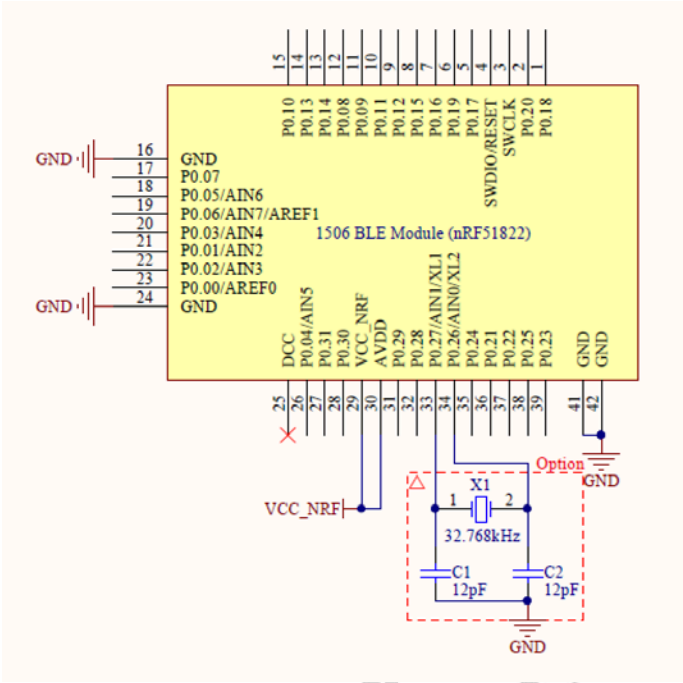

Figure 6 : Schematic with internal LDO

7.2 Schematic with Internal DC/DC Converter

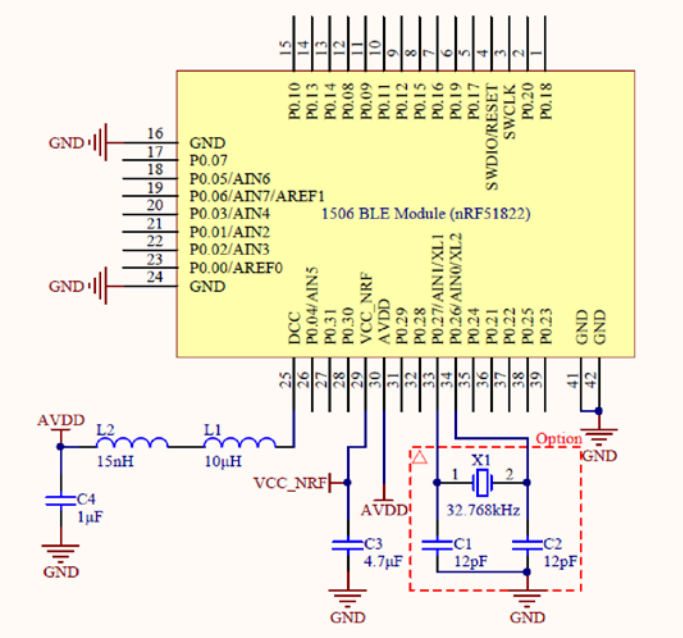

Figure 7 : Schematic with internal DC/DC converter

8. Development Kit

The ISBLE1506-EV is a versatile single board development kit for iSenseTek 1506 BLE module series. The kit gives access to all module I/O and interfaces via connectors and has 4 LEDs and 4 buttons which are user-programmable. Using the ISBLE1506-EV it enables setting up of a peer device that you can use to test the connection of your application, it provides a complete solution, allowing faster time to market.

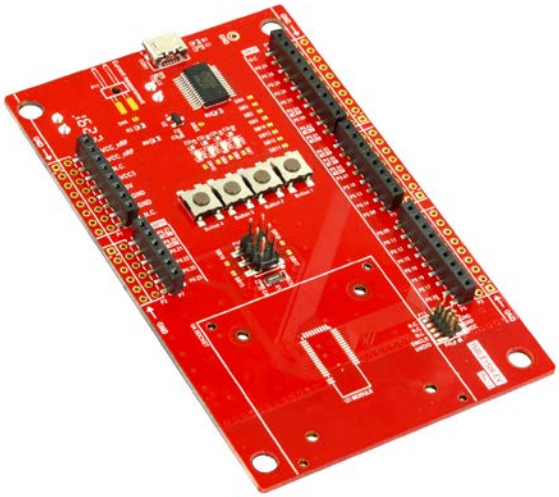

Figure 8: Development Kit

FEATURES
Support USB to UART for DTM use
All GPIO and interfaces available at edge connectors
Button *4 and LED *4
CR2032 battery holder *1
Support module test & program socket

9. Antenna Forbidden Zone Description

The PCB and mechanism design need to meet antenna forbidden zone description Table. Otherwise affect the efficiency of the antenna.

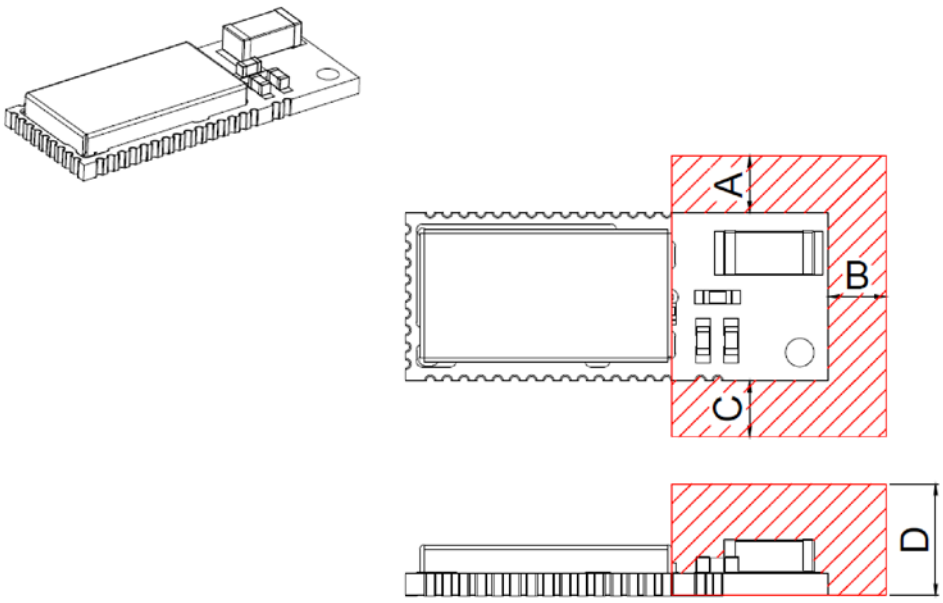

Figure 9 : Antenna Forbidden Zone Description

Material \ Dimension	A	B	C	D
FR4 (without Copper)	≧ 2mm	≧ 3mm	≧ 0.5mm	≧ 5mm
FR4 (with Copper)	≧ 6mm	≧ 6mm	≧ 3mm	≧ 8mm
Metal	≧ 6mm	≧ 6mm	≧ 3mm	≧ 8mm
Plastic	≧ 2mm	≧ 2mm	≧ 0.5mm	≧ 3.5mm

Table 14 : Antenna Forbidden Zone List

10. SMT Reflow Solder Guide

The reflow solder parameters for the Module shown in below figure and Table.

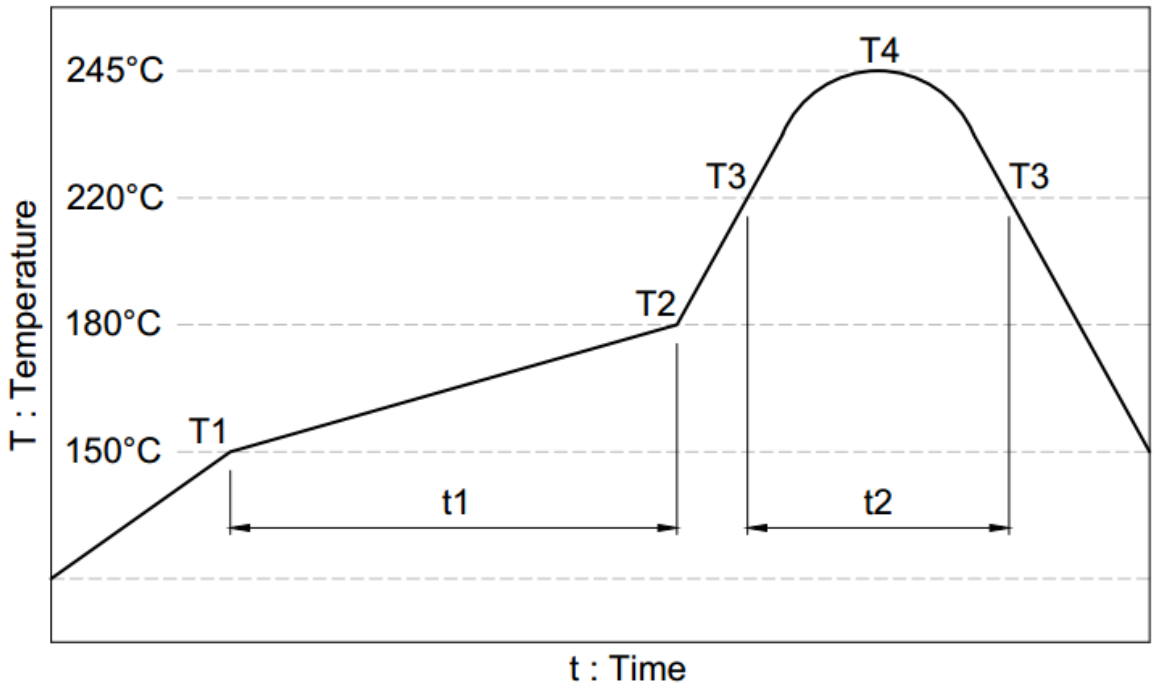

Figure 10 : Reflow Solder Guide

Solder Step	Temperature	Time
Ramp Rate	/	3°C / Second
Pre-Heat	T1 : 150°C ~ T2 : 180°C	t1 : 60~120 seconds
Soaking	T3 : 220°C	t2 : 30~90 seconds
Peak Temp.	T4 : 245±5°C	Within 20 seconds
Ramp Down Rate	/	6°C / Second (Maximum)

Table 15 : Reflow Solder Temp. List

11. Document History

Revision	Date	Description/Changes
1.0	2016/11/17	First Release.
1.1	2017/02/22	Overall Introduction description update. P3
1.2	2017/03/24	Add SMT Reflow Solder Guide. P21