BoT-nLE523

DATASHEET

V 1.0.3

CHIPSEN

■ History

Rev	Date	Description	Author
1.0.3	2022. 04. 06	- Land pattern consideration update	Enoch
1.0.2	2022. 02. 23	- Power consumption update	Enoch
1.0.1	2022. 02. 08	- Pin Configuration update - Antenna Design Guide update	Enoch
1.0.0	2022. 02. 07	- First release	Enoch

Table of Contents

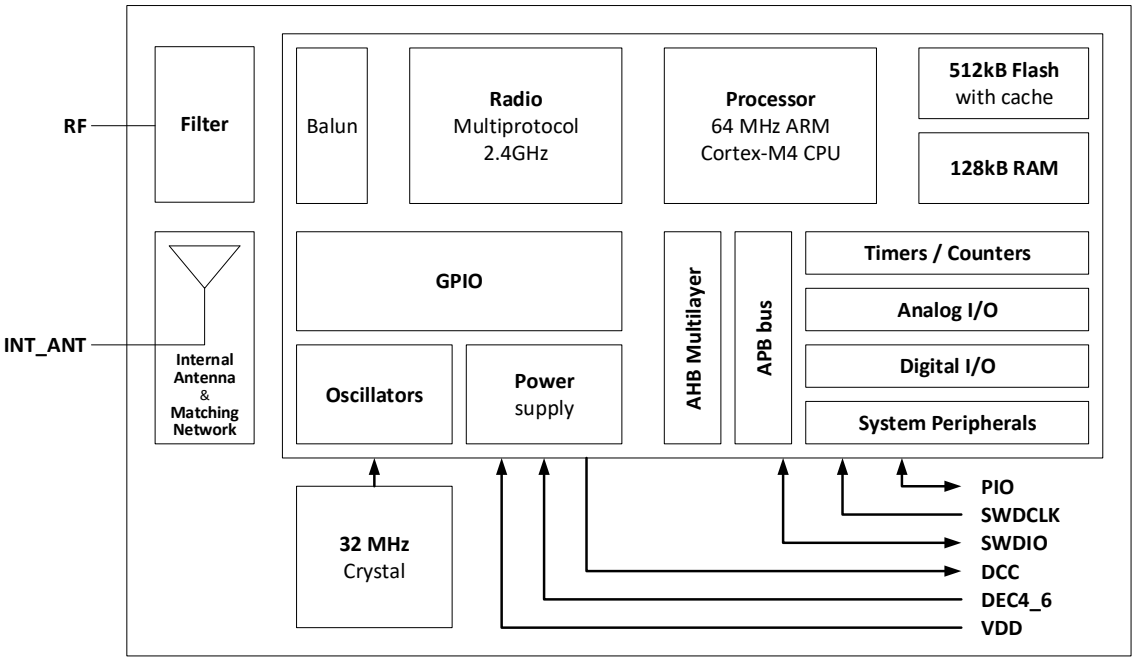
1. General

1.1 Overview

The BoT-nLE523 module is a cost-effective, low-power, true system-on-chip (SoC) for Bluetooth Smart (Bluetooth low energy) applications. It enables robust BLE nodes to be built with very low total bill-of-material costs. BoT-nLE523 combines an excellent RF transceiver with an industry-standard enhanced Cortec-M4 CPU, in-system programmable 512 kB flash memory, 128kB RAM, and many other powerful supporting features and peripherals. The BoT-nLE523 is suitable for systems where very low power.

Consumption is required. Very low-power sleep modes are available. Short transition times between operating modes further enable low power consumption.

1.2 Block Diagram



BoT-nLE523 Block Diagram

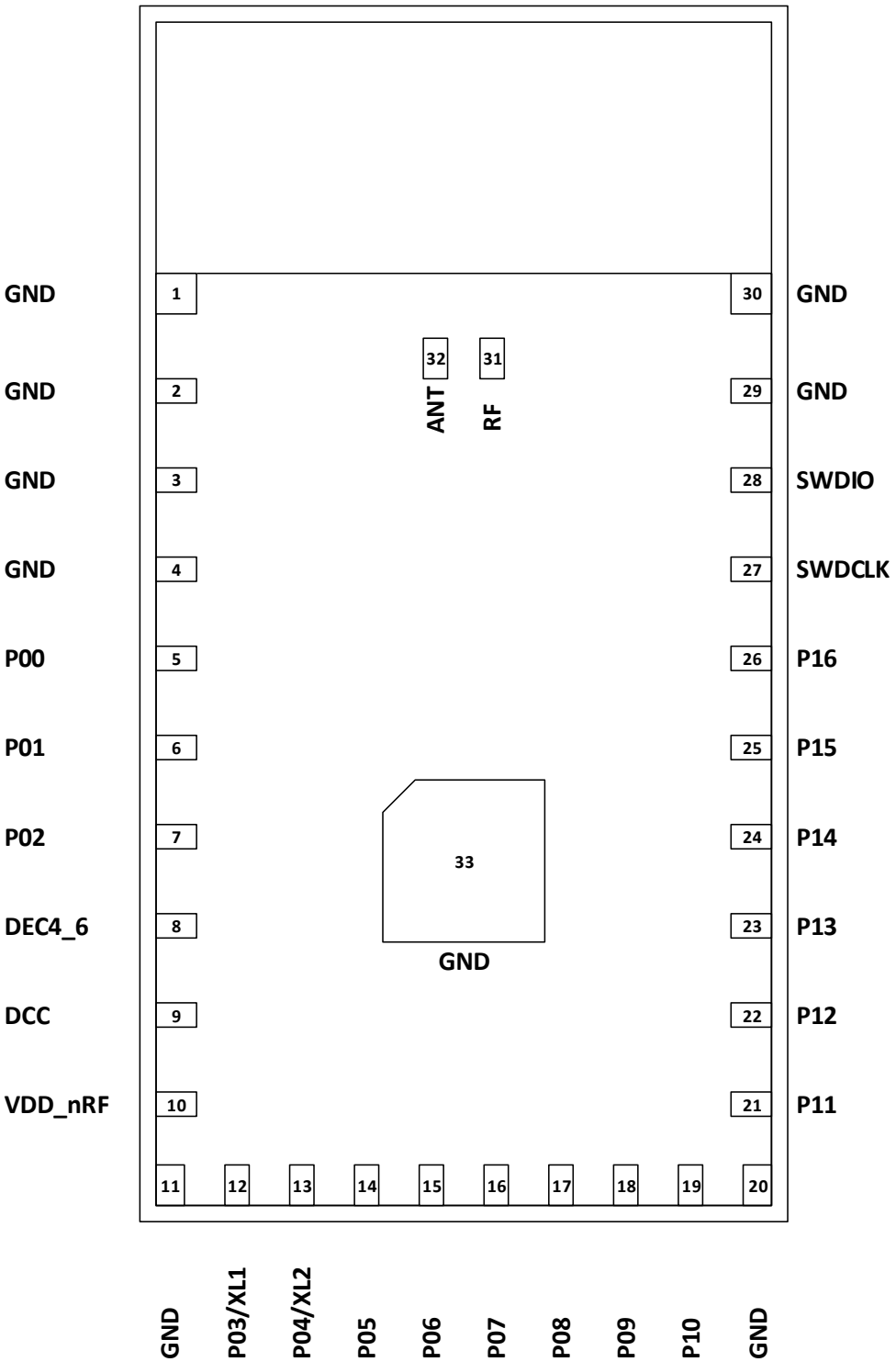
1.3 Features

- BT Ver. : Bluetooth 5.1
- Built in Antenna Bluetooth Smart (Bluetooth Low Energy) Module.
- ARM® Cortex®-M4 32-bit processor with FPU, 64 MHz
- Memory: 512 kB Flash / 128 kB RAM
- RF Output Power: MAX +7 dBm (-20 ~ 7 dBm)
- RF Receive Sensitivity: -93.5 dBm @ Dirty Tx enable, 1Mbps Bluetooth Low Energy mode
- Type 2 near field communication (NFC-A) tag with wakeup-on-field and touch to-pair capabilities
- On-chip LDO and DC/DC converter system (Used LDO by Default)
- Temperature Sensor
- UART (CTS/RTS) with EasyDMA, SPI, and I2C data interfaces.
- 12-Bit 200 ksps ADC with - 7 configurable channels with programmable gain
- Size: 15 mm x 8 mm x 1.8 mm
- Operating Voltage: 2.7V to 3.6V
- Operating Temperature: -40 to +85℃
- RoHS compliant

1.4 Application

- 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 watches
- Remote control toys

1.5 Pin Configuration



TOP VIEW

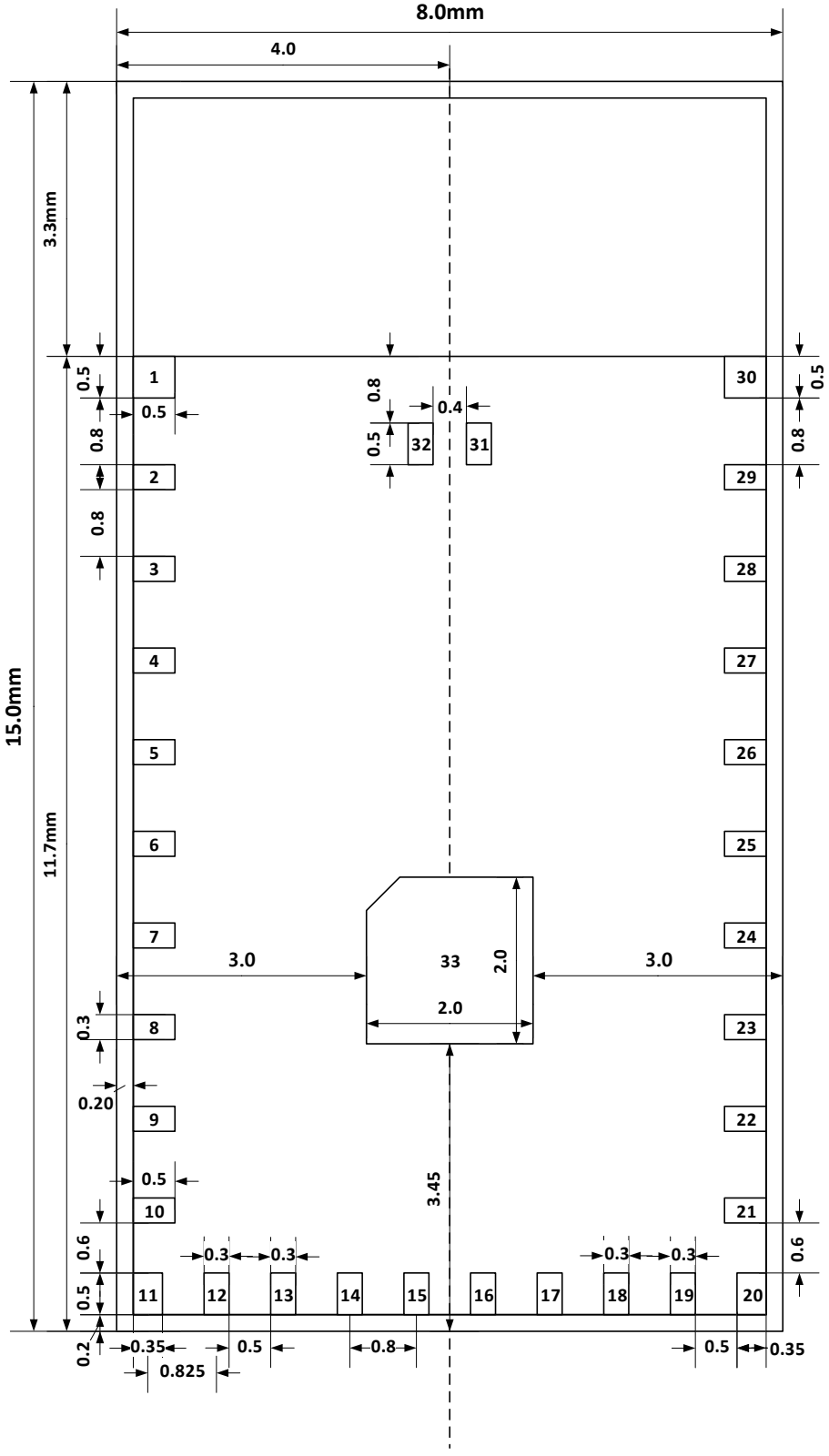
1.6 PIN Description

Pin No.	Pin Name	Pin Function	Description
05	P00	DIGITAL I/O	Standard drive, low frequency I/O only
	AIN1	ANALOG INPUT	
06	P01	DIGITAL I/O	Standard drive, low frequency I/O only
	AIN0	ANALOG INPUT	
07	P02	DIGITAL I/O	Standard drive, low frequency I/O only.
	AIN4	ANALOG INPUT	
12	P03	DIGITAL I/O	General purpose I/O pin.
	XL1	ANALOG INPUT	Connection for 32.768 kHz crystal
13	P04	DIGITAL I/O	General purpose I/O pin.
	XL2	ANALOG INPUT	Connection for 32.768 kHz crystal
14	P05	DIGITAL I/O	General purpose I/O pin.
	AIN2	ANALOG INPUT	Analog input
	CTS [1]	DIGITAL OUTPUT	UART CTS
15	0P6	DIGITAL I/O	General purpose I/O pin.
	AIN3	ANALOG INPUT	Analog input
	RTS [1]	DIGITAL INPUT	UART RTS
16	P07	DIGITAL I/O	General purpose I/O pin.
	RXD [1]	DIGITAL INPUT	UART RXD
17	P08	DIGITAL I/O	General purpose I/O pin.
	TXD [1])	DIGITAL OUTPUT	UART TXD
18	P09	DIGITAL I/O	General purpose I/O pin.
	AIN6	ANALOG INPUT	Analog input
	FACTORY_RST [1]	DIGITAL INPUT	DISCONNECT & FACTORY_RESET [2]
19	P10	DIGITAL I/O	General purpose I/O pin.
	AIN5	ANALOG INPUT	Analog input
	ENTER_SLEEP WAKE_UP [1]	DIGITAL INPUT	ENTER_SLEEP / WAKE_UP [2]
21	P11	DIGITAL I/O	General purpose I/O pin.
22	P12	DIGITAL I/O	General purpose I/O pin.
23	P13	DIGITAL I/O	General purpose I/O pin.
	UART ON/OFF [1]	DIGITAL INPUT	UART ENABLE / DISABLE [2]
24	P14	DIGITAL I/O	General purpose I/O pin.
	AT COMMAND BYPASS [1]	DIGITAL INPUT	AT COMMAND / BYPASS [2]
25	P15	DIGITAL I/O	General purpose I/O pin.
	CONNECTION STATUS [1]	DIGITAL OUTPUT	CONNECTION STATUS [2]
26	P16	DIGITAL I/O	General purpose I/O pin.
27	SWDCLK	DIGITAL INPUT	Serial Wire Debug clock input for debug and programming
28	SWDIO	DIGITAL I/O	Serial Wire Debug I/O for debug and programming
31	RF	RF IN / OUT PORT	Bluetooth 50Ω transmitter output / receiver input
32	ANT	INTERNAL ANTENNA IN / OUT	Internal antenna. It should be connected to 31 Pin RF for using internal antenna.
08	DEC4_6	POWER	1.3 V regulator supply decoupling Input from DC/DC converter. Output from 1.3 V LDO
09	DCC	POWER	DC/DC converter output
10	VCC	POWER	Power supply pin.
01,02,03,04 ,11,20,29,3 0,33	GND	GROUND	Ground Pin.

1) This I/O function operate on CHIPSEN commercial firmware.

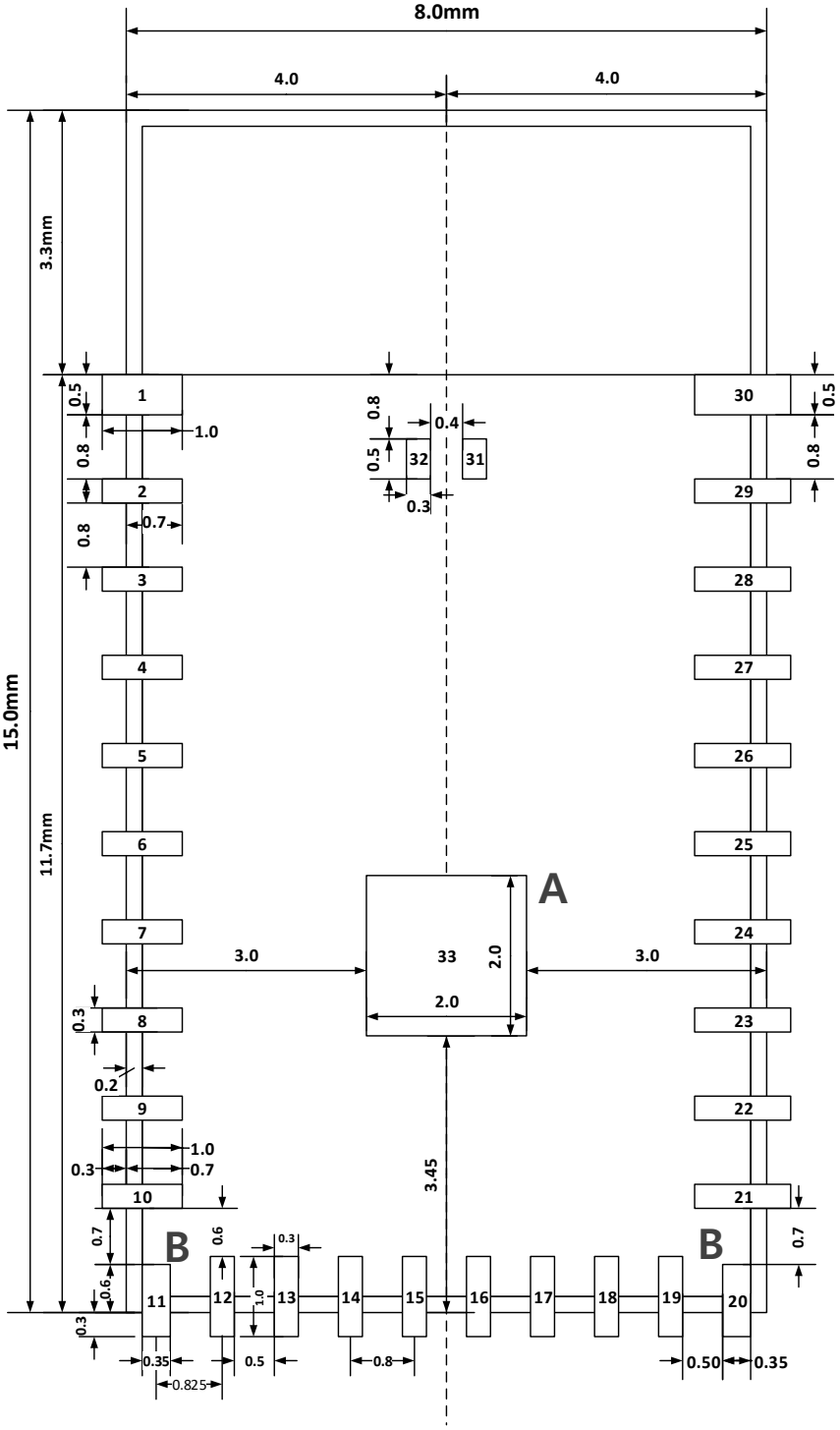
2) For more information refer to CHIPSEN commercial firmware document.

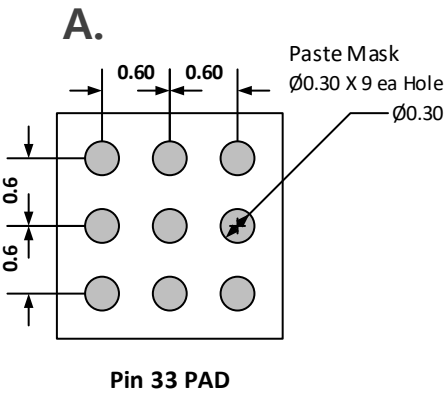
1.7 Dimensions



TOP VIEW

1.8 Land Pattern

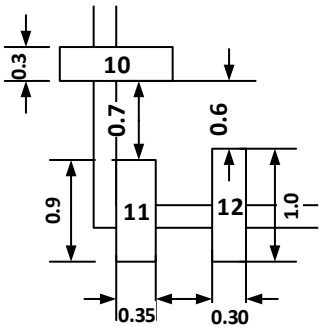




Pin 33 PAD

B.

(Caution) Be careful not to short-circuit pins 10-11 and 20-21 in PCB land pattern and paste mask design.



Land Pattern (TOP VIEW)

2. Characteristics

2.1 Electrical Characteristics

▪ Absolute Maximum Ratings

Symbol	Parameter	Min.	Max.	Units
VDD		-0.3	+3.9	V
GND			0	V
$V_{I/O}$, VDD≤3.6V		-0.3	VDD + 0.3	V
$V_{I/O}$, VDD >3.6V		-0.3	+3.9	V
Storage temperature		-40	+125	°C
Radio ra	RF Input Level		10	dBm
MSL	Moisture Sensitivity Level	2		
ESD HBM	Human Body Model		4	kV
ESD CDM	Charged Device Model		750	V
Endurance	Flash Memory Endurance	10000		write/erase cycles
Retention	Flash Memory Retention	10 years		At 85 °C

▪ Recommended Operating Conditions

Symbol	Parameter	Min.	Typ.	Max.	Units
VDD	LDO Regulator Operation (Default Mode)	2.7	3.3	3.6	V
VDD	DC/DC Regulator Oprtation	2.7	3.3	3.6	V
$t_{R_}$VDD	Supply rise time (0V to 1.7V)			60	ms
TA	Operation temperature	-40	25	85	°C

▪ DC Characteristics

Symbol	Parameter (condition)	Min.	Typ.	Max.	Units
V_{IH}	Input high voltage	0.7 X VDD		VDD	V
V_{IL}	Input low voltage	VSS		0.3 X VDD	V
$V_{OH,SD}$	Output high voltage, standard drive, 0.5 mA, VDD ≥1.7	VDD-0.4		VDD	V
$V_{OH,HDH}$	Output high voltage, high drive, 5 mA, VDD ≥ 2.7 V	VDD-0.4		VDD	V
$V_{OH,HDL}$	Output high voltage, high drive, 3 mA, VDD ≥ 1.7 V	VDD-0.4		VDD	V
$V_{OL,SD}$	Output low voltage, standard drive, 0.5 mA, VDD ≥1.7	VSS		VSS +0.4	V
$V_{OL,HDH}$	Output low voltage, high drive, 5 mA, VDD ≥ 2.7 V	VSS		VSS +0.4	V
$V_{OL,HDL}$	Output low voltage, high drive, 3 mA, VDD ≥ 1.7 V	VSS		VSS +0.4	V
R_{PU}	Pull-up resistance	11	13	16	kΩ
R_{PD}	Pull-down resistance	11	13	16	kΩ
I_{TX},+4dBm,DCDC	TX only run current (DCDC, 3V) P_{RF}=+8 dBm		9.6		mA
I_{TX},+4dBm	TX only run current P_{RF}=+4 dBm		20.7		mA
I_{RX},1M,DCDC	RX only run current (DCDC, 3V) 1Msps		4.6		mA
I_{RX},1M	RX only run current 1Msps		9.6		mA
I_{RX},2M,DCDC	RX only run current (DCDC, 3V) 2Msps		5.2		mA
I_{RX},2M	RX only run current 2Msps		10.7		mA
$I_{ON\_RAMOFF\_EVENT}$	System ON, No RAM retention, Wake on any event		1.1		μA
$I_{ON\_RAMON\_EVENT}$	System ON, Full 128kB RAM retention, Wake on any event		1.8		μA
$I_{ON\_RAMON\_POF}$	System ON, Full 128kB RAM retention, Wake on any event, Power fail comparator enabled		1.9		μA
$I_{ON\_RAMON\_GPIOTE}$	System ON, Full 128kB RAM retention, Wake on GPIOTE input (Event mode)		7.4		μA
$I_{ON\_RAMON\_GPIOTEPORT}$	System ON, Full 128kB RAM retention, Wake on GPIOTE PORT event		1.8		μA
$I_{ON\_RAMON\_RTC}$	System ON, Full 24 kB RAM retention, Wake on RTC (running from LFRC clock)		1.5		μA
$I_{OFF\_RAMOFF\_RESET}$	System OFF, No RAM retention, Wake on reset		0.6		μA
$I_{OFF\_RAMON\_RESET}$	System OFF, Full 128kB RAM retention, Wake on reset		1.3		μA

2.2 RF Characteristics

Symbol	Description	Min.	Typ.	Max.	Units
f_{OP}	Operating frequencies	2360		2500	MHz
$f_{PLL,CH,SP}$	PLL channel spacing		1		MHz
$f_{DELTA,BLE,1M}$	Frequency deviation @ BLE 1Msps		±250		kHz
$f_{DELTA,BLE,2M}$	Frequency deviation @ BLE 2Msps		±320		kHz
P_{RF}	Maximum output power		0	7	dBm
P_{RFC}	RF power control range		28		dB
P_{RFCR}	RF power accuracy			±4	dB
$P_{RF1.1}$	1st Adjacent Channel Transmit Power 1 MHz (1		-25		dBc
$P_{RF2.1}$	2nd Adjacent Channel Transmit Power 2 MHz (1		-54		dBc
$P_{RF1.2}$	1st Adjacent Channel Transmit Power 2 MHz (2		-26		dBc
$P_{RF2.2}$	2nd Adjacent Channel Transmit Power 4 MHz (2		-54		dBc
$P_{RX,MAX}$	Maximum received signal strength at < 0.1% PER		0		dBm
$P_{SENS,IT,SP,1M,BLE}$	Sensitivity, 1Msps BLE ideal transmitter, <=37 bytes BER=1E-3		-93.5		dBm
$P_{SENS,IT,SP,2M,BLE}$	Sensitivity, 2Msps BLE ideal transmitter, <=37		-91		dBm
$RSSI_{ACC}$	RSSI Accuracy Valid range -90 to -20 dBm		±2		dB
$RSSI_{RESOLUTION}$	RSSI resolution		1		dB
$RSSI_{PERIOD}$	Sample period		8		us

2.3 Reference RF Measurement Report (Conduction)

31 RF test cases started: Wed Dec 29 18:55:22 2021

_____Output Power (TP/TRM-LE/CA/BV-01-C)

Initial conditions:

Test Method:	Test mode
Hopping:	off
Payload:	PRBS9
Payload's length:	37 bytes
Number of packets:	1
Path losses:	1.50dB

Limits:

-20.00dBm <= Pavg <= 10.00dBm, Ppk-av <= 3.00dB

Results (power in dBm):

#ch	f(MHz)	Pavg	Ppk	Ppk-av	Pmin	Verdict
0	2402	-0.62	-0.45	0.17	-0.81	PASSED
19	2440	-1.02	-0.85	0.17	-1.21	PASSED
39	2480	-1.54	-1.40	0.14	-1.74	PASSED

Test time: 1 sec.

_____In-band emissions (TP/TRM-LE/CA/BV-03-C)

Initial conditions:

Test Method:	Test mode
Payload:	PRBS9
Payload's length:	37 bytes
Number of sweeps:	10
Path losses:	1.50dB

Limits:

P[N]<=-20.00dBm if abs(M-N)=2,P[N]<=-30.00dBm if abs(M-N)>3,-30.00dBm<=P[i]<=-20.00dBm less then for 3 channels

Results:

freq=2406MHz (M=4), P[N] in dBm:

N	P[N]	N	P[N]	N	P[N]	N	P[N]
2401	-59.58	2422	-60.14	2443	-60.35	2464	-60.04
2402	-59.56	2423	-59.96	2444	-59.98	2465	-60.67
2403	-57.75	2424	-61.75	2445	-59.45	2466	-60.14
2404	-48.77	2425	-62.83	2446	-59.18	2467	-60.15
2405	-24.51	2426	-63.28	2447	-59.85	2468	-60.72
2406	-1.50	2427	-56.19	2448	-60.23	2469	-60.30
2407	-20.78	2428	-59.80	2449	-60.42	2470	-60.03
2408	-49.20	2429	-60.24	2450	-59.95	2471	-60.26
2409	-57.83	2430	-60.57	2451	-60.35	2472	-60.24
2410	-59.63	2431	-60.23	2452	-60.14	2473	-60.25
2411	-59.79	2432	-60.29	2453	-60.08	2474	-60.29
2412	-59.95	2433	-60.51	2454	-60.07	2475	-60.55
2413	-60.00	2434	-60.17	2455	-60.11	2476	-60.28
2414	-60.00	2435	-60.08	2456	-60.34	2477	-60.41
2415	-60.17	2436	-60.24	2457	-60.51	2478	-59.94
2416	-60.18	2437	-59.73	2458	-59.98	2479	-60.25
2417	-59.82	2438	-58.89	2459	-60.19	2480	-60.76
2418	-60.41	2439	-59.63	2460	-60.40	2481	-60.32
2419	-60.50	2440	-60.54	2461	-60.13		
2420	-60.37	2441	-60.27	2462	-60.27		
2421	-60.27	2442	-60.26	2463	-60.81		
					Verdict: PASSED		

freq=2440MHz (M=38), P[N] in dBm:

N	P[N]	N	P[N]	N	P[N]	N	P[N]
2401	-60.13	2422	-58.61	2443	-58.02	2464	-60.28
2402	-60.13	2423	-60.24	2444	-59.41	2465	-60.27
2403	-60.12	2424	-60.37	2445	-60.11	2466	-60.21
2404	-60.00	2425	-60.62	2446	-60.31	2467	-60.51
2405	-59.19	2426	-60.35	2447	-59.93	2468	-60.25
2406	-59.88	2427	-60.39	2448	-60.24	2469	-59.83

2407	-60.04	2428	-60.28	2449	-59.87	2470	-59.80
2408	-58.97	2429	-60.09	2450	-59.98	2471	-60.14
2409	-60.23	2430	-60.34	2451	-60.55	2472	-59.09
2410	-60.47	2431	-60.12	2452	-60.04	2473	-60.03
2411	-60.54	2432	-60.25	2453	-60.20	2474	-60.36
2412	-60.19	2433	-60.41	2454	-60.06	2475	-60.41
2413	-60.51	2434	-59.93	2455	-60.23	2476	-59.85
2414	-60.43	2435	-60.25	2456	-60.14	2477	-60.31
2415	-60.80	2436	-59.23	2457	-59.75	2478	-60.44
2416	-60.45	2437	-57.46	2458	-61.48	2479	-59.52
2417	-60.45	2438	-49.11	2459	-62.75	2480	-59.03
2418	-62.06	2439	-24.87	2460	-63.14	2481	-59.62
2419	-63.22	2440	-1.97	2461	-55.93		
2420	-61.47	2441	-21.16	2462	-60.06		
2421	-53.70	2442	-49.45	2463	-60.51		
					Verdict: PASSED		

freq=2476MHz (M=74), P[N] in dBm:

N	P[N]	N	P[N]	N	P[N]	N	P[N]
2401	-60.21	2422	-60.33	2443	-60.16	2464	-60.27
2402	-60.09	2423	-59.89	2444	-59.31	2465	-60.13
2403	-60.47	2424	-60.32	2445	-60.16	2466	-59.90
2404	-60.28	2425	-60.05	2446	-60.61	2467	-60.10
2405	-60.26	2426	-60.09	2447	-60.21	2468	-60.00
2406	-60.24	2427	-60.37	2448	-60.30	2469	-60.47
2407	-60.56	2428	-60.22	2449	-60.41	2470	-59.95
2408	-60.22	2429	-60.10	2450	-60.35	2471	-59.63
2409	-60.12	2430	-60.43	2451	-60.07	2472	-59.63
2410	-60.57	2431	-59.99	2452	-60.58	2473	-57.86
2411	-60.28	2432	-60.21	2453	-60.31	2474	-48.58
2412	-59.99	2433	-60.37	2454	-61.98	2475	-24.55
2413	-60.02	2434	-60.44	2455	-63.22	2476	-1.56
2414	-60.34	2435	-60.49	2456	-61.27	2477	-21.12
2415	-60.14	2436	-60.39	2457	-53.73	2478	-49.21
2416	-60.20	2437	-60.19	2458	-58.51	2479	-58.14
2417	-60.64	2438	-60.16	2459	-60.33	2480	-59.39
2418	-60.45	2439	-60.00	2460	-60.01	2481	-60.02
2419	-60.46	2440	-60.26	2461	-60.43		
2420	-60.41	2441	-59.21	2462	-60.39		
2421	-60.51	2442	-60.30	2463	-59.97		
					Verdict: PASSED		

Test time: 3 min. 5 sec.

_____Modulation Characteristics (TP/TRM-LE/CA/BV-05-C)

Initial conditions:

Test Method: Test mode
Hopping: off
Payload: 11110000 and 1010 bit patterns
Payload's length: 37 bytes
Number of packets: 10

Limits:

225.0KHz <= df1_avg <= 275.0KHz, df2_pass_rate >= 99.90%, df2/df1 >= 0.80

Results (frequency deviations in KHz):

#ch	f(MHz)	df1_avg	df2_avg	df2_min	df2_rate(%)	df2/df1	Verdict	
0	2402	258.2	253.8	229.6	100.00		0.98	PASSED
19	2440	258.1	254.8	222.7	100.00		0.99	PASSED
39	2480	258.5	257.4	230.8	100.00		1.00	PASSED

Test time: 3 sec.

_____Carrier frequency offset and drift (TP/TRM-LE/CA/BV-06-C)

Initial conditions:

Test Method: Test mode
Payload: 1010 bit pattern
Payload's length: 37 bytes

Number of packets: 10

Limits:

|fTX-f[n]| <= 150.0KHz, |f[0]-f[n]| <= 50.0KHz, |f[1]-f[0]| <= 23.0KHz, |f[n]-f[n-5]| <= 20.0KHz

Results (maximum of absolute values in KHz):

#ch	f(MHz)	fTX-f[n]	f[0]-f[n]	f[1]-f[0]	f[n]-f[n-5]	Verdict	
0	2402	17.1	-4.4	-3.1	3.2		PASSED
19	2440	17.2	-4.2	-1.9	4.2		PASSED
39	2480	17.5	-3.8	-2.1	3.5		PASSED

Test time:<1 sec.

_____In-band emissions at 2 Ms/s (TP/TRM-LE/CA/BV-08-C)

Initial conditions:

Test Method: Test mode
Payload: PRBS9
Payload's length: 31 bytes
Number of sweeps: 10
Path losses: 1.50dB

Limits:

P[N]<=-20.00dBm if abs(M-N)=4 or abs(M-N)= 5,P[N]<=-30.00dBm if abs(M-N)>6,-30.00dBm<=P[i]<=-20.00dBm less then for 3 channels

Results:

freq=2406MHz (M=4), P[N] in dBm:

N	P[N]	N	P[N]	N	P[N]	N	P[N]
2401	-59.44	2422	-60.45	2443	-60.63	2464	-60.12
2402	-58.66	2423	-60.05	2444	-60.14	2465	-60.60
2403	-52.89	2424	-62.95	2445	-60.36	2466	-60.44
2404	-38.62	2425	-63.42	2446	-60.01	2467	-59.96
2405	-13.66	2426	-63.62	2447	-60.28	2468	-60.34
2406	-5.05	2427	-56.05	2448	-60.16	2469	-60.88
2407	-13.89	2428	-59.98	2449	-60.59	2470	-59.82
2408	-37.79	2429	-60.50	2450	-60.05	2471	-60.05
2409	-53.39	2430	-60.20	2451	-60.48	2472	-60.50
2410	-58.89	2431	-60.44	2452	-60.65	2473	-60.26
2411	-60.04	2432	-60.39	2453	-60.08	2474	-59.63
2412	-59.63	2433	-60.48	2454	-60.18	2475	-59.98
2413	-60.10	2434	-60.44	2455	-60.12	2476	-60.31
2414	-60.08	2435	-60.03	2456	-60.34	2477	-59.87
2415	-60.13	2436	-60.24	2457	-60.82	2478	-60.01
2416	-60.11	2437	-60.13	2458	-60.15	2479	-60.40
2417	-60.16	2438	-59.90	2459	-60.03	2480	-60.26
2418	-60.55	2439	-60.08	2460	-60.85	2481	-59.63
2419	-60.24	2440	-60.29	2461	-60.04		
2420	-60.84	2441	-60.66	2462	-60.09		
2421	-60.13	2442	-59.96	2463	-60.70		

Verdict: PASSED

freq=2440MHz (M=38), P[N] in dBm:

N	P[N]	N	P[N]	N	P[N]	N	P[N]
2401	-60.57	2422	-58.68	2443	-53.20	2464	-60.41
2402	-60.30	2423	-60.21	2444	-58.89	2465	-60.01
2403	-59.99	2424	-59.76	2445	-59.75	2466	-60.31
2404	-59.72	2425	-60.37	2446	-59.57	2467	-60.23
2405	-60.18	2426	-60.24	2447	-59.87	2468	-60.20
2406	-60.18	2427	-60.34	2448	-60.32	2469	-60.49
2407	-59.75	2428	-60.33	2449	-59.99	2470	-60.18
2408	-59.35	2429	-60.31	2450	-59.87	2471	-60.04
2409	-60.54	2430	-60.29	2451	-60.41	2472	-59.64
2410	-59.98	2431	-59.86	2452	-60.22	2473	-59.77
2411	-59.91	2432	-59.92	2453	-60.10	2474	-60.07
2412	-60.58	2433	-59.64	2454	-59.93	2475	-60.82
2413	-60.89	2434	-59.72	2455	-60.28	2476	-60.11
2414	-60.82	2435	-60.17	2456	-59.99	2477	-60.29
2415	-60.24	2436	-59.70	2457	-60.07	2478	-60.08
2416	-60.24	2437	-54.72	2458	-62.76	2479	-59.91

2417	-60.65	2438	-40.93	2459	-63.55	2480	-59.94
2418	-62.25	2439	-16.33	2460	-63.62	2481	-60.32
2419	-63.50	2440	-7.19	2461	-56.83		
2420	-61.81	2441	-15.46	2462	-60.04		
2421	-54.32	2442	-38.42	2463	-59.88		
					Verdict: PASSED		

freq=2476MHz (M=74), P[N] in dBm:

N	P[N]	N	P[N]	N	P[N]	N	P[N]
2401	-60.33	2422	-60.38	2443	-60.28	2464	-59.74
2402	-59.80	2423	-60.48	2444	-60.28	2465	-60.18
2403	-59.87	2424	-60.88	2445	-59.95	2466	-60.10
2404	-59.94	2425	-60.42	2446	-60.23	2467	-60.13
2405	-60.01	2426	-60.78	2447	-60.66	2468	-60.17
2406	-59.95	2427	-61.13	2448	-60.26	2469	-60.00
2407	-60.54	2428	-60.37	2449	-59.63	2470	-60.03
2408	-60.36	2429	-60.29	2450	-60.79	2471	-58.96
2409	-60.85	2430	-60.43	2451	-60.83	2472	-58.91
2410	-60.55	2431	-59.98	2452	-60.06	2473	-53.23
2411	-60.88	2432	-60.07	2453	-60.36	2474	-39.10
2412	-60.33	2433	-60.68	2454	-62.31	2475	-14.37
2413	-60.27	2434	-60.90	2455	-63.30	2476	-6.92
2414	-60.42	2435	-60.49	2456	-61.87	2477	-16.23
2415	-60.13	2436	-60.20	2457	-55.16	2478	-39.80
2416	-60.10	2437	-59.73	2458	-58.90	2479	-54.64
2417	-59.87	2438	-60.22	2459	-59.97	2480	-59.59
2418	-60.37	2439	-60.61	2460	-60.83	2481	-59.97
2419	-60.74	2440	-60.60	2461	-60.06		
2420	-60.24	2441	-59.88	2462	-60.00		
2421	-60.29	2442	-59.73	2463	-60.60		
					Verdict: PASSED		

Test time: 3 min. 5 sec.

_____Modulation Characteristics at 2 Ms/s (TP/TRM-LE/CA/BV-10-C)

Initial conditions:

Test Method: Test mode
Hopping: off
Payload: 11110000 and 1010 bit patterns
Payload's length: 31 bytes
Number of packets: 10

Limits:

450.0KHz <= df1_avg <= 550.0KHz, df2_pass_rate >= 99.90%, df2/df1 >= 0.80

Results (frequency deviations in KHz):

#ch	f(MHz)	df1_avg	df2_avg	df2_min	df2_rate(%)	df2/df1	Verdict	
0	2402	483.5	443.4	399.4	100.00		0.92	PASSED
19	2440	485.5	446.8	396.5	100.00		0.92	PASSED
39	2480	492.7	451.8	407.6	100.00		0.92	PASSED

Test time: 4 sec.

_____Carrier frequency offset and drift at 2 Ms/s (TP/TRM-LE/CA/BV-12-C)

Initial conditions:

Test Method: Test mode
Payload: 1010 bit pattern
Payload's length: 31 bytes
Number of packets: 10

Limits:

|fTX-f[n]| <= 150.0KHz, |f[0]-f[n]| <= 50.0KHz, |f[1]-f[0]| <= 23.0KHz, |f[n]-f[n-5]| <= 20.0KHz

Results (maximum of absolute values in KHz):

#ch	f(MHz)	fTX-f[n]	f[0]-f[n]	f[1]-f[0]	f[n]-f[n-5]	Verdict	
0	2402	17.4	-5.0	-3.1	-2.8		PASSED
19	2440	18.2	-4.0	-3.6	4.1		PASSED
39	2480	18.0	4.0	2.8	-2.8		PASSED

Test time:<1 sec.

_____Modulation Characteristics LE Coded (S=8) (TP/TRM-LE/CA/BV-13-C)

Initial conditions:

Test Method:	Test mode
Hopping:	off
Payload:	11110000 bit pattern
Payload's length:	31 bytes
Number of packets:	10

Limits:

225.0KHz <= df1_avg <= 275.0KHz, df1_pass_rate >= 99.90%

Results (frequency deviations in kHz):

#ch	f(MHz)	df1_avg	df1_min	df1_rate(%)	Verdict	
0	2402	258.2	233.3	100.00		PASSED
19	2440	258.3	233.6	100.00		PASSED
39	2480	257.5	229.9	100.00		PASSED

Test time: 3 sec.

_____Carrier frequency offset and drift LE Coded (S=8) (TP/TRM-LE/CA/BV-14-C)

Initial conditions:

Test Method:	Test mode
Payload:	11110000 bit pattern
Payload's length:	31 bytes
Number of packets:	10

Limits:

|fTX-f[n]| <= 150.0KHz, |f[0]-f[n]| <= 50.0kHz, |f[0]-f[3]| <= 19.20kHz, |f[n]-f[n-3]| <= 19.20kHz

Results (maximum of absolute values in kHz):

#ch	f(MHz)	fTX-f[n]	f[0]-f[n]	f[0]-f[3]	f[n]-f[n-3]	Verdict	
0	2402	16.7	2.6	-1.1	16.7		PASSED
19	2440	17.1	2.7	-1.2	17.4		PASSED
39	2480	17.6	2.9	-1.7	17.1		PASSED

Test time: 3 sec.

_____Receiver sensitivity (TP/RCV-LE/CA/BV-01-C)

Initial conditions:

Test Method:	Test mode
Payload:	PRBS9
Payload's length:	37 bytes
Packets to transmit:	1500
RX (DUT) power:	-70.00dBm
Path losses:	1.50dB
Dirty TX mode:	On
PER limit mode:	Specification

Limits:

pkts_sent >= 1500, PER < 30.80%

Results:

#ch	f(MHz)	pkts_sent	pkts_rcvd	PER(%)	Verdict		
0	2402	1500		1500		0.000	PASSED
19	2440	1500		1500		0.000	PASSED
39	2480	1500		1500		0.000	PASSED

Test time: 5 sec.

_____Maximum input signal level (TP/RCV-LE/CA/BV-06-C)

Initial conditions:

Test Method:	Test mode
Payload:	PRBS9
Payload's length:	37 bytes
Packets to transmit:	1500
RX (DUT) power:	-30.00dBm
Path losses:	1.50dB
PER limit mode:	Specification

Limits:

pkts_sent >= 1500, PER < 30.80%

Results:

#ch	f(MHz)	pkts_sent	pkts_rcvd	PER(%)	Verdict		
0	2402	1500		1500		0.000	PASSED
19	2440	1500		1500		0.000	PASSED

39	2480	1500		1500	0.000	PASSED

Test time: 2 sec.

_____PER Report Integrity (TP/RCV-LE/CA/BV-07-C)

Initial conditions:

Test Method:	Test mode
Payload:	PRBS9
Payload's length:	37 bytes
Packets to transmit:	1500
RX (DUT) power:	-30.00dBm
Path losses:	1.50dB
PER limit mode:	Specification

Limits:

pkts_sent >= 1500, 50.00% <= PER <= 65.40%

Results:

#ch	f(MHz)	pkts_sent	pkts_rcvd	PER(%)	Verdict		
0	2402	1500		750		50.000	PASSED
19	2440	1500		750		50.000	PASSED
39	2480	1500		750		50.000	PASSED

Test time: 2 sec.

_____Receiver sensitivity at 2 Ms/s (TP/RCV-LE/CA/BV-08-C)

Initial conditions:

Test Method:	Test mode
Payload:	PRBS9
Payload's length:	31 bytes
Packets to transmit:	1500
RX (DUT) power:	-70.00dBm
Path losses:	1.50dB
Dirty TX mode:	On
PER limit mode:	Specification

Limits:

pkts_sent >= 1500, PER < 30.80%

Results:

#ch	f(MHz)	pkts_sent	pkts_rcvd	PER(%)	Verdict		
0	2402	1500		1500		0.000	PASSED
19	2440	1500		1500		0.000	PASSED
39	2480	1500		1500		0.000	PASSED

Test time: 4 sec.

_____Maximum input signal level at 2 Ms/s (TP/RCV-LE/CA/BV-12-C)

Initial conditions:

Test Method:	Test mode
Payload:	PRBS9
Payload's length:	31 bytes
Packets to transmit:	1500
RX (DUT) power:	-10.00dBm
Path losses:	1.50dB
PER limit mode:	Specification

Limits:

pkts_sent >= 1500, PER < 30.80%

Results:

#ch	f(MHz)	pkts_sent	pkts_rcvd	PER(%)	Verdict		
0	2402	1500		1500		0.000	PASSED
19	2440	1500		1500		0.000	PASSED
39	2480	1500		1500		0.000	PASSED

Test time: 3 sec.

_____PER Report Integrity at 2 Ms/s (TP/RCV-LE/CA/BV-13-C)

Initial conditions:

Test Method:	Test mode
Payload:	PRBS9
Payload's length:	31 bytes
Packets to transmit:	1500
RX (DUT) power:	-30.00dBm

Path losses: 1.50dB
PER limit mode: Specification
Limits:
pkts_sent >= 1500, 50.00% <= PER <= 65.40%
Results:

#ch	f(MHz)	pkts_sent	pkts_rcvd	PER(%)	Verdict		
0	2402	1500		750		50.000	PASSED
19	2440	1500		750		50.000	PASSED
39	2480	1500		750		50.000	PASSED

Test time: 3 sec.
_____Receiver Sensitivity uncoded data at 1 Ms/s Stable Modulation Index (TP/RCV-LE/CA/BV-14-C)
Initial conditions:
Test Method: Test mode
Payload: PRBS9
Payload's length: 37 bytes
Packets to transmit: 1500
RX (DUT) power: -70.00dBm
Path losses: 1.50dB
Dirty TX mode: On
PER limit mode: Specification
Limits:
pkts_sent >= 1500, PER < 30.80%
Results:

#ch	f(MHz)	pkts_sent	pkts_rcvd	PER(%)	Verdict		
0	2402	1500		1500		0.000	PASSED
19	2440	1500		1500		0.000	PASSED
39	2480	1500		1500		0.000	PASSED

Test time: 4 sec.
_____Maximum input signal level uncoded data at 1 Ms/s Stable Modulation Index (TP/RCV-LE/CA/BV-18-C)
Initial conditions:
Test Method: Test mode
Payload: PRBS9
Payload's length: 37 bytes
Packets to transmit: 1500
RX (DUT) power: -10.00dBm
Path losses: 1.50dB
PER limit mode: Specification
Limits:
pkts_sent >= 1500, PER < 30.80%
Results:

#ch	f(MHz)	pkts_sent	pkts_rcvd	PER(%)	Verdict		
0	2402	1500		1500		0.000	PASSED
19	2440	1500		1500		0.000	PASSED
39	2480	1500		1500		0.000	PASSED

Test time: 3 sec.
_____PER Report Integrity uncoded data at 1 Ms/s Stable Modulation Index (TP/RCV-LE/CA/BV-19-C)
Initial conditions:
Test Method: Test mode
Payload: PRBS9
Payload's length: 37 bytes
Packets to transmit: 1500
RX (DUT) power: -30.00dBm
Path losses: 1.50dB
PER limit mode: Specification
Limits:
pkts_sent >= 1500, 50.00% <= PER <= 65.40%
Results:

#ch	f(MHz)	pkts_sent	pkts_rcvd	PER(%)	Verdict		
0	2402	1500		750		50.000	PASSED
19	2440	1500		750		50.000	PASSED
39	2480	1500		750		50.000	PASSED

Test time: 3 sec.

_____Receiver sensitivity at 2 Ms/s Stable Modulation Index (TP/RCV-LE/CA/BV-20-C)

Initial conditions:

Test Method:	Test mode	
Payload:	PRBS9	
Payload's length:	31 bytes	
Packets to transmit:	1500	
RX (DUT) power:		-70.00dBm
Path losses:	1.50dB	
Dirty TX mode:		On
PER limit mode:		Specification

Limits:

pkts_sent >= 1500, PER < 30.80%

Results:

#ch	f(MHz)	pkts_sent	pkts_rcvd	PER(%)	Verdict		
0	2402	1500		1500		0.000	PASSED
19	2440	1500		1500		0.000	PASSED
39	2480	1500		1500		0.000	PASSED

Test time: 4 sec.

_____Maximum input signal level at 2 Ms/s Stable Modulation Index (TP/RCV-LE/CA/BV-24-C)

Initial conditions:

Test Method:	Test mode	
Payload:	PRBS9	
Payload's length:	31 bytes	
Packets to transmit:	1500	
RX (DUT) power:		-10.00dBm
Path losses:	1.50dB	
PER limit mode:		Specification

Limits:

pkts_sent >= 1500, PER < 30.80%

Results:

#ch	f(MHz)	pkts_sent	pkts_rcvd	PER(%)	Verdict		
0	2402	1500		1500		0.000	PASSED
19	2440	1500		1500		0.000	PASSED
39	2480	1500		1500		0.000	PASSED

Test time: 3 sec.

_____PER Report Integrity at 2 Ms/s Stable Modulation Index (TP/RCV-LE/CA/BV-25-C)

Initial conditions:

Test Method:	Test mode	
Payload:	PRBS9	
Payload's length:	31 bytes	
Packets to transmit:	1500	
RX (DUT) power:		-30.00dBm
Path losses:	1.50dB	
PER limit mode:		Specification

Limits:

pkts_sent >= 1500, 50.00% <= PER <= 65.40%

Results:

#ch	f(MHz)	pkts_sent	pkts_rcvd	PER(%)	Verdict		
0	2402	1500		750		50.000	PASSED
19	2440	1500		750		50.000	PASSED
39	2480	1500		750		50.000	PASSED

Test time: 3 sec.

_____Receiver sensitivity LE Coded (S=2) (TP/RCV-LE/CA/BV-26-C)

Initial conditions:

Test Method:	Test mode	
Payload:	PRBS9	
Payload's length:	31 bytes	
Packets to transmit:	1500	
RX (DUT) power:		-75.00dBm
Path losses:	1.50dB	

Dirty TX mode: On
PER limit mode: Specification
Limits:
pkts_sent >= 1500, PER < 30.80%
Results:

#ch	f(MHz)	pkts_sent	pkts_rcvd	PER(%)	Verdict		
0	2402	1500		1500		0.000	PASSED
19	2440	1500		1500		0.000	PASSED
39	2480	1500		1500		0.000	PASSED

Test time: 7 sec.

_____Receiver sensitivity LE Coded (S=8) (TP/RCV-LE/CA/BV-27-C)
Initial conditions:
Test Method: Test mode
Payload: PRBS9
Payload's length: 31 bytes
Packets to transmit: 1500
RX (DUT) power: -80.00dBm
Path losses: 1.50dB
Dirty TX mode: On
PER limit mode: Specification
Limits:
pkts_sent >= 1500, PER < 30.80%
Results:

#ch	f(MHz)	pkts_sent	pkts_rcvd	PER(%)	Verdict		
0	2402	1500		1500		0.000	PASSED
19	2440	1500		1500		0.000	PASSED
39	2480	1500		1500		0.000	PASSED

Test time: 15 sec.

_____PER Report Integrity LE Coded (S=2) (TP/RCV-LE/CA/BV-30-C)
Initial conditions:
Test Method: Test mode
Payload: PRBS9
Payload's length: 31 bytes
Packets to transmit: 1500
RX (DUT) power: -30.00dBm
Path losses: 1.50dB
PER limit mode: Specification
Limits:
pkts_sent >= 1500, 50.00% <= PER <= 65.40%
Results:

#ch	f(MHz)	pkts_sent	pkts_rcvd	PER(%)	Verdict		
0	2402	1500		750		50.000	PASSED
19	2440	1500		750		50.000	PASSED
39	2480	1500		750		50.000	PASSED

Test time: 6 sec.

_____PER Report Integrity LE Coded (S=8) (TP/RCV-LE/CA/BV-31-C)
Initial conditions:
Test Method: Test mode
Payload: PRBS9
Payload's length: 31 bytes
Packets to transmit: 1500
RX (DUT) power: -30.00dBm
Path losses: 1.50dB
PER limit mode: Specification
Limits:
pkts_sent >= 1500, 50.00% <= PER <= 65.40%
Results:

#ch	f(MHz)	pkts_sent	pkts_rcvd	PER(%)	Verdict		
0	2402	1500		750		50.000	PASSED
19	2440	1500		750		50.000	PASSED
39	2480	1500		750		50.000	PASSED

Test time: 14 sec.

_____Receiver sensitivity LE Coded (S=2) Stable Modulation Index (TP/RCV-LE/CA/BV-32-C)

Initial conditions:

Test Method:	Test mode	
Payload:	PRBS9	
Payload's length:	31 bytes	
Packets to transmit:	1500	
RX (DUT) power:	-75.00dBm	
Path losses:	1.50dB	
Dirty TX mode:	On	
PER limit mode:	Specification	

Limits:

pkts_sent >= 1500, PER < 30.80%

Results:

#ch	f(MHz)	pkts_sent	pkts_rcvd	PER(%)	Verdict		
0	2402	1500		1500		0.000	PASSED
19	2440	1500		1500		0.000	PASSED
39	2480	1500		1500		0.000	PASSED

Test time: 7 sec.

_____Receiver sensitivity LE Coded (S=8) Stable Modulation Index (TP/RCV-LE/CA/BV-33-C)

Initial conditions:

Test Method:	Test mode	
Payload:	PRBS9	
Payload's length:	31 bytes	
Packets to transmit:	1500	
RX (DUT) power:	-80.00dBm	
Path losses:	1.50dB	
Dirty TX mode:	On	
PER limit mode:	Specification	

Limits:

pkts_sent >= 1500, PER < 30.80%

Results:

#ch	f(MHz)	pkts_sent	pkts_rcvd	PER(%)	Verdict		
0	2402	1500		1500		0.000	PASSED
19	2440	1500		1500		0.000	PASSED
39	2480	1500		1500		0.000	PASSED

Test time: 16 sec.

_____PER Report Integrity LE Coded (S=2) Stable Modulation Index (TP/RCV-LE/CA/BV-36-C)

Initial conditions:

Test Method:	Test mode	
Payload:	PRBS9	
Payload's length:	31 bytes	
Packets to transmit:	1500	
RX (DUT) power:	-30.00dBm	
Path losses:	1.50dB	
PER limit mode:	Specification	

Limits:

pkts_sent >= 1500, 50.00% <= PER <= 65.40%

Results:

#ch	f(MHz)	pkts_sent	pkts_rcvd	PER(%)	Verdict		
0	2402	1500		750		50.000	PASSED
19	2440	1500		750		50.000	PASSED
39	2480	1500		750		50.000	PASSED

Test time: 6 sec.

_____PER Report Integrity LE Coded (S=8) Stable Modulation Index (TP/RCV-LE/CA/BV-37-C)

Initial conditions:

Test Method:	Test mode	
Payload:	PRBS9	
Payload's length:	31 bytes	
Packets to transmit:	1500	
RX (DUT) power:	-30.00dBm	

Path losses: 1.50dB
PER limit mode: Specification

Limits:

pkts_sent >= 1500, 50.00% <= PER <= 65.40%

Results:

#ch	f(MHz)	pkts_sent	pkts_rcvd	PER(%)	Verdict		
0	2402	1500		750		50.000	PASSED
19	2440	1500		750		50.000	PASSED
39	2480	1500		750		50.000	PASSED

Test time: 14 sec.

_____Quick (Output Power + Modulation Characteristics + Carrier Frequency Offset Drift)

Initial conditions:

Test Method: Test mode
Hopping: off
Payload: 11110000 and 1010 bit patterns
Payload's length: 37 bytes
Number of packets: 2
Path losses: 1.50dB

Limits:

-20.00dBm < Pavg < 10.00dBm, Ppk-av < 3.00dB
df0_max <= 150.0 KHz, df0_min >= -150.0 KHz
|fTX-f[n]| <= 150.0KHz, |f[0]-f[n]| <= 50.0KHz, |f[1]-f[0]| <= 23.0KHz, |f[n]-f[n-5]| <= 20.0KHz
225.0KHz <= df1_avg <= 275.0KHz, df2_pass_rate >= 99.90%, df2/df1 >= 0.80

Results (power in dBm, frequency offsets in KHz):

#ch	f(MHz)	Pavg	Ppk	Ppk-av	Pmin	df0_max	df0_min
0	2402	-0.60	0.09	0.69	-1.47	17.0	16.2
19	2440	-1.18	-0.49	0.69	-2.08	16.2	15.8
39	2480	-1.58	-0.85	0.73	-2.56	16.6	16.5

Results (maximum of absolute values in KHz):

#ch	f(MHz)	fTX-f[n]	f[0]-f[n]	f[1]-f[0]	f[n]-f[n-5]
0	2402	17.0	-2.8	-2.8	2.5
19	2440	17.4	-1.7	1.2	-2.5
39	2480	17.8	-2.2	-1.1	2.6

Results (frequency deviations in KHz):

#ch	f(MHz)	df1_avg	df2_avg	df2_min	df2_rate(%)	df2/df1	Verdict	
0	2402	257.7	253.6	229.7	100.00		0.98	PASSED
19	2440	257.8	255.6	234.5	100.00		0.99	PASSED
39	2480	258.8	257.5	230.9	100.00		0.99	PASSED

Test time: 2 sec.

_____Carr freq offset + Mod char (preamble)

Initial conditions:

Test Method: Test mode
Hopping: off
Payload's length: 37 bytes
Number of packets: 2

Limits:

df0_max <= 150.0 KHz, df0_min >= -150.0 KHz
df2_avg >= 185.0KHz, df2_min >= 92.5KHZ

Results (frequency offsets and deviations in KHz):

#ch	f(MHz)	df0_max	df0_min	df0_avg	df2_avg	df2_min	Verdict
0	2402	19.1	16.8	17.9	252.0	238.0	PASSED
19	2440	16.8	16.0	16.4	254.7	239.4	PASSED
39	2480	17.0	16.3	16.6	261.3	250.2	PASSED

Test time: 1 sec.

31 RF test cases completed: Wed Dec 29 19:03:56 2021

3. Power and clock management

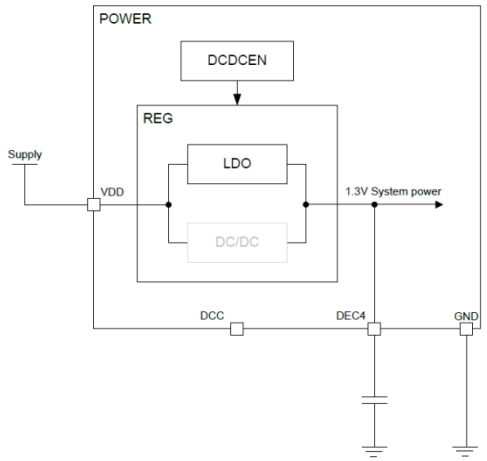
3.1 Regulator

The following internal power regulator alternatives are supported:

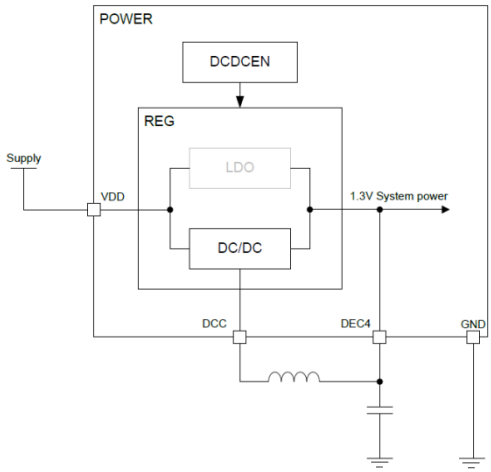
- Internal LDO regulator
- Internal DC/DC converter

The LDO is the default regulator.

Using the DC/DC regulator will reduce current consumption compared to when using the LDO regulator, but the DC/DC regulator requires an external LC filter to be connected, as shown in Figure.



LDO Regulator Setup



DC/DC Regulator Setup

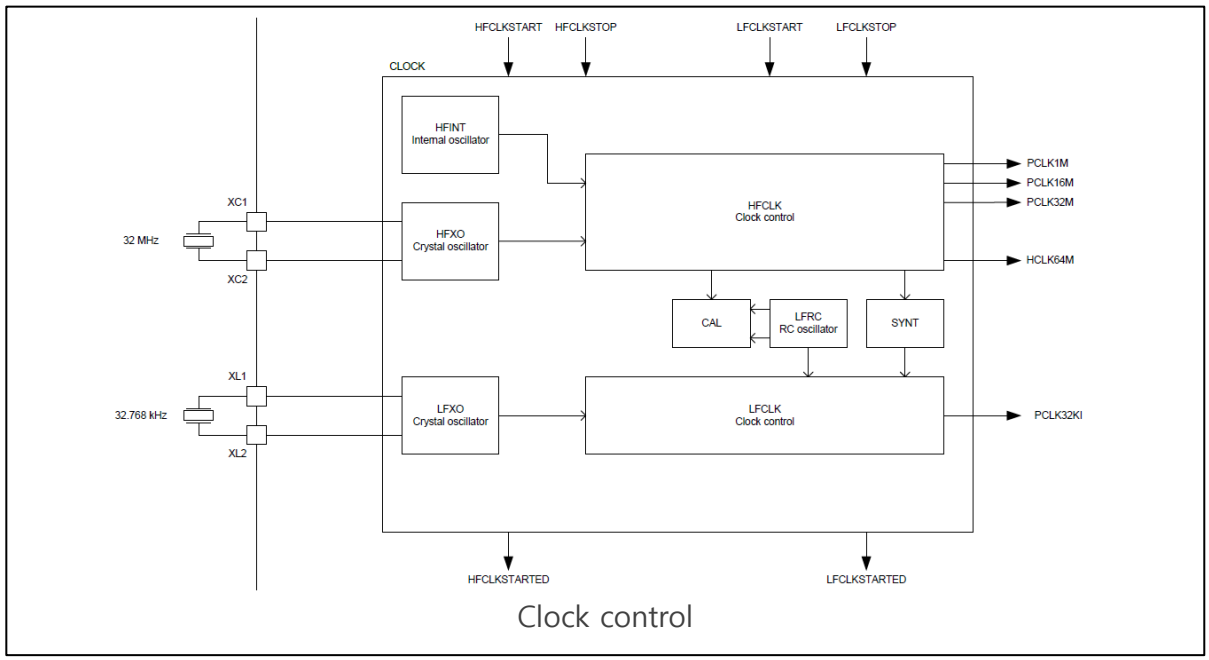
3.2 32.768KHz Crystal Oscillator

The BoT-nLE523 external 32.768KHz Crystal does not required for BLE mode

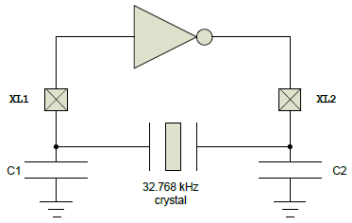
If you choose to use an internal 32.768kHz oscillator, an average of 10uA of current is consumed compared to an external crystal.

The ANT specification requires ± 50ppm accuracy for a 32.768kHz clock. The internal 32.768kHz oscillator may not meet specifications.

BoT-nLE523 F/W does not yet support ANT Mode.



Clock control



Circuit diagram of the 32.768 kHz crystal oscillator

The load capacitance (CL) is the total capacitance seen by the crystal across its terminals and is given by:

$$CL = \frac{(C1' \cdot C2')}{(C1' + C2')}$$

$$C1' = C1 + C_{pcb1} + C_{pin}$$
$$C2' = C2 + C_{pcb2} + C_{pin}$$

C1 and C2 are ceramic SMD capacitors connected between each crystal terminal and ground.

Cpcb1 and Cpcb2 are stray capacitances on the PCB.

▪ 32.768 kHz RC oscillator (LFRC)

Symbol	Description	Min.	Typ.	Max.	Units
f_{NOM_LFRC}	Nominal frequency		32.768		kHz
f_{TOL_LFRC}	Frequency tolerance		±2		%
$f_{TOL\_CAL\_LFRC}$	Frequency tolerance for LFRC after calibration		±500		ppm

▪ 32.768 kHz crystal oscillator (LFXO)

Symbol	Description	Min.	Typ.	Max.	Units
f_{NOM_LFXO}	Crystal frequency		32.768		kHz
$f_{TOL\_LFXO\_BLE}$	Frequency tolerance requirement for BLE stack		±250		ppm
$f_{TOL\_LFXO\_ANT}$	Frequency tolerance requirement for ANT stack		±50		ppm
C_{L_LFXO}	Load capacitance			12.5	pF
C_{0_LFXO}	Shunt capacitance			2	pF
R_{S_LFXO}	Equivalent series resistance			100	kohm
P_{D_LFXO}	Drive level			1	uW
C_{pin}	Input capacitance on XL1 and XL2 pads		4		pF

4. Power Consumption

UART State / BoT State	UART ON[1]	UART OFF[2]		
		Internal Pull-Down	External Pull-Down 470K **Make internal pull-x register to no-pull state using "AT+INTPULLDOWN=OFF" command	Internal Pull-Down & External Pull-Down 470K
Advertising	755uA	266uA	**25uA**	272uA
Connected	1.06mA	609uA	**383uA**	616uA
Sleep[3]	N/A	235uA	**7uA**	242uA

1) : PAD#23(P13, UART ON/OFF control) signal level LOW
2) : PAD#23(P13, UART ON/OFF control) signal level HIGH
3) : PAD#19(P10, ENTER_SLEEP/WAKE_UP control) signal level HIGH

<Measure condition>

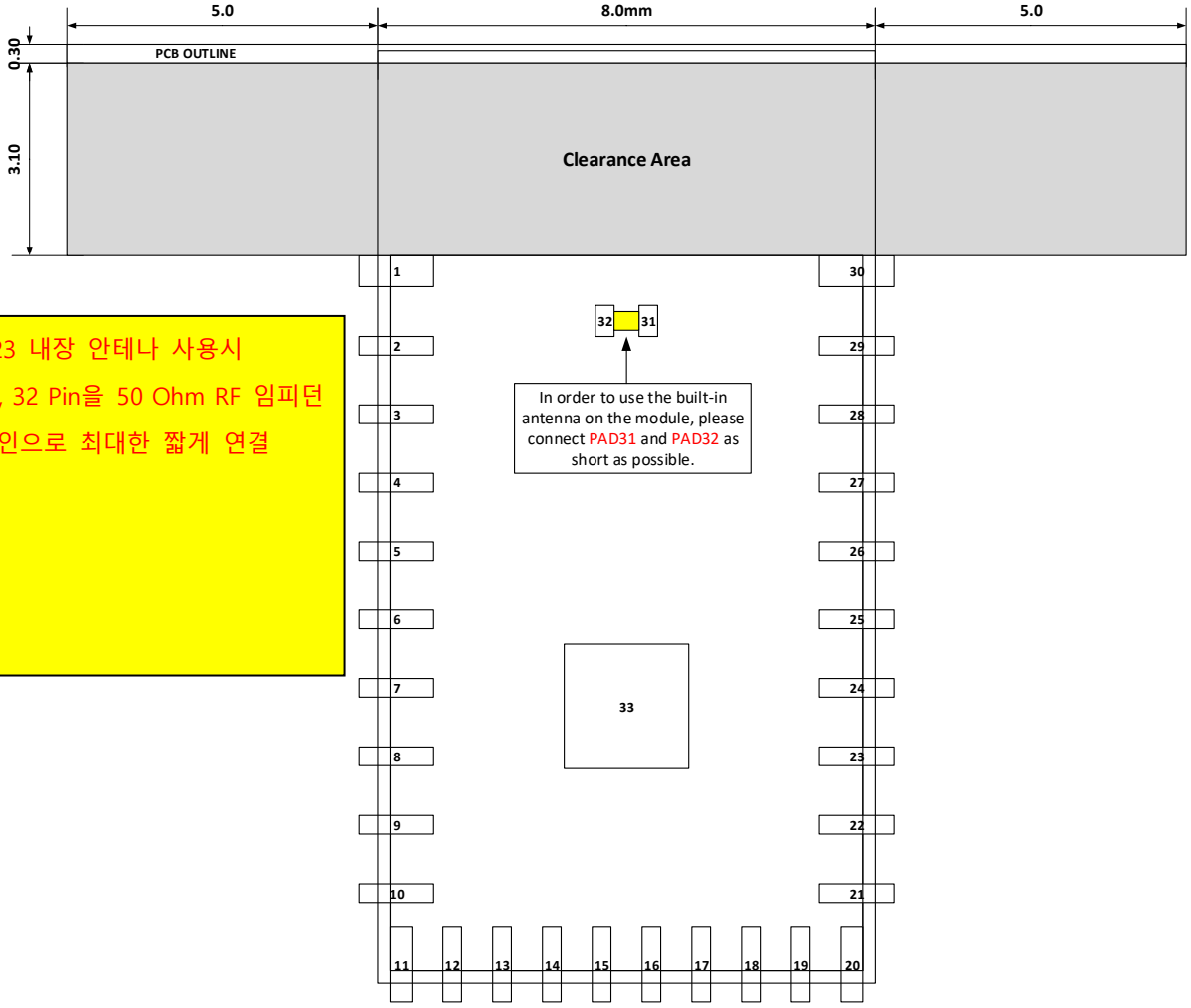
- Firmware : CHIPSEN Standard firmware / over V0.9.0
- Test role : Server role
- Test phone : Samsung Galaxy S8+
- Software setting : Default

<Notice>

- Power consumption can be change by customer's hardware or(and) software design
- Not recommended to operate UART OFF in Sleep. it makes increase power consumption

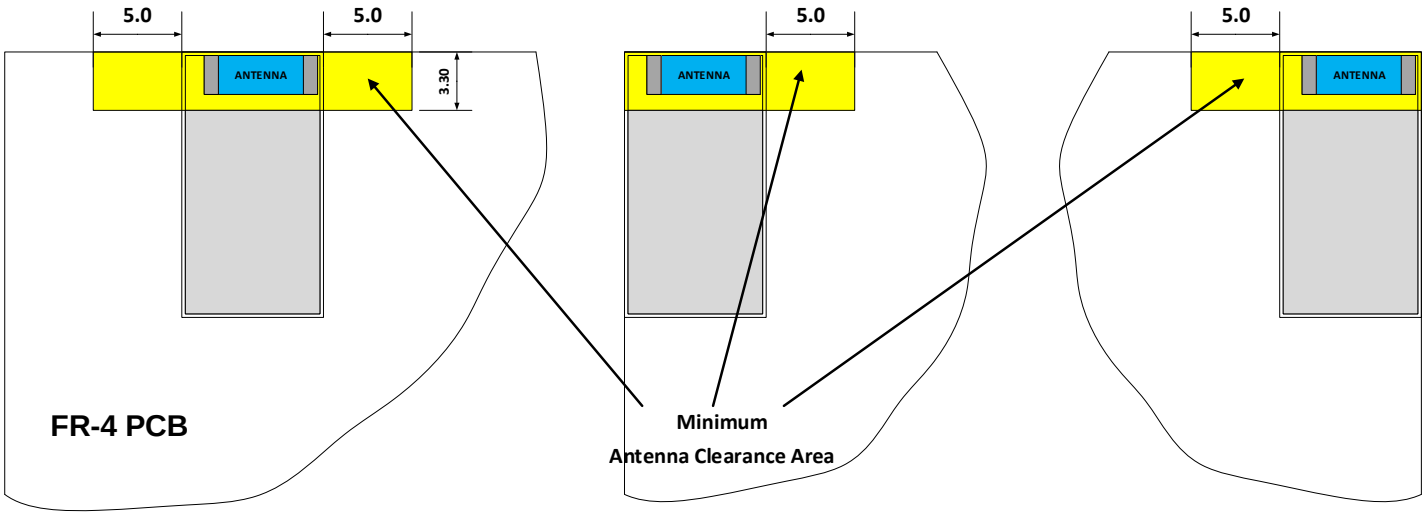
5. Antenna

5.1 Antenna Layout Guide

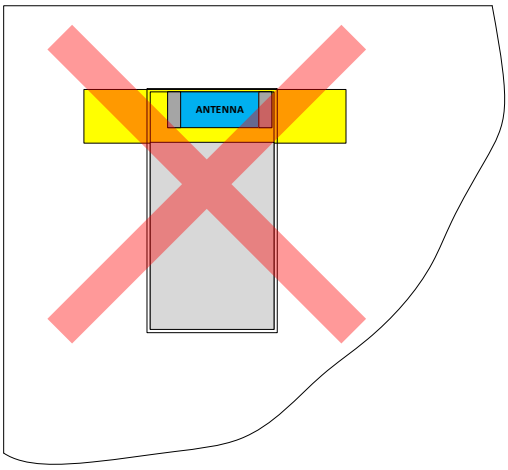


BoT-nLE523 내장 안테나 사용시 반드시 31, 32 Pin을 50 Ohm RF 임피던스매칭 라인으로 최대한 짧게 연결

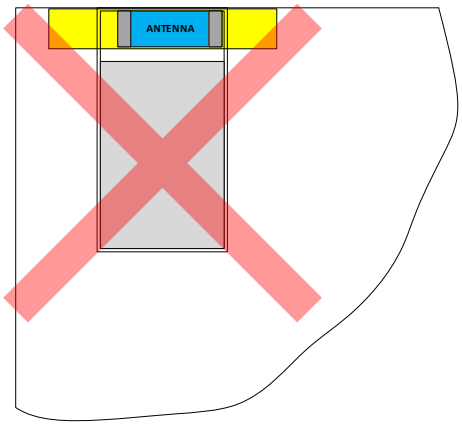
5.2 Recommended Module Mounting



Recommended Module Mounting Example



Antenna 영역을 GND가 둘러싸고 있는 형태

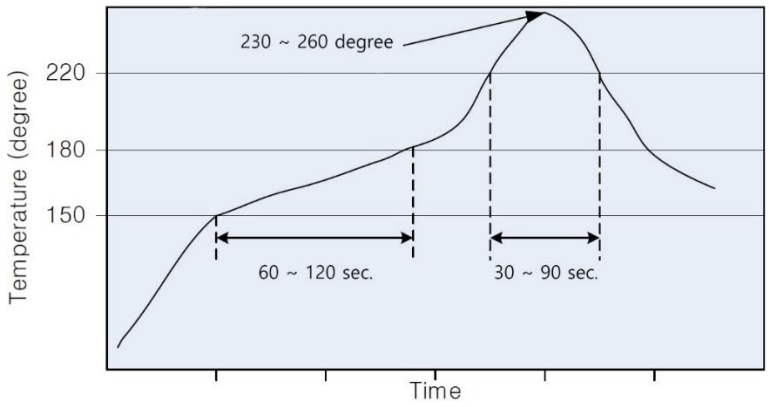


Antenna 영역을 크기를 임의로 조정 또는
Antenna 영역에 GND가 겹치는 형태

Wrong Module Mounting Example

6. Reflow Temperature Profiles

Recommended solder reflow profile are shown in below and follow the lead-free profile I accordance with JEDEC Std 20C.
Table lists the critical reflow temperatures.
Flux residue remaining from board assembly can contribute to electrochemical migration over time.
This depends on number of factors, including flux type, amount of flux residue remaining after reflow, and stress conditions during product use, such as temperature, humidity, and potential difference between pins.
Care should be taken in selecting production board/module assembly processes and materials, taking into account these factors.



Process Step	Lead-Free Solder
Ramp rate	3°C/sec
Preheat	Max. 150°C to 180°C, 60 to 180 sec
Time above liquidus	+220°C 30 to 90 sec
Peak temperature	+255°C ±5°C
Time within 5°C of peak temperature	10 to 20 sec
Ramp-down rate	6°C/sec max

WARNING : For BoT-nLE523
If you have reflow process multiple times in your product, you must be proceed this module in the final reflow process. If not the Shield can will drop out if shield-can adopted.

7. Application Schematic

Design consideration

- All I/O(including UART) should be up after VCC applied.
- All I/O(including UART) should NOT be present fast or be held high before VCC is high.

7.1 Reference Application

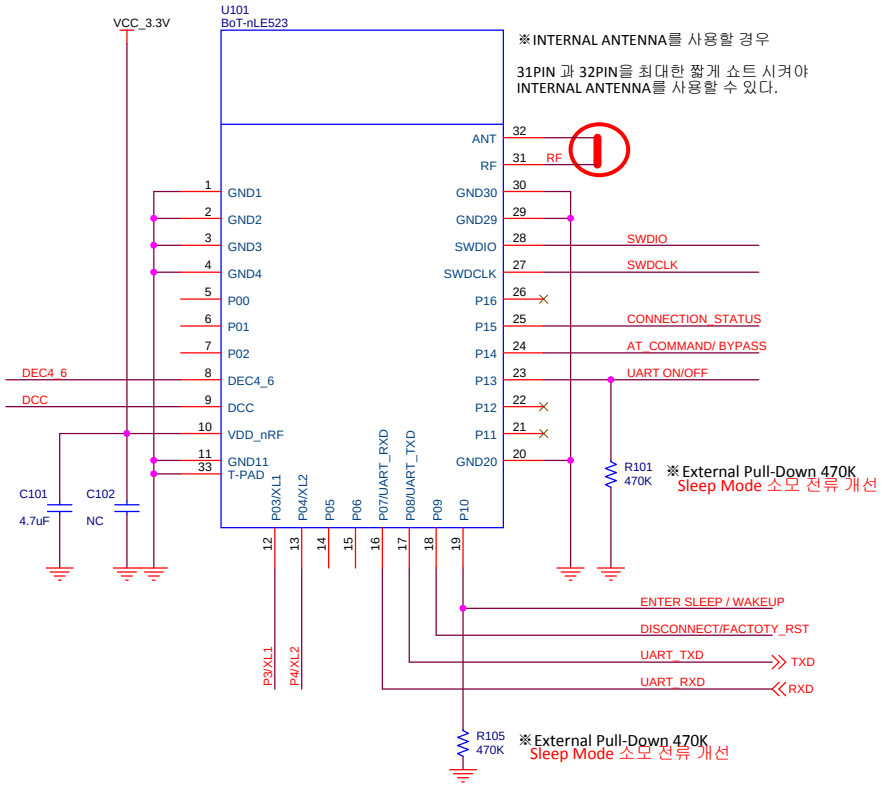
7.2 Internal ANT. / 3.3V UART Application

7.3 Internal ANT. / 5V UART Application

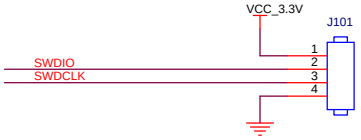
7.4 External ANT. / 3.3V UART Application

- All reference applications are attached next page.

■ BoT-nLE523 REF. APPLICATION



J-LINK DEBUG PORT



※ Wireless Certification

무선 인증 진행 시 DTM F/W Download Port

ENTER SLEEP /WAKEUP (P10)

ENTER SLEEP / WAKEUP	INPUT
LOW POWER MODE	HIGH(RISING EDGE)
WAKE UP & REBOOTING	LOW(FALLING EDGE)

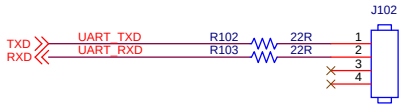
※ENTER SLEEP / WAKE UP
High Level(Rising Edge) 이 감지되면 저전력 모드로 진입이 되며,
저전력 모드상태에서는 Low Level (Falling Edge) 이 감지되면
Wake Up 되고 모듈이 자동으로 재부팅한다.

UART ON/OFF (P13)

UART ON /OFF	INPUT
UART DISABLE	HIGH(RISING EDGE)
UART ENABLE	LOW(FALLING EDGE)

※UART ON / OFF
High Level(Rising Edge) 이 감지되면
UART가 동작을 멈추고(DISABLE) 저전력 모드로 진입
UART DISABLE 상태에서 Low Level (Falling Edge) 이 감지되면
UART 동작이 재시작(ENABLE)함.

UART PORT (P7, P8)



※UART Port for SIG / Wireless Certification RF test

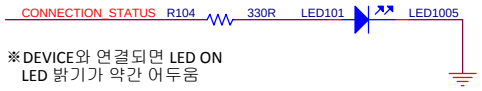
무선 인증 진행 시 DTM F/W로 주파수 컨트롤 시 UART를 사용
반드시 라인 절체할 수 있는 저항 필수 추가

CONNECTION_STATUS LED OPTION (P15)

■ CONNECTION STATE

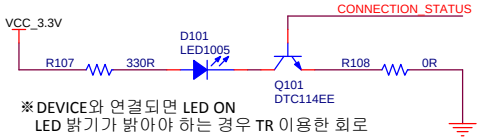
DESCRIPTION	OUTPUT
DEVICE CONNECTION	HIGH
DEVICE DISCONNECTION	LOW

■ EXAMPLE 1



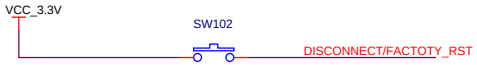
※DEVICE와 연결되면 LED ON
LED 밝기가 약간 어두움

■ EXAMPLE 2



※DEVICE와 연결되면 LED ON
LED 밝기가 밝아야 하는 경우 TR 이용한 회로

DISCONNECT/FACTOTY_RST (P9)



※DISCONNECT

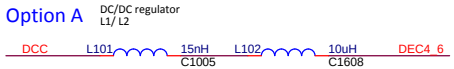
High Level (Rising Edge)이 감지 되었을 때
상대 장치와 연결되어 있다면 연결을 종료 한다.

※FACTOTY_RST

4초 이상 HIGH 유지시 +OK 응답 후 공장초기화 상태로 복귀시킨다.

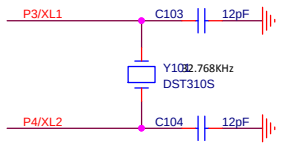
OPTION

Option A



DEFAULT LDO MODE, DO NOT DESIGN DC/DC MODE CIRCUIT

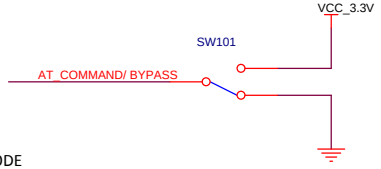
Option B



DEFAULT INTERNAL 32.768KHz MODE
DO NOT DESIGN EXTERNAL 32.768KHz CRYSTAL

※OPTION
DEFAULT F/W에서 OPTION A / B 지원하지 않음

AT_COMMAND/ BYPASS (P14)



■ UART MODE

DESCRIPTION	INPUT
AT COMMAND MODE	HIGH
BYPASS MODE (DATA MODE)	LOW

※DEVICE와 연결되기 전에는 AT COMMAND MODE로 동작
※DEVICE와 연결 후 UART MODE PIN HIGH,LOW로 UART MODE 동작 결정

BoT-nLE523 REF. APPLICATION - UART 3.3V level input

Example Schematic

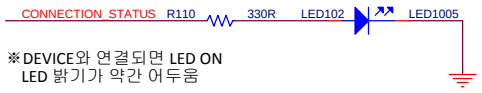
- INTERNAL ANTENNA
- UART 3.3V level input
- Bypass in Bluetooth connected state
- Default LDO Mode
- Default Internal 32.768KHz Mode
- UART ON
- WAKE UP

CONNECTION_STATUS LED OPTION (P15)

■ CONNECTION STATE

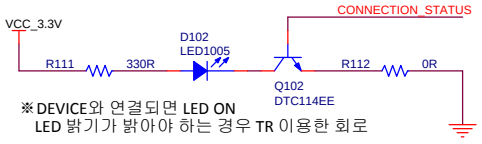
DESCRIPTION	OUTPUT
DEVICE CONNECTION	HIGH
DEVICE DISCONNECTION	LOW

■ EXAMPLE 1



※DEVICE와 연결되면 LED ON
LED 밝기가 약간 어두움

■ EXAMPLE 2



※DEVICE와 연결되면 LED ON
LED 밝기가 밝아야 하는 경우 TR 이용한 회로

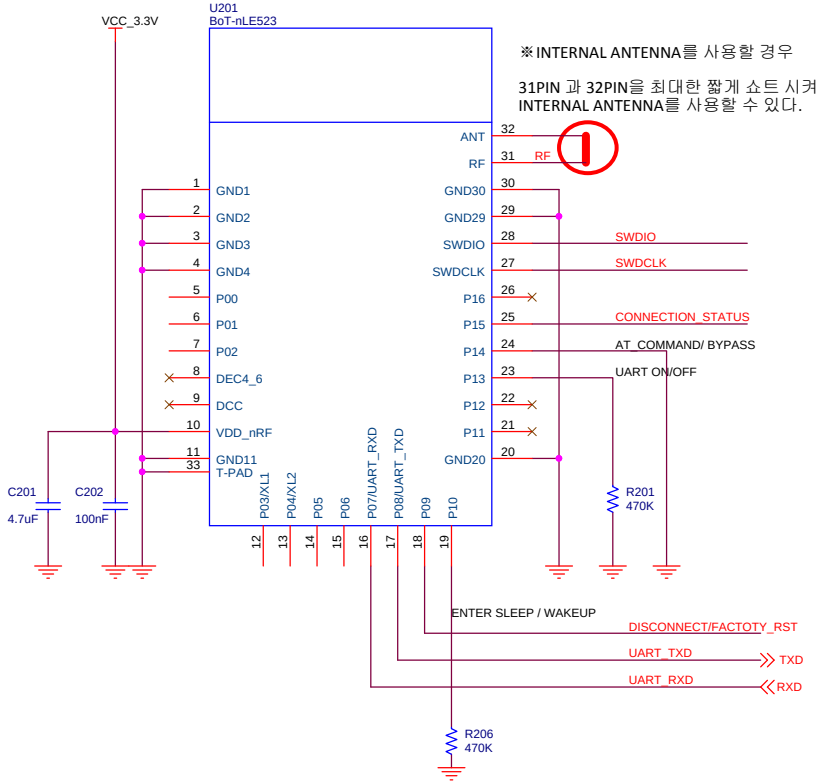
DISCONNECT/FACTOTY_RST (P9)

※DISCONNECT

High Level (Rising Edge)이 감지 되었을 때
상대 장치와 연결되어 있다면 연결을 종료 한다.

※FACTOTY_RST

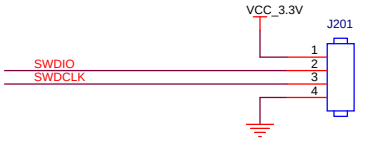
4초 이상 HIGH 유지시 +OK 응답 후 공장초기화 상태로 복귀시킨다.



※INTERNAL ANTENNA를 사용할 경우

31PIN 과 32PIN을 최대한 짧게 쇼트 시켜야
INTERNAL ANTENNA를 사용할 수 있다.

J-LINK DEBUG PORT



※ Wireless Certification

무선 인증 진행 시 DTM F/W Download Port

ENTER SLEEP /WAKEUP (P10)

※ WAKE UP

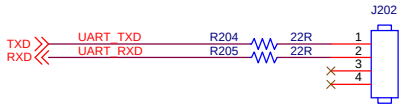
LOW INPUT : 저전력 모드로 들어가지 않은 기본 동작상태

UART ON/OFF (P13)

※UART ON

LOW INPUT : UART ON (ENABLE) 상태

UART PORT (P7, P8)



※UART Port for SIG / Wireless Certification RF Test

무선 인증 진행 시 DTM F/W로 주파수 컨트롤 시 UART를 사용
반드시 라인 절체할 수 있는 저항 필수 추가

AT_COMMAND/ BYPASS (P14)

■ BYPASS MODE

LOW INPUT : BYPASS MODE (DATA 전송 모드)

※DEVICE와 연결되기 전에는 AT COMMAND MODE로 동작
※DEVICE와 연결 후 UART MODE PIN HIGH,LOW로 UART MODE 동작 결정

BoT-nLE523 REF. APPLICATION - UART 5V level input

Example Schematic

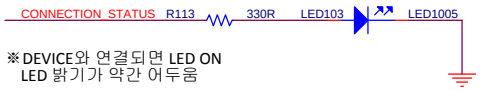
- INTERNAL ANTENNA
- UART 5V level input
- Bypass in Bluetooth connected state
- Default LDO Mode
- Default Internal 32.768KHz Mode
- UART ON
- WAKE UP

CONNECTION_STATUS LED OPTION (P15)

■ CONNECTION STATE

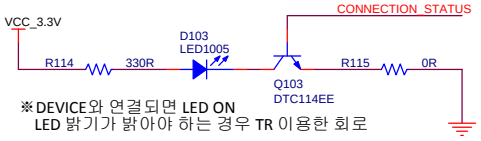
DESCRIPTION	OUTPUT
DEVICE CONNECTION	HIGH
DEVICE DISCONNECTION	LOW

■ EXAMPLE 1



※DEVICE와 연결되면 LED ON
LED 밝기가 약간 어두움

■ EXAMPLE 2



※DEVICE와 연결되면 LED ON
LED 밝기가 밝아야 하는 경우 TR 이용한 회로

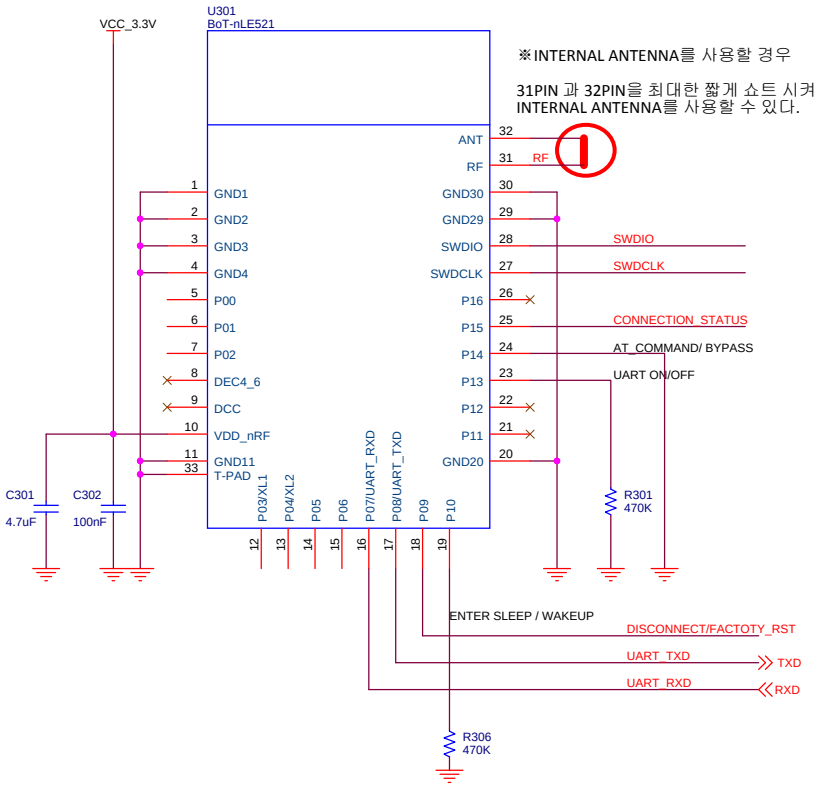
DISCONNECT/FACTOTY_RST (P9)

※DISCONNECT

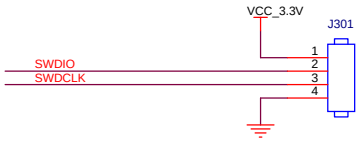
High Level (Rising Edge)이 감지 되었을 때
상대 장치와 연결되어 있다면 연결을 종료 한다.

※FACTOTY_RST

4초 이상 HIGH 유지시 +OK 응답 후 공장초기화 상태로 복귀시킨다.



J-LINK DEBUG PORT



※ Wireless Certification

무선 인증 진행 시 DTM F/W Download Port

ENTER SLEEP /WAKEUP (P10)

※ WAKE UP

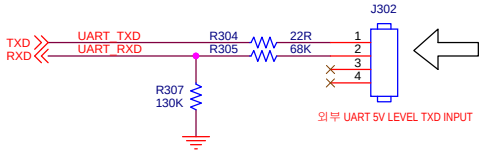
LOW INPUT : 저전력 모드로 들어가지 않은 기본 동작상태

UART ON/OFF (P13)

※UART ON

LOW INPUT : UART ON (ENABLE) 상태

UART PORT (P7, P8)



※UART Port for SIG / Wireless Certification

무선 인증 진행 시 DTM F/W로 주파수 컨트롤 시 UART를 사용
반드시 라인 절체할 수 있는 저항 필수 추가

AT_COMMAND/ BYPASS (P14)

■ BYPASS MODE

LOW INPUT : BYPASS MODE (DATA 전송 모드)

※DEVICE와 연결되기 전에는 AT COMMAND MODE로 동작

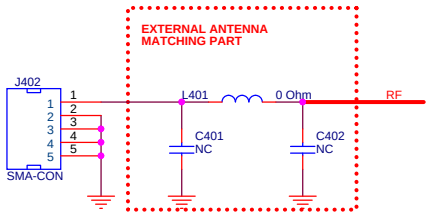
※DEVICE와 연결 후 UART MODE PIN HIGH,LOW로 UART MODE 동작 결정

BoT-nLE523 REF. APPLICATION - EXTERNAL ANTENNA / UART 3.3V LEVEL INPUT

Example Schematic

- EXTERNAL ANTENNA
- UART 3.3V level input
- Bypass in Bluetooth connected state
- Default LDO Mode
- Default Internal 32.768KHz Mode
- Not Used WAKE

EXTERNAL ANTENNA

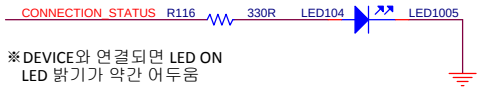


CONNECTION_STATUS LED OPTION (P15)

■ CONNECTION STATE

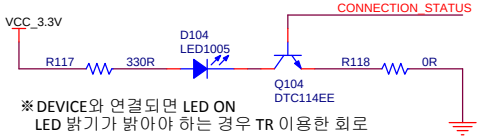
DESCRIPTION	OUTPUT
DEVICE CONNECTION	HIGH
DEVICE DISCONNECTION	LOW

■ EXAMPLE 1



※DEVICE와 연결되면 LED ON
LED 밝기가 약간 어두움

■ EXAMPLE 2



※DEVICE와 연결되면 LED ON
LED 밝기가 밝아야 하는 경우 TR 이용한 회로

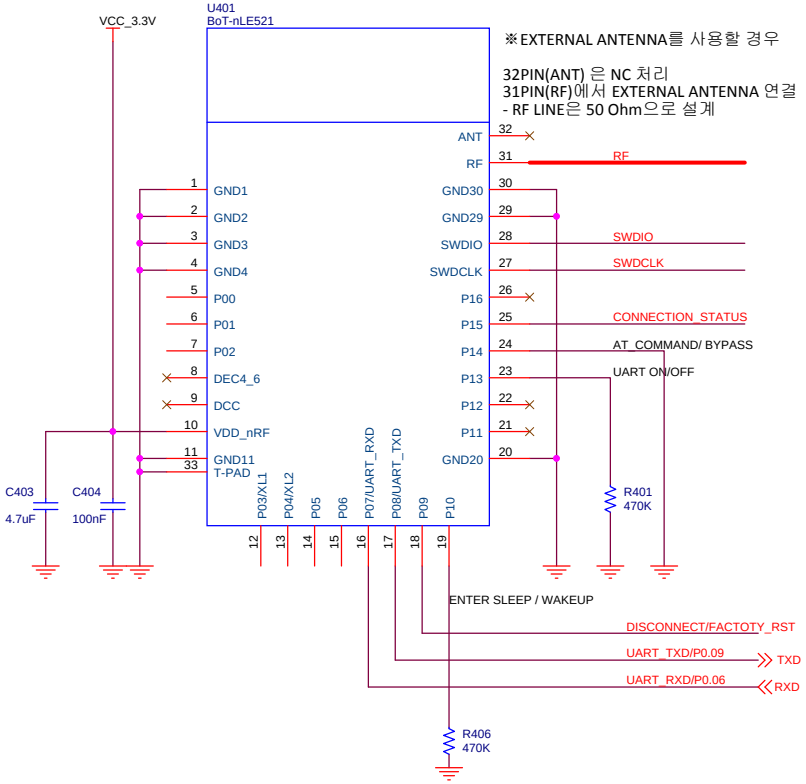
DISCONNECT/FACTOTY_RST (P9)

※DISCONNECT

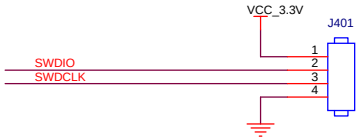
High Level (Rising Edge)이 감지 되었을 때
상대 장치와 연결되어 있다면 연결을 종료 한다.

※FACTOTY_RST

4초 이상 HIGH 유지시 +OK 응답 후 공장초기화 상태로 복귀시킨다.



J-LINK DEBUG PORT



※ Wireless Certification

무선 인증 진행 시 DTM F/W Download Port

ENTER SLEEP /WAKEUP (P10)

※ WAKE UP

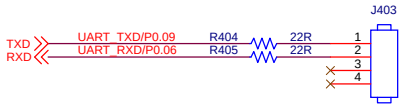
LOW INPUT : 저전력 모드로 들어가지 않은 기본 동작상태

UART ON/OFF (P13)

※UART ON

LOW INPUT : UART ON (ENABLE) 상태

UART PORT (P7, P8)



※UART Port for SIG / Wireless Certification

무선 인증 진행 시 DTM F/W로 주파수 컨트롤 시 UART를 사용
반드시 라인 절체할 수 있는 저항 필수 추가

AT_COMMAND/ BYPASS (P14)

■ BYPASS MODE

LOW INPUT : BYPASS MODE (DATA 전송 모드)

※DEVICE와 연결되기 전에는 AT COMMAND MODE로 동작

※DEVICE와 연결 후 UART MODE PIN HIGH,LOW로 UART MODE 동작 결정