China

FCC/ISED - TEST REPORT

Report Number	:	**709502006714-00**	Date of Issue:	March 12, 2021
Model	:	9290029816		
Product Type	:	Digital Device		
FCC ID:	:	2AGBW9290029816X		
IC:	:	20812-29816X		
Applicant	:	Signify (China) Investment Co., Ltd.		
Address	:	Building no.9, Lane 888, Tianlin Road, Minhang District Shanghai, 200233 China		
Production Facility 1	:	Dongguan ZOYO Electronics TechnologyCo., Ltd		
Address	:	No.11,Nange west Road,Nanya Village,Daojiao Town,Dongguan City 523187,Guangdong ,China		
Production Facility 2	:	Longhorn Intelligent Tech Co., Ltd.		
Address	:	Tongfuyu Third Funtional Area, Tongshen Community, Dalany Street, Longhua District, Shenzhen City, Guangdong Province, P. R. China		
Test Result	:	■ **Positive** ☐ **Negative**		
Total pages including Appendices	:	80		

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2 Details about the Test Laboratory

Details about the Test Laboratory
Test Site 1

Company name:	TÜV SÜD Certification and Testing (China) Co., Ltd. Shanghai Branch No.16 Lane, 1951 Du Hui Road, Shanghai 201108, P.R. China
FCC Registration No.:	820234
IC Registration No.:	25988
Telephone:	+86 21 6141 0123
Fax:	+86 21 6140 8600

3 Description of the Equipment under Test

Description of the Equipment Under Test

Product:	Digital Device
Model no.:	9290029816
FCC ID:	2AGBW9290029816X
IC:	20812-29816X
Options and accessories:	LED Light Strip
Rating:	24VDC, 3A
RF Transmission Frequency:	2402~2480MHz for BT 5.0 LE; 2405-2480MHz for Zigbee
No. of Operated Channel:	40 channels for BLE (Channel 00: 2402MHz, Channel 01: 2404MHz, … Channel 19: 2440MHz, … Channel 38: 2478MHz, Channel 39: 2480MHz) 5 channels for Zigbee (2405MHz; 2425MHz; 2450MHz; 2475MHz; 2480MHz)
Modulation:	GFSK PHY for BT 5.0 LE (LE Coded S=2/8, LE 1M, LE 2M); 16-ary orthogonal modulation, O-QPSK PHY for Zigbee
Data transmission rate:	2 Mbit/s Max for BT 5.0 LE (125 Kbit/s, 500 Kbit/s, 1Mbit/s, 2Mbit/s); 250kbps Max for Zigbee
Antenna Type:	PIFA Antenna
Antenna Gain:	4.7 dBi gain
Description of the EUT:	The Equipment Under Test (EUT) is a Digital Device RF Module support Bluetooth 5.0 and Zigbee. We tested it and listed the worst data in this report.

The sample's mentioned in this report is supplied by client. The laboratory therefore assumes no responsibility for accuracy of information on the brand name, model number, origin of manufacture, consignment, antenna gain or any information supplied.

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4 Summary of Test Standards

Test Standards	
FCC Part 15 Subpart C 10-1-2014 Edition	PART 15 - RADIO FREQUENCY DEVICES Subpart C - Intentional Radiators
RSS-Gen Issue 5 Amendment 1 March 2019	General Requirements for Compliance of Radio Apparatus
RSS-247 Issue 2 February 2017	Digital Transmission Systems (DTSS), Frequency Hopping Systems (FHSS) and License-Exempt Local Area Network (LE-LAN) Devices

All the test methods were according to KDB 558074 D01 15.247 Meas Guidance v05r02 and ANSI C63.10 (2013).

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5 Summary of Test Results

Technical Requirements						
FCC Part 15 Subpart C						
Test Condition		Pages	Test Site	Test Result		
				Pass	Fail	N/A
§15.207 & RSS-GEN 8.8	Conducted emission AC power port	---	---	☐	☐	☒
§15.247 (b) (3) & RSS-247 5.4(d)	Conducted peak output power	11-17	Site 1	☒	☐	☐
§15.247(a)(1) & RSS-247 5.1(b)	20dB bandwidth	---	---	☐	☐	☒
§15.247(a)(1) & RSS-247 5.1(b)	Carrier frequency separation	---	---	☐	☐	☒
§15.247(a)(1)(iii) & RSS-247 5.1(d)	Number of hopping frequencies	---	---	☐	☐	☒
§15.247(a)(1)(iii) & RSS-247 5.1(d)	Dwell Time	---	---	☐	☐	☒
§15.247(a)(2) & RSS-247 5.2(a) & RSSGEN 6.7	6dB bandwidth and 99% Occupied Bandwidth	18-30	Site 1	☒	☐	☐
§15.247(e) & RSS-247 5.2(b)	Power spectral density	31-37	Site 1	☒	☐	☐
§15.247(d) & RSS-247 5.5	Spurious RF conducted emissions	38-63	Site 1	☒	☐	☐
§15.247(d) & RSS-247 5.5	Band edge	64-68	Site 1	☒	☐	☐
§15.247(d) & §15.209 & RSS-247 5.5 & RSS-Gen 6.13	Spurious radiated emissions for transmitter	69-76	Site 1	☒	☐	☐
§15.203 & RSS-Gen 6.8	Antenna requirement	See note 1		☒	☐	☐

Remark 1: N/A – Not Applicable.
Note 1: The EUT uses a PIFA Antenna, which gain is 4.7dBi. In accordance to §15.203 and RSS-Gen 6.8, It is considered sufficiently to comply with the provisions of this section.

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6 General Remarks

Remarks

This submittal(s) (test report) is intended for FCC ID: 2AGBW9290029816X,
IC: 20812-29816X complies with Section 15.207, 15.209, 15.247 of the FCC Part 15, Subpart C Rules and RSS-247, RSS-GEN.

This report is only for the 2.4GHz BLE test report, for the 2.4GHz Zigbee test report please refer to 709502124202-00.

SUMMARY:

All tests according to the regulations cited on page 5 were

■ - Performed

☐ - **Not** Performed

The Equipment under Test

■ - **Fulfills** the general approval requirements.

☐ - **Does not** fulfill the general approval requirements.

Sample Received Date: December 21, 2020

Testing Start Date: December 24, 2020

Testing End Date: February 25, 2021

- TÜV SÜD Certification and Testing (China) Co., Ltd. Shanghai Branch

Reviewed by:	Prepared by:	Tested by:
Hui TONG	Wenqiang LU	Jiaxi XU
EMC Section Manager	EMC Project Engineer	EMC Test Engineer

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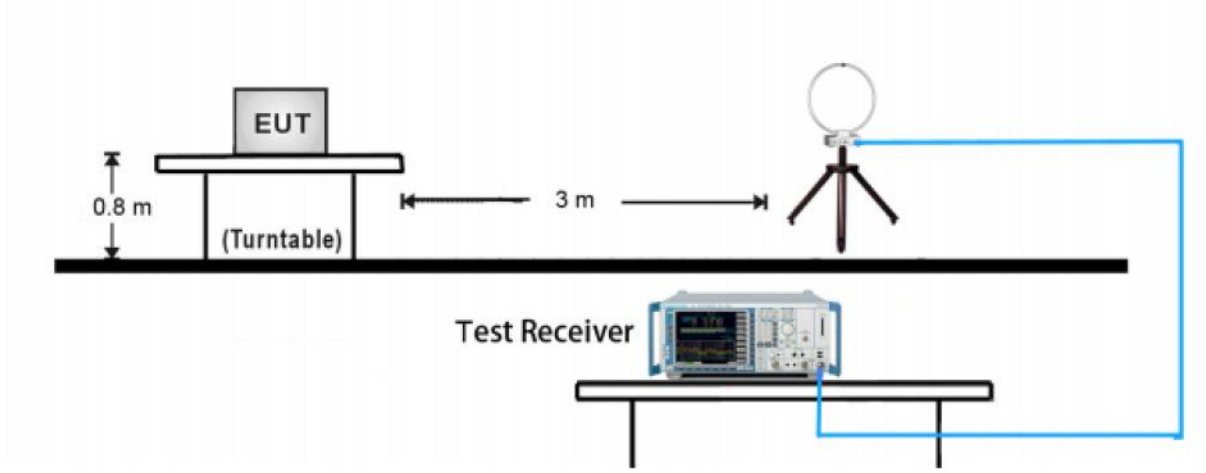
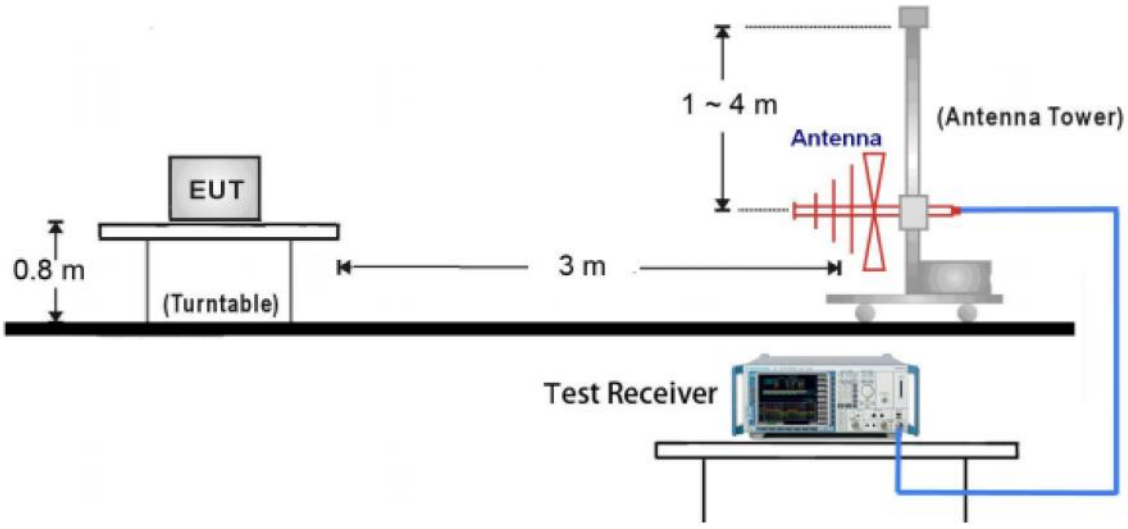
7 Test Setups

7.1 Radiated test setups

9kHz ~ 30MHz Test Setup:



30MHz ~ 1GHz Test Setup:



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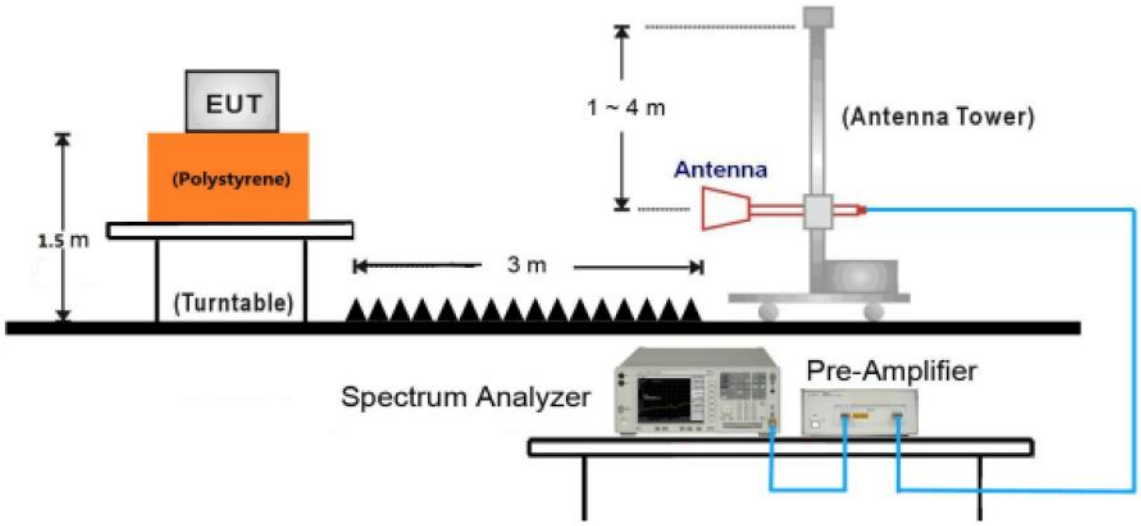
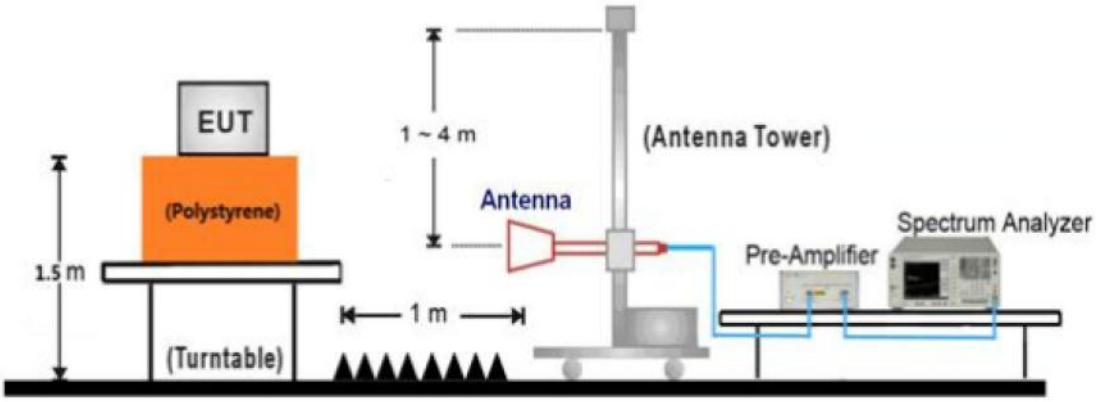
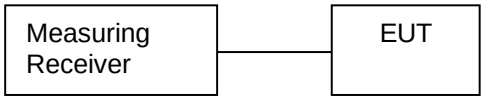
1GHz ~ 18GHz Test Setup:



18GHz ~ 25GHz Test Setup:



7.2 Conducted RF test setups



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8 Systems test configuration

Auxiliary Equipment Used during Test:

DESCRIPTION	MANUFACTURER	MODEL NO.(SHIELD)	S/N(LENGTH)
Notebook	Lenove	X240	Notebook

Test software: HueApprobationTool

The system was configured to channel 0, 19, and 39 for the test.

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9 Technical Requirement

9.1 Conducted peak output power

Test Method

1. Use the following spectrum analyzer settings:
   RBW > the 6 dB bandwidth of the emission being measured, VBW≥3RBW, Span≥3RBW
   Sweep = auto, Detector function = peak, Trace = max hold.
2. Add a correction factor to the display.
3. Allow the trace to stabilize. Use the marker-to-peak function to set the marker to the peak of the emission. The indicated level is the peak output power.

Limits

According to §15.247 (b) (1) & RSS-247 5.4(d), conducted peak output power limit as below:

Frequency Range MHz	Limit W	Limit dBm
2400-2483.5	≤1	≤30

Frequency Range MHz	Limit (EIRP) W	Limit dBm
2400-2483.5	≤4	≤36

Test result as below table

TestMode	Channel	Conducted Peak Output Power Result[dBm]	Limit[dBm]	Verdict
BLE_125K	2402	5.62	<=30	PASS
	2440	5.5	<=30	PASS
	2480	5.43	<=30	PASS
BLE_500K	2402	5.64	<=30	PASS
	2440	**6.17**	<=30	PASS
	2480	5.95	<=30	PASS
BLE_1M	2402	5.63	<=30	PASS
	2440	5.51	<=30	PASS
	2480	5.43	<=30	PASS
BLE_2M	2402	5.62	<=30	PASS
	2440	5.5	<=30	PASS
	2480	5.41	<=30	PASS

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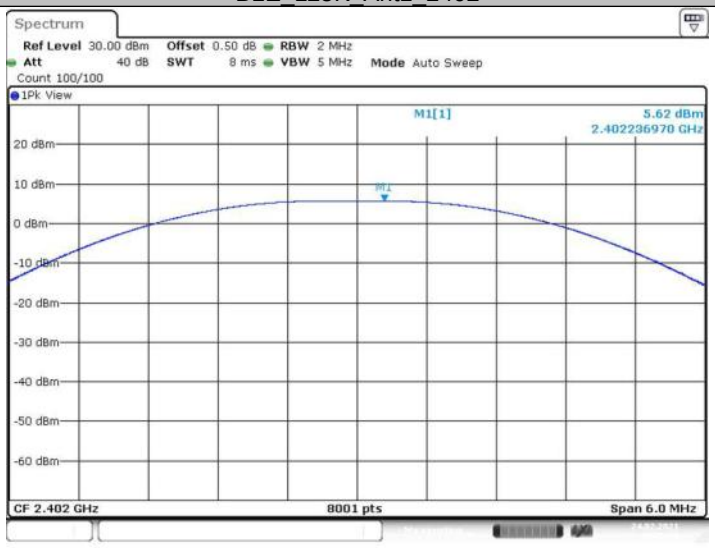
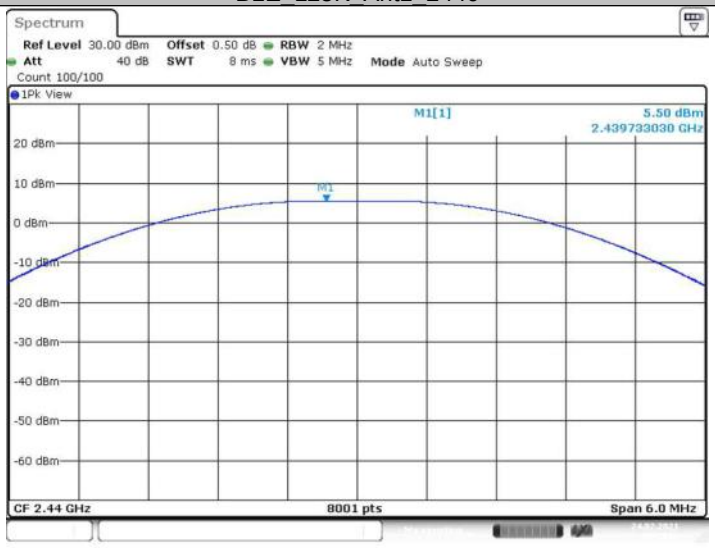
TestMode	Channel	EIRP Result[dBm]	Limit[dBm]	Verdict
BLE_125K	2402	10.32	<=36	PASS
	2440	10.2	<=36	PASS
	2480	10.13	<=36	PASS
BLE_500K	2402	10.34	<=36	PASS
	2440	10.87	<=36	PASS
	2480	10.65	<=36	PASS
BLE_1M	2402	10.33	<=36	PASS
	2440	10.21	<=36	PASS
	2480	10.13	<=36	PASS
BLE_2M	2402	10.32	<=36	PASS
	2440	10.2	<=36	PASS
	2480	10.11	<=36	PASS

Test Graphs

BLE_125K_Ant1_2402



BLE_125K_Ant1_2440



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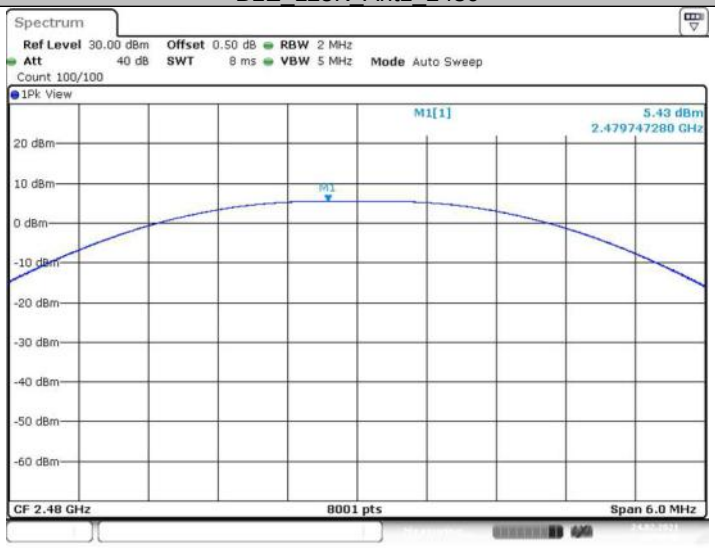
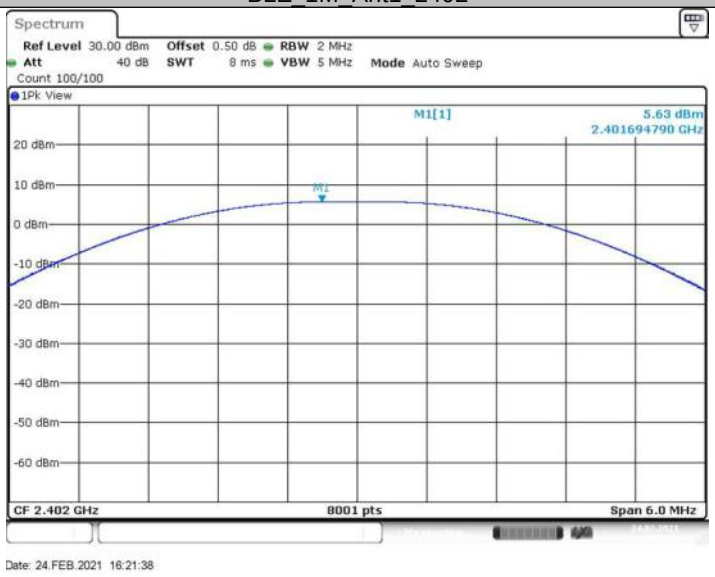
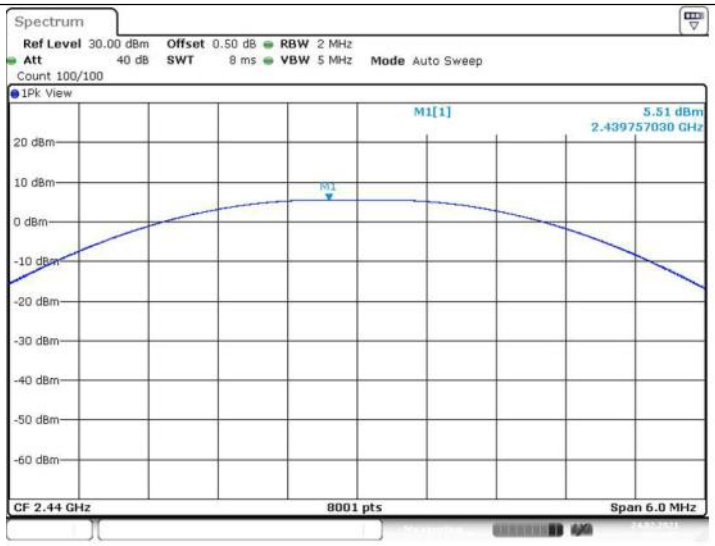
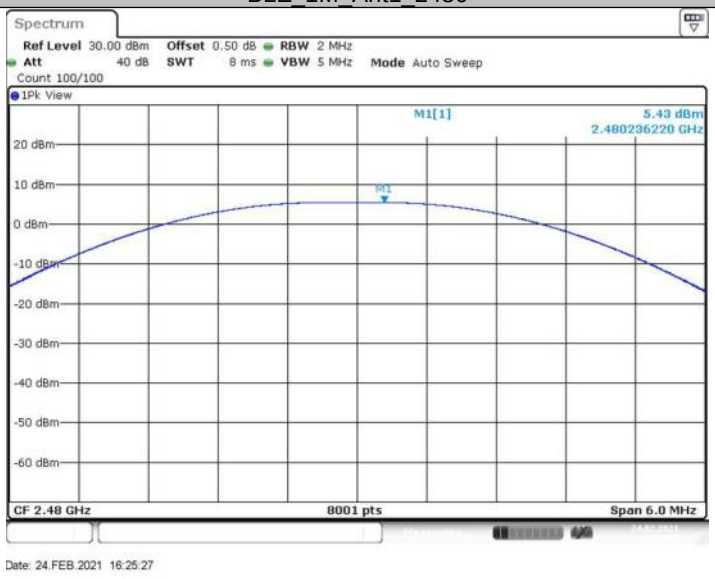
BLE_125K_Ant1_2480

BLE_1M_Ant1_2402

BLE_1M_Ant1_2440



BLE_1M_Ant1_2480



BLE_2M_Ant1_2402

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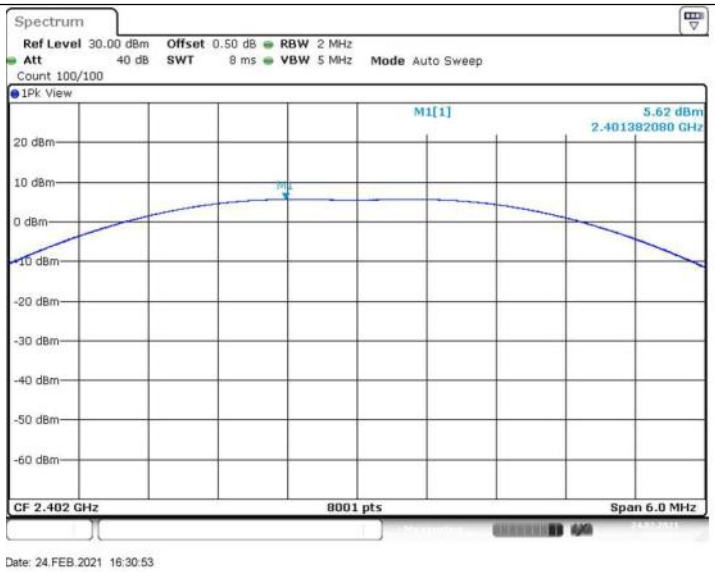

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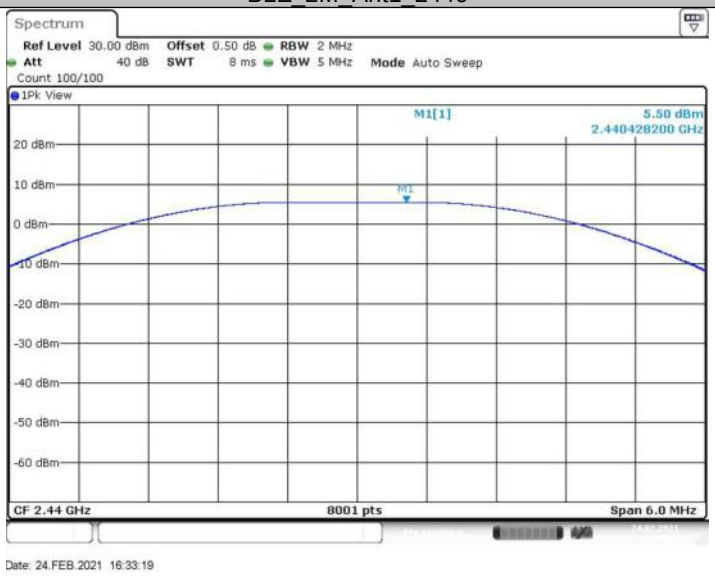

BLE_2M_Ant1_2480

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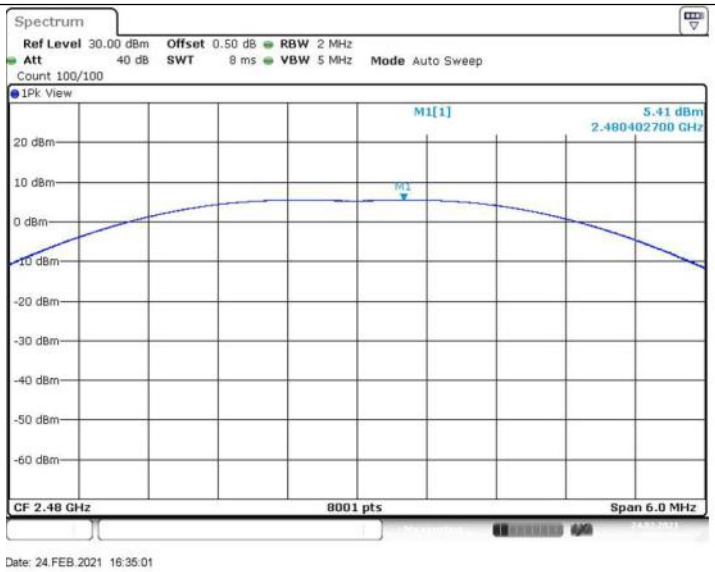
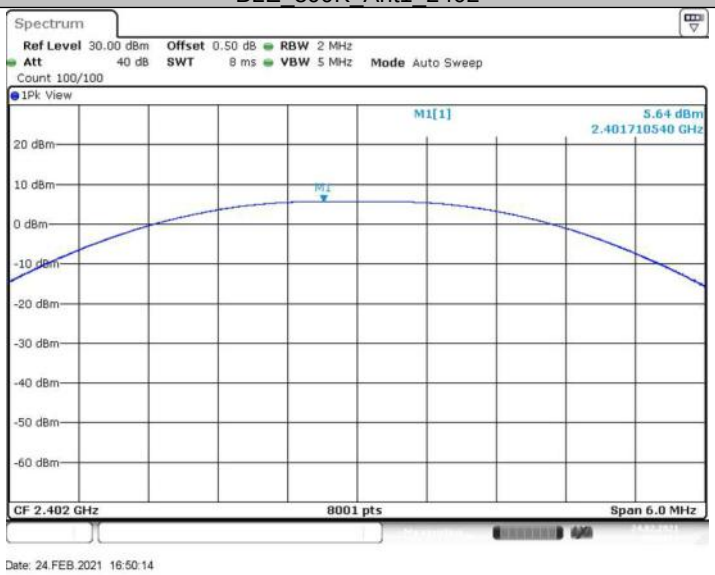


BLE_500K_Ant1_2402



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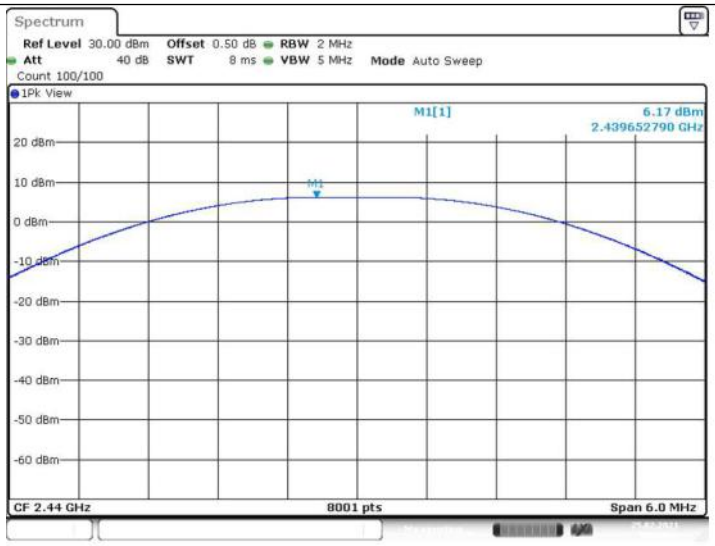

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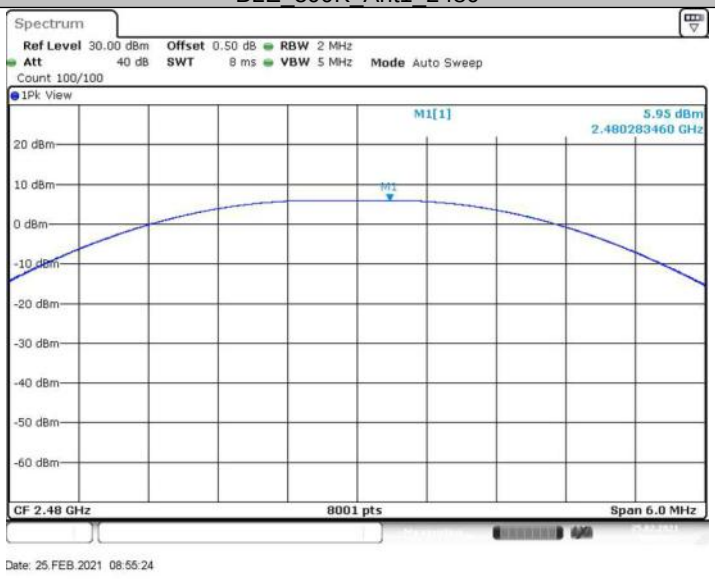

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9.2 6dB bandwidth and 99% Occupied Bandwidth

Test Method

1. Use the following spectrum analyzer settings:
   RBW=100K, VBW≥3RBW, Sweep = auto, Detector function = peak, Trace = max hold
2. Use the automatic bandwidth measurement capability of an instrument, may be employed using the X dB bandwidth mode with X set to 6 dB, care shall be taken so that the bandwidth measurement is not influenced by any intermediate power nulls in the fundamental emission that might be ≥ 6 dB.
3. Allow the trace to stabilize, record the X dB Bandwidth value.

Test Method for 99 % Bandwidth

1. Use the following spectrum analyzer settings:
   RBW=1% to 5% of the actual occupied, VBW≥3RBW, Sweep = auto,
   Detector function = peak, Trace = max hold
2. Use the automatic bandwidth measurement capability of an instrument, care shall be taken so that the bandwidth measurement is not influenced by any intermediate power nulls in the fundamental emission that might be ≥ 6 dB.
3. Allow the trace to stabilize, record the X dB Bandwidth value.

Limit

Limit [kHz]
≥500

Test result

6dB Bandwidth

TestMode	Channel	DTS BW [MHz]	FL[MHz]	FH[MHz]	Limit[MHz]	Verdict
BLE_125K	2402	0.732	2401.596	2402.328	0.5	PASS
	2440	0.732	2439.596	2440.328	0.5	PASS
	2480	0.728	2479.596	2480.324	0.5	PASS
BLE_1M	2402	0.692	2401.612	2402.304	0.5	PASS
	2440	0.692	2439.612	2440.304	0.5	PASS
	2480	0.688	2479.612	2480.300	0.5	PASS
BLE_2M	2402	1.380	2401.272	2402.652	0.5	PASS
	2440	1.372	2439.276	2440.648	0.5	PASS
	2480	1.376	2479.272	2480.648	0.5	PASS
BLE_500K	2402	0.800	2401.564	2402.364	0.5	PASS
	2440	0.796	2439.568	2440.364	0.5	PASS
	2480	0.796	2479.564	2480.360	0.5	PASS

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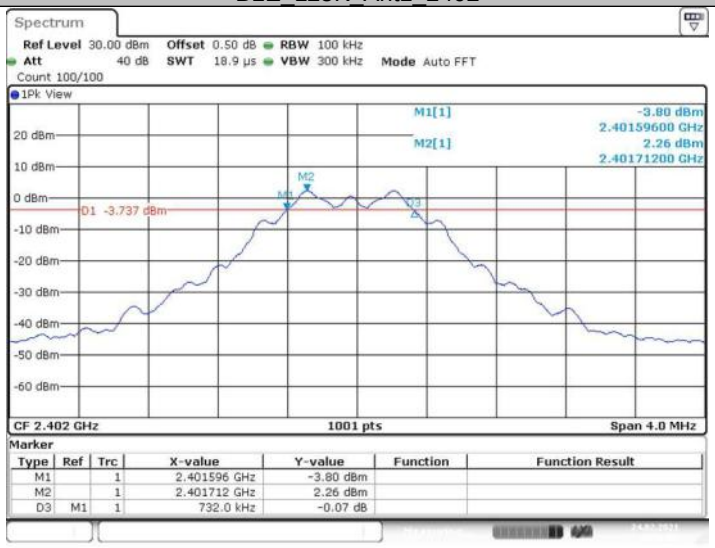
BLE_125K_Ant1_2402


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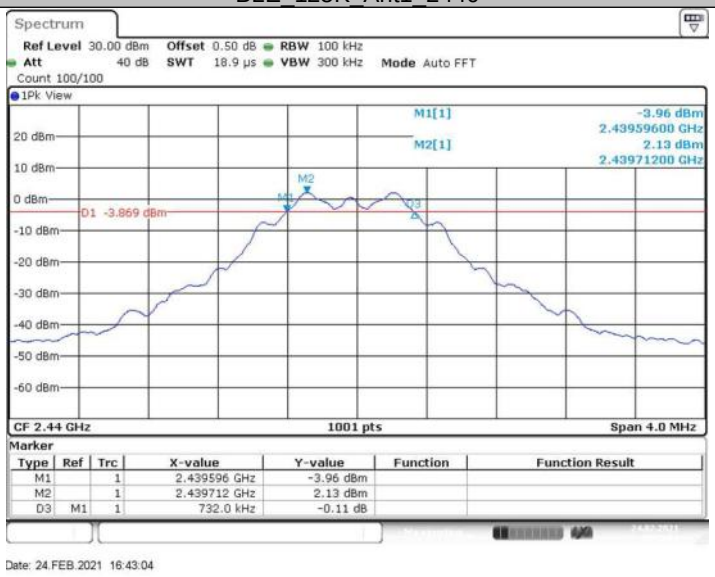

BLE_125K_Ant1_2480

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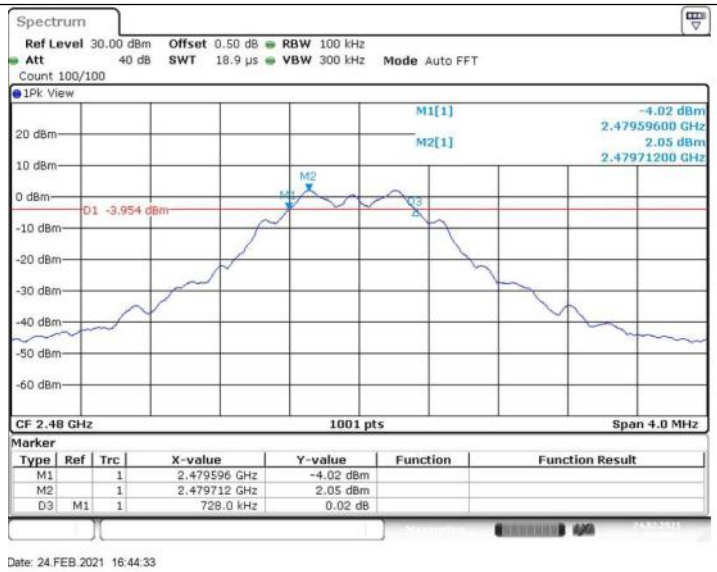

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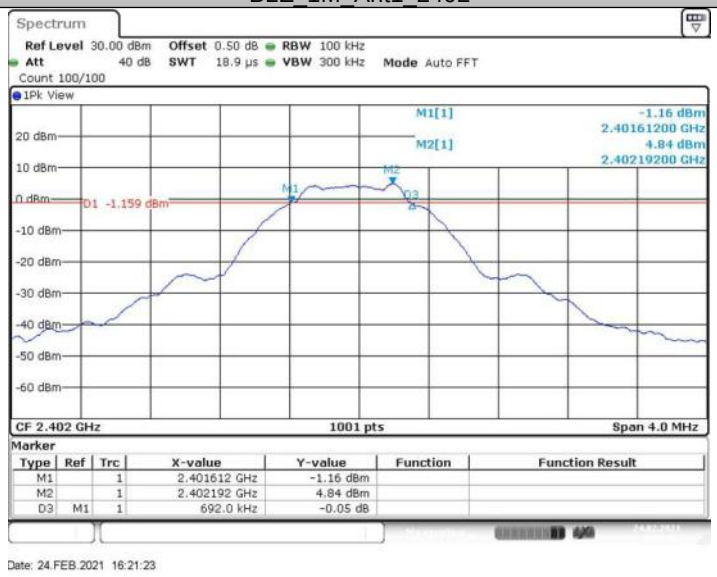

BLE_1M_Ant1_2440

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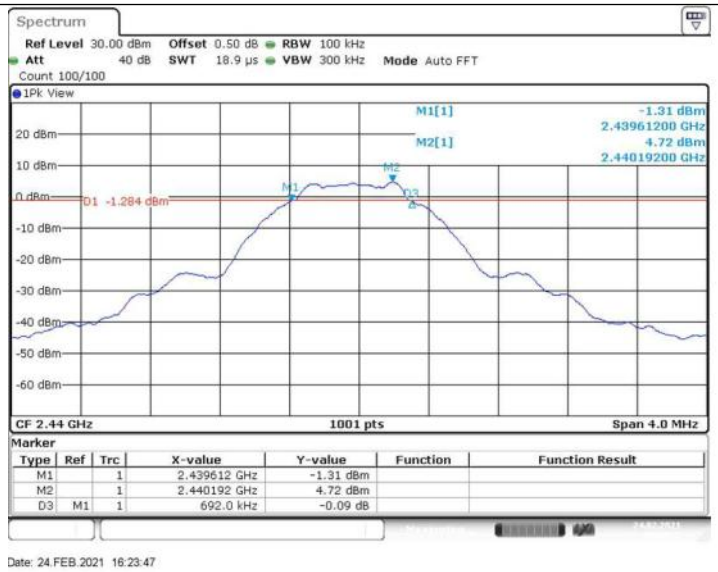

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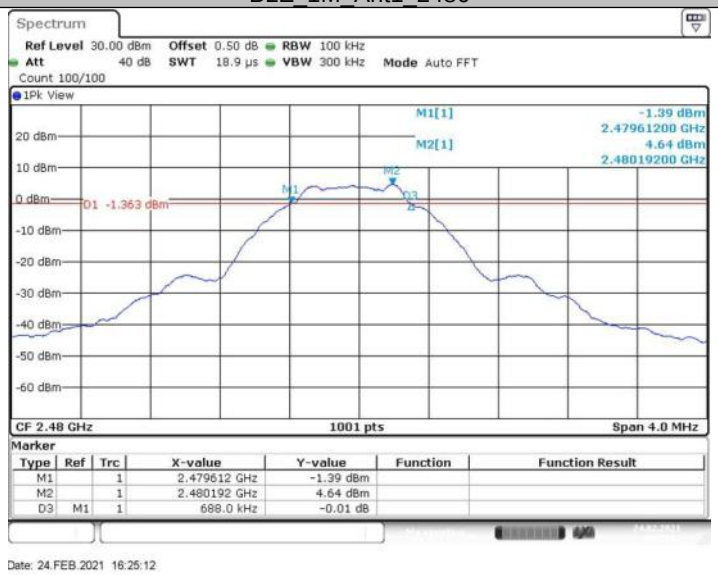

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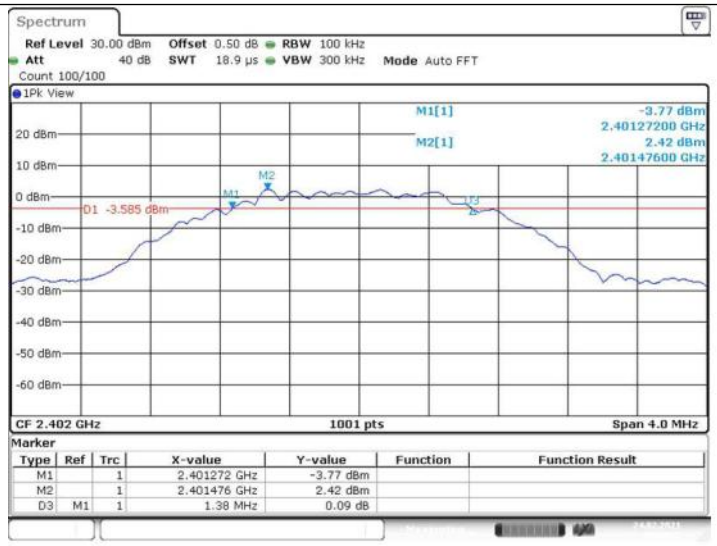

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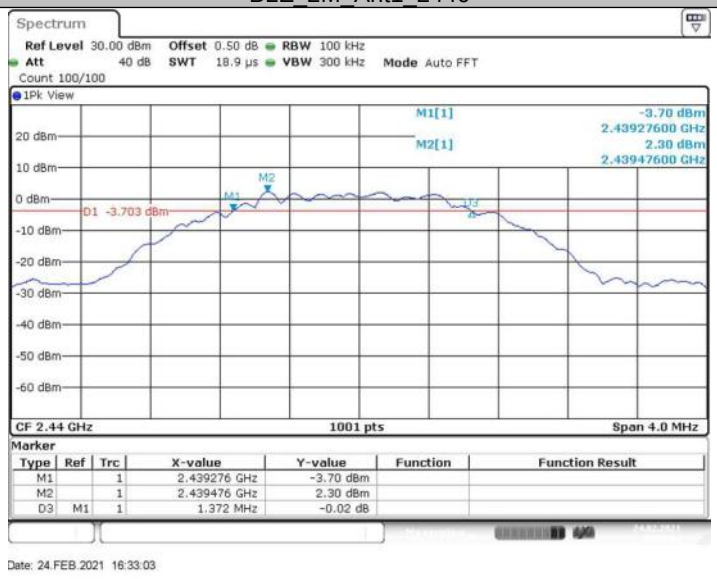

BLE_2M_Ant1_2480

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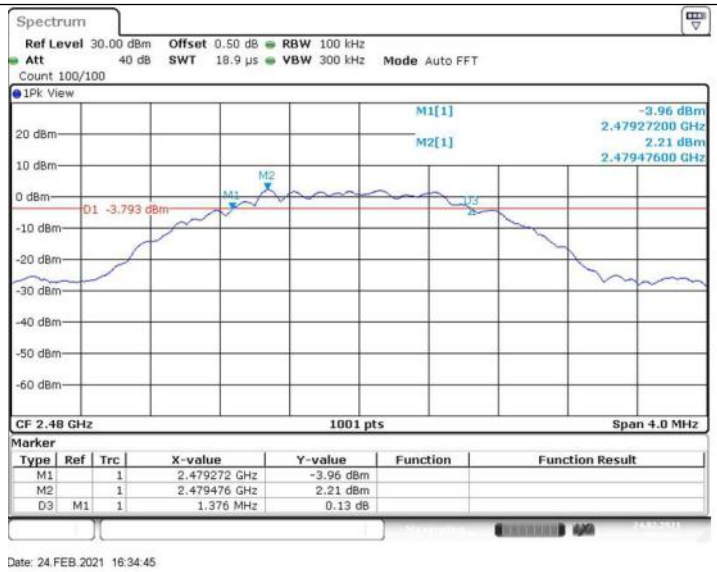
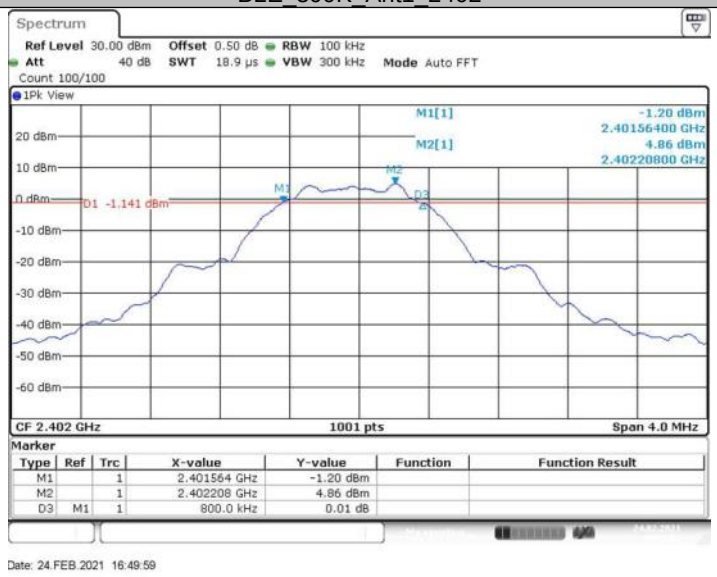
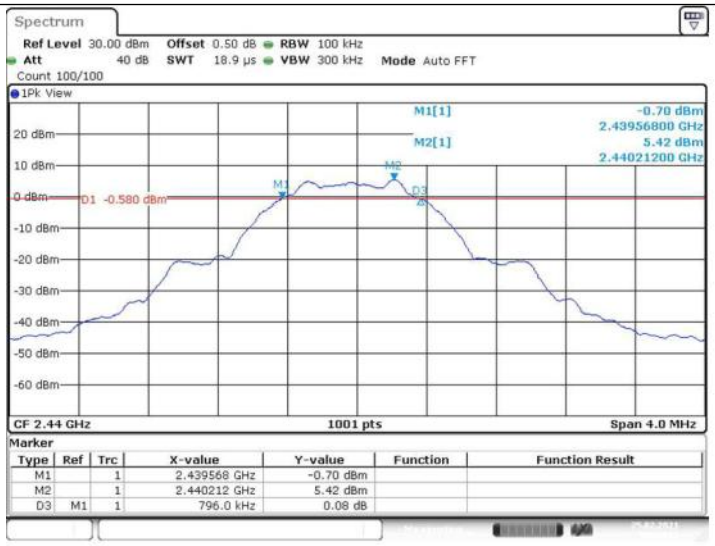


BLE_500K_Ant1_2402

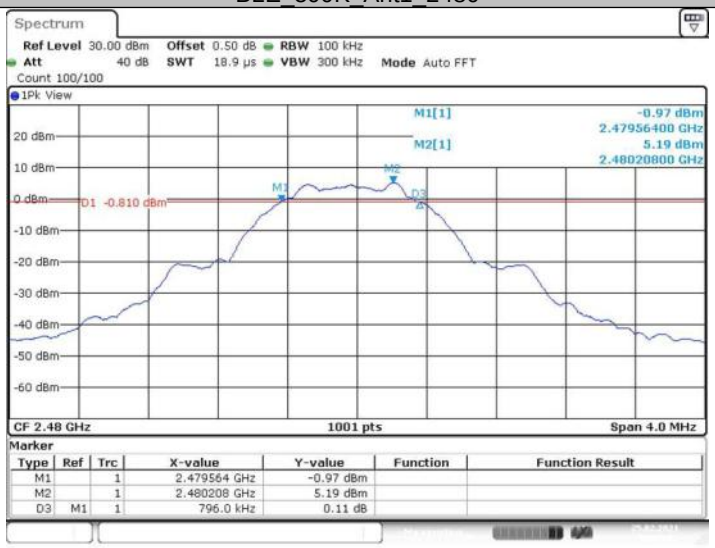


BLE_500K_Ant1_2440



Date: 25.FEB.2021 08:53:12

BLE_500K_Ant1_2480



Date: 25.FEB.2021 08:55:08

99% Occupied Bandwidth

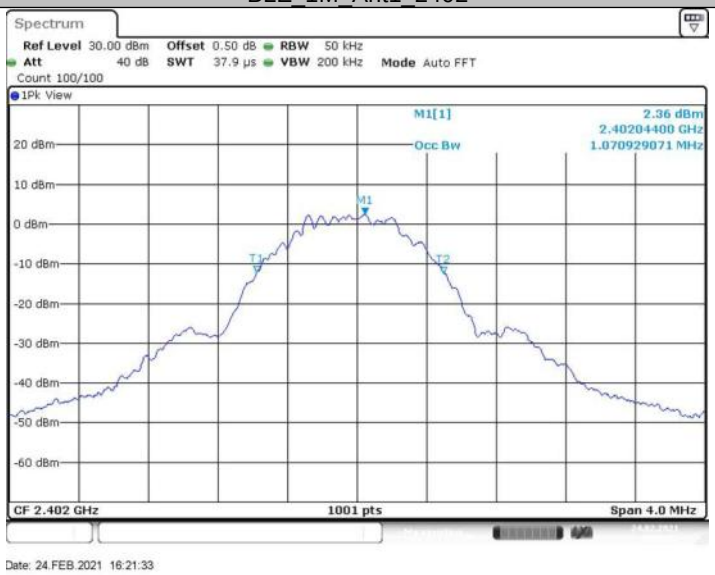
TestMode	Channel	OCB [MHz]	FL[MHz]	FH[MHz]	Limit[MHz]	Verdict
BLE_125K	2402	1.155	2401.385	2402.539	---	PASS
	2440	1.151	2439.385	2440.535	---	PASS
	2480	1.151	2479.385	2480.535	---	PASS
BLE_1M	2402	1.071	2401.425	2402.496	---	PASS
	2440	1.071	2439.425	2440.496	---	PASS
	2480	1.067	2479.425	2480.492	---	PASS
BLE_2M	2402	2.158	2400.889	2403.047	---	PASS
	2440	2.166	2438.885	2441.051	---	PASS
	2480	2.166	2478.885	2481.051	---	PASS
BLE_500K	2402	1.147	2401.385	2402.531	---	PASS
	2440	1.143	2439.389	2440.531	---	PASS
	2480	1.139	2479.389	2480.527	---	PASS

BLE_125K_Ant1_2402

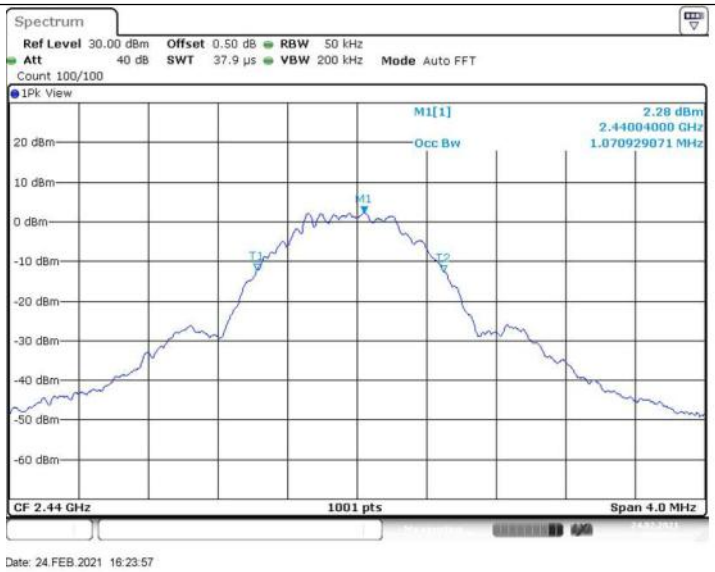
BLE_125K_Ant1_2440

BLE_125K_Ant1_2480

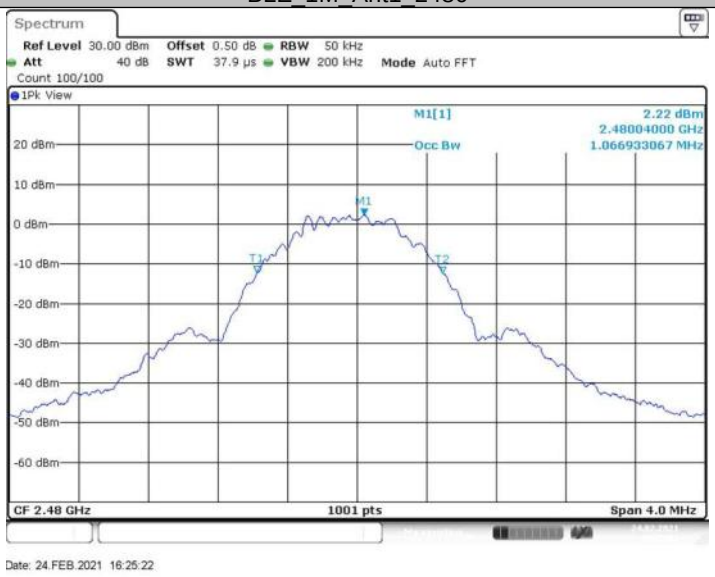
BLE_1M_Ant1_2402



BLE_1M_Ant1_2440



BLE_1M_Ant1_2480



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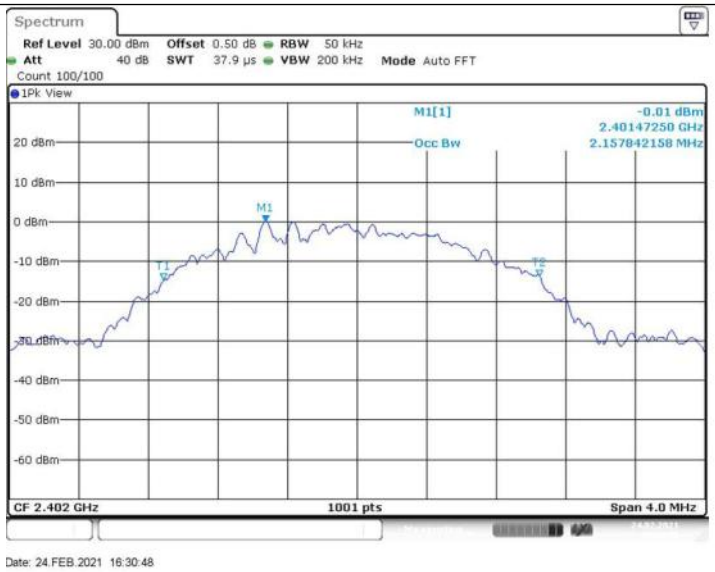
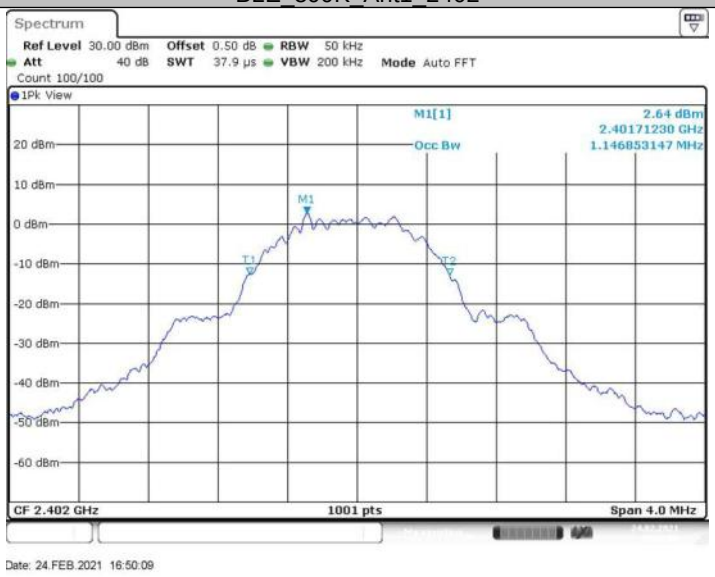


BLE_2M_Ant1_2440

BLE_2M_Ant1_2480

BLE_500K_Ant1_2402



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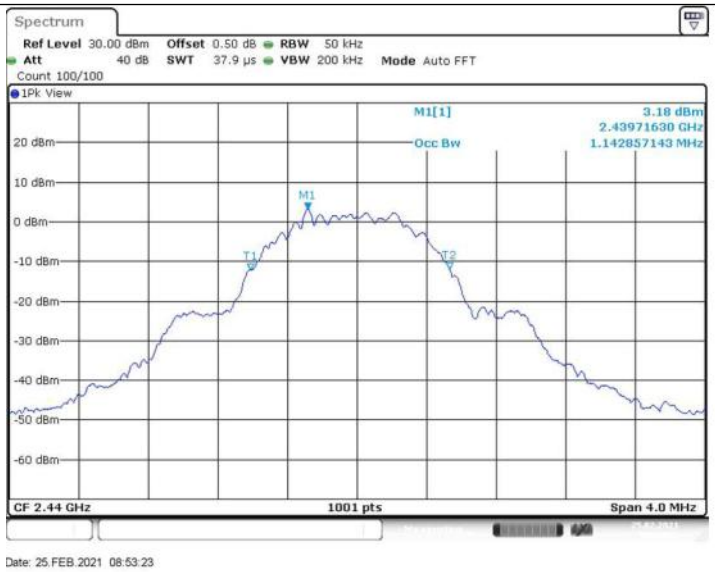
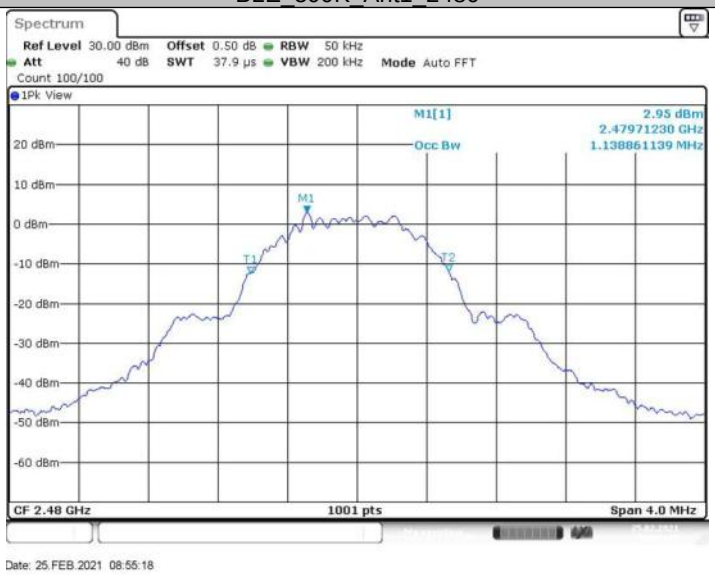


BLE_500K_Ant1_2480



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9.3 Power spectral density

Test Method

This procedure shall be used if maximum peak conducted output power was used to demonstrate compliance:

1. Set analyzer center frequency to DTS channel center frequency. RBW=3kHz, VBW≥3RBW, Span=1.5 times DTS bandwidth, Detector=Peak, Sweep=auto, Trace= max hold.
2. Allow trace to fully stabilize, use the peak marker function to determine the maximum amplitude level within the RBW.
3. Repeat above procedures until other frequencies measured were completed.

Limit

Limit [dBm/3kHz]

≤8

Test result

TestMode	Channel	Result[dBm/3kHz]	Limit[dBm/3kHz]	Verdict
BLE_125K	2402	0.11	<=8	PASS
	2440	-0.12	<=8	PASS
	2480	-0.19	<=8	PASS
BLE_1M	2402	-4.58	<=8	PASS
	2440	-4.76	<=8	PASS
	2480	-4.79	<=8	PASS
BLE_2M	2402	-8.02	<=8	PASS
	2440	-8.2	<=8	PASS
	2480	-8.27	<=8	PASS
BLE_500K	2402	-5.35	<=8	PASS
	2440	-4.77	<=8	PASS
	2480	-4.98	<=8	PASS

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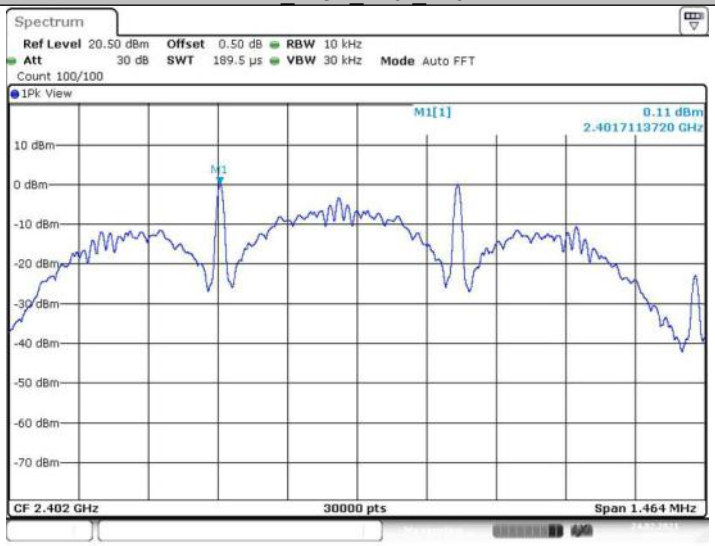
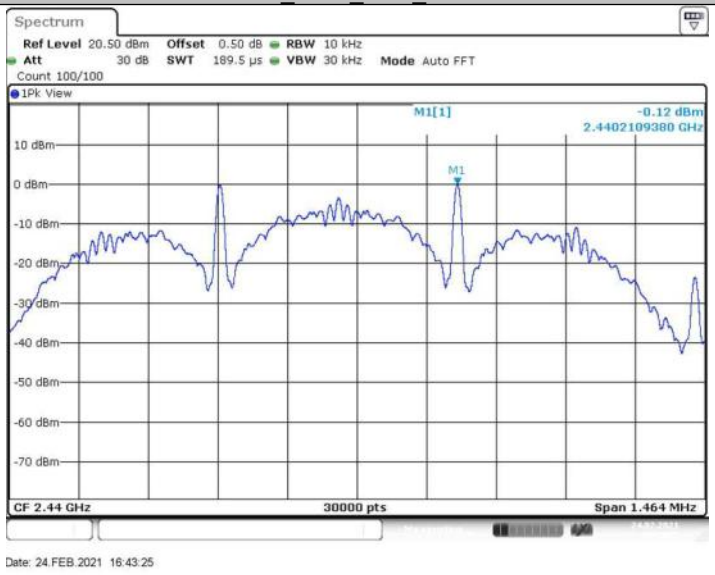
Test Graphs

BLE_125K_Ant1_2402



BLE_125K_Ant1_2440



BLE_125K_Ant1_2480

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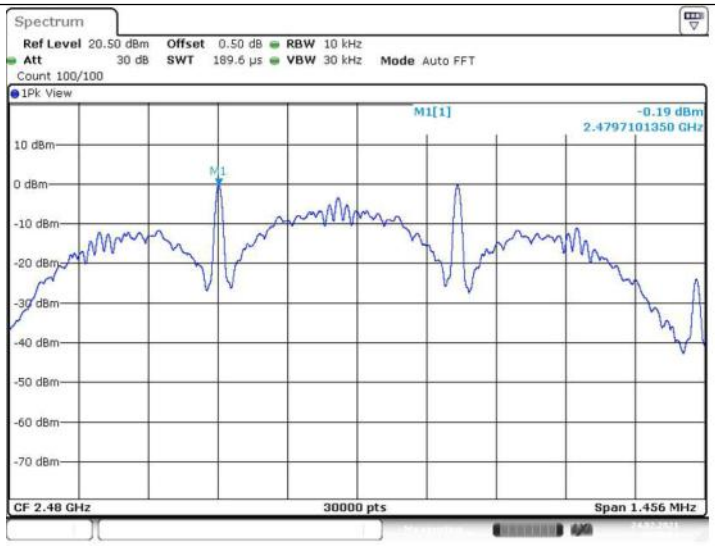

BLE_1M_Ant1_2402

BLE_1M_Ant1_2440

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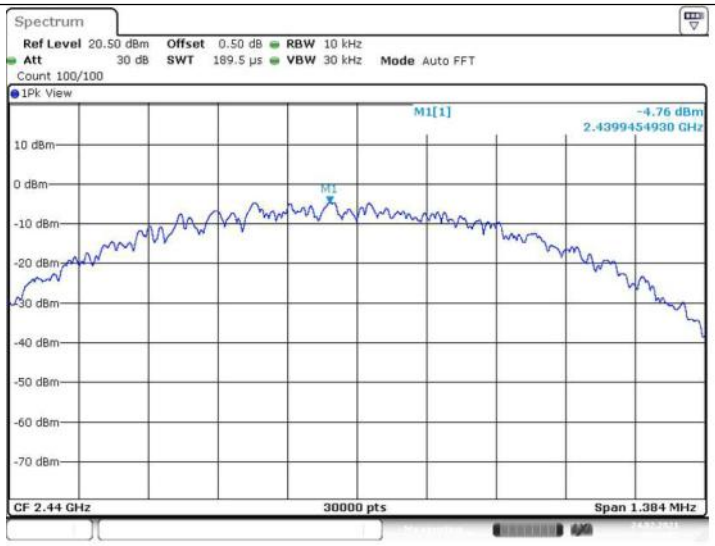
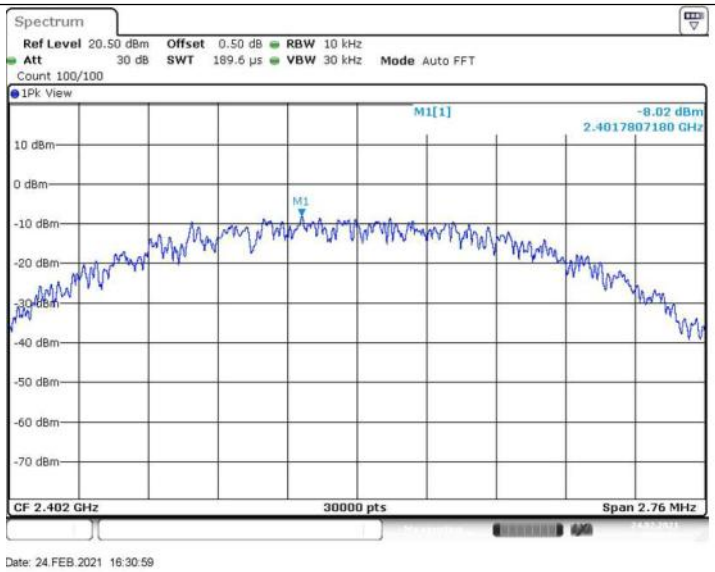
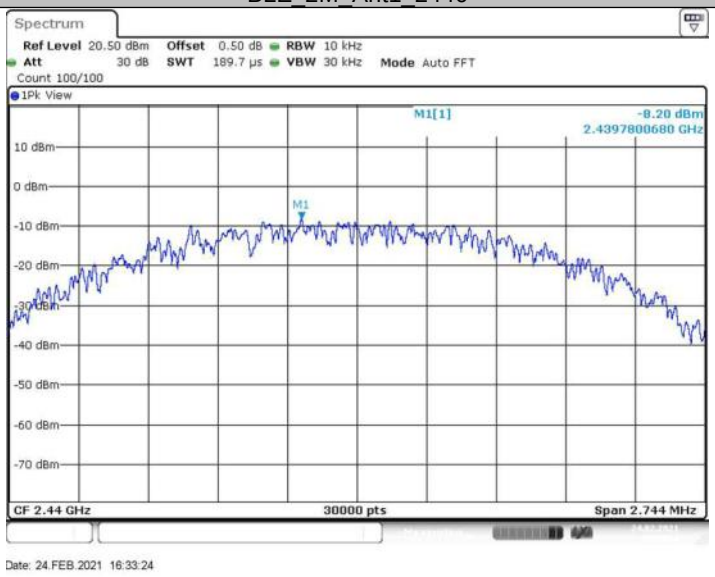


BLE_1M_Ant1_2480

BLE_2M_Ant1_2402



BLE_2M_Ant1_2440



BLE_2M_Ant1_2480

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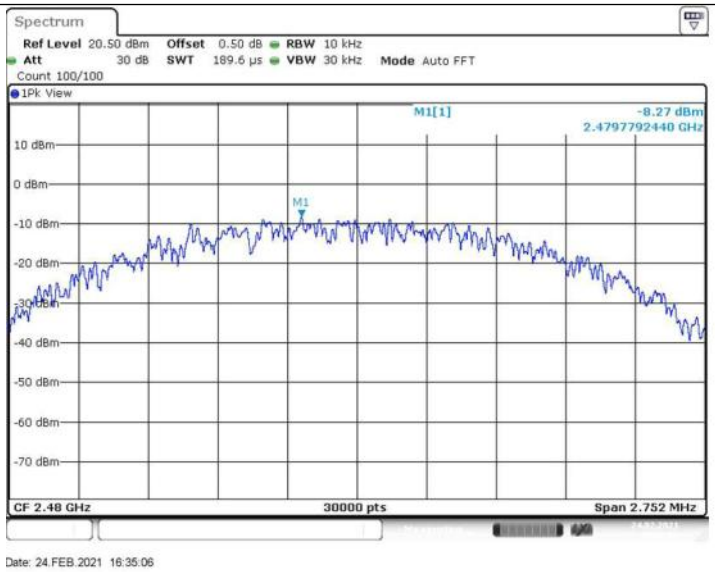
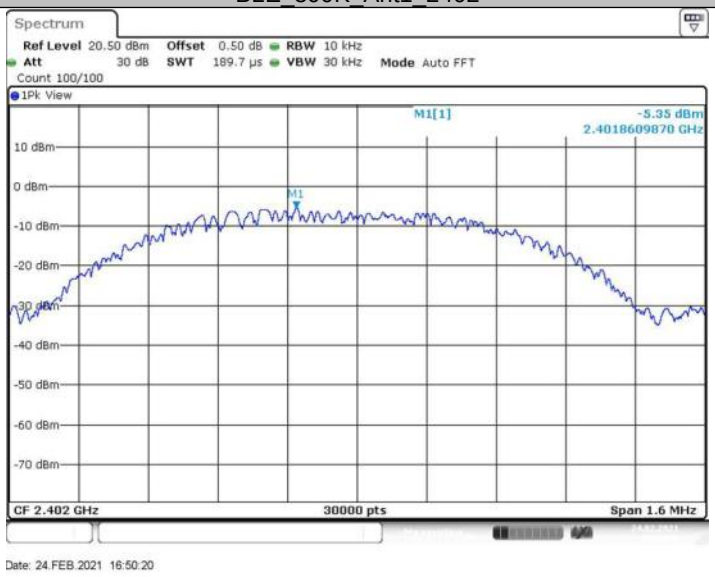
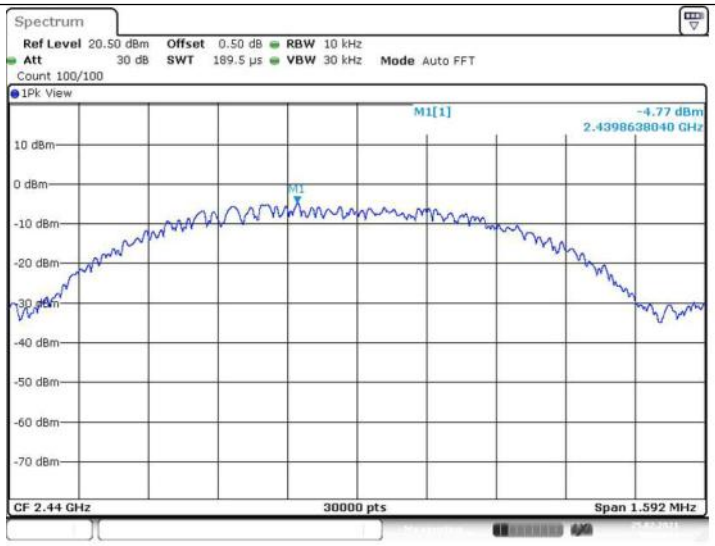


BLE_500K_Ant1_2402

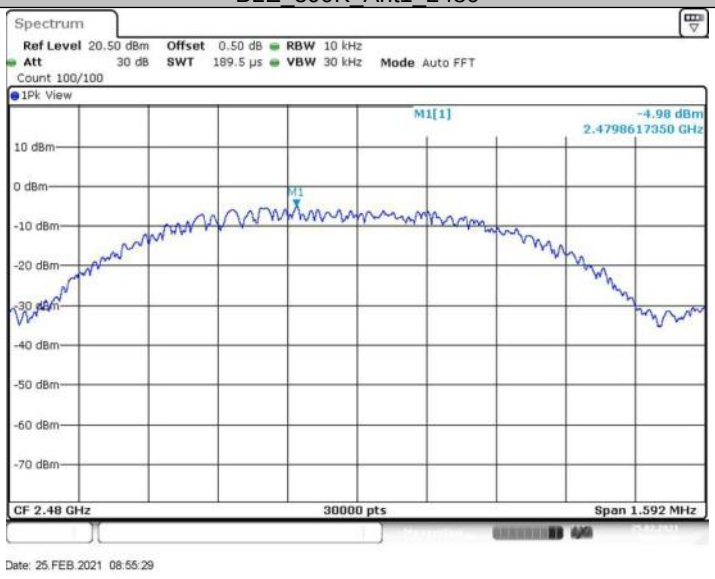


BLE_500K_Ant1_2440

China



BLE_500K_Ant1_2480



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9.4 Spurious RF conducted emissions

Test Method

1. Establish a reference level by using the following procedure:
   a. Set RBW=100 kHz. VBW≥3RBW. Detector =peak, Sweep time = auto couple, Trace mode = max hold.
   b. Allow trace to fully stabilize, use the peak marker function to determine the maximum PSD level.
2. Use the maximum PSD level to establish the reference level.
   a. Set the center frequency and span to encompass frequency range to be measured.
   b. Use the peak marker function to determine the maximum amplitude level. Ensure that the amplitude of all unwanted emissions outside of the authorized frequency band (excluding restricted frequency bands) are attenuated by at least the minimum requirements, report the three highest emissions relative to the limit.
3. Repeat above procedures until other frequencies measured were completed.

Limit

Frequency Range MHz	Limit (dBc)
30-26500	-20

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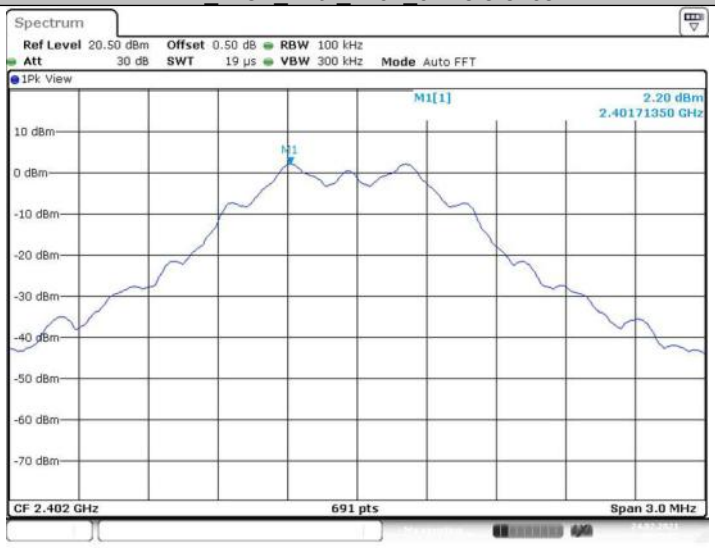
TestMode	Channel	FreqRange [MHz]	RefLevel [dBm]	Result[dBm]	Limit[dBm]	Verdict
BLE_125K	2402	Reference	2.20	2.20	---	PASS
		30~1000	2.20	-58.86	<=-17.8	PASS
		1000~5000	2.20	-55.06	<=-17.8	PASS
		5000~26500	2.20	-47.45	<=-17.8	PASS
	2440	Reference	1.99	1.99	---	PASS
		30~1000	1.99	-58.6	<=-18.01	PASS
		1000~5000	1.99	-50.19	<=-18.01	PASS
		5000~26500	1.99	-48.83	<=-18.01	PASS
	2480	Reference	1.92	1.92	---	PASS
		30~1000	1.92	-58.91	<=-18.08	PASS
		1000~5000	1.92	-54	<=-18.08	PASS
		5000~26500	1.92	-46.22	<=-18.08	PASS
BLE_1M	2402	Reference	4.77	4.77	---	PASS
		30~1000	4.77	-58.94	<=-15.23	PASS
		1000~5000	4.77	-55.3	<=-15.23	PASS
		5000~26500	4.77	-46.68	<=-15.23	PASS
	2440	Reference	4.57	4.57	---	PASS
		30~1000	4.57	-58.74	<=-15.43	PASS
		1000~5000	4.57	-54.5	<=-15.43	PASS
		5000~26500	4.57	-46.74	<=-15.43	PASS
	2480	Reference	4.50	4.50	---	PASS
		30~1000	4.50	-58.51	<=-15.5	PASS
		1000~5000	4.50	-52.94	<=-15.5	PASS
		5000~26500	4.50	-43.06	<=-15.5	PASS
BLE_2M	2402	Reference	2.36	2.36	---	PASS
		30~1000	2.36	-58.87	<=-17.64	PASS
		1000~5000	2.36	-56.13	<=-17.64	PASS
		5000~26500	2.36	-48.02	<=-17.64	PASS
	2440	Reference	2.15	2.15	---	PASS
		30~1000	2.15	-58.35	<=-17.85	PASS
		1000~5000	2.15	-55.67	<=-17.85	PASS
		5000~26500	2.15	-49.04	<=-17.85	PASS
	2480	Reference	2.07	2.07	---	PASS
		30~1000	2.07	-58.66	<=-17.93	PASS
		1000~5000	2.07	-54.52	<=-17.93	PASS
		5000~26500	2.07	-45.6	<=-17.93	PASS
BLE_500K	2402	Reference	4.79	4.79	---	PASS
		30~1000	4.79	-59.25	<=-15.21	PASS
		1000~5000	4.79	-55.47	<=-15.21	PASS
		5000~26500	4.79	-45.3	<=-15.21	PASS
	2440	Reference	5.23	5.23	---	PASS
		30~1000	5.23	-57.72	<=-14.77	PASS
		1000~5000	5.23	-55.1	<=-14.77	PASS
		5000~26500	5.23	-46.14	<=-14.77	PASS
	2480	Reference	5.02	5.02	---	PASS
		30~1000	5.02	-58.57	<=-14.98	PASS
		1000~5000	5.02	-53.13	<=-14.98	PASS
		5000~26500	5.02	-43.26	<=-14.98	PASS

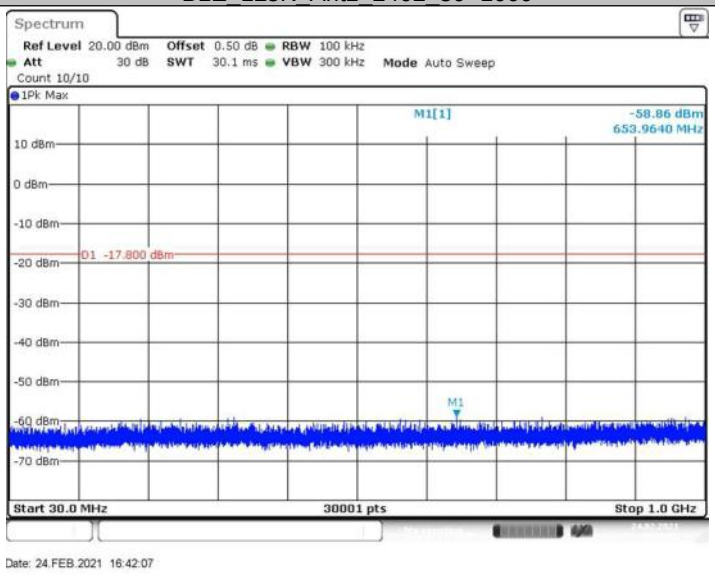
China

Test Graphs

BLE_125K_Ant1_2402_0~Reference



BLE_125K_Ant1_2402_30~1000



BLE_125K_Ant1_2402_1000~5000

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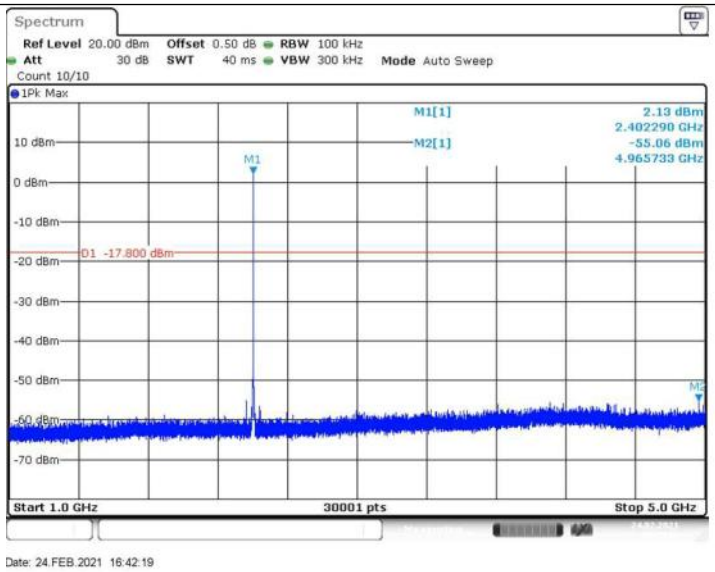
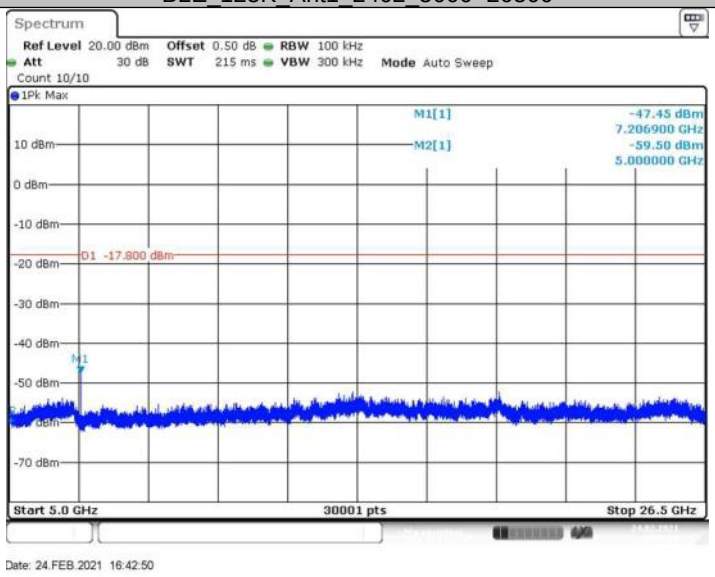


BLE_125K_Ant1_2402_5000~26500



BLE_125K_Ant1_2440_0~Reference

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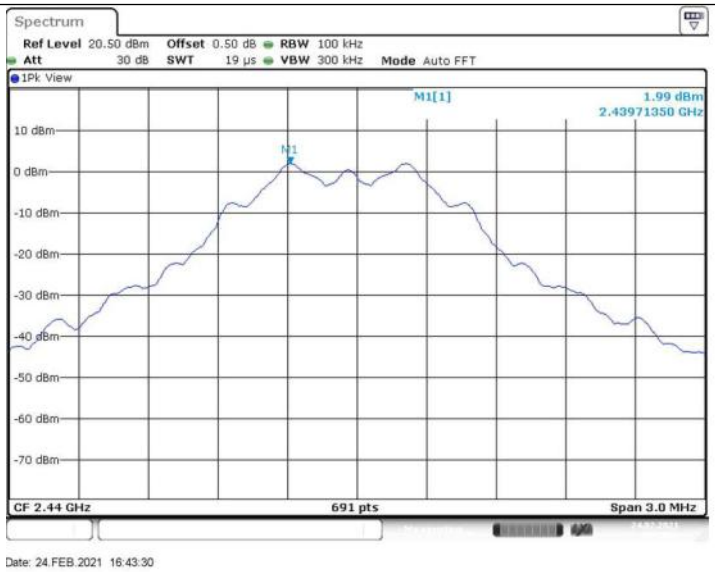
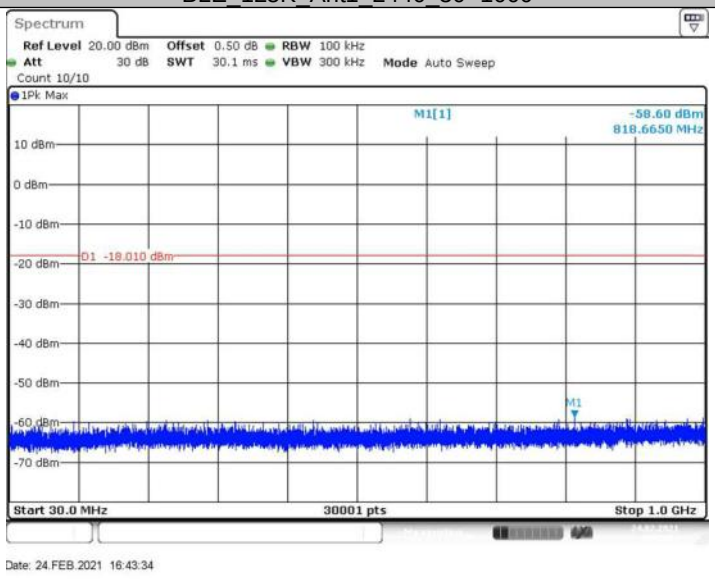


BLE_125K_Ant1_2440_30~1000



BLE_125K_Ant1_2440_1000~5000

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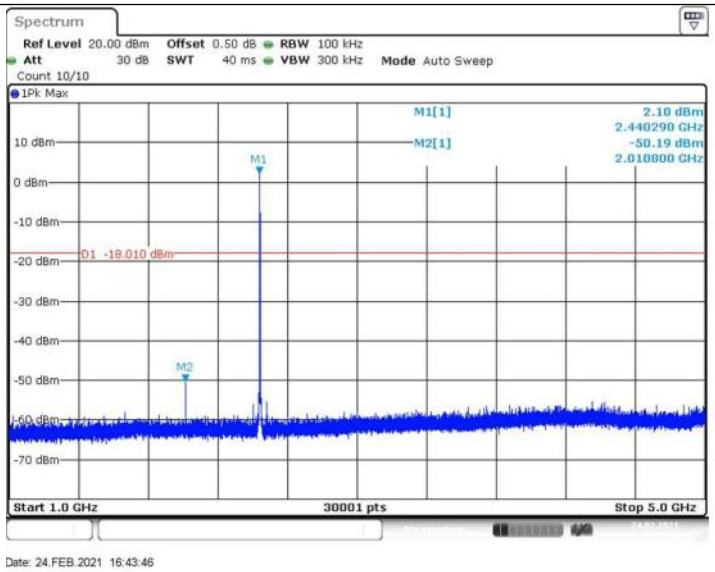
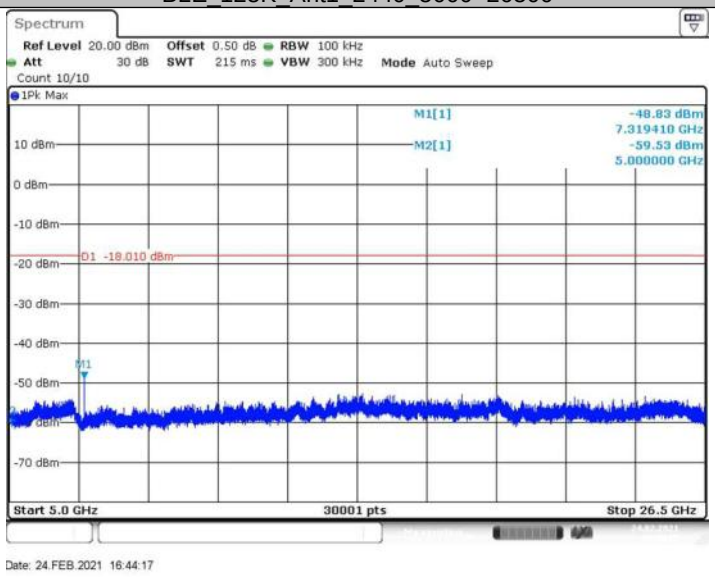
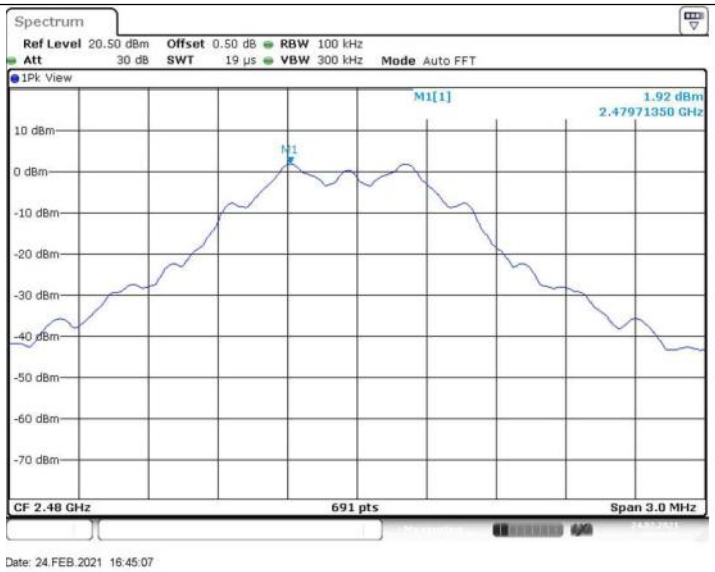


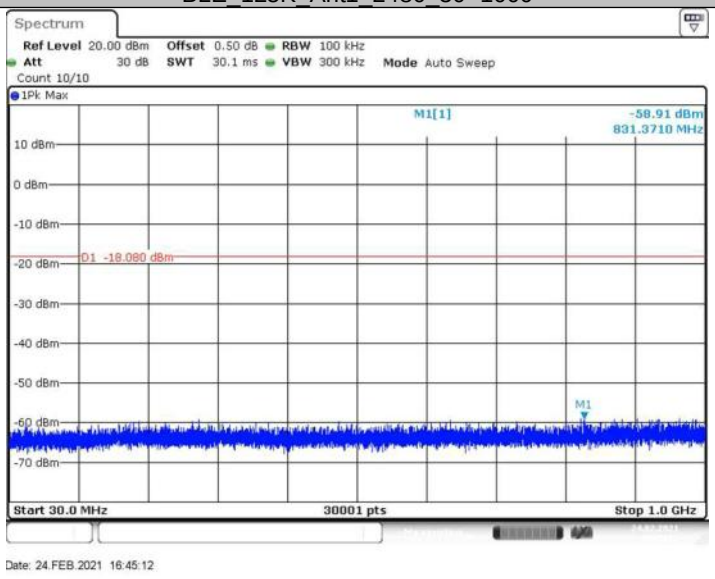
BLE_125K_Ant1_2440_5000~26500



BLE_125K_Ant1_2480_0~Reference



BLE_125K_Ant1_2480_30~1000



BLE_125K_Ant1_2480_1000~5000

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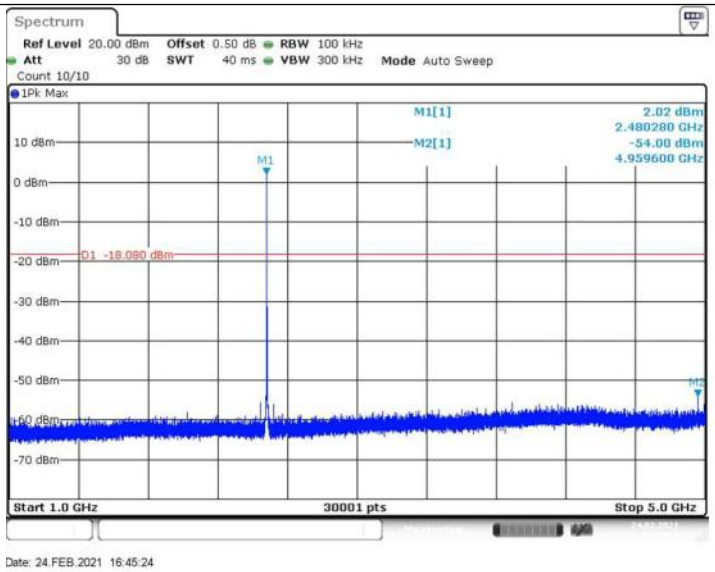
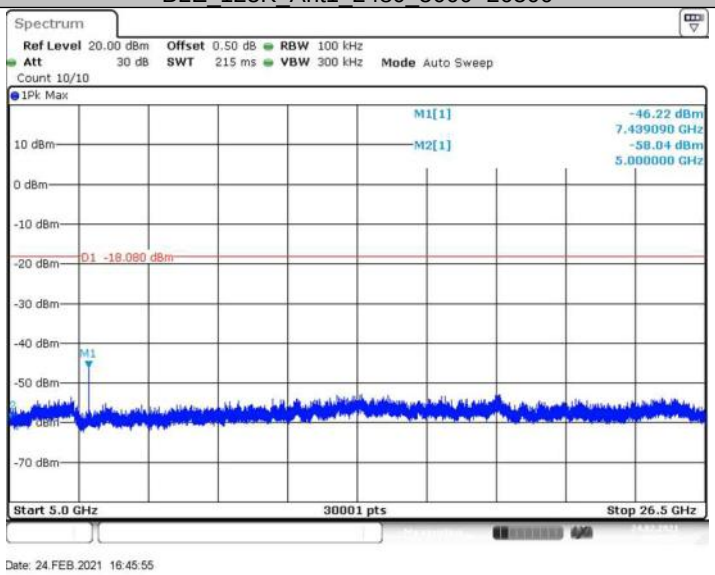


BLE_125K_Ant1_2480_5000~26500



BLE_1M_Ant1_2402_0~Reference

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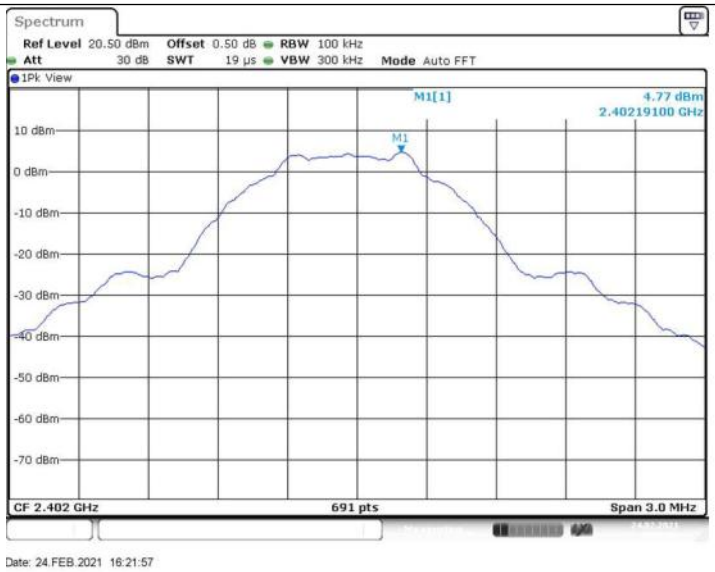
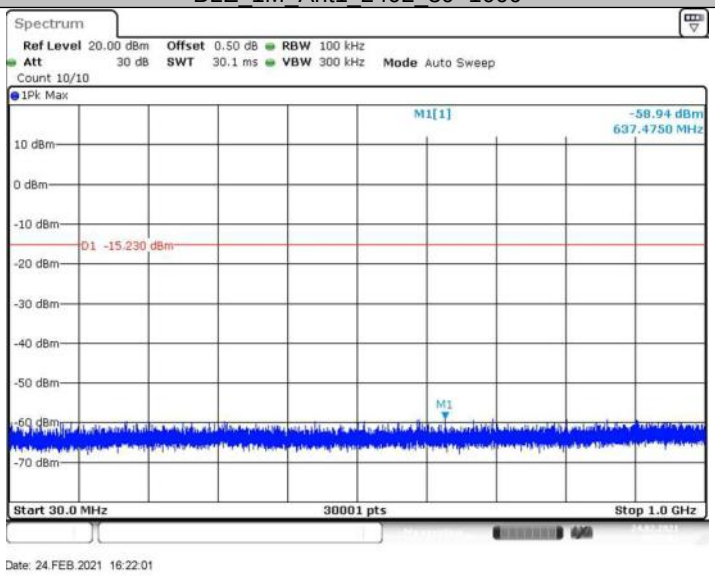


BLE_1M_Ant1_2402_30~1000



BLE_1M_Ant1_2402_1000~5000

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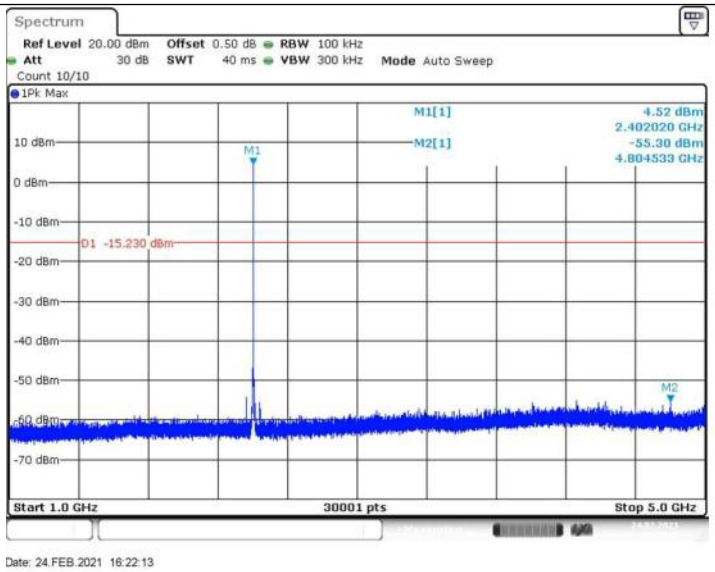
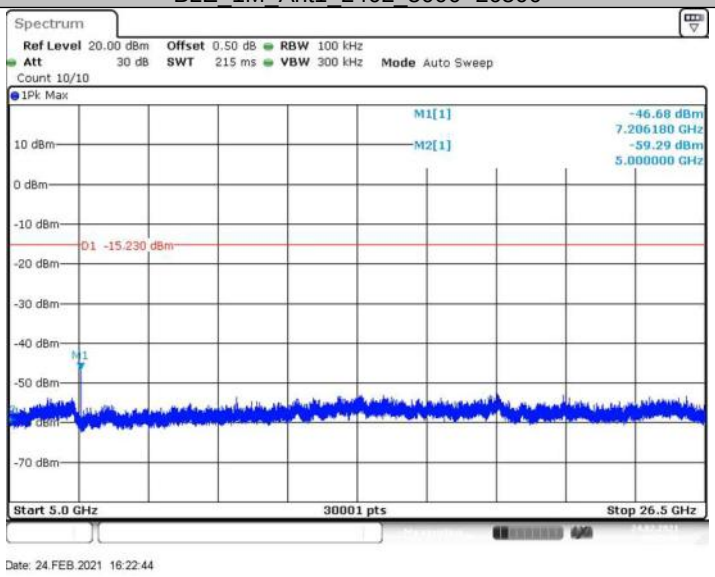


BLE_1M_Ant1_2402_5000~26500



BLE_1M_Ant1_2440_0~Reference

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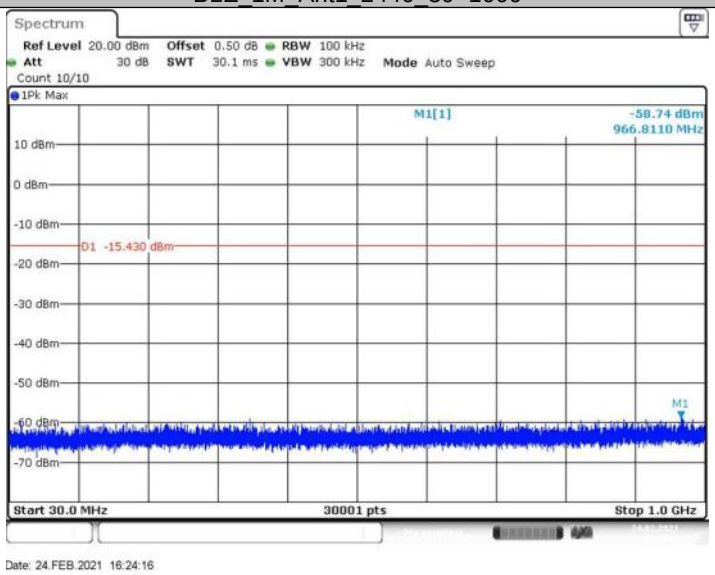
BLE_1M_Ant1_2440_30~1000



BLE_1M_Ant1_2440_1000~5000

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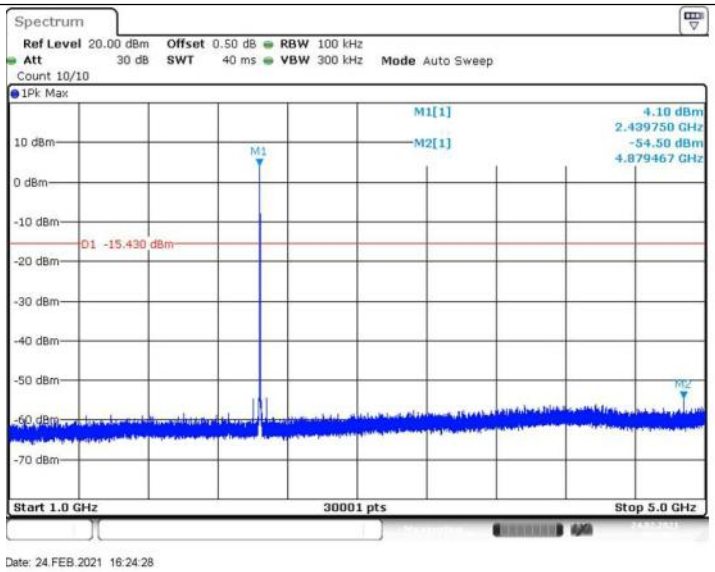
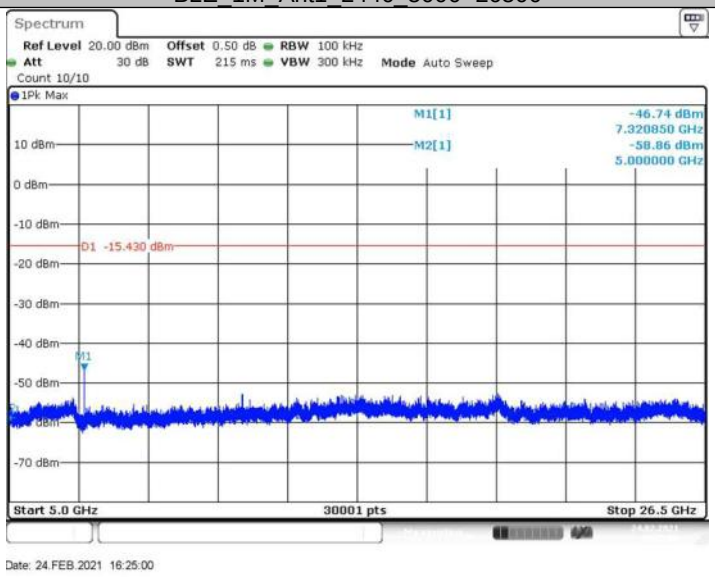


BLE_1M_Ant1_2440_5000~26500



BLE_1M_Ant1_2480_0~Reference

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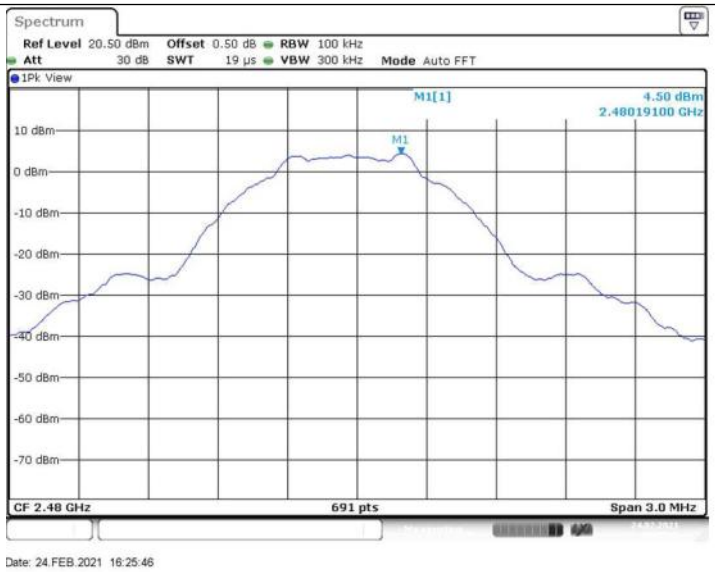

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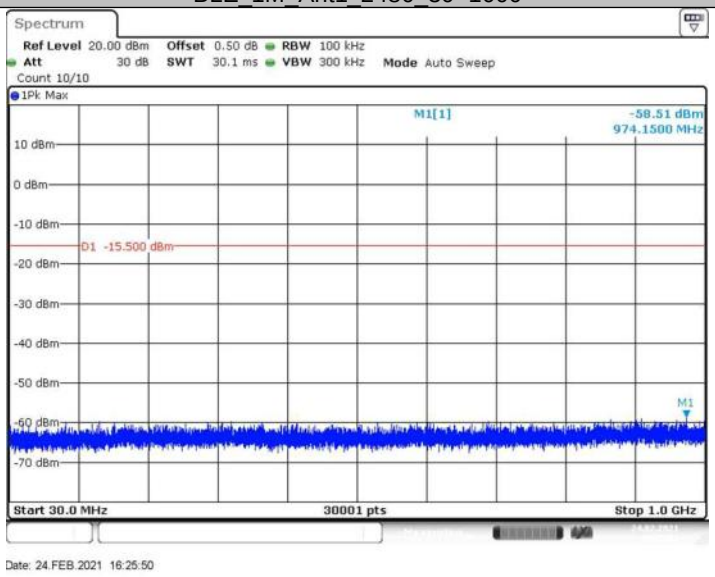

BLE_1M_Ant1_2480_1000~5000

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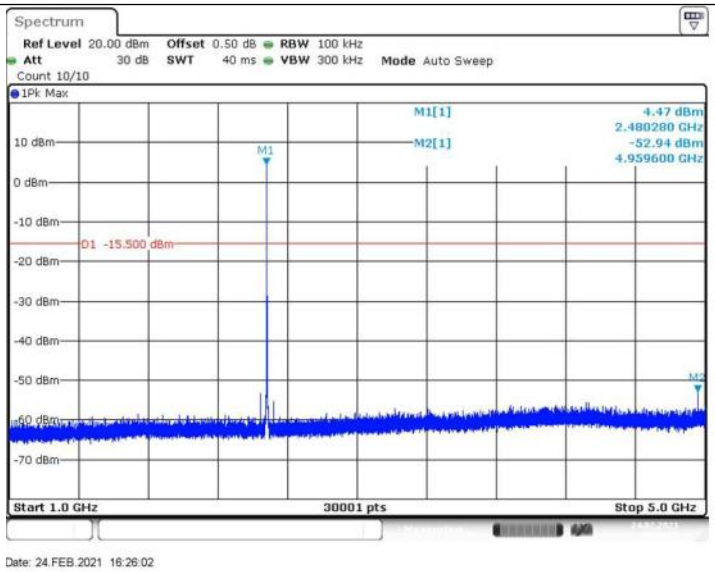
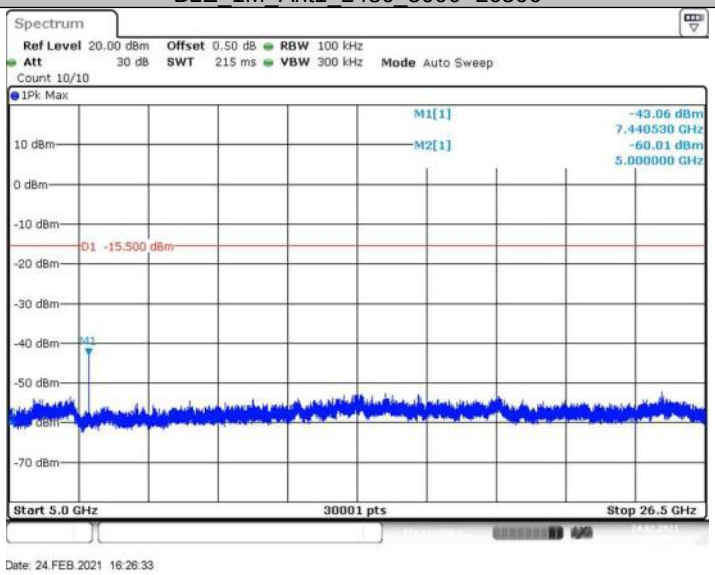


BLE_1M_Ant1_2480_5000~26500



BLE_2M_Ant1_2402_0~Reference

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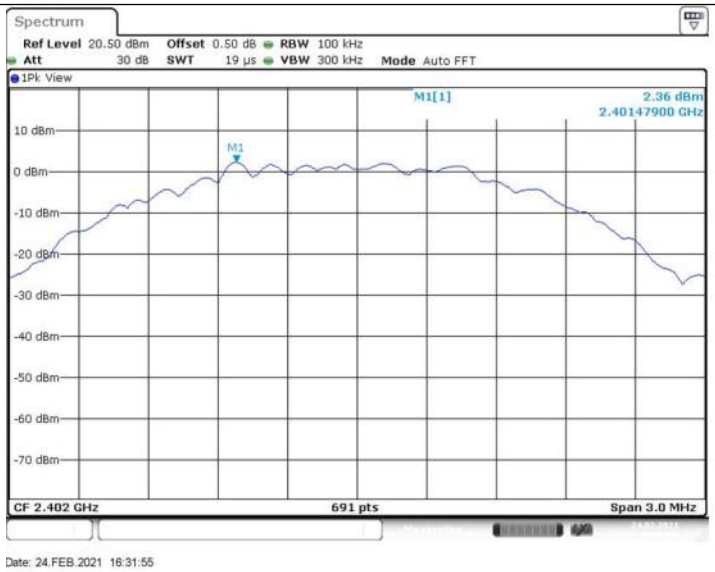
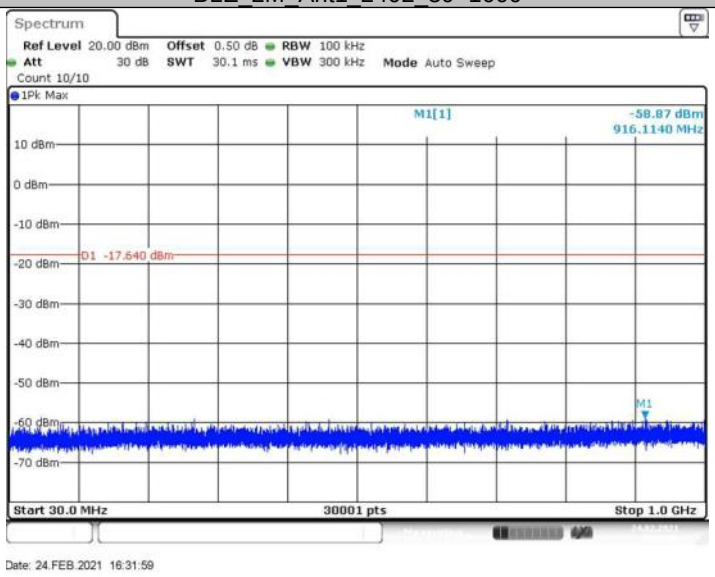


BLE_2M_Ant1_2402_30~1000



BLE_2M_Ant1_2402_1000~5000

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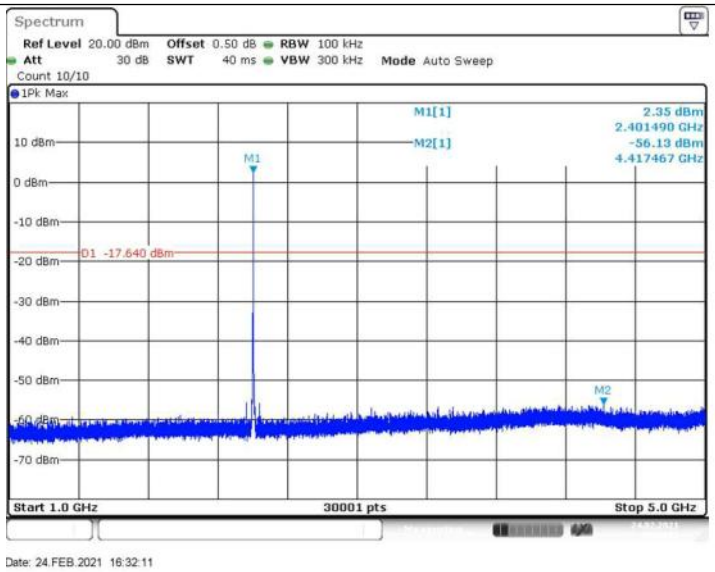
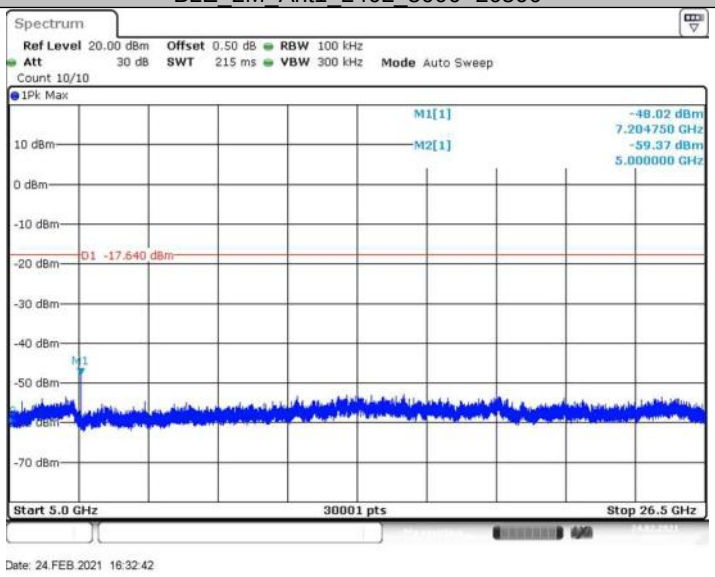


BLE_2M_Ant1_2402_5000~26500



BLE_2M_Ant1_2440_0~Reference

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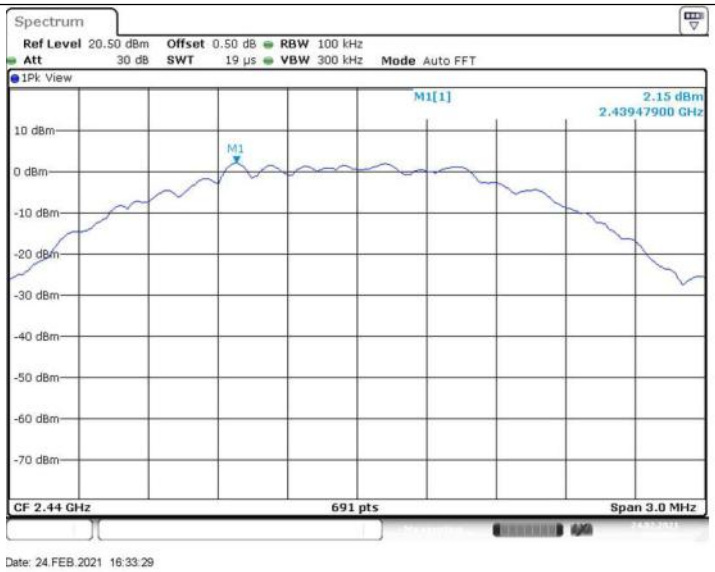

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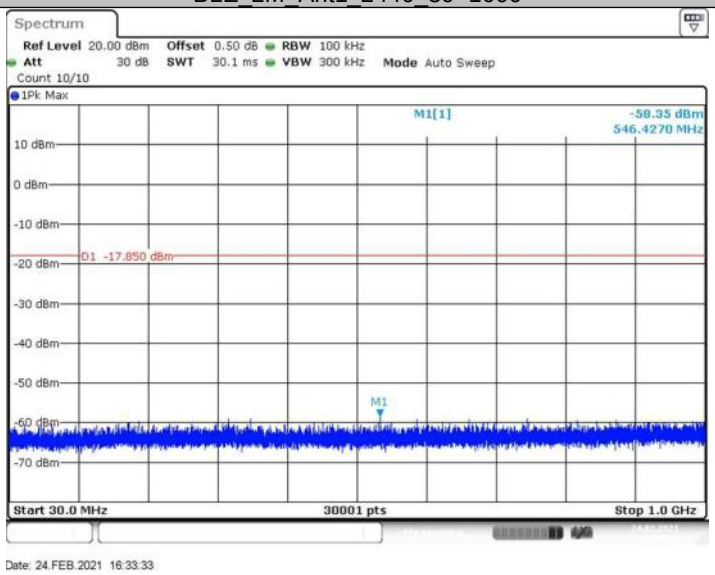

BLE_2M_Ant1_2440_1000~5000

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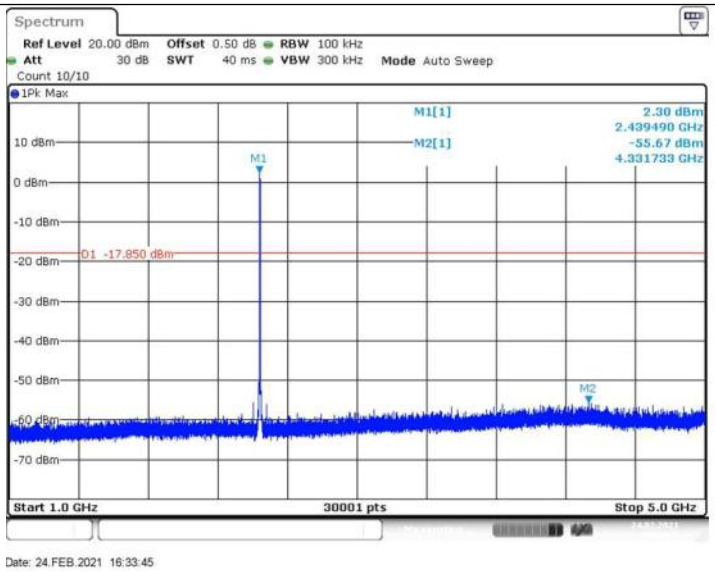

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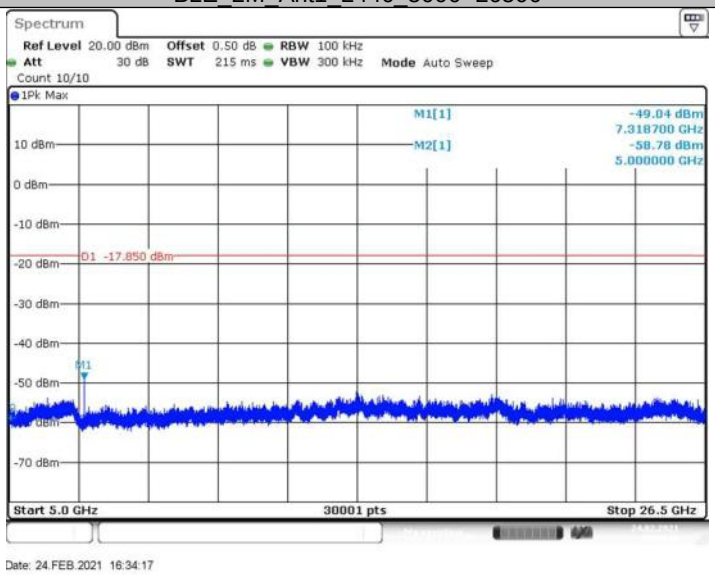

BLE_2M_Ant1_2480_0~Reference

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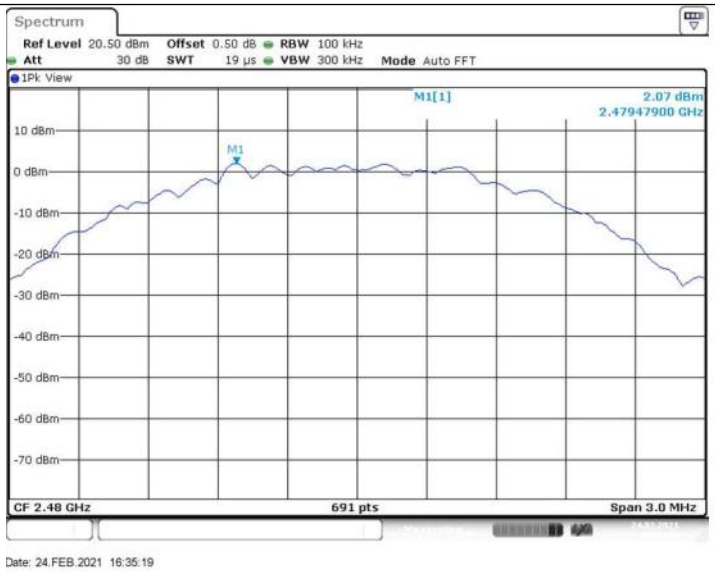

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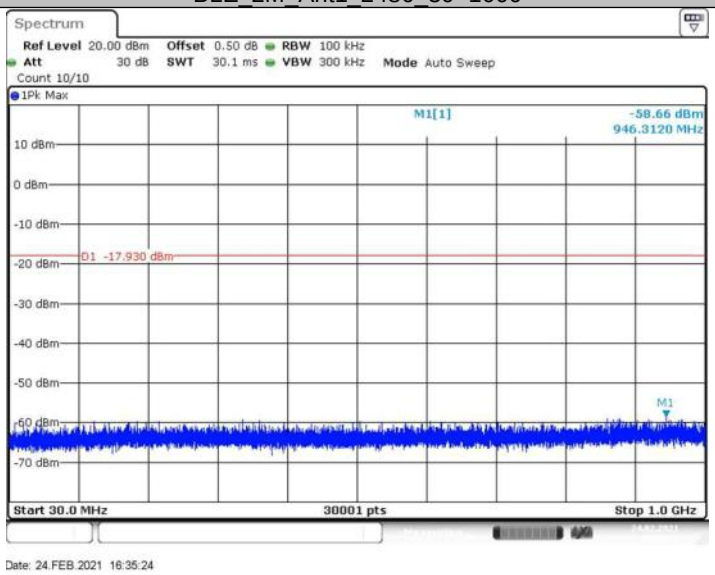

BLE_2M_Ant1_2480_1000~5000

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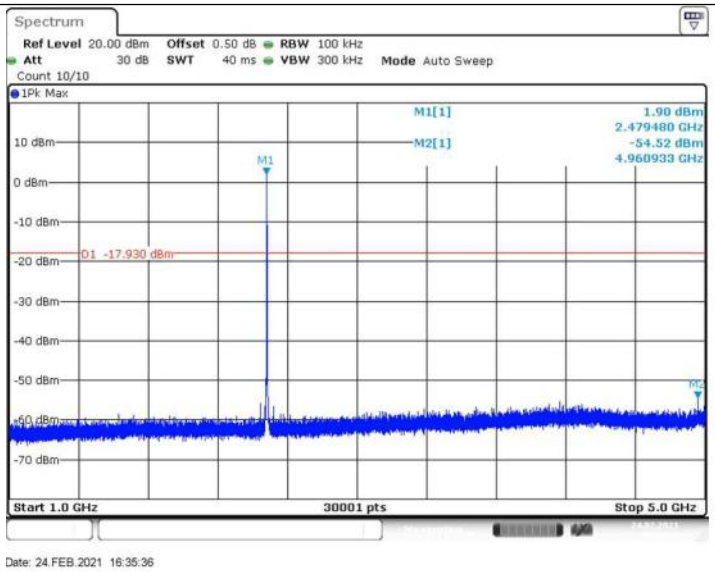

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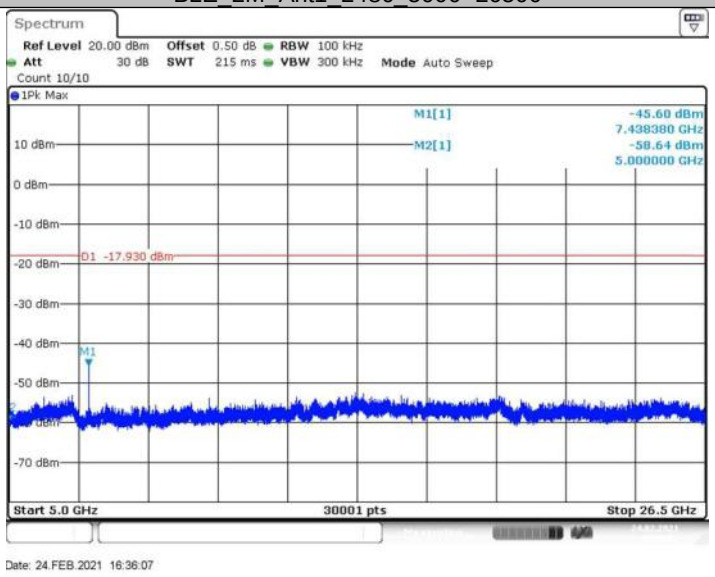

BLE_500K_Ant1_2402_0~Reference

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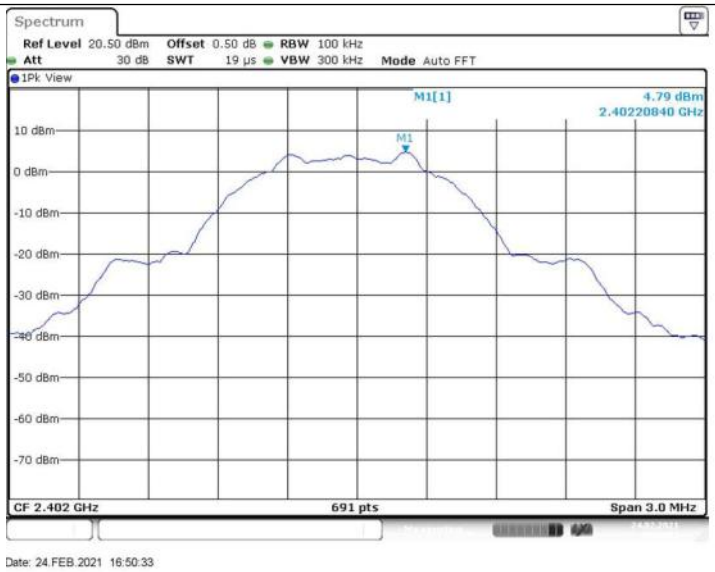
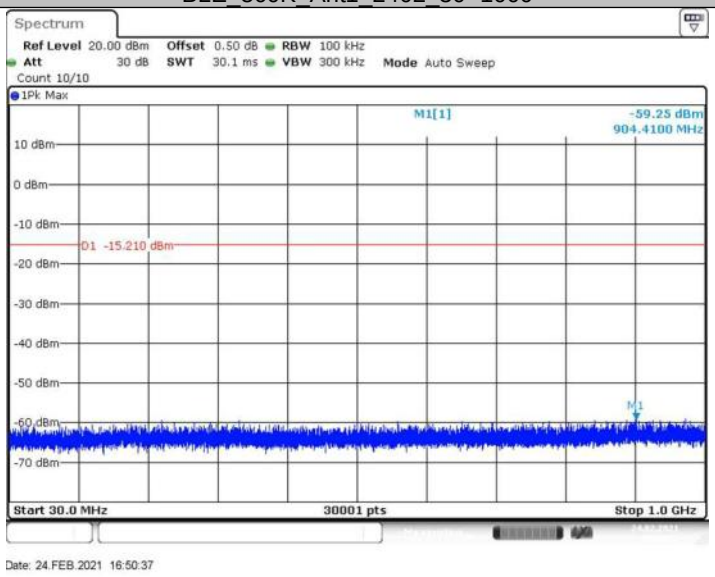


BLE_500K_Ant1_2402_30~1000



BLE_500K_Ant1_2402_1000~5000

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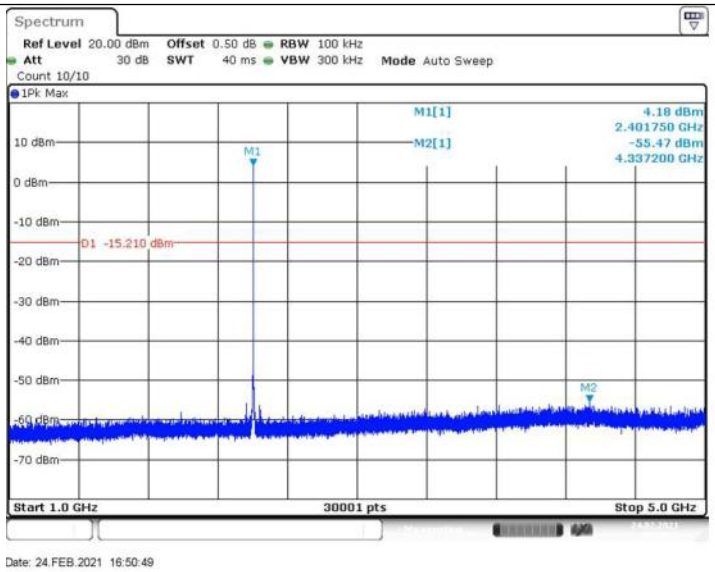
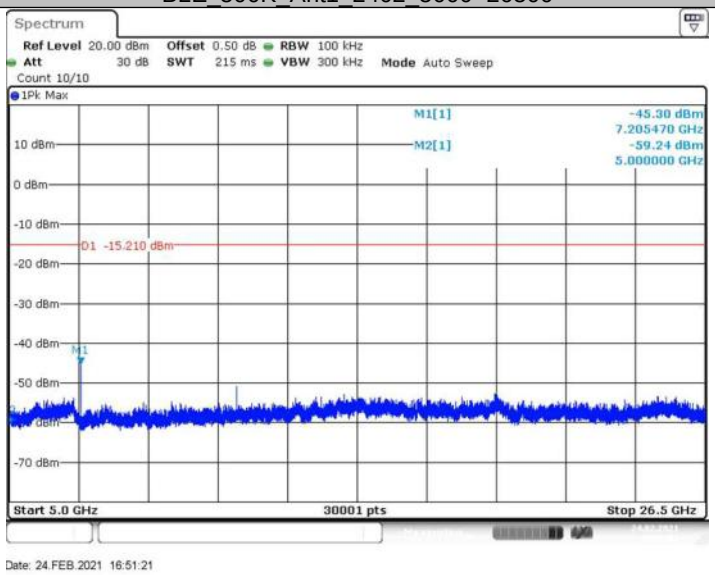


BLE_500K_Ant1_2402_5000~26500



BLE_500K_Ant1_2440_0~Reference

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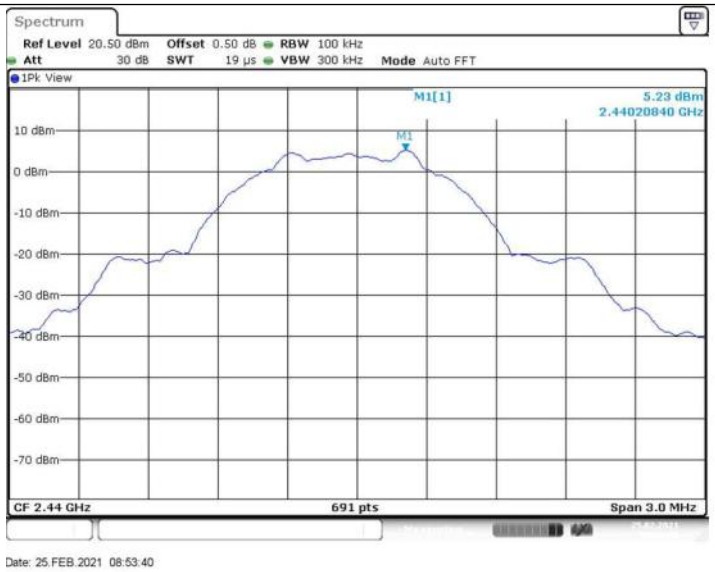

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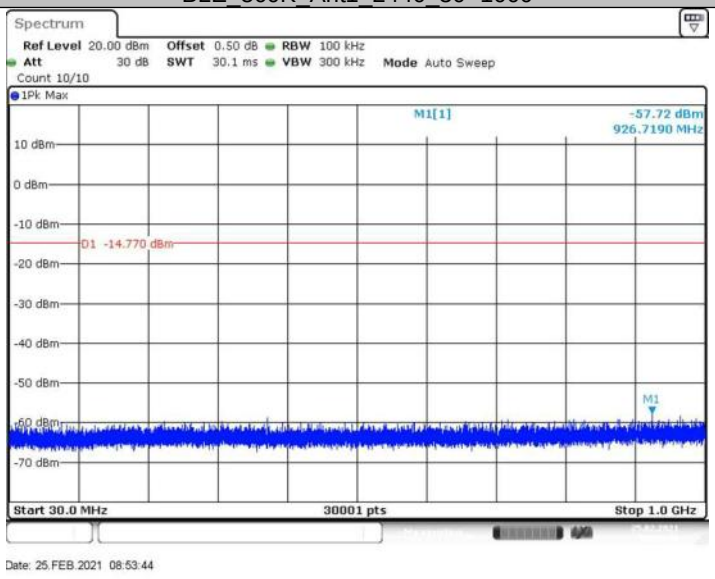

BLE_500K_Ant1_2440_1000~5000

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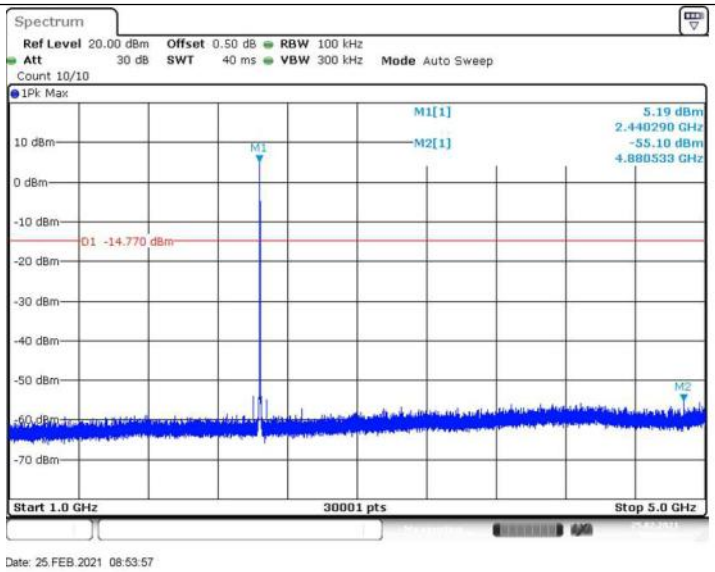

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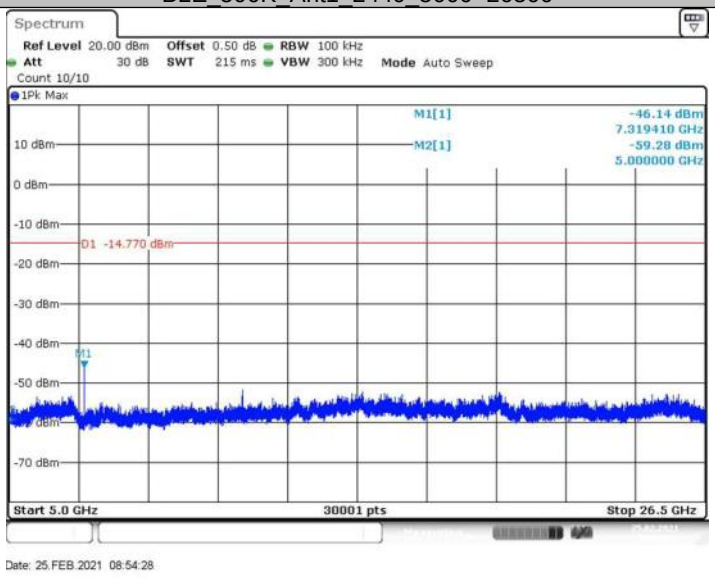

BLE_500K_Ant1_2480_0~Reference

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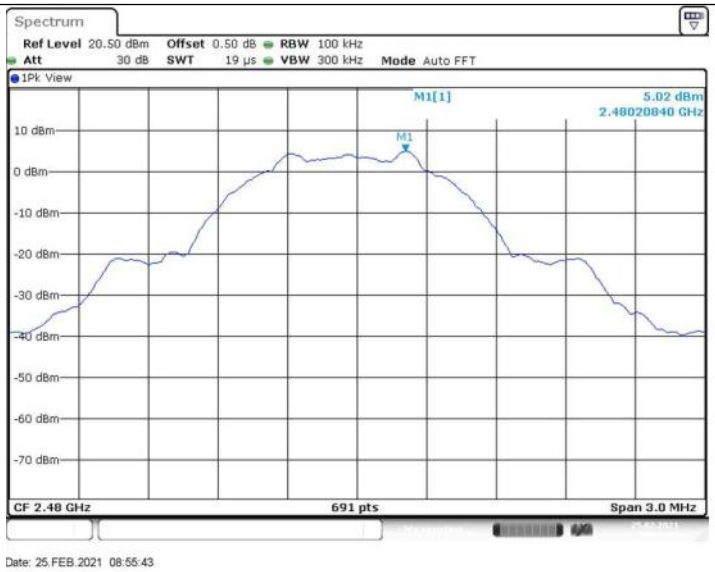

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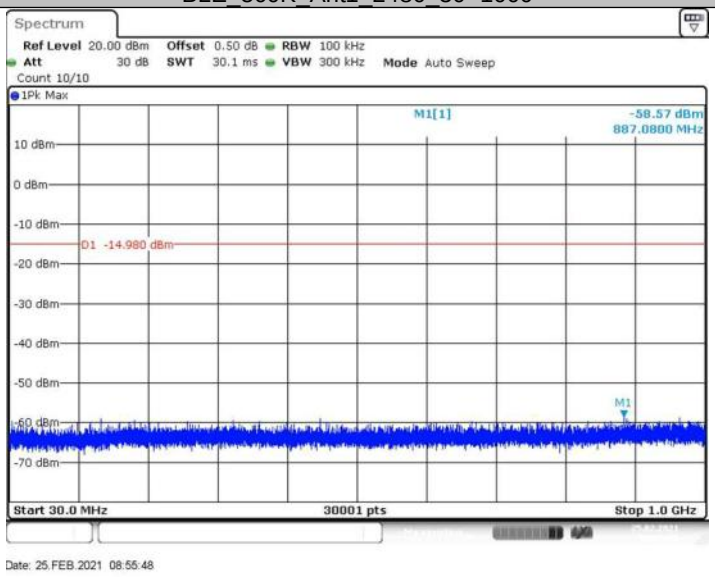

BLE_500K_Ant1_2480_1000~5000

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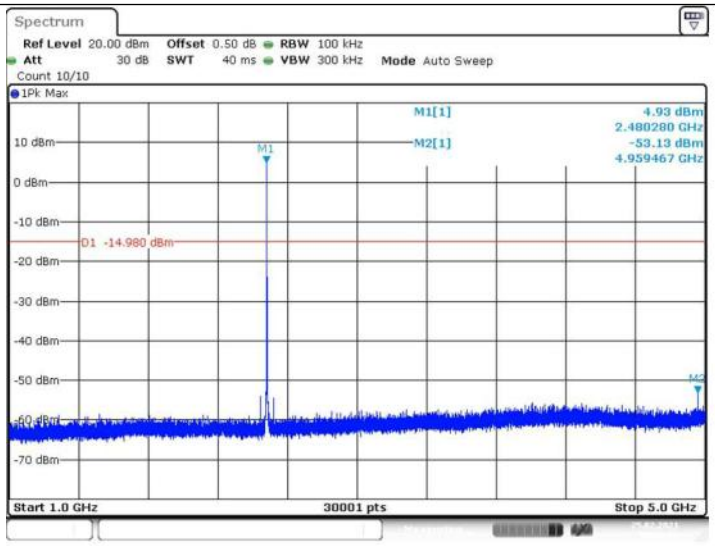
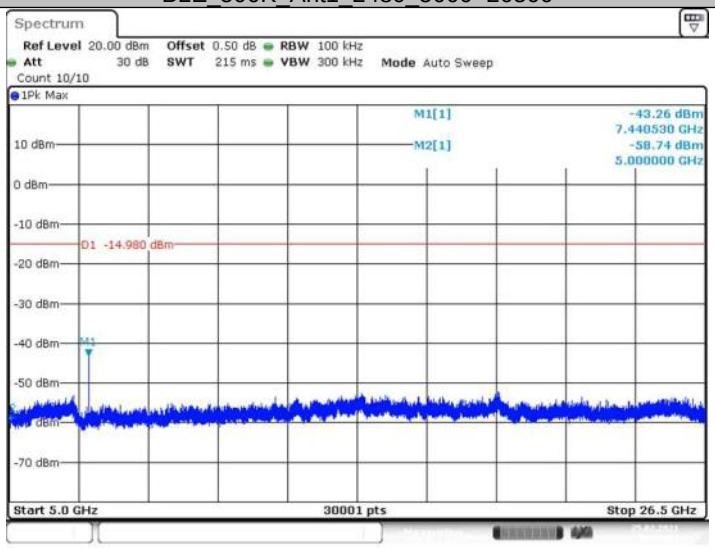


BLE_500K_Ant1_2480_5000~26500



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9.5 Band edge

Test Method

1 Use the following spectrum analyzer settings:
Span = wide enough to capture the peak level of the in-band emission and all spurious
RBW = 100 kHz, VBW≥RBW, Sweep = auto, Detector function = peak, Trace = max hold.
2 Allow the trace to stabilize, use the peak and delta measurement to record the result.
3 The level displayed must comply with the limit specified in this Section.

Limit

According to §15.247(d) and RSS-247 5.5, in any 100 kHz bandwidth outside the frequency bands in which the spread spectrum intentional radiator in operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a) and RSS-Gen 8.10, must also comply with the radiated emission limits specified in 15.209(a) (see Section 15.205(c)) and RSS-Gen.

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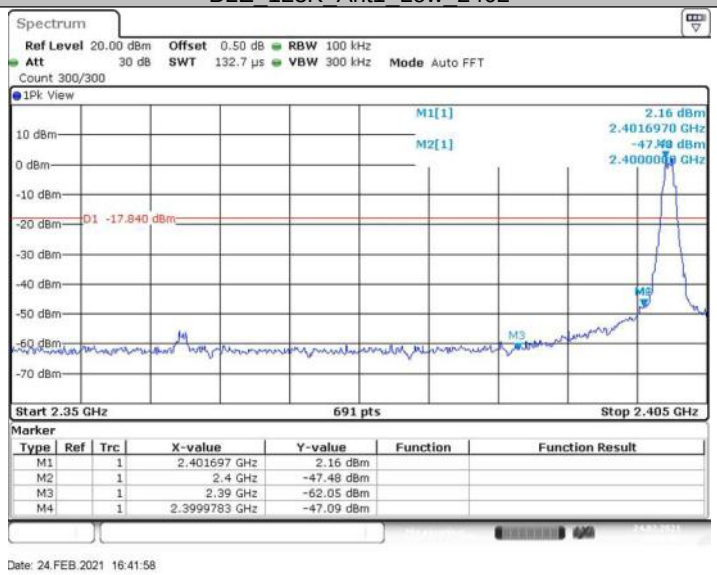
Test result

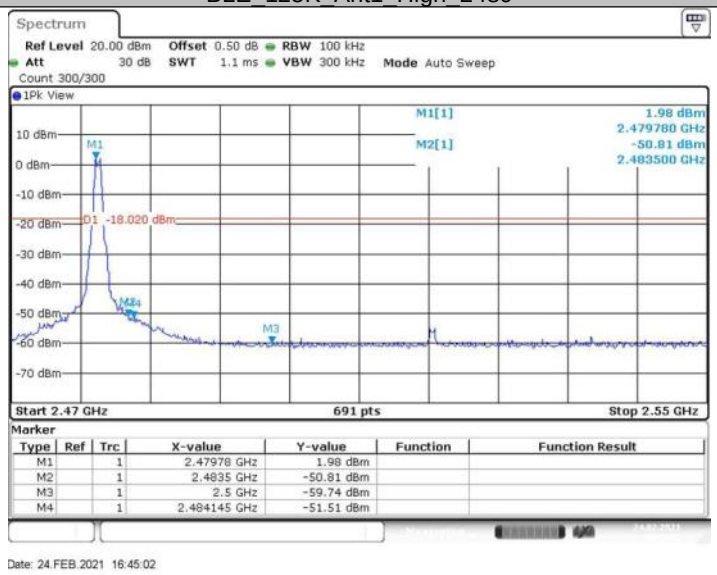
TestMode	ChName	Channel	RefLevel[dBm]	Result[dBm]	Limit[dBm]	Verdict
BLE_125K	Low	2402	2.16	-47.09	<=-17.84	PASS
	High	2480	1.98	-51.51	<=-18.02	PASS
BLE_1M	Low	2402	4.75	-47.07	<=-15.25	PASS
	High	2480	4.59	-50.46	<=-15.41	PASS
BLE_2M	Low	2402	2.35	-27.49	<=-17.65	PASS
	High	2480	2.13	-47.37	<=-17.87	PASS
BLE_500K	Low	2402	4.77	-48.31	<=-15.23	PASS
	High	2480	5.14	-50.8	<=-14.86	PASS

Test Graphs

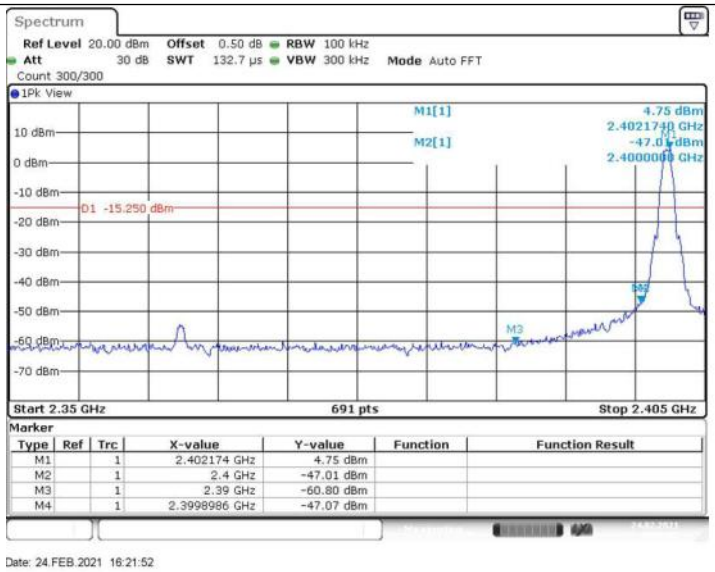
BLE_125K_Ant1_Low_2402



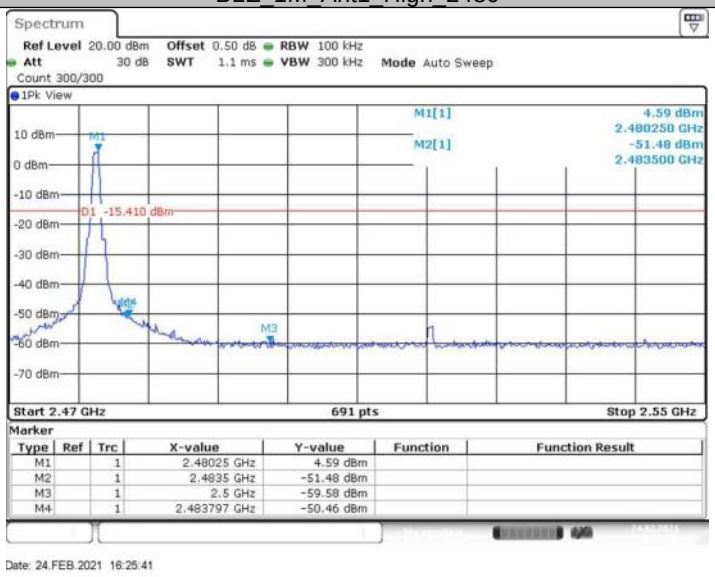
BLE_125K_Ant1_High_2480



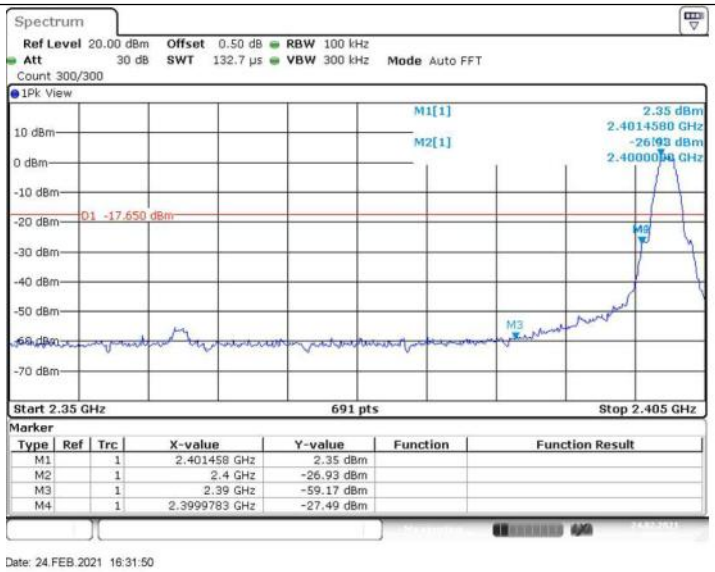
BLE_1M_Ant1_Low_2402



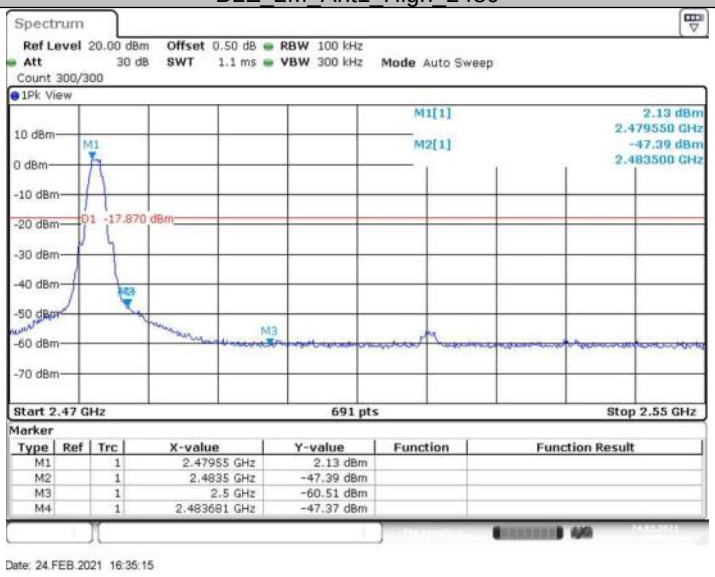
BLE_1M_Ant1_High_2480



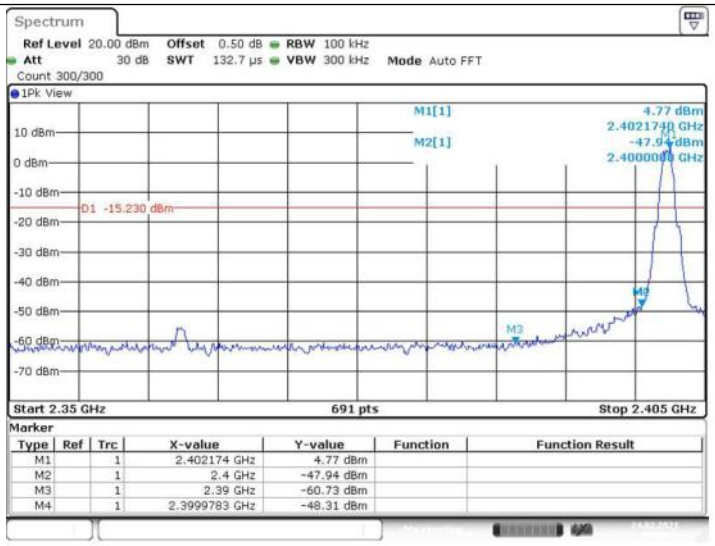
BLE_2M_Ant1_Low_2402



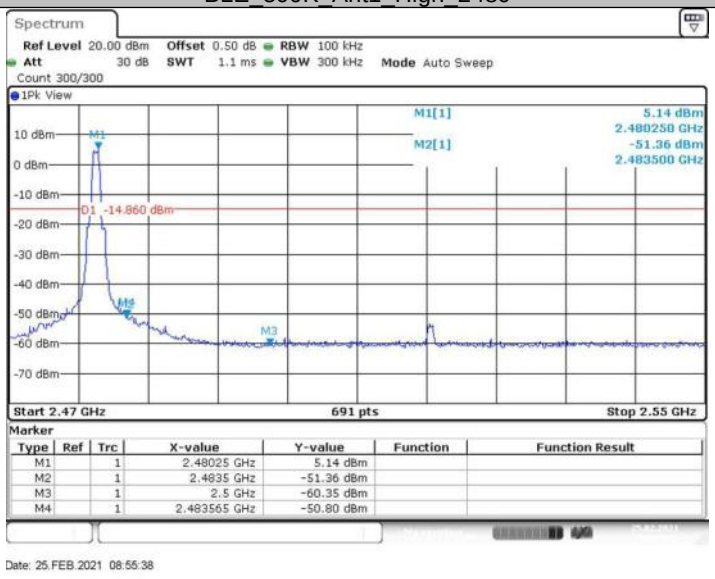
BLE_2M_Ant1_High_2480



BLE_500K_Ant1_Low_2402



BLE_500K_Ant1_High_2480



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9.6 Spurious radiated emissions for transmitter

Test Method

1. The EUT was place on a turn table which is 1.5m above ground plane for above 1GHz and 0.8m above ground for below 1GHz at 3 meter chamber room for test. The table was rotated 360 degrees to determine the position of the highest radiation.
2. The EUT was set 3 meters away from the interference – receiving antenna, which was mounted on the top of a variable – height antenna tower.
3. The height of antenna is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
4. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.
5. Use the following spectrum analyzer settings According to C63.10:

For Below 1GHz

Use the following spectrum analyzer settings:
Span = wide enough to capture the peak level of the in-band emission and all spurious
RBW = 100 kHz to 120 kHz, VBW≥RBW for peak measurement, Sweep = auto, Detector function = peak, Trace = max hold.

For Peak unwanted emissions Above 1GHz:

Span = wide enough to capture the peak level of the in-band emission and all spurious
RBW = 1MHz, VBW≥RBW for peak measurement, Sweep = auto, Detector function = peak, Trace = max hold.

Procedures for average unwanted emissions measurements above 1000 MHz

a) RBW = 1MHz.
b) VBW ≥ [3 × RBW].
c) Detector = RMS (power averaging), if [span / (# of points in sweep)] ≤ RBW / 2. Satisfying this condition can require increasing the number of points in the sweep or reducing the span. If the condition is not satisfied, then the detector mode shall be set to peak.
d) Averaging type = power (i.e., rms) (As an alternative, the detector and averaging type may be set for linear voltage averaging. Some instruments require linear display mode to use linear voltage averaging. Log or dB averaging shall not be used.)
e) Sweep time = auto.
f) Perform a trace average of at least 100 traces if the transmission is continuous. If the transmission is not continuous, then the number of traces shall be increased by a factor of 1 / D, where D is the duty cycle. For example, with 50% duty cycle, at least 200 traces shall be averaged. (If a specific emission is demonstrated to be continuous—i.e., 100% duty cycle—then rather than turning ON and OFF with the transmit cycle, at least 100 traces shall be averaged.)
g) If tests are performed with the EUT transmitting at a duty cycle less than 98%, then a correction factor shall be added to the measurement results prior to comparing with the emission limit, to compute the emission level that would have been measured had the test been performed at 100% duty cycle. The correction factor is computed as follows:
1) If power averaging (rms) mode was used in the preceding step e), then the correction

factor is [10 log (1 / D)], where D is the duty cycle. For example, if the transmit duty cycle was 50%, then 3 dB shall be added to the measured emission levels.
2) If linear voltage averaging mode was used in the preceding step e), then the correction factor is [20 log (1 / D)], where D is the duty cycle. For example, if the transmit duty cycle was 50%, then 6 dB shall be added to the measured emission levels.
3) If a specific emission is demonstrated to be continuous (100% duty cycle) rather than turning ON and OFF with the transmit cycle, then no duty cycle correction is required for that emission.

Limit

The radio emission outside the operating frequency band shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power. Radiated emissions which fall in the restricted bands, as defined in section15.205 and RSS-GEN 8.10 must comply with the radiated emission limits specified in section 15.209.

Frequency MHz	Field Strength uV/m	Measured Distance Meters
0.009~0.490	2400/F (kHz)	300
0.490~1.705	24000/F (kHz)	30
1.705~30	30	30

Frequency MHz	Field Strength uV/m	Field Strength dBµV/m	Detector
30-88	100	40	QP
88-216	150	43.5	QP
216-960	200	46	QP
960-1000	500	54	QP
Above 1000	500	54	AV
Above 1000	5000	74	PK

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Spurious radiated emissions for transmitter

According to C63.10, if the peak (or quasi-peak) measured value complies with the average limit, it is unnecessary to perform an average measurement, so AV emission value did not show in below table if the peak value complies with average limit.

Transmitting spurious emission test result as below:

Test mode: GFSK (125 kbit/s)
Channel (2402MHz)

Frequency	Mmission Level	Limit	Margin	Detector	Polarization
MHz	dBuV/m	dBµV/m	dB		
2383.9	44.04	74.0	29.96	Peak	Horizontal
4803.4	44.48	74.0	29.52	Peak	Horizontal
7205.0	53.05	74.0	20.95	Peak	Horizontal
2331.9	44.12	74.0	29.88	Peak	Vertical
4810.9	45.28	74.0	28.72	Peak	Vertical
7206.7	48.96	74.0	25.04	Peak	Vertical

Test mode: GFSK (125 kbit/s)
Channel (2440MHz)

Frequency	Mmission Level	Limit	Margin	Detector	Polarization
MHz	dBuV/m	dBµV/m	dB		
7319.4	50.99	74.0	23.01	Peak	Horizontal
7321.1	48.85	74.0	25.15	Peak	Vertical

Test mode: GFSK (125 kbit/s)
Channel (2480MHz)

Frequency	Mmission Level	Limit	Margin	Detector	Polarization
MHz	dBuV/m	dBµV/m	dB		
2483.6	55.28	74.0	18.72	Peak	Horizontal
2483.6	48.60	54.0	5.4	AV	Horizontal
4960.4	45.60	74.0	28.4	Peak	Horizontal
7390.0	49.37	74.0	24.63	Peak	Horizontal
2483.7	48.94	74.0	25.06	Peak	Vertical
7535.3	48.04	74.0	25.96	Peak	Vertical

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Test mode: GFSK (500 kbit/s)
Channel (2402MHz)

Frequency	Mmission Level	Limit	Margin	Detector	Polarization
MHz	dBuV/m	dBµV/m	dB		
2363.3	43.29	74.0	30.71	Peak	Horizontal
2385.6	44.31	74.0	29.69	Peak	Horizontal
4804.6	44.30	74.0	29.7	Peak	Horizontal
7205.0	52.33	74.0	21.67	Peak	Horizontal
2384.3	44.55	74.0	29.45	Peak	Vertical
7205.0	49.55	74.0	24.45	Peak	Vertical

Test mode: GFSK (500 kbit/s)
Channel (2440MHz)

Frequency	Mmission Level	Limit	Margin	Detector	Polarization
MHz	dBuV/m	dBµV/m	dB		
7320.6	49.97	74.0	24.03	Peak	Horizontal
2663.1	48.55	74.0	25.45	Peak	Vertical
7318.9	49.12	74.0	24.88	Peak	Vertical

Test mode: GFSK (500 kbit/s)
Channel (2480MHz)

Frequency	Mmission Level	Limit	Margin	Detector	Polarization
MHz	dBuV/m	dBµV/m	dB		
2483.6	52.73	74.0	21.27	Peak	Horizontal
2483.6	46.1	54.0	7.9	AV	Horizontal
7439.0	48.89	74.0	25.11	Peak	Horizontal
2483.6	48.35	74.0	25.65	Peak	Vertical
4810.8	44.05	74.0	29.95	Peak	Vertical
6889.3	46.89	74.0	27.11	Peak	Vertical

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Test mode: GFSK (1 Mbit/s)
Channel (2402MHz)

Frequency	Mmission Level	Limit	Margin	Detector	Polarization
MHz	dBuV/m	dBµV/m	dB		
2363.2	43.07	74.0	30.93	Peak	Horizontal
2384.5	45.11	74.0	28.89	Peak	Horizontal
4803.4	44.05	74.0	29.95	Peak	Horizontal
7206.7	52.93	74.0	21.07	Peak	Horizontal
2382.7	43.95	74.0	30.05	Peak	Vertical
7206.7	49.84	74.0	24.16	Peak	Vertical

Test mode: GFSK (1 Mbit/s)
Channel (2440MHz)

Frequency	Mmission Level	Limit	Margin	Detector	Polarization
MHz	dBuV/m	dBµV/m	dB		
7320.0	50.77	74.0	23.23	Peak	Horizontal
7320.6	48.49	74.0	25.51	Peak	Vertical

Test mode: GFSK (1 Mbit/s)
Channel (2480MHz)

Frequency	Mmission Level	Limit	Margin	Detector	Polarization
MHz	dBuV/m	dBµV/m	dB		
2483.6	52.23	74.0	21.77	Peak	Horizontal
4960.4	44.05	74.0	29.95	Peak	Horizontal
7439.6	48.46	74.0	25.54	Peak	Horizontal
2483.5	47.96	74.0	26.04	Peak	Vertical
7522.3	47.64	74.0	26.36	Peak	Vertical

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Test mode: GFSK (2 Mbit/s)
Channel (2402MHz)

Frequency	Mmission Level	Limit	Margin	Detector	Polarization
MHz	dBuV/m	dBµV/m	dB		
2363.4	42.76	74.0	31.24	Peak	Horizontal
2384.7	43.97	74.0	30.03	Peak	Horizontal
7206.7	52.54	74.0	21.46	Peak	Horizontal
2383.2	44.45	74.0	29.55	Peak	Vertical
7205.5	49.26	74.0	24.74	Peak	Vertical

Test mode: GFSK (2 Mbit/s)
Channel (2440MHz)

Frequency	Mmission Level	Limit	Margin	Detector	Polarization
MHz	dBuV/m	dBµV/m	dB		
7319.4	50.38	74.0	23.62	Peak	Horizontal
7318.9	50.26	74.0	23.74	Peak	Vertical

Test mode: GFSK (2 Mbit/s)
Channel (2480MHz)

Frequency	Mmission Level	Limit	Margin	Detector	Polarization
MHz	dBuV/m	dBµV/m	dB		
2483.5	53.51	74.0	20.49	Peak	Horizontal
2483.6	45.1	74.0	28.9	AV	Horizontal
7439.0	48.15	74.0	25.85	Peak	Horizontal
2483.5	47.73	74.0	26.27	Peak	Vertical
7432.2	47.74	74.0	26.26	Peak	Vertical

Remark:

(1) Emission level= Original Receiver Reading + Correct Factor
(2) Correct Factor = Antenna Factor + Cable Loss -Amplifier gain
(3) Margin = limit – Corrected Reading

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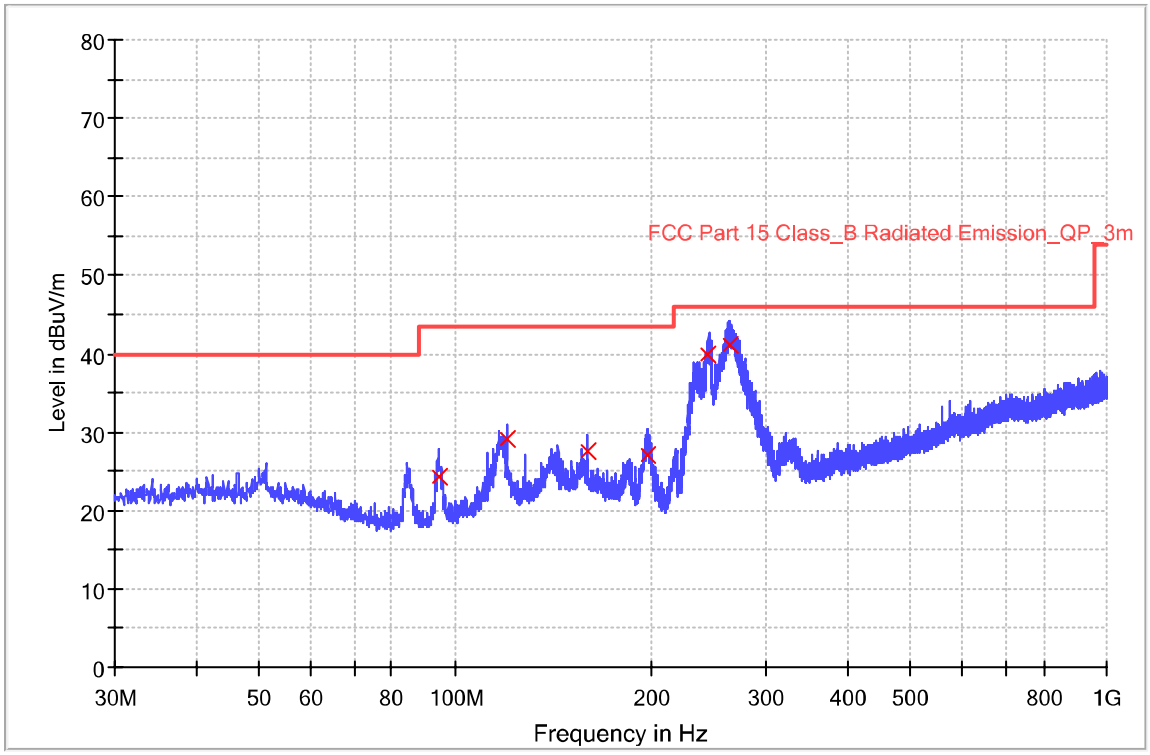
The worst case of Radiated Emission below 1GHz:

Site: 3 meter chamber	Time: 2021/02/23 - 14:04
Limit: FCC_Part15.209 and RSS-GEN 8.8_RE(3m)	Engineer: Jiaxi XU
Probe: VULB9168	Polarity: Horizontal
EUT: Digital Device, Model no: 9290029816	Power: DC 24V
Note: Transmit by at channel 2440MHz BLE_500 kbit/s. Note: Pre-scan with three orthogonal axis and worst case as X axis.	

RE_VULB9168_pre_Cont_30-1000



Limit and Margin

Frequency (MHz)	QuasiPeak (dBuV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)	Margin - QPK (dB)	Limit - QPK (dBuV/m)
94.360000	24.3	1000.0	120.000	100.2	H	132.0	10.9	19.2	43.5
119.960000	29.0	1000.0	120.000	100.2	H	263.0	13.5	14.5	43.5
159.920000	27.7	1000.0	120.000	100.2	H	36.0	15.7	15.8	43.5
196.840000	27.0	1000.0	120.000	100.2	H	315.0	11.8	16.5	43.5
245.080000	39.9	1000.0	120.000	100.2	H	207.0	13.6	6.2	46.0
263.080000	41.3	1000.0	120.000	100.2	H	148.0	13.9	4.8	46.0

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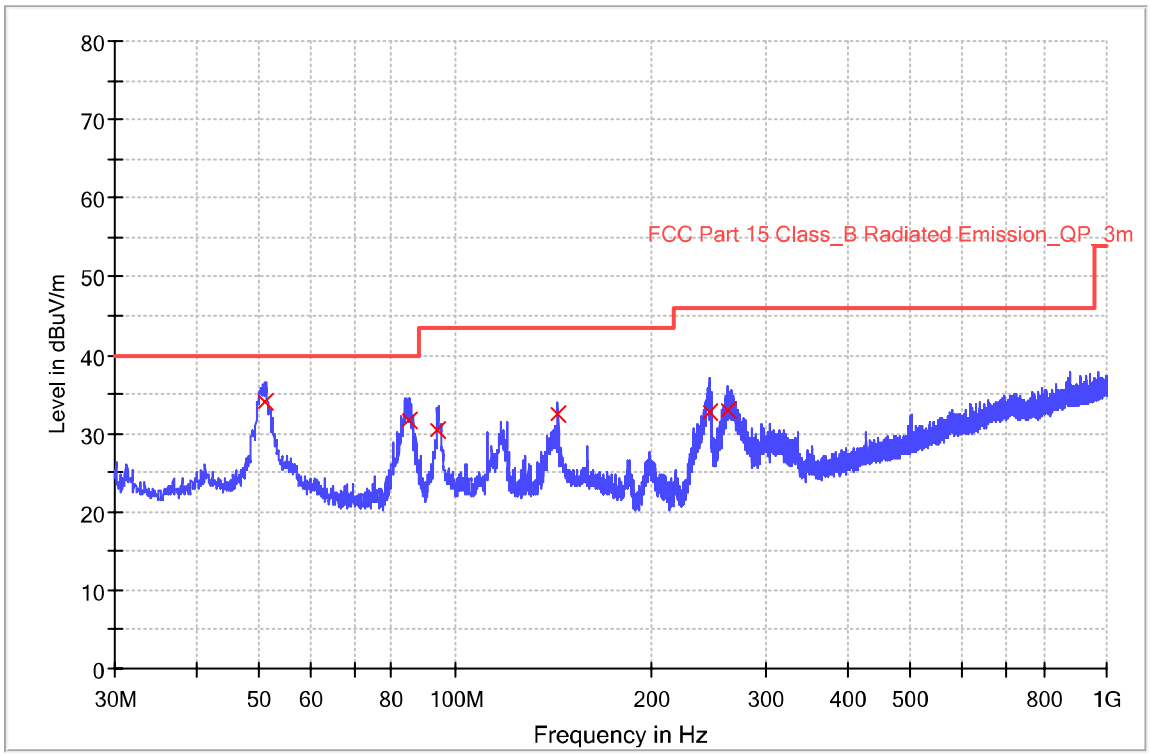
Site: 3 meter chamber	Time: 2021/02/23 – 14:00
Limit: FCC_Part15.209 and RSS-GEN 8.8_RE(3m)	Engineer: Jiaxi XU
Probe: VULB9168	Polarity: Vertical
EUT: Digital Device, Model no: 9290029816	Power: DC 24V
Note: Transmit by at channel 2440MHz BLE_500 kbit/s. Note: Pre-scan with three orthogonal axis and worst case as X axis.	

RE_VULB9168_pre_Cont_30-1000



Limit and Margin

Frequency (MHz)	QuasiPeak (dBuV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)	Margin - QPK (dB)	Limit - QPK (dBuV/m)
51.200000	34.0	1000.0	120.000	100.2	V	195.0	14.2	6.0	40.0
84.920000	31.6	1000.0	120.000	100.2	V	71.0	10.4	8.4	40.0
94.160000	30.3	1000.0	120.000	100.2	V	205.0	10.9	13.2	43.5
143.960000	32.5	1000.0	120.000	100.2	V	63.0	15.2	11.0	43.5
245.200000	32.8	1000.0	120.000	100.2	V	198.0	13.6	13.2	46.0
262.960000	32.9	1000.0	120.000	100.2	V	287.0	13.9	13.1	46.0

Note 1: Measure Level (dBuV/m) = Reading Level (dBuV) + Factor (dB)
Factor (dB) = Cable Loss (dB) + Antenna Factor (dB/m)
Note 2: The test trace is same as the ambient noise and the amplitude of the emissions are attenuated more than 20dB below the permissible (the test frequency range: 9kHz ~ 30MHz, 18GHz ~ 26.5GHz), therefore no data appear in the report.

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10 Test Equipment List

List of Test Instruments

Test Site1

	DESCRIPTION	MANUFACTURER	MODEL NO.	SERIAL NO.	CAL. DATE	CAL. DUE DATE
C	Signal Analyzer	Rohde & Schwarz	FSV40	101091	2020-8-4	2021-8-3
RE	EMI Test Receiver	Rohde & Schwarz	ESR3	101906	2020-8-4	2021-8-3
	Signal Analyzer	Rohde & Schwarz	FSV40	101091	2020-8-4	2021-8-3
	Trilog Super Broadband Test Antenna	Schwarzbeck	VULB 9168	961	2019-3-16	2022-3-15
	Horn Antenna	Rohde & Schwarz	HF907	102393	2018-6-11	2021-4-1
	Pre-amplifier	Rohde & Schwarz	SCU-18D	19006451	2020-8-4	2021-8-3
	Loop antenna	Rohde & Schwarz	HFH2-Z2	100443	2020-6-28	2021-6-27
	DOUBLE-RIDGED WAVEGUIDE HORN WITH PRE-AMPLIFIER (18 GHZ - 40 GHZ)	ETS-Lindgren	3116C-PA	002222727	2018-1-29	2021-1-28
	3m Semi-anechoic chamber	TDK	9X6X6	----	2018-5-11	2021-5-10
CE	EMI Test Receiver	Rohde & Schwarz	ESR3	101907	2020-8-4	2021-8-3
	LISN	Rohde & Schwarz	ENV216	101924	2020-8-4	2021-8-3

Measurement Software Information			
Test Item	Software	Manufacturer	Version
C	Bluetooth and WiFi Test System	Shenzhen JS tonscend co.,ltd	2.6.77.0518
RE	EMC 32	Rohde & Schwarz	V9.15.00
CE	EMC 32	Rohde & Schwarz	V9.15.03

C - Conducted RF tests

- Conducted peak output power
- 6dB bandwidth and 99% Occupied Bandwidth
- Power spectral density*
- Spurious RF conducted emissions
- Band edge

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11 System Measurement Uncertainty

For a 95% confidence level, the measurement expanded uncertainties for defined systems, in accordance with the recommendations of ISO 17025 were:

Items	Extended Uncertainty
Conducted Disturbance at Mains Terminals	150kHz to 30MHz, LISN, ±3.16dB
Radiated Disturbance	30MHz to 1GHz, ±5.03dB (Horizontal) ±5.12dB (Vertical) 1GHz to 18GHz, ±5.49dB 18GHz to 40GHz, ±5.63dB
Carrier power conducted measurement	50MHz~18GHz, ±1.238dB
Spurious Emission Conducted Measurement	9kHz ~40GHz, ± 1.224dB

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12 Photographs of Test Set-ups

Refer to the < Test Setup photos >.

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13 Photographs of EUT

Refer to the < External Photos > & < Internal Photos >.

THE END

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