Test Report No.:
FCC2022-0034-RF

RF Test Report

EUT	:	**Bluetooth module**
MODEL	:	**MB5601L**
BRAND NAME	:	**N/A**
CLIENT	:	**Hua Shu Communications(Shenzhen) Co.,Ltd**
Classification Of Test	:	**N/A**

CVC Testing Technology Co., Ltd.

.

Client	**Name : Hua Shu Communications(Shenzhen) Co.,Ltd** **Address : Room 125, Building 1, South District of Yuanchuangspace, Mingzhu Branch Road, Minzhi Street, Longhua District, Shenzhen**
Manufacturer	**Name : Hua Shu Communications(Shenzhen) Co.,Ltd** **Address : Room 125, Building 1, South District of Yuanchuangspace, Mingzhu Branch Road, Minzhi Street, Longhua District, Shenzhen**
Equipment Under Test	**Name : Bluetooth module** **Model/Type: MB5601L** **Trade mark : N/A** **Serial NO.:N/A** **Sampe NO.:4-1**

Date of Receipt.	**2022.06.08**	Date of Testing	**2022.06.08～2022.07.08**

Test Specification	**Test Result**
FCC Part 15, Subpart C, Section 15.247	PASS

Evaluation of Test Result	The equipment under test was found to comply with the requirements of the standards applied. **Issue Date: 2022.07.08**

Tested by:	Reviewed by:	Approved by:
Xu ZhenFei	Liu YongHai	Chen HuaWen
Name Signature	Name Signature	Name Signature

Other Aspects: NONE.

Abbreviations:OK, Pass= passed Fail = failed N/A= not applicable EUT= equipment, sample(s) under tested

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RELEASE CONTROL RECORD

ISSUE NO.	REASON FOR CHANGE	DATE ISSUED
FCC2022-0034-RF	Original release	2022.07.08

1 SUMMARY OF TEST RESULTS

The EUT has been tested according to the following specifications:

PPLIED STANDARD: FCC Part 15, Subpart C			
STANDARD SECTION	**TEST TYPE AND LIMIT**	**RESULT**	**REMARK**
15.207	AC Power Conducted Emission	PASS	Meet the requirement of limit.
15.247(d) 15.209	Radiated Emissions	PASS	Meet the requirement of limit.
15.247(d)	Band Edge Measurement	PASS	Meet the requirement of limit.
15.247(a)(2)	6dB bandwidth	PASS	Meet the requirement of limit.
15.247(b)	Conducted Output power	PASS	Meet the requirement of limit.
15.247(e)	Power Spectral Density	PASS	Meet the requirement of limit.
15.203	Antenna Requirement	PASS	Meet the requirement of limit.

1.1 LIST OF TEST AND MEASUREMENT INSTRUMENTS

Test Equipment	Type/Mode	SERIAL NO.	Equipment No.	Manufacturer	Cal. Due
WIFI & Bluetooth Test System 1					/
Communication Shielded Room 2	4m*3m*3m	CRTDSWKSR44301	VGDS-0700	CRT	2024/04/24
Bluetooth system integration	/	/	-	Tonscend	/
Spectrum Analyzer	FSV40	101580	DZ-000238-3	R&S	2023/06/05
Comprehensive Test Instrument	CMW270	100304	DZ-000240-1	R&S	2022/12/09
Analog Signal Generator	SMB100A	181858	DZ-000238-2	R&S	2023/06/05
Vector Signal Generator	SGT100A	111661	DZ-000238-1	R&S	2023/06/05
RF Radio Frequency Switch	JS0806-2	19H9080187	`	Tonscend	2023/06/06
Programmable DC Power Supply	E3644A	MY58036222	DZ-000178	KEYSIGHT	2023/04/21
Radiation SpuriousTest System					/
3m Semi-Anechoic Chamber	FACT-4	ST08035	WKNA-0024	ETS	2024/12/12
Spectrum Analyzer	N9010B	MY57470323	DZ-000174	KEYSIGHT	2023/03/02
EMI Test Receiver	N9038A-508	MY532290079	EM-000397	Agilent	2023/03/02
Broadband Antenna	VULB 9163	9163-530	EM-000342	SCHWARZBECK	2023/06/26
Waveguide Horn Antenna	HF906	360306/008	WKNA-0024-8	R&S	2023/03/04
Waveguide Horn Antenna	BBHA9170	00949	DZ-000209-2	SCHWARZBECK	2022/08/27
Preamplifier	BBV 9721	9721-050	DZ-000209-1	SCHWARZBECK	2023/06/05
5G Bandstop Filters	WRCJV12-4900-5100-5900-6100-50EE	1	DZ-000186	WI	2022/12/20
Comprehensive tester	CMW500	159000	DZ-000240-2	R&S	2022/12/20
Conducted emission					/
EMI Test Receiver	ESCI	100857	WKNB-0081	R&S	2022-12-08
EMI Test Receiver	ESR3	102394	VGDY-0705	R&S	2023-03-04
LISN	NSLK 8127	8127644	VGDY-0150	SCHWARZBECK	2022-09-01
LISN	NSLK 8129	8129-268	EM-000388	SCHWARZBECK	2023-03-03
Plus Limiter（#1）	VTSD 9561 F-N	00515	VGDY-0808	SCHWARZBECK	2023-03-04
Impedance Stabilization Network	ISN T800	27095	WKNE-0195	TESEQ	2022-09-01
Voltage Probe	TK9420	9420-499	VGDY-0128	SCHWARZBECK	2023-03-04
Power Divider	4901.17.B	22643830	DB-0016	HUBER+SUHNER	2023-09-01
AudioSignalGenerator	GAG-810	EK871591	EM-000309	GW	2022-12-08
Shielding Room(#1)	GP1A	001	WKNF-0001	LEINING	2024-08-08

1.2 MEASUREMENT UNCERTAINTY

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the EUT as specified in CISPR 16-4-2:

No.	ITEM	FREQUENCY	UNCERTAINTY
1	Conducted emissions	9kHz~30MHz	±2.66dB
2	Radiated emissions	9KHz ~ 30MHz	±0.769dB
		30MHz ~ 1GMHz	±0.877dB
		1GHz ~ 18GHz	±0.777dB
		18GHz ~ 40GHz	±1.315dB

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the EUT as specified in CISPR 16-4-2:

1.3 TEST LOCATION

The tests and measurements refer to this report were performed by EMC testing Lab. of CVC Testing Technology Co., Ltd.

Address: No.3, TiantaiyiRoad, KaitaiAvenue, ScienceCity, Guangzhou, China
Post Code：510663 Tel：020-32293888
FAX：020-32293889 E-mail：office@cvc.org.cn

2 GENERAL INFORMATION

2.1 GENERAL PRODUCT INFORMATION

PRODUCT	Bluetooth module
BRAND	N/A
MODEL	MB5601L
ADDITIONAL MODEL	N/A
FCC ID	2A75I5601L
POWER SUPPLY	DC 3.3V from host unit
MODULATIONTECHNOLOGY	GFSK
MODULATION TYPE	BT-LE for DTS
OPERATING FREQUENCY	2402-2480MHz for BT-LE(GFSK)
PEAK OUTPUT POWER	BLE: -2.4dBm (Maximum)
ANTENNA TYPE	BLE: PCB Antenna, 2dBi Gain (by the client)
I/O PORTS	Refer to user's manual
CABLE SUPPLIED	N/A

Remark:

1. For more detailed features description, please refer to the manufacturer's specifications or the User's Manual.
2. For the test results, the EUT had been tested with all conditions. But only the worst case was shown in test report.
3. Please refer to the EUT photo document for detailed product photo. (Report NO.: FCC2022-0034-E).
4. The Antenna Gain is provided by the manufacturer. The laboratoer is not responsible for the technical data provided by the customer.
5. The EUT have SISO function, provides 1 completed transmitter and 1 receiver.

MODULATION MODE	TX FUNCTION
BT-LE	1TX/1RX

2.2 Description of Accessories

N/A

2.3 OTHER INFORMATION

Operating frequency of each channel

BT-LE(1Mbps+2Mbps)					
CHANNEL	FREQ. (MHz)	CHANNEL	FREQ. (MHz)	CHANNEL	FREQ. (MHz)
0	**2402**	14	2430	28	2458
1	2404	15	2432	29	2460
2	2406	16	2434	30	2462
3	2408	17	2436	31	2464
4	2410	18	2438	32	2466
5	2412	**19**	**2440**	33	2468
6	2414	20	2442	34	2470
7	2416	21	2444	35	2472
8	2418	22	2446	36	2474
9	2420	23	2448	37	2476
10	2422	24	2450	38	2478
11	2424	25	2452	**39**	**2480**
12	2426	26	2454		
13	2428	27	2456		

Note: The channels which were indicated in bold type of the above channel list were selected as representative test channel. Therefore only the data of the test channels were recorded in this report.

2.4 TEST MODE APPLICABILITY AND TESTED CHANNEL DETAIL

Pre-scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates, xyz axis and antenna ports

EUT CONFIGURE MODE	APPLICABLE TEST ITEMS				DESCRIPTION
	RE<1G	RE≥1G	PLC	APCM	
A	√	√	√	√	BT link

Where **RE<1G:** Radiated Emission below 1GHz **RE≥1G:** Radiated Emission above 1GHz
PLC: Power Line Conducted Emission **APCM:** Antenna Port Conducted Measurement

RADIATED EMISSION TEST (BELOW 1 GHz):

☒ Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, XYZ axis, antenna ports (if EUT with antenna diversity architecture) and packet type.

☒ The worst case was found when positioned on x axis for radiated emission. Following channel(s) was (were) selected for the final test as listed below:

EUT CONFIGURE MODE	MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION TECHNOLOGY	MODULATION TYPE	DATA RATE (Mbps)
A	BT-LE	0 to 39	0	DTS	BT-LE	1.0

For the test results, only the worst case was shown in test report.

RADIATED EMISSION TEST (ABOVE 1 GHz):

☒ Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, XYZ axis, antenna ports (if EUT with antenna diversity architecture) and packet type.

☒ The worst case was found when positioned on x axis for radiated emission. Following channel(s) was (were) selected for the final test as listed below:

EUT CONFIGURE MODE	MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION TECHNOLOGY	MODULATION TYPE	DATA RATE (Mbps)
A	BT-LE	0 to 39	0,19, 39	DTS	BT-LE	1.0
A	BT-LE	0 to 39	0,19, 39	DTS	BT-LE	2.0

POWER LINE CONDUCTED EMISSION TEST:

☒ Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, antenna ports (if EUT with antenna diversity architecture), and packet types.

☒ Following channel(s) was (were) selected for the final test as listed below.

EUT CONFIGURE MODE	TESTED CONDITION
-	BT LINK

ANTENNA PORT CONDUCTED MEASUREMENT:

☒ This item includes all test value of each mode, but only includes spectrum plot of worst value of each mode.

☒ Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, antenna ports (if EUT with antenna diversity architecture), and packet types.

☒ Following channel(s) was (were) selected for the final test as listed below.

EUT CONFIGURE MODE	MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION TECHNOLOGY	MODULATION TYPE	DATA RATE (Mbps)
A	BT-LE	0 to 39	0,19, 39	DTS	BT-LE	1.0
A	BT-LE	0 to 39	0,19, 39	DTS	BT-LE	2.0

TEST CONDITION:

APPLICABLE TO	ENVIRONMENTAL CONDITIONS	TEST VOLTAGE (SYSTEM)	TESTED BY
RE<1G	24deg. C, 55%RH	DC 3.3 V from host unit	Liu shiwei
RE≥1G	24deg. C, 55%RH	DC 3.3 V from host unit	Liu shiwei
PLC	24deg. C, 55%RH	DC 3.3 V from host unit	Liu shiwei
APCM	25deg. C, 58%RH	DC 3.3 V from host unit	Liu shiwei

2.5 GENERAL DESCRIPTION OF APPLIED STANDARDS

The EUT is a RF product, according to the specifications of the manufacturers. It must comply with the requirements of the following standards:

FCC PART 15, Subpart C. Section 15.247
KDB 558074 D01 15.247 Meas Guidance v05r02
ANSI C63.10-2020

All test items have been performed and recorded as per the above standards

2.6 DESCRIPTION OF SUPPORT UNITS

The EUT has been tested as an independent unit together with other necessary accessories or support units. The following support units or accessories were used to form a representative test configuration during the tests.

Support Equipment					
NO	Description	Brand	Model No.	Serial Number	Supplied by

Support Cable							
NO	Description	Quantity (Number)	Length (cm)	Detachable (Yes/ No)	Shielded (Yes/ No)	Cores (Number)	Supplied by

3 TEST TYPES AND RESULTS

3.1 CONDUCTED EMISSION MEASUREMENT

3.1.1 Limit

Frequency (MHz)	Conducted Limits(dBμV)	
	Quasi-peak	Average
0.15 - 0.5	66 to 56 *	56 to 46*
0.5 - 5	56	46
5 - 30	60	50
NOTE: 1. The lower limit shall apply at the transition frequencies. NOTE: 2. The limit decreases in line with the logarithm of the frequency in the range of 0.15 to 0.50MHz.		

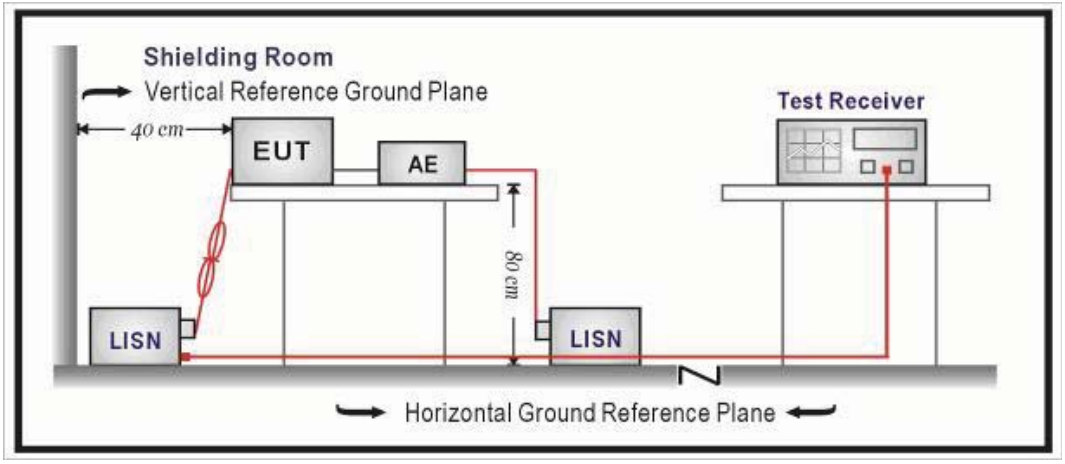
3.1.2 Measurement procedure

a. The EUT was placed on a platform of nominal size, 1 m by 1.5 m, raised 80 cm above the conducting ground plane. The vertical conducting plane was located 40 cm to the rear of the EUT. All other surfaces of EUT were at least 80 cm from any other grounded conducting surface. The EUT and simulators are connected to the main power through a line impedance stabilization network (LISN). The LISN provides a 50 ohm /50uH coupling impedance for the measuring equipment. The peripheral devices are also connected to the main power through a LISN. (Please refer to the Test photographs) Each current-carrying conductor of the EUT power cord, except the ground (safety) conductor, was individually connected through a LISN to the input power source.The equipment under test shall be placed on a support of non-metallic material, the height of which shall be1.5m above the ground,

b. The excess length of the power cord between the EUT and the LISN receptacle were folded back and forth at the center of the lead to form a bundle not exceeding 40 cm in length.

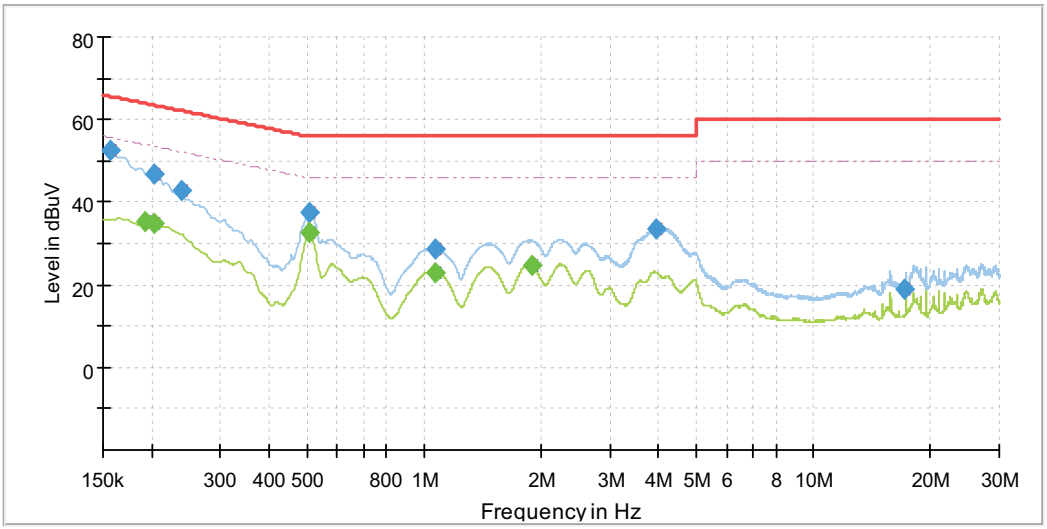
c. Conducted emissions were investigated over the frequency range from 0.15MHz to 30MHz using a receiver bandwidth of 9 kHz.

3.1.3 Test setup



3.1.4 Test results

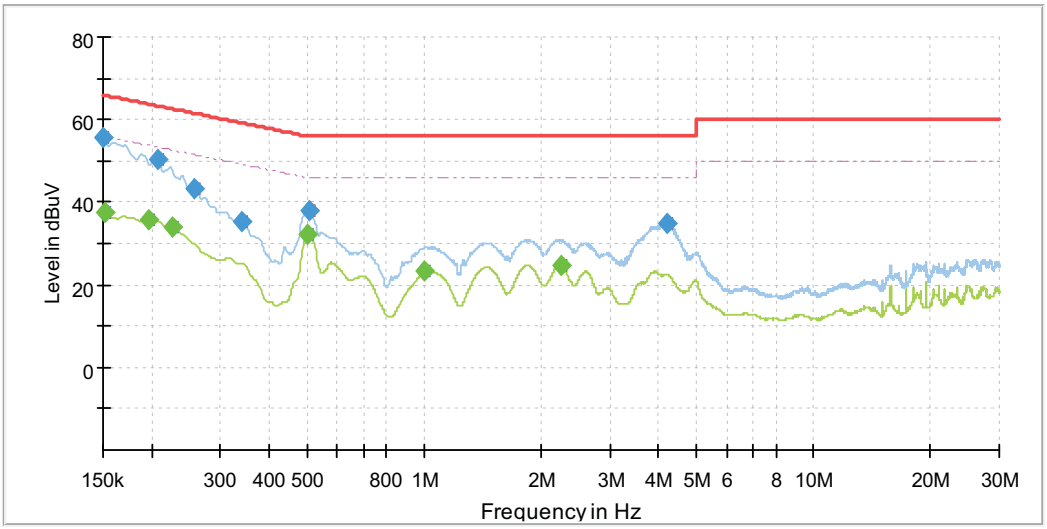
Test Mode	BT Link	Frequency Range	150KHz ~ 30MHz
PHASE	Line (L)		



NO	Frequency (MHz)	QuasiPeak (dBuV)	Average (dBuV)	Limit (dBuV)	Margin (dB)	Line	Corr.Factor (dB)
1	0.157	52.4	---	65.6	13.2	L1	19.5
2	0.193	---	35.4	53.9	18.5	L1	19.5
3	0.204	---	34.9	53.4	18.5	L1	19.5
4	0.204	47.0	---	63.4	16.5	L1	19.5
5	0.238	42.7	---	62.2	19.5	L1	19.5
6	0.506	---	32.5	46.0	13.5	L1	19.5
7	0.508	37.7	---	56.0	18.3	L1	19.5
8	1.073	---	22.9	46.0	23.1	L1	19.5
9	1.075	28.7	---	56.0	27.3	L1	19.5
10	1.896	---	24.7	46.0	21.3	L1	19.6
11	3.932	33.4	---	56.0	22.6	L1	19.6
12	17.203	19.0	---	60.0	41.0	L1	19.9

Remark: The emission levels of other frequencies were very low against the limit.

Test Mode	BT Link	Frequency Range	150KHz ~ 30MHz
PHASE	Line (N)		



NO	Frequency (MHz)	QuasiPeak (dBuV)	Average (dBuV)	Limit (dBuV)	Margin (dB)	Line	Corr.Factor (dB)
1	0.150	55.7	---	66.0	10.3	N	19.5
2	0.152	---	37.5	55.9	18.4	N	19.5
3	0.197	---	35.8	53.7	17.9	N	19.5
4	0.206	50.5	---	63.4	12.8	N	19.5
5	0.227	---	34.0	52.6	18.6	N	19.5
6	0.258	43.4	---	61.5	18.1	N	19.6
7	0.341	35.3	---	59.2	23.8	N	19.5
8	0.503	---	32.2	46.0	13.8	N	19.6
9	0.506	37.8	---	56.0	18.2	N	19.6
10	1.007	---	23.2	46.0	22.8	N	19.6
11	2.256	---	24.5	46.0	21.5	N	19.6
12	4.218	34.9	---	56.0	21.1	N	19.7

Remark: The emission levels of other frequencies were very low against the limit.

3.2 RADIATED EMISSION AND BANDEDGE MEASUREMENT

3.2.1 Limit

Radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a).

FREQUENCIES (MHz)	FIELD STRENGTH (Microvolts/Meter)	MEASUREMENT DISTANCE (Meters)
0.009 ~ 0.490	2400/F(kHz)	300
0.490 ~ 1.705	24000/F(kHz)	30
1.705 ~ 30.0	30	30
30 ~ 88	100	3
88 ~ 216	150	3
216 ~ 960	200	3
Above 960	500	3
NOTE: 1. The lower limit shall apply at the transition frequencies. NOTE: 2. Emission level (dBuV/m) = 20 log Emission level (uV/m). NOTE: 3. As shown in 15.35(b), for frequencies above 1000MHz, the field strength limits are based on average detector, however, the peak field strength of any emission shall not exceed the maximum permitted average limits, specified above by more than 20dB under any condition of modulation.		

3.2.2 Measurement procedure

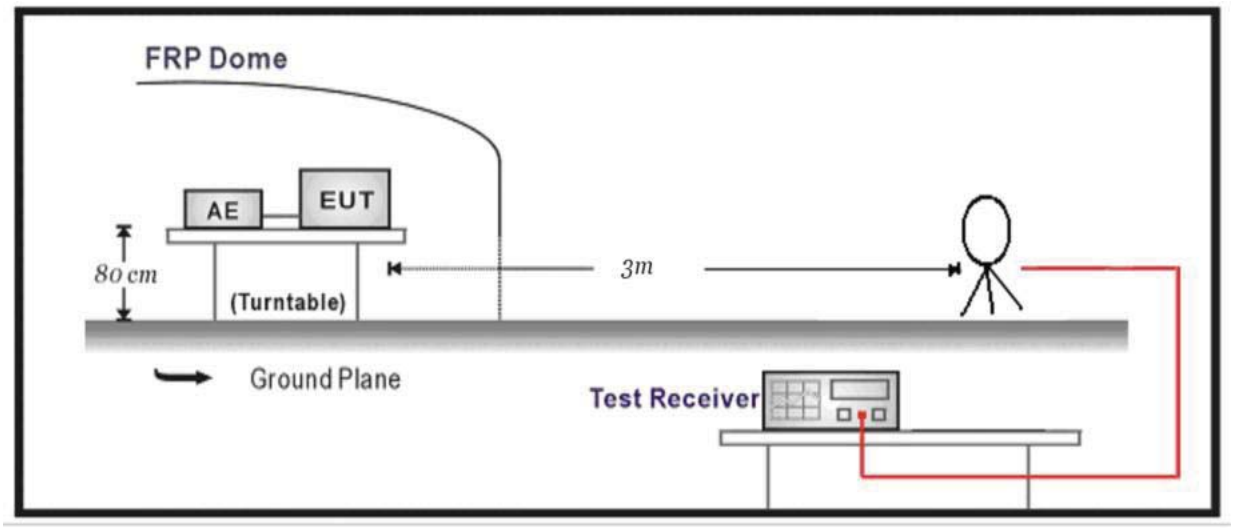
a. The EUT was placed on the top of a rotating table 1.5 meters(above 1GHz) and 0.8 meters(below 1GHz) above the ground at a 3 meters semi-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation.
b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
c. For below 1GHz was used bilog antenna, and above 1GHz was used horn antenna, and its height 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.
d. 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.
e. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.
f. For below 30MHz, a loop antenna with its vertical plane is place 3m from the EUT and rotated about its vertical axis for maximum response at each azimuth about the EUT. And the centre of the loop shall be 1m above the ground.
g. During the test, each emission was maximized by: having the EUT continuously working, investigated all operating modes, rotated about all 3 axis (X, Y & Z) and considered typical configuration to obtain worst position, manipulating interconnecting cables, For battery operated equipment, the equipment tests shall be perform using fresh batteries. The turntable was rotated to maximize the emission level.

NOTE:

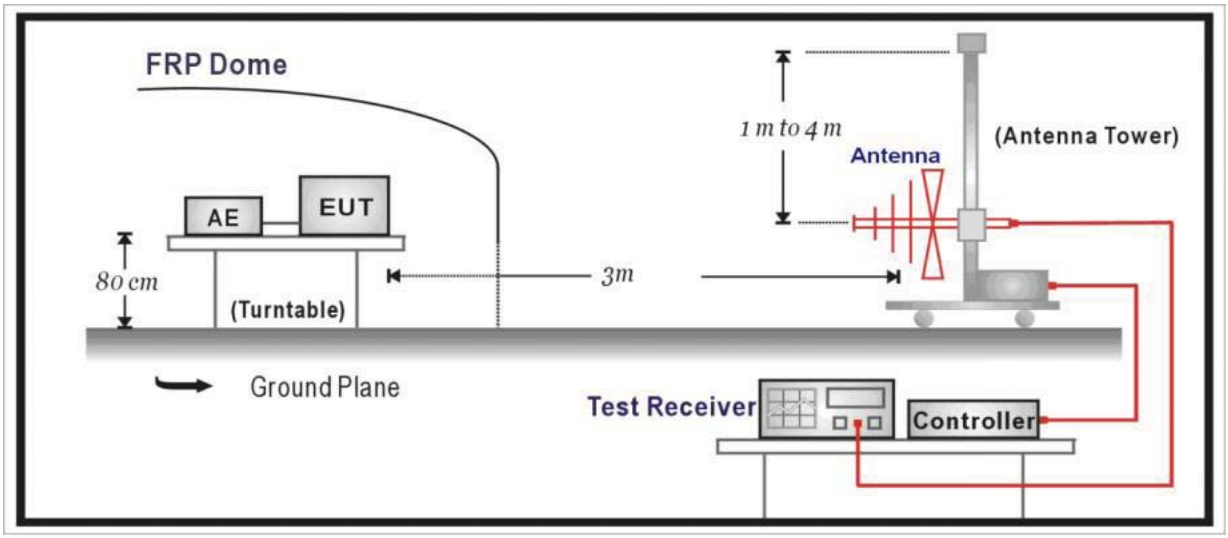
1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120kHz for Quasi-peak detection at frequency below 1GHz.
2. The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and video bandwidth is 3MHz for Peak detection at frequency above 1GHz.
3. The resolution bandwidth of test receiver/spectrum analyzer is 1MHz and the video bandwidth is ⩾ 1/T (Duty cycle < 98%) or 10Hz(Duty cycle > 98%) for Average detection (AV) at frequency above 1GHz.
4. All modes of operation were investigated and the worst-case emissions are reported.
5. The testing of the EUT was performed on all 3 orthogonal axes; the worst-case test configuration was reported on the file test setup photo.

3.2.3 Test setup

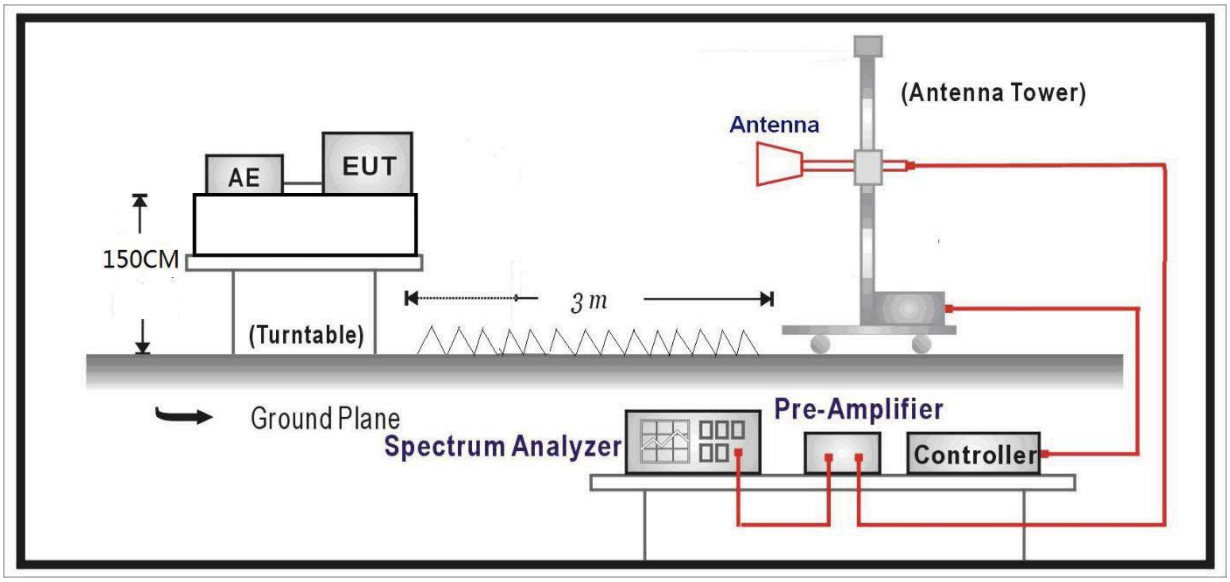
Below 30MHz Test Setup:



Below 1GHz Test Setup:



Above 1GHz Test Setup:

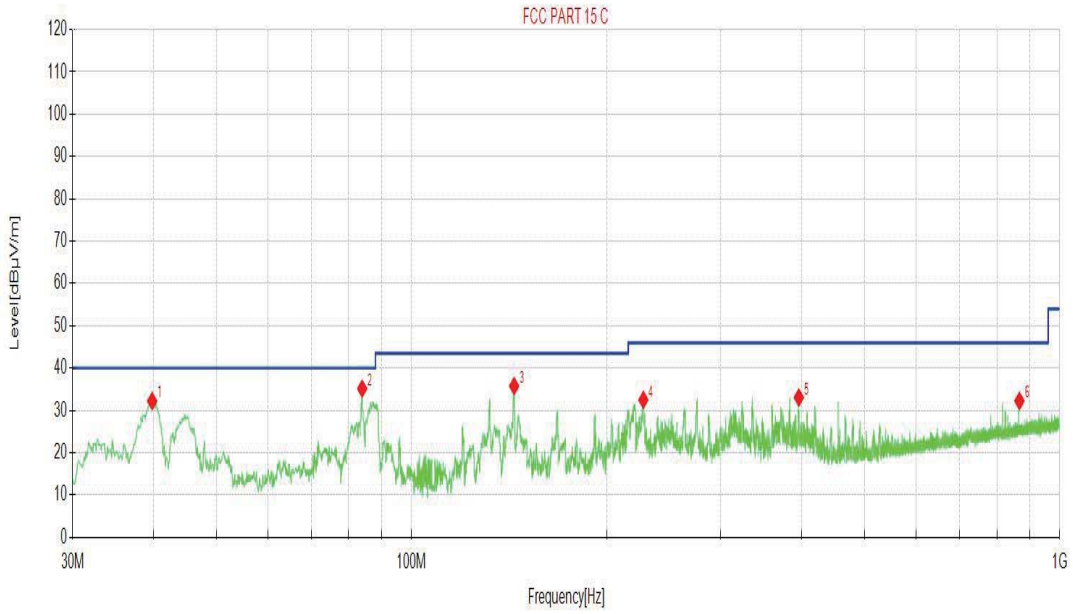


3.2.4 Test results

BELOW 1GHz WORST-CASE DATA:

Worst Test Mode	BT-LE	Channel	CH 0
Frequency Range	9KHz ~ 1GHz	Detector Function	Quasi-Peak (QP)

Horizontal

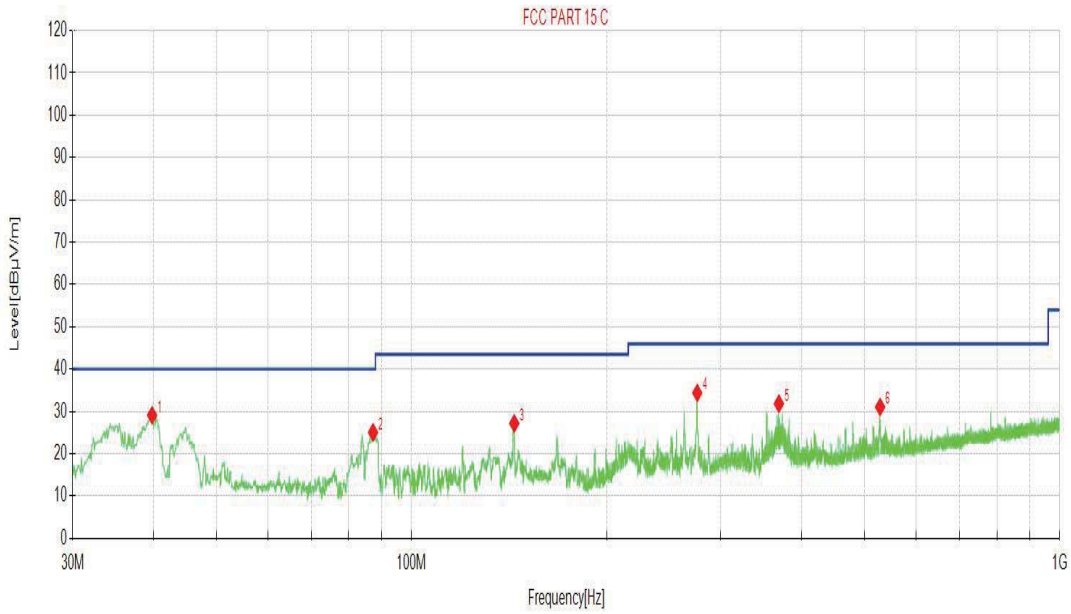


NO.	Freq. [MHz]	Reading [dBµV/m]	Factor [dB]	Level [dBµV/m]	Limit [dBµV/m]	Margin [dB]	Height [cm]	Angle [°]
1	39.7980	17.49	14.73	32.22	40.00	7.78	100	24
2	83.9374	24.50	10.64	35.14	40.00	4.86	100	24
3	143.9864	20.35	15.41	35.76	43.50	7.74	100	349
4	227.8998	19.17	13.33	32.50	46.00	13.50	100	61
5	395.9206	15.37	17.67	33.04	46.00	12.96	100	323
6	866.7087	6.48	25.78	32.26	46.00	13.74	100	93

Remark: 1. 9KHz~30MHz have been test and test data more than 20dB margin.
2. The emission levels of other frequencies were greater than 20dB margin.
3. Level (dBuV/m) = Reading (dBuV/m) + Factor (dB).
4. Factor (dB/m) = Antenna Factor (dB/m) + Cable Factor (dB).
5. Margin(dB) = Limit[dBµV/m] - Level [dBµV/m]

Worst Test Mode	**BT-LE**	**Channel**	CH 0
Frequency Range	9KHz ~ 1GHz	**Detector Function**	Quasi-Peak (QP)

Vertical



NO.	Freq. [MHz]	Reading [dBµV/m]	Factor [dB]	Level [dBµV/m]	Limit [dBµV/m]	Margin [dB]	Height [cm]	Angle [°]
1	39.7980	14.37	14.73	29.10	40.00	10.90	100	55
2	87.2357	14.31	10.74	25.05	40.00	14.95	100	64
3	144.0834	11.76	15.42	27.18	43.50	16.32	100	290
4	276.0166	19.66	14.71	34.37	46.00	11.63	100	7
5	368.8549	14.86	16.97	31.83	46.00	14.17	100	138
6	528.4358	10.74	20.32	31.06	46.00	14.94	100	28

Remark: 1. 9KHz~30MHz have been test and test data more than 20dB margin.
2. The emission levels of other frequencies were greater than 20dB margin.
3. Level (dBuV/m) = Reading (dBuV/m) + Factor (dB).
4. Factor (dB/m) = Antenna Factor (dB/m) + Cable Factor (dB).
5. Margin(dB) = Limit[dBµV/m] - Level [dBµV/m]

ABOVE 1GHz DATA

BT-LE(1Mpbs)

Channel	BT-LE CH 0	Frequency	2402MHz
Frequency Range	Above 1G	Detector Function	PK/AV

Horizontal

NO.	Freq. [MHz]	Reading [dBμV/m]	Factor [dB]	Level [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Height [cm]	Angle [°]	Detector
1	2390.0000	36.26	-0.15	36.11	54.00	17.89	187	228	AV
2	2390.0000	44.44	-0.15	44.29	74.00	29.71	226	0	PK
3	2401.7602	77.36	-0.04	77.32			399	89	PK
4	2401.9502	76.97	-0.03	76.94			247	89	AV
5	4804.0000	35.39	9.29	44.68	54.00	9.32	388	115	AV
6	4804.0000	43.79	9.29	53.08	74.00	20.92	359	115	PK
7	7205.6706	42.37	12.82	55.19	74.00	18.81	230	324	PK
8	7205.6706	37.55	12.82	50.37	54.00	3.63	242	1	AV
9	12009.0009	33.40	16.45	49.85	74.00	24.15	107	1	PK
10	12009.0009	27.46	16.45	43.91	54.00	10.09	274	359	AV

Vertical

NO.	Freq. [MHz]	Reading [dBμV/m]	Factor [dB]	Level [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Height [cm]	Angle [°]	Remark
1	2390.0000	36.95	-0.15	36.80	54.00	17.20	264	262	AV
2	2390.0000	44.75	-0.15	44.60	74.00	29.40	298	262	PK
3	2401.9692	76.80	-0.03	76.77			318	98	AV
4	2402.2922	77.28	-0.03	77.25			303	91	PK
5	4804.0000	42.89	9.29	52.18	74.00	21.82	174	117	PK
6	4804.0000	35.60	9.29	44.89	54.00	9.11	177	122	AV
7	7205.6706	38.03	12.82	50.85	54.00	3.15	369	233	AV
8	7205.6706	41.82	12.82	54.64	74.00	19.36	220	337	PK
9	12009.0009	32.90	16.45	49.35	74.00	24.65	319	360	PK
10	12009.0009	27.27	16.45	43.72	54.00	10.28	129	360	AV

Remark: 1. The emission levels of other frequencies were greater than 20dB margin.
2. Level (dBuV/m) = Reading (dBuV/m) + Factor (dB).
3. Factor (dB/m) = Antenna Factor (dB/m) + Cable Factor (dB).
4. Margin(dB) = Limit[dBμV/m] - Level [dBμV/m]

Channel	BL-LE CH 19	Frequency	2440MHz
Frequency Range	Above 1G	Detector Function	PK/AV

Horizontal

NO.	Freq. [MHz]	Reading [dBμV/m]	Factor [dB]	Level [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Height [cm]	Angle [°]	Detector
1	4880.0000	35.73	9.80	45.53	54.00	8.47	225	171	AV
2	4880.0000	43.26	9.80	53.06	74.00	20.94	165	300	PK
3	7319.1719	43.33	11.02	54.35	74.00	19.65	248	324	PK
4	7319.1719	38.71	11.02	49.73	54.00	4.27	170	324	AV
5	12198.5599	33.99	17.00	50.99	74.00	23.01	101	3	PK
6	12198.5599	26.67	17.00	43.67	54.00	10.33	345	1	AV

Vertical

NO.	Freq. [MHz]	Reading [dBμV/m]	Factor [dB]	Level [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Height [cm]	Angle [°]	Remark
1	4880.0000	34.86	9.80	44.66	54.00	9.34	240	125	AV
2	4880.0000	43.10	9.80	52.90	74.00	21.10	349	130	PK
3	7319.1719	42.22	11.02	53.24	74.00	20.76	329	230	PK
4	7319.1719	36.19	11.02	47.21	54.00	6.79	117	240	AV
5	12198.5599	27.98	17.00	44.98	54.00	9.02	259	345	AV
6	12200.9001	34.22	16.99	51.21	74.00	22.79	350	11	PK

Remark: 1. The emission levels of other frequencies were greater than 20dB margin.
2. Level (dBuV/m) = Reading (dBuV/m) + Factor (dB).
3. Factor (dB/m) = Antenna Factor (dB/m) + Cable Factor (dB).
4. Margin(dB) = Limit[dBμV/m] - Level [dBμV/m]

Channel	BT-LE CH 39	Frequency	2480MHz
Frequency Range	Above 1G	Detector Function	PK/AV

Horizontal

NO.	Freq. [MHz]	Reading [dBμV/m]	Factor [dB]	Level [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Height [cm]	Angle [°]	Detector
1	2479.7440	74.24	0.33	74.57			179	91	PK
2	2480.0290	73.86	0.32	74.18			365	91	AV
3	2483.5000	36.76	0.46	37.22	54.00	16.78	336	250	AV
4	2483.5000	45.25	0.46	45.71	74.00	28.29	333	210	PK
5	4960.0000	43.63	10.69	54.32	74.00	19.68	244	154	PK
6	4960.0000	36.22	10.69	46.91	54.00	7.09	332	149	AV
7	7438.5239	41.45	9.72	51.17	74.00	22.83	163	220	PK
8	7439.6940	37.09	9.73	46.82	54.00	7.18	335	206	AV
9	12398.6499	31.68	17.24	48.92	74.00	25.08	390	2	PK
10	12400.9901	25.41	17.27	42.68	54.00	11.32	248	8	AV

Vertical

NO.	Freq. [MHz]	Reading [dBμV/m]	Factor [dB]	Level [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Height [cm]	Angle [°]	Remark
1	2479.7630	74.41	0.33	74.74			263	98	PK
2	2480.1240	73.89	0.32	74.21			197	91	AV
3	2483.5000	36.98	0.46	37.44	54.00	16.56	213	242	AV
4	2483.5000	48.27	0.46	48.73	74.00	25.27	234	242	PK
5	4960.0000	43.50	10.69	54.19	74.00	19.81	217	116	PK
6	4960.0000	35.83	10.69	46.52	54.00	7.48	298	116	AV
7	7438.5239	40.47	9.72	50.19	74.00	23.81	349	215	PK
8	7439.6940	36.08	9.73	45.81	54.00	8.19	337	210	AV
9	12400.9901	25.11	17.27	42.38	54.00	11.62	285	6	AV
10	12400.9901	32.42	17.27	49.69	74.00	24.31	160	6	PK

Remark: 1. The emission levels of other frequencies were greater than 20dB margin.
2. Level (dBuV/m) = Reading (dBuV/m) + Factor (dB).
3. Factor (dB/m) = Antenna Factor (dB/m) + Cable Factor (dB).
4. Margin(dB) = Limit[dBμV/m] - Level [dBμV/m]

BT-LE(2Mpbs)

Channel	BT-LE CH 0	Frequency	2402MHz
Frequency Range	Above 1G	Detector Function	PK/AV

Horizontal

NO.	Freq. [MHz]	Reading [dBμV/m]	Factor [dB]	Level [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Height [cm]	Angle [°]	Detector
1	2390.0000	36.36	-0.15	36.21	54.00	17.79	255	341	AV
2	2390.0000	45.20	-0.15	45.05	74.00	28.95	263	328	PK
3	2401.4751	77.98	-0.04	77.94			322	91	PK
4	2402.0452	77.19	-0.03	77.16			263	85	AV
5	4804.0000	35.63	9.29	44.92	54.00	9.08	230	208	AV
6	4804.0000	43.73	9.29	53.02	74.00	20.98	236	149	PK
7	7204.5005	42.87	12.83	55.70	74.00	18.30	230	284	PK
8	7205.6706	39.04	12.82	51.86	54.00	2.14	213	250	AV
9	12007.8308	27.90	16.45	44.35	54.00	9.65	179	305	AV
10	12012.5113	32.42	16.52	48.94	74.00	25.06	365	319	PK

Vertical

NO.	Freq. [MHz]	Reading [dBμV/m]	Factor [dB]	Level [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Height [cm]	Angle [°]	Remark
1	2390.0000	36.55	-0.15	36.40	54.00	17.60	251	360	AV
2	2390.0000	44.45	-0.15	44.30	74.00	29.70	203	144	PK
3	2401.4751	77.98	-0.04	77.94			149	84	PK
4	2402.0452	76.85	-0.03	76.82			184	91	AV
5	4804.0000	35.10	9.29	44.39	54.00	9.61	365	289	AV
6	4804.0000	43.54	9.29	52.83	74.00	21.17	229	3	PK
7	7205.6706	36.01	12.82	48.83	54.00	5.17	351	338	AV
8	7206.8407	40.79	12.81	53.60	74.00	20.40	267	338	PK
9	12007.8308	26.31	16.45	42.76	54.00	11.24	160	11	AV
10	12012.5113	31.61	16.52	48.13	74.00	25.87	139	3	PK

Remark: 1. The emission levels of other frequencies were greater than 20dB margin.
2. Level (dBuV/m) = Reading (dBuV/m) + Factor (dB).
3. Factor (dB/m) = Antenna Factor (dB/m) + Cable Factor (dB).
4. Margin(dB) = Limit[dBμV/m] - Level [dBμV/m]

Channel	BL-LE CH 19	Frequency	2440MHz
Frequency Range	Above 1G	Detector Function	PK/AV

Horizontal

NO.	Freq. [MHz]	Reading [dBμV/m]	Factor [dB]	Level [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Height [cm]	Angle [°]	Detector
1	4880.0000	43.79	9.80	53.59	74.00	20.41	169	184	PK
2	4880.0000	35.20	9.80	45.00	54.00	9.00	114	184	AV
3	7318.0018	37.10	11.02	48.12	54.00	5.88	108	270	AV
4	7321.5122	43.27	11.00	54.27	74.00	19.73	179	259	PK
5	12197.3897	31.42	17.00	48.42	74.00	25.58	359	309	PK
6	12197.3897	24.50	17.00	41.50	54.00	12.50	216	309	AV

Vertical

NO.	Freq. [MHz]	Reading [dBμV/m]	Factor [dB]	Level [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Height [cm]	Angle [°]	Remark
1	4880.0000	43.10	9.80	52.90	74.00	21.10	272	4	PK
2	4880.0000	35.05	9.80	44.85	54.00	9.15	132	4	AV
3	7318.0018	35.68	11.02	46.70	54.00	7.30	251	239	AV
4	7321.5122	41.73	11.00	52.73	74.00	21.27	365	327	PK
5	12197.3897	26.48	17.00	43.48	54.00	10.52	331	338	AV
6	12203.2403	34.03	16.97	51.00	74.00	23.00	147	342	PK

Remark: 1. The emission levels of other frequencies were greater than 20dB margin.
2. Level (dBuV/m) = Reading (dBuV/m) + Factor (dB).
3. Factor (dB/m) = Antenna Factor (dB/m) + Cable Factor (dB).
4. Margin(dB) = Limit[dBμV/m] - Level [dBμV/m]

Channel	BT-LE CH 39	Frequency	2480MHz
Frequency Range	Above 1G	Detector Function	PK/AV

Horizontal

NO.	Freq. [MHz]	Reading [dBμV/m]	Factor [dB]	Level [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Height [cm]	Angle [°]	Detector
1	2479.4589	75.79	0.34	76.13			268	168	PK
2	2480.1430	74.92	0.32	75.24			254	168	AV
3	2483.5000	37.31	0.46	37.77	54.00	16.23	279	174	AV
4	2483.5000	47.49	0.46	47.95	74.00	26.05	393	174	PK
5	4960.0000	42.47	10.69	53.16	74.00	20.84	327	91	PK
6	4960.0000	35.72	10.69	46.41	54.00	7.59	201	253	AV
7	7438.5239	40.39	9.72	50.11	74.00	23.89	308	245	PK
8	7439.6940	36.00	9.73	45.73	54.00	8.27	201	329	AV
9	12398.6499	21.76	17.24	39.00	54.00	15.00	358	28	AV
10	12632.6733	28.39	17.71	46.10	74.00	27.90	251	162	PK

Vertical

NO.	Freq. [MHz]	Reading [dBμV/m]	Factor [dB]	Level [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Height [cm]	Angle [°]	Remark
1	2479.5730	74.78	0.34	75.12			389	242	PK
2	2480.0290	74.26	0.32	74.58			365	242	AV
3	2483.5000	36.81	0.46	37.27	54.00	16.73	229	209	AV
4	2483.5000	48.63	0.46	49.09	74.00	24.91	351	209	PK
5	4960.0000	42.64	10.69	53.33	74.00	20.67	251	359	PK
6	4960.0000	34.88	10.69	45.57	54.00	8.43	390	289	AV
7	7439.6940	40.20	9.73	49.93	74.00	24.07	281	223	PK
8	7439.6940	36.13	9.73	45.86	54.00	8.14	119	223	AV
9	12397.4797	23.97	17.23	41.20	54.00	12.80	264	356	AV
10	12397.4797	31.70	17.23	48.93	74.00	25.07	120	356	PK

Remark: 1. The emission levels of other frequencies were greater than 20dB margin.
2. Level (dBuV/m) = Reading (dBuV/m) + Factor (dB).
3. Factor (dB/m) = Antenna Factor (dB/m) + Cable Factor (dB).
4. Margin(dB) = Limit[dBμV/m] - Level [dBμV/m]

3.3 6dB BANDWIDTH MEASUREMENT

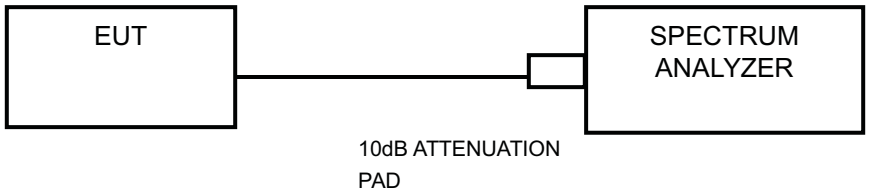
3.3.1 Limits

The minimum of 6dB Bandwidth Measurement is 0.5 MHz.

3.3.2 Measurement procedure

a. Set resolution bandwidth (RBW) = 100KHz
b. Set the video bandwidth (VBW) ≥ 3 x RBW, Detector = Peak.
c. Trace mode = max hold.
d. Sweep = auto couple.
e. Measure the maximum width of the emission that is constrained by the frequencies associatedwith the two amplitude points (upper and lower) that are attenuated by 6 dB relative to themaximum level measured in the fundamental emission.

3.3.3 Test setup



3.3.4 Test result

Please refer Annex A

3.4 CONDUCTED OUTPUT POWER

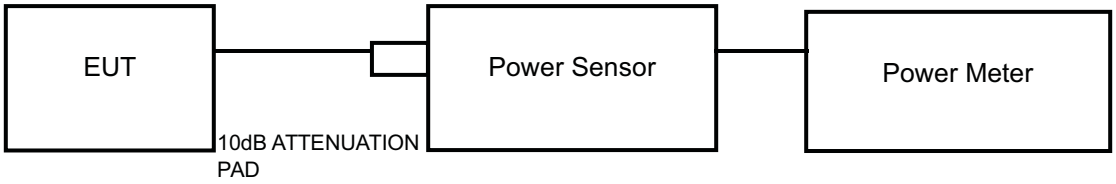
3.4.1 Limits

Forsystems using digital modulation in the 2400–2483.5 MHz band: 1 Watt (30dBm).

3.4.2 Measurement procedure

a. A peak power sensor was used on the output port of the EUT. A power meter was used to read the response of the peak power sensor and set the detector to PEAK. Record the power level.
b. Anaverage power sensor was used on the output port of the EUT. A power meter was used to read the response of the average power senso and set the detector to AVERAGE. Record the power level.

3.4.3 Test setup



3.4.4 Test result

Please refer Annex A.

3.5 POWER SPECTRAL DENSITY MEASUREMENT

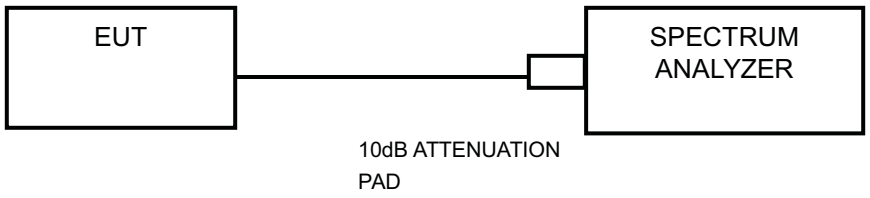
3.5.1 Limits

The Maximum of Power Spectral Density Measurement is 8dBm/3KHz.

3.5.2 Measurement procedure

a. Set instrument center frequency to DTS channel center frequency.
b. Set the span to 1.5 times the DTS bandwidth.
c. Set RBW to: 3KHz
d. Set VBW ≥3 x RBW.
e. Detector = peak
f. Ensure that the number of measurement points in the sweep ≥ 2 x span/RBW.
g. Sweep time = auto couple.
h. Use the peak marker function to determine the maximum amplitude level.

3.5.3 Test setup



3.5.4 Test result

Please refer Annex A.

3.6 OUT OF BAND EMISSION MEASUREMENT AND BAND EDGE MEASUREMENT

3.6.1 Limits

Below –20dB of the highest emission level of operating band (in 100kHz Resolution Bandwidth).

3.6.2 Measurement procedure

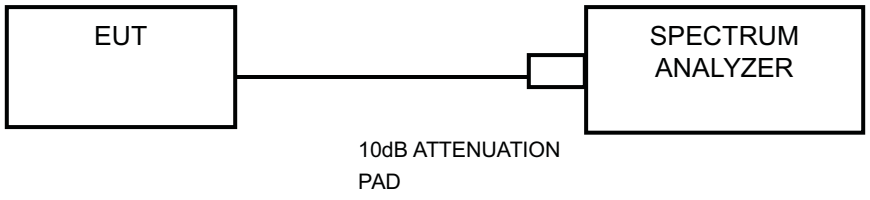
Measurement Procedure -Reference Level

a. Set the RBW = 100 kHz.
b. Set the VBW ≥ 300 kHz.
c. Detector = peak.
d. Sweep time = auto couple.
e. Trace mode = max hold.
f. Allow trace to fully stabilize.
g. Use the peak marker function to determine the maximum power level in any 100 kHzband segment within the fundamental EBW.

Measurement Procedure –Unwanted Emission Level

a. Set RBW = 100 kHz.
b. Set VBW ≥ 300 kHz.
c. Set span to encompass the spectrum to be examined
d. Detector = peak.
e. Trace Mode = max hold.
f. Sweep = auto couple.

3.6.3 Test setup



3.6.4 Test result

Please refer Annex A.

4 PHOTOGRAPHS OF TEST SETUP

Please refer to the attached file (Test Setup Photo).

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5 Appendix A

Please refer to the following pages for test results.

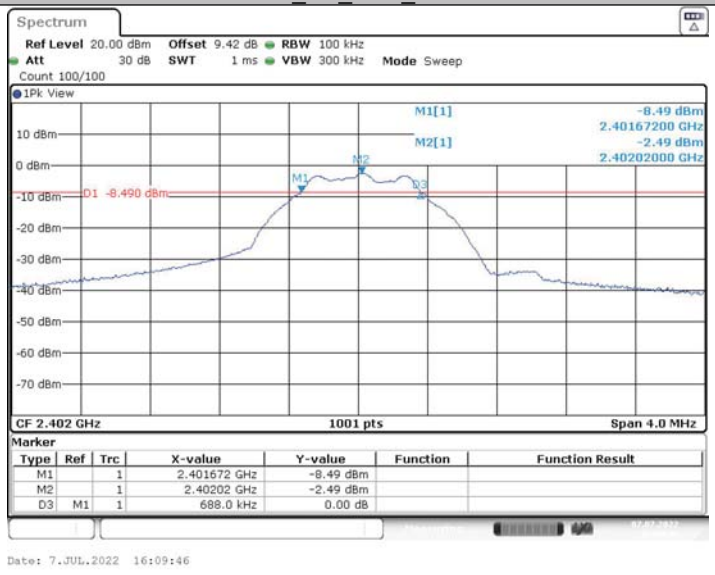
5.1 6DB BANDWIDTH MEASUREMENT

5.1.1 Test Result

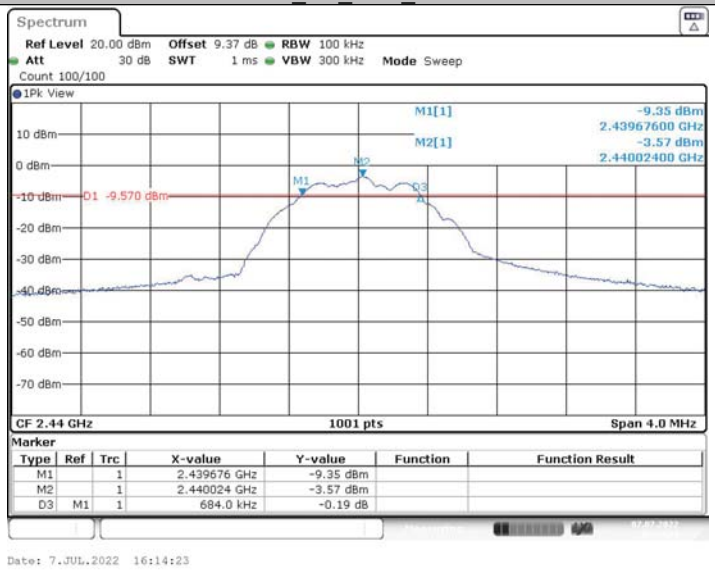
TestMode	Antenna	Frequency[MHz]	DTS BW [MHz]	FL[MHz]	FH[MHz]	Limit[MHz]	Verdict
BLE_1M	Ant1	2402	0.69	2401.67	2402.36	0.5	PASS
		2440	0.68	2439.68	2440.36	0.5	PASS
		2480	0.60	2479.68	2480.28	0.5	PASS
BLE_2M	Ant1	2402	1.20	2401.42	2402.61	0.5	PASS
		2440	1.12	2439.50	2440.62	0.5	PASS
		2480	0.87	2479.41	2480.28	0.5	PASS

5.1.2 Test Graphs

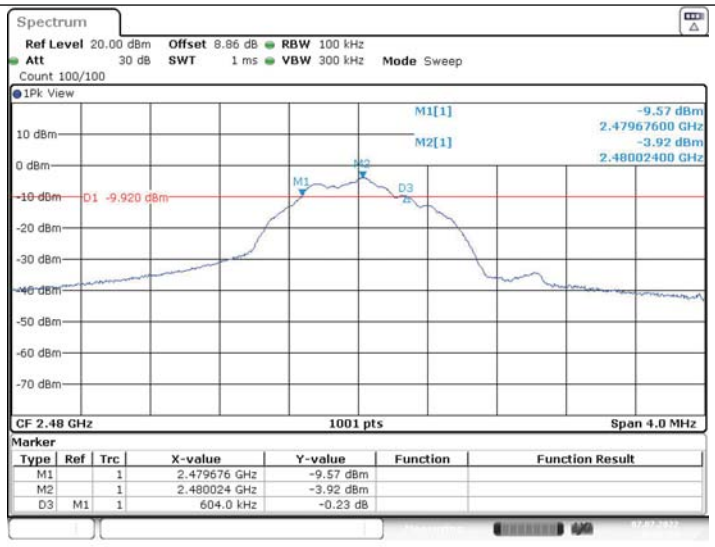
BLE_1M_Ant1_2402



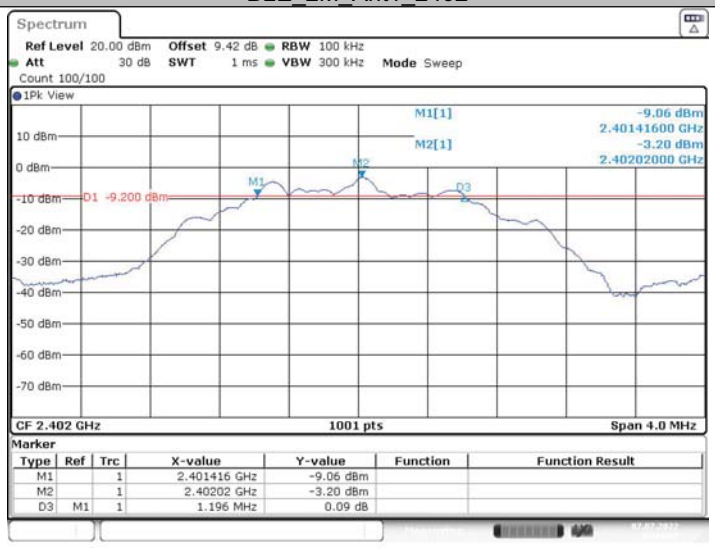
BLE_1M_Ant1_2440



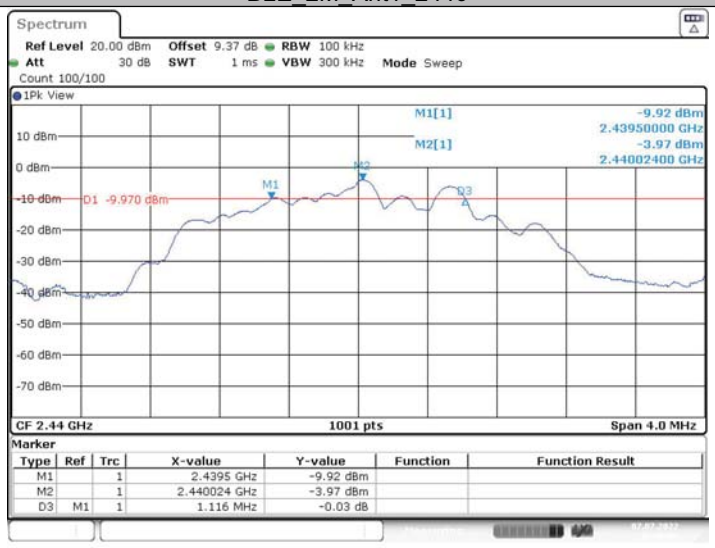
BLE_1M_Ant1_2480



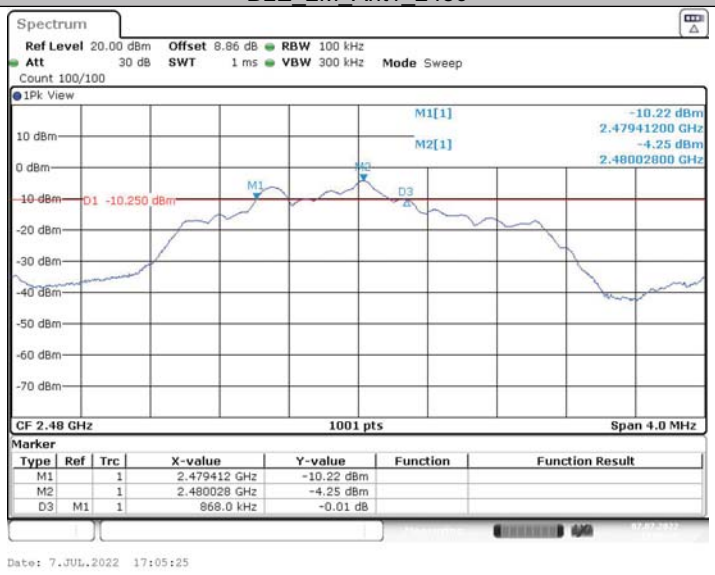
BLE_2M_Ant1_2402



BLE_2M_Ant1_2440



BLE_2M_Ant1_2480



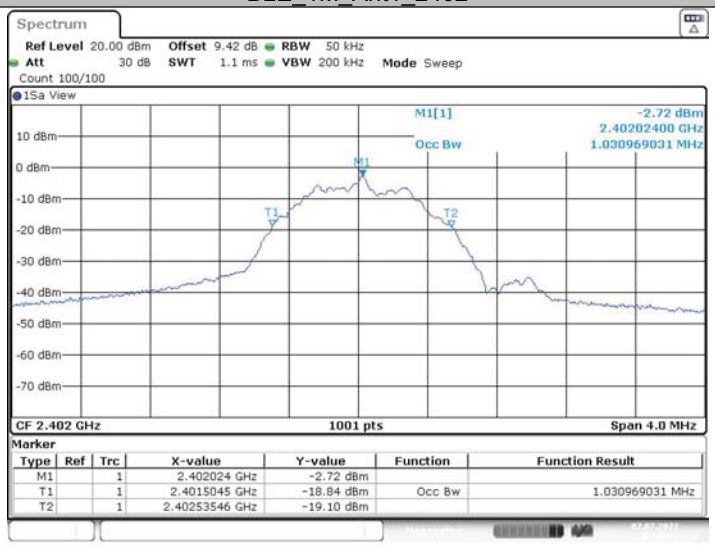
5.2 Occupied Channel Bandwidth

5.2.1 Test Result

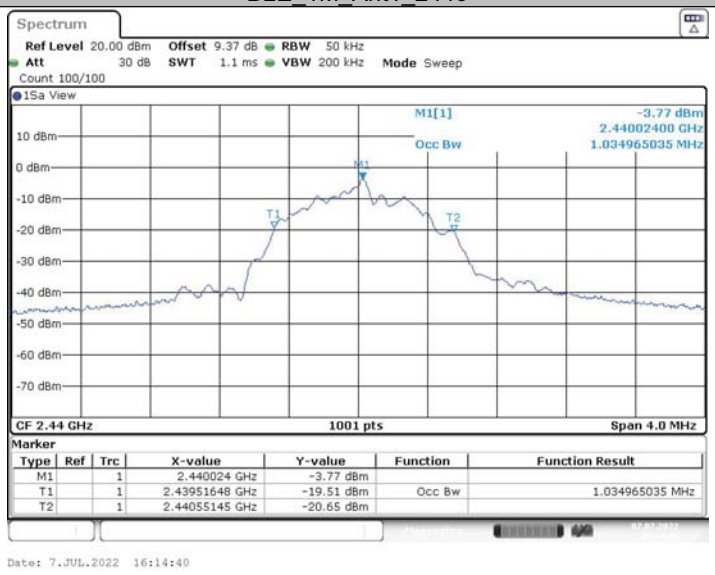
TestMode	Antenna	Frequency[MHz]	OCB [MHz]	FL[MHz]	FH[MHz]	Limit[MHz]	Verdict
BLE_1M	Ant1	2402	1.031	2401.504	2402.535	---	---
		2440	1.035	2439.516	2440.551	---	---
		2480	1.071	2479.481	2480.551	---	---
BLE_2M	Ant1	2402	2.038	2401.013	2403.051	---	---
		2440	2.034	2439.021	2441.055	---	---
		2480	2.074	2478.985	2481.059	---	---

5.2.1 Test Graphs

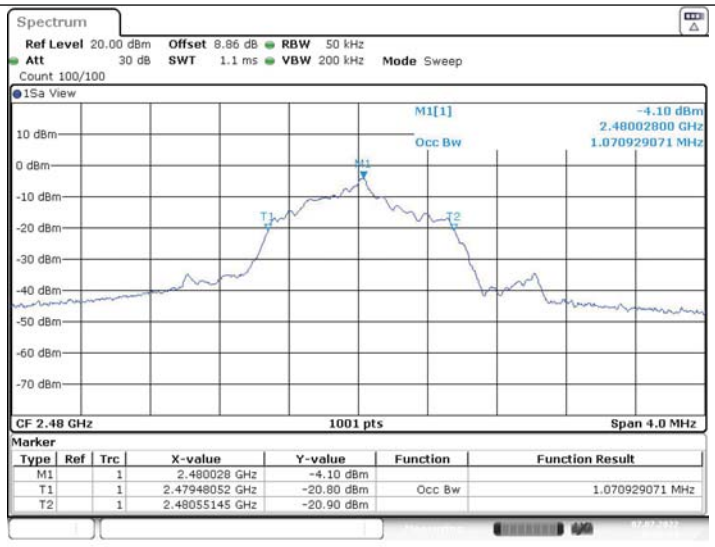
BLE_1M_Ant1_2402



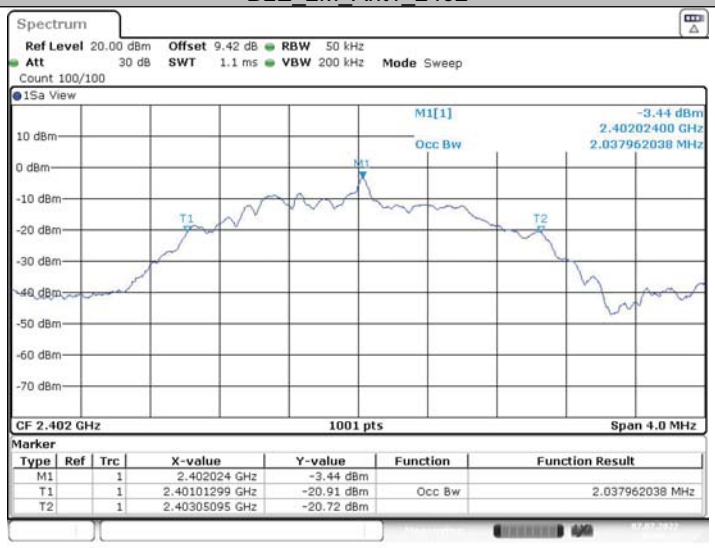
BLE_1M_Ant1_2440



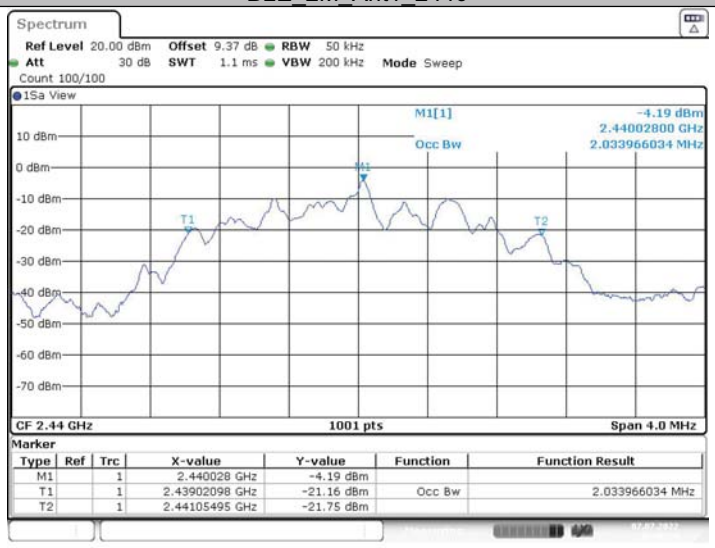
BLE_1M_Ant1_2480



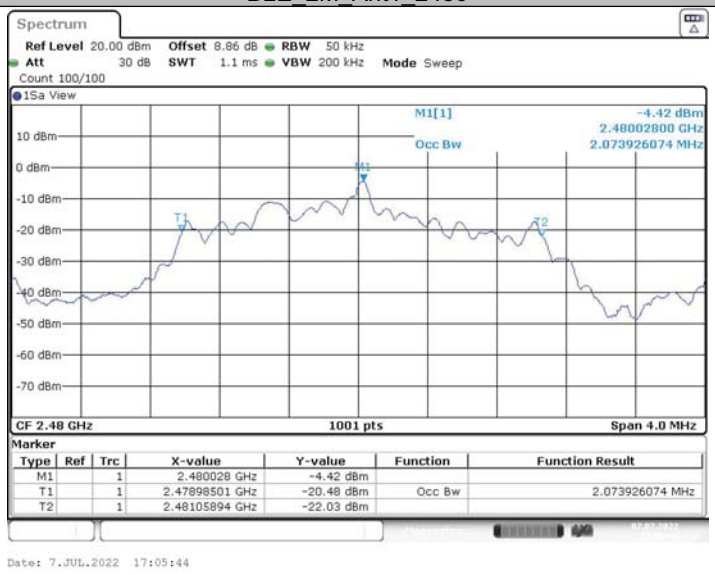
BLE_2M_Ant1_2402



BLE_2M_Ant1_2440



BLE_2M_Ant1_2480



5.3 CONDUCTED OUTPUT POWER

5.3.1 Test Result

PEAK

TestMode	Antenna	Frequency[MHz]	Conducted Peak Powert[dBm]	Conducted Limit[dBm]	EIRP[dBm]	EIRP Limit[dBm]	Verdict
BLE_1M	Ant1	2402	-2.40	≤30	-0.40	≤36	PASS
		2440	-3.39	≤30	-1.39	≤36	PASS
		2480	-3.74	≤30	-1.74	≤36	PASS
BLE_2M	Ant1	2402	-3.00	≤30	-1.00	≤36	PASS
		2440	-3.72	≤30	-1.72	≤36	PASS
		2480	-4.00	≤30	-2.00	≤36	PASS

AV

Test Mode	Antenna	Frequency[MHz]	Conducted Sensor power[dBm]	Duty Cycle [%]	DC Factor [dBm]	Result [dBm]	Limit [dBm]	Gain [dBi]	EIRP [dBm]	EIRP Limit [dBm]	Verdict
BLE_1M	Ant1	2402	-6.00	65.08	1.87	-4.13	≤30.00	2.00	-2.13	≤36.00	PASS
		2440	-6.45	64.52	1.90	-4.55	≤30.00	2.00	-2.55	≤36.00	PASS
		2480	-6.76	64.52	1.90	-4.86	≤30.00	2.00	-2.86	≤36.00	PASS
BLE_2M	Ant1	2402	-8.50	36.51	4.38	-4.12	≤30.00	2.00	-2.12	≤36.00	PASS
		2440	-8.93	36.51	4.38	-4.55	≤30.00	2.00	-2.55	≤36.00	PASS
		2480	-9.20	36.51	4.38	-4.82	≤30.00	2.00	-2.82	≤36.00	PASS

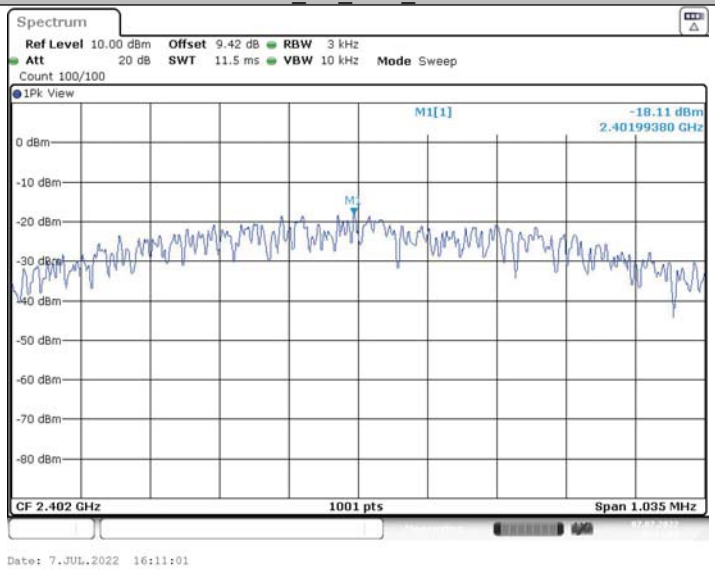
5.4 POWER SPECTRAL DENSITY MEASUREMENT

5.4.1 Test Result

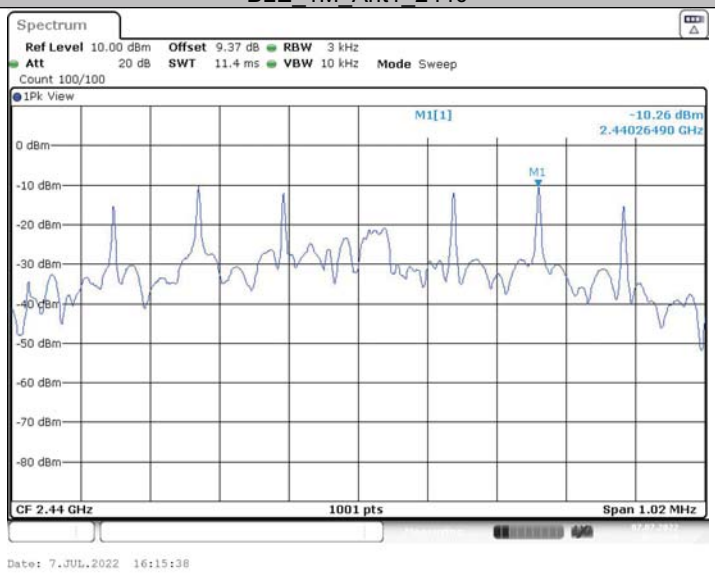
TestMode	Antenna	Frequency[MHz]	Result[dBm/3kHz]	Limit[dBm/3kHz]	Verdict
BLE_1M	Ant1	2402	-18.11	≤8.00	PASS
		2440	-10.26	≤8.00	PASS
		2480	-5.31	≤8.00	PASS
BLE_2M	Ant1	2402	-19.69	≤8.00	PASS
		2440	-14.01	≤8.00	PASS
		2480	-9.74	≤8.00	PASS

5.4.2 Test Graphs

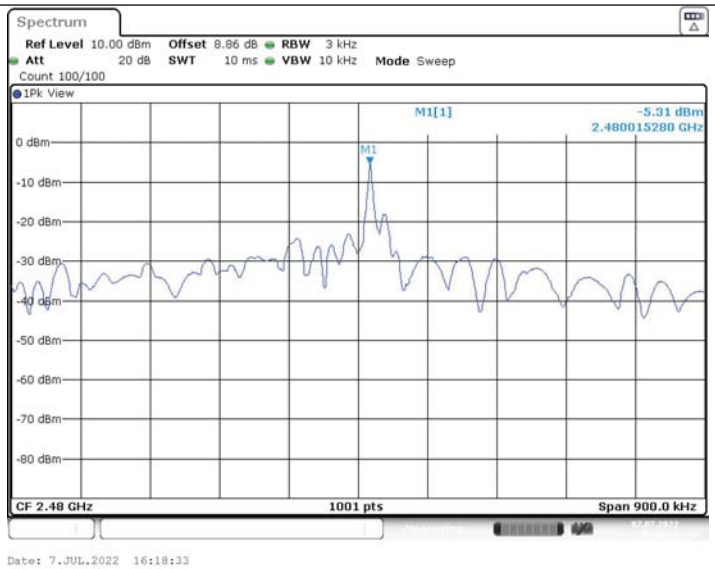
BLE_1M_Ant1_2402



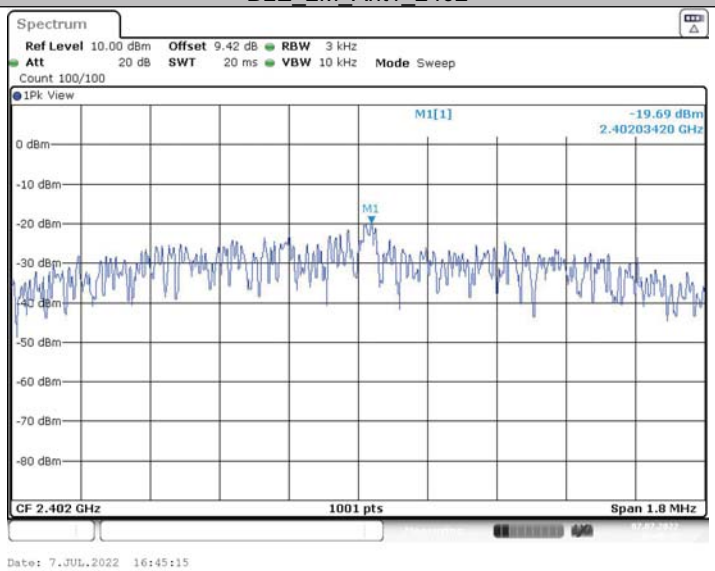
BLE_1M_Ant1_2440



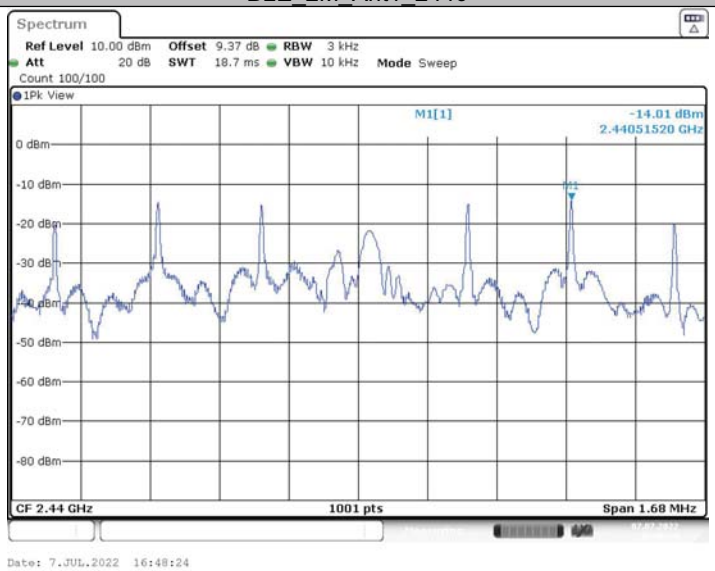
BLE_1M_Ant1_2480



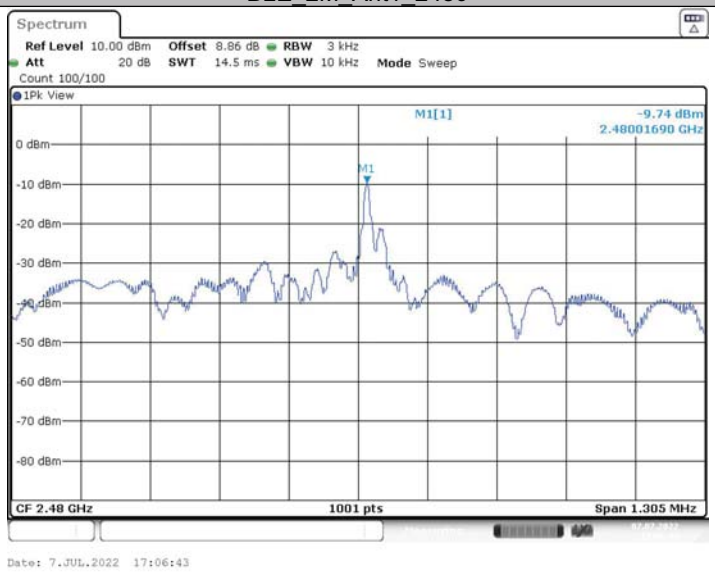
BLE_2M_Ant1_2402



BLE_2M_Ant1_2440



BLE_2M_Ant1_2480



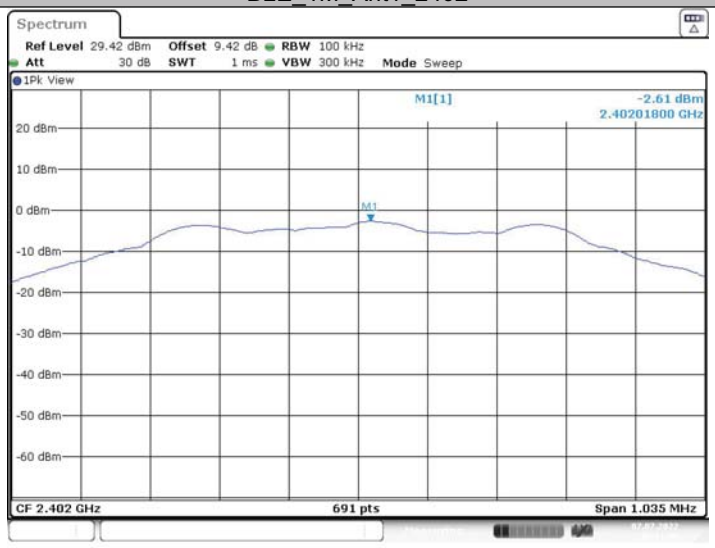
5.5 Reference level measurement

5.5.1 Test Result

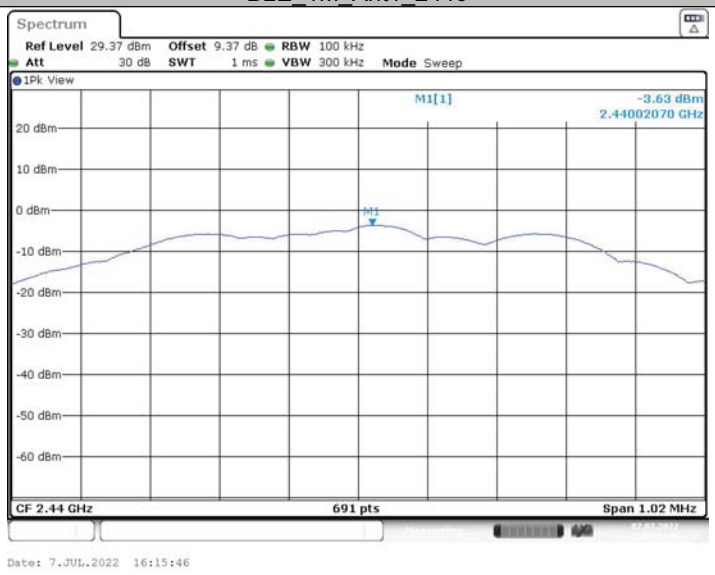
TestMode	Antenna	Freq(MHz)	Max.Point[MHz]	Result[dBm]
BLE_1M	Ant1	2402	2402.02	-2.61
		2440	2440.02	-3.63
		2480	2480.02	-3.97
BLE_2M	Ant1	2402	2402.02	-3.22
		2440	2440.02	-4.00
		2480	2480.02	-4.25

5.5.2 Test Graphs

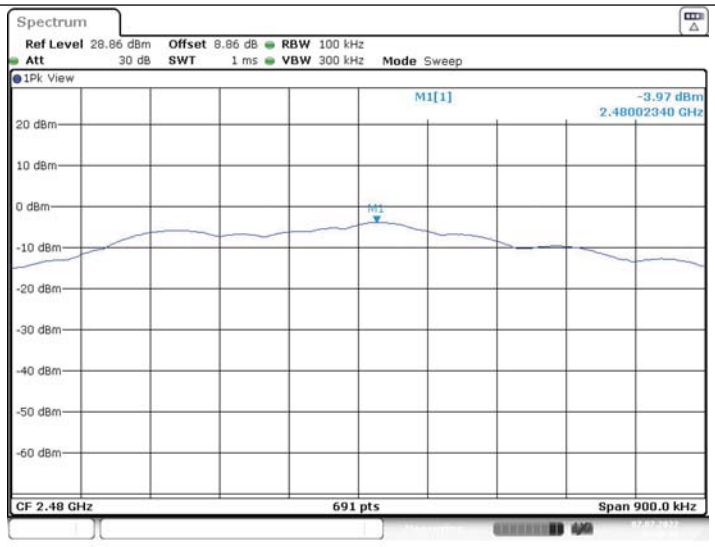
BLE_1M_Ant1_2402



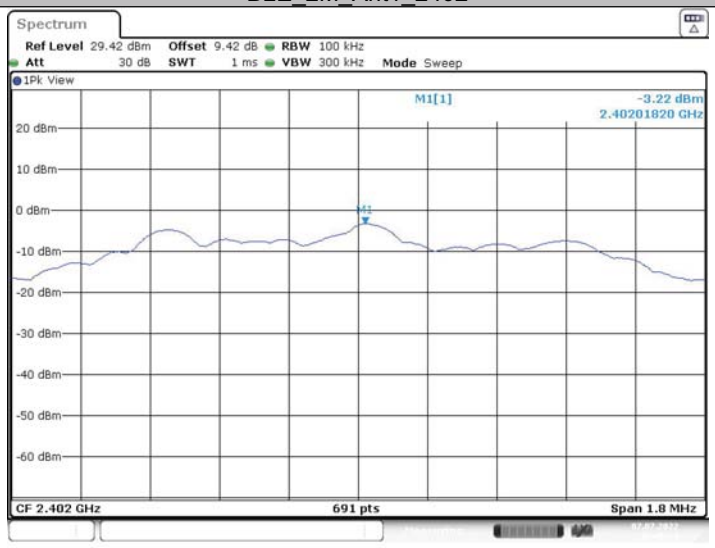
BLE_1M_Ant1_2440



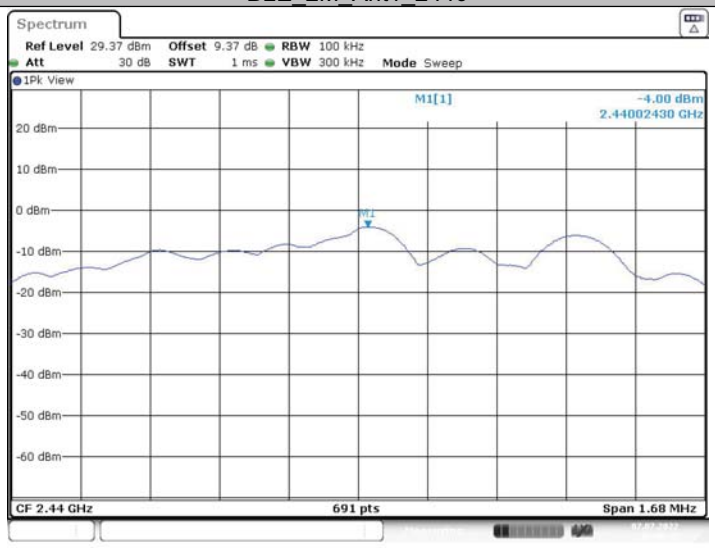
BLE_1M_Ant1_2480



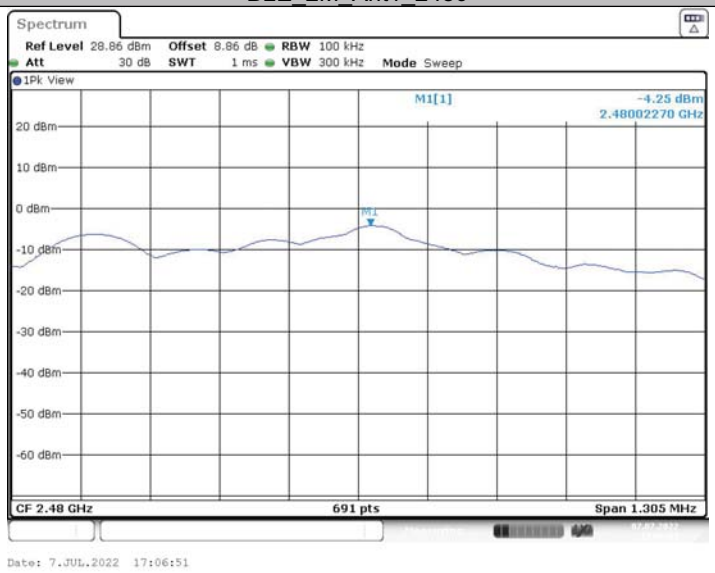
BLE_2M_Ant1_2402



BLE_2M_Ant1_2440



BLE_2M_Ant1_2480



5.6 Band edge measurements

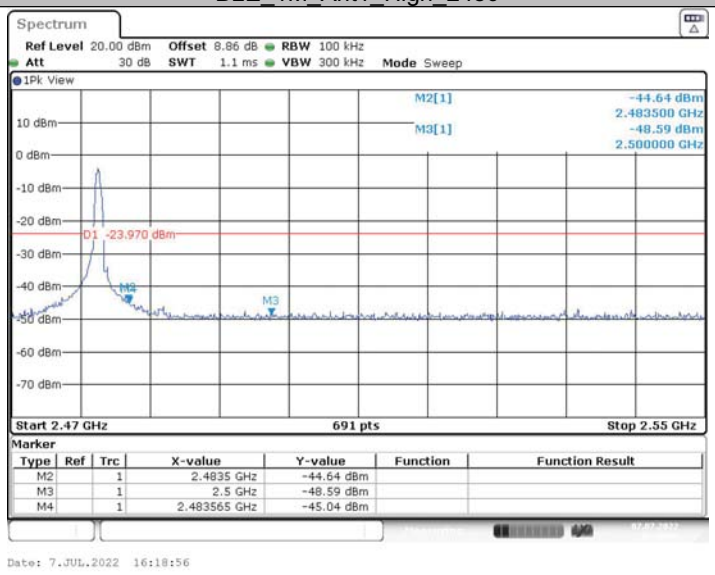
5.6.1 Test Result

TestMode	Antenna	ChName	Frequency[MHz]	RefLevel[dBm]	Result[dBm]	Limit[dBm]	Verdict
BLE_1M	Ant1	Low	2402	-2.61	-38.83	≤-22.61	PASS
		High	2480	-3.97	-45.04	≤-23.97	PASS
BLE_2M	Ant1	Low	2402	-3.22	-36.58	≤-23.22	PASS
		High	2480	-4.25	-46.02	≤-24.25	PASS

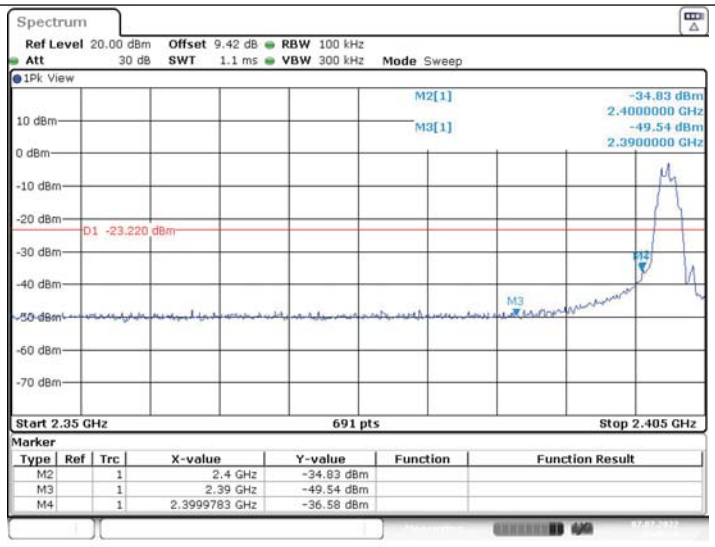
5.6.2 Test Graphs

BLE_1M_Ant1_Low_2402

BLE_1M_Ant1_High_2480



BLE_2M_Ant1_Low_2402



BLE_2M_Ant1_High_2480

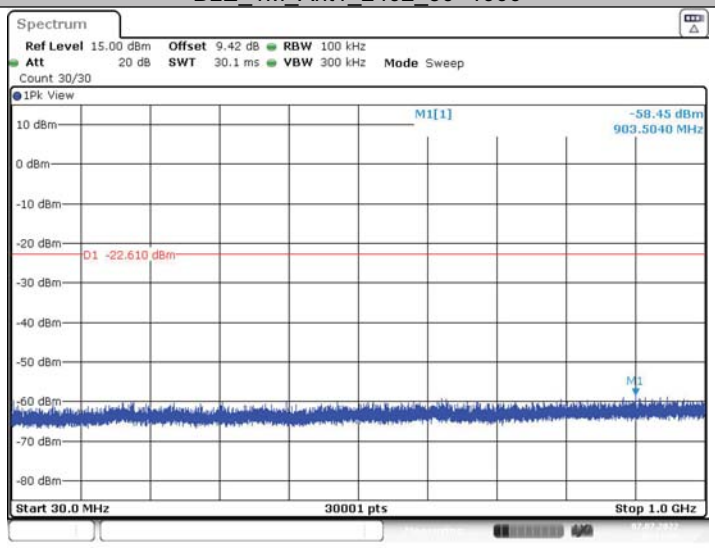
5.7 OUT OF BAND EMISSION MEASUREMENT

5.7.1 Test Result

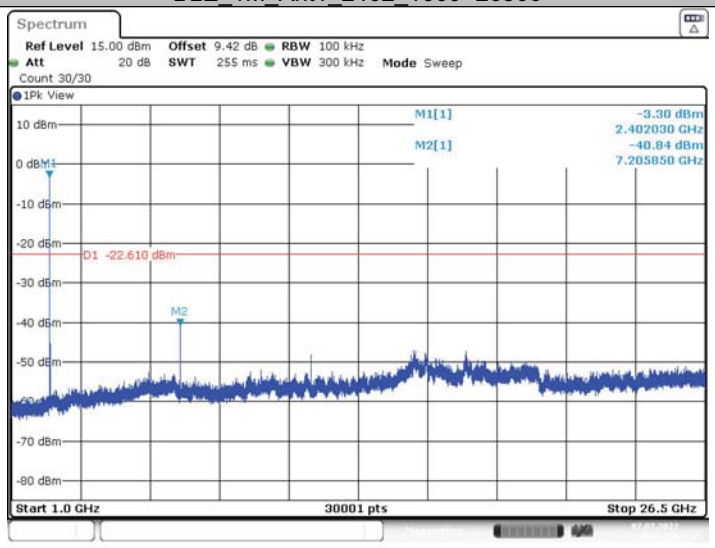
TestMode	Antenna	Frequency[MHz]	FreqRange [MHz]	RefLevel [dBm]	Result[dBm]	Limit[dBm]	Verdict
BLE_1M	Ant1	2402	30~1000	-2.61	-58.45	≤-22.61	PASS
			1000~26500	-2.61	-40.84	≤-22.61	PASS
		2440	30~1000	-3.63	-58.68	≤-23.63	PASS
			1000~26500	-3.63	-43.55	≤-23.63	PASS
		2480	30~1000	-3.97	-58.38	≤-23.97	PASS
			1000~26500	-3.97	-45.14	≤-23.97	PASS
BLE_2M	Ant1	2402	30~1000	-3.22	-59.14	≤-23.22	PASS
			1000~26500	-3.22	-45.22	≤-23.22	PASS
		2440	30~1000	-4.00	-58.12	≤-24	PASS
			1000~26500	-4.00	-48.08	≤-24	PASS
		2480	30~1000	-4.25	-58.8	≤-24.25	PASS
			1000~26500	-4.25	-44.81	≤-24.25	PASS

5.7.2 Test Graphs

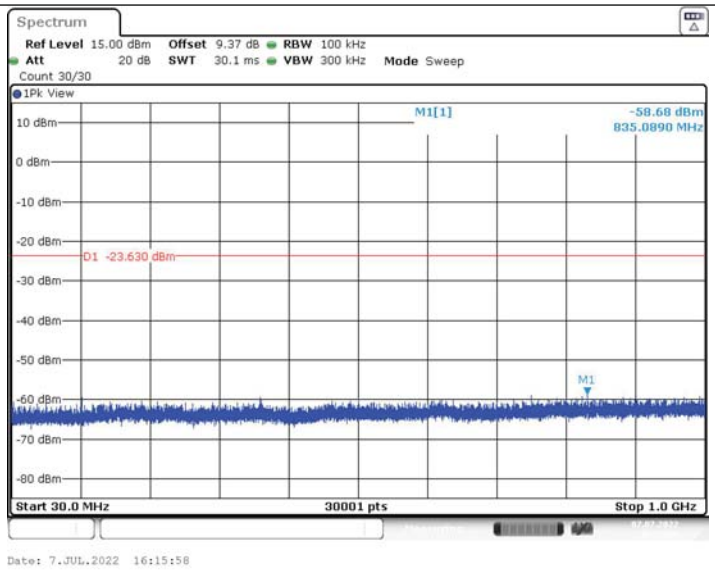
BLE_1M_Ant1_2402_30~1000



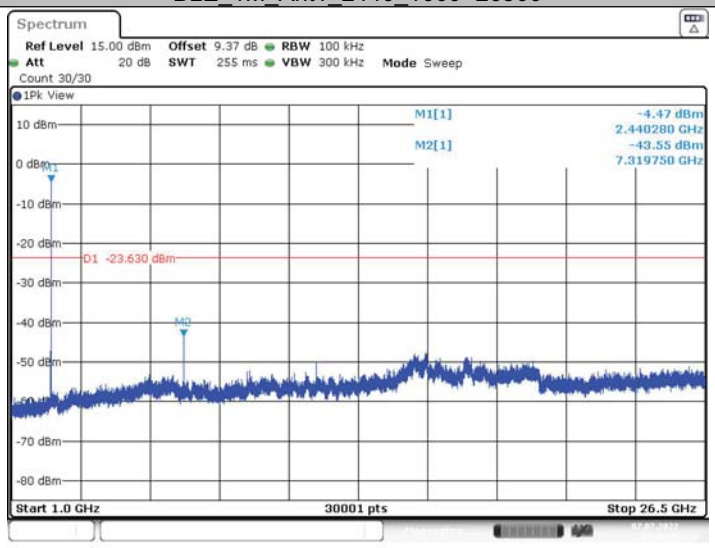
BLE_1M_Ant1_2402_1000~26500



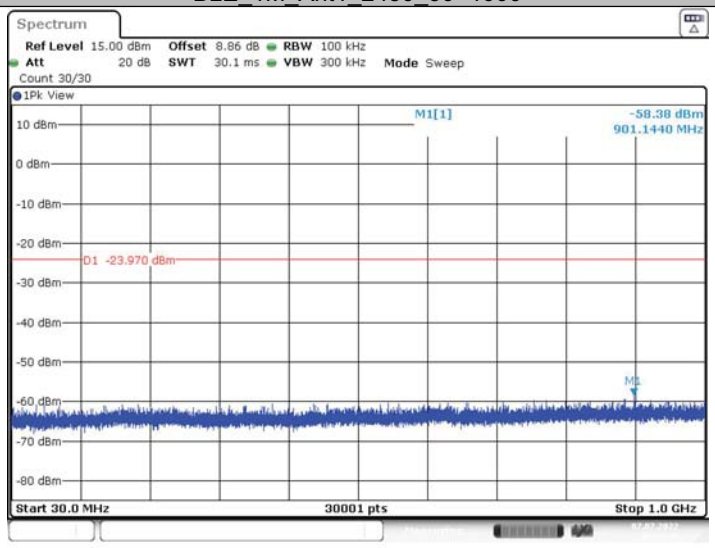
BLE_1M_Ant1_2440_30~1000



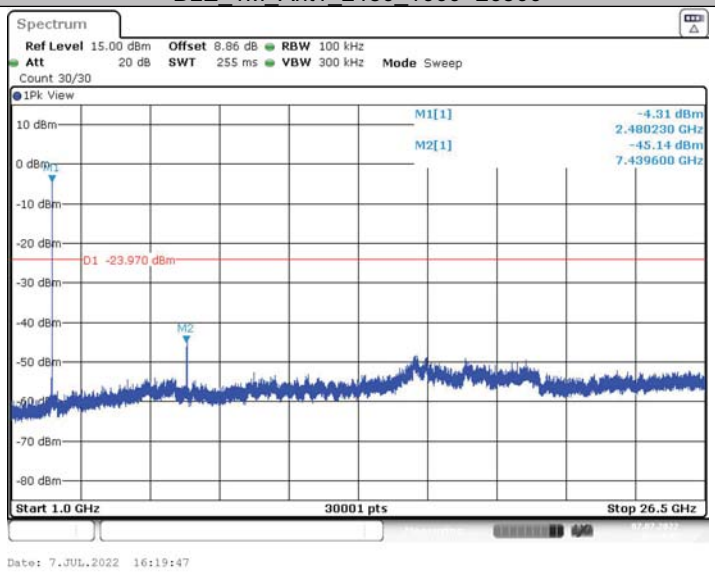
BLE_1M_Ant1_2440_1000~26500



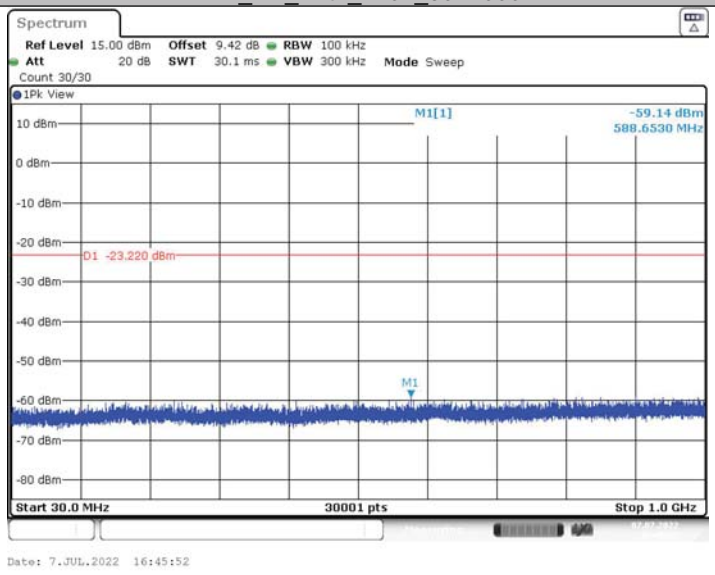
BLE_1M_Ant1_2480_30~1000



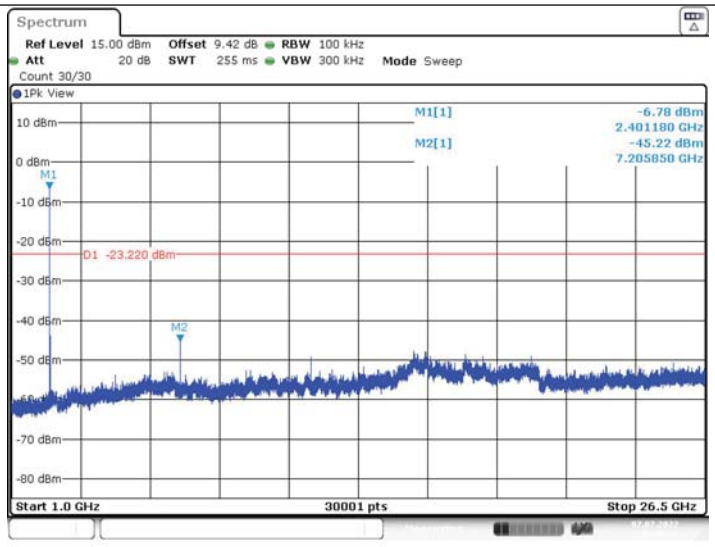
BLE_1M_Ant1_2480_1000~26500



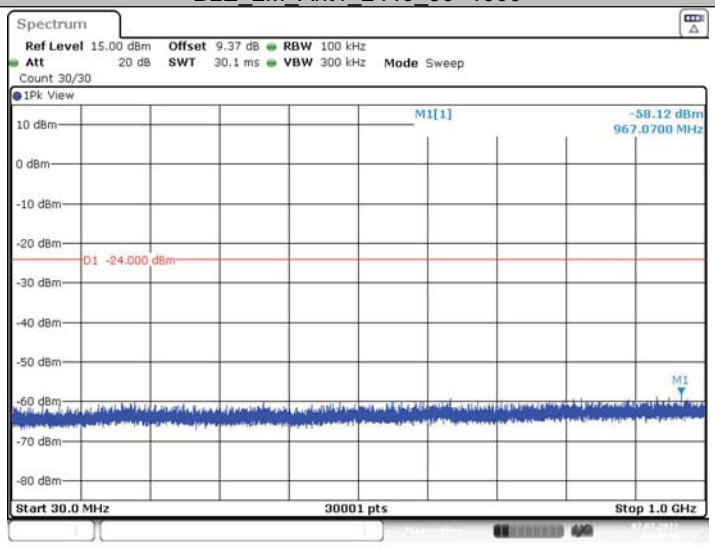
BLE_2M_Ant1_2402_30~1000



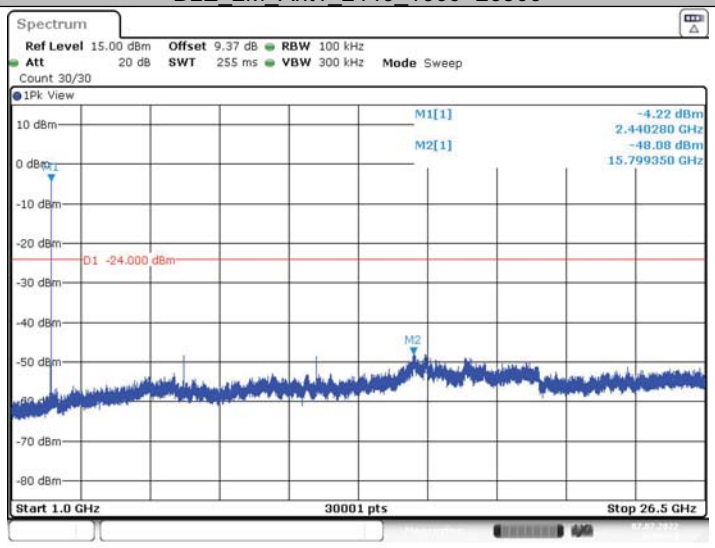
BLE_2M_Ant1_2402_1000~26500



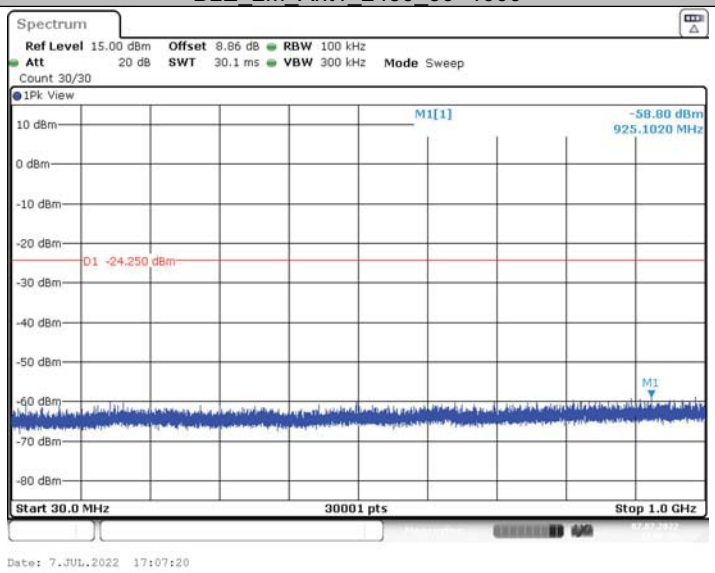
BLE_2M_Ant1_2440_30~1000



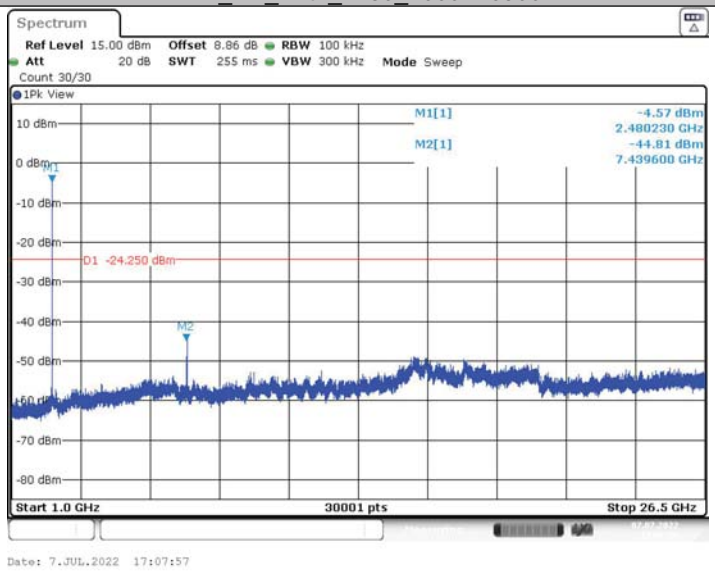
BLE_2M_Ant1_2440_1000~26500



BLE_2M_Ant1_2480_30~1000



BLE_2M_Ant1_2480_1000~26500



Important

(1) The test report is valid with the official seal of the laboratory and the signatures of Test engineer, Author and Reviewer simultaneously.

(2) The test report is invalid if altered.

(3) Any photocopies or part photocopies in the test report are forbidden without the written permission from the laboratory.

(4) Objections to the test report must be submitted to the laboratory within 15 days.

(5) Generally, commission test is responsible for the tested samples only.

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