FCC Part 15.247

TEST REPORT

For

CC&C Technologies Inc.

8F, 150, Jian Yi Road, Zhonghe District, New Taipei City, Taiwan 235, R. O. C.

FCC ID: PANBT505

Report Type:	**Product Type:**
Original Report	Bluetooth 5.0 Dual-mode Dongle

Report Producer : Jane Chen

Report Number : RXZ210511001RF01

Report Date : 2021-07-02

Reviewed By: Andy Shih

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Revision History

Revision	No.	Report Number	Issue Date	Description	Author/ Revised by
1.0	RXZ210511001	RXZ210511001RF01	2021-07-02	Original Report	Jane Chen

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1 General Information

1.1 Product Description for Equipment under Test (EUT)

Applicant	CC&C Technologies Inc.
	8F, 150, Jian Yi Road, Zhonghe District, New Taipei City, Taiwan 235, R. O. C.
Manufacturer	CC&C Technologies Inc.
	8F, 150, Jian Yi Road, Zhonghe District, New Taipei City, Taiwan 235, R. O. C.
Brand(Trade) Name	CC&C
Product (Equipment)	Bluetooth 5.0 Dual-mode Dongle
Main Model Name	BT-505
Frequency Range	BLE(1M) / BLE(2M) : 2402 ~ 2480 MHz
Transmit Power	BLE(1M) Mode : 6.65 dBm (0.005W) BLE(2M) Mode : 6.85 dBm (0.005W)
Modulation Technique	BLE(1M) / BLE(2M) : GFSK
Channel Separation	BLE(1M) / BLE(2M) : 2 MHz
Number of Channels	BLE(1M) / BLE(2M) : 40 Channels
Antenna Specification	BLE(1M) / BLE(2M) : Printed Antenna / -4.10 dBi
Power Operation (Voltage Range)	☐ AC 120V/60Hz ☐ Adapter I/P: ☐ By AC Power Cord ☐ PoE
	☒ DC Type ☐ Battery ☐ DC Power Supply ☒ External from USB 5V, 500mA ☐ External DC Adapter
	☐ Host System
Received Date	June 10, 2021
Date of Test	June 18, 2021 ~ June 22, 2021

**All measurement and test data in this report was gathered from production sample serial number: RXZ210511001-01 (Assigned by BACL, New Taipei Laboratory).*

1.2 Objective

This report is prepared on behalf of *CC&C Technologies Inc*. in accordance with Part 2, Subpart J, Part 15, Subparts A and C of the Federal Communication Commission's rules.

The objective is to determine compliance with FCC Part 15.247 rules for Output Power, Antenna Requirements, 6 dB Bandwidth, Power Spectral Density, 100 kHz Bandwidth of Band Edges Measurement, Conducted and Radiated Spurious Emissions.

1.3 Related Submittal(s)/Grant(s)

FCC Part 15.247 DSS Submittal with FCC ID: PANBT505

1.4 Test Methodology

All measurements contained in this report were conducted with ANSI C63.10-2013, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices.

KDB 558074 D01 Meas Guidance v05r02

1.5 Statement of Compliance

Decision Rule: No, (The test results do not include MU judgment)

Test Result: ☐ Valid acceptance ☐ False acceptance ☐ False rejection ☐ Valid rejection

Unless otherwise stated the results shown in this test report refer only to the sample(s) tested.

The determination of the test results does not require consideration of the uncertainty of the measurement, unless the assessment is required by customer agreement, regulation or standard document specification.

1.6 Measurement Uncertainty

Parameter		Uncertainty
AC Mains		+/- 3.82 dB
RF output power, conducted		+/- 0.84 dB
Power Spectral Density, conducted		+/- 0.566 dBm/3kHz
Occupied Bandwidth		+/- 0.162 MHz
Unwanted Emissions, conducted		+/- 1.672 dBm
Emissions, radiated	30 MHz~1GHz	+/- 5.46 dB
	1 GHz~6 GHz	+/- 5.24 dB
	6 GHz~18 GHz	+/- 5.62 dB
	18 GHz~40 GHz	+/- 5.86 dB
Temperature		+/- 0.401 °C
Humidity		+/- 2.6 %

1.7 Test Facility

The Test site used by Bay Area Compliance Laboratories Corp.(New Taipei Laboratory) to collect test data is located on

☒70, Lane 169, Sec. 2, Datong Road, Xizhi Dist., New Taipei City 22183, Taiwan, R.O.C.

Bay Area Compliance Laboratories Corp.(New Taipei Laboratory) is accredited to ISO 17025 by Taiwan Accreditation Foundation (TAF code: 3732) and the FCC designation No.TW3732 under the Mutual Recognition Agreement (MRA) in FCC Test. The facility also complies with the radiated and AC line conducted test site criteria set forth in ANSI C63.10.

2 System Test Configuration

2.1 Description of Test Configuration

For BLE mode, there are totally 40 channels.

Channel	Frequency (MHz)	Channel	Frequency (MHz)
0	2402	20	2442
1	2404	--	--
2	2406	--	--
3	2408	37	2476
--	--	38	2478
19	2440	39	2480

For BLE Modes were tested with channel 0, 19 and 39.

2.2 Equipment Modifications

No modification was made to the EUT.

2.3 EUT Exercise Software

The test software was used "RTLBATAPP"

Test Frequency		Low	Mid	High
Power Level Setting	BLE 1M	Default	Default	Default
	BLE 2M	Default	Default	Default

The EUT was configured for testing in an engineering mode which was provided by the manufacturer.

The worst-case data rates are determined to be as follows for each mode based upon investigations by measuring the average power and PSD across all data rates bandwidths, and modulations.

BLE 1M : 1 Mbps

BLE 2M : 2 Mbps

2.4 Support Equipment List and Details

Description	Manufacturer	Model Number	S/N
NB	DELL	E6410	8N7PXN1
AC adapter	DELL	DA90PE3-00	N/A

2.5 External Cable List and Details

Cable Description	Length (m)	From	To
N/A	N/A	N/A	N/A

2.6 Test Mode

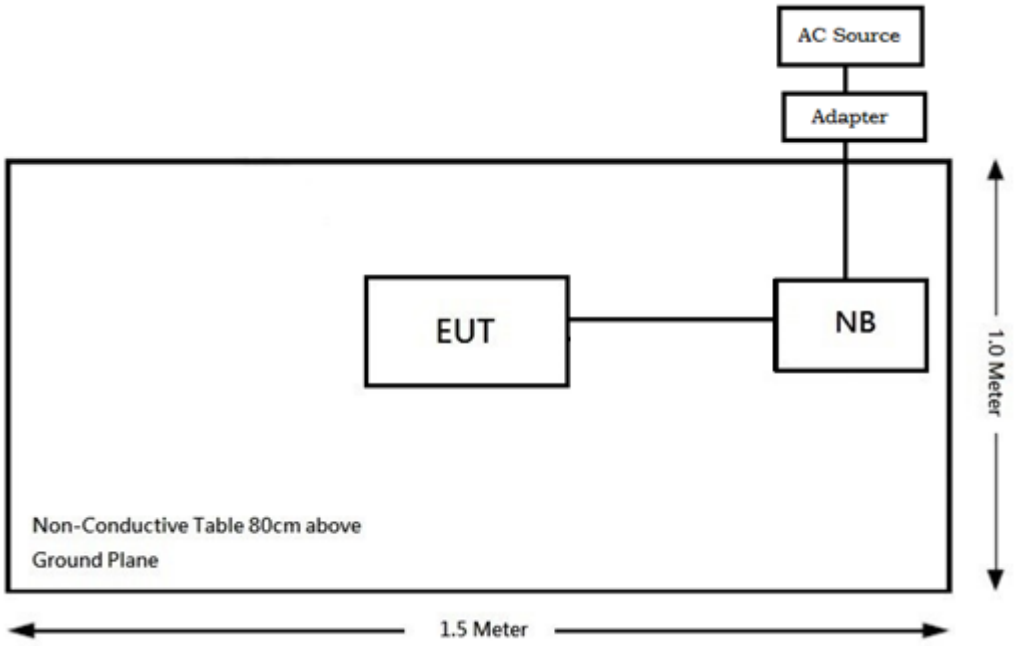
Full System (model: BT-505) for all test item.

2.7 Block Diagram of Test Setup

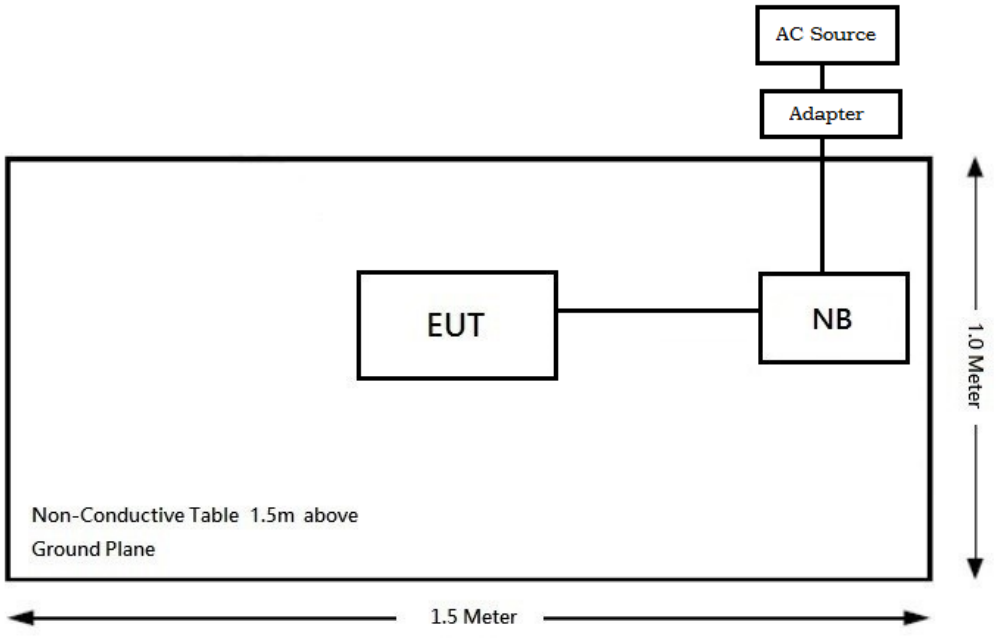
See test photographs attached in setup photos for the actual connections between EUT and support equipment.

Radiation:

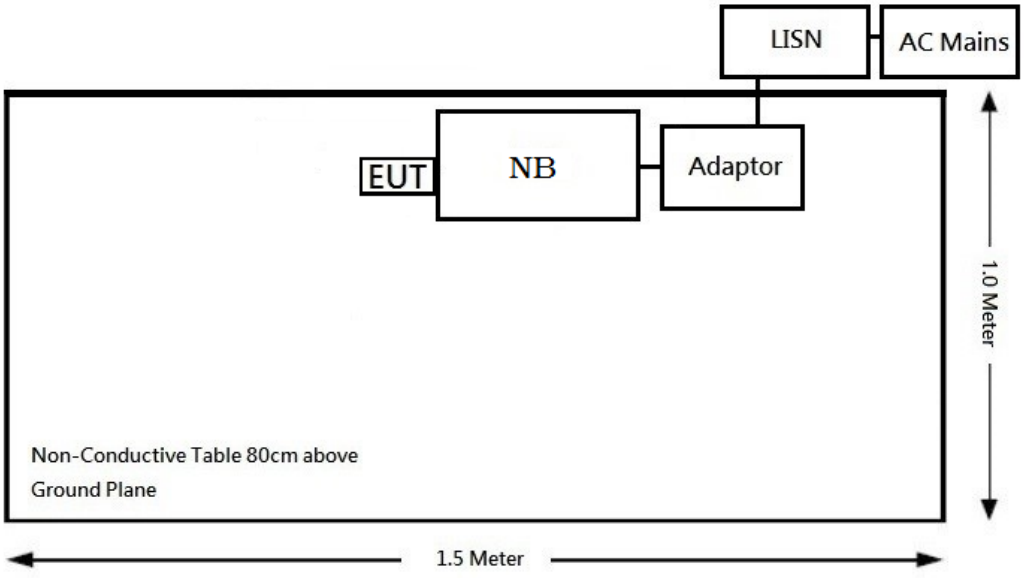
Below 1GHz:



Above 1GHz:



Conduction:


LISN
AC Mains
EUT
NB
Adaptor
1.0 Meter
Non-Conductive Table 80cm above
Ground Plane
1.5 Meter

2.8 Duty Cycle

According to KDB 558074 D01 15.247 Meas Guidance v05r02 section 6.0:

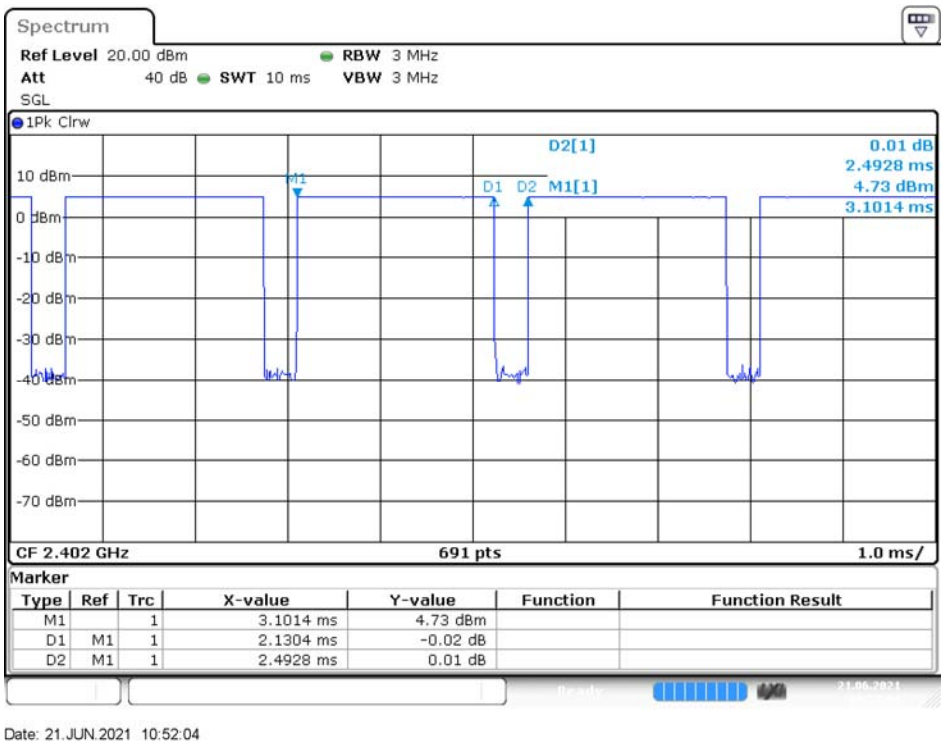
All measurements are to be performed with the EUT transmitting at 100% duty cycle at its maximum power control level; however, if 100% duty cycle cannot be achieved, measurements of duty cycle, x, and maximumpower transmission duration, T, are required for each tested mode of operation.

Radio Mode	On Time (ms)	Period (ms)	Duty Cycle (%)	Duty Cycle Correction Factor (dB)
BLE(1M)	2.1304	2.4928	85	0.71
BLE(2M)	1.087	1.8841	58	2.37

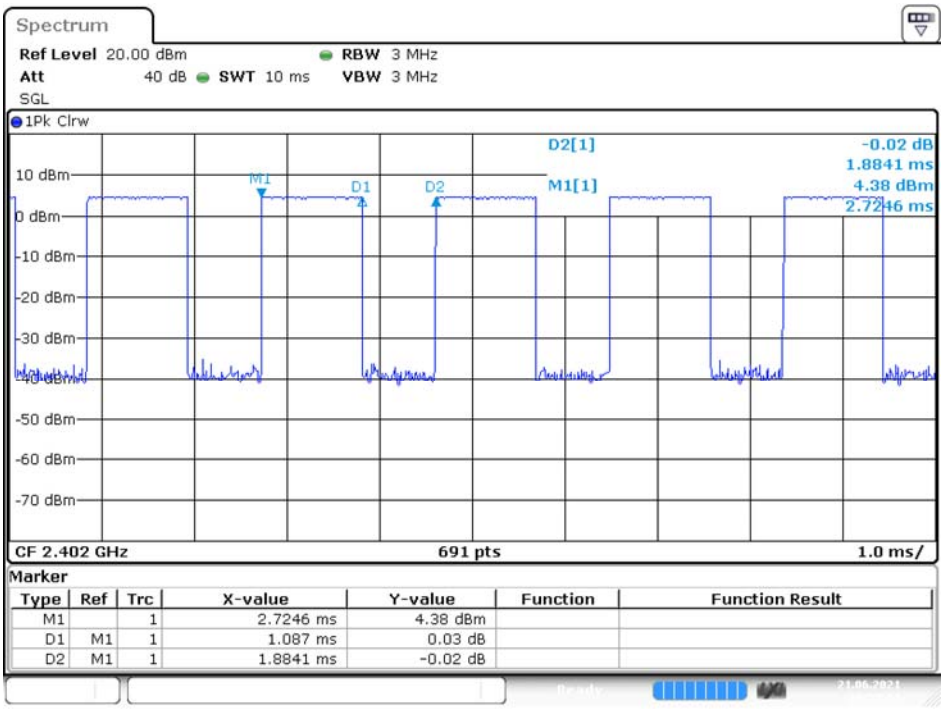
Note: Duty Cycle Correction Factor = 10*log(1/duty cycle)

Please refer to the following plots.

BLE(1M) Mode



BLE(2M) Mode



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3 Summary of Test Results

FCC Rules	Description of Test	Results
§15.247(i), §1.1310, §2.1093	RF Exposure	Compliance
§15.203	Antenna Requirement	Compliance
§15.207(a)	AC Line Conducted Emissions	Compliance
§15.205, §15.209, §15.247(d)	Spurious Emissions	Compliance
§15.247(a)(2)	6 dB Emission Bandwidth	Compliance
§15.247(b)(3)	Maximum Peak Output Power	Compliance
§15.247(d)	100 kHz Bandwidth of Frequency Band Edge	Compliance
§15.247(e)	Power Spectral Density	Compliance

4 Test Equipment List and Details

Description	Manufacturer	Model	Serial Number	Calibration Date	Calibration Due Date
AC Line Conduction Room (CON-A)					
LISN	Rohde & Schwarz	ENV216	101612	2020/12/30	2021/12/29
LISN	COM-POWER	LI-550A	211726	2020/12/30	2021/12/29
EMI Test Receiver	Rohde & Schwarz	ESR3	102099	2021/6/2	2022/6/1
Pulse Limiter	Rohde & Schwarz	ESH3Z2	TXZEM104	2020/7/31	2021/7/31
RF Cable	EMEC	EM-CB5D	1	2021/6/11	2022/6/11
Software	AUDIX	E3	V9.150826k	N.C.R	N.C.R
Radiated Room (966-A)					
Bilog Antenna with 6 dB Attenuator	SUNOL SCIENCES & MINI-CIRCUITS	JB6/UNAT-6+	A050115/15542_01	2021/1/19	2022/1/18
EMI Test Receiver	Rohde & Schwarz	ESR7	101419	2020/11/12	2021/11/11
Horn Antenna	EMCO	SAS-571	1020	2021/4/23	2022/4/22
Horn Antenna	ETS-Lindgren	3116	62638	2020/8/20	2021/8/19
Preamplifier	Sonoma	310N	130602	2021/6/8	2022/6/7
Preamplifier	A.H.	PAM-0118P	466	2020/11/05	2021/11/04
Microware Preamplifier	EM Electronics Corporation	EM18G40G	60656	2020/12/30	2021/12/29
Spectrum Analyzer	Rohde & Schwarz	FSV40	101435	2021/1/7	2022/1/6
Micro flex Cable	UTIFLEX	UFB197C-1-2362-70U-70U	225757-001	2021/2/1	2022/1/31
Coaxial Cable	COMMATE	PEWC	8Dr	2020/12/25	2021/12/24
Coaxial Cable	UTIFLEX	UFB311A-Q-1440-300300	220490-006	2021/2/1	2022/1/31
Micro flex Cable	ROSNOL	K1K50-UP0264-K1K50-450CM	160309-1	2021/2/1	2022/1/31
Software	Farad	EZ_EMC	BACL-03A1	N.C.R	N.C.R
Conducted Room					
Spectrum Analyzer	Rohde & Schwarz	FSV40	101140	2021/1/7	2022/1/6
Cable	WOKEN	SFL402	S02-160323-07	2021/1/28	2022/1/28

Power Sensor	KEYSIGHT	U2021XA	MY54080018	2021/1/28	2022/1/28
Attenuator	MINI-CIRCUITS	BW-S10W5+	N/A	2021/6/15	2024/6/14
Power Splitter	Mini-Circuits	ZFRSC-183-S+	S F448201614	2020/6/23	2021/6/23

***Statement of Traceability:** BACL Corp. attests that all of the calibrations on the equipment items listed above were traceable to the SI System of Units via the R.O.C. Center for Measurement Standards of the Electronics Testing Center, Taiwan (ETC) or to another internationally recognized National Metrology Institute (NMI), and were compliant with the current Taiwan Accreditation Foundation (TAF) requirements*

5 FCC §15.247(i), §1.1310, § 2.1093 - RF Exposure

5.1 Applicable Standard

According to §2.1093 and §1.1307(b)(1), systems operating under the provisions of this section shall be operated in a manner that ensure that the public is not exposed to radio frequency energy level in excess of the Commission's guideline.

According to KDB 447498 D01 General RF Exposure Guidance v06

The 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at test separation distances ≤ 50 mm are determined by:

[(max. power of channel, including tune-up tolerance, mW)/(min. test separation distance, mm)] · [√f(GHz)] ≤ 3.0 for 1-g SAR and ≤ 7.5 for 10-g extremity SAR, where

1. f(GHz) is the RF channel transmit frequency in GHz.
2. Power and distance are rounded to the nearest mW and mm before calculation.
3. The result is rounded to one decimal place for comparison.
4. When the minimum test separation distance is < 5 mm, a distance of 5 mm is applied to determine SAR test Exclusion.

5.2 RF Exposure Evaluation Result

RF Exposure evaluation:

Mode	Frequency	Tunp-up Average Power		Evaluation Distrance	Calculated Value	Threshold	SAR Test Exclusion
	(MHz)	(dBm)	(mW)	(mm)		(1-g SAR)	
BT	2402-2480	7	5.01	5	1.6	3	Yes
BLE	2402-2480	7	5.01	5	1.6	3	Yes

Result: SAR test is exempted.

6 FCC §15.203 – Antenna Requirements

6.1 Applicable Standard

According to § 15.203,

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the user of a standard antenna jack or electrical connector is prohibited.

And according to FCC 47 CFR section 15.247 (b), if the transmitting antennas of directional gain greater than 6dBi are used, the power shall be reduced by the amount in dB that the directional gain of the antenna does not exceed 6dBi.

6.2 Antenna Information

Manufacturer	Model	Type	Antenna Gain	Result
CC&C Technologies, Inc.	BT-330S-V2	Printed Antenna	-4.10 dBi	Compliance

The EUT has one integral antenna arrangement, which was permanently attached; fulfill the requirement of this section.

7 FCC §15.207(a) – AC Line Conducted Emissions

7.1 Applicable Standard

According to §15.207

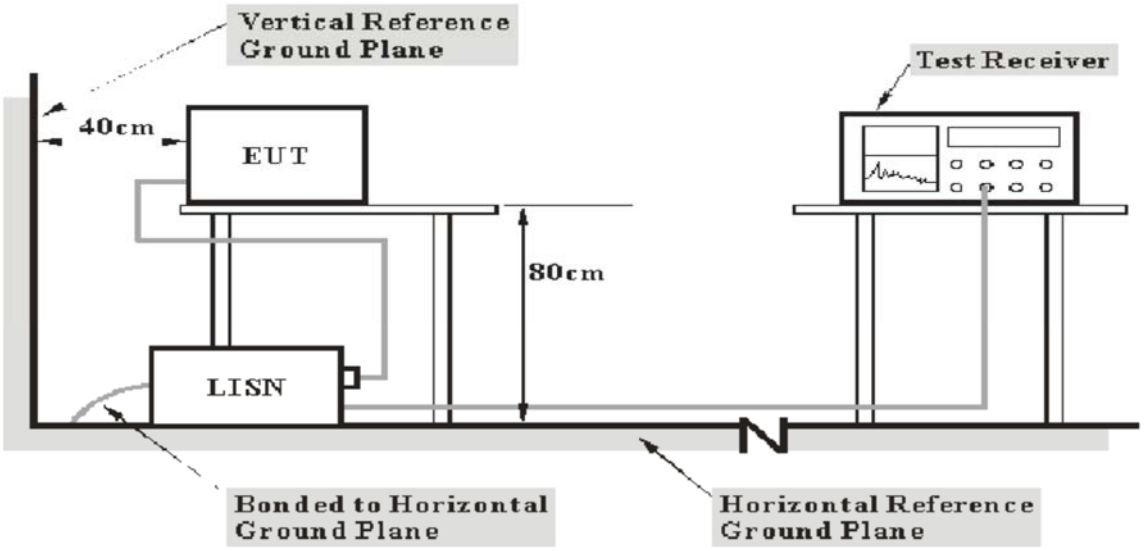
For an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed the limits in the following table, as measured using a 50 μH/50 ohms line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequencies ranges.

Frequency of Emission (MHz)	Conducted Limit (dBuV)	
	Quasi-Peak	Average
0.15-0.5	66 to 56 Note 1	56 to 46 Note 2
0.5-5	56	46
5-30	60	50

Note 1: Decreases with the logarithm of the frequency.

Note 2: A linear average detector is required

7.2 EUT Setup



Note: 1. Support units were connected to second LISN.
2. Both of LISNs (AMN) 80 cm from EUT and at the least 80 cm from other units and other metal planes support units.

The setup of EUT is according with per ANSI C63.10-2013 measurement procedure. The specification used was with the FCC Part 15.207 limits.

7.3 EMI Test Receiver Setup

The EMI test receiver was set to investigate the spectrum from 150kHz to 30MHz.

During the conducted emission test, the EMI test receiver was set with the following configurations

Frequency Range	IF B/W
150kHz – 30MHz	9kHz

7.4 Test Procedure

During the conducted emission test, the adapter was connected to the outlet of the LISN.

Maximizing procedure was performed on the six (6) highest emissions of the EUT.

All data was recorded in the Quasi-peak and average detection mode.

7.5 Corrected Factor & Margin Calculation

The factor is calculated by adding LISN/ISN VDF (Voltage Division Factor), Cable Loss and Transient Limiter Attenuation. The basic equation is as follows:

Factor = LISN VDF + Cable Loss + Transient Limiter Attenuation

The "Over Limit" column of the following data tables indicates the degree of compliance with the applicable limit. For example, an over limit of -7 dB means the emission is 7 dB below the limit. The equation for Over Limit calculation is as follows:

Over Limit = Level – Limit Line

7.6 Environmental Conditions

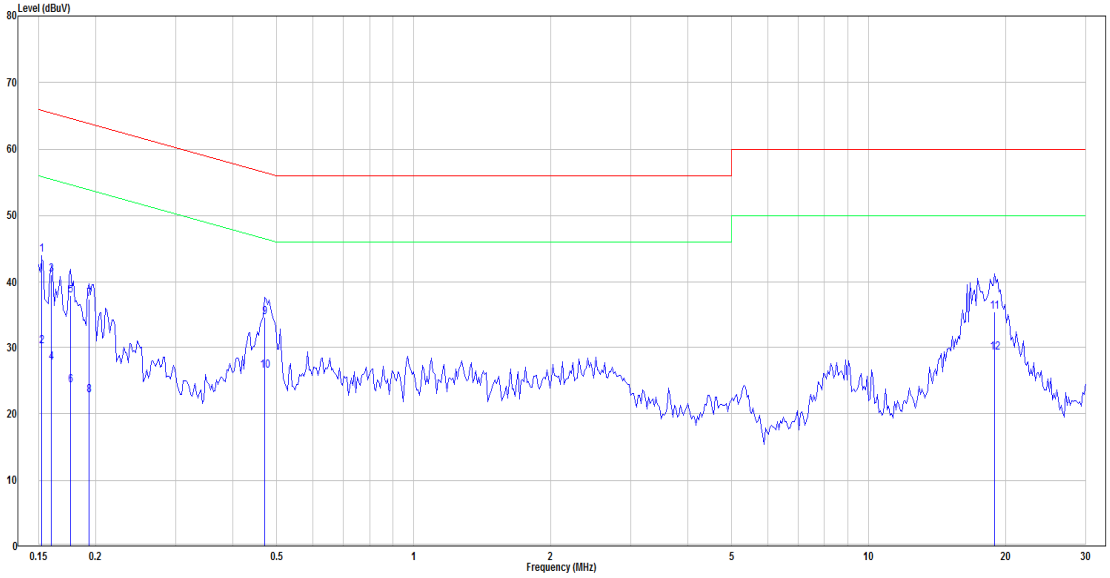
Temperature:	22.5 ℃
Relative Humidity:	45 %
ATM Pressure:	1010 hPa

The testing was performed by Ken Yu on 2021-06-22.

7.7 Test Results

Test Mode: Transmitting

Main: AC120 V, 60 Hz, Line



No.	Frequency (MHz)	Reading (dBµV)	Correct Factor(dB)	Result (dBµV)	Limit (dBµV)	Over limit (dB)	Remark
1	0.152	24.53	19.59	44.12	65.87	-21.75	QP
2	0.152	10.53	19.59	30.12	55.87	-25.75	Average
3	0.160	21.49	19.59	41.08	65.49	-24.41	QP
4	0.160	8.18	19.59	27.77	55.49	-27.72	Average
5	0.176	18.26	19.59	37.85	64.66	-26.81	QP
6	0.176	4.75	19.59	24.34	54.66	-30.32	Average
7	0.193	17.64	19.58	37.23	63.90	-26.68	QP
8	0.193	3.27	19.58	22.85	53.90	-31.05	Average
9	0.471	14.91	19.58	34.49	56.50	-22.01	QP
10	0.471	6.86	19.58	26.44	46.50	-20.06	Average
11	18.925	15.48	19.84	35.32	60.00	-24.68	QP
12	18.925	9.36	19.84	29.20	50.00	-20.80	Average

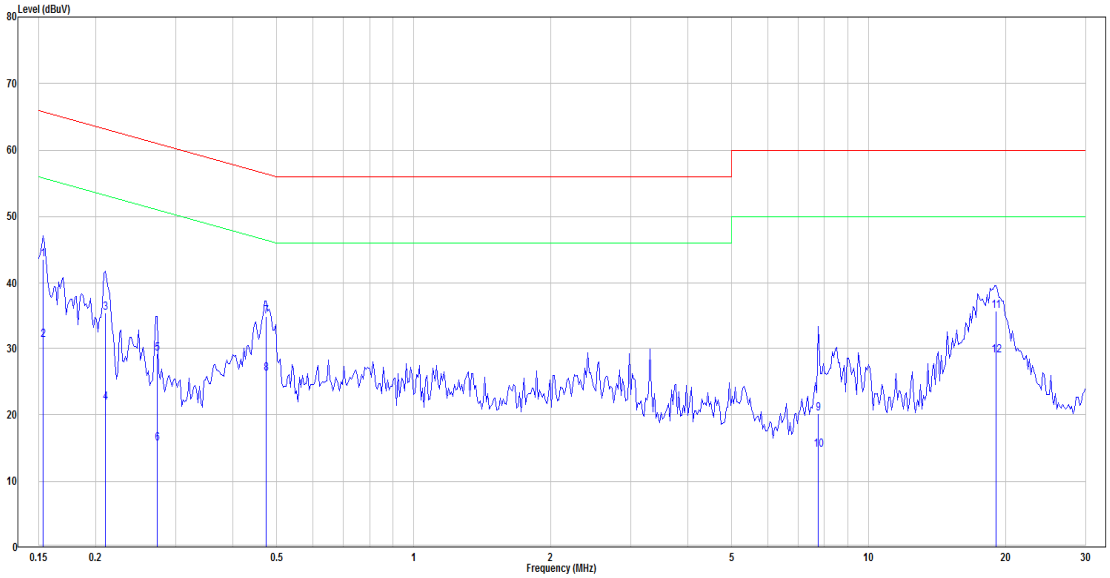
Note:

Level = Read Level + Factor

Over Limit = Level – Limit Line

Factor = (LISN, ISN, PLC or current probe) Factor + Cable Loss + Attenuator

Main: AC120 V, 60 Hz, Neutral



No.	Frequency	Reading	Correct	Result	Limit	Over limit	Remark
	(MHz)	(dBµV)	Factor(dB)	(dBµV)	(dBµV)	(dB)	
1	0.153	24.01	19.59	43.60	65.81	-22.21	QP
2	0.153	11.67	19.59	31.26	55.81	-24.55	Average
3	0.210	15.84	19.58	35.42	63.19	-27.77	QP
4	0.210	2.26	19.58	21.84	53.19	-31.35	Average
5	0.273	9.66	19.58	29.24	61.03	-31.79	QP
6	0.273	-3.84	19.58	15.74	51.03	-35.29	Average
7	0.475	15.22	19.58	34.80	56.43	-21.63	QP
8	0.475	6.58	19.58	26.16	46.43	-20.27	Average
9	7.766	0.41	19.75	20.16	60.00	-39.84	QP
10	7.766	-5.03	19.75	14.72	50.00	-35.28	Average
11	19.071	15.76	19.87	35.63	60.00	-24.37	QP
12	19.071	9.10	19.87	28.97	50.00	-21.03	Average

Note:

Level = Read Level + Factor

Over Limit = Level – Limit Line

Factor = (LISN, ISN, PLC or current probe) Factor + Cable Loss + Attenuator

8. FCC §15.209, §15.205 , §15.247(d) – Spurious Emissions

8.1 Applicable Standard

As per FCC §15.35(d): Unless otherwise specified, on any frequency or frequencies above 1000 MHz, the radiated emission limits are based on the use of measurement instrumentation employing an average detector function. Unless otherwise specified, measurements above 1000 MHz shall be performed using a minimum resolution bandwidth of 1MHz.

As Per FCC §15.205(a) except as show in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.090 – 0.110 0.495 – 0.505 2.1735 – 2.1905 4.125 – 4.128 4.17725 – 4.17775 4.20725 – 4.20775 6.215 – 6.218 6.26775 – 6.26825 6.31175 – 6.31225 8.291 – 8.294 8.362 – 8.366 8.37625 – 8.38675 8.41425 – 8.41475 12.29 – 12.293 12.51975 – 12.52025 12.57675 – 12.57725 13.36 – 13.41	16.42 – 16.423 16.69475 – 16.69525 16.80425 – 16.80475 25.5 – 25.67 37.5 – 38.25 73 – 74.6 74.8 – 75.2 108 – 121.94 123 – 138 149.9 – 150.05 156.52475 – 156.52525 156.7 – 156.9 162.0125 –167.17 167.72 – 173.2 240 – 285 322 – 335.4 399.9 – 410	608 – 614 960 – 1240 1300 – 1427 1435 – 1626.5 1645.5 – 1646.5 1660 – 1710 1718.8 – 1722.2 2200 – 2300 2310 – 2390 2483.5 – 2500 2690 – 2900 3260 – 3267 3.332 – 3.339 3 3458 – 3 358 3.600 – 4.400	4. 5 – 5. 15 5. 35 – 5. 46 7.25 – 7.75 8.025 – 8.5 9.0 – 9.2 9.3 – 9.5 10.6 – 12.7 13.25 – 13.4 14.47 – 14.5 15.35 – 16.2 17.7 – 21.4 22.01 – 23.12 23.6 – 24.0 31.2 – 31.8 36.43 – 36.5 Above 38.6

As per FCC §15.209(a): Except as provided elsewhere in this Subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

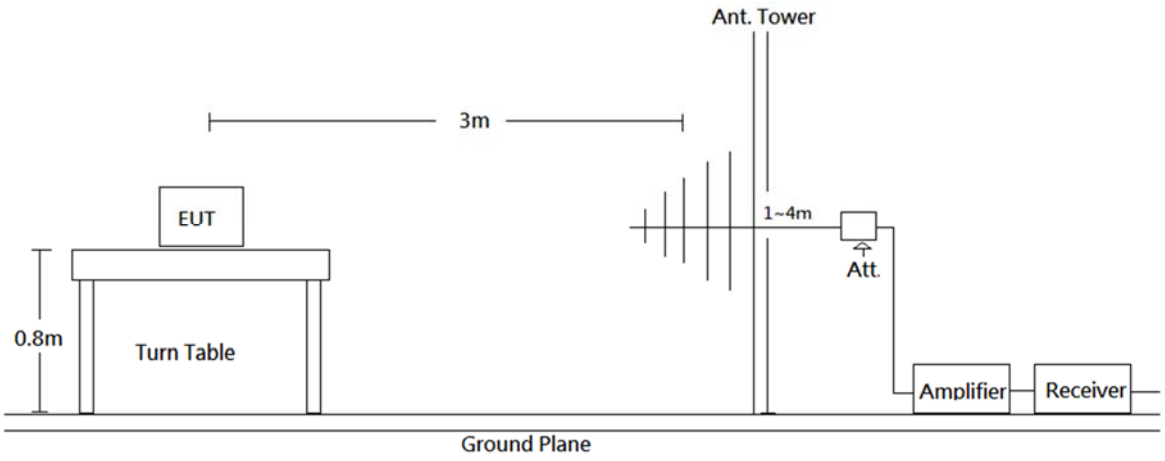
Frequency (MHz)	Field Strength (micro volts/meter)	Measurement Distance (meters)
0.009 - 0.490	2400/F(kHz)	300
0.490 - 1.705	24000/F(kHz)	30
1.705 - 30.0	30	30
30 - 88	100**	3
88 - 216	150**	3
216 - 960	200**	3
Above 960	500	3

** Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this Section shall not be located in the frequency bands 54-72 MHz, 76-88 MHz, 174-216 MHz or 470-806 MHz. However, operation within these frequency bands is permitted under other sections of this Part, e.g., Sections 15.231 and 15.241.

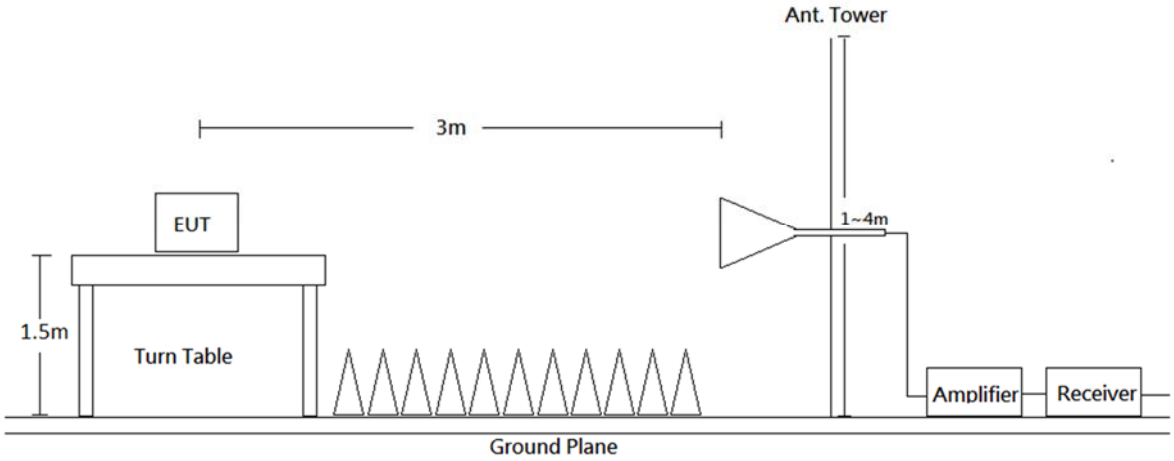
As per FCC §15.247 (d) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the 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. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c).

8.2 EUT Setup

Below 1 GHz:



Above 1 GHz:



Radiated emission tests were performed in the 3 meters chamber test site, using the setup accordance with the ANSI C63.10-2013. The specification used was the FCC Part 15.209 and FCC 15.247 Limits.

8.3 EMI Test Receiver & Spectrum Analyzer Setup

The system was investigated from 30 MHz to 26.5 GHz. During the radiated emission test, the EMI test receiver was set with the following configurations measurement method 6.3 in ANSI C63.10.

Frequency Range	RBW	VBW	Detector	Duty cycle	Measurement method
30-1000 MHz	120 kHz	/	QP		QP
Above 1 GHz	1 MHz	3 MHz	PK		PK
	1 MHz	3 MHz	RMS	>98%	Ave
	1 MHz	1/T	PK	<98%	Ave

8.4 Test Procedure

Maximizing procedure was performed on the highest emissions to ensure that the EUT complied with all installation combinations.

All data was recorded in the Quasi-peak detector mode from 30 MHz to 1 GHz and PK and average detector modes for frequencies above 1 GHz.

8.5 Corrected Factor & Margin Calculation

The Correct Factor is calculated by adding the Antenna Factor and Cable Loss, and subtracting the Amplifier Gain from the Meter Reading. The basic equation is as follows:

Correct Factor = Antenna Factor + Cable Loss – Amplifier Gain

The "Margin" column of the following data tables indicates the degree of compliance with the applicable limit. For example, a margin of -7 dB means the emission is 7 dB below the limit. The equation for margin calculation is as follows:

Margin = Result – Limit

8.6 Test Results Summary

According to the data in the following table, the EUT complied with the FCC §15.209 Limit.

8.7 Environmental Conditions

Radiation Spurious Emissions		Conducted Spurious Emissions	
Temperature:	24.8 ℃	**Temperature:**	23.8 ℃
Relative Humidity:	63 %	**Relative Humidity:**	54 %
ATM Pressure:	1010 hPa	**ATM Pressure:**	1010 hPa

The Radiation Spurious Emissions testing was performed by Ken Yu on 2021-06-18~2021-06-21.

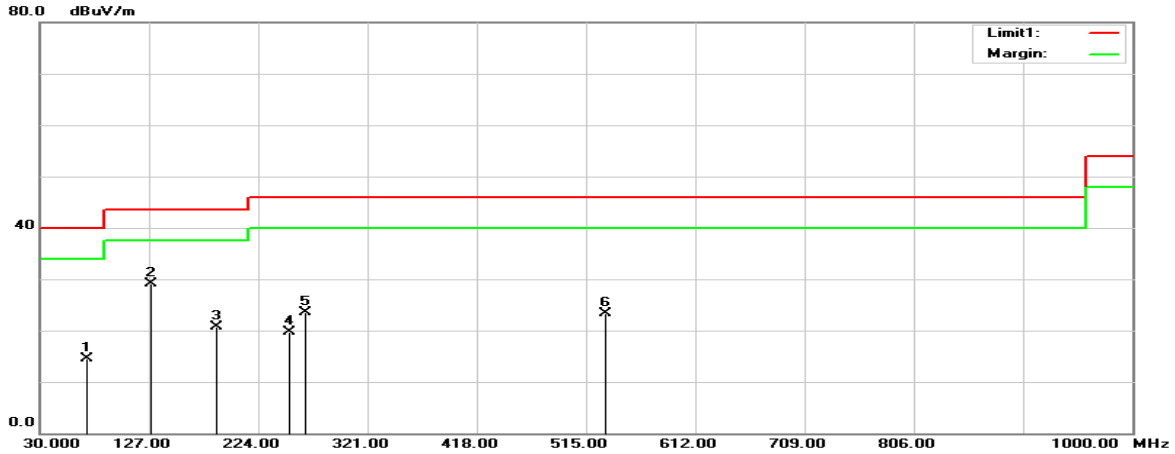
The Conducted Spurious Emissions testing was performed by David Hsu on 2021-06-21.

8.8 Test Results

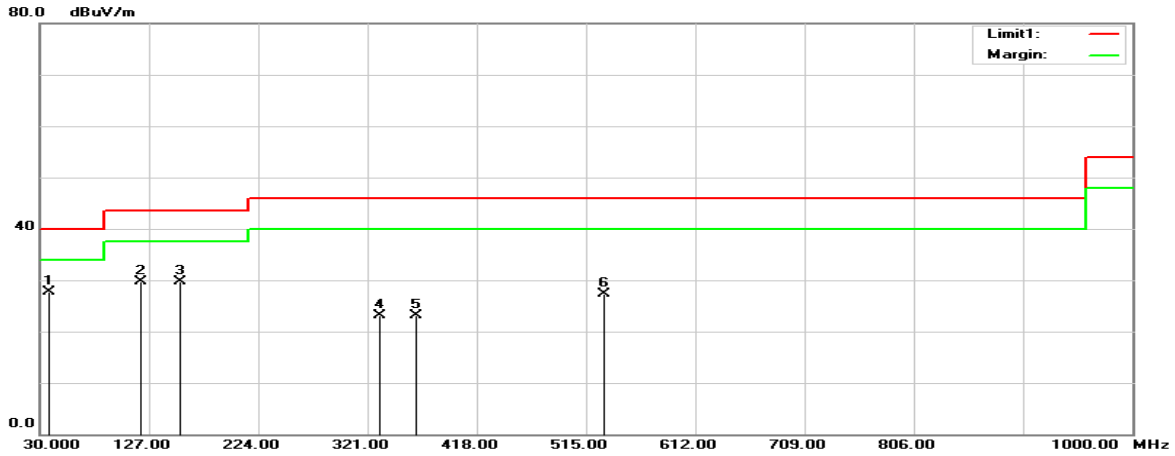
Test Mode: Transmitting *(Pre-scan with three orthogonal axis, and worse case as Y axis.)*

30MHz-1GHz: (*worst case is BLE 1M mode low channel*)

Horizontal



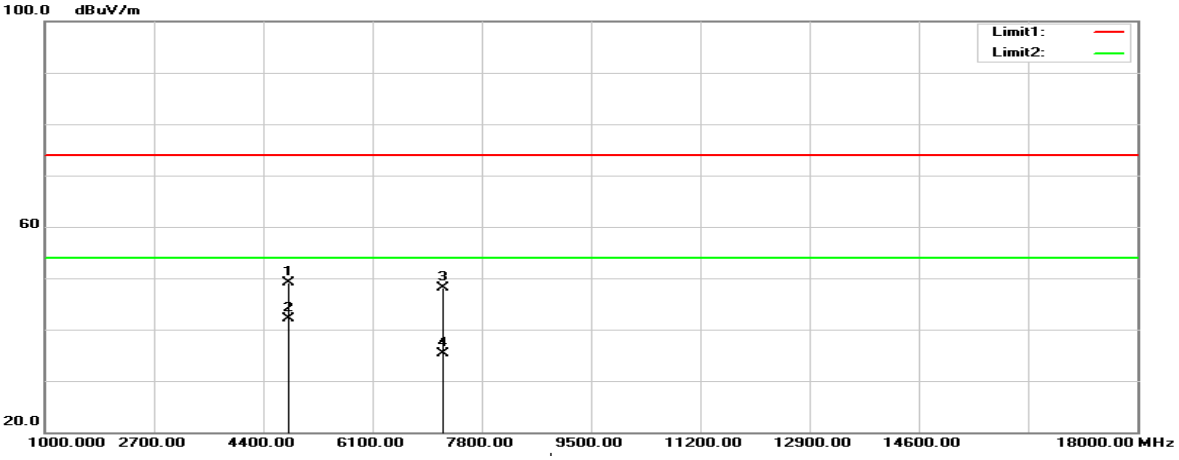
Vertical



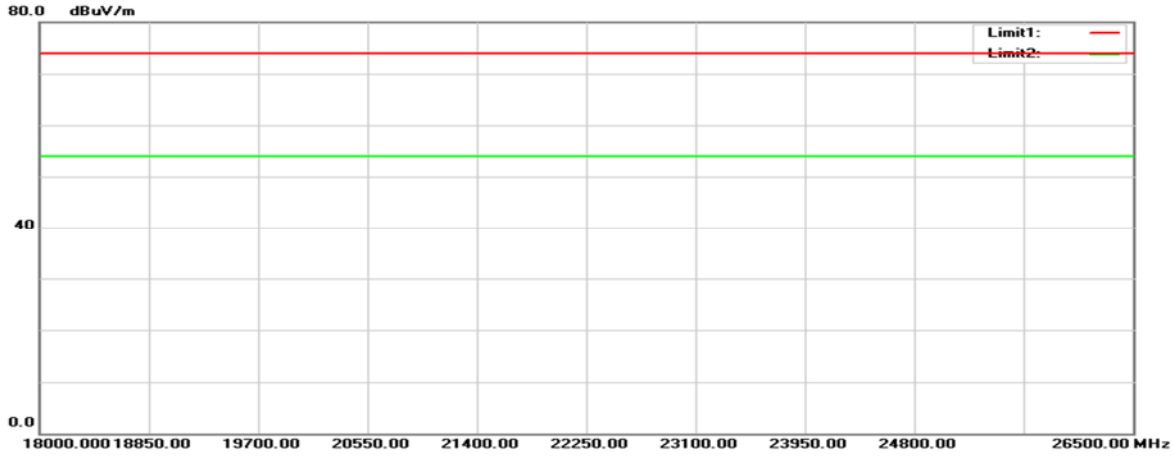
BLE(1M) Mode

Horizontal (*worst case is low channel*)

1GHz-18GHz:

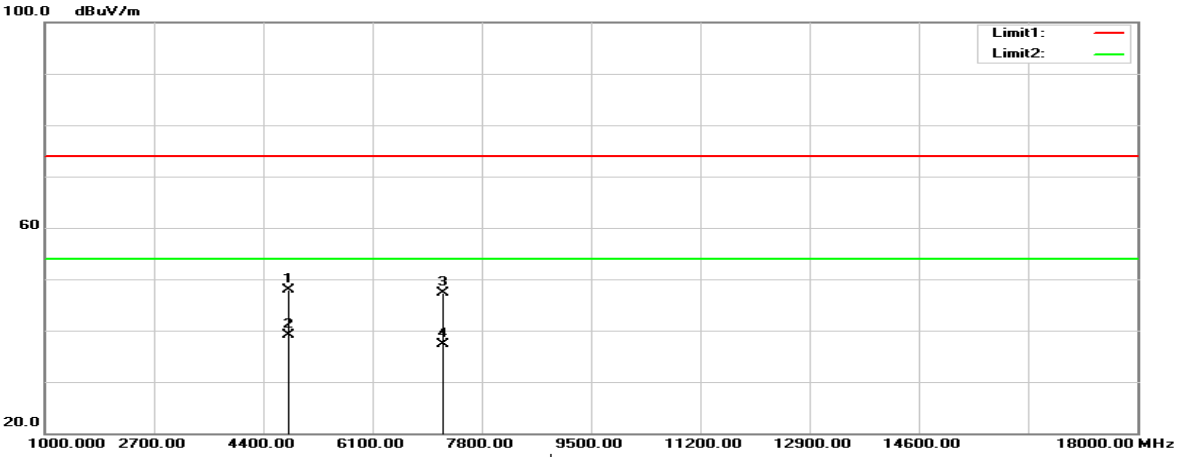


18GHz-26.5GHz:

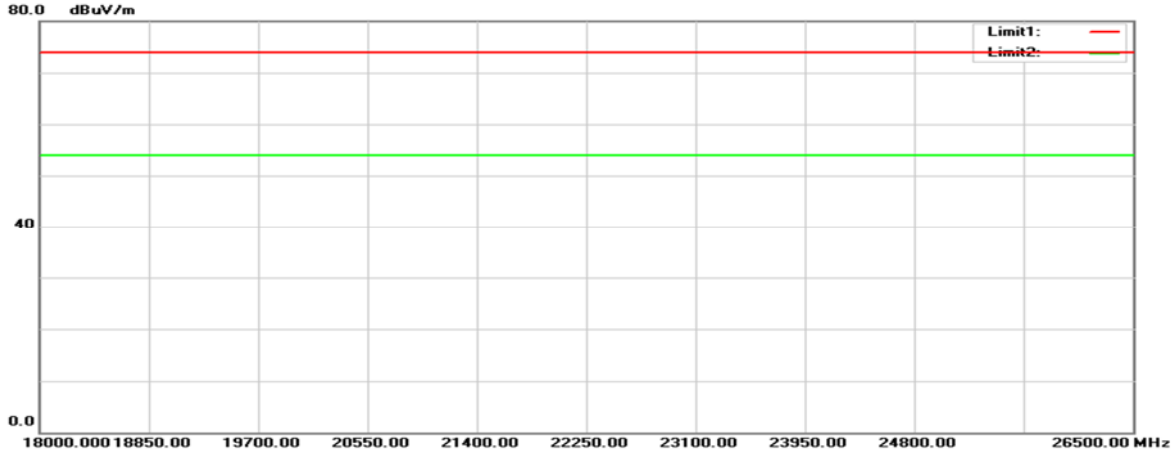


Vertical (*worst case is low channel*)

1GHz-18GHz:



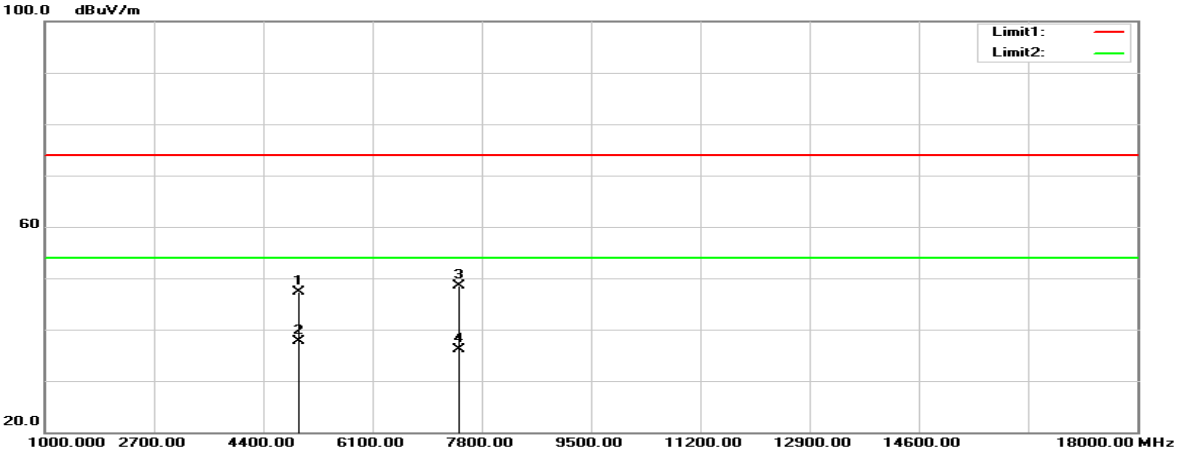
18GHz-26.5GHz:



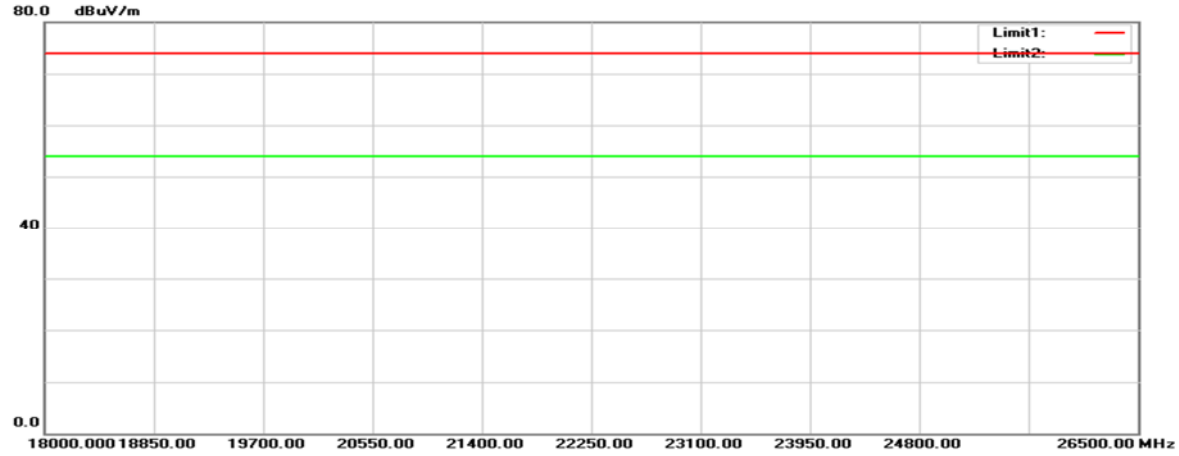
BLE(2M) Mode

Horizontal (*worst case is high channel*)

1GHz-18GHz:

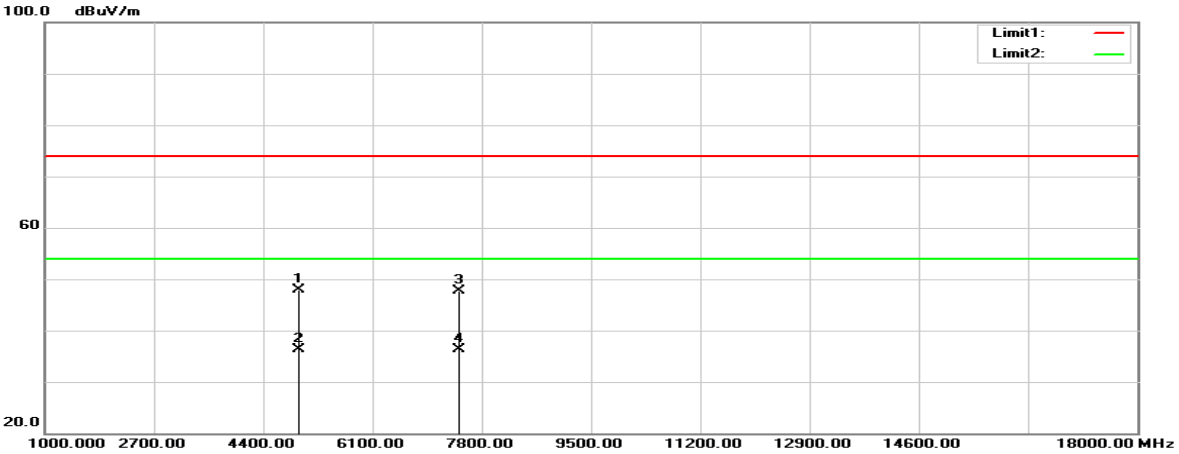


18GHz-26.5GHz:

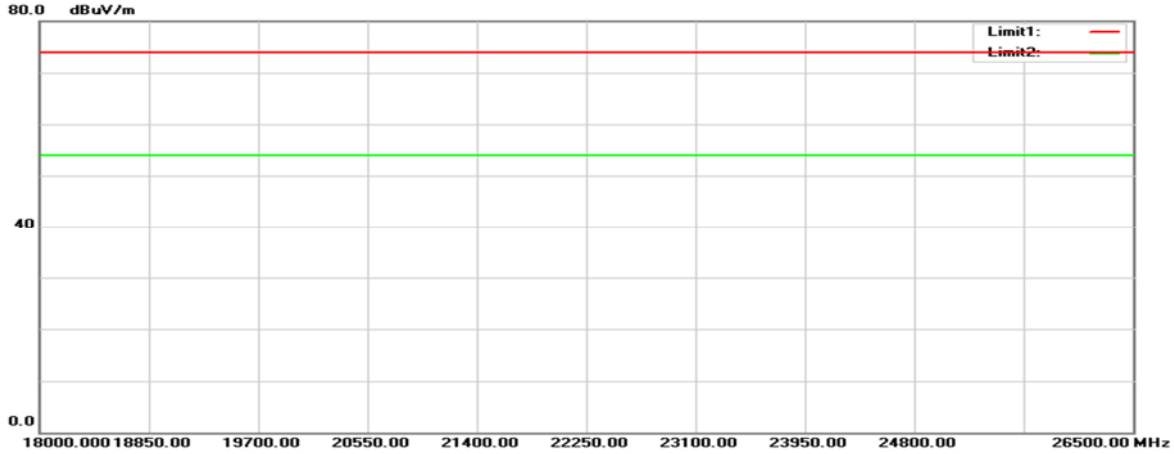


Vertical (*worst case is high channel*)

1GHz-18GHz:



18GHz-26.5GHz:



Below 1GHz

Horizontal

Frequency (MHz)	Reading (dBuV)	Correct Factor(dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Height (cm)	Degree (°)	Remark
71.7100	30.66	-16.14	14.52	40.00	-25.48	100	271	peak
128.9400	39.44	-10.31	29.13	43.50	-14.37	100	290	peak
187.1400	33.62	-12.89	20.73	43.50	-22.77	100	258	peak
252.1300	31.97	-12.29	19.68	46.00	-26.32	100	290	peak
265.7100	34.26	-10.80	23.46	46.00	-22.54	100	132	peak
532.4600	28.90	-5.64	23.26	46.00	-22.74	100	350	peak

Vertical

Frequency (MHz)	Reading (dBuV)	Correct Factor(dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Height (cm)	Degree (°)	Remark
37.7600	36.53	-8.77	27.76	40.00	-12.24	100	135	QP
119.2400	40.15	-10.54	29.61	43.50	-13.89	100	327	peak
155.1300	40.64	-10.96	29.68	43.50	-13.82	100	180	peak
331.6700	32.57	-9.44	23.13	46.00	-22.87	100	182	peak
364.6500	31.97	-8.79	23.18	46.00	-22.82	100	201	peak
531.4900	32.84	-5.63	27.21	46.00	-18.79	100	180	peak

Result = Reading + Correct Factor
Margin = Result – Limit
Correct Factor = Antenna Factor + Cable Loss – Amplifier Gain
Spurious emissions more than 20 dB below the limit were not reported.

BLE(1M) Mode

Above 1GHz

Horizontal

Frequency (MHz)	Reading (dBµV)	Correct Factor(dB/m)	Result (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Degree (°)	Remark
Low channel								
2390.000	56.44	-10.23	46.21	74.00	-27.79	122	207	peak
2390.000	45.04	-10.23	34.81	54.00	-19.19	122	207	AVG
2402.000	108.40	-10.14	98.26	N/A	N/A	122	207	peak
2402.000	107.80	-10.14	97.66	N/A	N/A	122	207	AVG
4804.000	52.38	-3.28	49.10	74.00	-24.90	144	173	peak
4804.000	45.43	-3.28	42.15	54.00	-11.85	144	173	AVG
7206.000	44.97	3.10	48.07	74.00	-25.93	150	312	peak
7206.000	32.16	3.10	35.26	54.00	-18.74	150	312	AVG
Middle channel								
2390.000	56.86	-10.23	46.63	74.00	-27.37	136	204	peak
2390.000	44.48	-10.23	34.25	54.00	-19.75	136	204	AVG
2440.196	107.33	-9.82	97.51	N/A	N/A	136	204	peak
2440.196	106.79	-9.82	96.97	N/A	N/A	136	204	AVG
2483.500	55.06	-9.26	45.80	74.00	-28.20	136	204	peak
2483.500	44.41	-9.26	35.15	54.00	-18.85	136	204	AVG
4880.000	51.15	-3.03	48.12	74.00	-25.88	150	309	peak
4880.000	42.53	-3.03	39.50	54.00	-14.50	150	309	AVG
7320.000	45.35	4.07	49.42	74.00	-24.58	150	83	peak
7320.000	32.17	4.07	36.24	54.00	-17.76	150	83	AVG
High channel								
2480.004	107.87	-9.31	98.56	N/A	N/A	118	209	peak
2480.004	107.26	-9.31	97.95	N/A	N/A	118	209	AVG
2483.500	56.69	-9.26	47.43	74.00	-26.57	118	209	peak
2483.500	45.68	-9.26	36.42	54.00	-17.58	118	209	AVG
4960.000	51.07	-2.69	48.38	74.00	-25.62	143	209	peak
4960.000	41.12	-2.69	38.43	54.00	-15.57	143	209	AVG
7440.000	44.10	4.25	48.35	74.00	-25.65	150	144	peak
7440.000	31.84	4.25	36.09	54.00	-17.91	150	144	AVG

Result = Reading + Correct Factor
Margin = Result – Limit
Correct Factor = Antenna Factor + Cable Loss – Amplifier Gain
Spurious emissions more than 20 dB below the limit were not reported.

Vertical

Frequency (MHz)	Reading (dBµV)	Correct Factor(dB/m)	Result (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Degree (°)	Remark
Low channel								
2390.000	55.89	-10.23	45.66	74.00	-28.34	107	216	peak
2390.000	44.40	-10.23	34.17	54.00	-19.83	107	216	AVG
2402.100	102.59	-10.13	92.46	N/A	N/A	107	216	peak
2402.100	101.99	-10.13	91.86	N/A	N/A	107	216	AVG
4804.000	51.11	-3.28	47.83	74.00	-26.17	150	279	peak
4804.000	42.46	-3.28	39.18	54.00	-14.82	150	279	AVG
7206.000	44.30	3.10	47.40	74.00	-26.60	150	130	peak
7206.000	34.20	3.10	37.30	54.00	-16.70	150	130	AVG
Middle channel								
2390.000	54.82	-10.23	44.59	74.00	-29.41	100	214	peak
2390.000	44.40	-10.23	34.17	54.00	-19.83	100	214	AVG
2439.712	102.26	-9.82	92.44	N/A	N/A	100	214	peak
2439.712	101.71	-9.82	91.89	N/A	N/A	100	214	AVG
2483.500	54.78	-9.26	45.52	74.00	-28.48	100	214	peak
2483.500	44.46	-9.26	35.20	54.00	-18.80	100	214	AVG
4880.000	50.42	-3.03	47.39	74.00	-26.61	152	309	peak
4880.000	40.50	-3.03	37.47	54.00	-16.53	152	309	AVG
7320.000	44.15	4.07	48.22	74.00	-25.78	150	83	peak
7320.000	32.63	4.07	36.70	54.00	-17.30	150	83	AVG
High channel								
2479.840	104.85	-9.31	95.54	N/A	N/A	102	199	peak
2479.840	104.29	-9.31	94.98	N/A	N/A	102	199	AVG
2483.500	55.88	-9.26	46.62	74.00	-27.38	102	199	peak
2483.500	44.85	-9.26	35.59	54.00	-18.41	102	199	AVG
4960.000	50.08	-2.69	47.39	74.00	-26.61	150	1	peak
4960.000	40.38	-2.69	37.69	54.00	-16.31	150	1	AVG
7440.000	44.85	4.25	49.10	74.00	-24.90	150	237	peak
7440.000	32.02	4.25	36.27	54.00	-17.73	150	237	AVG

Result = Reading + Correct Factor
Margin = Result – Limit
Correct Factor = Antenna Factor + Cable Loss – Amplifier Gain
Spurious emissions more than 20 dB below the limit were not reported.

BLE(2M) Mode

Above 1GHz

Horizontal

Frequency (MHz)	Reading (dBµV)	Correct Factor(dB/m)	Result (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Degree (°)	Remark
Low channel								
2390.000	55.68	-10.23	45.45	74.00	-28.55	118	206	peak
2390.000	45.18	-10.23	34.95	54.00	-19.05	118	206	AVG
2401.600	108.09	-10.14	97.95	N/A	N/A	118	206	peak
2401.600	106.33	-10.14	96.19	N/A	N/A	118	206	AVG
4804.000	51.90	-3.28	48.62	74.00	-25.38	150	289	peak
4804.000	41.76	-3.28	38.48	54.00	-15.52	150	289	AVG
7206.000	45.14	3.10	48.24	74.00	-25.76	150	147	peak
7206.000	32.97	3.10	36.07	54.00	-17.93	150	147	AVG
Middle channel								
2390.000	55.42	-10.23	45.19	74.00	-28.81	135	204	peak
2390.000	44.78	-10.23	34.55	54.00	-19.45	135	204	AVG
2439.954	107.48	-9.82	97.66	N/A	N/A	135	204	peak
2439.954	105.68	-9.82	95.86	N/A	N/A	135	204	AVG
2483.500	55.43	-9.26	46.17	74.00	-27.83	135	204	peak
2483.500	44.43	-9.26	35.17	54.00	-18.83	135	204	AVG
4880.000	50.41	-3.03	47.38	74.00	-26.62	150	119	peak
4880.000	38.77	-3.03	35.74	54.00	-18.26	150	119	AVG
7320.000	45.71	4.07	49.78	74.00	-24.22	150	150	peak
7320.000	33.05	4.07	37.12	54.00	-16.88	150	150	AVG
High channel								
2480.086	107.97	-9.31	98.66	N/A	N/A	117	208	peak
2480.086	106.19	-9.31	96.88	N/A	N/A	117	208	AVG
2483.500	60.37	-9.26	51.11	74.00	-22.89	117	208	peak
2483.500	49.46	-9.26	40.20	54.00	-13.80	117	208	AVG
4960.000	50.08	-2.69	47.39	74.00	-26.61	150	176	peak
4960.000	40.47	-2.69	37.78	54.00	-16.22	150	176	AVG
7440.000	44.16	4.25	48.41	74.00	-25.59	150	318	peak
7440.000	31.79	4.25	36.04	54.00	-17.96	150	318	AVG

Result = Reading + Correct Factor
Margin = Result – Limit
Correct Factor = Antenna Factor + Cable Loss – Amplifier Gain
Spurious emissions more than 20 dB below the limit were not reported.

Vertical

Frequency (MHz)	Reading (dBµV)	Correct Factor(dB/m)	Result (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Degree (°)	Remark
Low channel								
2390.000	55.51	-10.23	45.28	74.00	-28.72	112	205	peak
2390.000	44.73	-10.23	34.50	54.00	-19.50	112	205	AVG
2401.600	103.46	-10.14	93.32	N/A	N/A	112	205	Peak
2401.600	101.72	-10.14	91.58	N/A	N/A	112	205	AVG
4804.000	51.06	-3.28	47.78	74.00	-26.22	150	41	peak
4804.000	40.53	-3.28	37.25	54.00	-16.75	150	41	AVG
7206.000	46.44	3.10	49.54	74.00	-24.46	150	41	peak
7206.000	32.75	3.10	35.85	54.00	-18.15	150	41	AVG
Middle channel								
2390.000	55.78	-10.23	45.55	74.00	-28.45	106	202	peak
2390.000	44.64	-10.23	34.41	54.00	-19.59	106	202	AVG
2439.954	103.89	-9.82	94.07	N/A	N/A	106	202	peak
2439.954	102.11	-9.82	92.29	N/A	N/A	106	202	AVG
2483.500	55.39	-9.26	46.13	74.00	-27.87	106	202	peak
2483.500	44.47	-9.26	35.21	54.00	-18.79	106	202	AVG
4880.000	48.34	-3.03	45.31	74.00	-28.69	150	253	peak
4880.000	37.42	-3.03	34.39	54.00	-19.61	150	253	AVG
7320.000	44.38	4.07	48.45	74.00	-25.55	150	26	peak
7320.000	33.04	4.07	37.11	54.00	-16.89	150	26	AVG
High channel								
2480.004	102.15	-9.31	92.84	N/A	N/A	111	218	peak
2480.004	100.34	-9.31	91.03	N/A	N/A	111	218	AVG
2483.500	56.33	-9.26	47.07	74.00	-26.93	111	218	peak
2483.500	46.57	-9.26	37.31	54.00	-16.69	111	218	AVG
4960.000	50.51	-2.69	47.82	74.00	-26.18	150	90	peak
4960.000	39.05	-2.69	36.36	54.00	-17.64	150	90	AVG
7440.000	43.36	4.25	47.61	74.00	-26.39	150	106	peak
7440.000	32.15	4.25	36.40	54.00	-17.60	150	106	AVG

Result = Reading + Correct Factor
Margin = Result – Limit
Correct Factor = Antenna Factor + Cable Loss – Amplifier Gain
Spurious emissions more than 20 dB below the limit were not reported.

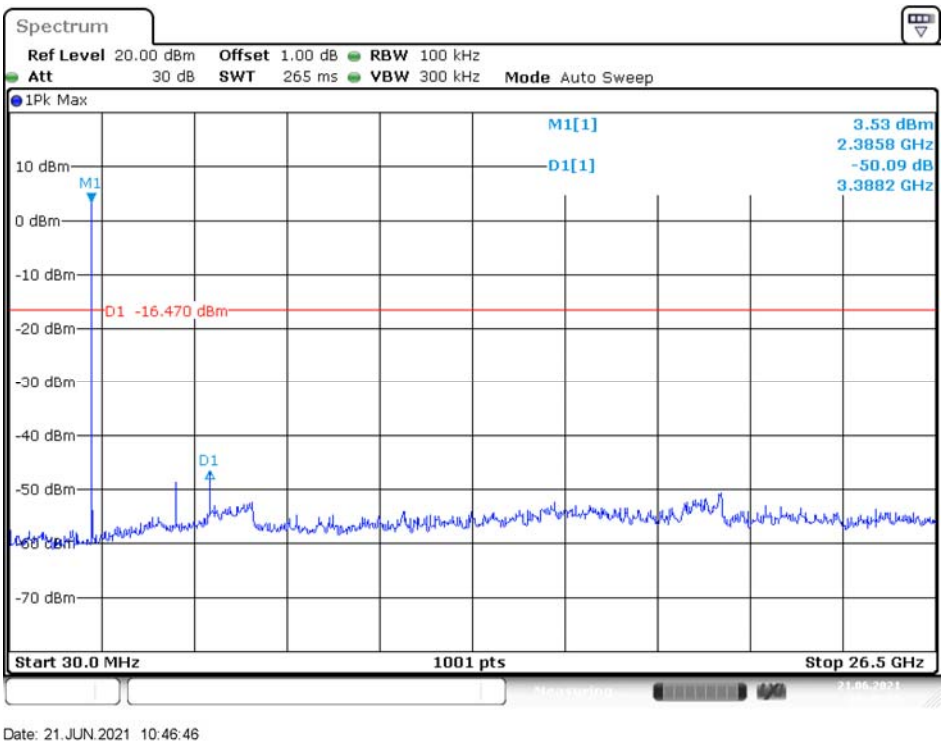
Conducted Spurious Emissions:

Channel	Frequency (MHz)	Delta Peak to Band Emission (dBc)	Limit (dBc)	Result
BLE(1M) Mode				
Low	2402	50.09	≥ 20	PASS
Mid	2441	50.52	≥ 20	PASS
High	2480	51.81	≥ 20	PASS
BLE(2M) Mode				
Low	2402	52.69	≥ 20	PASS
Mid	2441	50.84	≥ 20	PASS
High	2480	48.51	≥ 20	PASS

Please refer to the following plots

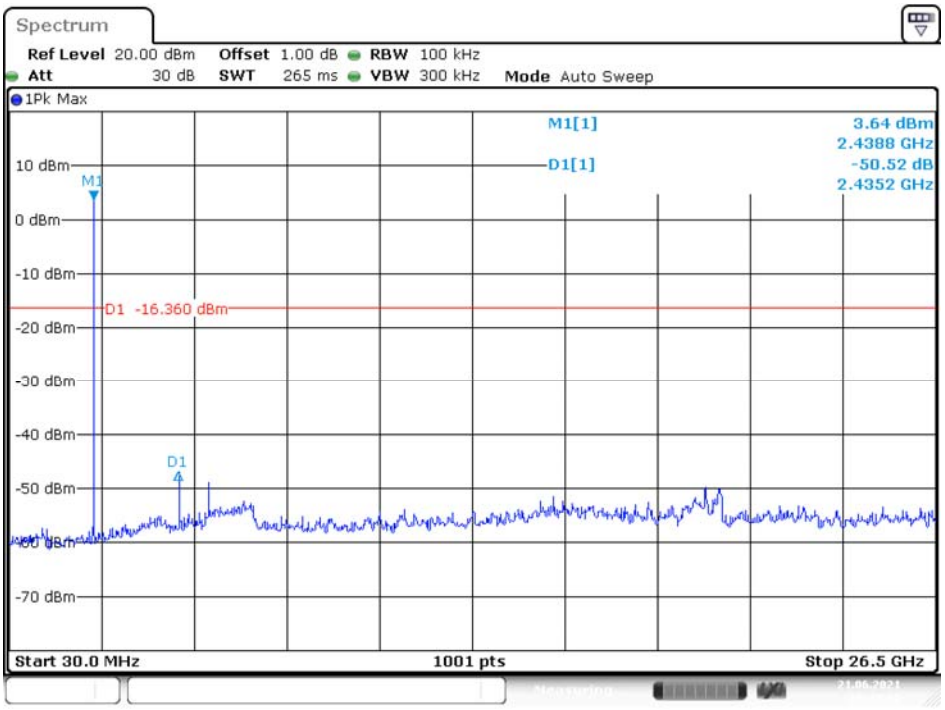
BLE(1M) Mode

Low Channel



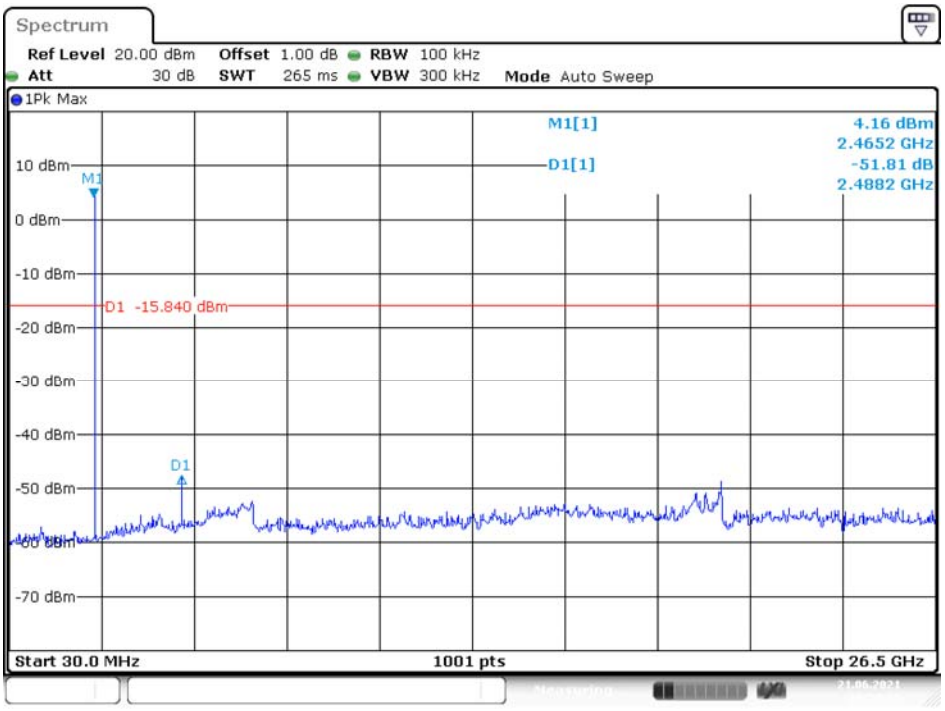
Date: 21.JUN.2021 10:46:46

Middle Channel



Date: 21.JUN.2021 10:48:48

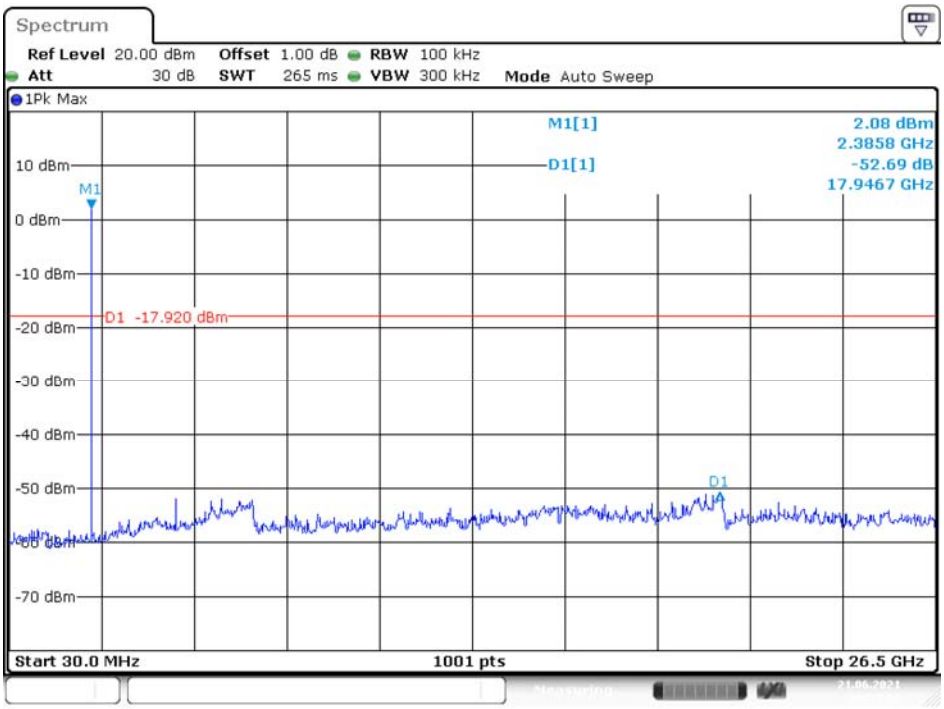
High Channel



Date: 21.JUN.2021 10:50:33

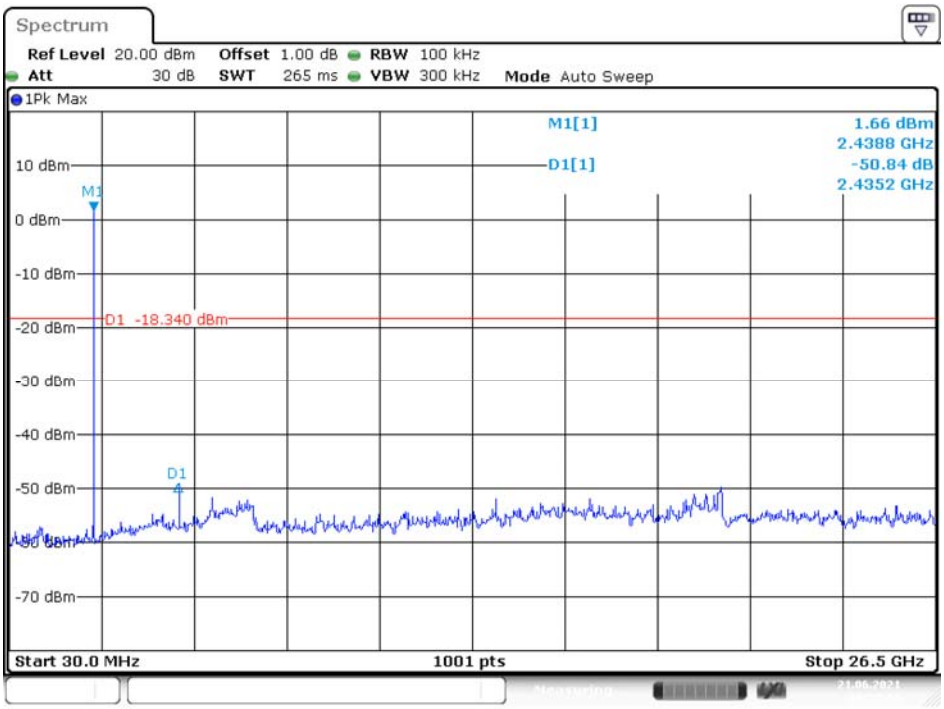
BLE(2M) Mode

Low Channel



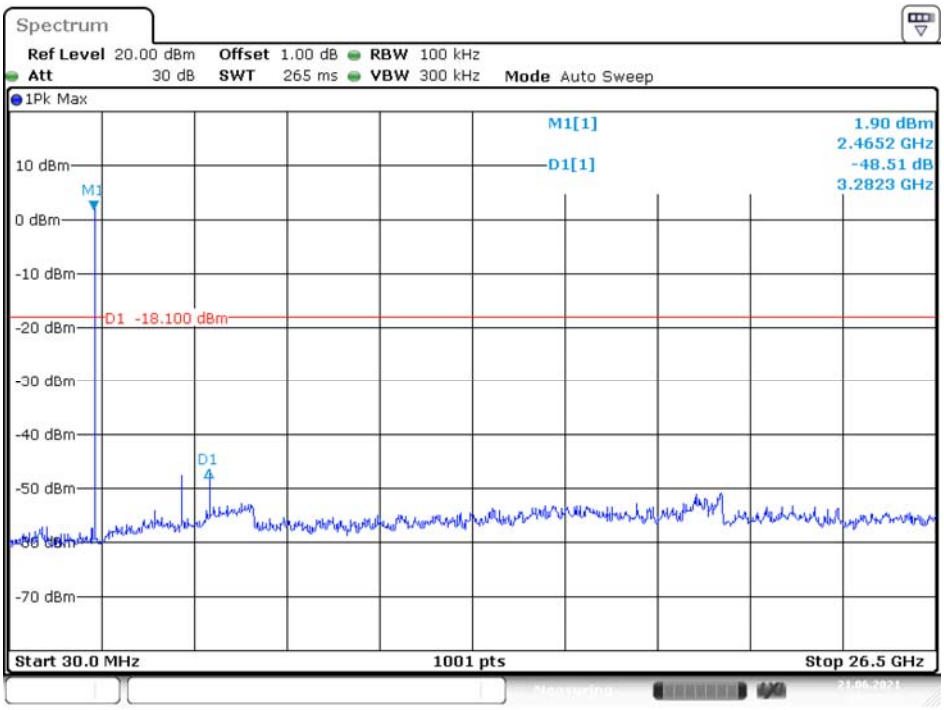
Date: 21.JUN.2021 10:55:19

Middle Channel



Date: 21.JUN.2021 10:57:13

High Channel



Date: 21.JUN.2021 10:58:46

9 FCC §15.247(a)(2) – 6 dB Emission Bandwidth

9.1 Applicable Standard

According to FCC §15.247(a)(2).

Systems using digital modulation techniques may operate in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

9.2 Test Procedure

The steps for the first option are as follows:

a) Set RBW = 100 kHz.

b) Set the VBW ≥ [3 × RBW].

c) Detector = peak.

d) Trace mode = max hold.

e) Sweep = auto couple.

f) Allow the trace to stabilize.

g) Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

9.3 Environmental Conditions

Temperature:	23.8 ℃
Relative Humidity:	54 %
ATM Pressure:	1010 hPa

The testing was performed by David Hsu on 2021-06-21.

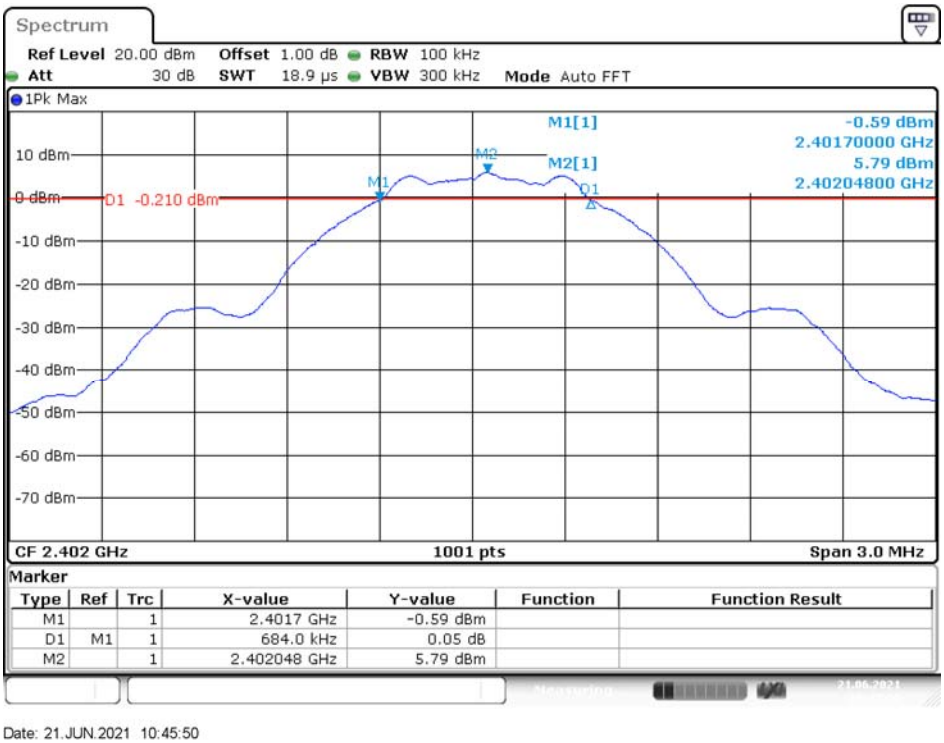
9.4 Test Results

Channel	Frequency (MHz)	6 dB Emission Bandwidth (kHz)	Limit (kHz)	Result
BLE(1M) Mode				
Low	2402	684	> 500	Compliance
Middle	2440	696	> 500	Compliance
High	2480	702	> 500	Compliance
BLE(2M) Mode				
Low	2402	1149	> 500	Compliance
Middle	2440	1155	> 500	Compliance
High	2480	1155	> 500	Compliance

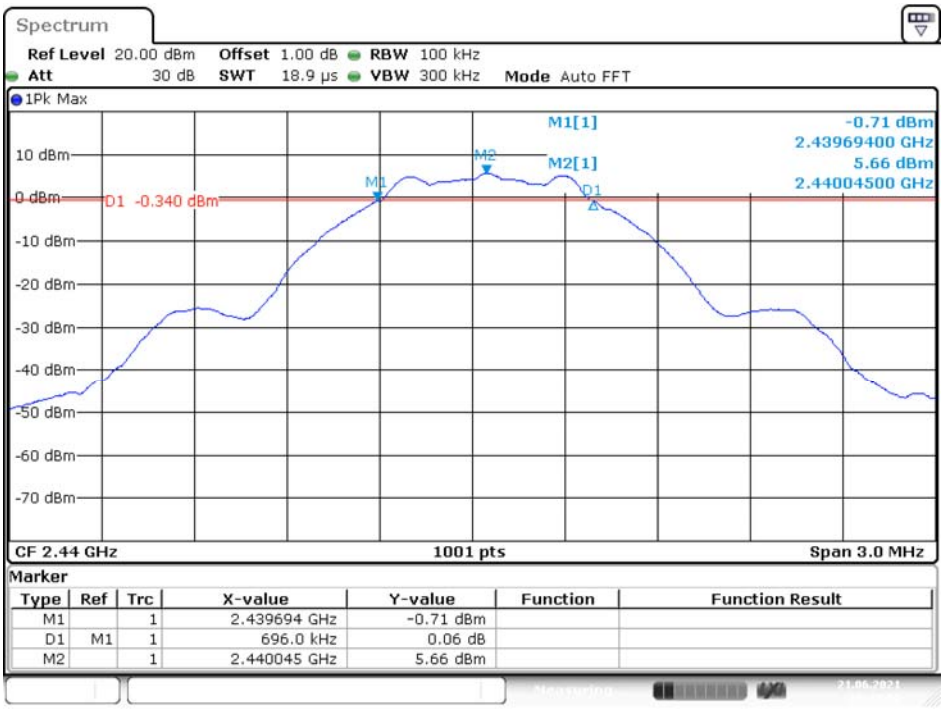
Please refer to the following plots

BLE(1M) Mode

Low Channel



Middle Channel



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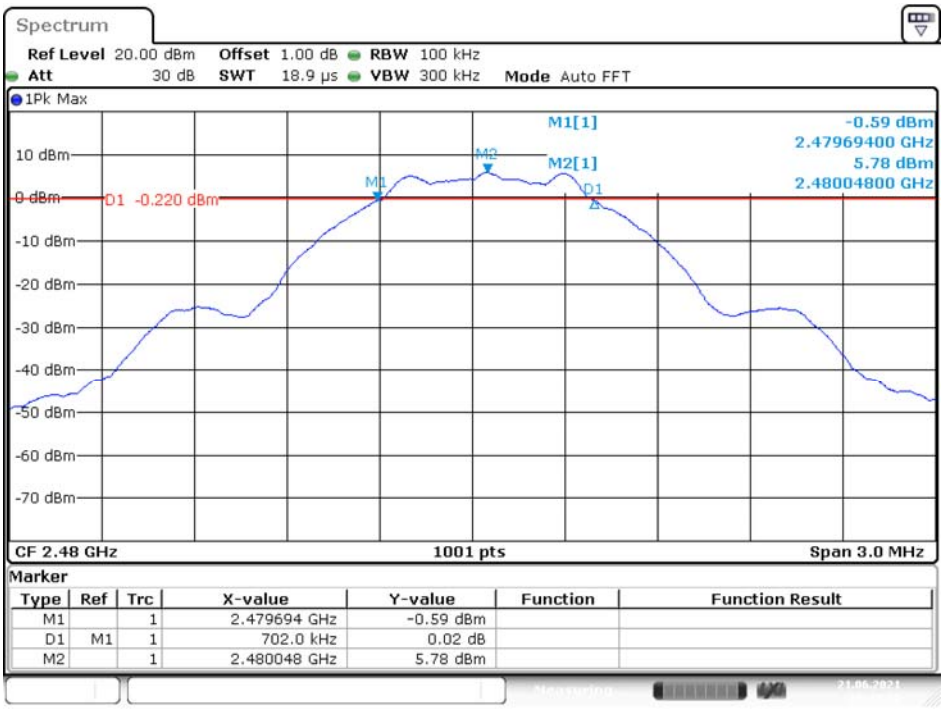
High Channel



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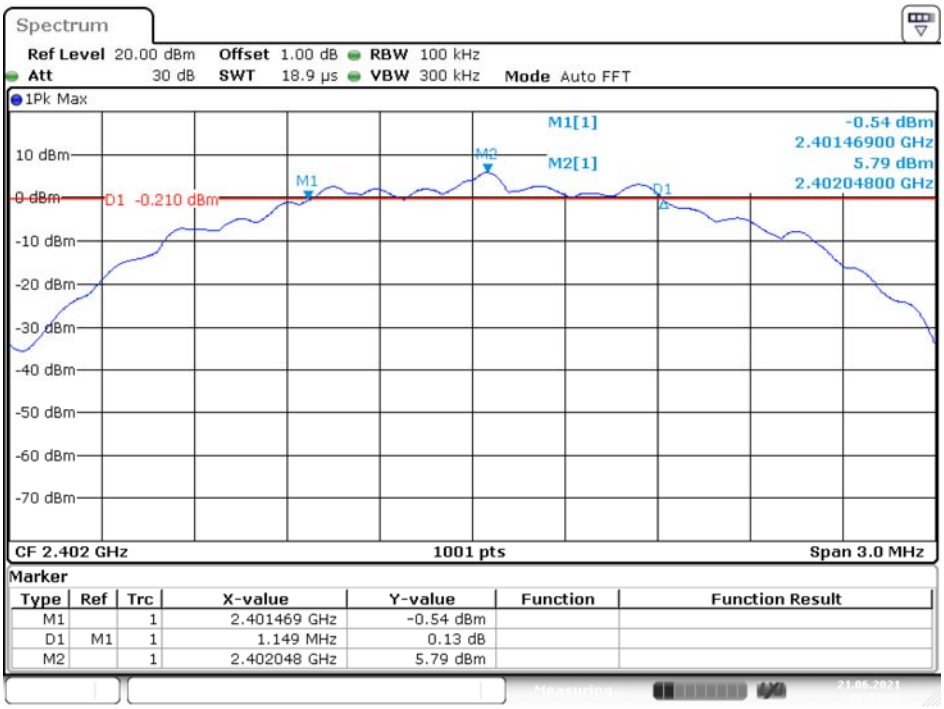
BLE(2M) Mode

Low Channel



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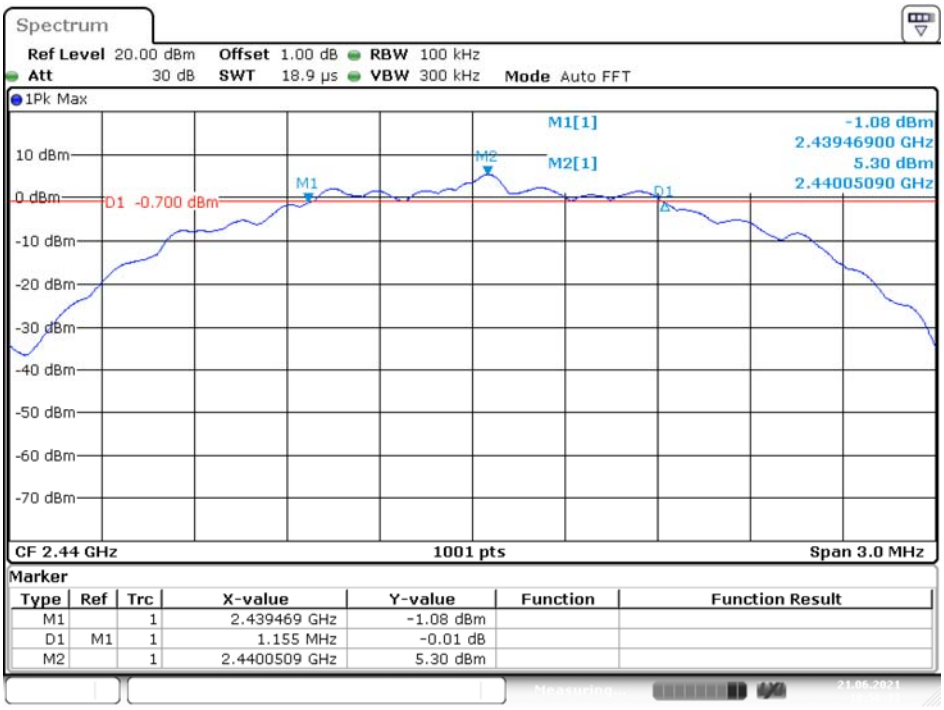
Middle Channel



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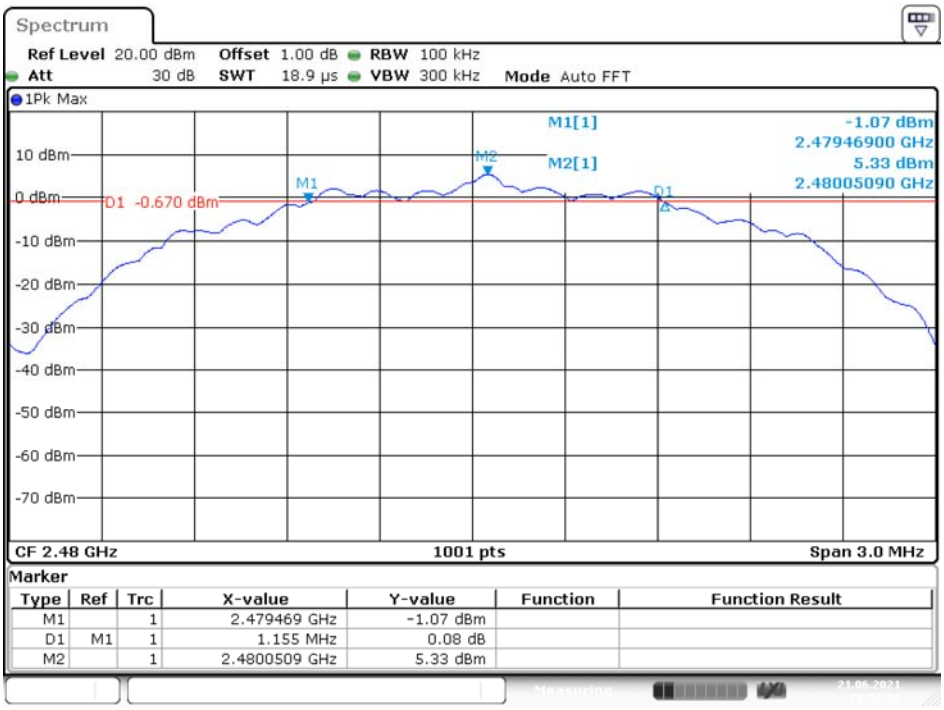
High Channel



10 FCC §15.247(b)(3) – Maximum Output Power

10.1 Applicable Standard

According to FCC §15.247(b) (3).

Systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the maximum conducted output power is the highest total transmit power occurring in any mode.

10.2 Test Procedure

1. Place the EUT on a bench and set it in transmitting mode.

2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to measuring equipment.

10.3 Environmental Conditions

Temperature:	23.8 ℃
Relative Humidity:	54 %
ATM Pressure:	1010 hPa

The testing was performed by David Hsu on 2021-06-21.

10.4 Test Results

Channel	Frequency	Maximum peak Conducted Output Power		Limit	Result
	(MHz)	(dBm)	(W)	(W)	
BLE(1M) Mode					
Low	2402	6.65	0.005	1	PASS
Middle	2440	6.46	0.004	1	PASS
High	2480	6.58	0.005	1	PASS
BLE(2M) Mode					
Low	2402	6.38	0.004	1	PASS
Middle	2440	6.22	0.004	1	PASS
High	2480	6.85	0.005	1	PASS
Channel	**Frequency**	**Average Conducted Output Power**		**Limit**	**Result**
	(MHz)	**(dBm)**	**(W)**	**(W)**	
BLE(1M) Mode					
Low	2402	6.54	0.005	N/A	PASS
Middle	2440	6.21	0.004	N/A	PASS
High	2480	6.32	0.004	N/A	PASS
BLE(2M) Mode					
Low	2402	6.05	0.004	N/A	PASS
Middle	2440	5.95	0.004	N/A	PASS
High	2480	6.57	0.005	N/A	PASS

11 FCC§15.247(d) – 100 kHz Bandwidth of Frequency Band Edge

11.1 Applicable Standard

According to FCC §15.247(d).

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is 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. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

11.2 Test Procedure

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.

2. Position the EUT without connection to measurement instrument. Turn on the EUT and connect its antenna terminal to measurement instrument via a low loss cable. Then set it to any one measured frequency within its operating range, and make sure the instrument is operated in its linear range.

3. Set RBW to 100 kHz and VBW of spectrum analyzer to 300 kHz with a convenient frequency span including 100 kHz bandwidth from band edge.

4. Measure the highest amplitude appearing on spectral display and set it as a reference level. Plot the graph with marking the highest point and edge frequency.

5. Repeat above procedures until all measured frequencies were complete.

11.3 Environmental Conditions

Temperature:	23.8 ℃
Relative Humidity:	54 %
ATM Pressure:	1010 hPa

The testing was performed by David Hsu on 2021-06-21.

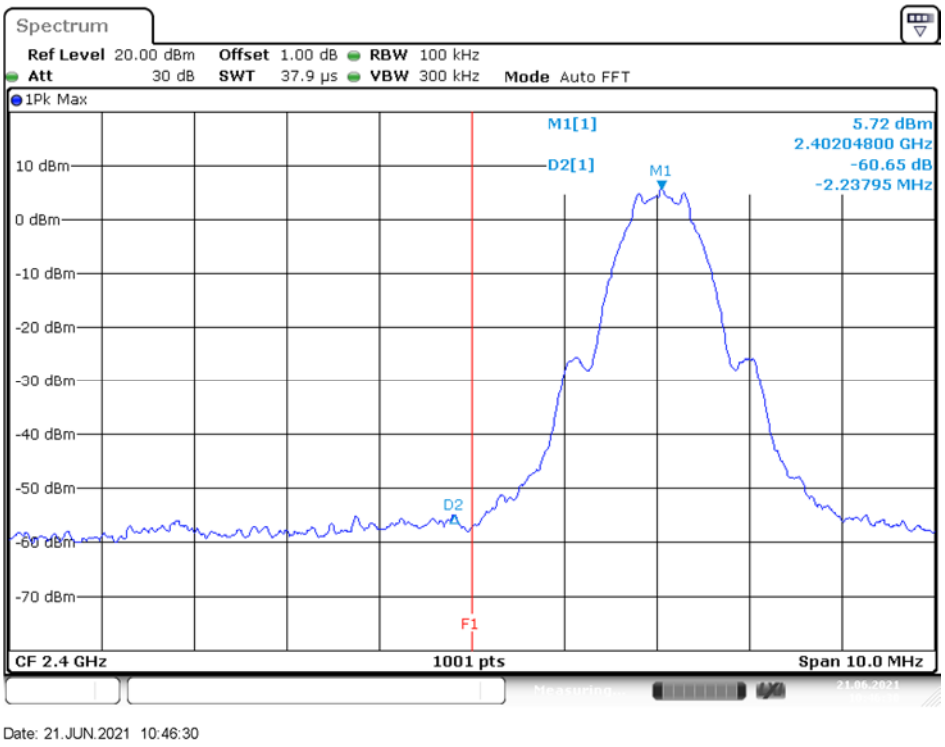
11.4 Test Results

Channel	Frequency (MHz)	Delta Peak to Band Emission (dBc)	Limit (dBc)	Result
BLE(1M) Mode				
Low	2402	60.65	≥ 20	PASS
High	2480	61.55	≥ 20	PASS
BLE(2M) Mode				
Low	2402	36.20	≥ 20	PASS
High	2480	60.58	≥ 20	PASS

Please refer to the following plots

BLE(1M) Mode

Band Edge, Left Side



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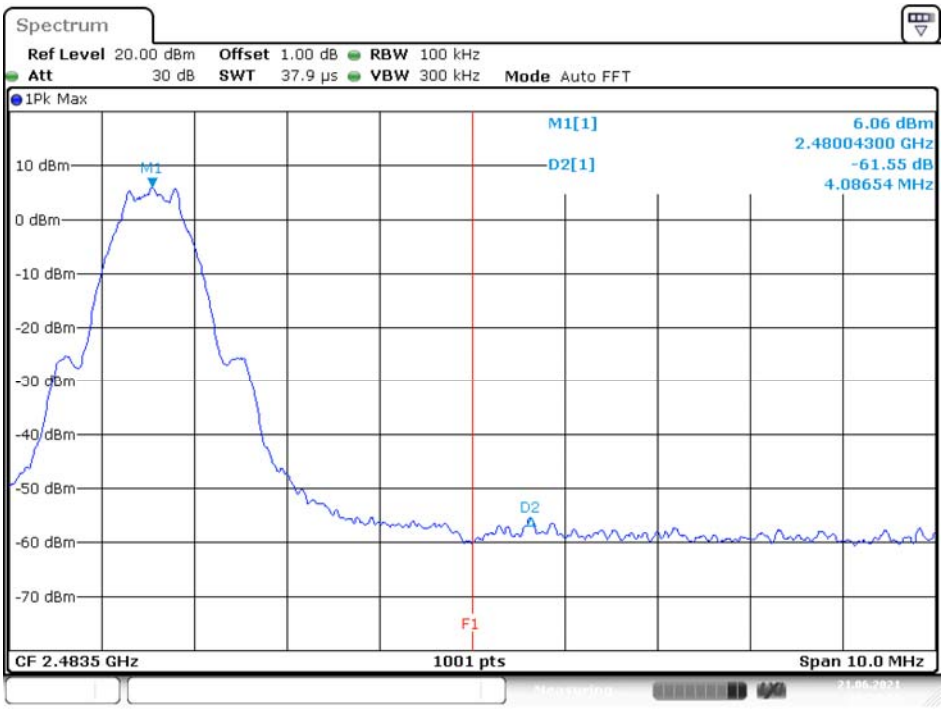
Band Edge, Right Side



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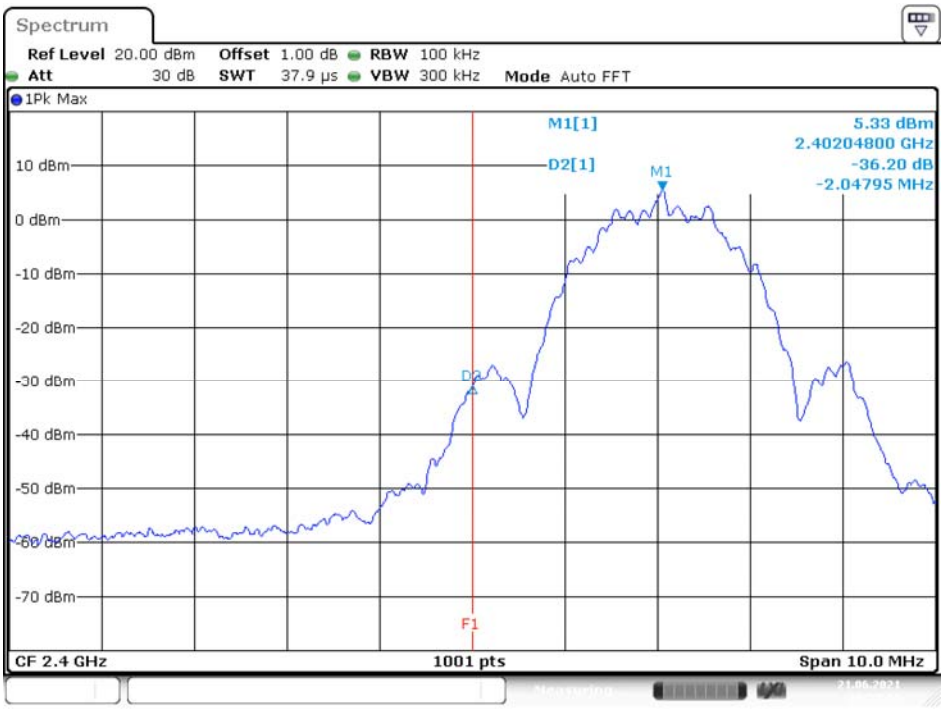
BLE(2M) Mode

Band Edge, Left Side



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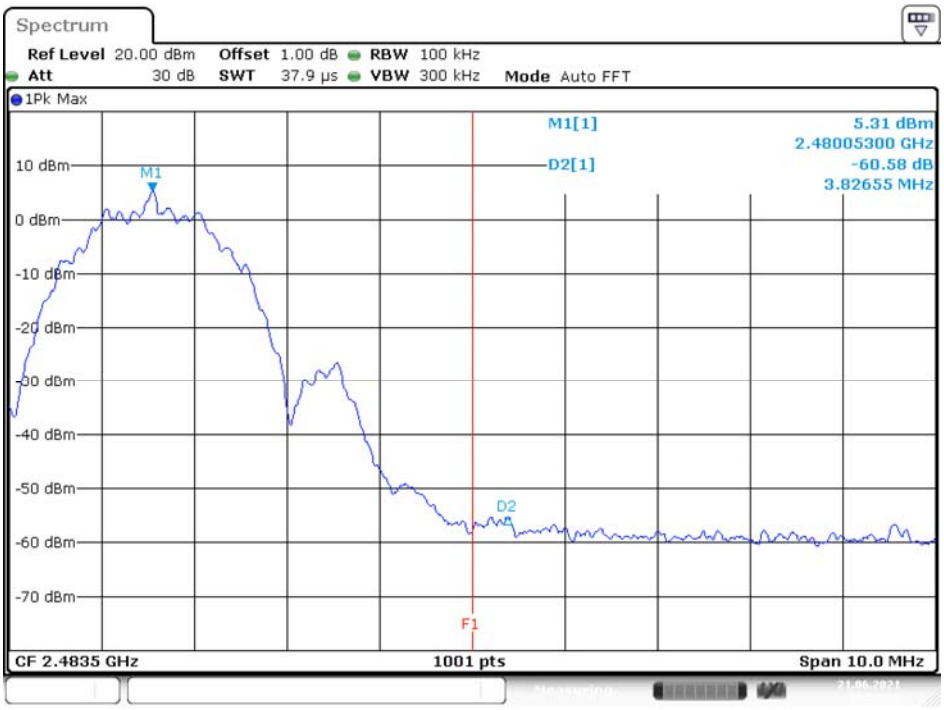
Band Edge, Right Side



12 FCC §15.247(e) – Power Spectral Density

12.1 Applicable Standard

According to FCC §15.247(e).

For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

12.2 Test Procedure

According to ANSI C63.10-2013

a) Set analyzer center frequency to DTS channel center frequency.

b) Set the span to 1.5 times the DTS bandwidth.

c) Set the RBW to 3 kHz ≤ RBW ≤ 100 kHz.

d) Set the VBW ≥ [3 × RBW].

e) Detector = peak.

f) Sweep time = auto couple.

g) Trace mode = max hold.

h) Allow trace to fully stabilize.

i) Use the peak marker function to determine the maximum amplitude level within the RBW.

j) If measured value exceeds requirement, then reduce RBW (but no less than 3 kHz) and repeat

12.3 Environmental Conditions

Temperature:	23.8 ℃
Relative Humidity:	54 %
ATM Pressure:	1010 hPa

The testing was performed by David Hsu on 2021-06-21.

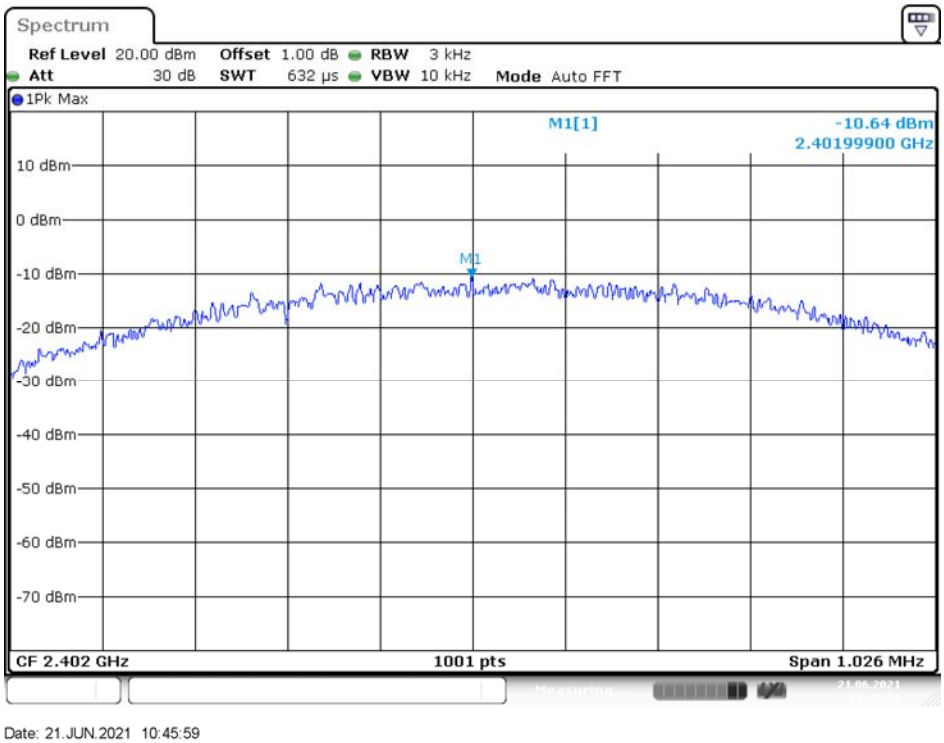
12.4 Test Results

Channel	Frequency (MHz)	Power Spectral Density (dBm/3 kHz)	Limit (dBm/3 kHz)	Result
BLE(1M) Mode				
Low	2402	-10.64	8	Compliance
Middle	2440	-9.94	8	Compliance
High	2480	-8.76	8	Compliance
BLE(2M) Mode				
Low	2402	-11.66	8	Compliance
Middle	2440	-12.86	8	Compliance
High	2480	-12.46	8	Compliance

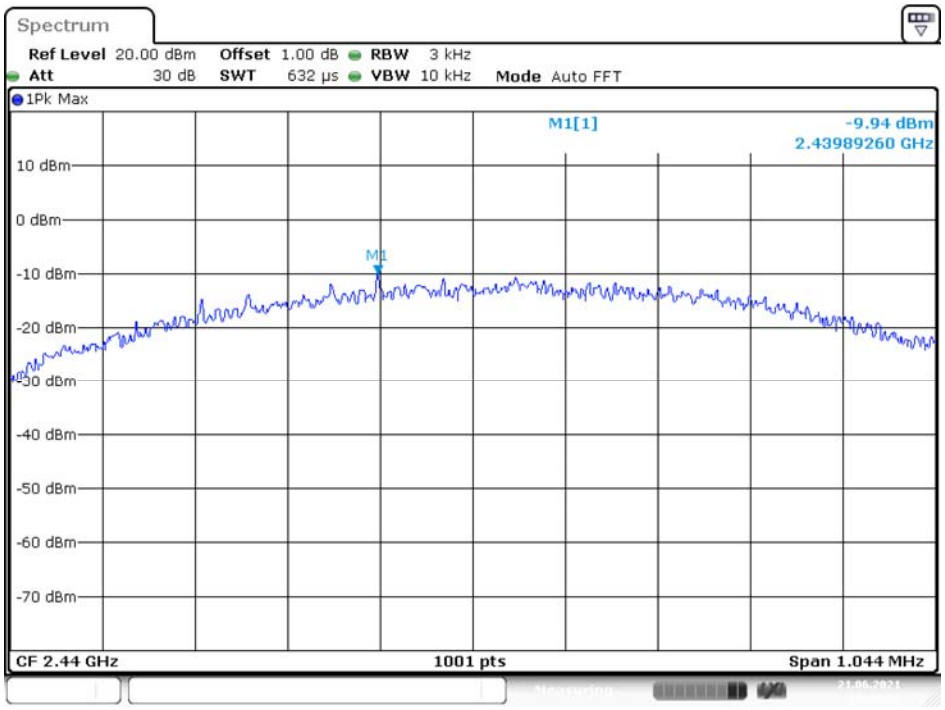
Please refer to the following plots

BLE(1M) Mode

Low Channel



Middle Channel



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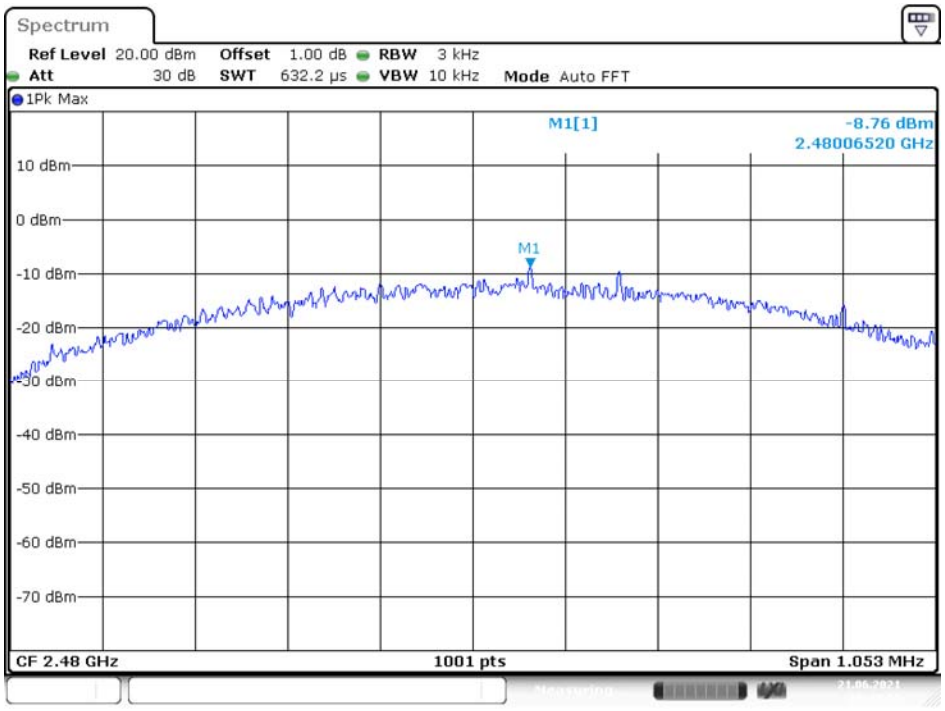
High Channel



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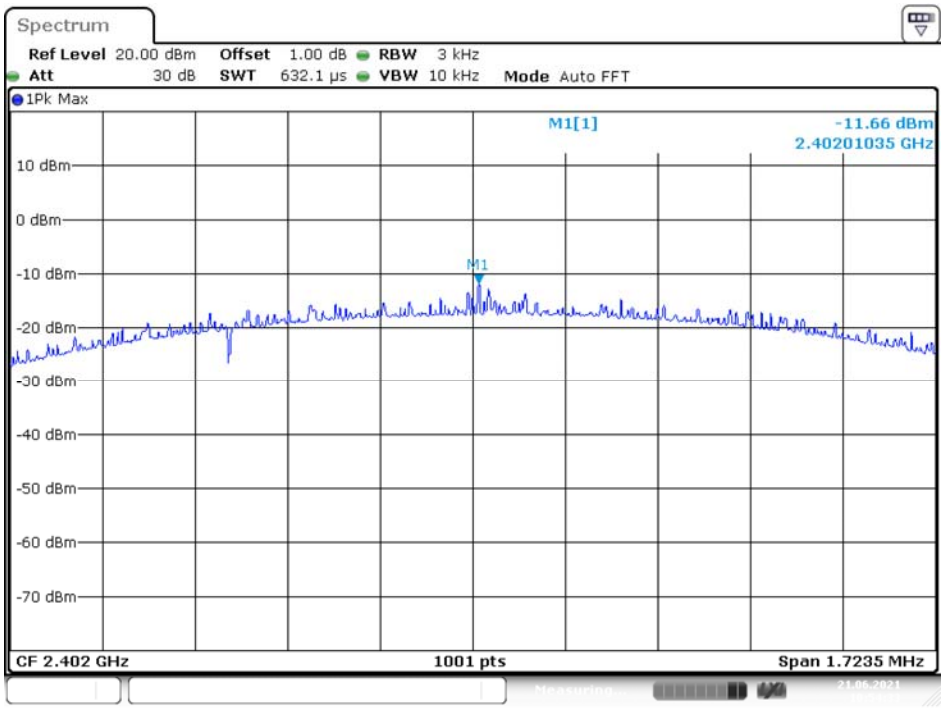
BLE(2M) Mode

Low Channel



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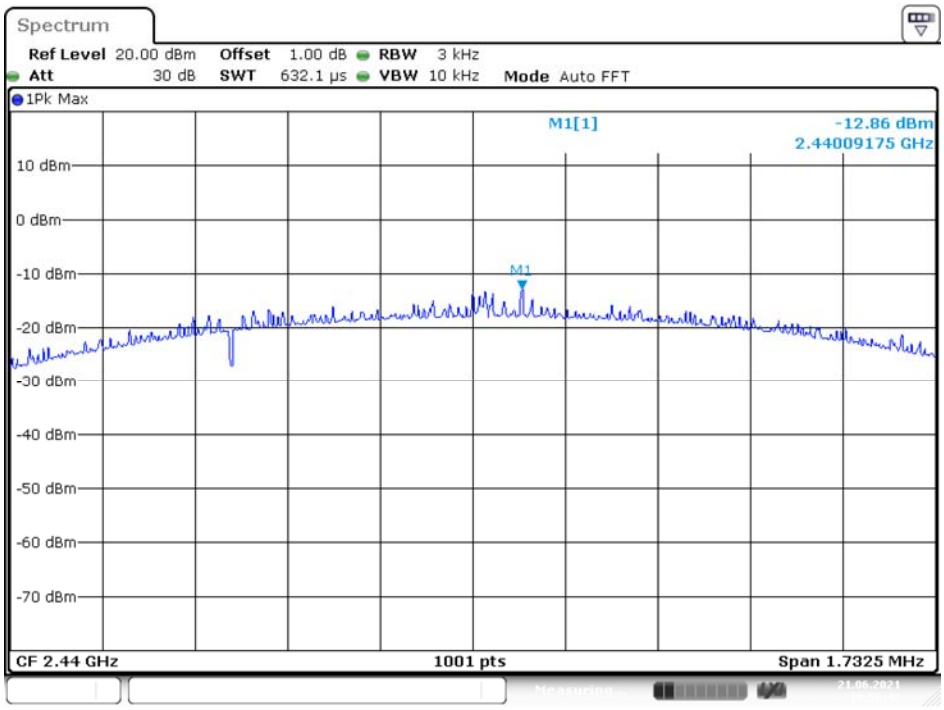
Middle Channel



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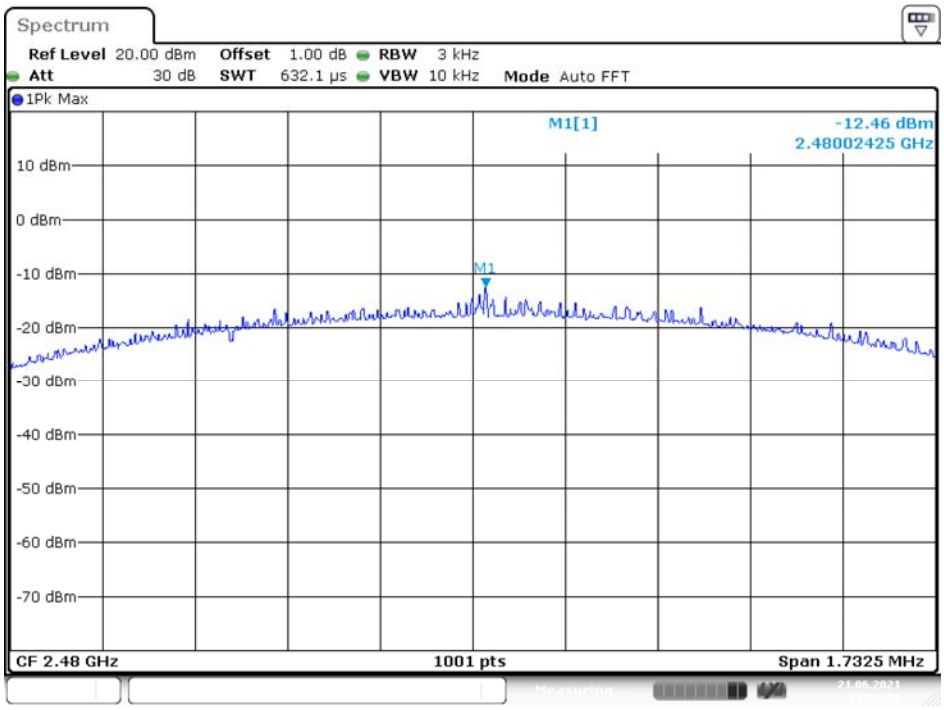
High Channel



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